

CITY OF CERES

# Water Master Plan Report





# Water Master Plan

---

Prepared for  
**City of Ceres**

June 2011



---

Gerry Nakano





## Table of Contents

---

### Executive Summary

ES 1.1 Purpose of the Water Master Plan .....	ES-1
ES 1.2 Overview of the Water Service Area (Chapter 2) .....	ES-1
ES 1.3 Existing and Projected Water Demands (Chapter 3) .....	ES-2
ES 1.3.1 Existing Water Demands.....	ES-2
ES 1.3.2 Compliance with 20 x 2020 Legislation.....	ES-3
ES 1.3.3 Future Water Demands.....	ES-3
ES 1.4 Existing and Projected Water Supplies (Chapter 4) .....	ES-4
ES 1.4.1 Existing Water Supply .....	ES-4
ES 1.4.2 Future Water Supply - Integrated Water Supply Plan.....	ES-4
ES 1.5 Evaluation of Existing and Future Water System (Chapters 5, 6, 7) .....	ES-5
ES 1.5.1 Existing Water System Evaluation and Recommended Improvements.....	ES-5
ES 1.5.1.1 Future Water System Evaluation and Recommended Improvements .....	ES-5
ES 1.5.2 Recommended Capital Improvement Program (Chapter 8) .....	ES-6

### Chapter 1. Introduction

1.1 Water System Master Plan Purpose .....	1-1
1.2 Authorization.....	1-1
1.3 Report Organization .....	1-1
1.4 Acronyms and Abbreviations.....	1-2
1.5 Acknowledgments .....	1-4

### Chapter 2. Existing Water System

2.1 Existing Service Area and Study Area .....	2-1
2.2 Existing Service Connections and Population Served .....	2-1
2.3 Existing Water Supplies.....	2-2
2.3.1 Groundwater .....	2-2
2.3.2 Surface Water .....	2-2
2.3.3 Non-Potable Water.....	2-2
2.3.4 Recycled Water.....	2-2
2.4 Existing Water System Facilities .....	2-3
2.4.1 Groundwater Wells.....	2-3
2.4.2 Water Distribution System & Storage and Pumping Facilities .....	2-5
2.4.2.1 Water Pipelines .....	2-5
2.4.2.2 Treated Water Storage Facilities .....	2-6
2.4.2.3 Booster Pump Station.....	2-6
2.4.3 Backup Power Provisions .....	2-7
2.4.4 SCADA System.....	2-7

### Chapter 3. Existing and Future Demands

3.1 Overview.....	3-1
3.2 Water Service Area Characteristics .....	3-1
3.2.1 Existing Number of Services.....	3-2
3.2.2 Historical and Future Population.....	3-2



## Table of Contents

---

3.2.3 Summary of Existing and Projected Future Land Use.....	3-3
3.2.4 Existing and Potential Non-Potable Water Use Areas.....	3-6
3.3 Historical Water Production and Consumption.....	3-6
3.3.1 Historical Water Production .....	3-7
3.3.2 Historical Water Consumption .....	3-7
3.3.3 Historical Unaccounted for Water (UAFW) .....	3-8
3.3.4 Historical Per Capita Water Demand .....	3-9
3.4 Water Conservation .....	3-9
3.4.1 Existing Water Conservation.....	3-10
3.4.2 Compliance with 20 x 2020 Legislation .....	3-10
3.5 Adopted Peaking Factors .....	3-11
3.6 Water Demand Projections.....	3-12
3.6.1 Development of Unit Water Demand Factors .....	3-13
3.6.2 Adopted Unit Water Demand Factors .....	3-17
3.6.3 Estimated Savings from Metering of Residential Flat Accounts .....	3-17
3.6.4 Projected Future Water Demands .....	3-18
3.6.4.1 Comparison with the 2007 Model Update TM .....	3-20
3.6.4.2 Comparison of Land Use and Population Based Demand Projections.....	3-20
3.6.4.3 Recommended Water Master Plan Demand Projections.....	3-21

## Chapter 4. Integrated Water Supply Plan

4.1 Groundwater Supply.....	4-1
4.1.1 Groundwater Basin Description .....	4-1
4.1.1.1 Geology .....	4-1
4.1.1.2 Unconfined Aquifer .....	4-3
4.1.1.3 Confined Aquifer.....	4-3
4.1.1.4 Groundwater Flow Direction .....	4-3
4.1.2 Groundwater Levels.....	4-3
4.1.3 Groundwater Quality .....	4-4
4.1.3.1 Overview of Water Quality in the Turlock Subbasin.....	4-4
4.1.3.2 Groundwater Ambient Monitoring and Assessment Program .....	4-5
4.1.3.3 Local Groundwater Contamination .....	4-6
4.1.3.4 Water Quality Contaminants of Concern in City Wells.....	4-6
4.1.3.4.1 Nitrate.....	4-7
4.1.3.4.2 Uranium.....	4-8
4.1.3.4.3 Arsenic .....	4-8
4.1.3.4.4 Manganese .....	4-8
4.1.3.4.5 Specific Conductance .....	4-9
4.1.3.5 Recommended Groundwater Treatment Alternatives.....	4-11
4.1.4 Historical Groundwater Pumpage .....	4-12
4.1.4.1 Agricultural Groundwater Pumpage .....	4-13
4.1.4.2 Municipal Groundwater Pumpage .....	4-14
4.1.4.2.1 City of Ceres Groundwater Pumpage .....	4-14
4.1.4.2.2 Other Municipal Groundwater Pumpage .....	4-14
4.1.4.3 Private Groundwater Pumpage .....	4-14
4.1.5 Other Groundwater Outflows .....	4-14
4.1.6 Groundwater Recharge.....	4-15
4.1.7 Water Balance in the Turlock Subbasin.....	4-16
4.1.8 Groundwater Management .....	4-17



## Table of Contents

---

4.1.8.1 Turlock Groundwater Basin Association .....	4-17
4.1.8.2 Groundwater Management Plan .....	4-17
4.1.9 Groundwater Supply Conclusions.....	4-18
4.1.9.1 Groundwater Yield.....	4-18
4.1.9.2 Groundwater Quality.....	4-18
4.1.9.3 Recommendations for New Wells .....	4-19
4.2 Future Surface Water Supply .....	4-20
4.2.1 Surface Water Supplies from City of Modesto/Modesto Irrigation District.....	4-20
4.2.2 Surface Water Supplies from Turlock Irrigation District.....	4-20
4.3 Recycled Water Supply .....	4-22
4.3.1 Current Recycled Water Use .....	4-22
4.3.2 Future Recycled Water Use.....	4-22
4.4 Recommended Integrated Water Supply Plan.....	4-22
4.4.1 Potential Future Supply Scenarios.....	4-22
4.4.1.1 Scenario 1: Groundwater Only .....	4-23
4.4.1.2 Scenario 2: Groundwater Plus Treated Surface Water.....	4-26
4.4.2 Findings and Recommendations .....	4-28

## Chapter 5. System Performance and Operational Criteria

5.1 Overview.....	5-1
5.2 General Water System Reliability and Recommendations .....	5-1
5.2.1 Water Quality Standards.....	5-2
5.3 Fire Flow Requirements .....	5-2
5.4 Water System Capacity During High Demand Periods.....	5-4
5.4.1 Maximum Day Demand .....	5-4
5.4.2 Maximum Day Demand plus Fire Flow .....	5-4
5.4.3 Peak Hour Demand.....	5-4
5.5 Pumping Facility Capacity .....	5-5
5.6 Treated Water Storage Capacity .....	5-5
5.6.1 Operational Storage .....	5-5
5.6.2 Fire Storage .....	5-6
5.6.3 Emergency Storage .....	5-6
5.6.4 Groundwater Storage Credit .....	5-7
5.6.5 Total Storage Capacity Recommended.....	5-7
5.7 Water Transmission and Distribution Pipeline Sizing and Recommended System Pressures .....	5-8
5.7.1 Water Transmission System .....	5-8
5.7.1.1 Average Day Demand .....	5-8
5.7.1.2 Maximum Day Demand .....	5-8
5.7.1.3 Peak Hour Demand.....	5-9
5.7.2 Water Distribution System .....	5-9
5.7.3 Average Day Demand.....	5-9
5.7.3.1 Maximum Day Demand plus Fire Flow .....	5-9
5.7.3.2 Peak Hour Demand .....	5-9



## Table of Contents

---

### Chapter 6. Evaluation of Existing Water System

6.1 Existing Water Demands .....	6-1
6.2 Existing Water System Facility Evaluation .....	6-2
6.2.1 Maximum Supply Capacity .....	6-2
6.2.2 Water Storage Capacity .....	6-3
6.2.3 Peak Pumping Capacity .....	6-5
6.3 Hydraulic Model Update and Verification .....	6-6
6.3.1 Existing Hydraulic Model Description .....	6-6
6.3.2 Review of Existing Water System Facilities .....	6-6
6.3.3 Model Demand Allocation .....	6-7
6.3.4 Hydraulic Model Verification .....	6-7
6.4 Existing Water System Performance Evaluation .....	6-10
6.4.1 Existing Water System Performance Criteria .....	6-10
6.4.1.1 Peak Hour Demand Scenario .....	6-10
6.4.1.2 Maximum Day Demand plus Fire Flow Scenario .....	6-10
6.4.1.3 Recommended Improvements Criteria .....	6-11
6.4.2 Existing Water System Evaluation Results .....	6-11
6.4.2.1 Peak Hour Demand Scenario .....	6-11
6.4.2.2 Maximum Day Demand plus Fire Flow Scenario .....	6-12
6.5 Summary of Recommended Improvements for the Existing Water System .....	6-13
6.5.1 Pipelines .....	6-13
6.5.2 Distribution System Programs .....	6-14
6.5.3 Wells .....	6-14
6.5.4 Backup Power .....	6-14
6.5.5 Storage Reservoir and Booster Pump Station .....	6-14

### Chapter 7. Evaluation of Future Water System

7.1 Future Water Demands .....	7-1
7.2 Future Water System Facility and Network Assumptions .....	7-2
7.2.1 West Landing Specific Plan Facilities .....	7-2
7.2.2 RSWSP .....	7-3
7.3 Future Water System Facility Evaluation .....	7-3
7.3.1 Maximum Supply Capacity .....	7-3
7.3.2 Water Storage Capacity .....	7-4
7.3.3 Peak Pumping Capacity .....	7-6
7.4 Future Water System Performance Evaluation .....	7-7
7.4.1 Future Water System Performance Criteria .....	7-7
7.4.1.1 Peak Hour Demand Scenario .....	7-7
7.4.1.2 Maximum Day Demand plus Fire Flow Scenario .....	7-8
7.4.1.3 Recommended Improvements Criteria .....	7-8
7.4.2 2015 Water System Evaluation Results .....	7-8
7.4.2.1 2015 Peak Hour Demand Scenario .....	7-8
7.4.2.2 2015 Maximum Day Demand plus Fire Flow Scenario .....	7-9
7.4.3 Buildout Water System Evaluation Results .....	7-9
7.4.3.1 Buildout Peak Hour Demand Scenario .....	7-9
7.4.3.2 Buildout Maximum Day Demand plus Fire Flow Scenario .....	7-10



## Table of Contents

---

7.5 Summary of Recommended Improvements for the Future Water System .....	7-12
7.5.1 Pipelines.....	7-12
7.5.1.1 2015 Time Frame .....	7-12
7.5.1.2 Buildout Time Frame .....	7-12
7.5.2 Wells .....	7-12
7.5.2.1 2015 Time Frame .....	7-12
7.5.2.2 Buildout Time Frame .....	7-12
7.5.3 Storage Reservoirs and Booster Pump Stations .....	7-14
7.5.3.1 2015 Time Frame .....	7-14
7.5.3.2 Buildout Time Frame .....	7-14

## Chapter 8. Recommended Capital Improvement Program

8.1 Overview.....	8-1
8.2 Recommended Potable Water System Capital Improvement Program.....	8-2
8.2.1 Water Supply Improvements.....	8-2
8.2.1.1 Existing Water Supply Improvements .....	8-2
8.2.1.2 Future Water Supply Improvements.....	8-5
8.2.1.2.1 2015 Time Frame.....	8-5
8.2.1.2.2 Buildout Time Frame.....	8-5
8.2.2 Water Distribution System Improvements .....	8-5
8.2.2.1 Existing Water Distribution System Improvements .....	8-5
8.2.2.2 Future Water Distribution System Improvements .....	8-6
8.2.3 Recommended Potable Water System CIP Costs .....	8-7
8.3 Capital Improvement Program Implementation.....	8-8

## List of Appendices

- Appendix A: City of Ceres Sewer Master Plan Existing and 1997 General Plan Growth Area Land Use, May 4, 2010
- Appendix B: Water Demand Assumptions and Calculations
- Appendix C: Wellhead Treatment Alternatives Evaluation Technical Memorandum, May 25, 2010
- Appendix D: Available Fire Flows for Existing Maximum Day Plus Fire Scenario
- Appendix E: Engineer's Report
- Appendix F: Cost Estimating Assumptions



## Table of Contents

---

### List of Tables

Table ES-1. Recommended Water Master Plan Demand Projections.....	ES-3
Table ES-2. Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP .....	ES-7
Table ES-3. Recommended Implementation Schedule for Improvements in the Master Plan CIP .....	ES-9
Table 2-1. City of Ceres Groundwater Well Information.....	2-4
Table 2-2. City of Ceres Treated Water Storage Facilities.....	2-6
Table 2-3. City of Ceres Reservoir Booster Pump Station Characteristics .....	2-6
Table 3-1. Summary of Existing Water Service Connections by Meter Size .....	3-2
Table 3-2. Historical and Projected Population .....	3-3
Table 3-3. Assumed Phasing of Future Development for Water Distribution System Master Plan.....	3-4
Table 3-4. Summary of Existing and Projected Future Land Use .....	3-5
Table 3-5. Historical Water Production (2000-2009) .....	3-7
Table 3-6. Historical Metered Water Consumption by Customer Class, million gallons/year .....	3-8
Table 3-7. Historical Per Capita Water Demand (2000-2009) .....	3-9
Table 3-8. Historical Maximum Day Peaking Factors .....	3-11
Table 3-9. Ceres Adopted Peaking Factors .....	3-12
Table 3-10. Unit Water Demand Factors Developed For Master Plan.....	3-15
Table 3-11. Low Density Residential Unit Water Demand Factor Calculation .....	3-16
Table 3-12. Adopted Unit Water Demand Factors .....	3-17
Table 3-13. Summary of Existing and Projected Water Demands and Production .....	3-19
Table 3-14. Calculated Per Capita Water Demand Using Land Use Based Water Demand Projections.....	3-20
Table 3-15. Recommended Water Master Plan Demand Projections .....	3-21
Table 4-1. Summary of Water Quality Concerns in City of Ceres Wells .....	4-10
Table 4-3. Average Annual Groundwater Pumpage in the Turlock Subbasin .....	4-13
Table 4-4. Proposed Participation and Share of Regional Surface Water Supply Project Costs .....	4-21
Table 4-5. Water Supply Scenario Cost Comparison.....	4-25
Table 4-6. Summary of Water Supply Scenario Advantages and Disadvantages .....	4-29
Table 5-1. Recommended Fire Flow Requirements.....	5-3
Table 5-2. Summary of Recommended Potable Water System Performance and Operational Criteria.....	5-10
Table 6-1. Baseline Water Demands for the Existing System Analysis .....	6-2
Table 6-2. Comparison of Overall City Required and Available Supply Capacity to Meet Maximum Day Demand .....	6-3
Table 6-3. Comparison of Available and Required Storage Capacity .....	6-4



## Table of Contents

---

Table 6-4. Evaluation of Total Firm Pumping Capacity to Meet Peak Hour Demand .....	6-5
Table 6-5. Comparison of Model and SCADA, June 25, 2009, 8 PM .....	6-9
Table 6-6. Existing System – Identified Fire Flow Improvements .....	6-13
Table 7-1. Water Demands for the Future System Analysis .....	7-2
Table 7-2. Comparison of Overall City Required and Available Supply Capacity to Meet Maximum Day Demand .....	7-4
Table 7-3. Comparison of Available and Required Storage Capacity .....	7-5
Table 7-4. Evaluation of Total Firm Pumping Capacity to Meet Peak Hour Demand .....	7-7
Table 7-5. Buildout System – Identified Fire Flow Improvements .....	7-11
Table 7-6. Future System Recommended Pipeline Improvements .....	7-13
Table 8-1 Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP .....	8-3
Table 8.2 Recommended Implementation Schedule for Improvements in the Master Plan CIP .....	8-9

## List of Figures

Figure ES-1. Existing and Proposed Service Areas .....	ES-11
Figure ES-2. Existing and Projected Annual Potable Water Production .....	ES-12
Figure ES-3. City of Ceres Future Supply vs. Demand (with Existing Groundwater Supply + Future RSWSP) .....	ES-13
Figure ES-4. Existing Water System .....	ES-14
Figure ES-5. Existing System Recommended Improvements .....	ES-15
Figure ES-6. Future Water System Recommended Improvements to Serve 2015 and Buildout .....	ES-16
Figure 2-1. Existing Water System .....	2-8
Figure 3-1. Existing and Proposed Service Areas .....	3-22
Figure 3-2. Existing Land Use .....	3-23
Figure 3-3. 2015 Land Use .....	3-24
Figure 3-4. Buildout Land Use .....	3-25
Figure 3-5. Historical Annual Water Production (2000-2009) .....	3-26
Figure 3-6. Historical Monthly Water Production (2005-2009) .....	3-27
Figure 3-7. Comparison of Historical Per Capita Water Demand, Production and Population .....	3-28
Figure 3-8. July 2009 Diurnal Curves .....	3-29
Figure 3-9. Methodology Used to Calculate Unit Water Demand Factors .....	3-14
Figure 3-10. Existing and Projected Annual Potable Water Production .....	3-30
Figure 4-1. Turlock Groundwater Subbasin Location & Boundary .....	4-30
Figure 4-2. East-West Cross-Section Showing Water Bearing Zones .....	4-31
Figure 4-3. Groundwater Movement Direction Within the Turlock Subbasin .....	4-32
Figure 4-4. Locations of Intermediate-Depth Monitoring Wells in the Turlock Subbasin .....	4-33



## Table of Contents

---

Figure 4-5. Hydrographs for Intermediate-Depth Monitoring Wells in the Turlock Subbasin.....	4-34
Figure 4-6. Historical Spring Groundwater Elevation Contours .....	4-35
Figure 4-7. Historical Spring Groundwater Elevations in DWR-Monitored Wells Near the City of Ceres .....	4-36
Figure 4-8. Historical Spring Groundwater Elevations in City of Ceres Wells.....	4-37
Figure 4-9. Nitrate Concentrations in City of Ceres Wells.....	4-38
Figure 4-10. Uranium Concentrations in City of Ceres Wells.....	4-39
Figure 4-11. Arsenic Concentrations in City of Ceres Wells .....	4-40
Figure 4-12. Manganese Concentrations in City of Ceres Wells .....	4-41
Figure 4-13. Specific Conductance Concentrations in City of Ceres Wells .....	4-42
Figure 4-14. City of Ceres Historical Annual Groundwater Production .....	4-43
Figure 4-15. Reduction in Firm Groundwater Pumping Capacity Over Time Due to Well Age .....	4-44
Figure 4-16. City of Ceres Historical and Projected Annual Potable Water Demand .....	4-45
Figure 4-17. City of Ceres Future Potable Water Supply vs. Demand (with only Existing Groundwater Supply) .....	4-46
Figure 4-18. City of Ceres Future Supply vs. Demand (with Existing Groundwater Supply + Future RSWSP) .....	4-47
Figure 6-1. Existing Water System.....	6-15
Figure 6-2. Existing System Peak Hour Pressures .....	6-16
Figure 6-3. Existing System Comparison of Available and Required Fire Flow.....	6-17
Figure 6-4. Existing System Available Fire Flow .....	6-18
Figure 6-5. Existing System Recommended Improvements .....	6-19
Figure 6-6. Existing System with Recommended Improvements - Peak Hour Pressures .....	6-20
Figure 7-1. Buildout Water System.....	7-15
Figure 7-2. 2015 System Peak Hour Pressures with Recommended Improvements.....	7-16
Figure 7-3. 2015 System Comparison of Available and Required Fire Flow .....	7-17
Figure 7-4. 2015 System Available Fire Flow.....	7-18
Figure 7-5. Buildout System Peak Hour Pressures.....	7-19
Figure 7-6. Buildout System Comparison of Available and Required Fire Flow .....	7-20
Figure 7-7. Buildout System Available Fire Flow.....	7-21
Figure 7-8. Future Water System Recommended Improvements.....	7-22
Figure 8-1. Recommended Existing Potable Water System CIP .....	8-11
Figure 8-2. Recommended Future Potable Water System CIP .....	8-12



## EXECUTIVE SUMMARY

---

### ES 1.1 PURPOSE OF THE WATER MASTER PLAN

This Water Master Plan for the City of Ceres (City) identifies strategies for maintaining adequate water supplies and service levels for the community; guides capital expenditures for the system; furnishes important guidance on operational issues; and charts a course for future updates to water rates. To accomplish these goals, the following work tasks were performed in the Water Master Plan:

- Evaluate and summarize existing water system and key system facilities, including an assessment of well condition and remaining useful life;
- Develop water demand projections through buildout;
- Evaluate existing and future water supplies to develop an integrated water supply strategy for the City to meet existing and future water demands;
- Develop performance and operational criteria under which the water system will be analyzed and future facilities will be formulated;
- Update and refine the distribution system hydraulic model;
- Evaluate existing, 2015 and buildout water system conditions to identify the City's water distribution system facility needs; and,
- Develop a capital improvement program for recommended existing and future water system facilities.

As part of the Water Master Plan, a financial analysis was also performed to evaluate conversion of residential flat rate users to metered use. The analysis guided the adoption of a new metered rate schedule to transition customers to metered billing and maintain water rate revenues. The new metered rate schedule will be implemented in September of 2011.

Each of the Water Master Plan work tasks is summarized in the following sections. Complete descriptions of the water system evaluations and recommendations are provided in the chapters and appendices of this Water Master Plan.

### ES 1.2 OVERVIEW OF THE WATER SERVICE AREA (CHAPTER 2)

The City is located in Stanislaus County, approximately 5 miles south of the City of Modesto and south of the Tuolumne River. The City's existing service area is approximately 4,860 acres, or about 7.6 square miles. While the existing water service area is generally contiguous with the City limit, there are some county pockets located in the northwest portion of the City that receive water service from the City of Modesto. The City also provides water service to a small number of customers who are located outside the current City limit.



## Executive Summary

---

The Water Master Plan Study Area (Study Area) is based on the City's current General Plan, which was adopted in 1997. The Study Area includes areas within the Primary and Secondary Spheres of Influence (SOIs), as well as some areas on the south and east side of the City that were designated within the General Plan, but fall outside of the SOIs. Figure ES-1 shows the boundaries for the Study Area, City limits, and Primary and Secondary SOIs.

The City currently provides water service to approximately 11,000 residential, commercial, industrial and institutional/governmental service connections. Almost all of the City's multi-family, commercial, industrial and institutional/governmental water services are metered and the City is currently implementing a meter installation program targeted at single-family residential customers (and other currently non-metered customers), which is anticipated to be completed by Spring 2011.

The current City population is approximately 42,000. During the late 1980's and early 1990's, the City experienced a surge in population growth and new housing development. Since 2000, the population of the City has increased approximately 25 percent, mainly as a result of development occurring in the eastern and southwestern portions of the City.

The City currently depends solely on groundwater to meet its customer water demands. Groundwater is pumped from fifteen active wells capable of producing a total of about 14,500 gallons per minute. Of these wells, four wells are estimated to be close to the end of their design useful life, requiring replacement within the next 10 years. Another five wells are estimated to require replacement within the next 20 years.

### **ES 1.3 EXISTING AND PROJECTED WATER DEMANDS (CHAPTER 3)**

#### **ES 1.3.1 Existing Water Demands**

Existing water demands for the City were determined based on historical water production and consumption data. Peaking factors for maximum day and peak hour demand were also developed based on historical production records. The following peaking factors were adopted for this Water Master Plan:

- Maximum Day Demand: 1.8 times Average Day Demand; and
- Peak Hour Demand: 2.9 times Average Day Demand.

Existing water system demands are based on the City's total water production from 2007 (10,823 af/yr or 9.7 mgd equivalent average daily demand). Water production data from 2007 was used instead of 2008 or 2009 data because it is more representative of normal water use within the City before the recent economic downturn and drought conditions, and provides a more conservative water demand estimate to account for typical water use patterns during normal hydrologic conditions. Existing maximum day demand is estimated to be 17.4 mgd. Peak hour demand is estimated to be 28.0 mgd.



## Executive Summary

### ES 1.3.2 Compliance with 20 x 2020 Legislation

On November 10, 2009, Governor Arnold Schwarzenegger signed Senate Bill x7-7 (SBx7-7) The Water Conservation Act of 2009, one of several bills passed as part of a comprehensive set of new Delta and water policy legislation. SBx7-7 requires a 20 percent reduction in urban water usage by 2020 and establishes four methodologies for urban water suppliers to establish their interim (2015) and final (2020) per capita water use targets.

Based on West Yost's evaluation of these four methods, West Yost recommended that the City adopt Method 1, which uses 10 and 20 percent reductions from historical baseline conditions to calculate its 2015 interim urban water use and 2020 final target urban water use. Under Method 1 the City's baseline water use would be calculated to be 243 gpcd. Therefore, the 2015 interim target would be 90 percent of 243 gpcd, or 219 gpcd and the 2020 final target would be 80 percent of 243 gpcd, or 194 gpcd. The City adopted these urban water use targets in a public hearing held as part of its regular City Council meeting on March 28, 2011.

### ES 1.3.3 Future Water Demands

Future water demands were calculated using a unit water demand methodology based on the additional land use areas to be developed. Total projected water demands for 2015 and buildout of the City's Study Area were calculated by multiplying the adopted unit water demand factors by the land use acreage projected to be served in 2015 and buildout, respectively. Water demand projections also take into account anticipated water savings from the conversion of residential flat rate to metered use, unaccounted for water, and other planned conservation programs.

Table ES-1 shows the recommended water use projections used for the Water Master Plan for the 2015 and buildout time frames. Figure ES-2 illustrates the existing and projected annual potable water production until buildout.

**Table ES-1. Recommended Water Master Plan Demand Projections**

Planning Horizon	Recommended Water Master Plan Projection, af/yr	Estimated Per Capita Water Use, gpcd	Notes
2015	10,700 <sup>(a)</sup>	219	Estimated per capita water use for compliance with SBx7-7
Buildout	19,800 <sup>(b)</sup>	183 <sup>(c)</sup>	Per capita water use less than SBx7-7 2020 water use target of 194 gpcd

<sup>(a)</sup> Based on a per capita water use of 219 gpcd and projected population of 43,600.  
<sup>(b)</sup> Based on projected buildout land uses.  
<sup>(c)</sup> Based on projected buildout population of 96,100.



## Executive Summary

### ES 1.4 EXISTING AND PROJECTED WATER SUPPLIES (CHAPTER 4)

#### ES 1.4.1 Existing Water Supply

Currently, the City's sole source of potable water is groundwater pumped from fifteen (15) active municipal supply wells which obtain water from the underlying Turlock Subbasin, which is part of the larger San Joaquin Valley Groundwater Basin. Several of the City's wells have water quality concerns and several wells are equipped with wellhead treatment systems to be able to provide a potable water supply which meets applicable drinking water standards.

Based on available data regarding the groundwater conditions in the Turlock Subbasin, it appears that historical and current conditions in the western portion of the Turlock Subbasin are relatively stable with respect to groundwater levels. This is an indication that groundwater operations in this part of the Turlock Subbasin are generally in balance, with current groundwater pumpage in this part of the Subbasin generally being balanced by groundwater recharge.

As such, the City's current average annual groundwater production of about 10,000 af/yr appears to be sustainable into the future. However, if the City's groundwater pumpage were to significantly increase in the future, it is unclear what the impacts to the Subbasin would be, if any. The City's groundwater level monitoring program will be an important tool to track and monitor groundwater levels (and subsequent changes in groundwater basin storage) into the future.

#### ES 1.4.2 Future Water Supply - Integrated Water Supply Plan

The two following future water supply scenarios were evaluated to develop an integrated water supply plan to meet projected water demands:

- Scenario 1: Groundwater Only
- Scenario 2: Groundwater Plus Treated Surface Water from the Regional Surface Water Supply Project (RSWSP)

Based on our evaluation, West Yost strongly recommends Scenario 2 as shown on Figure ES-3. In Scenario 2, the City's primary supply source will still be groundwater. However, by 2018, 6 mgd (6,700 af/yr) of treated surface water is assumed to be available to the City from the RSWSP.

Even though the implementation and maintenance of the RSWSP will be costly, the costs for Scenario 2 are not significantly more than the estimated costs for Scenario 1. Scenario 2 provides significant reliability benefits by diversifying the City's water supply portfolio and reducing the City's reliance on groundwater. Furthermore, this scenario, if coupled with the construction of aquifer storage and recovery (ASR) wells, would provide the City with significant operational flexibility, and would allow the City to deliver a higher quality water to its customers and would minimize the potential for future water supply shortfalls. ASR wells have the capability to inject and store treated surface water supplies available during low demand periods and extract these supplies during peak summer periods.



## Executive Summary

### ES 1.5 EVALUATION OF EXISTING AND FUTURE WATER SYSTEM (CHAPTERS 5, 6, 7)

#### ES 1.5.1 Existing Water System Evaluation and Recommended Improvements

West Yost evaluated the City's existing water system facilities (see Figure ES-4) to identify existing deficiencies and recommended improvements. The evaluation (presented in Chapter 6) included an analysis of existing water storage capacity, pumping capacity, and the water system's ability to meet recommended performance criteria (Chapter 5) under maximum day demand plus fire flow and peak hour demand scenarios.

The following existing water distribution system improvements are recommended:

- Install new and replacement pipelines at various locations to improve water system looping and fire flow capacity, and eliminate high pipeline head loss and velocity simulated during peak hour demand conditions.
- Install new groundwater wells to provide additional pumping capacity to meet existing water demand.
- Replace existing wells as they reach the end of their useful lives.
- Install backup power and wellhead treatment to new and replacement wells as necessary.
- Construct a new 2.0 MG storage reservoir (River Bluff Reservoir) and an associated 4,200 gpm booster pump station.
- Maintain or improve the existing water system through distribution system program improvements such as the Main Replacement Program, Water System Maintenance and Repair Program, and the Large Meter Replacement Program.

Recommended existing water system improvements are illustrated on Figure ES-5.

#### ES 1.5.1.1 Future Water System Evaluation and Recommended Improvements

Development of the future water system includes an evaluation of the required future water storage and pumping capacity, and the future water system's ability to meet recommended water system performance and operational criteria (Chapter 5) under maximum day demand plus fire flow and peak hour demand scenarios for the 2015 and buildout time frames. Based on the hydraulic evaluation of the proposed future water system (presented in Chapter 7), the following future water distribution system improvements are recommended:

- Participate in Phase 1 of the RSWSP, with a planned delivery rate of 6 mgd.
- Install new and replacement pipelines at various locations to serve new water demands, improve water system looping and fire flow capacity, and eliminate high pipeline head loss and velocity simulated during peak hour demand conditions.
- Install new groundwater wells to provide additional pumping capacity to meet new future water demand.



## Executive Summary

---

- Install backup power and wellhead treatment to new wells as necessary.
- Construct a new 1.6 MG storage reservoir and an associated booster pump station for the West Landing Specific Plan area
- Construct a new 4.0 MG storage reservoir and an associated booster pump station, at a proposed site at Whitmore Avenue and Morgan Road.

Recommended 2015 and buildout water system improvements are illustrated on Figure ES-6.

### **ES 1.5.2 Recommended Capital Improvement Program (Chapter 8)**

The total capital cost of water system improvements to support the City's existing and future water demands is estimated to be approximately \$201.7 million. Improvements are summarized on Table ES-2. The water supply improvements CIP cost is estimated to be \$22.6 million for the existing water system and \$67.7 million for the buildout water system. The water distribution system improvements CIP cost is estimated to be \$29.4 million for existing water system, \$3.7 million for the 2015 water system, and \$78.3 million for the buildout water system. An Engineer's Report, which evaluates the cost allocation between existing and future customers, is included in Appendix E.

Table ES-3 presents a recommended implementation schedule for capital improvements, showing capital expenditures by fiscal year through 2015, over the 2016 through 2020 time frame, and long-term. Projects are placed on the schedule based on their recommended priority.

Table ES-2. Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP<sup>(a,b)</sup>

Improvement Type	Improvement Description	CIP ID	Quantity	Estimated Construction Cost	Capital Cost (includes mark-ups) <sup>(c,d)</sup>
<b>Supply Improvements</b>					
<b>Existing Time Frame</b>					
Well	Install replacement for Well 1	EX_SU01	1	LS	(e)
Well	Install new well on north side of City (assumed at Riverview Park)	EX_SU02	1	LS	750,000
Backup Power	Install standby generator at wells with a total capacity of 2,200 gpm (3 wells assumed)	EX_SU03	3	LS	600,000
Well <sup>(f)</sup>	Install replacement wells as existing wells are retired	EX_SU04	9	LS	6,750,000
Well	Wellhead treatment for replacement wells (assumes oxidation/filtration treatment)	EX_SU05	6	LS	6,000,000
				<b>Subtotal</b>	\$ 22,560,000
<b>Buildout Time Frame</b>					
Well <sup>(f,g)</sup>	Install new well near Redwood Avenue and Central Avenue with ASR capability	BO_SU01	1	LS	937,500
Well <sup>(f,g)</sup>	Install new well near Roeding Road and Esmar Road with ASR capability (alternate location - Well 6 replacement)	BO_SU02	1	LS	937,500
Well <sup>(h)</sup>	Install 2 new wells in the West Landing Specific Plan Area	BO_SU03	2	LS	1,500,000
Well	Wellhead treatment for new wells (assumes ion exchange treatment)	BO_SU04	2	LS	5,600,000
Backup Power	Install standby generator at wells with a total capacity of 5,500 gpm (6 wells assumed)	BO_SU05	6	LS	1,200,000
Surface Water <sup>(i)</sup>	Participation in Phase I Regional Surface Water Supply Project	BO_SU06	1	LS	--
				<b>Subtotal</b>	\$ 67,680,000
				<b>Total, Supply Improvements</b>	\$ 90,240,000
<b>Distribution System Improvements</b>					
<b>Existing Time Frame</b>					
Pipeline	Install 8-inch dia. pipes along Herndon Road, west of Grand View Avenue	EX_F01	400	If	60,000
Pipeline	Install 10-inch dia. pipes along Pine Street, east of Central Avenue	EX_F02	100	If	17,000
Pipeline	Install 10-inch dia. pipes along Whitmore Avenue, between Louise Avenue and Charlotte Avenue	EX_F03	100	If	17,000
Pipeline	Install 12-inch dia. pipes along Kinser Road, west of Central Avenue	EX_F04	200	If	40,000
Pipeline	Install 8-inch dia. pipes along Paramount Avenue, south of Giddings Street	EX_F05	100	If	15,000
Pipeline	Install 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	10,600	If	2,756,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	600	If	324,000
Pipeline	Install 16-inch dia. pipes along Hatch Road between Eastgate Boulevard and Faith Home Road	EX_T02	2,400	If	624,000
Pipeline	Install 12-inch dia. pipes along Faith Home Road, south of Helen Perry Road	EX_T03	200	If	40,000
Pipeline	Install 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	78,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	162,000
Pipeline	Install 12-inch dia. pipes along Fiddleleaf Lane between Hatch Road and Bougainvillea Drive	EX_PH02	600	If	120,000
Main Replacement Program	Replace 2-inch, 3-inch, and 4-inch diameter pipes with 8-inch diameter pipes	EX_F06	34,000	If	5,100,000
Water System Maintenance and Repair Program	Repair & maintenance of water valves, fire hydrants, pumping station piping, and other facilities	EX_DS01	1	LS	--
Large Meter Replacement Program	Changeout of large meters based on age most recent testing data	EX_DS02	1	LS	--
Storage	Construct new 2.0 MG storage reservoir	EX_S01	1	LS	2,300,000
Pump Station	Construct 4200 gpm booster pump station for new 2.0 MG storage reservoir	EX_S01	1	LS	1,700,000
				<b>Subtotal</b>	\$ 29,364,000
<b>2015 Time Frame</b>					
Pipeline	Install 16-inch dia. pipes along Hatch Road between Central Avenue and Faith Home Road	15_T01	9,000	If	2,340,000
				<b>Subtotal</b>	\$ 3,744,000
<b>Buildout Time Frame</b>					
Pipeline	Install 8-inch dia. pipes along Farm Supply Drive and Marchy Lane	BO_F01	300	If	45,000
Pipeline	Install 8-inch dia. pipes in Downtown Area	BO_F02	6,900	If	1,035,000
Pipeline	Install 8-inch dia. pipes along Darrah Street, Sequoia Street, Memorial Drive	BO_F03	4,300	If	645,000
Pipeline	Install 8-inch dia. pipes along Grand View Avenue, Belmont Avenue	BO_F04	1,100	If	165,000
Pipeline	Install 8-inch dia. pipes along Fifth Street	BO_F05	500	If	75,000
Pipeline	Install 8-inch dia. pipes along Sixth Street	BO_F06	200	If	30,000
Pipeline	Install 10-inch dia. pipes along Golf Links Drive	BO_F07	1,600	If	272,000
Pipeline	Install 12-inch dia. pipes along Colleen Drive, Della Drive	BO_F08	1,400	If	280,000



**Table ES-2. Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP<sup>(a,b)</sup>**

Improvement Type	Improvement Description	CIP ID	Quantity		Estimated Construction Cost	Capital Cost (includes mark-ups) <sup>(c,d)</sup>
Pipeline	Install 10-inch dia. pipes along Central Avenue, north of Hatch Road	BO_F09	1,000	lf	170,000	272,000
Pipeline	Install 8-inch dia. pipes along Rosewood Avenue	BO_F10	200	lf	30,000	48,000
Pipeline	Install 10-inch dia. pipes along Mitchell Road north of Hatch Road	BO_F11	900	lf	153,000	245,000
Pipeline	Install 16-inch dia. pipes along Whitmore Avenue, Central Avenue to Faith Home Road	BO_T01	10,600	lf	2,756,000	4,410,000
Pipeline	Install 12-inch dia. pipes along Service Road between Mitchell Road and Faith Home Road	BO_T02	4,700	lf	940,000	1,504,000
Pipeline	Install 16-inch dia. pipes along Service Road between Crows Landing Road and Morgan Road	BO_T03	5,400	lf	1,404,000	2,246,000
Pipeline	Install 16-inch dia. pipes along Mitchell Road between Hatch Road and Service Road	BO_T04	10,900	lf	2,834,000	4,534,000
Pipeline	Install 16-inch dia. pipes along Morgan Road between Hatch Road and Whitmore Avenue	BO_T05	5,500	lf	1,430,000	2,288,000
Pipeline	Install 16-inch dia. pipes along Morgan Road between Whitmore Avenue and Kinser Road	BO_T06	5,300	lf	1,378,000	2,205,000
Pipeline	Install 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	6,200	lf	1,612,000	2,579,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	300	lf	162,000	259,000
Pipeline	Install 16-inch dia. pipes along Faith Home Road between Hatch Road and Whitmore Avenue	BO_T08	5,100	lf	1,326,000	2,122,000
Pipeline	Install 12-inch dia. pipes along Faith Home Road between Whitmore Avenue and Redwood Avenue	BO_T09	8,000	lf	1,600,000	2,560,000
Pipeline	Install 16-inch dia pipes at various locations (New Transmission)	BO_T10A	26,200	lf	6,812,000	10,899,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia pipes at various locations (New Transmission)	BO_T10A	300	lf	162,000	259,000
Pipeline	Install 12-inch dia pipes at various locations (New Transmission)	BO_T10B <sup>(k)</sup>	86,000	lf	12,900,000	20,640,000
Jack and Bore <sup>(i)</sup>	Jack and bore 12-inch dia pipes at various locations (New Transmission)	BO_T10B <sup>(k)</sup>	900	lf	423,000	677,000
Pipeline	Install 16-inch dia. pipes to serve West Landing Specific Plan Area (New Transmission)	WL-T01	18,800	lf	4,888,000	7,821,000
Pipeline	Install 12-inch dia. pipes to serve West Landing Specific Plan Area (New Transmission)	WL-T02	5,200	lf	1,040,000	1,664,000
Pipeline	Install 12-inch dia. pipes along Upsize Proposed Mains for West Landing Specific Plan Area	WL-M01	6,700	lf	1,340,000	<sup>(l)</sup>
Storage	Construct a new 4.0 MG storage reservoir at Whitmore Avenue and Morgan Road Site	BO_S01	1	LS	<sup>(m)</sup>	<sup>(m)</sup>
Pump Station	Construct booster pump station for new 4.0 MG storage reservoir	BO_S01	1	LS	<sup>(n)</sup>	<sup>(n)</sup>
Storage	Construct a new 1.6 MG storage reservoir for the West Landing Project	BO_S02	1	LS	2,819,000	4,510,000
Pump Station	Construct 3300 gpm booster pump station for new 1.6 MG storage reservoir	BO_S02	1	LS	1,562,000	2,499,000
					<b>Subtotal</b>	\$ 78,316,000
					<b>Total, Distribution Improvements</b>	\$ 111,424,000
					<b>GRAND TOTAL</b>	\$ 201,664,000

<sup>(a)</sup> Costs shown are presented in December 2010 dollars based on an ENR CCI of 8952 (20-City Average).

<sup>(b)</sup> Costs do not include land acquisition costs. It is assumed that land for buildout facilities will be dedicated by the developer(s) or constructed on land already owned by the City.

<sup>(c)</sup> Costs include mark-ups equal to 60 percent (Design: 10 percent; Permitting, Regulatory, CEQA: 10 percent; Construction Management: 10 percent; Program Implementation: 5 percent; and Project Construction Contingency: 25 percent).

<sup>(d)</sup> Total rounded to nearest \$1,000.

<sup>(e)</sup> No dollar amount is shown because this project has already been funded in the FY 2009/10 CIP.

<sup>(f)</sup> Eleven replacement wells are assumed in the Master Plan time frame, including two planned wells - replacement for Well 1, and new well at Roeding/Esmar with alternate location at Well 6. These two wells are budgeted under a separate budget line item. Nine wells are budgeted under the replacement category.

<sup>(g)</sup> Costs are increased by 25 percent to include provision for ASR.

<sup>(h)</sup> Costs for a third well, reserved as a standby well in the West Landing Specific Plan Area, is not included, since this standby well is assumed to be funded by the developer as an in-tract improvement.

<sup>(i)</sup> RSWSP costs for the City of Ceres share of regional treatment and transmission facilities were estimated by project proponents as \$49M in April 2009 dollars. Costs are assumed to be capital costs and are escalated to December 2010 \$.

<sup>(j)</sup> Jack and bore costs are for casing pipe only, and do not include conductor pipe, which is included in pipe totals.

<sup>(k)</sup> The Public Facilities Fee (PFF) report designates 79,500 feet of 12-inch diameter transmission with a capital cost of \$8.3M at miscellaneous locations not specifically identified. The Master Plan includes 112,000 feet of new transmission pipelines (86,000 feet of 12-inch and 26,000 feet of 16-inch) in locations not specifically identified in the PFF. The Master Plan includes transmission grid in secondary sphere-of-influence areas not considered in the PFF report. 12-inch diameter lines under project BO\_T10B use undeveloped area pipeline costs.

<sup>(l)</sup> These 12-inch lines are assumed to be in-tract improvements paid for by the developer, and not funded by developer impact fees.

<sup>(m)</sup> Storage cost is included in the RSWSP cost estimate listed in Supply Improvements.

<sup>(n)</sup> Pump station cost is included in the RSWSP cost estimate listed in Supply Improvements.



Table ES-3. Recommended Implementation Schedule for Improvements in the Master Plan CIP

Improvement Type	Improvement Description	CIP ID	Quantity	Capital Cost	Recommended Implementation Timeframe						
					FY 2011/12	FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17 - FY 2020/21	Long-term
<b>Supply Improvements</b>											
Well	Install replacement for Well 1	EX_SU01	1	LS	(a)		(a)				
Well	Install new well on north side of City (assumed at Riverview Park)	EX_SU02	1	LS	\$ 1.2		\$ 1.2				
Backup Power	Install standby generator at wells with a total capacity of 2,200 gpm (3 wells assumed)	EX_SU04	3	LS	\$ 1.0	\$ 0.5	\$ 0.5				
Well	Install replacement wells as existing wells are retired <sup>(b)</sup>	EX_SU06	9	LS	\$ 10.8			1.2		\$ 4.8	
Well	Wellhead treatment for replacement wells (assumes oxidation/filtration treatment)	EX_SU07	6	LS	\$ 9.6					\$ 9.6	
Well	Install new well near Redwood Avenue and Central Avenue	BO_SU01	1	LS	\$ 1.5					\$ 1.5	
Well	Install new well near Roeding Road and Esmar Road (alternate location - Well 6 replacement)	BO_SU02	1	LS	\$ 1.5	\$ 1.5					
Well	Install 3 new wells in the West Landing Specific Plan Area <sup>(c)</sup>	BO_SU03	2	LS	\$ 2.4		\$ 0.2	\$ 2.2			
Well	Wellhead treatment for new wells (assumes ion exchange treatment)	BO_SU04	2	LS	\$ 9.0			\$ 3.0		\$ 6.0	
Backup Power	Install standby generator at wells with a total capacity of 5,500 gpm (6 wells assumed)	BO_SU05	6	LS	\$ 1.9					\$ 1.9	
Surface Water	Participation in Phase I Regional Surface Water Supply Project	BO_SU06	1	LS	\$ 51.4	\$ 1.5	\$ 1.5	\$ 1.5	\$ 3.1	\$ 43.7	
				<b>TOTAL</b>	\$ 90.2	\$ 0.5	\$ 4.7	\$ 3.0	\$ 6.7	\$ 3.1	\$ 48.5
											\$ 23.8
<b>Distribution System Improvements</b>											
Pipeline	Install 8-inch dia. pipes along Herndon Road, west of Grand View Avenue	EX_F01	400	If	\$ 0.1			\$ 0.10			
Pipeline	Install 10-inch dia. pipes along Pine Street, east of Central Avenue	EX_F02	100	If	\$ 0.0			\$ 0.03			
Pipeline	Install 10-inch dia. pipes along Whitmore Avenue, between Louise Avenue and Charlotte Avenue	EX_F03	100	If	\$ 0.0			\$ 0.03			
Pipeline	Install 12-inch dia. pipes along Kinser Road, west of Central Avenue	EX_F04	200	If	\$ 0.1			\$ 0.06			
Pipeline	Install 8-inch dia. pipes along Paramount Avenue, south of Giddings Street	EX_F05	100	If	\$ 0.0			\$ 0.02			
Pipeline	Install 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	10,600	If	\$ 4.4	0.44	\$ 3.97				
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	600	If	\$ 0.5	0.05	\$ 0.47				
Pipeline	Install 16-inch dia. pipes along Hatch Road between Eastgate Boulevard and Faith Home Road	EX_T02	2,400	If	\$ 1.0			\$ 0.1	\$ 0.9		
Pipeline	Install 12-inch dia. pipes along Faith Home Road, south of Helen Perry Road	EX_T03	200	If	\$ 0.1			\$ 0.1			
Pipeline	Install 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	\$ 0.1			\$ 0.1			
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	\$ 0.3			\$ 0.3			
Pipeline	Install 12-inch dia. pipes along Fiddleleaf Lane between Hatch Road and Bougainvillea Drive	EX_PH02	600	If	\$ 0.2			\$ 0.2			
Main Replacement Program	Replace 2-inch, 3-inch, and 4-inch diameter pipes with 8-inch diameter pipes	EX_F06	34,000	If	\$ 8.2	\$ 0.20	\$ 0.20	\$ 0.20	\$ 0.20	\$ 0.2	\$ 1.0
Maintenance and Repair Program	Repair & maintenance of water system facilities including but not limited to: main water valves, fire hydrants, pumping station piping	EX_DS01	1	LS	\$ 4.0	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.5
Large Meter Replacement Program	The City currently has 443 meters that are 1 1/2" and larger. Changeouts will be based on age most recent testing data	EX_DS02	1	LS	\$ 4.0	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 3.0
Storage	Construct new 2.0 MG storage reservoir	EX_S01	1	LS	\$ 3.7			\$ 0.4	\$ 3.3		
Pump Station	Construct 4200 gpm booster pump station for new 2.0 MG storage reservoir	EX_S01	1	LS	\$ 2.7			\$ 0.3	\$ 2.4		
Pipeline	Install 16-inch dia. pipes along Hatch Road between Central Avenue and Faith Home Road	15_T01	9,000	If	\$ 3.7						\$ 3.7
Pipeline	Install 8-inch dia. pipes along Farm Supply Drive and Marchy Lane	BO_F01	300	If	\$ 0.1						\$ 0.1
Pipeline	Install 8-inch dia. pipes in Downtown Area	BO_F02	6,900	If	\$ 1.7						\$ 1.7
Pipeline	Install 8-inch dia. pipes along Darrah Street, Sequoia Street, Memorial Drive	BO_F03	4,300	If	\$ 1.0						\$ 1.0
Pipeline	Install 8-inch dia. pipes along Grand View Avenue, Belmont Avenue	BO_F04	1,100	If	\$ 0.3						\$ 0.3
Pipeline	Install 8-inch dia. pipes along Fifth Street	BO_F05	500	If	\$ 0.1						\$ 0.1
Pipeline	Install 8-inch dia. pipes along Sixth Street	BO_F06	200	If	\$ 0.0						\$ 0.0
Pipeline	Install 10-inch dia. pipes along Golf Links Drive	BO_F07	1,600	If	\$ 0.4						\$ 0.4
Pipeline	Install 12-inch dia. pipes along Colleen Drive, Della Drive	BO_F08	1,400	If	\$ 0.4						\$ 0.4
Pipeline	Install 10-inch dia. pipes along Central Avenue, north of Hatch Road	BO_F09	1,000	If	\$ 0.3						\$ 0.3
Pipeline	Install 8-inch dia. pipes along Rosewood Avenue	BO_F10	200	If	\$ 0.0						\$ 0.0
Pipeline	Install 10-inch dia. pipes along Mitchell Road north of Hatch Road	BO_F11	900	If	\$ 0.2						\$ 0.2
Pipeline	Install 16-inch dia. pipes along Whitmore Avenue, Central Avenue to Faith Home Road	BO_T01	10,600	If	\$ 4.4						\$ 4.4
Pipeline	Install 12-inch dia. pipes along Service Road between Mitchell Road and Faith Home Road	BO_T02	4,700	If	\$ 1.5						\$ 1.5
Pipeline	Install 16-inch dia. pipes along Service Road between Crows Landing Road and Morgan Road	BO_T03	5,400	If	\$ 2.2						\$ 2.2



Table ES-3. Recommended Implementation Schedule for Improvements in the Master Plan CIP

Improvement Type	Improvement Description	CIP ID	Quantity		Capital Cost	Recommended Implementation Timeframe					
			FY 2011/12	FY 2012/13		FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17 - FY 2020/21	Long-term	
Pipeline	Install 16-inch dia. pipes along Mitchell Road between Hatch Road and Service Road	BO_T04	10,900	lf	\$ 4.5					\$ 4.5	
Pipeline	Install 16-inch dia. pipes along Morgan Road between Hatch Road and Whitmore Avenue	BO_T05	5,500	lf	\$ 2.3					\$ 2.3	
Pipeline	Install 16-inch dia. pipes along Morgan Road between Whitmore Avenue and Kinser Road	BO_T06	5,300	lf	\$ 2.2					\$ 2.2	
Pipeline	Install 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	6,200	lf	\$ 2.6					\$ 2.6	
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	300	lf	\$ 0.3					\$ 0.3	
Pipeline	Install 16-inch dia. pipes along Faith Home Road between Hatch Road and Whitmore Avenue	BO_T08	5,100	lf	\$ 2.1					\$ 2.1	
Pipeline	Install 12-inch dia. pipes along Faith Home Road between Whitmore Avenue and Redwood Avenue	BO_T09	8,000	lf	\$ 2.6					\$ 2.6	
Pipeline	Install 16-inch dia pipes at various locations (New Transmission)	BO_T10A	26,200	lf	\$ 10.9				\$ 2.20	\$ 8.7	
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia pipes at various locations (New Transmission)	BO_T10A	300	lf	\$ 0.3					\$ 0.3	
Pipeline	Install 12-inch dia pipes at various locations (New Transmission)	BO_T10B	86,000	lf	\$ 20.6					\$ 20.6	
Jack and Bore <sup>(d)</sup>	Jack and bore 12-inch dia pipes at various locations (New Transmission)	BO_T10B	900	lf	\$ 0.7					\$ 0.7	
Pipeline	Install 16-inch dia. pipes along New Transmission to serve West Landing Specific Plan Area	WL-T01	18,800	lf	\$ 7.8					\$ 7.8	
Pipeline	Install 12-inch dia. pipes along New Transmission to serve West Landing Specific Plan Area	WL-T02	5,200	lf	\$ 1.7					\$ 1.7	
Pipeline	Install 12-inch dia. pipes along Upsize Proposed Mains for West Landing Specific Plan Area	WL-M01	6,700	lf	(e)					(e)	
Storage	Construct a new 4.0 MG storage reservoir at Whitmore Avenue and Morgan Road Site	BO_S01	1	LS	(f)					(f)	
Pump Station	Construct booster pump station for new 4.0 MG storage reservoir	BO_S01	1	LS	(g)					(g)	
Storage	Construct a new 1.6 MG storage reservoir for the West Landing Project	BO_S02	1	LS	\$ 4.5					\$ 4.5	
Pump Station	Construct 3300 gpm booster pump station for new 1.6 MG storage reservoir	BO_S02	1	LS	\$ 2.5					\$ 2.5	
				<b>TOTAL</b>	\$ 111.4	\$ 0.9	\$ 4.8	\$ 0.6	\$ 1.1	\$ 7.7	\$ 8.0
				<b>GRAND TOTAL</b>	\$ 201.7	\$ 1.4	\$ 9.6	\$ 3.6	\$ 7.8	\$ 10.8	\$ 56.5
											\$ 112.0

<sup>(a)</sup>No dollar amount is shown because this project has already been funded in the FY 2009/10 CIP.

<sup>(b)</sup>Eleven replacement wells are assumed in the Master Plan time frame, including two of the planned wells in the Existing Time Frame. The two are budgeted under Planned Wells (Well 1 and 6), Well 14 is assumed replaced in 2013, Wells 16, 20, 21, and 22 in the 2016-2020 timeframe, and remaining wells after 2020.

<sup>(c)</sup>Costs for a 3rd well, reserved as a standby well in the West Landing Specific Plan Area, is not included, since the standby well would be funded by the developer as an in-tract improvement. Timing is approximate, and dependent on developer approvals.

<sup>(d)</sup>Jack and bore costs are for casing pipe only, and do not include conductor pipe, which is included in pipe totals.

<sup>(e)</sup>These 12-inch lines are assumed to be in-tract improvements paid for by the developer, and not funded by developer impact fees.

<sup>(f)</sup>Storage cost is included in the RSWSP cost estimate listed in Supply Improvements.

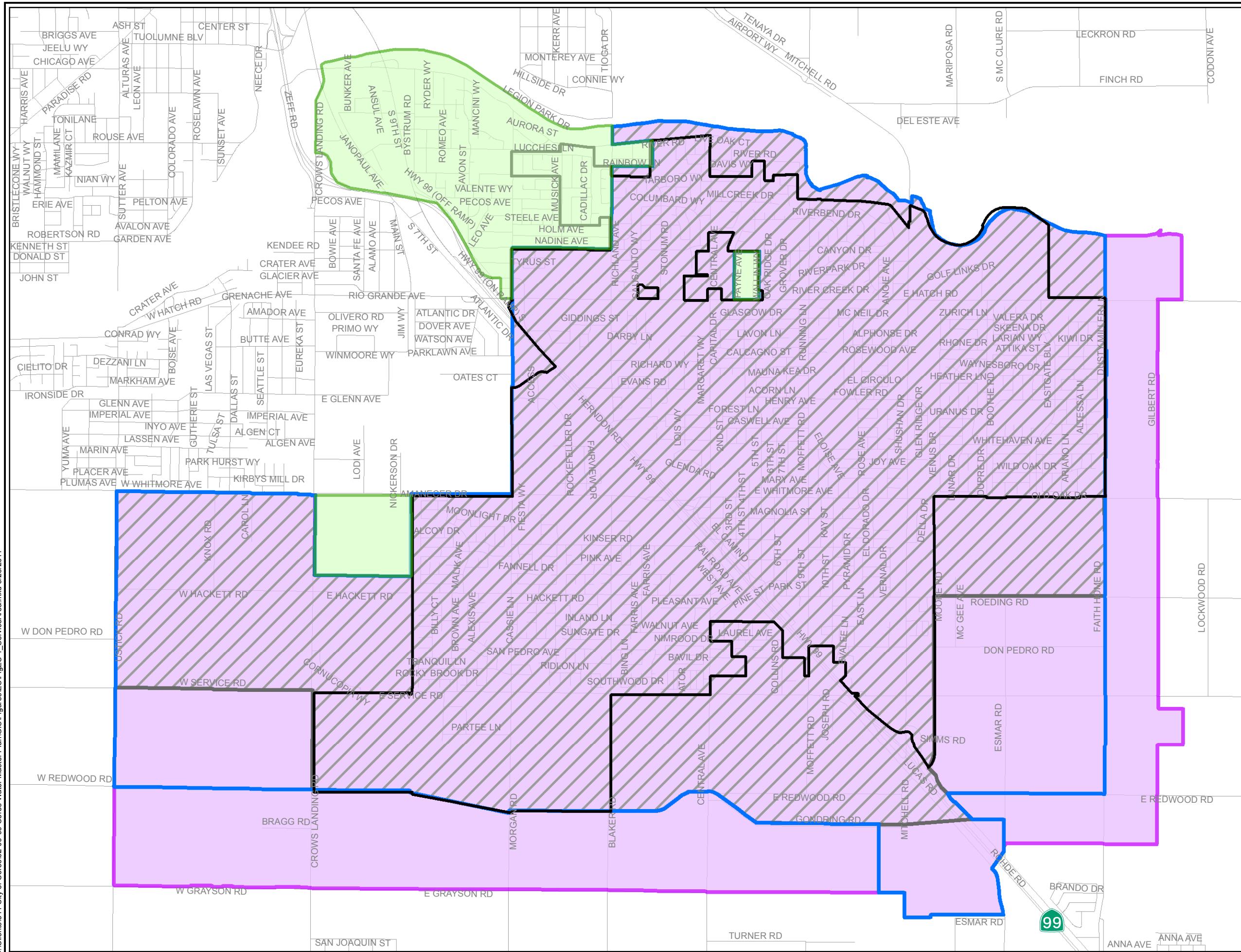
<sup>(g)</sup>Pump station cost is included in the RSWSP cost estimate listed in Supply Improvements.



## FIGURE ES-1

# **City of Ceres Water Master Plan**

## EXISTING AND PROPOSED SERVICE AREAS



## Notes

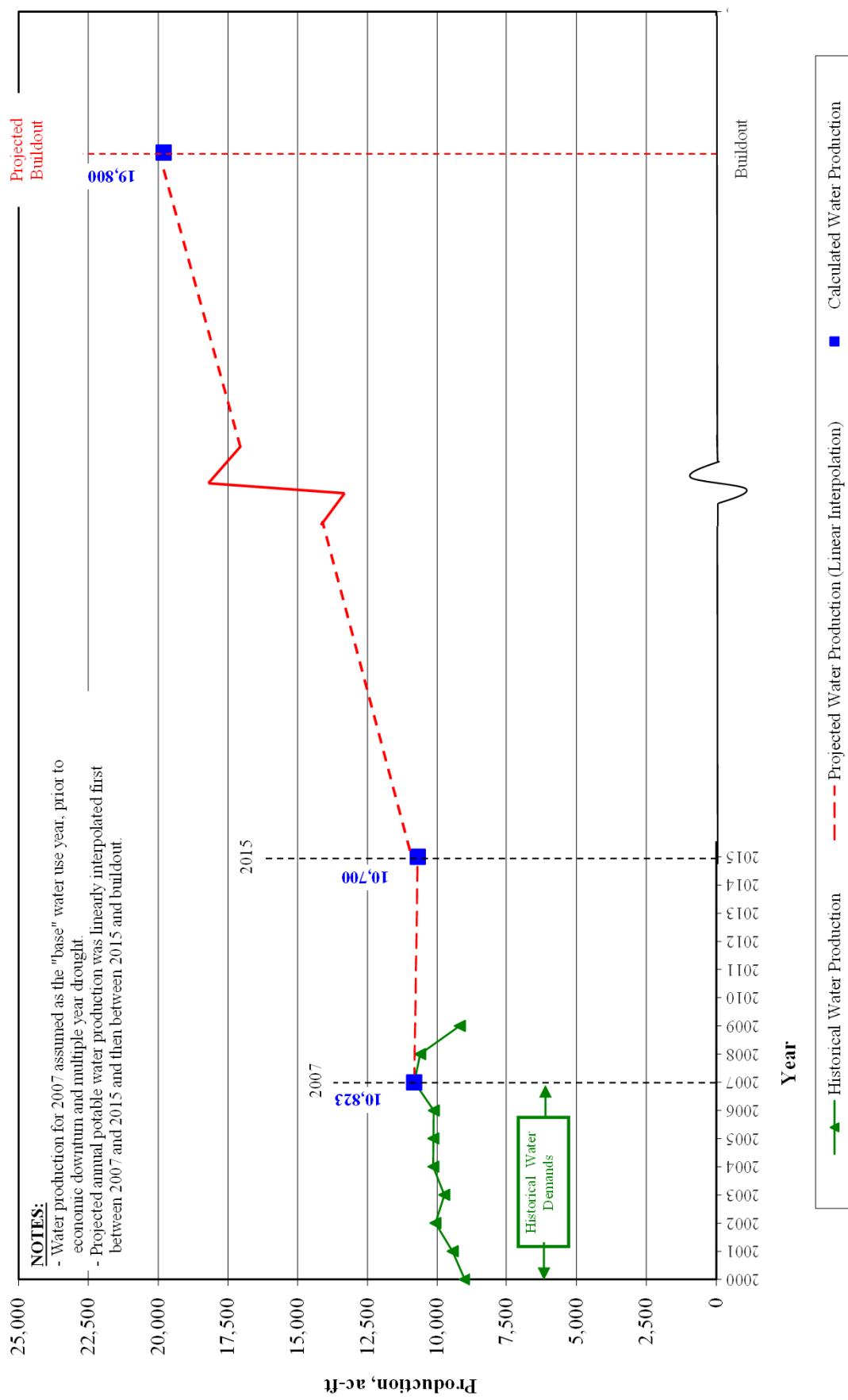
1. SOI and Study Area boundary files provided by ECO:LOGIC on 05/04/10. Boundaries have been revised to exclude area served by City of Modesto.
2. Existing City Limits file (Ctylmt01.dwg) provided by the City on 10/01/09.

## LEGEND

-  City Limits
-  Primary SOI
-  Secondary SOI
-  Water Master Plan Study Area
-  Area Served by City of Modesto Street

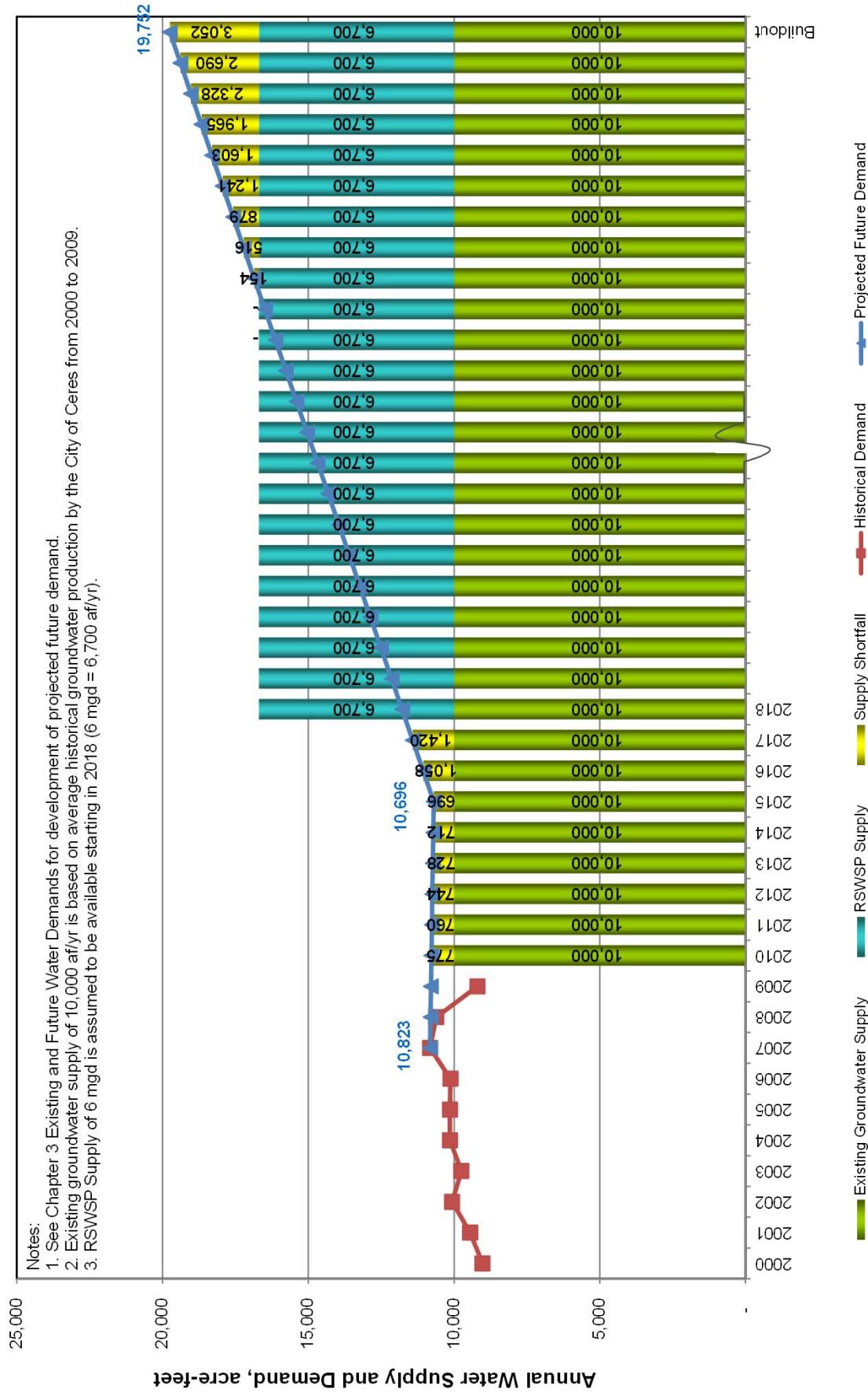


**Figure ES-2. Existing and Projected Annual Potable Water Production**





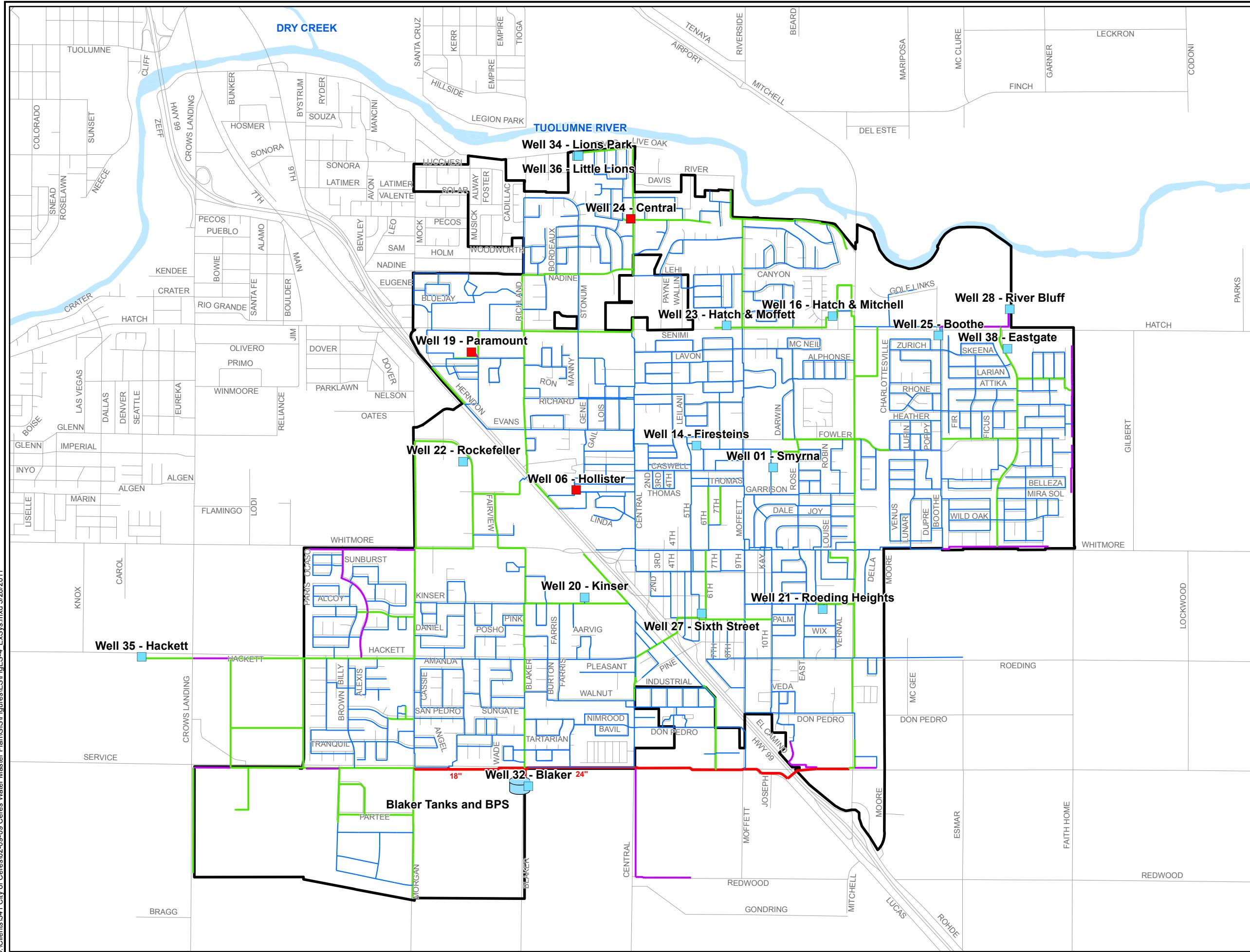
**Figure ES-3. City of Ceres Future Supply vs. Demand (with Existing Groundwater Supply + Future RSWSP)**



**FIGURE ES-4**

**City of Ceres  
Water Master Plan**

**EXISTING WATER SYSTEM**

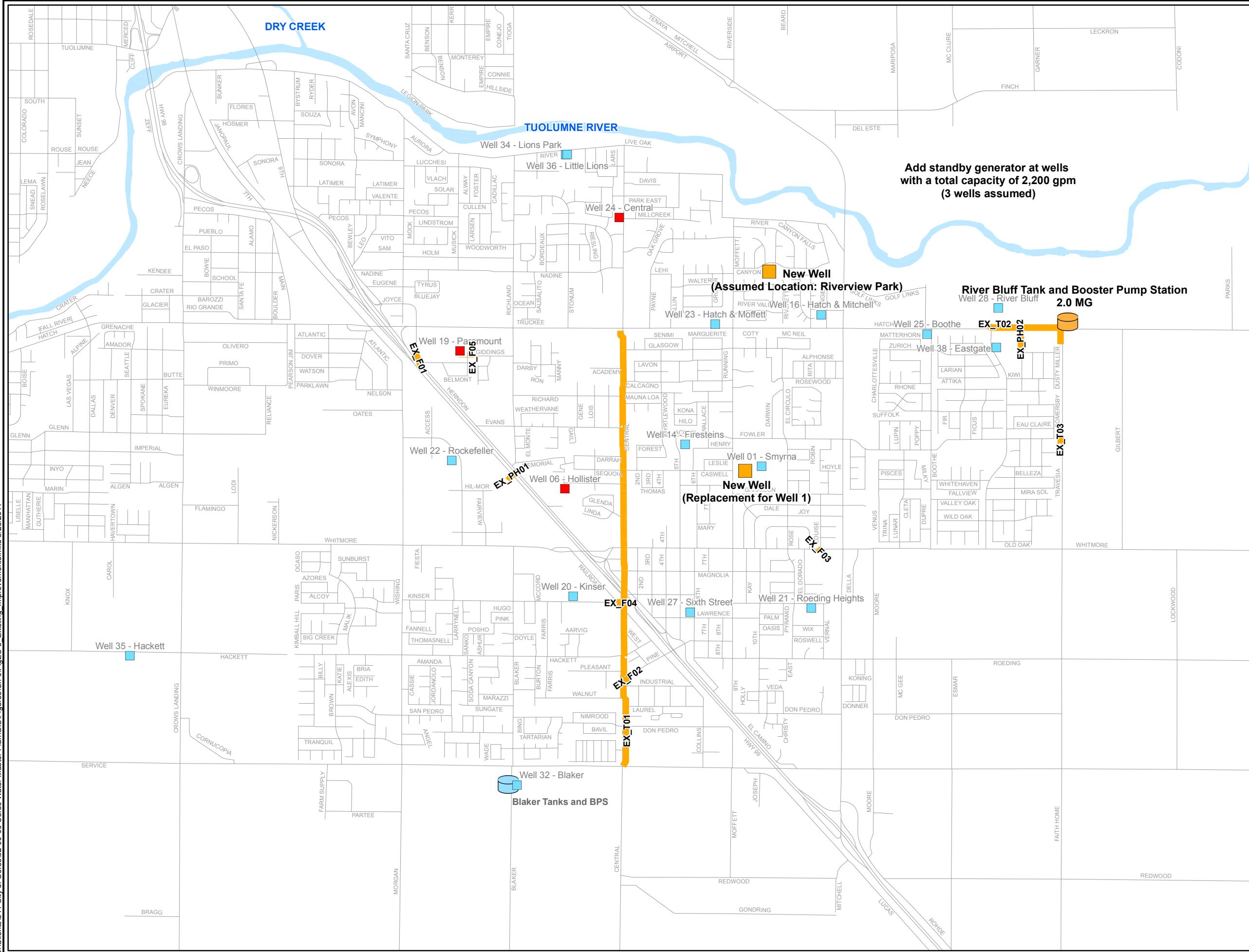




**FIGURE ES-5**

**City of Ceres  
Water Master Plan**

**EXISTING SYSTEM  
RECOMMENDED  
IMPROVEMENTS**



**LEGEND**

Street	Existing Well
Inactive Well	New Well
Existing Tank and Booster Pump Station	New Tank and Booster Pump Station
New Pipe	New Pipe



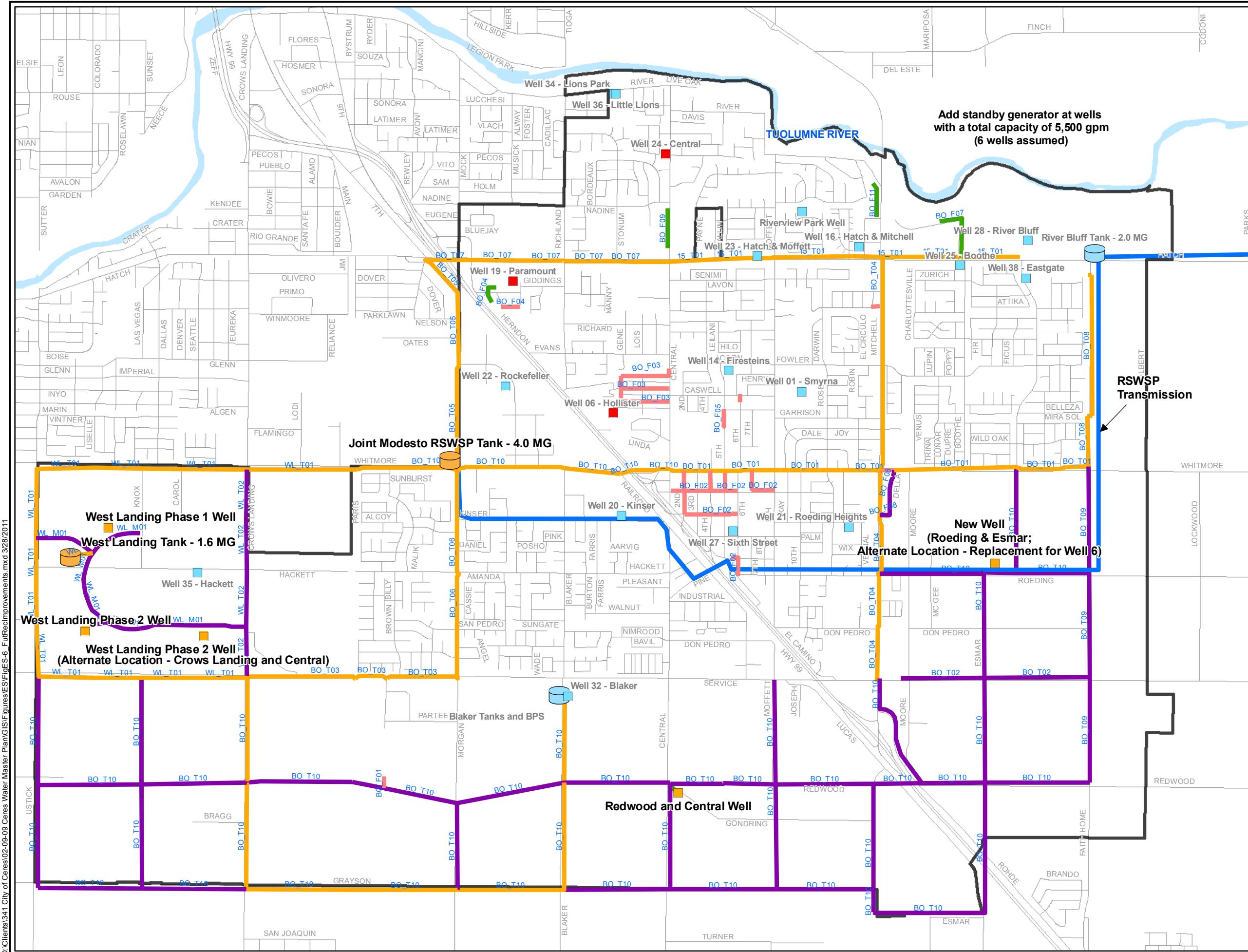
**WEST YOST  
ASSOCIATES**  
Consulting Engineers



FIGURE ES-6

City of Ceres  
Water Master Plan

FUTURE WATER  
SYSTEM RECOMMENDED  
IMPROVEMENTS TO  
SERVE 2015  
AND BUILDOUT



NOTES

1. Future facilities recommended in the Existing System Analysis are shown as existing facilities.
2. All improvements are included in the buildout timeframe except for Project 15-T01, new transmission on Hatch Road.



### 1.1 WATER SYSTEM MASTER PLAN PURPOSE

This Water Master Plan for the City of Ceres (City) identifies strategies for maintaining adequate water supplies and service levels for the community; guides capital expenditures for the system; furnishes important guidance on operational issues; and charts a course for future updates to water rates. To accomplish these goals, the following work tasks were performed in the Water Master Plan:

- Evaluate and summarize existing water system and key system facilities, including an assessment of well condition and remaining useful life;
- Develop water demand projections through buildout;
- Evaluate existing and future water supplies to develop an integrated water supply strategy for the City to meet existing and future water demands;
- Develop performance and operational criteria under which the water system will be analyzed and future facilities will be formulated;
- Update and refine the distribution system hydraulic model;
- Evaluate existing, 2015 and buildout water system conditions to identify the City's water distribution system facility needs; and,
- Develop a capital improvement program for recommended existing and future water system facilities.

As part of the Water Master Plan, a financial analysis was also performed to evaluate conversion of residential flat rate users to metered use. The analysis guided the adoption of a new metered rate schedule to transition customers to metered billing and maintain water rate revenues. The new metered rate schedule will be implemented in September 2011.

### 1.2 AUTHORIZATION

West Yost Associates (West Yost) was authorized to prepare this Water Master Plan by the City on January 25, 2010.

### 1.3 REPORT ORGANIZATION

This Water Master Plan is organized into the following chapters:

- Chapter 1: Introduction
- Chapter 2: Existing Water System
- Chapter 3: Existing and Future Demands
- Chapter 4: Integrated Water Supply Plan
- Chapter 5: System Performance and Operational Criteria
- Chapter 6: Evaluation of Existing Water System



Chapter 7: Evaluation of Future Water System

Chapter 8: Recommended Capital Improvement Program

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

Appendix A: City of Ceres Sewer Master Plan Existing and 1997 General Plan Growth Area Land Use, May 4, 2010

Appendix B: Water Demand Assumptions and Calculations

Appendix C: Wellhead Treatment Alternatives Evaluation Technical Memorandum, May 25, 2010

Appendix D: Available Fire Flows for Existing Maximum Day Plus Fire Scenario

Appendix E: Engineer's Report

Appendix F: Cost Estimating Assumptions

### 1.4 ACRONYMS AND ABBREVIATIONS

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

1,2,3—TCP	1,2,3-trichloropropane
ACP	Asbestos Cement
af/ac/yr	Acre Feet per Acre per Year
af/yr	Acre Feet Per Annum/Acre Feet Per Year
AL	Action Level
ASR	Aquifer Storage and Recovery
AWWA	American Water Works Association
bgs	below ground surface
BMOs	Basin Management Objectives
BMPs	Best Management Practices
BPS	Booster Pump Station
CADPH	California Department of Public Health
CCI	Construction Cost Index
CEQA	California Environmental Quality Act
CESJO	Central Eastside San Joaquin
CFC	California Fire Code
CII	Commercial, Industrial and Institutional
CIP	Capital Improvement Program
City	City of Ceres
DER	Department of Environmental Resources
DOF	California Department of Finance
DSWA	Damon S. Williams Associates
DU	Dwelling Unit
DWR	Department of Water Resources



EIR	Environmental Impact Report
ENR	Engineering News Record
fps	Feet Per Second
ft	Feet
ft/kft	Feet Per Thousand Feet
GAMA	Groundwater Ambient Monitoring and Assessment
General Plan	City of Ceres General Plan
GMP	Groundwater Management Plan
gpcd	gallons per capita per day
gpm	Gallons Per Minute
JPA	Joint Powers Authority
LLNL	Lawrence Livermore National Laboratory
LUST	leaking underground storage tanks
MCL	Maximum Contaminant Levels
MG	Million Gallons
mg/L	Milligrams Per Liter
mgd	Million Gallons Per Day
MID	Modesto Irrigation District
NDMA	<i>N</i> -nitrosodimethylamine
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NL	Notification Level
NO <sub>3</sub>	Nitrate
O&M	Operations and Maintenance
PCE	tetrachloroethylene
pCi/L	picoCuries per liter
PFF	Public Facility Fee
PLCs	programmable logic controllers
ppb	Parts Per Billion
psi	Pounds Per Square Inch
PVC	polyvinyl chloride
RAA	Running Annual Average
RSWSP	Regional Surface Water Supply Project
RWQCB	Regional Water Quality Control Board
SBX7-7	Senate Bill X7-7
SCADA	Supervisory Control and Data Acquisition
SLIC	Spills, Leaks, Investigation and Cleanup
SMCL	Secondary Maximum Contaminant Level
SOI	Sphere of Influence
Study Area	Master Plan Study Area
SWRCB	State Water Resources Control Board
TCE	trichloroethylene
TDS	Total Dissolved Solids
TID	Turlock Irrigation District
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey



UWMP	Urban Water Management Plan
VOC	Volatile Organic Chemical
West Yost	West Yost Associates
Wood Rodgers	Wood Rodgers, Inc.

### 1.5 ACKNOWLEDGMENTS

The development of this Water Master Plan would not have been possible without the key involvement and assistance of City staff. In particular, the following staff provided comprehensive information, significant input and important insights throughout the development of this Water Master Plan:

- Michael Brinton, Director Public Works/Assistant City Engineer
- Jeremy Damas, Water System Superintendent
- Tom Westbrook, Planning Manager
- Glenn Gebhardt, City Engineer
- Jason Chapman, Associate Engineer

## CHAPTER 2

### Existing Water System

---



This chapter describes the City's existing water distribution system. System information was obtained through the review of previous reports, maps, plans, operating records, and other available data provided to West Yost by the City. The following sections of this chapter describe the components of the City's existing water distribution system:

- Existing Service Area and Study Area
- Existing Service Connections and Population Served
- Existing Water Supplies
- Existing Water System Facilities

#### 2.1 EXISTING SERVICE AREA AND STUDY AREA

The City is located in Stanislaus County in California's Central San Joaquin Valley, approximately 5 miles south of the City of Modesto, south of the Tuolumne River. The City's existing service area is approximately 4,860 acres, or about 7.6 square miles. While the existing water service area is generally contiguous with the City limit, there are some county pockets located in the northwest portion of the City that receive water service from the City of Modesto. The City also provides water service to a small number of customers who are located outside the current City limit.

The Water Master Plan Study Area (Study Area) is based on the City's current General Plan, which was adopted in 1997. The Study Area includes areas within the Primary and Secondary Spheres of Influence (SOIs), as well as some areas on the south and east side of the City that were designated within the General Plan, but fall outside of the SOIs. Figure 3-1 (in Chapter 3) shows the Study Area, the City limits and the Primary and Secondary SOIs.

The City's water service area and the City's future growth potential are discussed further in *Chapter 3 Existing and Future Water Demands*.

#### 2.2 EXISTING SERVICE CONNECTIONS AND POPULATION SERVED

The City currently provides water service to approximately 11,000 residential, commercial, industrial and institutional/governmental service connections. Almost all of the City's multi-family, commercial, industrial and institutional/governmental water services are metered and the City is currently implementing a meter installation program targeted at single-family residential customers (and other currently non-metered customers), which is anticipated to be completed by Spring 2011.

The current City service area population is approximately 42,000.<sup>1</sup> During the late 1980's and early 1990's, the City experienced a surge in population growth and new housing development. Since 2000, the population of the City has increased approximately 25 percent, mainly as a result

---

<sup>1</sup> City population as reported by State of California, Department of Finance, May 2010. Service area estimated from GIS-based housing counts to exclude unincorporated pockets.



of development occurring in the eastern and southwestern portions of the City. As described in *Chapter 3 Existing and Future Water Demands*, the population of the City's service area at buildout is estimated to be about 96,000, more than double the current population.

A more complete description of the City's service connections and population estimates is provided in *Chapter 3 Existing and Future Water Demands*.

### **2.3 EXISTING WATER SUPPLIES**

#### **2.3.1 Groundwater**

Currently, the City's sole source of potable water is groundwater pumped from fifteen (15) active municipal supply wells which obtain water from the underlying Turlock Subbasin, which is part of the larger San Joaquin Valley Groundwater Basin. As described below, several of the City's wells have water quality concerns and several wells are equipped with wellhead treatment systems to be able to provide a potable water supply which meets applicable drinking water standards. Total production from the City's active wells in 2009 was 9,193 acre-feet.

#### **2.3.2 Surface Water**

The City currently does not have any surface water supplies. However, for the future, the City is exploring the concept of importing surface water supplies to supplement the City's existing groundwater supply. The City is currently evaluating potential future participation in the new Regional Surface Water Supply Project (RSWSP) supplied with water from the Turlock Irrigation District (TID).

#### **2.3.3 Non-Potable Water**

The City currently uses non-potable water pumped from irrigation wells to irrigate several of its public parks. Based on data obtained from City staff, only Smyrna and Roeding Parks are currently irrigated with potable water from the City's potable water system. A new potable well is planned to replace the existing Smyrna Park Well (Well 1) (budgeted in FY 2010/11 Capital Improvement Program). Once this well is completed, the existing well will be converted to irrigation use.

#### **2.3.4 Recycled Water**

The City has previously evaluated the possibility of constructing a secondary and tertiary wastewater treatment plant for the production of tertiary-treated recycled water which could be used for irrigation purposes (and thus offset current and future potable water demands). Recycled water is considered to be a reliable water source because it is consistently available. However, due to significant costs to build a tertiary treatment plant, install dual piping (*e.g.*, purple pipe) to parks and other large landscaped areas, and the Regional Water Quality Control Board's reluctance to add another surface water discharger to the San Joaquin River, the City decided against pursuing this alternative. Primary treated wastewater is currently reused for some minimal on-site landscape irrigation purposes at the City's wastewater treatment facility. Also, the City's existing wastewater treatment facility is designed to allow 74 percent of the treated



wastewater to percolate into the ground, which is recharging the groundwater basin beneath the percolation ponds.<sup>2</sup>

Further discussion of the City's existing and future use of available groundwater supplies, potential future recycled water use, and the potential for the future acquisition of surface water supplies, is provided in *Chapter 4 Integrated Water Supply Plan*.

#### 2.4 EXISTING WATER SYSTEM FACILITIES

##### 2.4.1 Groundwater Wells

As described above, the City currently depends solely on groundwater to meet its customer's water demands. Groundwater is pumped from fifteen (15) active wells capable of producing a total of approximately 14,470 gallons per minute (gpm).<sup>3</sup> Assuming that the largest producing well is out of service (Well 21 Roeding Heights), the City's current firm groundwater pumping capacity is about 12,700 gpm. The City also has three (3) inactive wells which are out of service due to various water quality issues. Figure 2-1 shows the locations of the City's groundwater wells.

Table 2-1 summarizes the available information on the City's active and inactive wells, including their age, current status, design flow rate, measured flow rate, current water quality concerns and current wellhead treatment. As shown in Table 2-1, the completed well depth varies from 93 feet (Well 6, which is currently inactive) to 465 feet (Well 24, which is currently inactive) below ground surface (bgs). Older wells are typically shallower, open-bottom wells, while the newer wells are generally deeper, higher producing gravel-packed wells.

Overall, about 57 percent of the City's firm well production capacity (about 7,300 gpm) does not require wellhead treatment. However, the other 43 percent of the City's firm well production capacity (about 5,400 gpm) does require some form of wellhead treatment. These wells include the following:

- Well 1 (Smyrna Well) is blended with 60 percent system water before entering the distribution system due to elevated uranium and nitrate concentrations;
- Well 25 (Boothe Well) pumps to Hatch Road for blending with water from Well 28 (River Bluff Well) before entering the distribution system due to elevated uranium and nitrate concentrations;
- Well 22 (Rockefeller Well) has an ion exchange wellhead treatment system for the removal of uranium;
- Well 32 (Blaker Well) has a coagulation/ oxidation/filtration wellhead treatment system for removal of arsenic and manganese; and

---

<sup>2</sup> Source: City of Ceres, 2005 Urban Water Management and Conservation Plan, December 2005.

<sup>3</sup> Based on the total combined flow rates of active wells during Summer 2010 pump efficiency testing.

**Table 2-1. City of Ceres Groundwater Well Information<sup>(a)</sup>**

Well No.	Well Name	Well Address	Current Status <sup>(b)</sup>	Backup Power	Variable Frequency Drive (VFD)	Date Drilled	Age of Well (Estimated Remaining Service Life), years <sup>(c)</sup>	Completed Well Depth (Casing Depth), ft bgs	Perforations, ft bgs	Design Flow Rate <sup>(d)</sup>	Measured Flow Rate, gpm <sup>(e)</sup>	Current Wellhead Treatment
<b>ACTIVE WELLS</b>												
1	Smyrna	2650 Fowler Road	Active		✓	1974	36 (<3)	190 (open borehole to 202 ft bgs)	96-186	800	410 (flow rate has been reduced from design flow rate to facilitate blending <sup>(a)</sup> )	Blended with 60% system water for dilution of uranium and nitrate; surface sand separator
14	Firesteins	1906 5 <sup>th</sup> Street	Active			1960	50 (<3)	261 (open borehole to 293 ft bgs)	130-179	240	160	None
16	Hatch & Mitchell	1441 Angie Avenue	Active			1969	41 (0-10)	223	120-160 180-220	230	185	None
20	Kinser	1905 Kinser Road	Active	✓	✓	1976	34 (0-16)	302	138-210	1,825	1,470	Sand separator
21	Roeding Heights	2824 Standford Avenue	Active	✓	✓	1977	33 (0-7)	335	100-124 145-155 290-327	1,600	1,750	None
22	Rockefeller	1921 Rockefeller Avenue	Active		✓	1983	27 (3-13)	252	124-147 162-173 192-210 228-246	1,000	1,586	Ion exchange for removal of uranium; sand filters
23	Hatch & Moffett	2607 Hatch Road	Active	✓	✓	1989	21 (9-19)	425	190-240 255-260 305-330 345-350 400-420	1,538	1,475	None
25	Boothe	1501 Boothe Road	Active			1988	22 (8-18)	264	84-166 172-199 227-241 253-260	563	633	Blended with Well 28 (River Bluff) for dilution of uranium and nitrate: 65% Well 28 and 35% Well 25
27	Sixth Street	2953 6 <sup>th</sup> Street	Active		✓	1998	12 (18-28)	320	195-202 212-236 308-316	1,300	1,400	None
28	River Bluff	3643 East Hatch Road	Active			2003	7 (23-33)	315	245-305	1,200	1,210	None
32	Blaker	4209 Blaker Road	Active		✓	1989	21 (9-19)	360	205-210 218-248 258-270 300-308 342-356	1,800	1,580	Coagulation/ Oxidation/ Filtration for removal of arsenic and manganese
34	Lions Park	1852 River Road	Active	Planned		2008	2 (28-38)	230	120-140 170-230	700	450	None
35	Hackett	401 Hackett Road	Active	Planned		2008	2 (28-38)	180	125-170	650	685	None
36	Little Lions	1856 River Road	Active	Planned		2006	4 (16-26)	230	120-140 170-230	350	405	None
38	Eastgate	1600 Eastgate Boulevard	Active			2009	<1 (40-50)	324	260-264 278-318	1,150	1,070	None
<b>Total Combined Measured Flow Rate for All Active Wells</b>											<b>14,469</b>	
<b>Firm Well Pumping Capacity (assumes largest well is out of service, Well 21 Roeding Heights)</b>											<b>12,719</b>	
<b>Firm Well Pumping Capacity not requiring Wellhead Treatment</b>											<b>5,677</b>	57%
<b>Firm Well Pumping Capacity requiring Wellhead Treatment (includes Well 28 which is blended with Well 25)</b>											<b>4,149</b>	43%
<b>INACTIVE WELLS</b>												
6	Hollister	1904 Hollister Road	Inactive (may be modified or a new well may be drilled at site)			1948	61 (0)	93 (open borehole to 118 ft bgs)	None	--	--	No treatment system; nitrate exceeds MCL
19	Paramount	1511 Giddings Street	Inactive (will either be converted to a monitoring well or will be destroyed)			1971	39 (0)	189 (open borehole to 201 ft bgs)	89-189	--	--	Ion exchange for removal of uranium and manganese; sand separator
24	Central	845 Central Avenue	Inactive (has never been used)			1989	21 (?)	465	225-235 304-334 25-430 441-461	--	--	No treatment system; specific conductance and manganese exceeding MCL

(a) Based on information compiled by Wood Rodgers for the City of Ceres Water Master Plan Well Field and Hydrogeologic Assessments dated July 13, 2010 (Table 1).

(b) Current status as of July 2010.

(c) Based on information compiled by Wood Rodgers for the City of Ceres Water Master Plan Well Field and Hydrogeologic Assessments dated July 13, 2010 (Table 1).

(d) Well design flow data provided by City of Ceres May 4, 2009.

(e) Well flow rates as measured during summer 2010 pump efficiency testing.

bgs = below ground surface

gpm = gallons per minute



- Well 19 (Paramount Well) has an ion exchange wellhead treatment system for the removal of uranium and manganese; however, the well is currently inactive as it also has a sand production problem.

During typical operations, the City's wells are sequenced to turn on/off to match customer demand patterns. The City's well pumps are currently automatically controlled based on local system pressures. Wells turn on when system pressures drop to about 40 to 45 pounds per square inch (psi), and turn off when pressures are about 60 to 65 psi. Once the system demands increase and exceed the supply capacity of the active wells and system pressures begin to decline, the booster pumps at Blaker Reservoir turn on. These pumps boost water from the existing storage tanks into the system, and are operated during high demand periods (see further discussion regarding the City's storage tanks and booster pumps below).

As part of this Water Master Plan effort, Wood Rodgers, Inc. prepared a Well Field and Hydrogeologic Assessment Report providing an assessment of the current condition, operation and quality of the groundwater produced by the City's wells. Part of this assessment was to evaluate the estimated remaining service life for each of the City's wells. As shown on Table 2-1, many of the City's wells are at or near their estimated service life. Although actual service life can vary greatly from well to well and depends on numerous factors, this is an indication that some of the City's wells may need to be replaced within the next few years.

Also, as part of the Water Master Plan, Damon S. Williams Associates (DSWA) prepared an evaluation of historical and current water quality produced by the City wells, and developed recommendations and conceptual cost estimates for potential groundwater treatment options, including various wellhead treatment technologies and various blending alternatives. A summary of the current wellhead treatment systems in place on existing City wells is provided in Table 2-1.

Information compiled and evaluated by Wood Rodgers, Inc. and DSWA is further discussed in the groundwater section of *Chapter 4 Integrated Water Supply Plan*.

#### **2.4.2 Water Distribution System & Storage and Pumping Facilities**

The City's water distribution system consists of a single pressure zone, with an average ground surface elevation of about 95 feet above mean sea level (approximately 100 feet at the intersection of Hatch and Mitchell roads in the northeast area of the City, and approximately 85 feet near Roeding and Blaker Roads in the southwest part of the City). The City's distribution system facilities are described as follows.

##### **2.4.2.1 Water Pipelines**

The City has approximately 140 miles of water system pipelines. These pipelines generally range from 2 to 24 inches in diameter, and are made up of mostly asbestos-cement (ACP), steel, and polyvinyl chloride (PVC). The newer pipelines (installed since the 1990s) are PVC, while the older pipelines installed in the 1980s are ACP. Generally, pipelines under 6 inches in diameter are steel. A few of the newer, larger pipelines are also ductile iron (such as the 18- and 24-inch diameter pipelines in Service Road).



#### 2.4.2.2 Treated Water Storage Facilities

The City has two at-grade reservoirs located adjacent to each other at their Blaker Road facility (see Figure 2-1). They have a total combined storage capacity of 3.8 million gallons (MG) as shown in Table 2-2. The construction of Reservoir 2 was completed in 2006.

**Table 2-2. City of Ceres Treated Water Storage Facilities**

Storage Facility	Capacity, MG	Diameter, feet	MSL Elevations, feet	
			Floor	Overflow
Reservoir 1	1.5	110	81.5	103
Reservoir 2	2.3	135	81.5	103
Total Capacity	3.8			

During periods of high demand, water is pumped from the tanks into the distribution system to supplement the well supplies. The tanks have a sustaining valve that opens to allow replenishment of the tanks during lower demand periods when well capacity is available.

#### 2.4.2.3 Booster Pump Station

The City has one booster pump station, the Blaker Booster Pump Station (BPS), located at the potable water storage tanks site at Blaker Road (see Figure 2-1). The station has a total of six booster pumps, with each pump rated at 1,500 gpm, as shown in Table 2-3. One pump is normally on stand-by, making the firm booster pump station capacity 7,500 gpm. The pumps have variable speed drives allowing them to produce a wide range of flows to meet demands.

The Blaker BPS is controlled by pressure points within the distribution system and turns on when pressures within the system drop below about 50 psi. Pumps then turn on sequentially as needed to maintain required pressures within the system.

**Table 2-3. City of Ceres Reservoir Booster Pump Station Characteristics**

Booster Pump	Design Flow, gpm	Horsepower, hp	Speed, rpm	Head, ft	Installation Date
Booster Pump #1	1,500	100	1,780	190	1991
Booster Pump #2	1,500	100	1,780	190	1991
Booster Pump #3	1,500	100	1,780	190	1991
Booster Pump #4	1,500	100	1,780	190	1991
Booster Pump #5	1,500	100	1,780	190	2006
Booster Pump #6	1,500	100	1,780	190	2006
Total Firm Capacity <sup>(a)</sup>	7,500				

<sup>(a)</sup> Assumes largest pump is out of service.



#### 2.4.3 Backup Power Provisions

The City currently has backup power facilities installed at some of its facilities. These include the following:

- Blaker BPS (for two pumps only; City has a Capital Improvement Project (CIP) planned to install a new generator to provide back-up power for the entire station);
- Well 20;
- Well 21; and
- Well 23.

In addition, the City has included funds in the FY 2010/11 budget to install generators at Wells 34, 35, and 36.

#### 2.4.4 SCADA System

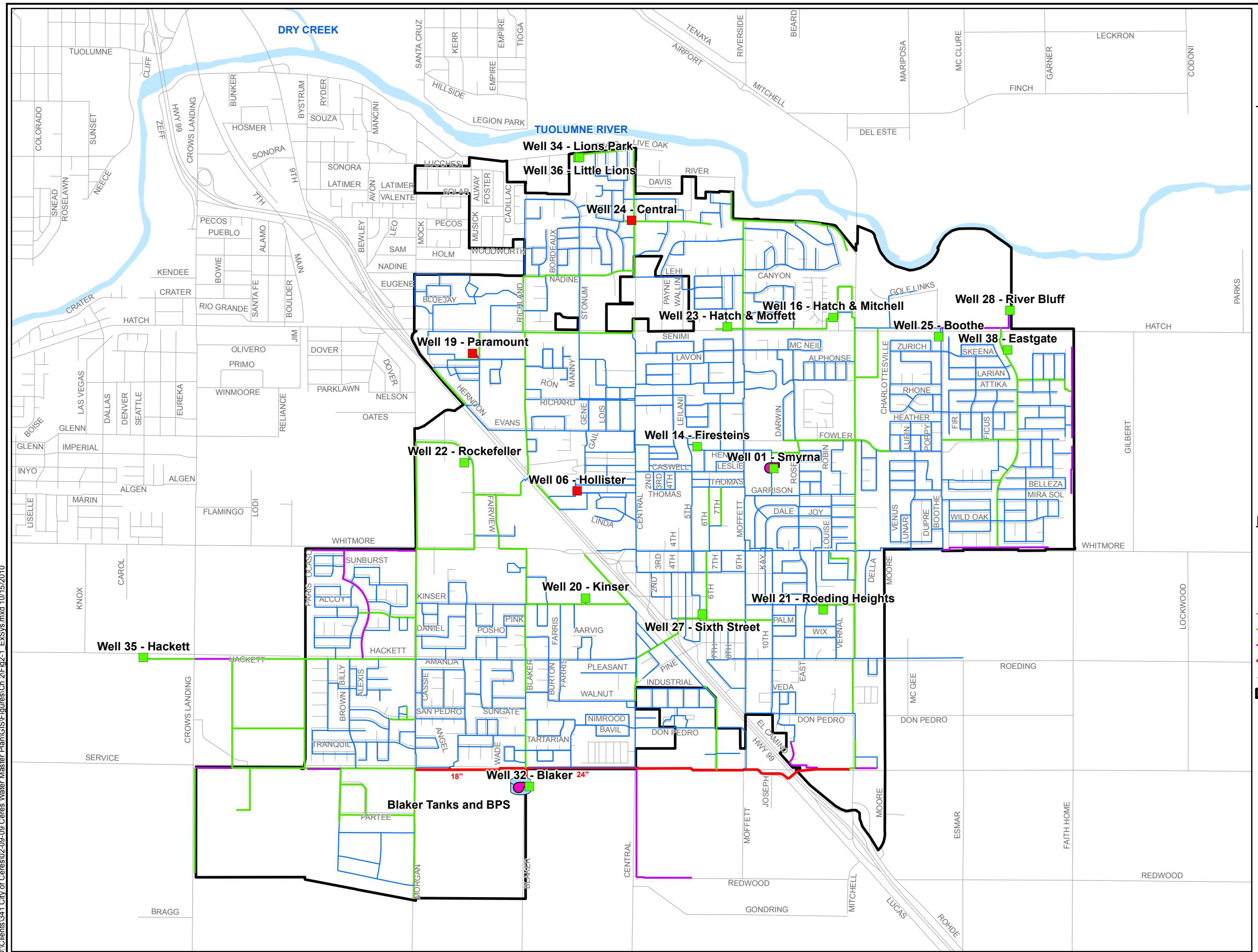
The City's SCADA system was installed in 2006 to enable remote monitoring and operational control of system facilities. However, since its installation, the SCADA system has not performed well due to a number of interface, calibration and controls issues. The City included funds in the FY 2009/10 fiscal year budget to repair the SCADA system. These repairs have yet to be made; however, once the SCADA system has been repaired and upgraded, the City will budget resources to calibrate and maintain the SCADA system.

Currently, as described above, the City's wells and Blaker BPS are locally controlled based on system pressures. The City is planning to install new programmable logic controllers (PLCs) at its stations (to be completed in the next few years) which will allow for remote control of the City's stations.

## FIGURE 2-1

## City of Ceres Water Master Plan

## EXISTING WATER SYSTEM



## CHAPTER 3

### Existing and Future Demands

---



#### 3.1 OVERVIEW

This chapter presents the existing and projected buildout water demands for the City. These water demand estimates were used to identify the required water supply to service the buildout water system. They were also used to update the City's water distribution system model for hydraulic analyses.

Accurate and detailed water demand data and projections are required to develop and calibrate the potable water system hydraulic model, help identify potential deficiencies in the existing water system, and assist in the assessment of the buildout water system capacity and future capital improvement program based on anticipated development. Future water demand projections also play a key role in helping the City identify and secure sufficient water supplies to serve their future customers under various hydrologic conditions.

The following sections of this chapter describe the data and methodology used to determine the City's existing and future water system demands:

- Water Service Area Characteristics
- Historic Water Production and Consumption
- Water Conservation
- Adopted Peaking Factors
- Water Demand Projections

#### 3.2 WATER SERVICE AREA CHARACTERISTICS

The City of Ceres is located in Stanislaus County approximately 5 miles south of the City of Modesto, south of the Tuolumne River. The City's existing water service area is approximately 4,860 acres or about 7.6 square miles. Figure 3-1 shows the Water Master Plan Study Area, the City limits and the Primary and Secondary SOIs. While the existing water service area is generally contiguous with the City limit, the northwest portion of the City receives water service from the City of Modesto, as shown on Figure 3-1. The City also provides water service to a small number of customers who are outside of the current City limit.

The Study Area used for this analysis is based on the City's current General Plan, which was adopted in 1997, and the land use defined in the General Plan<sup>1</sup>. The Study Area includes areas within the Primary and Secondary SOI's, as well as some areas on the south and east side of the City that were designated within the General Plan, but fall outside of the SOI's. Currently, future growth potential for the City includes infill within the City limits and development of areas outside the City limits within the proposed SOI boundary. Additional discussion regarding the City's land uses is presented in *Section 3.2.3 Summary of Existing and Projected Future Land Use*.

---

<sup>1</sup> See Section 3.2.3 Summary of Existing and Future Land Use for discussion regarding land uses within the Study Area.



## Chapter 3

### Existing and Future Demands

Subsequent sections describe the existing number of services by customer class, historical population served, and existing and projected land uses within the City.

#### 3.2.1 Existing Number of Services

The City is currently implementing a residential metering program (all other customer classes are already metered) and anticipates being fully metered by Spring 2011. Table 3-1 summarizes the number of water service connections by meter size.

<b>Table 3-1. Summary of Existing Water Service Connections by Meter Size<sup>(a)</sup></b>		
<b>Meter Size</b>	<b>Number of Services</b>	<b>Percent of Services</b>
5/8"	285	2.5%
3/4"	10,357	92.0%
1"	164	1.5%
1-1/2"	140	1.2%
2"	272	2.4%
3"	8	0.1%
4"	36	0.3%
8"	1	0.0%
<b>Total</b>	<b>11,263</b>	<b>100%</b>

<sup>(a)</sup> Source: Data provided by City staff on March 16, 2011.

#### 3.2.2 Historical and Future Population

The current City service area population is approximately 42,000. The historical annual population of the City, shown in Table 3-2, was obtained from the California Department of Finance (DOF), Table E-5, City/County Population and Housing estimates (State of California, Department of Finance, May 2010). The water service area excludes small areas in the northwest and northern parts of the City that are served by the City of Modesto. To determine the City's actual water service area population, the DOF population estimates were adjusted based on dwelling unit counts and average person per household densities reported by DOF to exclude the population within the Ceres city limit that is served by the City of Modesto. It is estimated that about 1,200 people are served by the City of Modesto. As shown in Table 3-2, the population of the City water service area has increased from about 33,400 people in 2000 to approximately 42,000 people in 2010, representing an approximately 25 percent increase over the past ten years. This increase in population is mainly the result of development occurring in the eastern and southwestern portions of the City.

Buildout population was estimated using projected land use for the Study Area, assumed future development at densities similar to historical development, and current persons/household estimates from Department of Finance. The population of the City's service area at buildout is estimated to be about 96,000.



**Table 3-2. Historical and Projected Population<sup>(a)</sup>**

Year	DOF Population	Service Area Population	Persons/HH
2000	34,609	33,395	3.307
2001	35,111	33,885	3.341
2002	35,805	34,570	3.364
2003	36,519	35,277	3.384
2004	37,473	36,231	3.385
2005	38,712	37,479	3.360
2006	40,719	39,502	3.317
2007	41,678	40,470	3.292
2008	42,491	41,282	3.295
2009	42,888	41,678	3.298
2010	43,219	42,001	3.320
2015 <sup>(b)</sup>		43,600	
Buildout <sup>(b)</sup>		96,100	

(a) Population estimates (with the exception of buildout estimates) obtained from State of California, Department of Finance, E-5, Population and Housing Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark. Sacramento, California, May 2010. Estimates are as of January 1st in each listed year. Service Area population was estimated by excluding homes in North Ceres that are served by the City of Modesto.  
(b) Calculated based on future developed land use within the Study Area, assuming continuation of development at historical densities, and using current Department of Finance estimates of persons/household. The Study Area, shown on Figure 3-1, includes areas within the Primary and Secondary SOI's, as well as areas designated in the General Plan, but currently outside of the SOI's.

### 3.2.3 Summary of Existing and Projected Future Land Use

Existing and future land use maps were developed by ECO:LOGIC for the City's Sewer Master Plan. These land use maps were developed based on data from (1) the City's most recent General Plan land use AutoCAD file,<sup>2</sup> which includes land use assumptions from the 1997 General Plan; (2) City-provided assumptions for dwelling unit densities of 9 units/acre for currently undesignated residential reserve areas; and (3) the City's most recent vacant land inventory<sup>3</sup> for land use parcels within the City limits. Vacant land use parcels outside of the City limits were identified previously by ECO:LOGIC in the October 2008 *City of Ceres Preliminary Wastewater System Capacity Analysis*. A memorandum, prepared by ECO:LOGIC, explaining the development of the existing and future land use maps is provided in Appendix A.

To provide consistency between the City's Sewer and Water Master Plans, the GIS land use files developed by ECO:LOGIC were subsequently provided to West Yost as a basis for developing the City's Water Master Plan. However, West Yost made some revisions to the GIS land use files provided by ECO:LOGIC to remove parcels currently in the City of Modesto's North Ceres and Walnut Manor water service areas. These parcels are currently served by the City of

<sup>2</sup> Source: *xr\_gp09.dwg* received from the City on October 14, 2009.

<sup>3</sup> Source: *Ceres Vacant Land Inventory 4-1-10.xls* received from the City on April 6, 2010



Modesto and will continue to be served by Modesto. In addition, based on a discussion with City staff, West Yost also re-categorized ECO:LOGIC's proposed future development phasing to better represent the timing of future development proposed for this Water Master Plan. Table 3-3 lists ECO:LOGIC's proposed phasing of future development and West Yost's respective re-categorization of those phases.

**Table 3-3. Assumed Phasing of Future Development for Water Distribution System Master Plan**

Sewer System Master Plan Phasing Category <sup>(a)</sup>	Water Master Plan Phasing Category
Phase I – Development of Infill within the existing City Limits	2015
Phase II - Development within the proposed Primary SOI	Buildout
Phase III – Remaining development areas within the Study Area	

<sup>(a)</sup> Source: *City of Ceres Sewer Master Plan Existing and 1997 General Plan Growth Area Land Use – Updated May 4, 2010*  
Memorandum prepared by ECO:LOGIC and dated May 4, 2010.

Figure 3-2 illustrates the City's existing land uses, Figure 3-3 illustrates the proposed land uses in 2015, and Figure 3-4 illustrates the proposed land uses at buildout of the City's Study Area developed for this Water Master Plan. As shown in Figures 3-3 and 3-4, future development in the City includes development of infill (vacant properties) within the City limits (2015), and development of areas outside of the City limits within the proposed Study Area (Buildout).

Table 3-4 summarizes the existing and projected future land uses within the City's Study Area, which were evaluated for this Water Master Plan. For reference, areas provided with water service by the City of Modesto are also provided on this table. Based on the existing vacant land use data presented in Table 3-4, approximately 11 percent of the City's service area is currently vacant. Consequently, this data indicates that the remaining 89 percent of the City is currently developed and has potable water use. However, as identified by City staff, most parks are irrigated with non-potable water (see *Section 3.3.4 Existing and Potential Non-Potable Water Use Areas*). Table 3-4 also indicates that by buildout, the City is expected to almost double its current service area.

As noted in Table 3-4, the following additional assumptions were made for Residential Agriculture and Downtown Commercial land use designations:

1. Based on ECO:LOGIC's EDU density assumptions, 0.4 dwelling units per acre (or 1 DU/2.5 acres) were assumed for the Residential Agriculture land use area. In addition, West Yost assumed that each dwelling unit would have a potable water use area of 0.25 acres, and no potable water demand was associated with the remaining 2.25-acre area. Consequently, the remaining acres of Residential Agriculture land use are considered Agriculture land use.
2. Downtown Commercial land use assumes that the proposed densification occurs at buildout of the Study Area.

**Table 3-4. Summary of Existing and Projected Future Land Use**

West Yost Land Use Designation	General Plan Land Use Designation	Existing Land Use <sup>(a)</sup>		2015 Land Use <sup>(b)</sup>		Buildout Land Use <sup>(c)</sup>	
		Existing Area in City of Ceres Service Area, acres <sup>(d)</sup>	Existing Area in City of Modesto Service Area, acres <sup>(d)</sup>	Additional Area in City of Ceres Service Area, acres <sup>(d)</sup>	Additional Area in City of Modesto Service Area, acres <sup>(d)</sup>	Additional Area in City of Ceres Service Area, acres <sup>(d)</sup>	Additional Area in City of Modesto Service Area, acres <sup>(d)</sup>
Low Density Residential	Very Low Density Residential	113	-	24	-	575	41
	Low Density Residential	1,492	113	29	24	857	66
	Residential Reserve <sup>(e)</sup>	-	-	-	-	659	-
	Residential Agriculture <sup>(e)</sup>	-	-	-	-	97	-
Medium Density Residential	Medium Density Residential	315	40	25	1	128	7
	High Density Residential	144	31	3	4	41	-
	Business Park	8	-	14	-	85	-
	Commercial Recreation	29	-	2	-	141	-
Commercial/Office	Community Commercial	180	-	52	9	26	1
	Downtown Commercial <sup>(f)</sup>	22	-	-	-	-	-
	Highway Commercial	64	3	19	2	11	-
	Neighborhood Commercial	16	2	9	-	6	1
Industrial	Office	42	-	8	-	28	-
	Regional Commercial	30	-	67	-	0	-
	Service Commercial	40	4	9	18	45	35
	General Industrial	204	-	93	-	-	161
Public/Institutional	Light Industrial	185	-	20	-	250	-
	Industrial Reserve	-	-	-	-	470	-
	Community Facilities	238	-	4	0	157	-
	School	148	-	-	9	89	-
Parks	Parks	136	-	38	-	20	32
	Vacant	417	68	-	-	-	-
<b>Total</b>		<b>3,822</b>	<b>259</b>	<b>417</b>	<b>68</b>	<b>3,685</b>	<b>345</b>

<sup>(a)</sup> Source: Existing Land Use Parcels in Service Area (West Yost).shp provided by ECO:LOGIC on May 5, 2010.

<sup>(b)</sup> Source: Build-out on Land Use Parcels in Service Area (West Yost).shp provided by ECO:LOGIC on May 5, 2010.

<sup>(c)</sup> Source: Phase I General Plan Development Land Use Parcels.shp and Phase II General Plan Development Land Use Parcels.shp provided by ECO:LOGIC on May 4, 2010.

<sup>(d)</sup> Area only accounts for net acreages (i.e., excluding streets and right-of-ways). At buildout, 20 percent of the gross acres from the buildout land use files is removed to account for future streets and right-of-ways.

<sup>(e)</sup> Assume 0.4 dwelling units per acre, based on ECO:LOGIC's EDU density assumptions. West Yost assumes a portable water area of 0.25 acres per dwelling unit.

<sup>(f)</sup> Proposed densification by buildout.



## Chapter 3

### Existing and Future Demands

---

The GIS land use files developed by ECO:LOGIC including revisions and assumptions made by West Yost, as discussed above, were used to calculate existing and future water demands (see *Section 3.6.5 Projected Future Water Demands*).

#### 3.2.4 Existing and Potential Non-Potable Water Use Areas

As discussed above, the City currently uses non-potable water to irrigate many of its public parks. These parks are supplied with non-potable groundwater from on-site irrigation wells. Based on data from City staff, only Smyrna and Roeding Parks are currently irrigated by the City's potable water system<sup>4</sup>. However, once a replacement well is constructed for Well 1, the existing well will be converted to irrigation use. There is currently a City municipal supply well located in Roeding Park. Over time, a replacement well will be needed, and at that time it is anticipated that the on-site well will be converted to irrigation use. Agricultural land use areas identified as Residential Agriculture land use are also assumed to be irrigated with non-potable water. Consequently, at buildout of the Study Area, it is assumed that all Parks and Agriculture land use areas will be irrigated with non-potable water.

In the future, the City may want to consider the use of non-potable water to also irrigate Commercial/Office, Industrial, and Public/Institutional landscaping. This will help offset and reduce the water demand from the City's potable water system. However, a new non-potable water supply (groundwater or possibly recycled water) and distribution system will be required, and may be cost prohibitive. Evaluations of potable water savings from the potential use of non-potable water to irrigate all or some of the Commercial/Office, Industrial, and Public/Institutional landscaping are beyond the scope of this Water Master Plan. However, West Yost recommends that these evaluations be performed if the City decides that the use of non-potable water to irrigate landscaping is feasible.

#### 3.3 HISTORICAL WATER PRODUCTION AND CONSUMPTION

Water production is the total quantity of water produced by the City's groundwater wells, while water consumption is the quantity of water actually consumed or used by its customers. As will be discussed later, the difference between production and consumption is unaccounted-for water (UAFW).

The City currently tracks all of the water produced by its wells, and with the exception of the unmetered Single Family Residential accounts, it also meters all of its multi-family and non-residential customers within the City. Although the City tracks water use in two ways (production records and meter records), unmetered single family residential consumption constitutes the largest use.<sup>5</sup> Therefore, UAFW must be estimated. Production, metered water use, and UAFW are discussed in more detail below.

---

<sup>4</sup> Source: *Irrigation Wells .doc* received from the City on May 19, 2010.

<sup>5</sup> At the time of the Water Master Plan analysis, the City's single family residential water users were unmetered. The City completed a meter installation program for its unmetered residential customers in Spring 2011.



#### 3.3.1 Historical Water Production

Annual groundwater production from the City's well operational records during the 10-year period from 2000 to 2009 is summarized in Table 3-5. The City produced on average approximately 9,900 acre feet per annum (af/yr), which is equivalent to an average day demand of approximately 8.9 million gallons per day (mgd).

**Table 3-5. Historical Water Production (2000-2009)<sup>(a)</sup>**

Year	Annual Production, af	Annual Production, MG	Average Day Production, mgd
2000	9,020	2,939	8.05
2001	9,451	3,080	8.44
2002	10,067	3,280	8.99
2003	9,748	3,176	8.70
2004	10,141	3,305	9.05
2005	10,140	3,304	9.05
2006	10,125	3,299	9.04
2007	10,823	3,527	9.66
2008	10,613	3,458	9.47
2009	9,193	2,996	8.21
Average	9,932	3,236	8.87

<sup>(a)</sup> Source: City Record data, Gallons Pumped.xls, containing monthly well production records and annual statistics from 2001 through 2010 (partial year).

Figure 3-5 compares the total historical annual water production with historical average annual rainfall for 2000 through 2009. For this relatively short historical period, there are no discernable trends between water use and rainfall.

Figure 3-6 illustrates the historical monthly water production between 2005 and 2009. The average maximum month production is approximately 440 MG. These data indicate that the City's highest monthly water production has historically occurred in either the month of June or July, which corresponds with high temperatures and minimal rainfall that is experienced in the City during these summer months. The lowest productions are observed during the winter months (December, January, and/or February), as expected when there is minimal outside water use.

#### 3.3.2 Historical Water Consumption

The City is currently implementing a residential metering program to meter all customers by the Spring of 2011. Prior to this program's implementation, most single family residential customers were unmetered and billed on a "flat rate" basis. Therefore, complete historical metered water consumption information for all customer classes is not available. Metered consumption is available for the Multi-Family Residential, Commercial, Industrial, Irrigation, and Government customer classes (approximately 23 percent of the City's total water production). However,



## Chapter 3

### Existing and Future Demands

billing records provided by the City had numerous duplicate accounts and anomalous readings. Table 3-6 summarizes the historical metered water consumption by customer class for the period 2006 through 2008, after adjustments to the data were made.

West Yost used the billing data to develop unit water demand factors, after adjusting the billing records as noted above (see *Section 3.6.2 Verification of Unit Water Demand Factors*). As the City implements its residential metering program, additional data will then be available to refine the City's historical metered water consumption.

**Table 3-6. Historical Metered Water Consumption by Customer Class, million gallons/year<sup>(a)</sup>**

Customer Class	2006	2007	2008
Multi-Family Residential	194	237	258
Commercial	109	165	161
Industrial	39	38	30
Irrigation	174	217	231
Government	173	171	129
Total Metered Consumption	689	827	809
Total Production	3,299	3,527	3,458
Metered Consumption as a Percent of Total Production	21%	23%	23%

<sup>(a)</sup> Source: City billing data (Consumption Export (3 Yr ALL).xls as adjusted by West Yost to remove duplicate accounts and anomalous readings.

### 3.3.3 Historical Unaccounted for Water (UAFW)

UAFW is typically the difference between the recorded water production and metered water consumption. UAFW includes a combination of various water uses that are not metered, such as water used for hydrant testing, firefighting, and system flushing or water that is lost from system leaks and water main breaks.

Because the City does not currently meter all customer water use, it is impossible to calculate the exact amount of unaccounted for water lost throughout the entire system. For purposes of this Water Master Plan, unaccounted for water for the overall system is assumed to be 15 percent. However, metering and reading of the City's entire residential sector will be required to verify this.

Water utilities strive to minimize the amount of unaccounted for water; however, it is difficult, if not impossible, to eliminate entirely. A survey of water agencies in the United States conducted by the American Water Works Association (AWWA) found that unaccounted for water in utilities across the country varied between 7.5 percent to 25 percent<sup>6</sup>. Therefore, the assumption

<sup>6</sup> Survey of State Agency Water Loss Reporting Practices, Final Report to the American Water Works Association, prepared by Janice A. Beecher, Ph.D., Beecher Policy Research, Inc., January 2002.



## Chapter 3

### Existing and Future Demands

of 15 percent UAFW is reasonable for the City's water system. Taking into account the planned meter installation schedule by the City's Operations Division, UAFW is assumed to decrease from 15 percent to 10 percent by buildout to account for improved leak detection and repair when the City is fully metered.

#### 3.3.4 Historical Per Capita Water Demand

Historical per capita water demands were calculated by dividing the annual water production by the service area annual population. Table 3-7 summarizes the historical per capita water demands for the City between 2000 and 2009. As shown in Table 3-7, the historical average per capita water demand has averaged to approximately 238 gallons per capita per day (gpcd) over the past ten years.

**Table 3-7. Historical Per Capita Water Demand (2000-2009)**

Year	Estimated Service Area Population <sup>(a)</sup>	Water Production, MG <sup>(b)</sup>	Per Capita Water Demand, gpcd
2000	33,995	2,939	241
2001	33,885	3,080	249
2002	34,570	3,280	260
2003	35,277	3,176	247
2004	36,231	3,305	250
2005	37,479	3,304	242
2006	39,502	3,299	229
2007	40,470	3,527	239
2008	41,282	3,458	230
2009	41,678	2,996	197
Average			238
<sup>(a)</sup> Source: See Table 3-2.			
<sup>(b)</sup> Source: See Table 3-5.			

Figure 3-7 compares the historical per capita water demand, historical water production, and historical population. As shown on the figure, the historical population has increased continuously since 2001, more rapidly between 2003 and 2006 and then more slowly from 2007 through 2009. During that same time period, water production has remained relatively constant. As a result, per capita water use has declined since 2002. The ten-year average per capita water use is 238 gpcd, while 2009 per capita use is 197 gpcd.

## 3.4 WATER CONSERVATION

A key principle that relates to the Water Master Plan is water conservation. Water conservation will be necessary to meet requirements set by the State under SBx7-7 (e.g., 20 x 2020 Legislation) to reduce the City's water use. Discussions regarding existing and future water conservation in the City are presented below.



## Chapter 3

### Existing and Future Demands

---

#### 3.4.1 Existing Water Conservation

The City is committed to preserving California's water resources through water conservation and efficient use of water, and currently has a Demand Management Measure Implementation Plan (ECO:LOGIC, November 2009) that implements many of the CUWCC's Best Management Practices (BMPs). These BMPs include residential surveys, public and school education programs, rebates for water efficient appliances large landscaping programs, commodity-based metering and system leak detection programs.

#### 3.4.2 Compliance with 20 x 2020 Legislation

In February 2008, Governor Arnold Schwarzenegger called for a statewide 20 percent reduction in per capita water use by 2020 and asked state and local agencies to develop a more aggressive plan of water conservation to achieve the goal. A team of state and federal agencies (the 20x2020 Agency Team) consisting of the DWR, SWRCB, California Energy Commission, Public Utilities Commission, Department of Public Health, Air Resources Board, CALFED Program, USBR, and CUWCC was formed to develop a statewide implementation plan for achieving this goal.

On November 10, 2009, Governor Arnold Schwarzenegger signed Senate Bill x7-7 (SBx7-7) The Water Conservation Act of 2009, one of several bills passed as part of a comprehensive set of new Delta and water policy legislation. SBx7-7 requires a 20 percent reduction in urban water usage by 2020 and establishes various methodologies for urban water suppliers to establish their interim (2015) and final (2020) per capita water use targets.

Four methodologies are identified in SBx7-7 for establishing per capita water use targets:

- Method 1: A 20 percent reduction from historical baseline per capita water use based on a 10-year running average per capita water use ending between December 31, 2004 and December 31, 2010.
- Method 2: Per capita water use based on 55 gallons per capita per day water use for residential water use, landscape irrigation use based on water efficiency equivalent to the standards of the Model Water Efficient Landscape Ordinance, and a 10 percent reduction from baseline commercial, industrial and institutional (CII) water use.
- Method 3: 95 percent of the hydrologic region targets established in the capita water use based on the April 2009 Draft 20x2020 Water Conservation Plan.
- Method 4: A provisional approach that considers the water conservation potential from (1) indoor residential savings, (2) metering savings, (3) commercial, industrial and institutional savings, and (4) landscape and water loss savings.



## Chapter 3

### Existing and Future Demands

Based on West Yost's evaluation of these four methods<sup>7</sup>, the City adopted Method 1 to calculate its 2015 interim urban water use and 2020 final target urban water use. Under Method 1 the City's baseline water use would be calculated to be 243 gpcd. Therefore, the 2015 interim target would be 90 percent of 243 gpcd, or 219 gpcd and the 2020 final target would be 80 percent of 243 gpcd, or 194 gpcd.

Based on 2009 per capita water use of 197 gpcd, the City is very close to meeting its 2020 target water use, if this level of water use can be sustained. Recent reductions in per capita use are likely influenced by the economic downturn and multiple dry years, and may not be sustainable once economic conditions improve. However, the City is also implementing metering of its single family residential customers, which is expected to reduce per capita residential water use by 10 to 20 percent.

### 3.5 ADOPTED PEAKING FACTORS

Demand peaking factors are multiplication factors used to calculate water demands expected during high demand conditions. The most commonly used demand conditions for water supply and system evaluations include maximum day and peak hour demands. These demands are generally used to evaluate and size water transmission pipelines, pumping facilities, and storage facilities, and to define water supply needs and capacity requirements.

Table 3-8 shows the historical average day and maximum day demand for the City's water system compiled from 2001 to 2009. The maximum day demand peaking factor varies from 1.63 to 1.98, and averages 1.74. It was decided, based on discussions with City staff, to use an average day to maximum day demand factor of 1.8 for this study.

**Table 3-8. Historical Maximum Day Peaking Factors<sup>(a)</sup>**

Year	Average Day, mgd	Maximum Day, mgd	Peaking Factor <sup>(b)</sup>
2001	8.44	14.66	1.74
2002	8.99	15.41	1.71
2003	8.70	15.09	1.73
2004	9.05	15.47	1.71
2005	9.05	16.65	1.84
2006	9.04	16.71	1.85
2007	9.66	15.77	1.63
2008	9.47	15.17	1.60
2009	8.21	16.25	1.98
Average			1.74

<sup>(a)</sup> All data from City's operational records.

<sup>(b)</sup> Maximum day peaking factor is the Maximum Day Demand divided by the Average Day Demand.

<sup>7</sup> Ceres historical baseline water use is calculated to be 243 gpcd, based on the 10-year running average from 1999 through 2008. See Compliance with the Water Conservation Act of 2009 prepared by West Yost Associates, dated March 22, 2011 for details of the gpcd calculations.



To evaluate hourly usage trends and peak hour usage, the City provided a SCADA report of total system flow and average pressure for June 23, 2009 through June 26, 2009, a peak usage period close to maximum day usage (the maximum use day in 2009 was June 27, 2009). This file reports flows and pressures at specific times throughout the four-day period, and appears to provide a flow or pressure report anytime there was a change in overall system status. Total system flow is assumed to include all well production, and Blaker booster station flow, but not flow through the altitude valve that re-fills the Blaker tanks, which is not recorded by SCADA. Separately, the City also provided hourly average flows and pressures for the Blaker tanks and booster station. Using these two files, West Yost constructed hourly diurnal curves for the three complete reporting days, June 24<sup>th</sup> through June 26<sup>th</sup>. Tank inflow was calculated from Blaker tank level data, and tank geometry.

Figure 3-8 shows the computed hourly diurnal curve for these three days. The curves for each day were normalized by dividing the computed hourly flow by the average daily flow, representing the ratio of the hourly flow to the average daily flow. In this way, the three days can be compared. As the figure shows, the three days show similar hourly usage patterns, with a morning and evening peak use period. The evening peak usage pattern occurs at 8:00 PM, and averages about 1.6 times the average daily use, significantly higher than the morning peak at about 1.2 times the average daily use. Based on the SCADA data, a peak hour peaking factor of 1.6 times maximum day demand, or 2.9 times average daily demand was selected for the Water Master Plan.

Table 3-9 summarizes the peaking factors used in this study for the sizing of water system facilities.

**Table 3-9. Ceres Adopted Peaking Factors**

Peaking Factor	Value
Average Day to Maximum Day Demand	1.8
Average Day to Peak Hour Demand	2.9

### 3.6 WATER DEMAND PROJECTIONS

Water demands are projected for 2015 and buildout of the City's Study Area by using data from: (1) existing water consumption and land use; (2) additional 2015 land use areas; and, (3) additional buildout land use areas (see Table 3-4).

Existing water demands were based on the City's total water production from 2007. Water production data from 2007 was used instead of 2008 or 2009 data because it is more representative of actual water use within the City before the recent economic downturn and drought conditions, and provides a more conservative water demand estimate to account for typical water use patterns during normal hydrologic conditions.



Future water demands were calculated using a unit water demand methodology based on the additional land use areas to be developed. Subsequent sections describe the development of the unit water demand methodology including estimated savings from conversion of residential flat rate to metered accounts, followed by a discussion of total projected water demands at 2015 and buildout.

#### 3.6.1 Development of Unit Water Demand Factors

Unit water demand factors were estimated for various land use types based on water consumption and land use data. These factors are typically expressed in annual water use per acre, and are multiplied by land use area data to calculate a water demand estimate. The following sections discuss the methodologies used to develop the unit water demand factors.

Unit water demand factors were calculated using the City's existing land use and Stanislaus County parcel information in GIS format, which were correlated to the City's existing metered water use data in Excel format. This process was completed using tools available in GIS software as discussed and illustrated below.

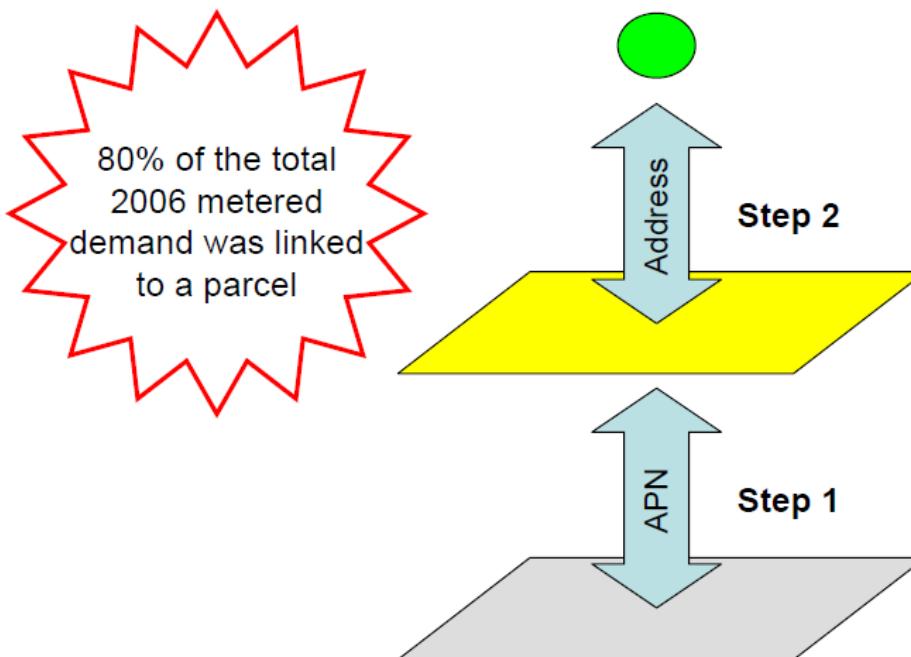
To calculate unit water demand factors by land use designation, the City's existing land use data was first linked to the Stanislaus County parcel data by assessor's parcel number (APN) to append an address to each parcel within the existing land use file (Step 1). This refined existing land use file was then linked to the City's 2006 meter data<sup>8</sup> by address, (Step 2) to assign the existing water use to each parcel. Figure 3-9 illustrates the methodology used to calculate the refined unit water demand factors. Using this methodology, approximately 80 percent of the City's 2006 metered water consumption was linked to an existing parcel.

---

<sup>8</sup> 2006 was adjusted to reflect more reasonable water consumption based on additional metered data from 2007 and 2008.



Figure 3-9. Methodology Used to Calculate Unit Water Demand Factors



APN	Address	2006_kgal	Acres	Land Use
127018017	3052 5 <sup>TH</sup> ST	451	0.62	Downtown Commercial



2006 Water Meter Data



Existing Land Use File (ECO:LOGIC)



Stanislaus County Parcel File



Linked Data Sample

The unit water demand factor for each land use designation was then calculated by dividing the total water use by the total parcel area for which it was linked (categorized by individual land use designation). However, the parcel area used in this initial calculation did not include streets/right-of-ways and therefore, represented net area. Accordingly, the factors calculated were “net” unit water demand factors.

Due to the issues inherent in the City’s historical meter data, the calculated “net” unit water demand factors were subsequently reviewed and some factors were adjusted based on West Yost’s engineering judgment to determine appropriate unit water demand factors. These “net” unit water demand factors were also “normalized” by multiplying the net demand factors by 1.07 to adjust them to a base year of 2007. 2007 was used as the base year for projecting water



## Chapter 3

### Existing and Future Demands

demands since it is a recent higher use year, relatively unaffected by drought and the economic downturn.

Table 3-10 summarizes the unit water demand factors developed for this Water Master Plan. A different methodology was used to calculate the Low Density Residential factor, because accounts that make up this land use, which are the majority of the single family residences in the City, are not currently metered. This method is discussed in more detail below.

**Table 3-10. Unit Water Demand Factors Developed For Master Plan**

Land Use Designation	2006 Water Use Matched to Parcel, af/yr	Parcel Area Matched to Metered Use, acres	"Net" Unit Water Demand Factor, af/ac/yr	Adjusted/ Recommended "Net" Water Demand Factor, af/ac/yr	Normalized Unit Water Demand Factor, af/ac/yr <sup>(a)</sup>
Low Density Residential	(k)	(k)	3.1	3.1	3.3
Medium Density Residential	283	104	2.7	2.7	2.9
High Density Residential	388	45	8.6	4.0 <sup>(b)</sup>	4.3
Commercial/ Office <sup>(c)</sup>	323	156	2.1	2.0 <sup>(d)</sup>	2.1
Industrial <sup>(e)</sup>	138	92	1.5	1.9 <sup>(f)</sup>	2.0
Public/ Institutional <sup>(g)</sup>	20	54	0.4	1.4 <sup>(h)</sup>	1.5
Parks (Irrigation) <sup>(i)</sup>	824	192	4.3	3.8 <sup>(j)</sup>	4.0

<sup>(a)</sup> Assumes a normalization factor of 1.07. This factor was calculated using the maximum total annual production over the past nine years, which was equal to 10,823 af in 2007 divided by the total production from 2006 (10,125 af).

<sup>(b)</sup> The "net" unit water demand factor appears to be too high; adjusted factor to be approximately 50 percent higher than Medium Density Residential water use.

<sup>(c)</sup> Includes Business Park, Office, Community Commercial, Downtown Commercial, Highway Commercial, Neighborhood Commercial, Regional Commercial, and Service Commercial land uses linked.

<sup>(d)</sup> The "net" unit water demand factor was rounded slightly.

<sup>(e)</sup> Includes General Industrial and Light Industrial land uses linked to metered water use.

<sup>(f)</sup> The "net" unit water demand factor appears to be low; adjusted factor to represent more typical Industrial water use (equal to the "net" unit water demand factor from Light Industrial land uses linked to metered water use).

<sup>(g)</sup> Includes Community Facilities and School land uses linked to metered water use.

<sup>(h)</sup> The "net" unit water demand factor appears to be too low; adjusted factor to represent more typical Public/Institutional water use.

<sup>(i)</sup> Directly calculated based on the total water consumption of Irrigation meters linked to parcels (i.e., not land use based) because a land use based calculation would not specifically identify water used for irrigation.

<sup>(j)</sup> The "net" unit water demand factor appears to be high; adjusted factor to represent more typical irrigation water use.

<sup>(k)</sup> Low density residential unit water demand calculated from production records less unaccounted for water and less water uses calculated for other land use designations.

The Low Density Family Residential unit water demand factor was calculated based on:

1. the City's 2006 water production data;
2. the City's existing land use areas; and
3. the recommended "net" unit water demand factors presented in Table 3-11.



To determine the Low Density Residential unit water demand factor, the recommended “net” unit water demand factors were first applied to the City’s existing land use areas (see Table 3-4) to calculate the existing water system demands. It was assumed that the existing Low Density Residential water demands would be the difference between the 2006 water production (excluding UAFW and existing Parks irrigation) and the existing water demands calculated based on the recommended “net” unit water demand factors. The resulting “net” unit water demand factor calculated for the Low Density Residential land use designation is equal to 3.1 af/ac/yr. Subsequent normalization increases the net unit water demand factor to 3.3 af/ac/yr.

To check this unit use factor, metered single family residential use records were reviewed for the period of August 20, 2010 through September 20, 2010 for 2,948 residential accounts where meters had already been installed. The average daily usage during this period was 800 gallons/dwelling unit/day for the sample. Annual usage per acre was estimated by extrapolating usage for other months, using monthly production records, and calculated historical dwelling unit densities for developments considered typical for low density residential usage. The computed net unit use factor is 3.4 af/ac/year, which is close to the value calculated from land use and production records. Therefore, the 3.3 af/ac/yr was judged to be a reasonable estimate to use for projecting Low Density Residential water use in this Water Master Plan.

Table 3-11 details the Low Density Residential unit water demand factor calculation.

<b>Table 3-11. Low Density Residential Unit Water Demand Factor Calculation</b>				
Existing Water Use Condition	Volume of Water, af/yr	Existing Land Use Area, acres <sup>(a)</sup>	“Net” Unit Water Demand Factor, af/ac/yr	Normalized Net Unit Water Demand Factor, af/ac/yr <sup>(b)</sup>
2006 Water Production	10,125	--	--	--
Parks Water Use <sup>(c)</sup>	(136)	--	--	--
UAFW (15 percent)	(1,519)	--	--	--
Estimated Water Use from all other Land Use Designations <sup>(d)</sup>	(3,567)	--	--	--
Estimated Low Density Residential Water Use	4,903	1,605	3.1 <sup>(e)</sup>	3.3

<sup>(a)</sup> See Table 3-4; represents net acreage.  
<sup>(b)</sup> Assumes a normalization factor of 1.07. This factor was calculated using the maximum total annual production over the past nine years, which was equal to 10,823 af in 2007 divided by the total production from 2006 (10,125 af).  
<sup>(c)</sup> The normalized Parks unit water demand factor was applied to Smyrna and Roeding parks, which are currently irrigated by the City’s potable water system. These parks have a combined area of 34 acres.  
<sup>(d)</sup> “Net” unit water demand factors were applied to the corresponding existing land use areas as shown in Table 3-4.  
<sup>(e)</sup> Calculated by dividing the estimated Low Density Residential water use by the existing Low Density Residential land use area.



### 3.6.2 Adopted Unit Water Demand Factors

Table 3-12 summarizes the unit water demand factors adopted for this Water Master Plan. Based on work completed to “spot check” and refine most of these adopted factors, they are appropriate for use in projecting future water demands as discussed further in *Section 3.6.4 Projected Future Water Demands*.

Table 3-12. Adopted Unit Water Demand Factors	
Land Use Designation	Unit Water Demand Factor, af/ac/yr <sup>(a)</sup>
Low Density Residential	3.3
Medium Density Residential	2.9
High Density Residential	4.3
Commercial/Office <sup>(b)</sup>	2.1
Industrial	2.0
Public/Institutional	1.5
Parks	4.0
Agriculture <sup>(c)</sup>	3.0

(a) Unit water demand factors exclude UAFW and are derived for net acreages (i.e., excluding streets and right-of-ways).  
 (b) Downtown Commercial land use will use the High Density Residential unit water demand factor at buildout to account for proposed densification.  
 (c) Unit water demand factor was not verified due to insufficient data from this land use designation.

The unit water demand factor for Agriculture land use was assumed to be 3.0 af/ac/yr, and it was not verified due to insufficient data from this land use designation. However, this assumption appears to be appropriate for this Water Master Plan since most general agricultural land uses (e.g., orchards and row crops) tend to be less water intensive than typical turf/grass land uses.

### 3.6.3 Estimated Savings from Metering of Residential Flat Accounts

For this Water Master Plan, Low Density Residential water use was reduced by 10 percent in 2015 and buildout, to account for anticipated water use reductions as the City implements its metering program. A discussion supporting this proposed recommendation is provided below.

West Yost researched potential savings from the conversion of flat rate customers to metered usage and found the following:

- Studies completed by the California Public Utilities Commission have shown that communities with metered water systems typically use 7 to 20 percent less water than non-metered systems.
- The California Urban Water Conservation Council indicates that a usage reduction of 20 percent can be assumed with a combination of conversion to metered usage, and volumetric rate charges.



## Chapter 3

### Existing and Future Demands

---

Consequently, actual savings will depend on a number of factors, including billings based on the volumetric rate charges compared with the flat rate service charge. However, in the absence of system-specific historical data, a savings of 10 percent was used as a conservative, but reasonable estimate for this Water Master Plan. As the City develops a significant residential metered use history, it will then be possible to refine residential unit water demand factors to project more accurate future water demands.

#### 3.6.4 Projected Future Water Demands

Total projected water demands for 2015 and buildout of the City's Study Area were calculated by multiplying the adopted unit water demand factors (see Table 3-13) by the land use acreage projected to be served in 2015 and buildout, respectively.

The resulting future potable water demand projection at 2015 was first adjusted to account for water savings from conversion of Single Family Residential flat accounts to metered, and then adjusted to account for UAFW (15 percent) to provide a projection of the total potable water production at 2015. This calculation resulted in a total potable water production of approximately 11,100 af/yr.

Subsequently, the resulting future potable water demand projection at buildout was also adjusted to account for water savings from conversion of Single Family Residential flat accounts to metered; however, UAFW was reduced from 15 percent to 10 percent to account for improved leak detection and repair on the fully metered system. An additional 5 percent reduction in water demands from all land use categories was also implemented at buildout to account for more aggressive water conservation measures. This calculation resulted in a total potable water production of approximately 20,000 af/yr.

As discussed previously in *Section 3.2.4 Existing and Potential Non-Potable Water Use Areas*, all Parks and Agriculture land uses will be irrigated with non-potable water by buildout. Based on this assumption, non-potable water demand at buildout is expected to be approximately 1,000 af/yr.

Table 3-13 summarizes the City's existing and projected 2015 and buildout potable and non-potable water demands and production. As shown in Table 3-13, even with the use of non-potable water on Parks and Agriculture land uses, and the projected water demand reductions resulting from (1) conversion of Single Family Residential flat accounts to metered, (2) future conservation, and (3) improved leak detection, the City's potable water demands are projected to increase by approximately 85 percent at buildout (from 10,800 af/yr to 20,000 af/yr). Most of the increase in water demand is associated with new development outside the current City limits, but within the Study Area. This significant demand increase will have great implications on the City's need for additional supplies and additional water transmission and distribution system improvements. These issues are evaluated and discussed in the subsequent chapters of this Water Master Plan.

Figure 3-10 illustrates the existing and projected annual potable water production until buildout. Appendix B provides a detailed buildout water demand calculation by individual General Plan land use designation.

**Table 3-13. Summary of Existing and Projected Water Demands and Production**

Land Use Designation	EXISTING (2007)				2015				BUILDOUT			
	Total Area, acres <sup>(a)</sup>	Potable Water Area, acres	Non-Potable Water Area, acres	Potable Water Demand, af/yr	Total Area, acres <sup>(a)</sup>	Potable Water Area, acres	Non-Potable Water Area, acres	Potable Water Demand, af/yr	Total Area, acres <sup>(a)</sup>	Potable Water Area, acres	Non-Potable Water Area, acres	Potable Water Demand, af/yr
Low Density Residential <sup>(b)</sup>	1,605	1,605	-	5,296	-	1,658	1,658	-	5,470	-	3,846	3,759
Medium Density Residential	315	315	-	912	-	340	340	-	985	-	468	468
High Density Residential	144	144	-	620	-	148	148	-	635	-	189	189
Commercial/Office	430	430	-	903	-	610	610	-	1,282	-	953	953
Industrial	389	389	-	778	-	502	502	-	1,005	-	1,222	1,222
Public/Institutional	386	386	-	580	-	391	391	-	587	-	636	636
Parks <sup>(c)</sup>	136	34	102	136	408	174	6	168	24	671	194	-
Vacant	417	417	-	-	-	-	-	-	-	-	-	778
Subtotal	3,922	3,720	102	9,225	408	3,832	3,654	168	9,988	671	7,508	7,226
Savings from Conversion of Flat Accounts to Metered (10%) <sup>(d)</sup>			-					(547)				(1,240)
Savings from Future Conservation (6%) <sup>(e)</sup>			-					-				(1,001)
UAFW <sup>(f)</sup>			1,598					1,666				1,975
Total Water Production			10,823					11,107				19,752

<sup>(a)</sup> Total area only accounts for net acreages (i.e., excluding streets and right-of-ways).

<sup>(b)</sup> Residential Agriculture land use assumes that there are 0.4 dwelling units per acre and that each dwelling unit will have 0.25 acres that will require potable water. The remaining acreage is assumed to use non-potable water.

<sup>(c)</sup> Currently, only Smyrna and Reeding parks are irrigated with potable water. By 2015, Smyrna park will have an irrigation well installed. At buildout, Reeding park is assumed to have an irrigation well installed.

<sup>(d)</sup> 10 percent savings from conversion of flat accounts to metered applied to Single Family Residential land uses only.

<sup>(e)</sup> Existing (2007) UAFW calculated based on the recorded 2007 water production minus the calculated existing potable water demand. UAFW at 2015 is assumed to continue at 15 percent, but will decrease to 10 percent at buildout due to improved leak detection and repair.



#### 3.6.4.1 Comparison with the 2007 Model Update TM

The City's projected water production at buildout was previously estimated in the 2007 Model Update TM prepared by West Yost Associates. That TM projected the City's buildout water production to be approximately 20,300 af/yr. The current estimate of the City's buildout water production is 20,000 af/yr, which is about 2 percent lower than the previous projection from the 2007 Model Update TM. This indicates that even though the unit water demand methodology and land use assumptions have changed, the overall water demand estimate at buildout is still very similar.

#### 3.6.4.2 Comparison of Land Use and Population Based Demand Projections

As discussed in *Section 3.4.2*, the Water Conservation Act of 2009 (SBx7-7) established a water conservation goal for reducing per capita use by 10 percent by 2015 and by 20 percent by 2020. This Water Master Plan uses the 2015 and buildout time-frames to establish supply and distribution system facilities requirements. This section compares the land-use based approach with the population-based methods for 2015 and buildout to develop recommended water demand projections for use in developing the subsequent recommended Capital Improvement Program.

Population projections were developed for the 2015 and buildout scenario based on estimates of historical development densities, provided by the City, and projected development densities for future development areas based on the General Plan allowable densities. The 2015 population is estimated to be 43,600, and the buildout population is estimated to be approximately 96,000.

Table 3-14 shows the estimated per capita water use for 2015 and for buildout, and compares these with the 2015 and 2020 per capita urban water use targets for compliance with SBx7-7. As the table shows, water use projected for the 2015 scenario results in a per capita water use of 227 gpcd, which is slightly above the SBx7-7 per capita use target of 219 gpcd. The total annual water use which would allow the City to comply with the SBx7-7 target of 219 gpcd is 10,700 af/yr, which is 400 af/yr less than the land use based calculated demand, indicating slightly more conservation will need to be achieved than identified in the Water Master Plan projections. The calculated buildout per capita water use is estimated to be less than the SBx7-7 2020 per capita water use target.

**Table 3-14. Calculated Per Capita Water Demand Using Land Use Based Water Demand Projections**

Year	Projected Population <sup>(a)</sup>	Total Annual Demand, af	Total Annual Demand, MG	Calculated Per Capita Water Use, gpcd
2015	43,600	11,100	3,620	227
		2015 Per Capita Water Use Target for Compliance with SBx7-7		219
Buildout	96,100	19,800	6,440	183
		2020 Per Capita Water Use Target for Compliance with SBx7-7		194

<sup>(a)</sup> Within City's General Plan water service area.



#### 3.6.4.3 Recommended Water Master Plan Demand Projections

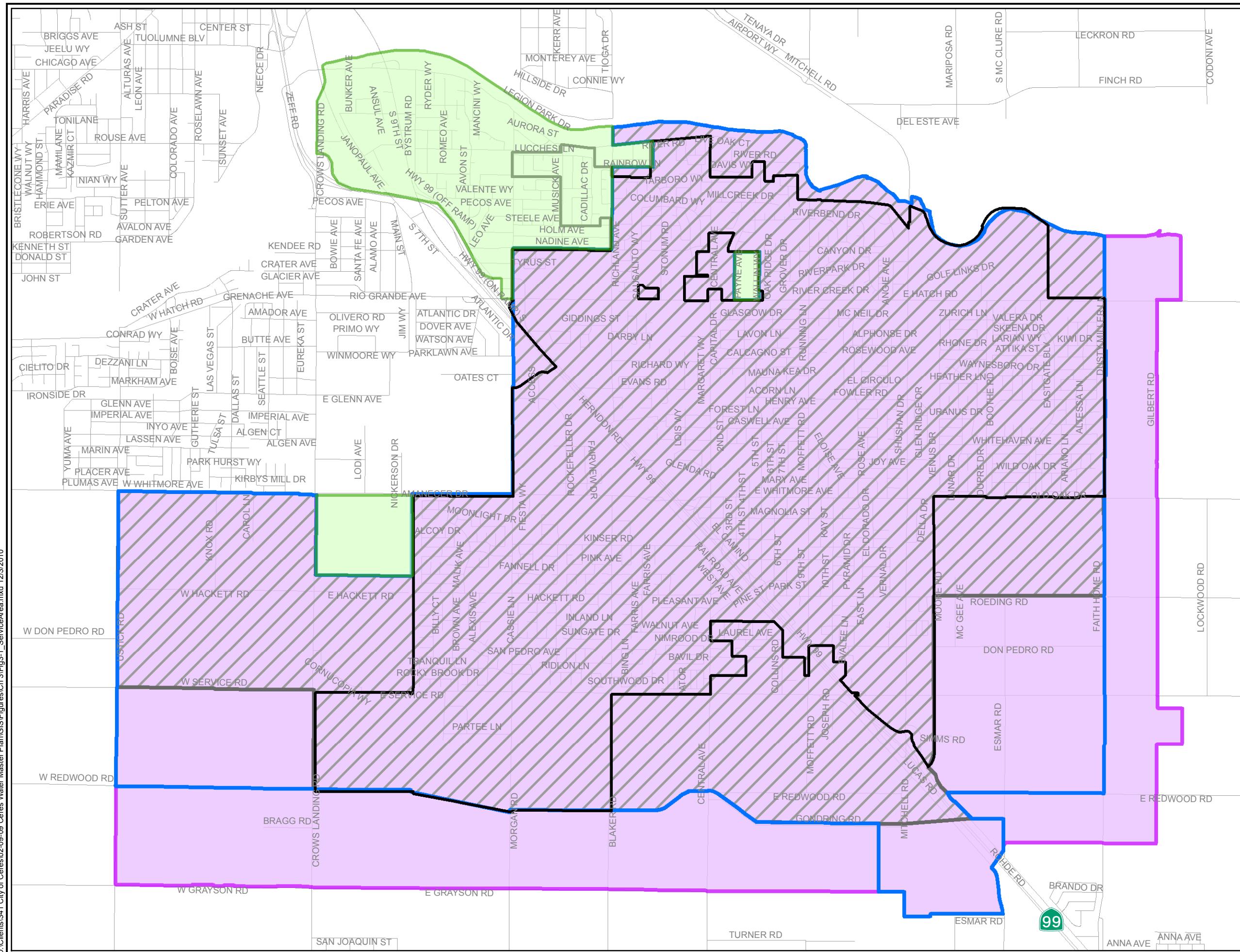
Table 3-15 shows the recommended water use projections to be used for the Water Master Plan for the 2015 and buildout time frames. For 2015, an annual water use projection of 10,700 af/yr is recommended, to be in compliance with SBx7-7. This projection is about 400 af/yr lower than the land use based projection developed in the Water Master Plan, indicating that slightly more water conservation than identified in the land use based projections will need to be achieved. Those projections already include an estimated savings of 550 af/yr due to implementation of the residential metering program. An additional four percent conservation would be needed to meet the SBx7-7 2015 per capita water use target. As shown in Table 3-7, the City's 2009 per capita water use is 197 gpcd, already lower than the SBx7-7 2015 conservation goal. However, there is a question whether the reduced 2009 per capita water use is sustainable into the future, or is an artifact of the economic downturn and several years of drought conditions.

For buildout, the calculated land use based projection is recommended, since the calculated per capita water use is lower than the 2020 per capita water use target established in the SBx7-7 legislation.

**Table 3-15. Recommended Water Master Plan Demand Projections**

Planning Horizon	Recommended Water Master Plan Projection, af/yr	Estimated Per Capita Water Use, gpcd	Notes
2015	10,700 <sup>(a)</sup>	219	Estimated per capita water use for compliance with SBx7-7
Buildout	19,800 <sup>(b)</sup>	183	Per capita water use less than SBx7-7 2020 water use target of 194 gpcd

(a) Based on a per capita water use of 219 gpcd and projected population of 43,600.  
 (b) Obtained from Table 3-14.

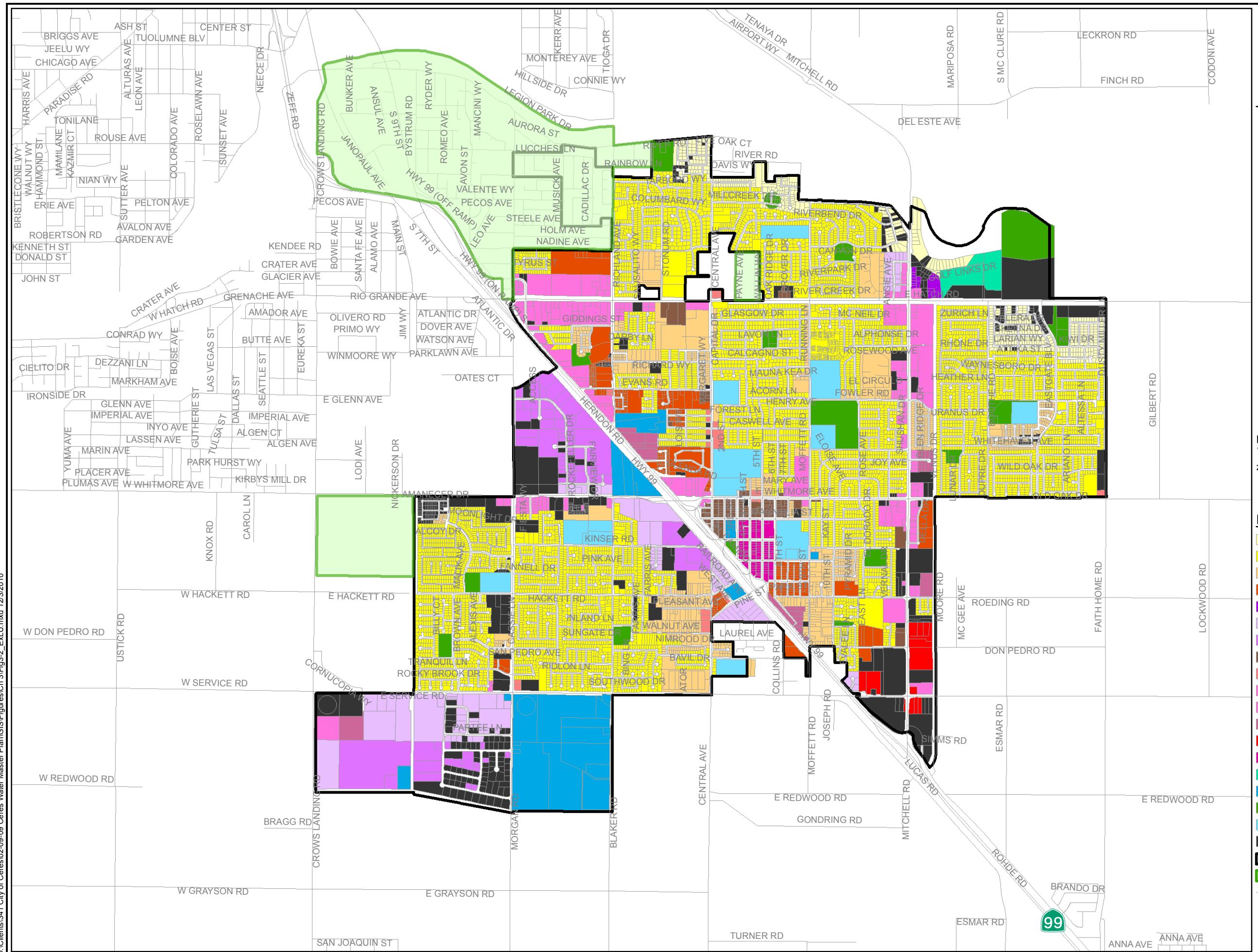
**FIGURE 3-1**
**City of Ceres**  
**Water Master Plan**
**EXISTING AND PROPOSED  
SERVICE AREAS**




## FIGURE 3-2

# **City of Ceres Water Master Plan**

## EXISTING LAND USE

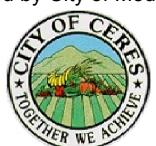


## Notes

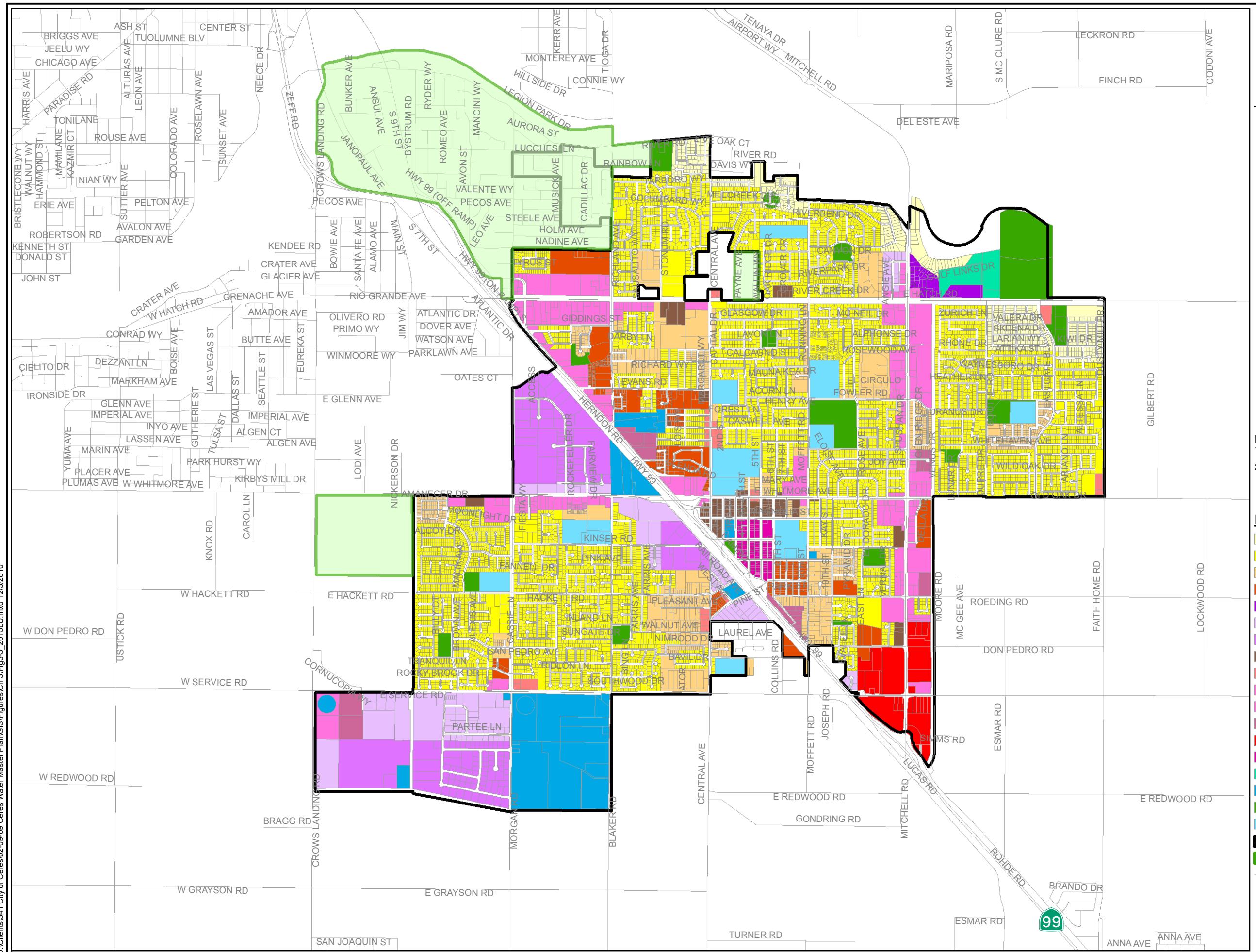
1. Existing land use file provided by ECO:LOGIC on 05/05/10.
2. Existing City Limits file (Ctylmt01.dwg) provided by the City on 10/01/09.

## LEGEND

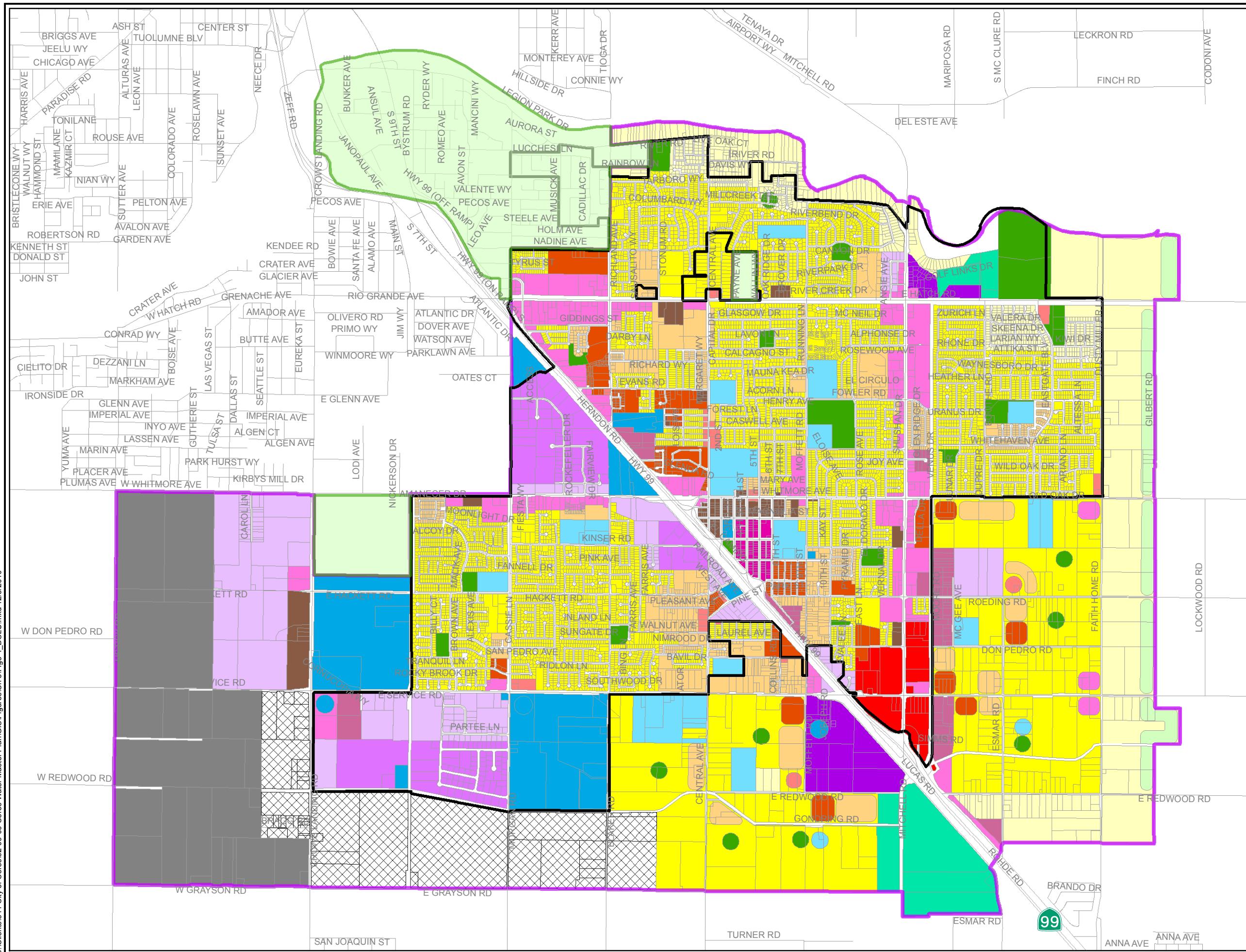
- Very Low Density Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Business Park
- Light Industrial
- General Industrial
- Office
- Neighborhood Commercial
- Community Commercial
- Highway Commercial
- Service Commercial
- Regional Commercial
- Downtown Commercial
- Commercial Recreation
- Community Facilities
- Parks
- School
- Vacant
- City Limits
- Area Served by City of Modesto
- Street



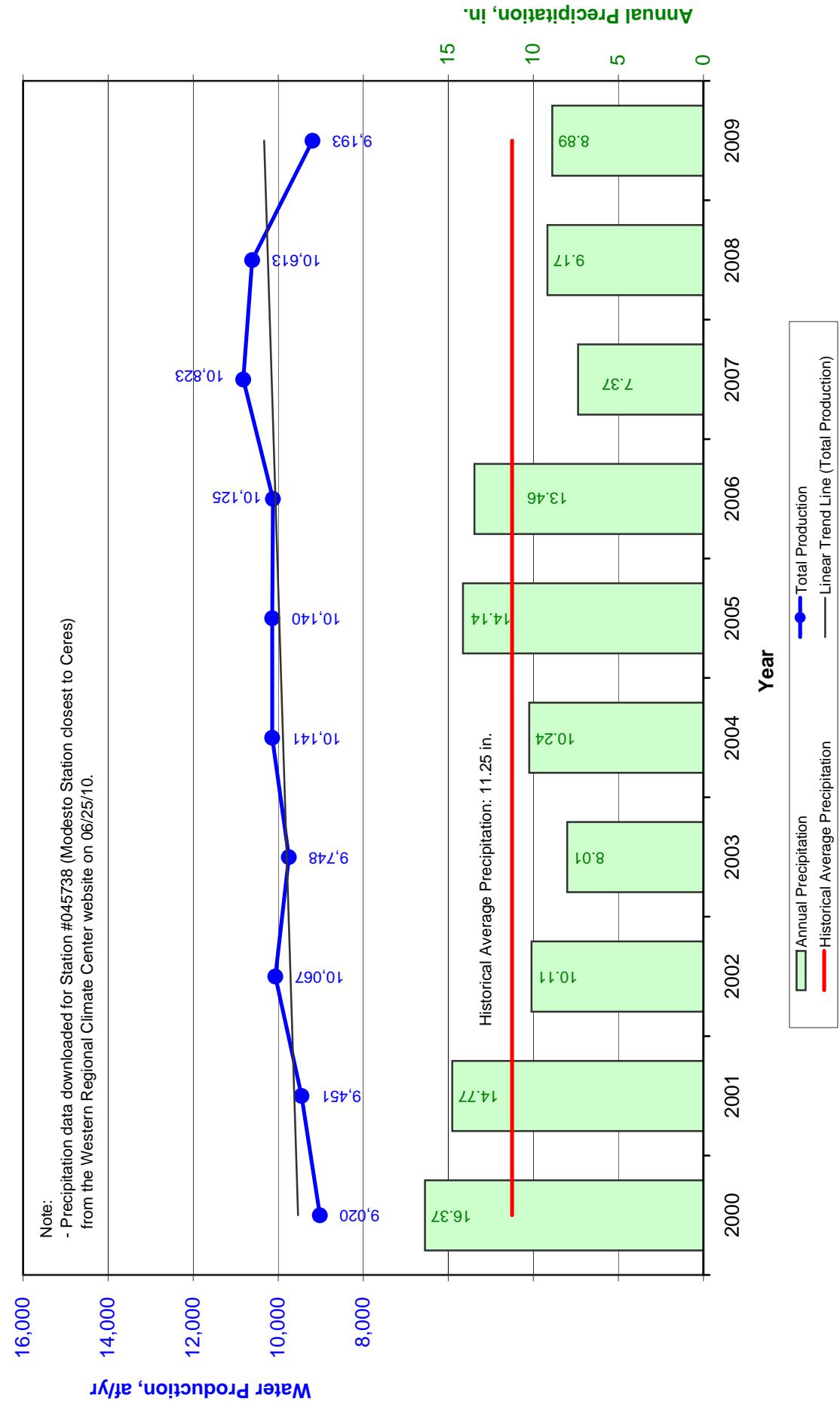


**FIGURE 3-3**
**City of Ceres  
Water Master Plan**
**2015 LAND USE**




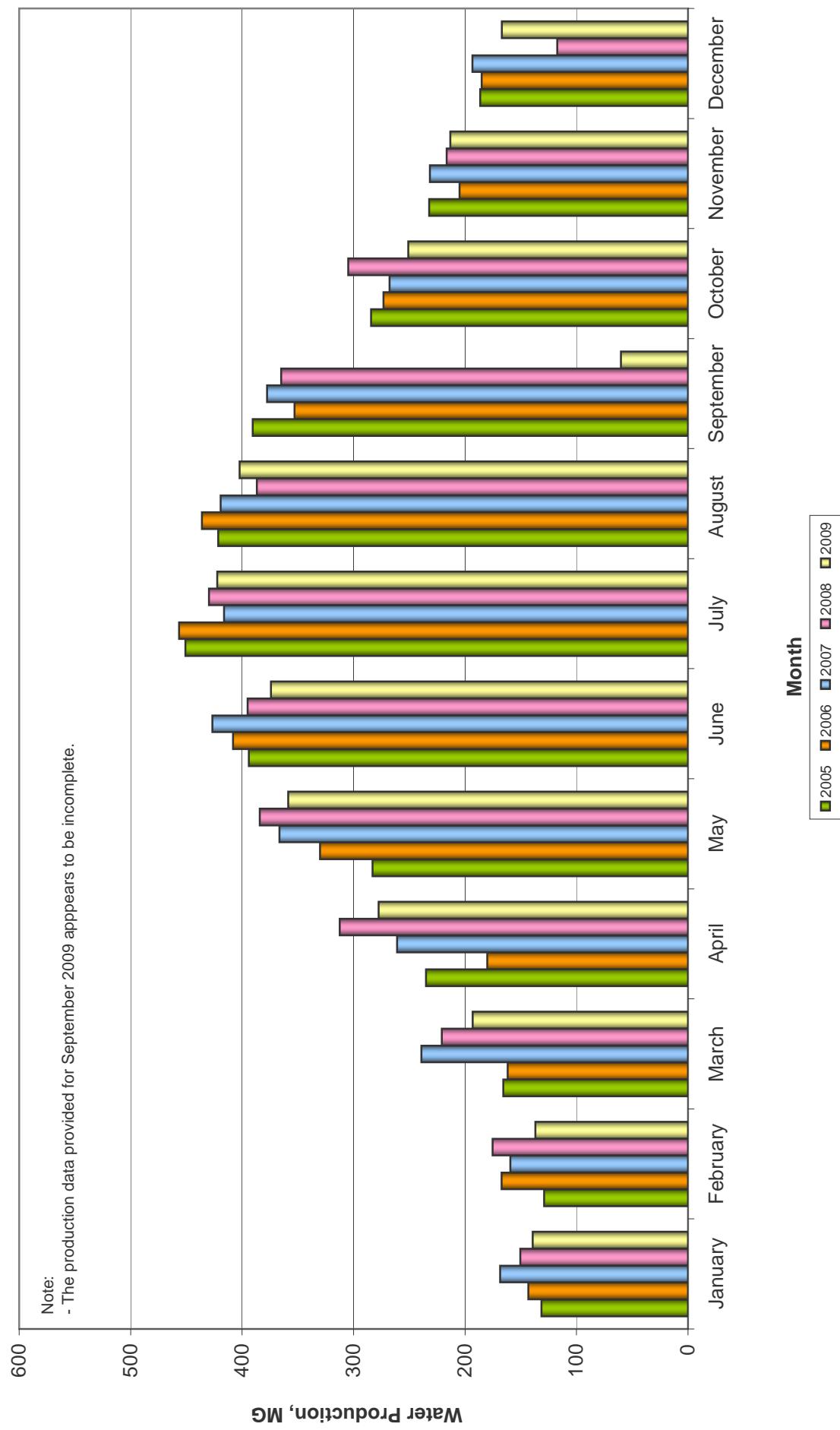
**FIGURE 3-4**
**City of Ceres**  
**Water Master Plan**
**BUILDOUT LAND USE**


**Figure 3-5. Historical Annual Water Production (2000-2009)**



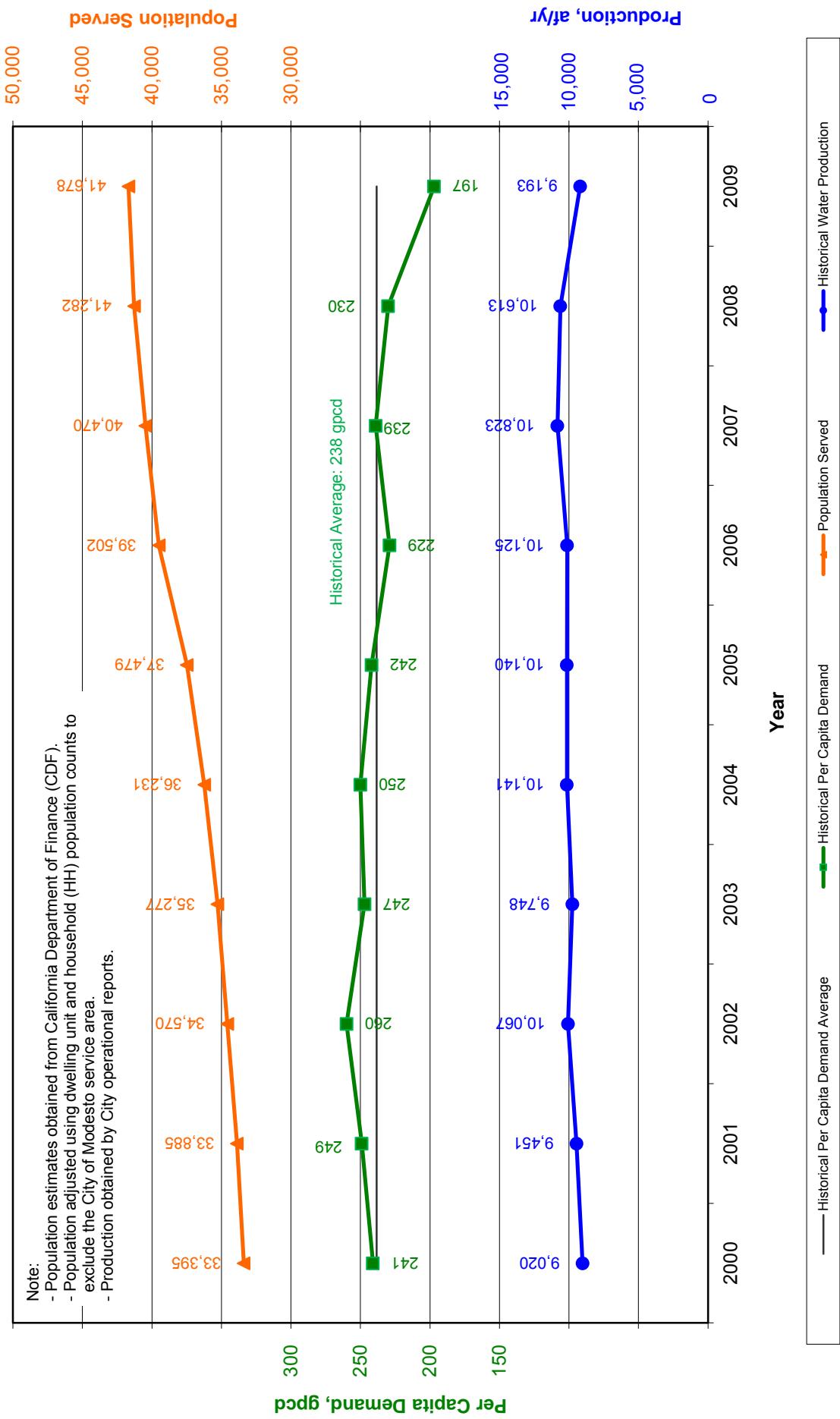


**Figure 3-6. Historical Monthly Water Production (2005-2009)**



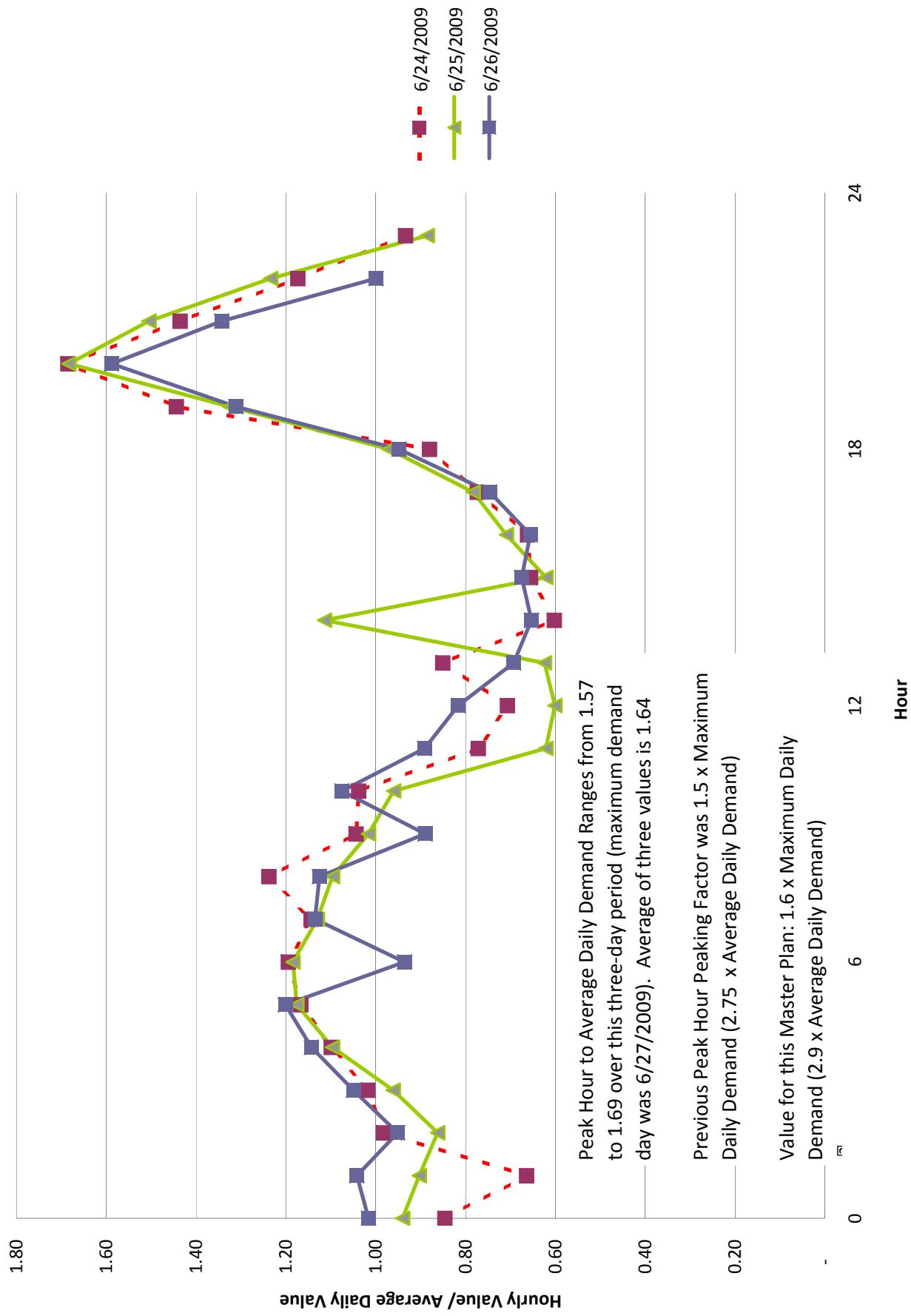


**Figure 3-7. Comparison of Historical Per Capita Water Demand, Production and Population**



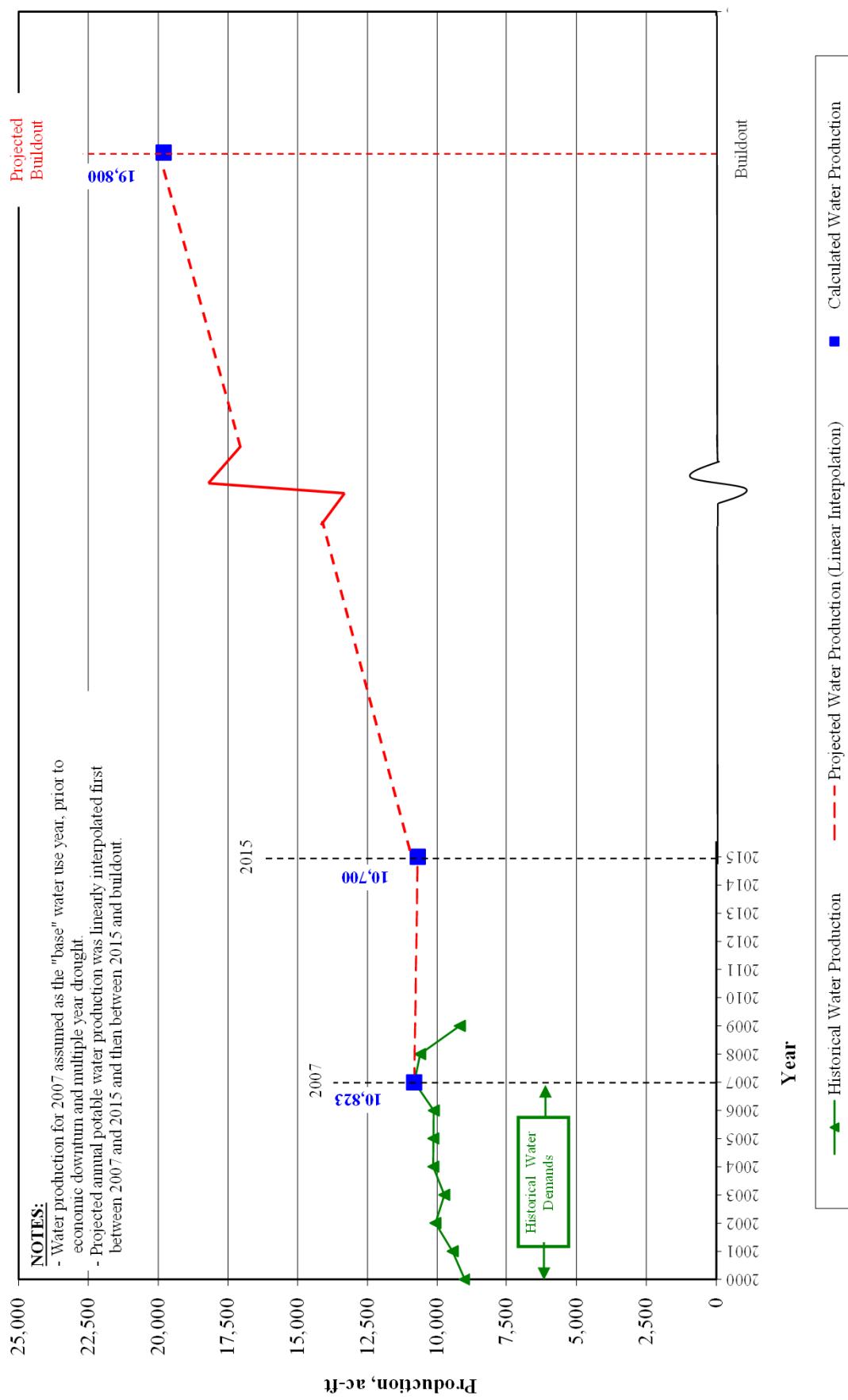


**Figure 3-8 July 2009 Diurnal Curves**





**Figure 3-10. Existing and Projected Annual Potable Water Production**





## CHAPTER 4

# Integrated Water Supply Plan

---



This chapter provides an evaluation of the City's existing and future water supplies, and their ability to meet the City's future projected demands through buildout. As described in *Chapter 3 Existing and Future Water Demands*, the City's projected future water demands are anticipated to increase significantly in the future, and additional water supplies will be needed to meet those demands. This chapter evaluates the City's existing groundwater supply and the ability to maintain and expand groundwater production capacity to meet future demands, and the proposed introduction of treated surface water supplies to supplement the City's groundwater supplies.

### 4.1 GROUNDWATER SUPPLY

As described in *Chapter 2 Existing Water System*, the City currently relies exclusively on groundwater to meet current water demands. However, many of the City's wells are at or near their estimated service life and may need to be replaced in the coming years to maintain the City's existing groundwater production capacity. There are also significant concerns that the quality of the groundwater in several of the City's wells will limit or restrict their use as municipal supply wells. This section describes the City's groundwater resource, including the groundwater basin description, groundwater management activities, historical groundwater levels, groundwater quality issues and concerns, historical groundwater pumpage, and estimated groundwater operational yield.

#### 4.1.1 Groundwater Basin Description

The local groundwater source is the Turlock Subbasin (DWR Basin Number 5-22.03), which is a sub-unit of the San Joaquin Valley Groundwater Basin (DWR Basin Number 5-22)<sup>1</sup>. The Turlock Subbasin lies in the eastern portions of Stanislaus and Merced counties and has an aerial extent of approximately 347,000 acres. The Turlock Subbasin is bounded by the Tuolumne River to the north, the Merced River to the south, the San Joaquin River to the west, and by crystalline basement rock of the Sierra Nevada foothills to the east (see Figure 4-1).

As shown on Figure 4-1, the City of Ceres is located in the northwestern part of the Turlock Subbasin, just south of the Tuolumne River.

##### 4.1.1.1 Geology

The primary hydrogeologic units in the Turlock Subbasin consist of either consolidated or unconsolidated sedimentary deposits. The consolidated deposits include the Ione Formation, the Valley Springs Formation, and the Mehrten Formation. They are described as follows:

- The Ione and Valley Springs formations lie beneath the Mehrten Formation and typically contain saline water of marine origin. These consolidated deposits are found at shallower depths in the eastern portion of the Turlock Subbasin and generally yield small quantities of water to wells.

---

<sup>1</sup> California Department of Water Resources, Bulletin 118, California's Groundwater, Groundwater Basin Descriptions, San Joaquin Valley Groundwater Basin—Turlock Subbasin, last updated January 20, 2006.



- The Mehrten Formation, however, yields greater quantities of water and is an important water source for the eastern portion of the Turlock Subbasin.

The unconsolidated deposits of the Turlock Lake, Riverbank, and Modesto formations overlie the consolidated deposits. These deposits generally yield moderate to large quantities of water to wells and are the main water-yielding units of the Turlock Subbasin. Fine grained deposits within the Modesto and Turlock Lake formations do not transmit substantial quantities of water and function as aquitards. In the western portion of the Turlock Subbasin, where surface deposits are of the Modesto Formation, a discontinuous shallow aquitard creates areas of shallow groundwater. The Corcoran Clay aquitard also occurs in the western portion of the Turlock Subbasin within the Turlock Lake hydrogeologic unit. The Corcoran Clay aquitard separates groundwater in the Turlock Subbasin into an upper, unconfined aquifer and a lower, confined aquifer.

The geologic formations that make up the groundwater system underlying the City of Ceres include the Modesto, Riverbank and Turlock Lake Formations. They are described as follows:

- The Modesto Formation outcrops in the western one-third of the City and is between 65 and 130 feet in thickness. The formation consists mostly of sand, gravel, silt and contains some silt and clay units. The formation yields moderate to large quantities of water. However, within the City, water quality within this formation has been heavily impacted by surface contamination<sup>2</sup>.
- The Riverbank Formation underlies the extent of the Modesto Formation. The thickness of the unit increases westward, but the thickness is generally less than 200 feet. The formation consists primarily of sand with scattered gravel and silt lenses and yields moderate to large quantities of water. Water quality in the Riverbank Formation has also been impacted by surface contamination<sup>3</sup>.
- The Turlock Lake Formation underlies the Riverbank Formation. The thickness of the unit increases westward, but the thickness is generally less than 600 feet. The formation consists mostly of fine sand and silt, and yields moderate to large quantities of water. In Ceres, the water quality in the Turlock Lake Formation has been impacted by contamination, but the upper portion of the formation appears to still have acceptable water quality for potable water use. Below a depth of about 350 feet, however, naturally-occurring poor water quality is encountered (high concentrations of specific conductance (dissolved solids), manganese, and arsenic).

The City's wells primarily tap a combination of the Riverbank Formation and the Turlock Lake formations for their water supply.

---

<sup>2</sup> See information on local groundwater contamination in *Section 4.1.3.3*.

<sup>3</sup> See information on local groundwater contamination in *Section 4.1.3.3*.



## Chapter 4

### Integrated Water Supply Plan

#### 4.1.1.2 Unconfined Aquifer

The unconfined aquifer is generally 150 feet in thickness and is the water-table aquifer, except in western portions of the Turlock Subbasin that are locally confined by the shallow aquitard. The unconfined aquifer is used for both private domestic supply and agricultural supply in the western part of the Turlock Subbasin. Wells less than 200 feet in depth draw from this aquifer.

#### 4.1.1.3 Confined Aquifer

The confined aquifer, which is located beneath the Corcoran Clay, occurs in the deeper hydrogeologic units of the Turlock Subbasin. In the eastern part of the Turlock Subbasin, the confined aquifer is only semi-confined. The confined aquifer provides extensive municipal and agricultural supplies to the Turlock Subbasin. Wells greater than 200 feet deep draw from the confined aquifer, but also may receive flow from the unconfined aquifer.

Below the principal water bearing units of the Turlock Subbasin is a deeply buried confined aquifer that contains saline brine. This saline confined aquifer is under sufficient hydraulic pressure to push water up toward the land surface. This phenomenon results in the migration of saline brines in certain areas (e.g., in groundwater wells or along cracks, fissures, and faults), sometimes as far upward as the unconsolidated sediments. Upwelling also occurs near the San Joaquin River, resulting in elevated concentrations of total dissolved solids (TDS) in groundwater near the river. The saline confined aquifer can be found from depths as shallow as 100 feet in the western portion of the Turlock Subbasin to as deep as 1,500 feet in the eastern portion of the Turlock Subbasin. Although the saline confined aquifer is not used as a source of supply, migration of the saline brines results in high TDS groundwater that may not be of a suitable quality for agricultural or municipal use where mixing occurs.

A cross-section of the Turlock Subbasin showing the depths of the various geological formations and the water-bearing zones is provided on Figure 4-2.

#### 4.1.1.4 Groundwater Flow Direction

The direction of regional groundwater flow in the unconfined aquifer portion of the Turlock Subbasin is mainly westward and southward towards the axis of the valley trough, with the exception of the eastern portion of the Subbasin (east of Denair) where there is a localized cone of depression (see Figure 4-3). As shown on Figure 4-3, the groundwater flow direction beneath the City of Ceres is generally to the northwest toward the Tuolumne River.

The direction of groundwater flow is controlled by the elevations of the Tuolumne, Merced and San Joaquin rivers. The elevation of the water table is maintained along these rivers at the local elevation of the water surface within the river. Groundwater levels are maintained by exchanges of water between the river and the groundwater system.

## **4.1.2 Groundwater Levels**

Based on information contained in DWR Bulletin 118, on average, water levels in the Turlock Subbasin declined approximately 7 feet from 1970 through 2000. The period from 1970 through 1992 showed a generally steep decline totaling about 15 feet. Between 1992 and 1994, water levels stayed near this low level. From 1994 to 2000, the water levels rebounded about 8 feet,



bringing them to approximately 7 feet below the 1970 levels. Water level declines have been more severe in the eastern portion of the Turlock Subbasin after 1982. From 1970 to 1982, water level declines were more severe in the western portion of the Turlock Subbasin.

Figure 4-4 shows the locations of four wells for which water level measurements have been taken since at least the 1970s, and Figure 4-5 shows the hydrographs for those four wells. As shown, the two wells located in the eastern part of the Subbasin have experienced significant groundwater level declines since the 1970s. Groundwater levels in the two wells located in the western part of the Subbasin have remained relatively stable, with only modest declines (less than 10 feet). This difference in water level trends on either side of the Subbasin is also demonstrated on Figure 4-6 which shows historical spring groundwater elevation contours for 1960, 1974, 1986 and 2005. As shown, since 1960, groundwater levels have remained relatively stable in the western part of the Subbasin. However, in that same period, in the eastern part of the Subbasin, a cone of depression has formed due to extensive agricultural pumping in the eastern part of the Subbasin. Figure 4-6 also indicates that the Tuolumne River has gone from a “losing” river to a “gaining” river in the period from 1960 to 2005, which could be an indication that the “local” groundwater operational yield has been reached.

Closer to the City of Ceres, long-term groundwater level measurements in DWR-monitored wells indicate that groundwater levels have varied over the years with about a 20 foot difference between high and low groundwater elevations. High elevations were experienced in the mid-1980s and the late 1990s. Low elevations were experienced in the early 1990s (likely as a result of 1987-1992 drought) and in 2009 (likely as a result of the dry years from 2007 to 2009). This is demonstrated on Figure 4-7 which shows hydrographs for four DWR-monitored wells located just outside the City limit (the locations of the wells are shown on Figure 4-4).

The City has also implemented a groundwater level monitoring program which involves measuring groundwater levels on a monthly basis in many of the City’s wells. Based on this data, in the last 10 years, water levels in the City’s wells appear to have remained relatively stable. This is demonstrated on Figure 4-8 which shows spring groundwater elevations in four of the City’s wells (Well 6, Well 14, Well 24 and Well 32) from 2001 through 2008. The City should continue its monitoring program to assess the impacts on groundwater levels as a result of the City’s on-going groundwater pumping and pumping by other groundwater users within the Subbasin.

#### 4.1.3 Groundwater Quality

##### 4.1.3.1 Overview of Water Quality in the Turlock Subbasin

According to the 2008 Groundwater Management Plan, groundwater quality in the Turlock Subbasin remains high throughout most of the region. Current knowledge indicates that salinity, nitrates, iron and manganese, boron, arsenic, radionuclides, bacteria, pesticides, trichloroethylene, and other trace organics have been found in the Turlock Subbasin. Some of the constituents found in the Turlock Subbasin occur naturally, while others have been introduced into the groundwater from human activities. Where particular constituent concentrations have exceeded drinking water limitations, the municipal water purveyors have implemented actions ranging from wellhead treatment and blending to well closure to maintain viable potable water supplies. As described below, some of the City’s wells have water quality concerns.



#### 4.1.3.2 Groundwater Ambient Monitoring and Assessment Program

The Groundwater Ambient Monitoring and Assessment (GAMA) Statewide Basin Assessment project was developed in response to the Groundwater Quality Monitoring Act of 2001 and is being conducted by the California State Water Resources Control Board (SWRCB) in collaboration with the U.S. Geological Survey (USGS) and the Lawrence Livermore National Laboratory (LLNL). One of the study units evaluated in the GAMA Program was the Central Eastside San Joaquin (CESJO) Basin, which includes the Turlock Subbasin. The CESJO GAMA Study was conducted in 2006 and was published in 2008<sup>4</sup>.

Groundwater quality in the approximately 1,695-square-mile CESJO study unit was investigated from March through June 2006 as part of the GAMA Study. The study was designed to provide a spatially unbiased assessment of raw groundwater quality within CESJO, as well as a statistically consistent basis for comparing water quality throughout California. Samples were collected from 78 wells in Merced and Stanislaus Counties.

The groundwater samples were analyzed for a large number of synthetic organic constituents (volatile organic compounds (VOCs), gasoline oxygenates and their degradates, pesticides and pesticide degradates), constituents of special interest (perchlorate, *N*-nitrosodimethylamine (NDMA), and 1,2,3-trichloropropene (1,2,3-TCP)), inorganic constituents that can occur naturally (nutrients, major and minor ions, and trace elements), radioactive constituents, and microbial indicators. Naturally occurring isotopes (tritium, carbon-14, and uranium isotopes and stable isotopes of hydrogen, oxygen, nitrogen, sulfur, and carbon), and dissolved noble and other gases also were measured to help identify the source and age of the sampled ground water.

Although VOCs and pesticides were detected in approximately half of the sampled wells, all detections in samples from CESJO wells were below health-based thresholds. All detections of nutrients and major elements in sampled wells also were below health-based thresholds. Most detections of constituents of special interest, trace elements, and radioactive constituents in sampled wells were below health-based thresholds. Exceptions included two detections of arsenic that were above the United States Environmental Protection Agency (USEPA) maximum contaminant level (MCL-US), one detection of lead above the USEPA action level (AL-US), and one detection of vanadium and three detections of 1,2,3-TCP that were above the California Department of Public Health (CDPH) notification levels (NL-CA). All detections of radioactive constituents were below health-based thresholds, although fourteen samples had activities of radon-222 above the lower proposed MCL-US. Most of the samples from CESJO sampled wells had concentrations of major elements, total dissolved solids, and trace elements below the non-enforceable thresholds set for aesthetic concerns. A few samples contained manganese or total dissolved solids at concentrations above the SMCL-CA thresholds.

No wells located with the City of Ceres were included in the GAMA Study. However, two wells located relatively close to the City of Ceres were included. They included a well located in South Modesto (designated as Well TRLK-06 in the GAMA Study) and a well located east of Ceres

---

<sup>4</sup> Landon, M.K., and Belitz, Kenneth, 2008, Groundwater Quality Data in the Central Eastside San Joaquin Basin 2006: Results from the California GAMA Program: U.S. Geological Survey Data Series 325.



near Hughson (designated as Well TRLK-03 in the GAMA Study). Results for these two wells were as follows:

- Well TRLK-03 (located near Hughson):
  - Arsenic was detected above the MCL-US
  - Lead was detected above the AL-US
- Well TRLK-06 (located in South Modesto):
  - 1,2,3-Trichloropropane (1,2,3-TCP) was detected above the NL-CA
  - Vanadium was detected above the NL-CA

#### 4.1.3.3 Local Groundwater Contamination

The Stanislaus County Department of Environmental Resources (DER) takes an active role in groundwater contamination activities in the Turlock Subbasin, with 61 active monitoring sites within its boundaries. These sites are monitored for groundwater quality on a quarterly basis. Depending on the type of constituent contamination present, groundwater is monitored for petroleum constituents (including gasoline and diesel), chlorinated solvents such as trichloroethylene (TCE) and tetrachloroethylene (PCE), metals, and various other analytes based on site-specific target needs.

According to the SWRCB's GeoTracker website, there are 38 sites in the City of Ceres which have been impacted by soil and/or groundwater contamination. These include Leaking Underground Storage Tank (LUST) sites and Spills, Leaks, Investigation and Cleanup (SLIC) sites. Most of the sites involve contamination by gasoline, diesel and/or other petroleum products, although a few involve contamination by solvents (including TCE and PCE) and metals. Most of the cases have been closed, but 11 of the sites still have open cases which are currently in site assessment, remediation, or verification monitoring phases.

#### 4.1.3.4 Water Quality Contaminants of Concern in City Wells

As part of this Water Master Plan effort, Wood Rodgers, Inc. (Wood Rodgers) and DWSA evaluated historical and current water quality conditions in the City's existing wells.<sup>5</sup>

The specific contaminants of concern for the City of Ceres are:

- Nitrate,
- Uranium,
- Arsenic,
- Manganese, and
- Specific conductance.

---

<sup>5</sup> The DWSA evaluation did not include the City's newest wells (Wells 34, 35, 36 and 38) as these wells have generally good water quality.



Nitrate, uranium and arsenic are regulated as primary contaminants which indicate that there can be adverse health effects at levels above the MCL. Manganese and specific conductance, a surrogate for TDS, are known as secondary contaminants. At concentrations above the Secondary MCL, these contaminants have negative impacts on the aesthetics of potable water. A description of each of these contaminants follows.

For each of the contaminants of concern, a “box and whisker plot” has been prepared for each of the wells. This type of plot allows for the effective presentation of data which has a substantial spread. In a “box and whisker plot”, a rectangle (or “box”) is drawn around the data points corresponding to the 25<sup>th</sup> and 75<sup>th</sup> percentiles<sup>6</sup>. The 50<sup>th</sup> percentile (the median) is shown by a horizontal line inside the rectangle. Vertical lines are drawn from the 25<sup>th</sup> and 75<sup>th</sup> percentile values to the 5<sup>th</sup> and 95<sup>th</sup> percentiles, respectively.

#### 4.1.3.4.1 Nitrate

Nitrate is an anthropogenic contaminant which does not naturally occur in the subsurface. The MCL for nitrate in public drinking water supplies is 45 mg/L (as NO<sub>3</sub>). Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and “blue-baby” syndrome. Elevated concentrations of nitrate are widespread in the Central Valley.

Water quality data from zone-specific test hole sampling indicates that nitrate concentrations decrease with depth throughout the City. This observation is typical in agricultural areas that have experienced nitrate loading from fertilizer use and applied irrigation, along with the likely contribution from septic systems or possible leaking sewer pipes in urbanized areas. Nitrate concentrations are elevated in the shallow aquifers above a depth of approximately 250 feet in the central portion of the City. The data suggests that concentrations of nitrate appear to decrease west of Highway 99, near the Tuolumne River.

As shown in Figure 4-9, the 95th percentile historical data for Well 6, Well 16, and Well 25 have exceeded the nitrate MCL and Well 1, Well 19, Well 21, and Well 22 have been above 80 percent of the MCL. Well 6 has been removed from service due to the nitrate concentrations. Well 19 is also out of service due to high uranium and manganese concentrations. The casing for Well 16 was repaired and has resulted in decreased nitrate concentrations. A blending program was initiated with Well 28 to alleviate the Well 25 nitrate problem. It is recommended the City consider on-line nitrate monitoring for any well that has exceeded the nitrate water quality goal. The monitoring will allow the City to collect real time data and more effectively manage its water supply for compliance.

---

<sup>6</sup> A percentile is the value of a variable below which a certain percent of observations fall. So the 75th percentile is the value (or score) below which 75 percent of the observations may be found.



#### 4.1.3.4.2 Uranium

Uranium is a radionuclide which is produced as a result of radioactive decay of certain elements. Radionuclides are primarily from natural sources and can affect drinking water supplies. The MCL for uranium is 20 picoCuries per liter (pCi/L). Long-term exposure to uranium levels exceeding the MCL have been linked to an increased risk of cancer and kidney toxicity.

As shown in Figure 4-10, the 95th percentile historical data for Well 1, Well 19, Well 22, and Well 25 has exceeded the uranium MCL. The City is currently blending Well 1 with 60 percent system water, and Well 25 is being blended with Well 28 to reduce the uranium concentrations to acceptable levels. Well 19 has been removed from service. Well 22 is equipped with a non-regenerable ion exchange system to reduce the uranium concentration.

#### 4.1.3.4.3 Arsenic

Arsenic is naturally present in rocks and minerals in the earth's crust, and is naturally present in groundwater. Concentrations higher than current and contemplated standards have been found in the U.S., especially in the western states. Arsenic is also found in some pesticides, which can be leached to groundwater. Arsenic has been linked to lung and bladder cancer in humans. As a result, in January 2006, the EPA promulgated a new, more stringent arsenic rule, lowering the MCL from 50 µg/L to 10 µg/L (10 parts per billion (ppb)).

As shown in Figure 4-11, the 95th percentile historical data for Well 20, Well 21, and Well 32 has exceeded the arsenic MCL, and Well 16, Well 22, Well 27 have been above 80 percent of the MCL. A violation of the arsenic MCL is based on the Running Annual Average (RAA) of the quarterly samples being greater than 10 µg/L. To date, Well 32 is the only well that has been in violation of the MCL. As such, a coagulation/oxidation/filtration system has been installed to reduce arsenic to levels below the MCL. No action has been taken yet for the arsenic levels at Well 20 and Well 21.

It should be noted that the first quarter 2010 arsenic result for Well 20 was 16 µg/L. The only consecutive sampling event prior to 2010 is a value of 7.4 µg/L from the fourth quarter of 2009. Ceres should be prepared to address arsenic at Well 20 should subsequent samples be above 8 µg/L.

#### 4.1.3.4.4 Manganese

Manganese is also naturally occurring element found in rocks and minerals. Its presence in groundwater originates from the groundwater moving through sediments containing manganese, which can dissolve it and transport it through the aquifer. Manganese is known as a secondary contaminant, affecting the aesthetic quality of the groundwater. The secondary MCL for manganese is 50 µg/L.

Groundwater in several areas within the Turlock Subbasin has elevated iron and/or manganese levels. As shown in Figure 4-12, the 95th percentile historical data for Well 14, Well 19, Well 20, and, Well 32 have exceeded the manganese MCL. However, the results for Well 14 and Well 20 have been attributed to sampling errors. Well 19 is currently off-line due to uranium.



The coagulation/oxidation/filtration system installed at Well 32 for arsenic control also removes manganese.

#### *4.1.3.4.5 Specific Conductance*

The specific conductance of groundwater is the measure of how effectively the water will conduct electricity, reported in micro-mhos ( $\mu\text{mhos}$ ) per centimeter. Specific conductance provides for the indirect measurement of the amount of dissolved solids (salts) in the groundwater. Applied irrigation and fertilizers add salts to the water that percolate into the hydrogeologic system. Specific conductance is known as a secondary contaminant, affecting the aesthetic quality of the groundwater. The recommended MCL for specific conductance is 900  $\mu\text{mhos}/\text{cm}$  (the upper limit is 1,600  $\mu\text{mhos}/\text{cm}$  and the short term maximum limit is 2,200  $\mu\text{mhos}$ ).

As shown in Figure 4-13, all of the City's wells with the exceptions of Well 28 and Well 32 have high specific conductance levels. While specific conductance is a secondary contaminant, the high costs of treatment and associated brine disposal issues do not make treatment viable for the City. In the future, the specific conductance issue could be mitigated by blending with treated surface water, as that resource becomes available.

A summary of the water quality concerns in the City's wells is provided in Table 4-1. The red boxes indicate that the 95<sup>th</sup> percentile of historical data is above the MCL for the constituent shown. The blue boxes indicate that the 95<sup>th</sup> percentile is above the water quality goal of 80 percent of the MCL for the constituent shown.

As shown in Table 4-1, nearly all of the City's active wells are impacted by a combination of inorganic contaminants with the exception of Well 28 which is currently used as a blending source for Well 25, and the City's newest wells (Wells 34, 35, 36 and 38). While the City has addressed the most prominent water quality issues with a combination of treatment and blending, additional strategies such as blending with future treated surface water supplies through the construction of Aquifer Storage and Recovery (ASR) wells, and/or the drilling and careful construction of new wells perforated in specific, discrete aquifer zones should be considered to protect the vulnerable groundwater supply.

**Table 4-1. Summary of Water Quality Concerns in City of Ceres Wells**

		City Well Number																	
		1	6	14	16	19	20	21	22	23	24	25	27	28	32	34 <sup>(a)</sup>	35 <sup>(a)</sup>	36 <sup>(a)</sup>	38 <sup>(a)</sup>
Treatment Type <sup>(b)</sup>	Treatment	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS
Nitrate																			
Uranium																			
Arsenic																			
Manganese																			
Specific Conductance																			

Legend:

Red box indicates the 95<sup>th</sup> percentile of historical data is above the MCL for the constituent shown.  
 Blue box indicates that the 95<sup>th</sup> percentile is above the water quality goal (80% of the MCL).

(a) Wells 34, 35, 36 and 38 are the City's newest wells, all constructed within the last two years. 2009 water quality sampling for Wells 34, 35, 36 and 38 indicate that water produced from these wells meets all the CDPH primary and secondary drinking water quality standards.

(b) Treatment Types: B = Blending; IX = Ion Exchange; C/Ox/F = Coagulation/Oxidation/Filtration; OS = Out of Service



#### 4.1.3.5 Recommended Groundwater Treatment Alternatives

DWSA has developed several potential groundwater treatment alternatives for addressing the water quality concerns described above. These include the following:

- Alternative 1: Blend Well 23 at Well 19: As previously mentioned, Well 19 is off-line due to uranium levels in excess of the MCL. Blending Well 23 with Well 19 could potentially reduce the uranium concentration below the regulated level.
- Alternative 2: Blend Well 6 with distribution system water: It is difficult to ascertain the feasibility of this alternative as the specific quality of the system water delivered to the Well 6 site is not certain (depends on which City wells are operating at the time); however, it is recommended that the City conduct a series of periodic sampling events of the water in the distribution system at the Well 6 location to allow a better determination of the feasibility of this alternative.
- Alternative 3a: Blend Well 20 at Well 6: Well 6 is currently off-line due to elevated nitrate concentrations. Blending Well 6 with Well 20 could potentially allow for Well 6 to be returned to service by reducing the nitrate concentration in Well 6, while simultaneously reducing the arsenic and manganese concentrations in Well 20.
- Alternative 3b: Blend Well 22 at Well 6: Well 22 is also a potential blending source that could address the Well 6 nitrate issues. Additionally, this option could allow the City to discontinue the use of the non-regenerable ion exchange system currently in use at Well 22 for uranium control.
- Alternative 3c: Blend Well 20 and Well 22 at Well 6: A synergy could be realized by blending Well 6, Well 20, and Well 22 as they are each impacted by different contaminants, namely nitrate, arsenic and manganese, and uranium. Option 1 combines Wells 20 and 22 at Whitmore Avenue and Blaker Road. Option 2 combines Wells 20 and 22 at Whitmore Avenue and Central Avenue.
- Alternative 4: Blend Well 20 and Well 22 at either well: Well 20 and Well 22 are impacted by arsenic, manganese, and uranium, respectively. Blending the two wells could potentially eliminate the need for the non-regenerable ion exchange system at Well 22 and eliminate the need for a future arsenic and manganese system at Well 20.
- Alternative 5: Install an Oxidation/Filtration System at Well 20 to address potential impacts by arsenic, manganese and specific conductance.

Costs for these groundwater treatment alternatives are summarized in Table 4-2 and are described in DWSA's Technical Memorandum (included in Appendix C). The costs include the pipeline to convey pumped water from one well to another well for blending, nitrate analyzers, and instrumentation and controls for SCADA integration. The differences in costs between the various blending alternatives are primarily attributable to the length of pipeline required to convey water from one well to the other designated blending well.



**Table 4-2. Groundwater Treatment Alternative Costs<sup>(a)</sup>**

Alternative	Estimated Cost <sup>(b)</sup>
Alternative 1: Blend Well 23 at Well 19	\$2,062,500
Alternative 2: Blend Well 6 with Distribution System Water	\$187,500
Alternative 3a: Blend Well 20 at Well 6	\$1,800,000
Alternative 3b: Blend Well 22 at Well 6	\$2,910,000
Alternative 3c (Option 1): Blend Well 20 and Well 22 at Well 6 (combines Wells 20 and 22 at Whitmore Avenue and Blaker Road)	\$4,237,500
Alternative 3c (Option 2): Blend Well 20 and Well 22 at Well 6 (combines Wells 20 and 22 at Whitmore Avenue and Central Avenue)	\$3,892,500
Alternative 4: Blend Well 22 and Well 20	\$1,813,500
Alternative 5: Install an Oxidation/Filtration System at Well 20	Net Present Worth Costs <sup>(c)</sup> range from \$1,524,200 to \$1,572,000 depending on life cycle assumed

<sup>(a)</sup> Costs developed by Damon S. Williams Associates in Wellhead Treatment Alternatives Evaluation dated May 25, 2010.

<sup>(b)</sup> Estimated cost includes markups for contingency, engineering, construction management and program implementation.

<sup>(c)</sup> Net Present Worth Costs represent the average capital and operational costs for 5, 10, 15 and 20 year life cycle cost with 6 percent interest.

Implementation of one or more of the treatment alternatives could serve to firm up the City's groundwater production capacity, and could possibly allow wells that are currently out of service to be returned to active status to increase the City's firm groundwater pumping capacity.

It should be noted that Well 6 is an old well (61 years old) which is relatively shallow (93-foot cased depth) with an open bottom. The well is currently inactive due to high nitrate concentrations. Due to the age and construction details of the existing Well 6, any of the alternatives listed above which involve Well 6 (Alternatives 2, 3a, 3b, and 3c) are not likely cost-effective using the existing well. The City is currently planning to drill a new well at the Well 6 (Hollister) site. Upon completion of a new well at the Well 6 site, the City should reevaluate the need for groundwater treatment for the new Well 6 and assess whether any of the potential blending options are appropriate.

Therefore, based on the high estimated costs for blending and wellhead treatment, compared to the cost of drilling a new well, and the lack of site, specific water quality and yield information from the planned Well 6 replacement well, it is recommended that all of the blending and treatment issues be temporarily deferred until additional information can be gathered.

#### 4.1.4 Historical Groundwater Pumpage

According to the 2008 Turlock Groundwater Basin Draft Groundwater Management Plan, it is estimated that an average of 457,000 af/yr was pumped from the Turlock Subbasin between 1997 and 2006 by agricultural and urban agencies, as well as small domestic water systems and private property owners, for domestic or agricultural uses. Table 4-3 shows the estimated average annual pumpage by each type of user in the Turlock Subbasin.



**Table 4-3. Average Annual Groundwater Pumpage in the Turlock Subbasin<sup>(a)</sup>**

User Type	Average Annual Groundwater Pumpage (1997 to 2006)	Percent of Total Average Annual Groundwater Pumpage
Agricultural	65,000	14.2%
	344,000	75.3%
Municipal <sup>(b)</sup>	44,000	9.6%
Private Domestic Pumpage <sup>(c)</sup>	4,000	0.9%
Total Groundwater Pumpage	457,000	100.0%

(a) Source: Turlock Groundwater Basin Draft Groundwater Management Plan, prepared by the Turlock Groundwater Basin Association, January 17, 2008.  
 (b) Includes pumpage by Ceres, Delhi, Denair, Hickman, Hilmar, Hughson, Keyes, South Modesto and Turlock.  
 (c) Includes domestic groundwater pumpage for about 3,700 residences that are not connected to a municipal water system.

As shown, agricultural pumpage within the Subbasin accounts for a majority of total pumpage within the Subbasin. Municipal pumpage within the Turlock Subbasin accounts for less than 10 percent of the total annual pumpage within the basin. As described further below, pumpage by the City of Ceres has averaged about 10,000 af/yr in recent years, and accounts for less than 25 percent of the municipal pumpage in the Turlock Subbasin, and only about 2 percent of the total annual pumpage in the Subbasin.

Each of these groundwater uses is described below.

#### 4.1.4.1 Agricultural Groundwater Pumpage

Groundwater is pumped for agricultural purposes throughout the Turlock Subbasin. The total annual application of groundwater for irrigation purposes varies from year to year depending on the availability of surface water and the timing of precipitation. In wet years, less groundwater is needed to supplement irrigation supplies. Drainage pumping to help lower groundwater levels also varies depending on the weather conditions.

For the period between 1997 and 2006, the average drainage pumping within the Turlock Subbasin was about 65,000 af/yr, while the average total agricultural pumping totaled 345,000 af/yr. The breakdown of agricultural pumpage is as follows:

- Pumpage from private and improvement district owned wells for various agricultural purposes: 22,000 af/yr,
- TID pumpage from rented wells to supplement surface water supplies: 18,000 af/yr,
- Groundwater pumpage by growers within the TID who choose not to receive surface water: 9,600 af/yr,
- Private groundwater pumpage for agricultural purposes within the Turlock Subbasin portion of the Merced ID: 100 af/yr to over 400 af/yr,



## Chapter 4

### Integrated Water Supply Plan

- Pumpage by growers within Eastside and Ballico-Cortez water districts: 180,000 af/yr, and
- Pumpage by growers within the non-district areas, located along the river margins and east of the Eastside and Ballico-Cortez water districts: 115,000 af/yr.

#### 4.1.4.2 Municipal Groundwater Pumpage

##### *4.1.4.2.1 City of Ceres Groundwater Pumpage*

As described in Chapter 2, the City of Ceres currently relies exclusively on groundwater for its water supplies. The City currently has fifteen active groundwater wells. The City's historical groundwater production is shown on Figure 4-14. Since 1980, the City's groundwater production has increased from about 3,300 af/yr to about 10,000 af/yr. As described in Chapter 3, groundwater production by the City over the last ten years (2000 to 2009) has been relatively constant and has averaged about 10,000 af/yr.

As described in Chapter 2, the City also uses non-potable water pumped from shallow irrigation wells to irrigate several of its public parks. This non-potable groundwater pumpage is not included in the City's municipal groundwater pumpage quantity.

As noted above, the City of Ceres accounts for only about 23 percent of the municipal groundwater pumpage within the Subbasin, and only about 2 percent of the total groundwater pumpage within the Subbasin.

##### *4.1.4.2.2 Other Municipal Groundwater Pumpage*

According to the 2008 Turlock Groundwater Basin Draft Groundwater Management Plan, the communities of Ceres, Delhi, Denair, Hickman, Hilmar, Hughson, Keyes, South Modesto, and Turlock pump, collectively, from approximately 75 wells. The average pumping from municipal wells was about 44,000 af/yr during the 1997 through 2006 period. As shown in Table 4-3, this municipal pumpage accounts for less than 10 percent of the total groundwater pumpage within the Subbasin. As urban development continues, the demands upon groundwater supplies will increase unless alternative supplies are considered.

#### 4.1.4.3 Private Groundwater Pumpage

There are an estimated 3,700 residences within the Turlock Basin that are not connected to a municipal water system that pump groundwater for domestic supply. The average annual pumping for rural residential areas averaged 4,000 af/yr between 1997 and 2006.

### **4.1.5 Other Groundwater Outflows**

Groundwater discharges occur along the lower reaches of the Tuolumne and Merced Rivers, and along the entire reach of the San Joaquin River. Along the upper reaches of the Tuolumne and Merced Rivers, groundwater is recharged by streamflow. However, under current conditions, the net effect is that the groundwater discharge to the rivers exceeds the streamflow recharge to the groundwater system. Between 1997 and 2006, the net groundwater discharge to rivers averaged nearly 30,000 af/yr.



High groundwater levels are known to occur in mainly the western and southern portions of the Subbasin. Water levels that encroach into the crop root zone can reduce crop yields. As a result, some local growers have installed subsurface drains to lower the groundwater table on their lands. Between 1997 and 2006, subsurface drains removed approximately 12,000 af/yr of high groundwater.

Lastly, phreatophytes (plants that live along the river system with their roots below or near the water table) extract their water requirements directly from the saturated zone. There are approximately 18,500 acres of native phreatophytes along the Tuolumne, Merced and San Joaquin rivers. The average groundwater consumption of riparian phreatophytes was estimated to be 41,500 af/yr between 1997 and 2006.

#### 4.1.6 Groundwater Recharge

Groundwater recharge occurring within the Subbasin is mainly the result of the irrigation of crops and landscape vegetation, precipitation, percolation from the Tuolumne and Merced rivers, leakage from Turlock Lake, underflow from the Sierra Nevada foothills, and upward seepage from deep geologic fractures. The total recharge from the various sources within the Subbasin was estimated to be approximately 520,000 af/yr between 1997 and 2006.

The majority of recharge results from irrigation practices. Recharge occurs when the applied irrigation water and effective precipitation exceed the consumptive use of agricultural crops or landscape vegetation. The excess water infiltrates below the crop root zone and then percolates downward into the groundwater table. It is estimated that urban and agricultural irrigation produces groundwater recharge of nearly 393,000 af/yr. Recharge from croplands was estimated to be 375,000 af/yr, while recharge from landscaping within urban areas is approximately 18,000 af/yr.

Other components of groundwater recharge include the following:

- Groundwater recharge from precipitation on dry, undeveloped land occurs when the effective precipitation exceeds the consumptive use of the annual or perennial vegetation.
- Turlock Lake, a regulating reservoir on TID's canal system, receives water from the Tuolumne River. Because Turlock Lake is underlain by the moderately permeable sediments of the Mehrten Formation, water leaks from the lake into the underlying and adjacent groundwater system.
- Seepage also occurs throughout TID's 230-mile canal distribution system, which is 90 percent lined.
- The Subbasin is also recharged from subsurface inflows that enter the groundwater basin across its eastern boundary and the base of the groundwater system.
- Streamflow from the Tuolumne and Merced rivers provide recharge to the Turlock Subbasin, mainly along the upper reaches of the rivers. However, within the lower reaches of the Tuolumne and Merced rivers, as well as where the San Joaquin River borders the Subbasin, groundwater typically discharges to the rivers. Consequently, discharge to the river system from the Subbasin significantly exceeded recharge.



#### 4.1.7 Water Balance in the Turlock Subbasin

A water balance study of the Turlock Subbasin was prepared in 2003<sup>7</sup> and updated in 2007 to estimate the inflows and outflows from the Subbasin between 1952 and 2006.

Outflows from the Subbasin result from:

- Municipal, domestic, and agricultural supply and drainage well pumping,
- Discharge to the local rivers,
- Discharges from subsurface agricultural drains, and
- Consumption by riparian vegetation.

The estimated average total outflow for the 1997-2006 period is 541,000 af/yr. The majority of outflow comes from estimated agricultural, municipal and rural residential, and drainage well pumping, which collectively averaged 457,000 af/yr for the 1997-2006 period.

Inflows to the Subbasin result primarily from:

- Deep percolation of agricultural and landscape irrigation water, and
- Infiltration of precipitation.

The estimated average total inflow for the 1997 to 2006 period is 519,000 af/yr. Approximately 72 percent of this quantity occurs on 245,000 irrigated acres of cropland within the Subbasin.

Groundwater storage decreased by approximately 21,500 af/yr between 1997 and 2006. The estimated reduction in storage suggests that the Subbasin may no longer be in the equilibrium state that existed in the 1990s. Increases in land use types that rely on groundwater for supply have increased the net discharge from the Subbasin. Slight decreases in storage are likely to continue if urban or irrigated land uses are developed in areas dependent upon groundwater.

Deep percolation of irrigation water is the largest inflow to the groundwater basin and plays an important role in maintaining groundwater recharge and replenishing groundwater storage. Surface water from the Turlock Irrigation District, and to a lesser extent the Merced Irrigation District, is used to supply more than half of the total irrigation water applied within the Subbasin. Hence, under current conditions the continued use of surface water for agricultural irrigation is vital for sustaining recharge in the Subbasin. Future changes to inflows or outflows resulting from shifts in land use patterns or water use patterns (*i.e.*, use of treated surface water for water supplies in lieu of groundwater to serve urban areas) have the potential to influence recharge and groundwater storage (either positively or negatively).

---

<sup>7</sup> Turlock Groundwater Basin Water Budget 1952--2002, prepared for Turlock Groundwater Basin Associations, December 2003.



## Chapter 4

### Integrated Water Supply Plan

---

#### 4.1.8 Groundwater Management

The local agencies within the Turlock Subbasin have agreed that groundwater and surface waters within the Turlock Subbasin are vitally important resources that provide the foundation for maintaining current and future water needs. Preservation of these resources is essential to maintaining the economic viability and prosperity of the Turlock Subbasin area.

##### 4.1.8.1 Turlock Groundwater Basin Association

Many local agencies are eligible to participate in groundwater management within the local groundwater basin. These agencies include the Turlock and Merced irrigation districts; the cities of Ceres, Turlock, Modesto and Hughson; the Hilmar and Delhi county water districts; the Keyes, Denair and Ballico community services districts; the Eastside and Ballico-Cortez water districts; and Stanislaus and Merced counties. These agencies have been cooperating on groundwater management activities in the Turlock Groundwater Basin since the mid-1990s.

A formal group for coordinating groundwater management activities, the Turlock Groundwater Basin Association (TGBA), was initiated in 1995. The TGBA developed the first basin-wide Groundwater Management Plan in 1997<sup>8</sup>. Although the founding Memorandum of Understanding expired upon completion of the Groundwater Management Plan, TGBA members continued to meet and discuss basin-wide planning activities. In 2001, the TGBA was formally reestablished to provide a mechanism to implement groundwater management activities and provide guidance for the management, preservation, protection, and enhancement of the Turlock Subbasin.

##### 4.1.8.2 Groundwater Management Plan

In 2008, the TGBA completed an updated Groundwater Management Plan to reflect updated knowledge and comply with changes to the Groundwater Management Act (California Water Code Section 10750 et seq.) resulting from the enactment of Senate Bill 1938 in 2002.<sup>9</sup>

It is the overall goal of the local water agencies that groundwater will continue to be a reliable, safe, efficient, and cost effective water supply. The 2008 Groundwater Management Plan includes seven Basin Management Objectives (BMOs) to meet this goal. The BMOs serve as targets to guide the groundwater management actions of the local water agencies and include the following:

1. Maintain an adequate water level in the groundwater basin.
2. Protect groundwater quality and implement measures, where feasible, to reduce the potential movement of existing contaminants.
3. Monitor groundwater extraction to reduce the potential for land subsidence.
4. Promote conjunctive use of groundwater and surface waters.

---

<sup>8</sup> Draft Turlock Groundwater Basin Groundwater Management Plan, August 1997.

<sup>9</sup> Turlock Groundwater Basin, Draft Groundwater Management Plan, prepared by the Turlock Groundwater Basin Association, January 2008.



5. Support and encourage water conservation. Develop and support alternate water supplies, and educate users on the benefits of water recycling.
6. Continue coordination and cooperation between the TGBA members and customers.

Water agencies in the Turlock Subbasin, individually and collectively, are pursuing water management strategies under each of the BMOs to ensure that groundwater continues to be a reliable, safe, efficient, and cost-effective water supply.

#### **4.1.9 Groundwater Supply Conclusions**

##### **4.1.9.1 Groundwater Yield**

Based on available data regarding the groundwater conditions in the Turlock Subbasin, it appears that historical and current conditions in the western portion of the Turlock Subbasin are relatively stable with respect to groundwater levels. This is an indication that groundwater operations in this part of the Turlock Subbasin are generally in balance, with current groundwater pumpage in this part of the Subbasin generally being balanced by groundwater recharge. Groundwater pumpage by the municipalities located within the Subbasin makes up a small percentage (less than 10 percent) of the total pumpage from the Subbasin. Pumpage by the City of Ceres accounts for only about 2 percent of the total annual pumpage in the Subbasin.

As such, the City's current average annual groundwater production of about 10,000 af/yr appears to be sustainable into the future. However, if the City's groundwater pumpage were to significantly increase in the future, it is unclear what the impacts to the Subbasin would be, if any. The City's groundwater level monitoring program will be an important tool to track and monitor groundwater levels (and subsequent changes in groundwater basin storage) into the future.

##### **4.1.9.2 Groundwater Quality**

The biggest threat to the City's continued and/or increased use of groundwater to meet potable water demands is water quality. As described in Chapter 2, the City's firm groundwater pumping capacity is about 12,700 gallons per minute (gpm). Approximately 5,400 gpm of this total capacity is groundwater that is currently treated or blended. This treated groundwater represents about 43 percent of the City's current firm groundwater pumping capacity. If groundwater levels begin to decline as a result of increased groundwater pumpage, existing groundwater gradients and flow directions will be impacted, possibly impacting the direction and gradient of existing groundwater contaminant plumes.

The City may also need to add wellhead treatment to additional wells if contaminant levels increase over time and/or additional wells are impacted. In the future, as the City looks to replace older wells and/or install new wells, careful evaluation of future well sites and well construction details will need to be made to minimize the need for wellhead treatment.



#### 4.1.9.3 Recommendations for New Wells

As noted in Chapter 2, many of the City's wells are at or nearing their estimated service life. Although actual service life can vary greatly from well to well, depending on numerous factors, this is an indication that some of the City's wells may need to be replaced within the next several years. As shown in Figure 4-15, as the wells reach their useful life (as estimated by Wood Rodgers in their July 2010 Report), the City's well production capacity is severely reduced, requiring the need for several replacement wells over time.

Locations and construction details (including well depth and perforated casing intervals) for proposed new wells should be carefully selected to maximize well production and minimize the need for wellhead treatment. To provide additional, future operational flexibility and storage capacity of treated surface water supplies are brought into the area, it is recommended that the City consider that new wells be designed as ASR wells. ASR wells have the capability to inject and store treated surface water supplies available during low water demand periods and extract these supplies during peak summer demand periods. The City currently is considering potential new wells at the following locations:

- Current Smyrna Well (Well 1) site;
- Near intersection of Mitchell Road and Service Road;
- Old Hollister Well (Well 6) site;
- Near intersection of Roeding Road and McGee Road; and
- Southwest of Whitmore Avenue and Crows Landing Road (3 to 4 new wells) to serve proposed West Landing Specific Plan area.

Candidate locations for new well sites should be initially screened by assessing the site suitability with regards to site access, well construction equipment size requirements, and CDPH set back requirements. Well sites meeting the above-ground requirements should be further assessed in the subsurface. An exploration drilling program should be conducted at all potential well locations prior to proceeding with ASR well construction. The exploration program should include drilling a test hole to identify geologic conditions and aquifer depths. Zone-specific water quality sampling in the test boring is also highly recommended. It is also recommended that a multiple-depth monitoring well be constructed at these sites to assess long-term water quality of the selected aquifers.

Based on information evaluated by Wood Rodgers, geologic cross-sections suggest that the most favorable aquifers in the central portion of the City are located between 250 and 320 feet. Wells in north Ceres near the Tuolumne River and in the West Landing Specific Plan area appear to have acceptable water quality in the 130 to 210 foot intervals, based on the available water quality data and conceptual cross-sections. However, the water quality below 210 feet is currently not known in the West Landing Specific Plan area.

The existing test hole data evaluated by Wood Rodgers suggests that groundwater that meets all of the CDPH water quality requirements may be difficult to locate in the southeast and south-central growth areas of the City. Well 35 is located in the West Landing Specific Plan area. Well 35 is a shallow (180-foot deep) well which meets all of the CDPH drinking water quality



requirements; however, it is only equipped to produce 640 gpm. Higher capacity wells in the West Landing Specific Plan area are likely possible, but they may require wellhead treatment to meet the CDPH drinking water quality requirements.

#### 4.2 FUTURE SURFACE WATER SUPPLY

Over the years, the City has considered two potential options for participating in future surface water supply projects. One option involves the City of Modesto and Modesto Irrigation District (MID), and the other involves the TID. Both are described below.

##### 4.2.1 Surface Water Supplies from City of Modesto/Modesto Irrigation District

The City of Modesto conjunctively uses groundwater and surface water supplies to meet the demand of its customers. The City of Modesto and several other communities north of the Tuolumne River receive treated surface water from the Modesto Reservoir through an agreement with the MID. A portion of the City of Modesto's contiguous water service area lies south of the Tuolumne River, and the City of Modesto also supplies groundwater to a portion of Ceres area residents who were historically served by the Del Este Water Company. A few years ago, the City of Modesto and the MID approached the City of Ceres concerning the expansion of their surface water project, but only preliminary discussions occurred. The City of Ceres has now focused its efforts on surface water supplies that may become available from the TID (see below).

##### 4.2.2 Surface Water Supplies from Turlock Irrigation District

A Surface Water Joint Powers Authority (JPA) made up of eight agencies was initially established in 1990 to evaluate bringing surface water from the Tuolumne River to the agencies for domestic use. The agencies included in the 1990 JPA were the cities of Ceres, Hughson, Modesto, and Turlock and the communities of Delhi, Denair, Keyes and Hilmar. In the mid 1990's, the TID established a proposed raw water rate to supply treated surface water. However, the majority of the cities and special districts felt that the cost to bring in treated surface water was too high. In 1997, the JPA decided not to pursue the surface water project with the TID and the JPA became inactive<sup>10</sup>.

In the last several years, however, a proposal for a TID surface water treatment project has re-emerged. In December 2006, the TID prepared an Environmental Impact Report (EIR) for a RSWSP to be supplied with water from TID<sup>11</sup>. Per the proposed project, the new surface water treatment plant would be located east of Geer Road and south of the Tuolumne River in unincorporated Stanislaus County, near the City of Hughson (east of the City of Ceres), and would treat up to 43 million gallons per day of water originating from Don Pedro Reservoir and drawn from the Tuolumne River near the Geer Road Bridge. Diversion of water from the Tuolumne River to the new water treatment plant would be accomplished under an existing TID

---

<sup>10</sup> Source: Page 3-4, City of Ceres, 2005 Urban Water Management and Conservation Plan, December 2005.

<sup>11</sup> Final Environmental Impact Report for the Turlock Irrigation District Regional Surface Water Supply Project, State Clearinghouse No. 2006022073, December 2006.



water right and using facilities already constructed or planned as part of TID's Infiltration Gallery Project in Special Run Pool 9.

The RSWSP is proposed to be developed in two phases. The first phase would deliver 29 mgd of treated surface water supply to participating communities within the TID's service area that currently rely exclusively on groundwater. These communities include Ceres, Hughson, South Modesto and Turlock in Stanislaus County. Under the proposed RSWSP, TID would construct a water treatment plant and pipeline facilities to treat and deliver surface water to those communities. The estimated cost for Phase 1 of the RSWSP is \$183 million<sup>12</sup>. This cost includes treatment, pumping, and conveyance facilities necessary to deliver water from the RSWSP to each City's proposed turnout location.

The proposed Ceres participation and share of Phase 1 RSWSP costs is shown in Table 4-4.

**Table 4-4. Proposed Participation and Share of Regional Surface Water Supply Project Costs<sup>(a)</sup>**

Participant	Proposed Phase 1 Participation	Estimated Share of Phase 1 Costs
Phase 1		
City of Ceres	6 mgd	\$49 million
City of Hughson	2 mgd	\$14 million
South Modesto	6 mgd	\$52 million
City of Turlock	15 mgd	\$68 million
Total Phase 1	29 mgd	\$183 million
Phase 2	14 mgd	To be determined
Total RSWSP	43 mgd	To be determined

<sup>(a)</sup> Source: RSWSP Special Study Session on March 24, 2010. Costs shown are in April 2009 dollars.

The City of Ceres is exploring the opportunity to enter into a new JPA with the cities of Modesto, Turlock and Hughson to move forward with Phase 1 of the RSWSP. The City of Ceres has requested a delivery of 6 mgd from Phase 1 of the proposed RSWSP, which equates to about 20 percent of Phase 1 of the RSWSP. This delivery amount for the City was based on the City's desired level of financial participation in the proposed RSWSP. As shown in Table 4-4, the City's estimated share of the estimated Phase 1 cost would be approximately \$49 million (April 2009 dollars).<sup>13</sup> In 2011, the cities established a Steering Committee to review possible technical and funding options for implementing the RSWSP, and to develop a recommendation to the participating cities on how to proceed.

<sup>12</sup> Based on a TID estimate dated February 2009, as presented at the RSWSP Special Study Session on March 24, 2010.

<sup>13</sup> As presented at the RSWSP Special Study Session on March 24, 2010.



The Water Master Plan assumes that the proposed RSWSP would begin providing treated surface water to each participating agency by approximately the year 2018. The water treatment plant would be operated on a full-time basis to deliver a base water supply to each of the communities up to their requested supply amounts; for the City of Ceres, this would be 6 mgd.

#### 4.3 RECYCLED WATER SUPPLY

##### 4.3.1 Current Recycled Water Use

The City currently disposes of its wastewater flows in the following three ways:

- Wastewater flows from the northwestern portion of Ceres and the County area (adjacent to Ceres city limits) are sent to the Modesto Wastewater Treatment Plant for treatment and disposal (via incidental groundwater recharge, agricultural irrigation and discharge to the San Joaquin River);
- Wastewater flows from the southern part of Ceres go to the Ceres Treatment Facility, and one million gallons of treated wastewater is sent to the Turlock Wastewater Treatment Facility for treatment and disposal (discharge to the San Joaquin River); and
- Remaining wastewater flows are sent to the Ceres Wastewater Treatment Facility for primary treatment, nominal reuse for on-site landscape irrigation at the City's wastewater treatment plant and disposal in on-site ponds for evaporation and incidental groundwater recharge. The City does not discharge any treated wastewater from its wastewater treatment plant to a river or any other surface water body.

The City is currently permitted to dispose of about 1,700 af/yr of secondary-treated wastewater at its on-site percolation ponds. Future disposal options are currently being evaluated by the City, but do not include plans to expand on-site use or disposal.

##### 4.3.2 Future Recycled Water Use

In the past, the City has analyzed upgrading the Ceres treatment facility to a tertiary level. However, the costs for the upgrade of the plant and the construction of recycled water distribution infrastructure were determined to be too expensive for the City to pursue. Currently, the City is working with the cities of Modesto and Turlock and the Del Puerto Irrigation District to deliver water that has been treated to tertiary standards at Modesto and Turlock facilities to the Del Puerto Irrigation District service area for irrigation use. Therefore, for the purposes of this Water Master Plan, it is assumed that tertiary-treated recycled water will not be available in the City to offset potable water demands.

#### 4.4 RECOMMENDED INTEGRATED WATER SUPPLY PLAN

##### 4.4.1 Potential Future Supply Scenarios

As described above, the City of Ceres has historically relied exclusively on groundwater to meet its water demands. These groundwater supplies have been adequate to meet the City's demands, and it appears that the City's current average groundwater pumpage of about 10,000 af/yr is



sustainable into the future. However, the City's groundwater supplies do have some water quality concerns, and several of the City's wells require wellhead treatment.

The City is considering participation in the proposed RSWSP. As described below, introduction of this proposed treated surface water supply into the City's water supply portfolio is needed to increase the reliability and diversity of the City's water supplies and will be critical to meet projected future water demands.

Projected future water demands for the City are presented on Figure 4-16 (based on the analysis described in Chapter 3) and indicate that through buildup of the City's General Plan the City's potable water demands are projected to essentially double from current demands of about 10,000 af/yr to about 20,000 af/yr. This projected increase in water demand is significant and will require a comprehensive water supply plan to ensure that the water demands of the City's existing and future customers can be reliably met.

For purposes of this Water Master Plan, two water supply scenarios have been evaluated:

- Scenario 1: Groundwater Only
- Scenario 2: Groundwater Plus Treated Surface Water

#### 4.4.1.1 Scenario 1: Groundwater Only

Scenario 1 (Groundwater Only) represents a continuation of the City's historical and current operations of using only groundwater to meet water demands. As described above, the City's current average groundwater use of about 10,000 af/yr appears sustainable as indicated by relatively stable groundwater levels over the past ten years in the City's wells. However, wellhead treatment will continue to be required for several of the City's wells to address constituents of concern (including nitrate, arsenic, uranium, manganese and specific conductance) and will probably need to be added to other existing and new wells if the City's groundwater pumpage were to double to meet projected future demands, as existing contaminant plumes migrate and are influenced by changed groundwater gradients and possible isolated well drawdown cones of depression.

The primary advantage of this water supply scenario is that the City would not be dependent on another agency (such as TID) for water supplies. Also, this scenario would involve continuation of the City's current operations and would not require significant transmission system capital improvement projects (e.g., major transmission mains to distribute surface water supplies within the City).

**The fatal flaw with this water supply scenario is that the groundwater supply from both a quantity and quality standpoint will not be adequate or sufficient to meet the City's projected future demands** (see Figure 4-17). Due to the current need to provide wellhead treatment or blending on most of the City's existing wells, and difficulty in locating new productive well sites, it must be assumed that it will be very difficult to double the existing groundwater production capacity without significant water quality and water level (groundwater storage) impacts. For purposes of this Water Master Plan, it will be assumed that the City's current 10,000 af/yr of groundwater pumpage is the maximum available "operational" yield of the basin for the City. With the City's operational groundwater pumpage set at 10,000 af/yr, the



City will have a projected supply shortfall continuing through buildout of the City's General Plan.

The projected supply shortfall in the next few years (from 2010 through 2015) is estimated to be about 700 af/yr, depending on specific hydrologic conditions, City customer response to the transition to metered rates, and the overall economic downturn. This projected interim shortfall could probably be met by some minimal additional groundwater pumpage (slightly beyond the 10,000 af/yr) and would likely have minimal impact to the underlying groundwater basin, as the groundwater pumpage would be slightly less than the City's historical maximum pumpage of 10,823 af/yr in 2007.

However, beyond 2015, the projected supply shortfall increases each year and would require increasingly more groundwater pumpage by the City each year to meet increasing demands. Pumpage of groundwater by the City at these increased quantities is probably not sustainable. This increased groundwater pumpage will probably impact groundwater levels in the portion of the Subbasin underlying the City unless groundwater recharge to this part of the Subbasin were to also increase through recharge basins and/or aquifer storage and recovery wells (if the correct hydrogeologic conditions could be identified) to offset the increase in pumpage. Such increased pumpage will likely also impact water quality in the City's wells, either triggering the need for additional wellhead treatment, adding treatment where none was previously required, or forcing wells to be taken out of service.

The estimated costs for implementation of this groundwater only supply scenario include the following components:

- Costs to replace existing wells as they reach the end of their useful lives (it is estimated that 11 replacement wells producing an average of 900 gpm each will be needed)
- Wellhead treatment for an estimated 50 percent of the replacement wells (estimated to be 6 wells),
- New wells to provide additional pumping capacity to meet the projected additional demands through buildout (it is estimated that 11 new wells will be required),
- Wellhead treatment for an estimated 100 percent of the new wells (assumes wells will need wellhead treatment as groundwater pumpage increases and cones of depression are created and water quality worsens).

The estimated costs for these components are shown in Table 4-5 and total about \$81 million for Scenario 1. Other intangible costs associated with this scenario are potential increased groundwater pumping costs associated with decreasing water levels as a result of exceeding the operational yield of the groundwater basin, and potential irreversible impacts to the underlying groundwater basin which may lead to loss of local control of groundwater resources to the State Water Resources Control Board, should the basin become significantly overdrafted.

Table 4-5. Water Supply Scenario Cost Comparison(a)

Table 4-5. Water Supply Scenario Cost Comparison(a)						
Water Supply Component	Comments	Quantity	Scenario 1: Groundwater Only		Scenario 2: Groundwater + RSWSP	
			Unit Cost	Total Cost	Unit Cost	Total Cost
<b>Groundwater Costs</b>						
Replacement Wells <sup>(a)</sup>	--To replace aging wells through buildup --City is projected to lose about 10,000 gpm of well production by buildup due to aging wells--see Figure 4-15 --Unit costs based on similar municipal wells drilled in the Central Valley	11 wells @ 900 gpm each = 9,900 gpm total	11	750,000	8,250,000	11
Wellhead Treatment for Replacement Wells	--Assumes oxidation/filtration treatment --Unit costs based on present worth cost estimates by DSWA (Treatment Alternative 5 in May 2010 TM)	Assumes 50% of Replacement Wells need Wellhead Treatment	6	1,600,000	9,600,000	6
New Wells <sup>(b)</sup>	--As needed to meet additional demands through buildup --Unit costs based on similar municipal wells drilled in the Central Valley	Scenario 1: Additional 9,300 gpm of maximum day pumping capacity required by buildup = 11 new wells	11	1,200,000	13,200,000	--
Wellhead Treatment for New Wells	--Assumes ion exchange treatment, assuming water quality issues worsen as groundwater pumping increases and cones of depression are created --Unit costs based on cost curves	Scenario 2: Additional 5,100 gpm of maximum day pumping capacity required by buildup = 6 new wells	--	--	6	1,300,000
<b>Treated Surface Water Costs</b>						
6 mgd participation in Phase 1 Regional Surface Water Supply Project			--	--	1	51,000,000
<b>Total</b>				<b>80,550,000</b>		<b>85,650,000</b>

THE JOURNAL OF CLIMATE

卷之三



#### 4.4.1.2 Scenario 2: Groundwater Plus Treated Surface Water

Scenario 2 (Groundwater Plus Treated Surface Water) represents the introduction of treated surface water from the proposed RSWSP into the City's water supply portfolio. As described above, the City is proposing to enter into a JPA with the cities of Modesto, Turlock and Hughson in 2011 to move forward with Phase 1 of the RSWSP. For purposes of this Water Master Plan, West Yost is assuming that the full 6 mgd of treated surface water supplies from Phase 1 of the RSWSP will be available to the City starting in 2018.

Implementation of this scenario would require the negotiation of a surface water treatment and delivery contract with TID. Such an agreement would need to establish provisions such as, but not limited to, the following:

- Maximum daily (in mgd) and/or monthly (in million gallons per month) delivery rates;
- Maximum annual delivery rates (in af/yr);
- Proportionate share of annual water supply costs;
- Proportionate share of capital and annual operations and maintenance (O&M) costs for treatment and delivery of the surface water supplies to the City; and
- Water shortage allocation policies.

This supply scenario is shown on Figure 4-18. As shown, the City's primary supply source will still be groundwater. However, starting in 2018, 6 mgd (6,700 af/yr) of treated surface water is assumed to be available to the City.

The significant advantage of this supply scenario is that it would diversify the City's water supply portfolio and improve the overall reliability and water quality of the City's water supplies by providing a second source of supply. This scenario would reduce the City's reliance on groundwater and allow the City to minimize its use of groundwater, thus helping to maintain and protect the City's groundwater resource. The City's combined use of groundwater and surface water would also allow the City to deliver a higher quality of water to its customers. This new treated surface water supply, coupled with the local installation of ASR wells, could allow the City to store treated surface water in the groundwater. Therefore, for those wells with water quality issues, this blending would provide a means for utilizing wells of marginal water quality.

The slight disadvantage of this supply scenario is the cost to implement and maintain it. As a participant in the RSWSP, the City would need to pay its proportionate share of the capital and annual O&M costs of the RSWSP facilities, including the surface water treatment plant, pump stations and transmission pipelines. The City would also need to upgrade its water transmission and distribution system capacity to enable the City to deliver the treated water supplies throughout the City's system. This conversion from a groundwater only system, with individual wells serving only localized parts of the City system, to a combined groundwater and surface water conjunctive use system, where surface water supplies need to be conveyed throughout the City from one or two main delivery points, will likely require significant transmission/distribution system improvements. There may be some options available to assist in staging the introduction of treated surface water supplies into the City system, to minimize water rate and



connection fee impacts. One option might involve the regional use of ASR wells, however additional studies will be required to confirm the feasibility of this approach.

Under this supply scenario, the City would have some projected supply shortfalls in the years before the RSWSP becomes available (2010 through 2017), and again in the years approaching buildout of the City's General Plan. As in Scenario 1, the projected supply shortfall in the next few years (from 2010 through 2017) is estimated to reach 1,400 af/yr. This projected interim shortfall could be interimly met by additional groundwater pumpage (beyond the 10,000 af/yr) and would likely have minimal impact to the underlying groundwater basin, as the groundwater pumpage would not be significantly more than the City's historical maximum pumpage of 10,823 af/yr in 2007.

The supply shortfalls projected to begin in the years approaching buildout could be met in one the following ways:

- Additional Groundwater Pumpage Beyond 10,000 af/yr: The projected shortfall at buildout would require an additional groundwater pumpage of about 3,100 af/yr, which would be a 31 percent increase over the City's current average groundwater pumpage. However, it is unclear what impacts this additional pumpage may have on water levels and/or water quality in the groundwater basin underlying the City.
- Additional Treated Surface Water: Additional participation in the RSWSP could provide the City with additional treated water supplies and could eliminate or reduce the projected future supply shortfalls. As shown on Figure 4-18, an additional 3,100 af/yr of supply would be required by buildout. This additional supply would require an additional participation in the RSWSP of about 3 mgd, for a total participation of 9 mgd.
- Additional Use of Non-Potable Groundwater to Offset Potable Water Demands: The City currently uses non-potable groundwater to irrigate several of its public parks. If this program were to be expanded to include additional parks, high school fields, and/or other landscaped areas, it may be possible to offset current and/or future potable water use using non-potable groundwater, and free up potable water supplies for other more important potable uses.

Capital budgeting for the buildout timeframe assumes that the shortfall will be met from additional groundwater pumping. Therefore, the estimated costs for implementation of this supply scenario include the following components:

- Costs to replace existing wells as they reach the end of their useful lives (it is estimated that 11 replacement wells producing an average of 900 gpm each will be needed)
- Wellhead treatment for an estimated 50 percent of the replacement wells (estimated to be 6 wells),
- Costs to participate in 6 mgd of the Phase 1 of the RSWSP,



- New wells to provide additional pumping capacity to meet the projected additional demands through buildup (it is estimated that 6 new wells will be required), and
- Wellhead treatment or provisions for ASR for 4 new wells (2 wells requiring wellhead treatment and 2 wells with provision for ASR). This scenario (assumes more wells will need wellhead treatment or provision for construction as ASR wells as groundwater pumpage increases and cones of depression are created and water quality worsens).

The estimated costs for these components are shown in Table 4-5 and total about \$86 million for Scenario 2.

#### **4.4.2 Findings and Recommendations**

Table 4-6 provides a summary of the primary advantages and disadvantages of the two water supply scenarios described above.

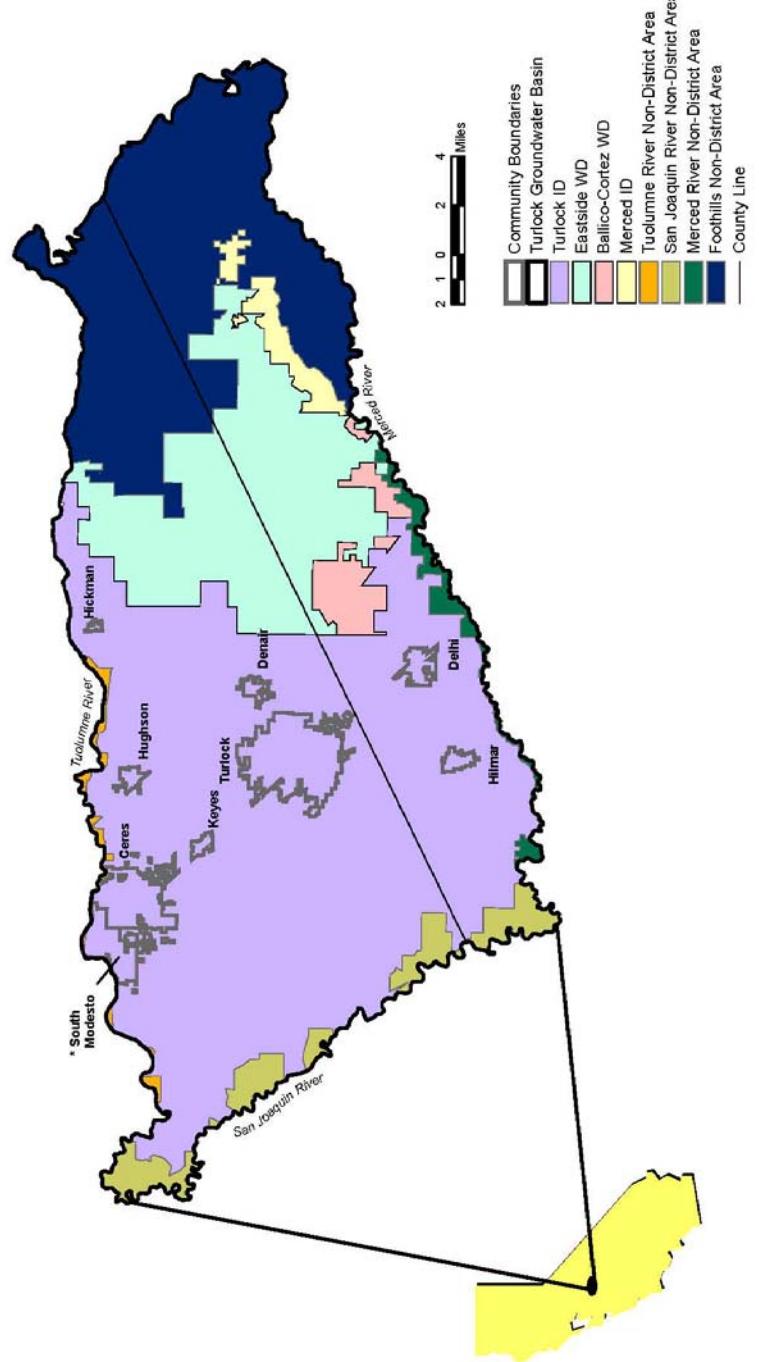
Based on our evaluation, West Yost strongly recommends Water Supply Scenario 2 for the City. As noted above, even though the implementation and maintenance of the RSWSP will be costly, the costs for Supply Scenario 2 are not significantly more than the estimated costs to increase groundwater production capacity (Supply Scenario 1) (especially if the intangible costs associated with increased groundwater pumpage under Supply Scenario 1 are considered). Also, Scenario 2 will diversify the City's water supply portfolio and will improve the City's overall water supply reliability by reducing the City's reliance on groundwater. Furthermore, this scenario, if coupled with the construction of ASR wells, would provide the City with significant operational flexibility, and would allow the City to deliver a higher quality water to its customers and would minimize the potential for future water supply shortfalls.



**Table 4-6. Summary of Water Supply Scenario Advantages and Disadvantages**

Water Supply Scenario	Advantages	Disadvantages
Scenario 1: Groundwater Only	<ul style="list-style-type: none"> <li>The City would not be dependent on another agency (e.g., TID) for water supplies</li> <li>Would require minimal distribution system improvements (only expansion of the distribution network to serve new development areas and replacement of older, smaller diameter pipelines to improve existing system operations)</li> </ul>	<ul style="list-style-type: none"> <li>Would require the construction of numerous additional wells (probably requiring wellhead treatment)</li> <li>Groundwater pumpage beyond the current average pumpage quantity (defined as the City's "operational" groundwater yield) may not be sustainable and may negatively impact groundwater levels and/or groundwater quality</li> <li>May lead to loss of local control of groundwater resources as a result of potential groundwater overdraft conditions</li> </ul>
Scenario 2: Groundwater (with ASR wells) Plus Treated Surface Water	<ul style="list-style-type: none"> <li>Would diversify the City's water supply portfolio</li> <li>Would improve overall water supply reliability and system flexibility</li> <li>Would reduce the City's reliance on groundwater</li> <li>Would allow the City to deliver a higher quality water to its customers</li> <li>Would minimize future supply shortfalls</li> </ul>	<ul style="list-style-type: none"> <li>Would have high capital and O&amp;M costs for the City's proportionate share of the RSWSP facilities</li> <li>Would require significant transmission and distribution system improvements to allow for delivery of the treated surface water supplies throughout the City's system</li> </ul>



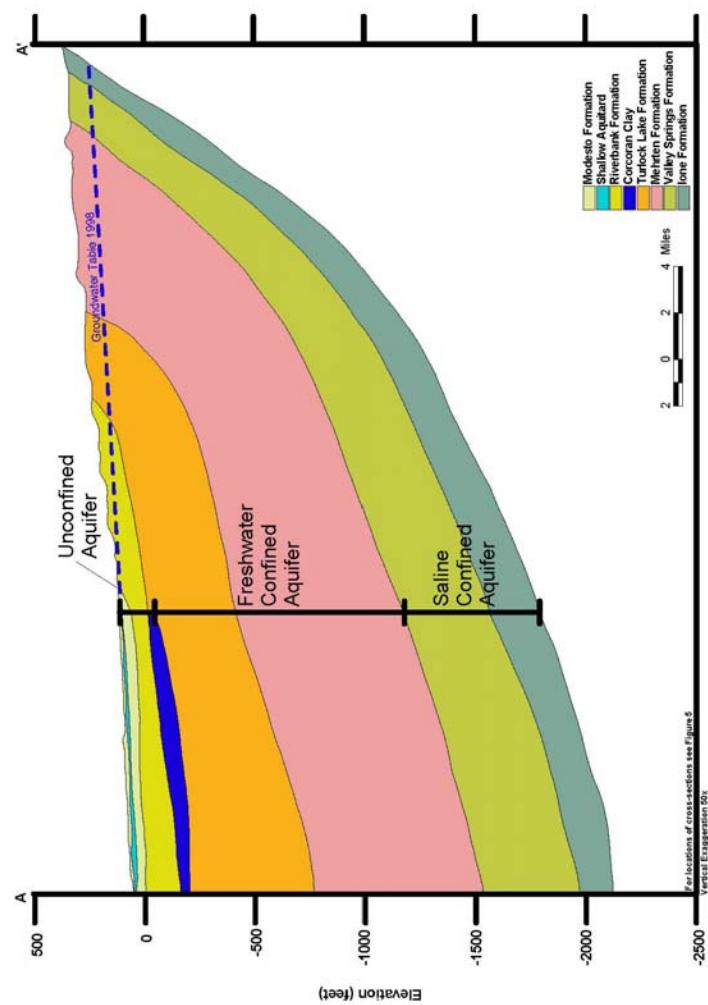
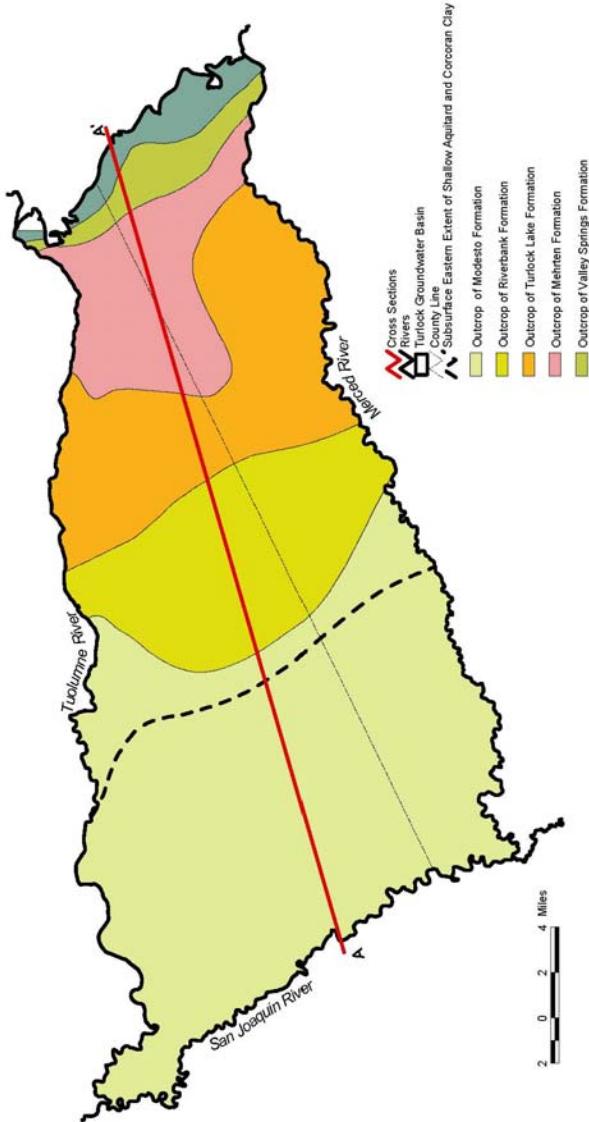


\* South Modesto represents the City of Modesto Service Area South of the Tuolumne River

**FIGURE 4-1**  
**City of Ceres**  
**Water Master Plan**  
**TURLOCK GROUNDWATER**  
**SUBBASIN LOCATION & BOUNDARY**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.

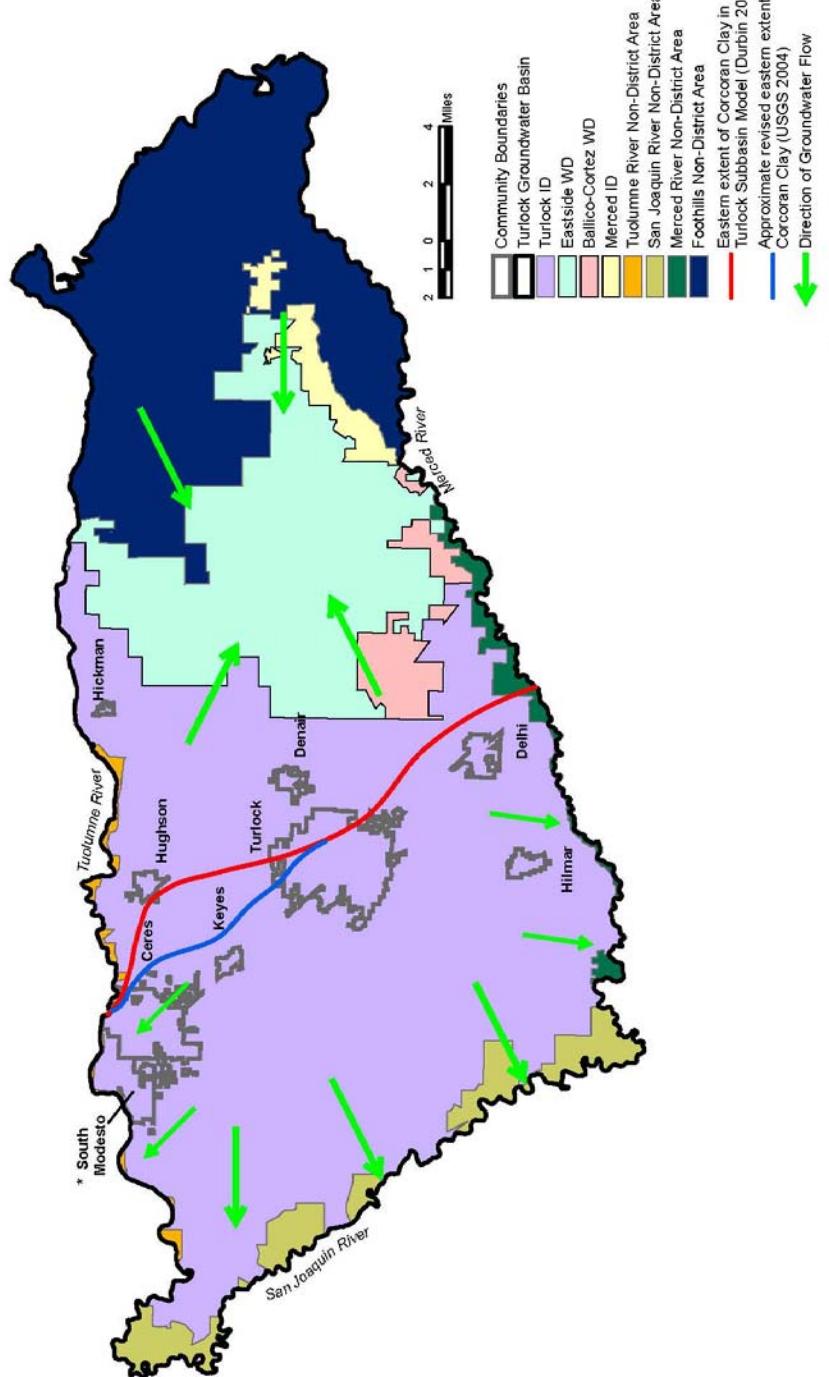




**FIGURE 4-2**  
**City of Ceres**  
**Water Master Plan**  
**EAST-WEST CROSS-SECTION**  
**SHOWING WATER BEARING**  
**ZONES**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.



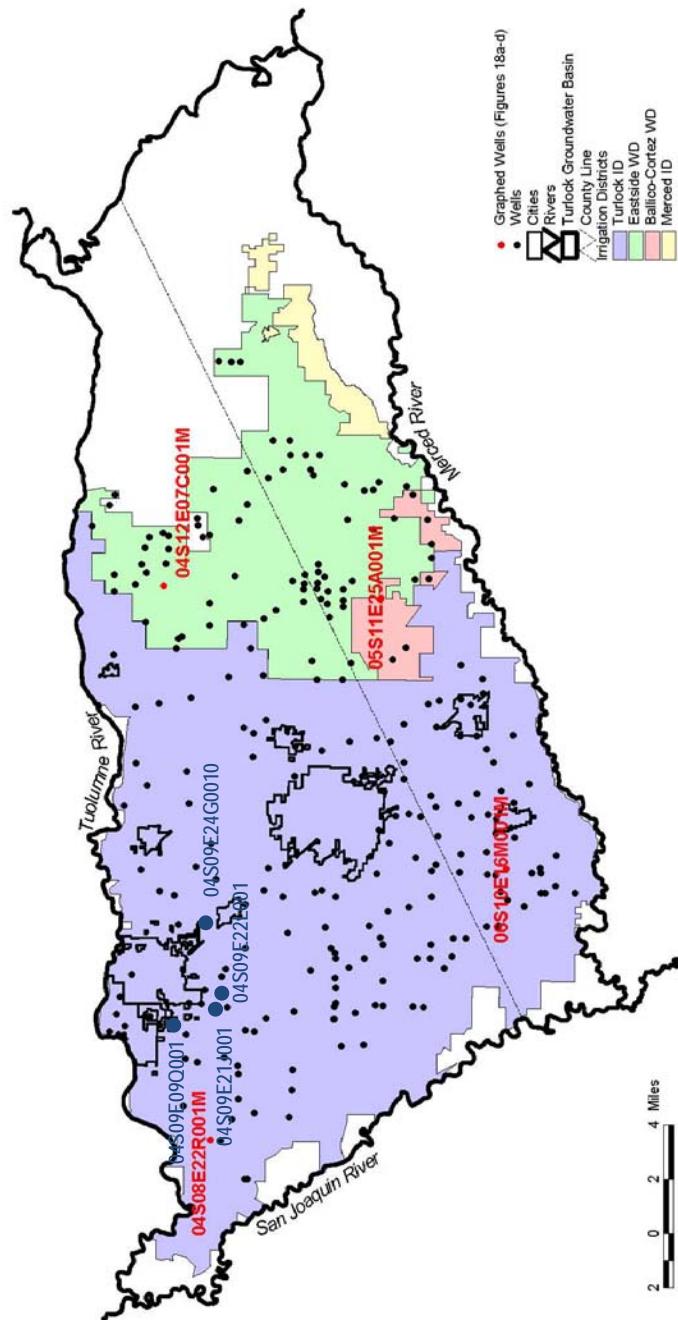


**FIGURE 4-3**  
**City of Ceres**  
**Water Master Plan**

**GROUNDWATER MOVEMENT  
DIRECTION WITHIN THE  
TURLOCK SUBBASIN**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.





Wells shown in **RED** are intermediate-depth monitoring wells (see Figure 4-5 for hydrographs for these wells)

Wells shown in **BLUE** are DWR-monitored wells (see Figure 4-7 for hydrographs for these wells)

**FIGURE 4-4**  
City of Ceres  
Water Master Plan  
**LOCATIONS OF**  
**INTERMEDIATE-DEPTH**  
**MONITORING WELLS IN THE**  
**TURLOCK SUBBASIN**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.

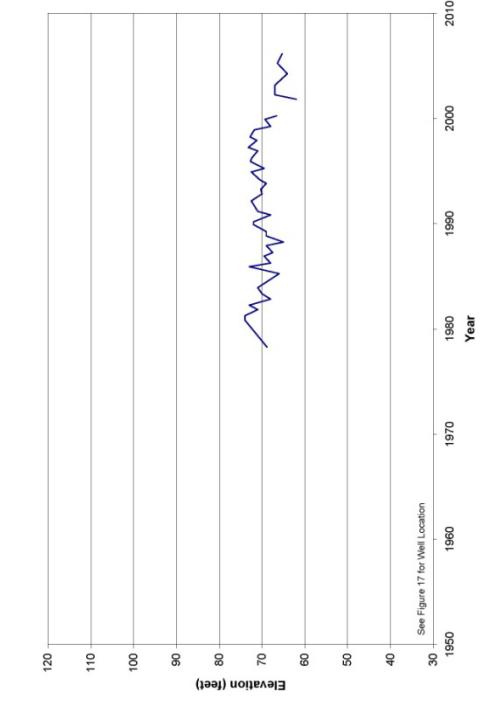




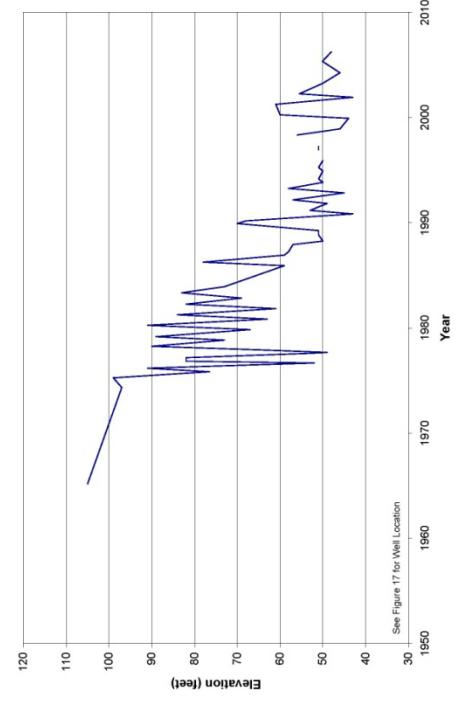
Well 04S08E22R001M



Well 04S12E07C001M



Well 05S11E25A001M



Well 06S10E16M001M

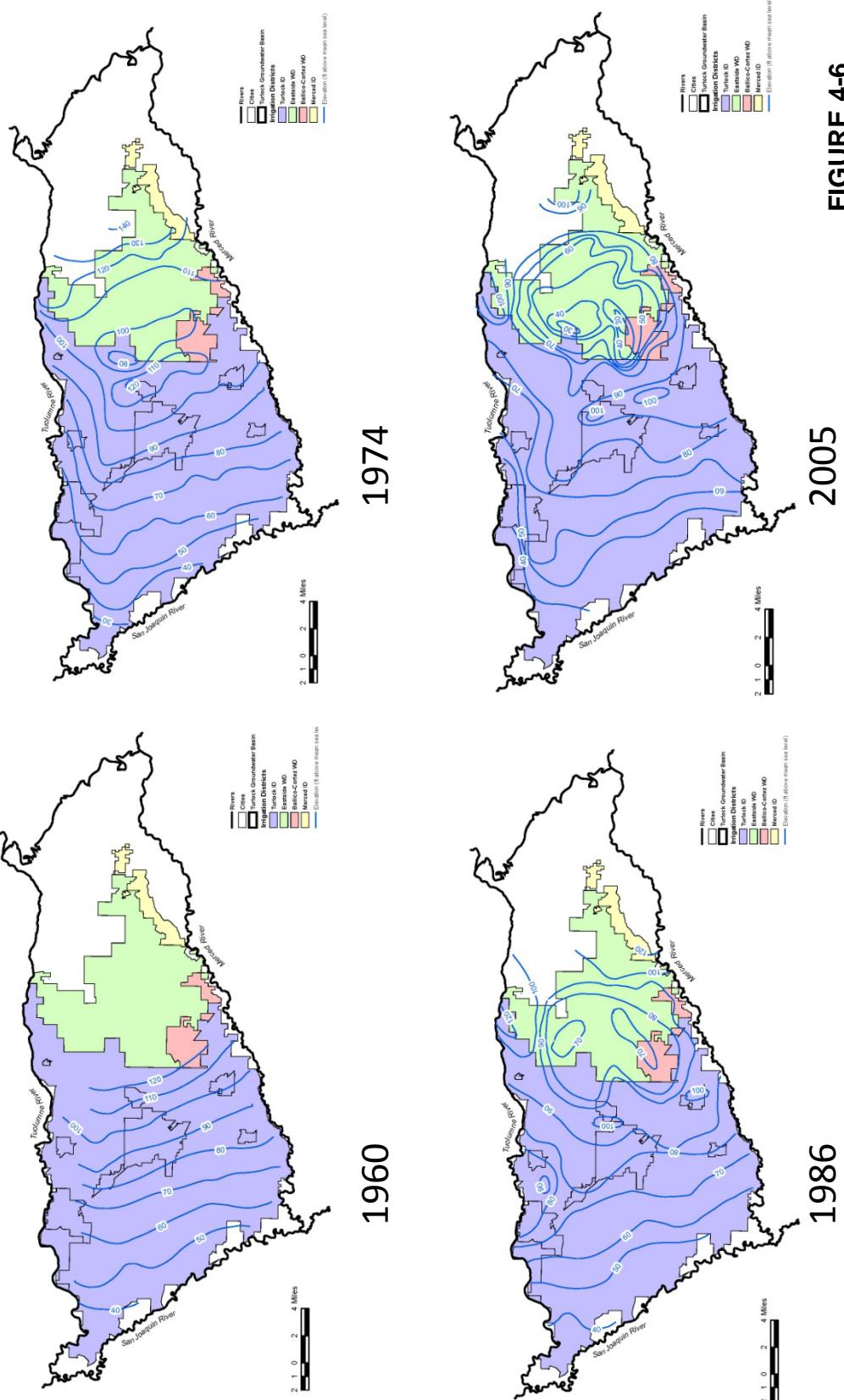
See Figure 4-4 for the locations of these four wells

FIGURE 4-5

City of Ceres  
Water Master Plan  
**HYDROGRAPHS FOR  
INTERMEDIATE-DEPTH  
MONITORING WELLS IN THE  
TURLOCK SUBBASIN**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.

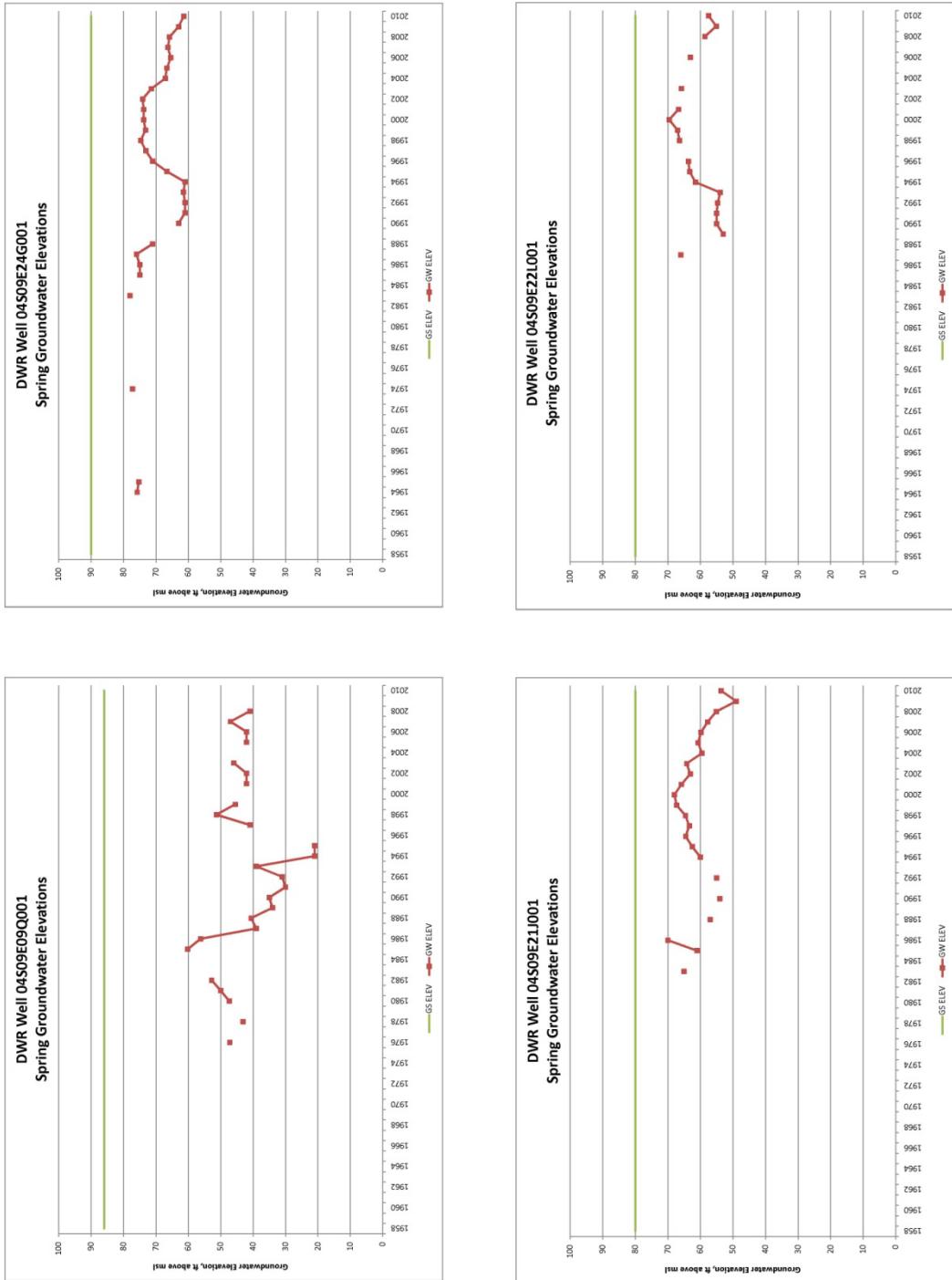




**FIGURE 4-6**  
**City of Ceres**  
**Water Master Plan**  
**HISTORICAL SPRING**  
**GROUNDWATER ELEVATION**  
**CONTOURS**

Source: Turlock Groundwater Basin Draft  
Groundwater Management Plan, prepared by Turlock  
Groundwater Basin Association, January 17, 2008.

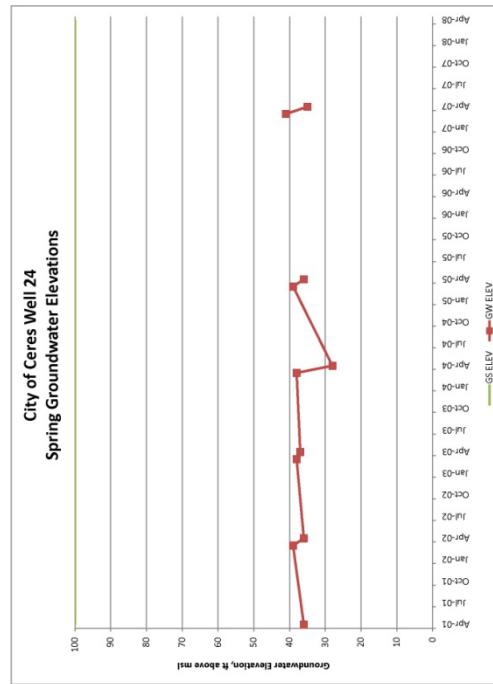
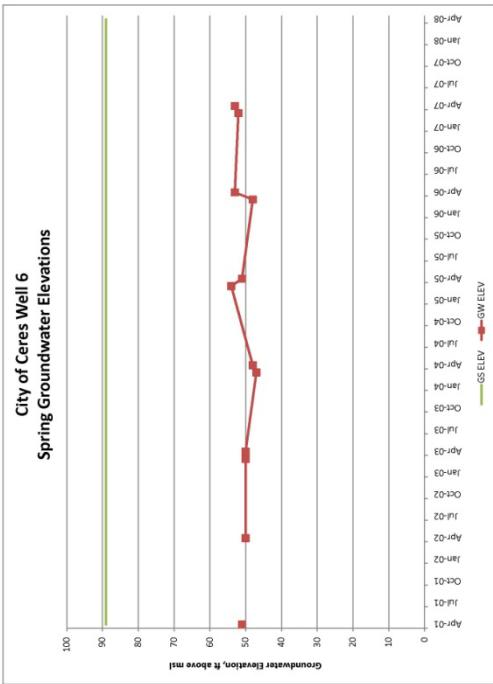
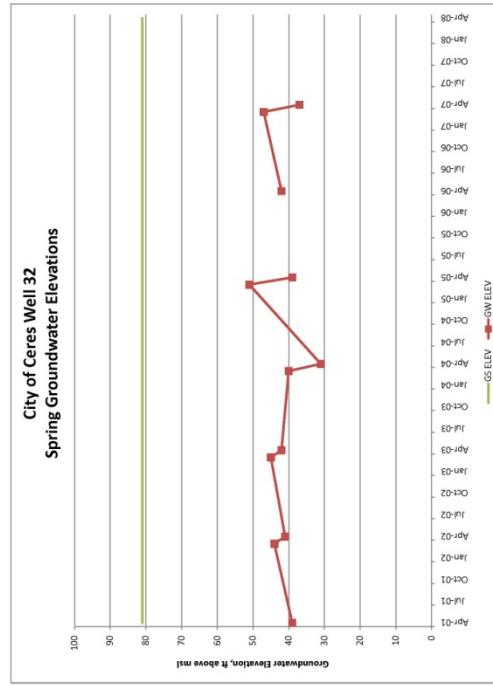
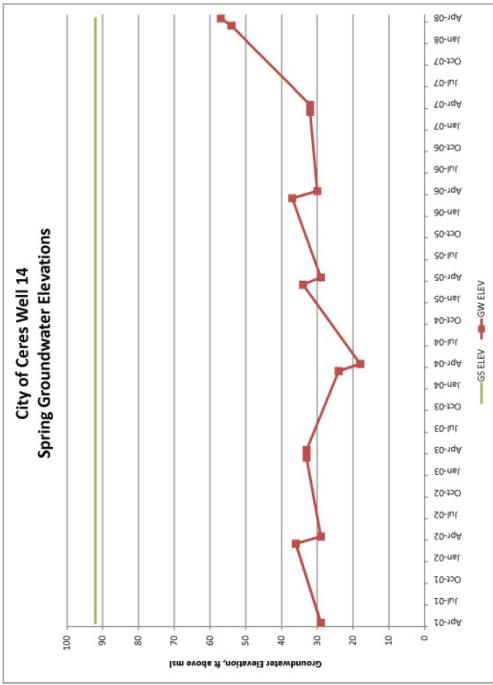




**FIGURE 4-7**  
City of Ceres  
Water Master Plan  
**HISTORICAL SPRING  
GROUNDWATER ELEVATIONS  
IN DWR-MONITORED WELLS  
NEAR THE CITY OF CERES**

See Figure 4-4 for the locations of  
these four wells

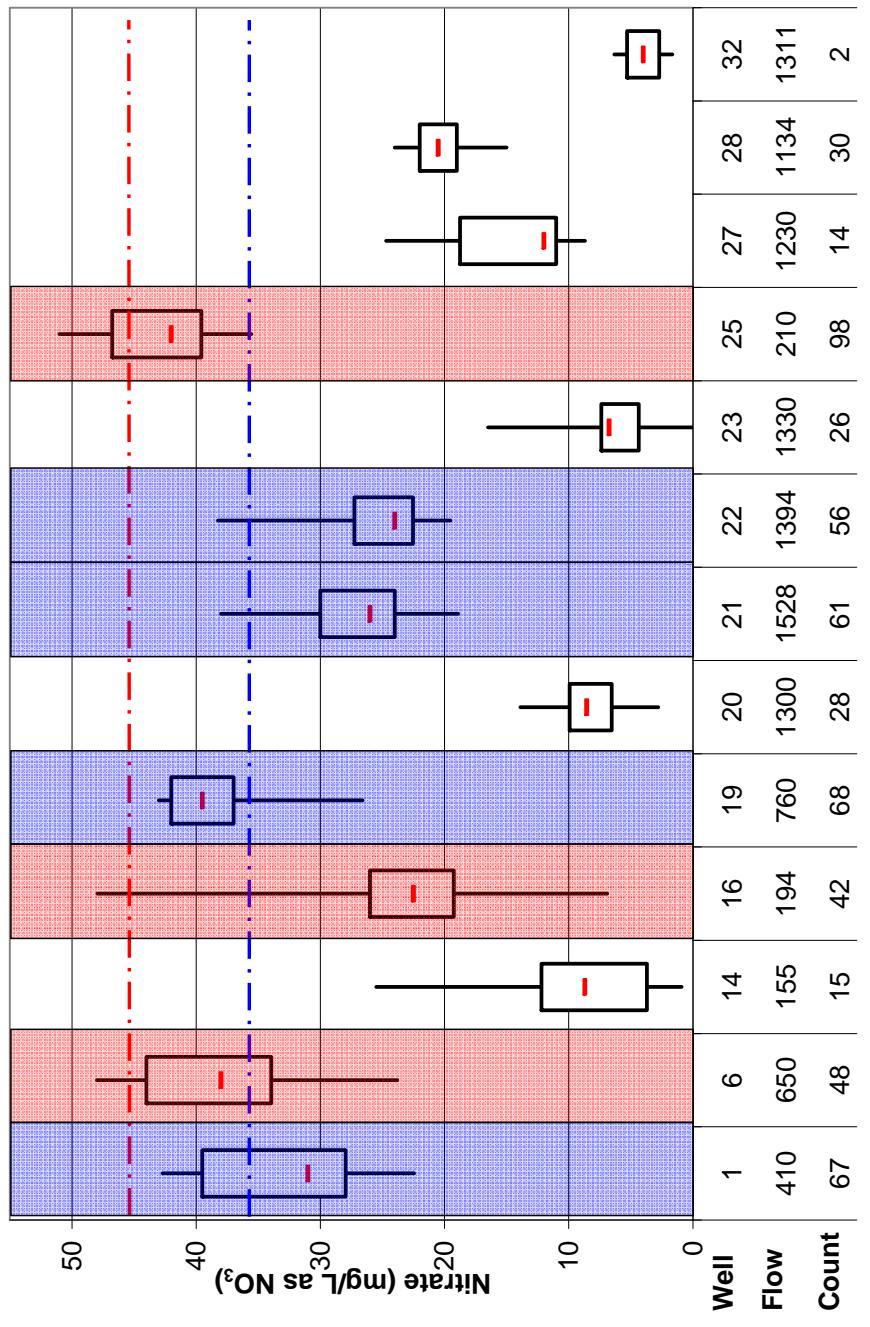




**FIGURE 4-8**  
**City of Ceres**  
**Water Master Plan**  
**HISTORICAL SPRING**  
**GROUNDWATER ELEVATIONS**  
**IN CITY OF CERES WELLS**

Source: City of Ceres Groundwater Level Data



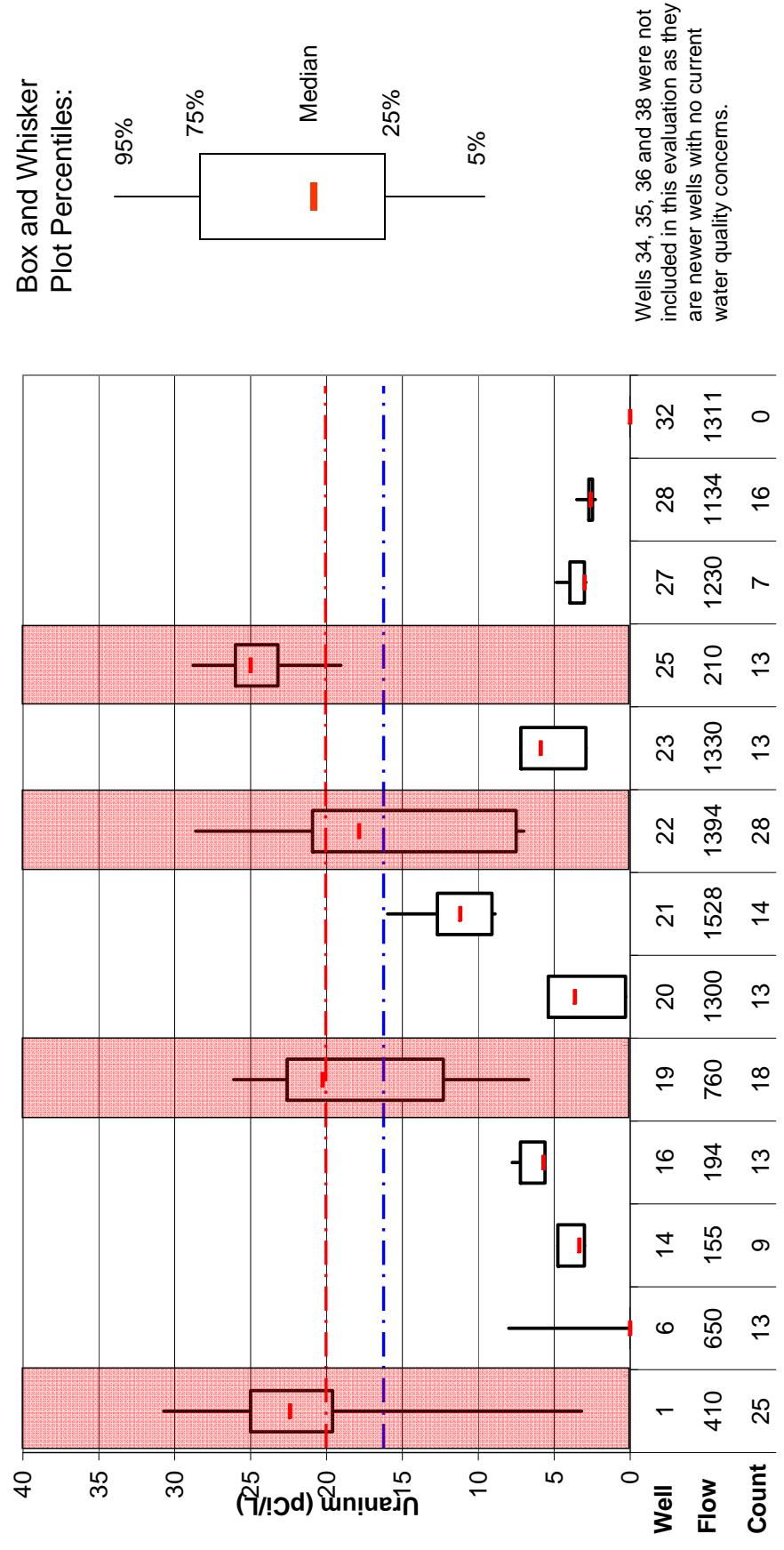


Wells 34, 35, 36 and 38 were not included in this evaluation as they are newer wells with no current water quality concerns.

**FIGURE 4-9**  
City of Ceres  
Water Master Plan  
**NITRATE CONCENTRATIONS  
IN CITY OF CERES WELLS**

Source: Damon S. Williams Associates, City of Ceres  
Water Master Plan—Wellhead Treatment Alternatives  
Evaluation, May 25, 2010

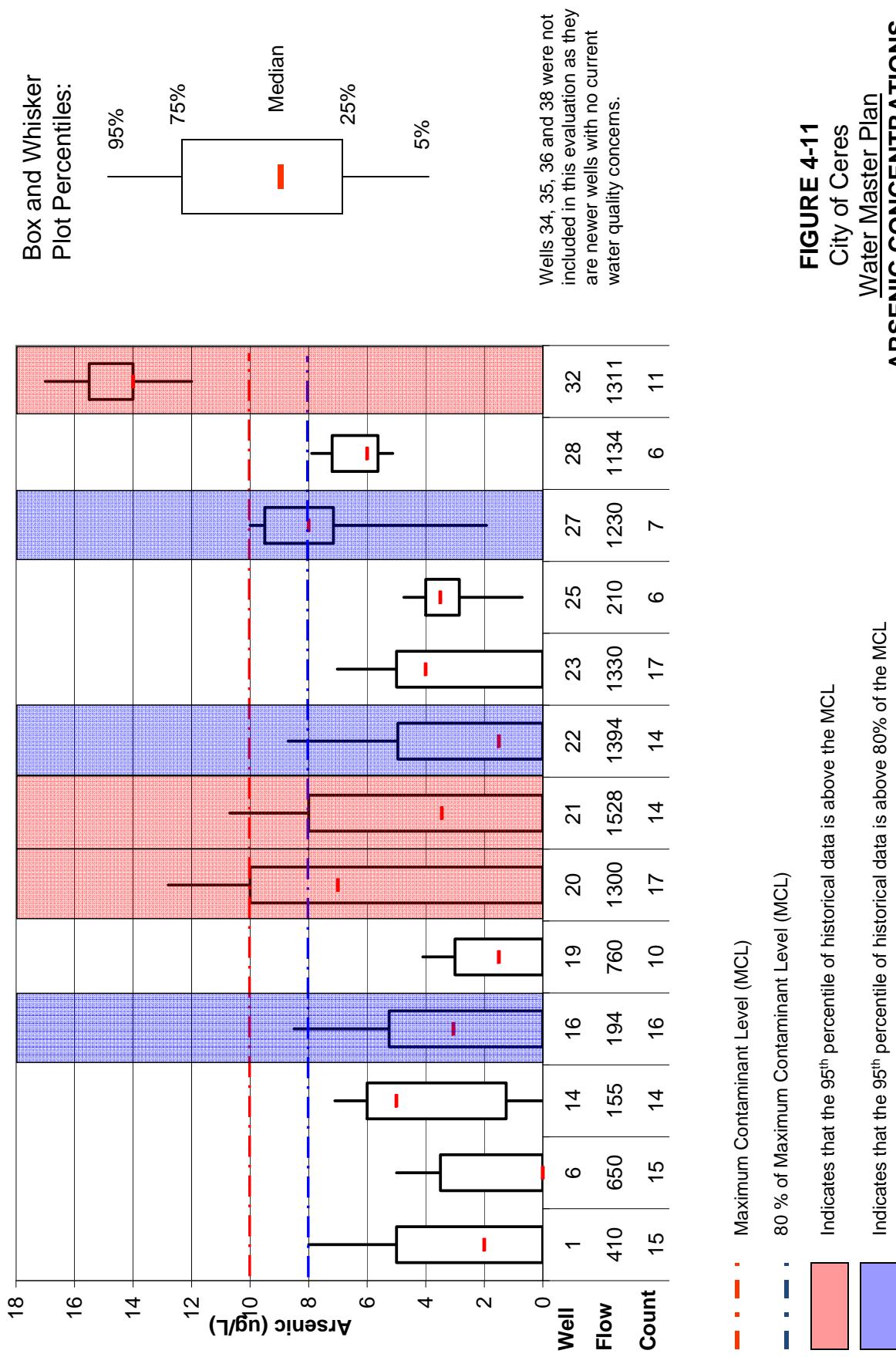




**FIGURE 4-10**  
**City of Ceres**  
**Water Master Plan**  
**URANIUM CONCENTRATIONS**  
**IN CITY OF CERES WELLS**

Source: Damon S. Williams Associates, City of Ceres  
 Water Master Plan—Wellhead Treatment Alternatives  
 Evaluation, May 25, 2010

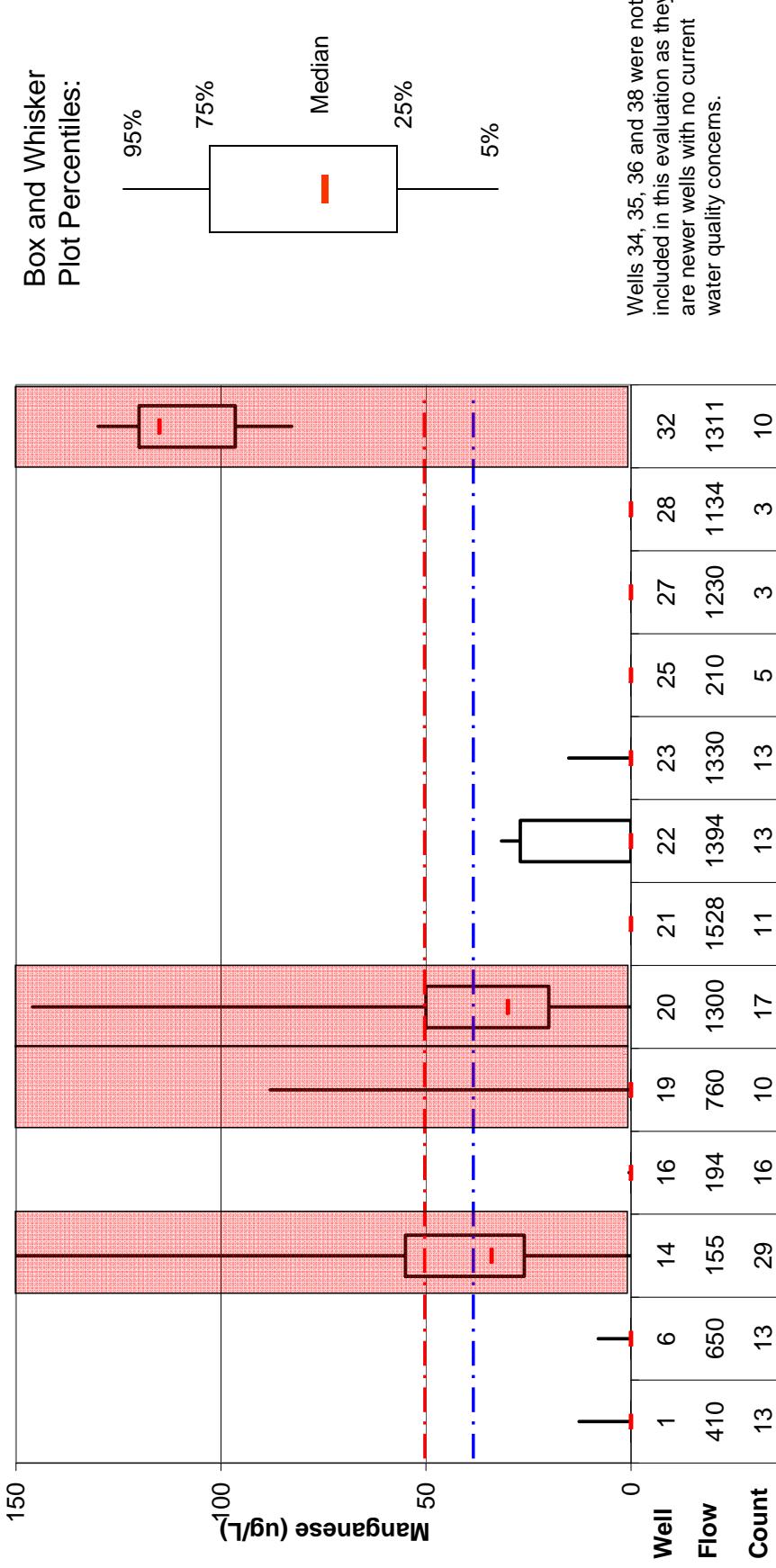




**FIGURE 4-11**  
**City of Ceres**  
**Water Master Plan**  
**ARSENIC CONCENTRATIONS**  
**IN CITY OF CERES WELLS**

Source: Damon S. Williams Associates, City of Ceres Water Master Plan—Wellhead Treatment Alternatives Evaluation, May 25, 2010

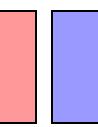




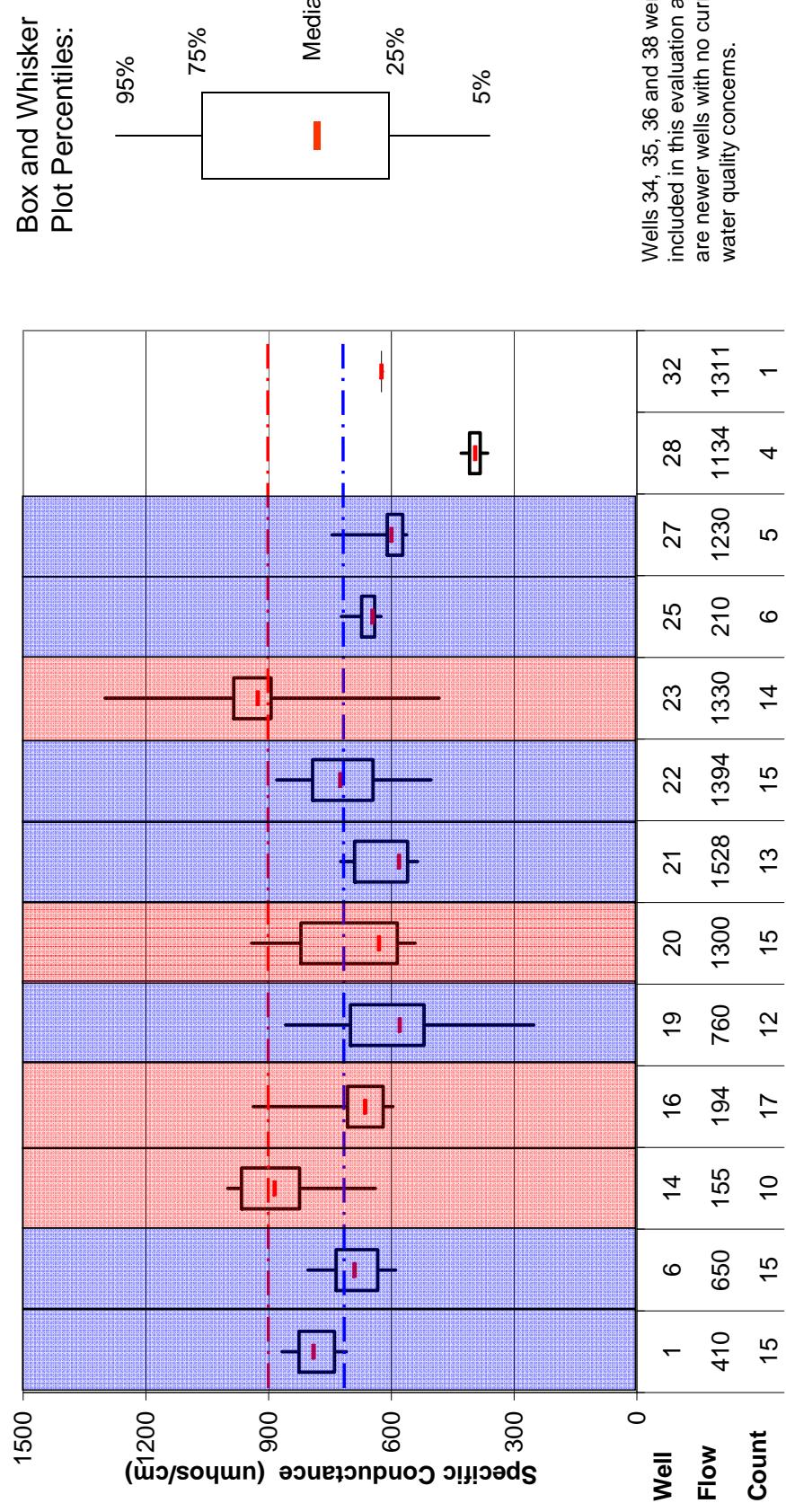
**FIGURE 4-12**  
City of Ceres  
Water Master Plan  
MANGANESE  
CONCENTRATIONS IN CITY OF  
CERES WELLS

Source: Damon S. Williams Associates, City of Ceres  
Water Master Plan—Wellhead Treatment Alternatives  
Evaluation, May 25, 2010

— - - Maximum Contaminant Level (MCL)  
— - - 80 % of Maximum Contaminant Level (MCL)  
— - - Indicates that the 95<sup>th</sup> percentile of historical data is above the MCL







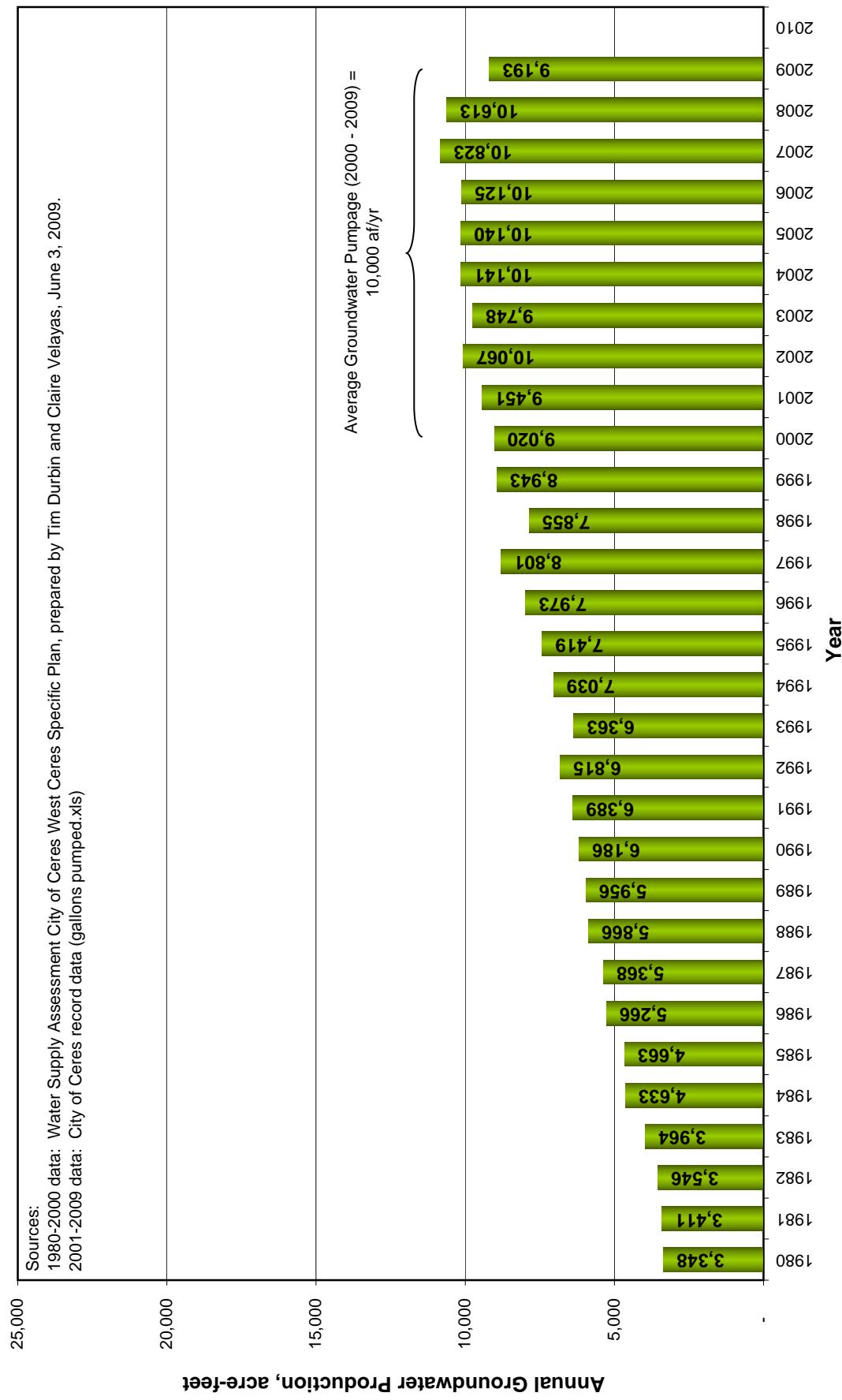
Wells 34, 35, 36 and 38 were not included in this evaluation as they are newer wells with no current water quality concerns.

**FIGURE 4-13**  
City of Ceres  
Water Master Plan  
SPECIFIC CONDUCTANCE CONCENTRATIONS IN CITY OF CERES WELLS

Source: Damon S. Williams Associates, City of Ceres Water Master Plan—Wellhead Treatment Alternatives Evaluation, May 25, 2010

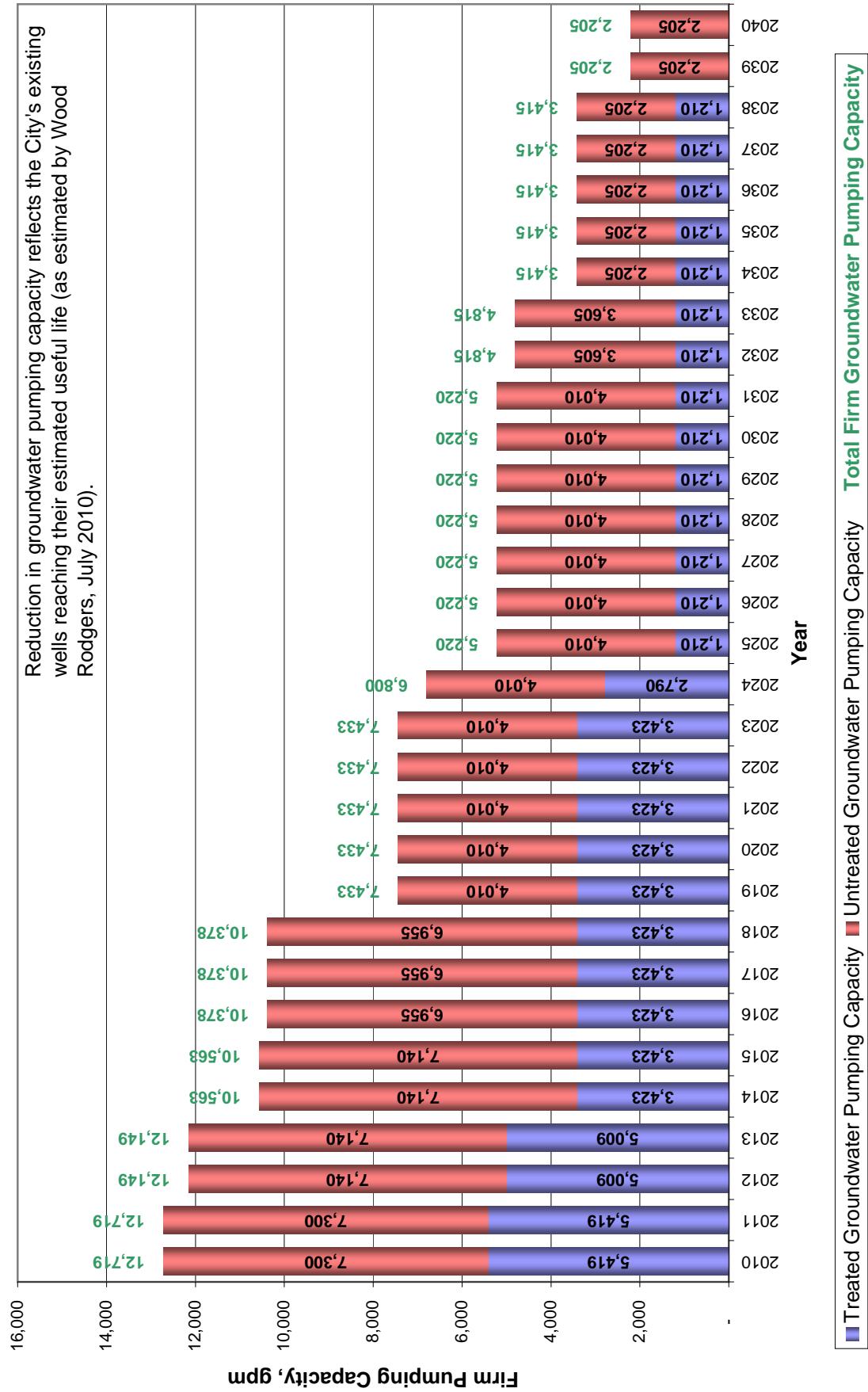


**Figure 4-14. City of Ceres Historical Annual Groundwater Production**



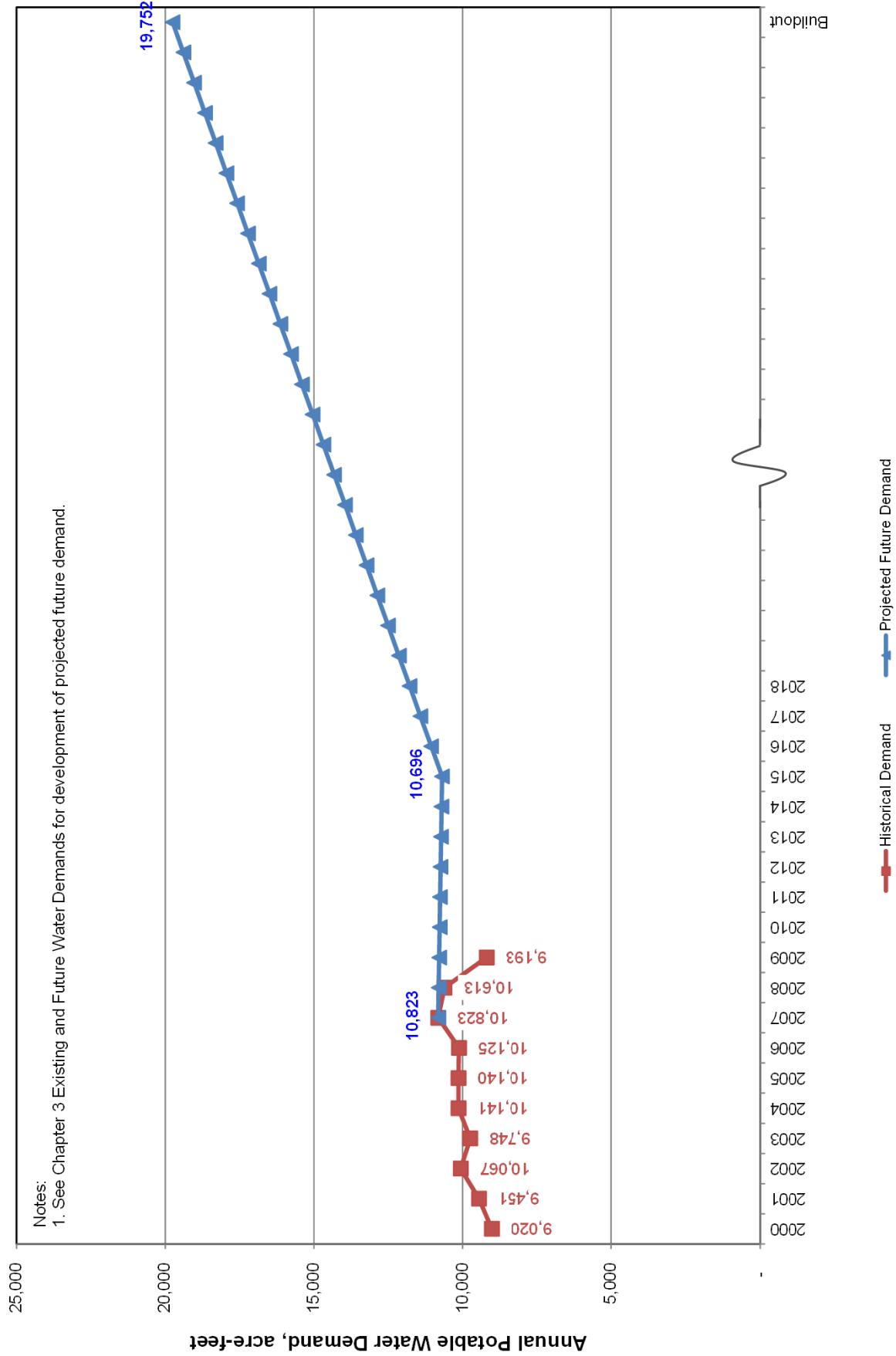


**Figure 4-15. Reduction in Firm Groundwater Pumping Capacity Over Time Due to Well Age**



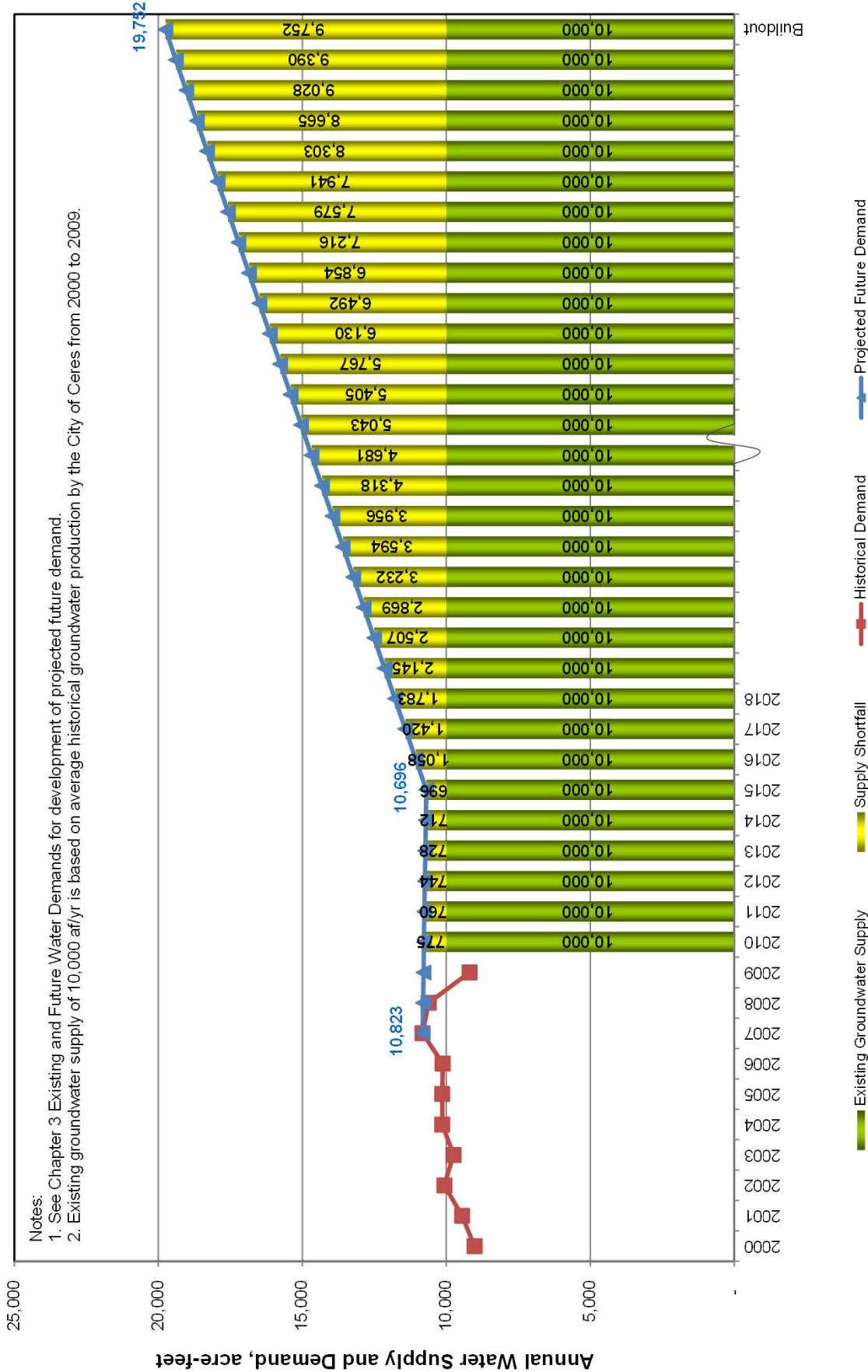


**Figure 4-16. City of Ceres Historical and Projected Annual Potable Water Demand**



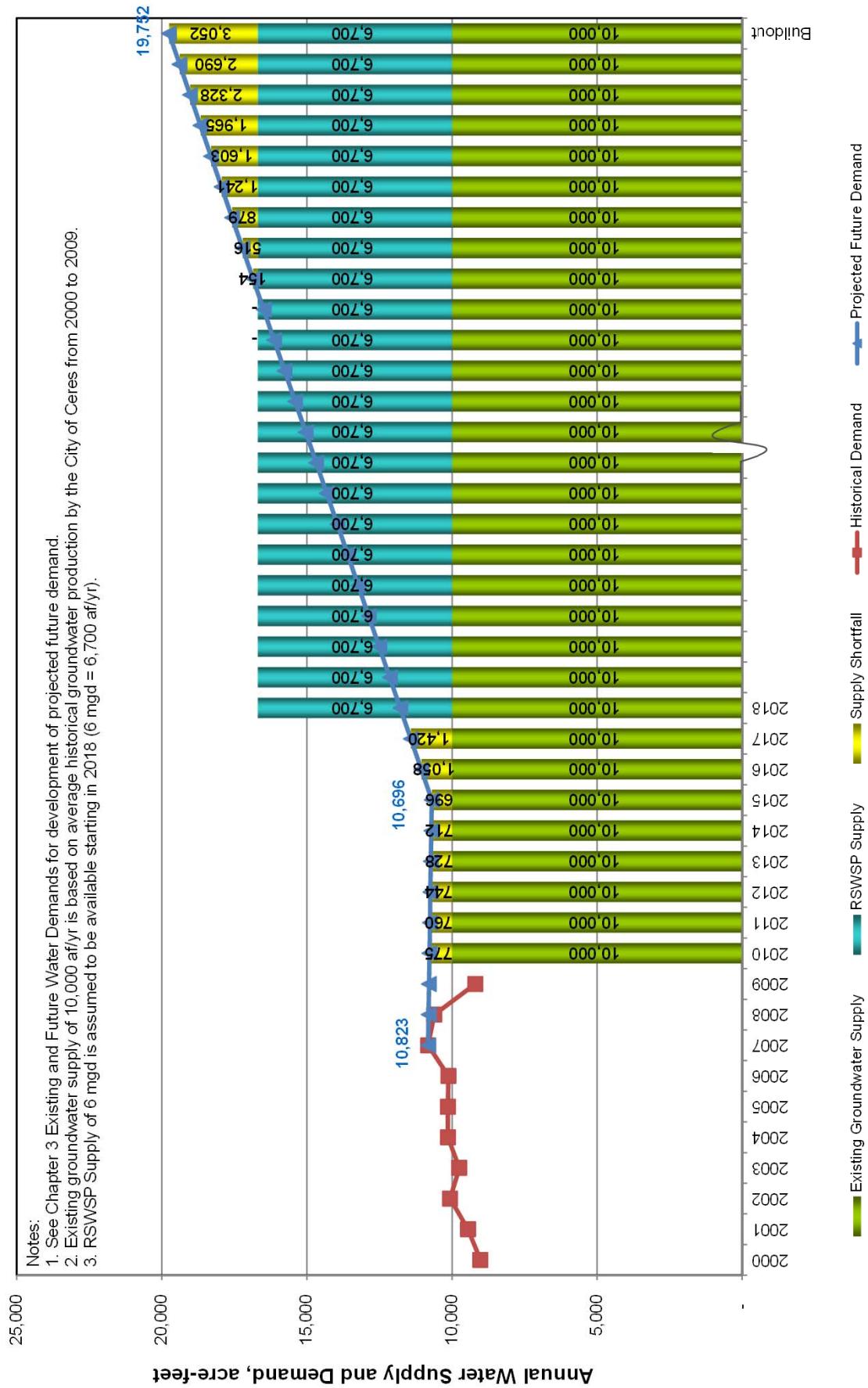


**Figure 4-17. City of Ceres Future Potable Water Supply (with only Existing Groundwater Supply)**





**Figure 4-18. City of Ceres Future Supply vs. Demand (with Existing Groundwater Supply + Future RSWSP)**







### 5.1 OVERVIEW

The purpose of this chapter is to define the recommended performance and operational criteria for the City's potable water distribution system. These criteria include recommendations for the required fire flow and flow duration, definition of "emergency events", system pumping capacity, system storage capacity (including operational, fire flow, and emergency components), minimum and maximum system pressures, and maximum pipeline velocity and head loss.

The City currently uses the City of Ceres Design Standards<sup>1</sup> for the planning and design of its water distribution system. Key water system design criteria and operational standards from this document are incorporated into this chapter; however, additional explanation and discussion have been added to further describe various system recommendations. The following sections of this chapter present the recommended performance and operational criteria for the City's potable water system:

- General Water System Reliability and Recommendations,
- Fire Flow Requirements,
- Water System Capacity During High Demand Periods,
- Pumping Facility Capacity,
- Critical Pumping Facility, and
- Water Transmission and Distribution Pipeline Sizing and Recommended System Pressures.

### 5.2 GENERAL WATER SYSTEM RELIABILITY AND RECOMMENDATIONS

Attention to enhancing the reliability of the system under all conditions is an important part of maintaining high quality water service. Water system reliability is achieved through a number of system features including: (1) appropriately sized storage facilities; (2) redundant or "firm" pumping, transmission, and treatment facilities where required; and (3) alternate power supplies. Reliability and water quality are also improved by designing looped water distribution pipelines and avoiding dead-end distribution mains whenever possible. Looping pipeline configurations reduces the potential for stagnant water and the associated problems of poor taste and low chlorine residuals. In addition, proper valve placement is also necessary to maintain reliable and flexible system operation under normal and abnormal operating conditions.

<sup>1</sup> Accessed at <http://www.ci.ceres.ca.us/40654.html> on 7/21/2010.



#### 5.2.1 Water Quality Standards

Water quality standards largely pertain to protecting public health and consistently delivering a satisfactory product to the customer. The U.S. Environmental Protection Agency (EPA) and the California Department of Public Health (DPH) are agencies responsible for establishing water quality standards. EPA and DPH prescribe regulations that limit the amount of certain contaminants in water provided by a public water system. The City, as water purveyor, is responsible for ensuring that all applicable water quality standards and regulations are met at all times.

#### 5.3 FIRE FLOW REQUIREMENTS

The City's Public Works Department operates and maintains the water distribution system within the City, but the City's Fire Department (Fire Department) is concerned with the availability of adequate water supply for firefighting purposes. Consequently, the Fire Department establishes minimum water flows and residual system pressures during a firefighting event, that the City is responsible for providing.

The Fire Department uses the California Fire Code (CFC) Table B150.1 *Minimum Required Fire Flow and Flow Duration for Buildings*, to assist them in establishing minimum fire flows and durations for individual structures. The recommended fire flow requirements for the City based on various land use designations are presented in Table 5-1. These fire flow requirements will be used for the evaluation of the existing and future water system.

For planning purposes, the minimum fire flows identified in Table 5-1 are to be met concurrently during an assumed maximum day demand condition while maintaining a minimum residual system pressure of 20 psi throughout the water system. Additionally, as discussed in subsequent sections of this chapter, minimum fire flows presented in Table 5-1 and their expected duration will also be used to establish the City's storage capacity requirements.

**Table 5-1. Recommended Fire Flow Requirements<sup>(a,b)</sup>**

Land Use Designation	Non-Sprinklered <sup>(c)</sup>			Sprinklered <sup>(c,d)</sup>		
	Fire Flow, gpm	Duration, hours	Recommended Storage, MG	Fire Flow, gpm	Duration, hours	Recommended Storage, MG
Single Family Residential <sup>(e)</sup>	1,500	2	0.18	--	--	--
Multi Family Residential <sup>(f)</sup>	2,000	2	0.24	--	--	--
Commercial/Office <sup>(g)</sup>	3,000	3	0.54	2,750 <sup>(j)</sup>	3	0.41 <sup>(k)</sup>
Industrial <sup>(h)</sup>	4,000	4	0.96	3,500 <sup>(j)</sup>	4	0.74 <sup>(k)</sup>
Public/Institutional <sup>(i)</sup>	4,000	4	0.96	3,500 <sup>(j)</sup>	4	0.72 <sup>(k)</sup>

(a) Construction type and fire flow calculation 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 should be reviewed by the Fire Chief on a case-by-case basis (e.g., proposed commercial/industrial areas and schools).

(c) Specific fire flows were determined from Table B105.1 of the 2007 CFC, and depend on construction type and fire flow calculation area. See Title 15, Chapter 15.07 of the City of Ceres Municipal Code for automatic sprinkler system requirements.

(d) Based on the document "Guidelines for Determining Required Fire Flows", developed by the Department of Public Safety – Emergency Services Division and dated September 28, 2004, the City's Fire Chief normally allows up to a 25 percent reduction in fire flow if a building is provided with an automatic sprinkler system. However, the CFC 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 Multi Family Residential buildings were considered non-sprinklered for this Water Master Plan.

(e) Single Family Residential includes Low Density Residential land use.

(f) Multi Family Residential includes Medium and High Density Residential land uses.

(g) Commercial/Office includes Business Park, Office, Community Commercial, Downtown Commercial, Neighborhood Commercial, Regional Commercial, and Service Commercial land uses.

(h) Industrial includes General Industrial and Light Industrial land uses

(i) Public/Institutional includes Community Facilities and School land uses.

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

(k) Recommended storage does not include the 500 gpm on-site sprinkler flows, because this flow is assumed to be for initial fire suppression inside the building prior to the arrival of the Fire Department, therefore it is interim only and will not last for any significant length of time.



#### 5.4 WATER SYSTEM CAPACITY DURING HIGH DEMAND PERIODS

Maximum day demand plus fire flow, and peak hour demand conditions will be used to assess the adequacy of the City's potable water supply and transmission/distribution system during high demand periods. Adopted peaking factors for maximum day and peak hour demands were discussed in Chapter 3. The following sections discuss the assumptions and recommended criteria for each demand condition.

##### 5.4.1 Maximum Day Demand

In accordance with California Title 22 requirements, the City's water supply system should be capable of meeting maximum day demand with the groundwater well system (well pumps) pumping at "firm capacity". Firm groundwater pumping capacity assumes that the City's highest producing active well would not be operating, but all other available wells would be operating.

##### 5.4.2 Maximum Day Demand plus Fire Flow

In accordance with typical industry standards, the City's water supply system should have the capability to meet a system demand condition equal to the occurrence of a maximum day demand concurrent with a single fire flow event while meeting the recommended system performance criteria (e.g., minimum and maximum system pressures) discussed under *Section 5.7 Water Transmission and Distribution Pipeline Sizing and Recommended System Pressures*. The fire flow is based on the highest fire flow rate designated in any particular area of the City's service area, based on land use within the service area.

Maximum day demand plus fire flow will be met by a combination of the City's wells and the Blaker water storage reservoirs. The analysis of specific fire flow evaluations will be conducted assuming the largest booster pump at the Blaker booster pump station is offline (*i.e.*, firm booster pumping capacity). In addition, the City's groundwater well system (well pumps) will be assumed to pump at firm groundwater pumping capacity during a specific fire flow evaluation.

These conservative assumptions ensure the reliability and flexibility of the system to provide sufficient flow during emergency fire flow conditions.

##### 5.4.3 Peak Hour Demand

Peak hour demand should be met from a combination of supply sources (*i.e.*, groundwater from wells and water stored in storage tanks). Assumptions regarding firm pumping capacity will also apply during a peak hour demand condition. During a peak hour demand condition, the City's water system should be able to meet the recommended system performance criteria (e.g., minimum and maximum system pressures) discussed under *Section 5.7 Water Transmission and Distribution Pipeline Sizing and Recommended System Pressures*.



#### 5.5 PUMPING FACILITY CAPACITY

Sufficient water system pumping capacity should be provided to meet the greater of the following two demand conditions within the system.

1. A maximum day demand concurrent with a fire flow event (with fire requirements based on the highest fire requirement for the different land use types within the system) with booster pumps and well pumps assumed to operate at firm pumping capacity; or
2. A peak hour demand with booster pumps and well pumps assumed to operate at firm pumping capacity.

The highest demand requirement between these two demand conditions sets the water system pumping capacity requirement. However, sufficient pumping capacity should also be provided so that the maximum day demand within the system can be supplied using firm well pumping capacity, with no assistance from storage reservoirs.

#### 5.6 TREATED WATER STORAGE CAPACITY

The total treated water storage capacity required will be based on the following three components:

- Operational Storage,
- Fire Storage, and
- Emergency Storage.

A discussion of these three storage components, along with a discussion of “credits” for groundwater supply available, follows.

##### 5.6.1 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 or school. Water demands will then decline to some nominal baseline level (depending on the proximity to 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 evening hours as people return home from work or school. Throughout the year, the peaks of this cycle will vary according to customer needs; thereby, creating maximum day and peak hour demands.

Typically, water treatment plants, supply turnouts, and/or wells are operated at a constant rate over a continuous period (baseline), augmented by additional flow from storage tanks, and/or additional wells during high demand periods, as needed. Storage tanks are normally refilled when demands drop below the baseline water production flow rate. The storage volume used to meet these higher than baseline demand periods is called operational storage.



The operational storage requirements should be calculated based on the diurnal demand in a 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 30 percent of the total volume of water used on a maximum day demand condition.

#### 5.6.2 Fire Storage

As discussed above, fire flow requirements are identified in the CFC. These requirements are based on flow (in gpm), 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 flow duration to produce an estimate of the total volume of fire flow storage required. Table 5-1 presented the recommended fire flow criteria and associated required fire flow storage. Based on the fire flows listed in Table 5-1, sufficient fire flow storage should be available for a 3,500 gpm fire flow with a duration of four hours (assuming sprinklered conditions), for a total fire storage volume of 0.84 MG. Since this fire flow storage volume must be provided by pumps, the pump(s) and motor(s) combination must be equipped with a backup power source of sufficient capacity to meet the required maximum fire flow and minimum residual system pressure requirements.

#### 5.6.3 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 disrupt the transmission/flow and 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 a few customers, such as a distribution or service pipeline break, malfunctioning valve, hydrant break, or a brief power loss. Utilities plan for minor emergencies and typically have staff and materials on-hand and available to mitigate these minor emergencies.
- Major emergency. A disaster that affects an entire, and/or large portion of a water system, lowers the quantity and quality of the water, or places the health and safety of the community at risk. Examples include water treatment plant failures, raw water contamination or major power grid outages. Water utilities seldom experience major emergencies.
- Natural disaster. A disaster caused by natural forces or events that create a major water utility emergency. Examples include earthquakes, forest or brush fires, hurricanes, tornados or high winds, floods, and other severe weather conditions such as freezing or drought that damage or cause water system facilities to not be able to operate.

Determination of the required 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 developing an emergency storage requirement for the City, typical industry standards were used.

The AWWA states that no formula exists for determining the amount of emergency storage required, and that the decision will be made by the individual utility based on a judgment about the perceived vulnerability of the system. For this Water Master Plan, it has been assumed that the emergency storage requirement will be based on minor emergencies and *specific* major emergency criteria. Based on this assumption, it is recommended that the City have a minimum quantity of emergency storage volume equivalent to two times the average day demand.

#### 5.6.4 Groundwater Storage Credit

Because the City water supply consists of numerous groundwater wells, the groundwater basin can account for a portion of the recommended water storage and system peaking capacity. Sufficient water transmission facilities, however, must be available to distribute this water to all demand areas.

Groundwater credit can be defined using the following two categories:

- Emergency Storage Credit – Equal to the groundwater supply of potable water that can be reliably produced over the duration of the emergency (in this case, assumed to be a 48-hour period) in the event of a power outage or any other emergency that would interrupt system-wide operations. In the case of the City, these facilities would include the firm capacity of the wells that are equipped with auxiliary power operated over a 48-hour period, where firm capacity is calculated as the total capacity of wells with auxiliary power minus the largest well with auxiliary power.

#### 5.6.5 Total Storage Capacity Recommended

The City's recommended potable water storage capacity should be the sum of the following components:

- Operational: Volume of water necessary to meet diurnal peaks observed throughout the day, assumed to be equivalent to at least 30 percent of the maximum day demand;
- Fire Flow: Volume of water necessary to supply a single fire flow event;
- Emergency: Volume of water necessary to provide two times an average day demand;
- Groundwater Credit: Equal to the firm groundwater supply that can be reliably accessed to meet emergency storage needs.

The amount of total system storage and system peaking capacity required to meet these criteria will change over time as the City continues to grow and potable water demands increase.



## 5.7 WATER TRANSMISSION AND DISTRIBUTION PIPELINE SIZING AND RECOMMENDED SYSTEM PRESSURES

The following criteria will be used as guidelines for sizing new transmission and distribution pipelines. However, the City's existing system will be evaluated on a case-by-case basis. For example, if an existing pipeline experiences head loss 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 system pressure criterion is satisfied.

Consequently, the City'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 to locate, and to help prioritize where water system improvements may be needed.

New transmission and distribution pipelines to serve the City's future planning areas should be located within designated utility corridors wherever possible. These designated utility corridors should be within public rights-of-way to minimize or eliminate the need for utility easements within private property.

Pressure criteria provided in this section range from a minimum of 40 psi to a maximum of 80 psi, to allow for variations in elevation, and different operational conditions. Eighty psi is the maximum allowable system operating pressure without requiring pressure regulation of individual customer services. The City normally operates its wells within a pressure range of 40 psi to 65 psi.

### 5.7.1 Water Transmission System

Transmission pipelines are generally defined as being 12 inches in diameter or larger and should be designed based on the criteria described below for average day, maximum day, and peak hour demand conditions. The criteria reflect industry standards and West Yost's experience working with the City's existing water system.

#### 5.7.1.1 Average Day Demand

- Pressures should be maintained between a maximum of 80 psi and a minimum of 50 psi.
- Maximum velocity within transmission pipelines should be 3 feet per second (fps).
- Head losses within the transmission system pipelines should be limited to 3 feet per thousand feet (ft/kft) of pipeline.

#### 5.7.1.2 Maximum Day Demand

- Pressures should be maintained between a maximum of 80 psi and a minimum of 40 psi.
- The maximum velocity within the transmission system pipelines should be 5 fps.
- Head losses within the transmission system pipelines should be limited to 3 ft/kft of pipeline.



#### 5.7.1.3 Peak Hour Demand

- Pressures should be maintained between a maximum of 80 psi and a minimum of 40 psi.
- The maximum velocity within the transmission system pipelines should be 7 fps.
- Head losses within the transmission system pipelines should be limited to 3 ft/kft of pipeline.

#### **5.7.2 Water Distribution System**

Distribution pipelines are generally less than 12 inches in diameter and should be sized 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 West Yost's experience working with the City's existing water system.

#### **5.7.3 Average Day Demand**

- Service pressures should be maintained between a maximum of 80 psi and a minimum of 50 psi.
- The maximum velocity within the distribution system pipelines should be 5 fps.
- Head losses within the distribution system pipelines should be limited to 7 ft/kft of pipeline.

#### 5.7.3.1 Maximum Day Demand plus Fire Flow

- The minimum allowable residual pressure should be 20 psi at the flowing fire hydrant.
- The maximum velocity within the distribution system pipelines should be 10 fps, or the head losses within the distribution system pipelines should be limited to 10 ft/kft of pipeline, whichever criteria is more conservative given the specific hydraulic/system condition.

#### 5.7.3.2 Peak Hour Demand

- Service pressures should be maintained between a maximum of 80 psi and a minimum of 40 psi.
- The maximum velocity within the distribution system pipelines should be 7 fps, or the head losses within the distribution system pipelines should be limited to 7 ft/kft of pipeline, whichever criteria is more conservative given the specific hydraulic/system condition.

A summary of the recommended potable water system performance and operational criteria is presented in Table 5-2 and reflect typical water system industry standards, including the California Safe Drinking Water Act and related laws, and AWWA standards.

**Table 5-2. Summary of Recommended Potable Water System Performance and Operational Criteria**

Component	Criteria	Remarks / Issues
<b>Fire Flow Requirements (flow [gpm] @ duration [hours])</b>		
Single Family Residential	1,500 gpm @ 2 hrs	Existing development will be evaluated on case-by-case basis because of the historical varying standard.
Multi Family Residential	2,000 gpm @ 2 hrs	
Commercial/Office	2,750 gpm @ 3 hrs (with approved automatic sprinkler system) / 3,000 gpm @ 3 hours (un-sprinklered system)	
Industrial/Public/Institutional	3,500 gpm @ 4 hrs (with approved automatic sprinkler system) / 4,000 gpm @ 4 hrs (un-sprinklered system)	
<b>Water System Capacity</b>		
Maximum Day Demand plus Fire Flow	Provide firm capacity equal to maximum day demand plus fire flow	Assume single concurrent fire flow events
Peak Hour Demand	Provide firm capacity equal to peak hour demand	
<b>Pumping Facility Capacity</b>		
Pumping Capacity	Provide the greater of maximum day concurrent with fire flow or peak hour demand	Assume firm pumping capacity. Sufficient pumping capacity should also be provided so that the maximum day demand can be supplied using firm pumping capacity with no assistance from storage reservoirs.
Backup Power	Equal to the firm capacity of the pumping facility	On-site generator for critical stations. <sup>(a)</sup> Plug in portable generator for less critical stations.
<b>Water Supply Capacity</b>		
Supply / Pumping Capacity	Provide capacity equal to maximum day demand	
<b>Water Storage Capacity</b>		
Operational	30 percent of maximum day demand	3,500 gpm @ 4 hours = 0.72 MG assuming sprinklered conditions (total storage volume does not include the 500 gpm sprinkler flow, as this is interim only until the arrival of the Fire Department).
Fire	Assume one Industrial/Institutional/Public fire flow	
Emergency	2 x average day demand	
Emergency Groundwater Credit (EGWC)	Equal to the firm groundwater supply that can be reliably pumped (facilities equipped with auxiliary power)	The maximum emergency storage credit is equal to the reliable pumping capacity over a 24-hour period
Total Water Storage Capacity	Operational + Fire + Emergency - EGWC	
<b>Water Transmission Line Sizing</b>		
Diameter	12 inches in diameter or larger	Locate new transmission pipelines within designated utility corridors wherever possible.
Average Day Demand Condition		Criteria based on requirements for new development, existing transmission mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, head loss, and pressure.
Minimum Pressure [psi]	50 psi	
Maximum Pressure [psi]	80 psi	
Maximum Head loss [ft/1000 ft]	3 ft/kft	
Maximum Velocity [ft/sec]	3 fps	
Maximum Day Demand Condition		
Minimum Pressure [psi]	40 psi	
Maximum Head loss [ft/1000 ft]	3 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	40 psi	
Maximum Head loss [ft/1000 ft]	3 ft/kft	
Maximum Velocity [ft/sec]	7 fps	
Hazen Williams "C" Factor	130	For consistency in hydraulic modeling.
Pipeline Material	Steel	For consistency in hydraulic modeling.
<b>Water Distribution Line Sizing</b>		
Diameter	Less than 12-inches in diameter	Must verify pipeline size with maximum day plus fire flow analysis. Locate new distribution pipelines within designated utility corridors wherever possible.
Average Day 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]	50 psi	
Maximum Pressure [psi]	80 psi	
Maximum Head loss [ft/1000 ft]	7 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Maximum Day w/ Fire Flow Demand Condition		
Minimum Residual System Pressure [psi] (at fire node)	20 psi	
Maximum Head loss [ft/1000 ft]	10 ft/kft	
Maximum Velocity [ft/sec]	10 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	40 psi	
Maximum Head loss [ft/1000 ft]	7 ft/kft	
Maximum Velocity [ft/sec]	7 fps	
Minimum Pipeline Diameter	8-inch	
Hazen Williams "C" Factor	140	For consistency in hydraulic modeling.
Pipeline Material	PVC	For consistency in hydraulic modeling.
<b>Maximum Water Service Pressure</b>	80 psi	Install PRV if service pressure is greater than 80 psi.

(a) A pumping facility is defined as critical if it provides service to pressure zone(s) and/or service area(s) without sufficient emergency storage and that meet the following criteria:

- The largest facility that provides water to a particular pressure zone and/or service area;
- A facility that provides the sole source of water to single or multiple pressure zones and/or service areas;
- A facility that provides water from a supply turnout; or
- A facility that provides water from key groundwater supply wells (depends on capacity, quality and location).

## CHAPTER 6

### Evaluation of Existing Water System

---



This chapter presents an overview evaluation of the City's existing water distribution system (see Figure 6-1), and its ability to meet the City's recommended performance and planning criteria under existing demand conditions. This evaluation includes an analysis of water storage capacity, pumping capacity, and the existing water system's ability to meet recommended operational and design criteria under maximum day demand plus fire flow and peak hour demand scenarios.

West Yost conducted this evaluation using the updated hydraulic model described in this chapter. Evaluations, findings, and recommendations for addressing the identified existing water distribution system deficiencies are included. Recommendations were then used to develop a CIP, including an estimate of probable construction costs. The recommended CIP is described further in Chapter 8.

The following topics are reviewed in this chapter:

- Existing Water Demands – summarizes demands used for the evaluation;
- Existing Water System Facility Evaluation – evaluates storage, peak supply capacity and peak pumping capacity needs to meet system requirements;
- Hydraulic Model Update and Verification – summarizes updates to the hydraulic model used for the existing water system performance evaluation.
- Existing Water System Performance Evaluation – assesses the hydraulic performance of the water system under existing peak hour and maximum day plus fire flow conditions; and
- Summary of Recommended Improvements for the Existing Water System.

#### 6.1 EXISTING WATER DEMANDS

Table 6-1 summarizes the City water demands used for the existing system hydraulic evaluation. The existing water demands for the City's water system were spatially located in the hydraulic model using historically-based unit use factors and land use data provided by the City (see Chapter 3 for more detail). Average daily demands represent 2007 conditions. Peak water demands were computed by scaling up the use to represent maximum day demand, and peak hour demand, based on the adopted Master Plan peaking factors.

The 2007 average daily production data was used as the City's "base" water year for the hydraulic evaluations because 2007 represents actual, typical historical City demands. The 2007 demands were not impacted (reduced) by the need to conserve water (because of drought conditions), or the economic downturn (and associated home foreclosures and renters moving out, reducing the City's water demand), as the 2008, 2009, and 2010 years were. Therefore, the use of the 2007 base water year demand leads to a slightly more conservative and reliable water system design and CIP.



The maximum day demand is slightly higher (4 percent) than historical observations, which is a very reasonable planning number to represent existing conditions. It is based on a peaking factor of 1.8 times the average daily demand, which is derived from historical data. In the last nine years, peaking factors have ranged from 1.6 to 2.0 times average daily demand (see Table 3-8). Peak hour usage was estimated based on analysis of three days of City Supervisory Control and Data Acquisition (SCADA) data from June 2009 during peak system demand conditions.

**Table 6-1. Baseline Water Demands for the Existing System Analysis**

Demand Scenario	Demand	
	gpm	mgd
Average Day <sup>(a)</sup>	6,700	9.7 (10,900 AFY)
Maximum Day <sup>(b)</sup>	12,100	17.4
Peak Hour <sup>(c)</sup>	19,400	28.0

(a) Average day demand is based on 2007 production data (City Gallons Pumped.xls).  
 (b) Maximum day demand calculated using a peaking factor of 1.8 times the average day demand, based on the average peaking factor for 2005 through 2009.  
 (c) Peak hour demand is 2.9 times the average day demand. This peaking factor was adopted based on peak diurnal water use developed from June 2009 operational data.

## 6.2 EXISTING WATER SYSTEM FACILITY EVALUATION

To evaluate the existing water system, the following analyses were conducted:

- Maximum Supply Capacity,
- Water Storage Capacity, and
- Peak Pumping Capacity.

The results of the existing water system facility analyses are discussed below.

### 6.2.1 Maximum Supply Capacity

The City's maximum supply capacity criterion is to provide sufficient supply capacity to equal maximum day demand. The City's current sole supply source is groundwater. Therefore, maximum day demand must be met from firm groundwater supply capacity, where firm groundwater supply capacity is defined as the total supply capacity from all wells, with the largest supply well offline.

Table 6-2 summarizes the existing maximum day demand, and compares it with the existing firm well capacity. As the table shows, there is a current supply surplus of 600 gpm or 0.9 mgd. In 2009, the City identified the need for two new wells. These wells include a planned replacement well for Well 1 (budgeted in FY 2009/10 CIP), and one new well with location to be determined (and not yet budgeted). The two planned wells will increase the well surplus capacity to about 2,000 gpm, or 2.9 mgd. As discussed in *Section 6.3 Hydraulic Model Update and Verification*, while overall, the City has sufficient peak supply capacity, because of a lack of a well-integrated and looped transmission system, there are areas of the City which require these additional wells to provide improved system pressure and flow.



**Table 6-2. Comparison of Overall City Required and Available Supply Capacity to Meet Maximum Day Demand**

Parameter	Required or Available Supply Capacity	
	Gpm	mgd
Existing Maximum Day Demand <sup>(a)</sup>	12,100	17.4
Existing Firm Well Capacity <sup>(b)</sup>	12,700	18.3
Peak Supply Capacity Surplus (Deficit)	600	0.9
Additional Capacity Provided by Planned Wells <sup>(c)</sup>	1,400	2.0
Peak Supply Capacity Surplus (Deficit) with Planned Wells	2,000	2.9

(a) Existing Maximum Day Demand is 1.8 times the average daily demand.  
 (b) Defined as the total active well capacity minus the largest well. Capacities are based on 2010 pump test data, as reported in Table 2-1.  
 (c) The Capital Improvement Program includes two new wells: a planned replacement well for Well 1 (budgeted FY 2009/10), and one other well at a location to be determined (and not yet budgeted). Wells have an assumed capacity of 900 gpm each; however only 500 gpm is credited, since 400 gpm of well capacity would be lost with the retirement of Well 1, for a net new capacity increase of 1,400 gpm.

### 6.2.2 Water Storage Capacity

The principal advantages that storage provides for the water system are: the ability to equalize demands on supply sources, production facilities, and distribution system mains; to provide emergency storage in case of supply failure; and to provide water to fight fires.

The City's criterion for storage is to provide for operational, fire and emergency storage needs, with the required volume for each storage component detailed below:

- Operational Storage: Volume equal to 30 percent of maximum day demand, to meet demands in excess of the average maximum day demand,
- Fire Flow: Volume of water necessary to supply a single fire flow for the most critical land use within the system (0.72 MG for Industrial/Public/Institutional land use (3,000 gpm for 4-hour duration), assuming sprinklered system), and
- Emergency Storage: Volume equal to two times average day demand to provide water during emergencies.

The City service area has two existing ground-level reservoirs, the Blaker Tanks, with a total capacity of 3.8 MG. Together, these two storage tanks must be sufficient to meet the City's storage criteria for the existing water system, if the storage requirement is all met from above-grade tanks. However, because the City water supply includes wells, the groundwater basin can account for a portion of the recommended water storage and system emergency capacity, in the form of a groundwater credit. However, sufficient water transmission facilities must be available to distribute this water to all demand areas.

## Chapter 6

### Evaluation of Existing Water System



An Emergency Storage Credit is included in calculations to account for wells equipped with standby power that would provide reliability equivalent to emergency storage. The storage credit is defined as:

- Emergency Storage Credit – Equal to the groundwater supply of potable water that can be reliably accessed in the event of a power outage or any other emergency that would interrupt system-wide operations. In the case of the City, these facilities would include wells that are equipped with auxiliary power. The minimum credit is equal to zero, and the maximum credit is equal to the required emergency storage capacity or a pumped volume equal to two average days demand.

The existing storage tanks, in conjunction with available groundwater credit, were evaluated to determine whether the City's existing water system has sufficient capacity to provide the required system storage. Table 6-3 summarizes the analysis.

**Table 6-3. Comparison of Available and Required Storage Capacity**

Scenario	Available Storage Capacity, MG			Required Storage Capacity, MG			Storage Capacity Surplus (Deficit) <sup>(b)</sup> , MG
	Reservoir Capacity	Groundwater Credit <sup>(a)</sup>	Total	Operational	Fire	Emergency	
Existing System	3.8	12.9	16.7				(8.5)
With Standby Power Added at Existing or Planned Wells <sup>(c)</sup>	3.8	19.3	23.1	5.2	0.7	19.3	25.2 (2.1)

<sup>(a)</sup> For Existing System, equal to the Emergency Storage Credit, calculated as the sum of the well capacity of all wells with standby power (Wells 20, 21, 23, 34, 35 and 36) minus the largest well (Well 21).  
<sup>(b)</sup> Equal to required storage minus available storage.  
<sup>(c)</sup> If standby power is added to existing or new wells with a total capacity of 2,300 gpm (providing 6.6 MG over 2 days), then emergency needs could be met entirely by wells. Additional storage would still be required to satisfy operational and fire needs.

As shown in Table 6-3, an additional 8.5 MG of storage is needed to meet current storage requirements. With the installation of standby power at existing or new wells, an additional 2,300 gpm of reliable capacity can be brought on-line, reducing the required system-wide storage capacity to 2.1 MG. New storage totaling 2.0 MG is recommended, based on consideration of overall future storage needs, as discussed in Chapter 7.



### 6.2.3 Peak Pumping Capacity

The peak pumping capacity criterion for the City, described in additional detail in Chapter 5, requires the City's existing water system to have sufficient pumping capacity to meet maximum day demand plus fire flow, or peak hour demand, whichever is greater. Peak pumping capacity can be provided from a combination of wells and booster stations that access ground-level storage.

The fire flow requirement for assessing peak pumping capacity is based on the land use with the highest requirement. Industrial and Public/Institutional land uses both have a 3,500 gpm fire flow requirement for a 4-hour duration for sprinklered buildings. Therefore, the requirement to meet maximum day plus fire flow is 15,570 gpm, compared with a peak hour requirement of 19,450 gpm. Therefore, the peak hour demand condition governs.

The City's pumping capacity was evaluated to assess its ability to deliver a reliable firm capacity to the existing service area, where the firm capacity includes the total groundwater pumping capacity plus the Blaker booster pump station capacity, with the largest well and booster pump out of service, to account for pumps out of service due to mechanical breakdowns, maintenance, water quality, or other operational issues. The results of the pumping capacity evaluation are summarized in Table 6-4.

As the table shows, there is a modest system-wide pumping capacity surplus of 800 gpm. With the planned two additional wells that are in the City's current Capital Improvement Program, the capacity surplus would increase to 2,200 gpm, or about 11 percent of the peak hour demand.

**Table 6-4. Evaluation of Total Firm Pumping Capacity to Meet Peak Hour Demand**

Available or Required Capacity	Capacity	
	gpm	mgd
Groundwater Wells	12,700	18.3
Blaker Booster Station	7,500	10.8
Total Available Pumping Capacity <sup>(a)</sup>	20,200	29.1
Peak Hour Demand <sup>(b)</sup>	19,400	28.0
Pumping Capacity Surplus (Deficit)	800	1.2
Additional Capacity with Planned Wells <sup>(c)</sup>	1,400	2.0
Pumping Capacity Surplus	2,200	3.2

<sup>(a)</sup> Defined as the total active well capacity minus the largest well.  
<sup>(b)</sup> Peak hour demand is 2.9 times the average daily demand.  
<sup>(c)</sup> The two new planned wells are assumed to have a capacity of 900 gpm each. Existing Well 1, which has a capacity of 400 gpm, is assumed to be converted to non-potable irrigation service.



#### 6.3 HYDRAULIC MODEL UPDATE AND VERIFICATION

A computer simulation model (hydraulic model) transforms information about the physical system into a mathematical model that solves for various demand conditions. The hydraulic model then generates information on pressure, flow, velocity and head loss that can be used to analyze system performance and identify system deficiencies. A hydraulic model can also be used to verify the adequacy of recommended or proposed system improvements.

As part of this Water Distribution System Master Plan, an update and verification of the City's current water system hydraulic model was performed to verify that the hydraulic model can accurately reflect the existing water system conditions. This section summarizes the tasks completed to update and verify the City's current hydraulic model of its water distribution system.

##### 6.3.1 Existing Hydraulic Model Description

The City's hydraulic model for the existing water system includes all 6-inch diameter and larger pipelines; however, some smaller diameter pipelines were added as needed to complete system loops. Key facilities, including all active wells, and the Blaker tanks and booster pump station are also included in the hydraulic model.

The current hydraulic model had its last major update in 2007. At that time, the model was converted to the AutoCAD-based hydraulic modeling software package H<sub>2</sub>ONET, developed by MWH Soft, and this model was subsequently updated and calibrated. The 2007 update included adding new facilities constructed since 2003, updating and re-allocating existing demands based on 2005 water use, updating key facilities data for wells and the Blaker tanks, and calibrating the model using data from hydrant tests performed in October 2006. Since 2007, minor updates have been made to the model, as part of ongoing developer studies, the most recent of which is the Mitchell Ranch evaluation.

As part of this Water Distribution System Master Plan, West Yost reviewed existing system facilities and pipelines, and updated the model to reflect current conditions. Once the model was updated, additional work was performed to re-allocate demands, and verify the existing water system hydraulic model. These tasks are discussed in more detail in this section.

##### 6.3.2 Review of Existing Water System Facilities

Based on a review of the available facilities data on the existing water distribution system, which was provided to West Yost by City staff, the following revisions and additions were made in the City's current hydraulic model:

- Updated all active wells with water surface elevation data and pump efficiency data from spring 2009. Subsequent 2010 well level and pump efficiency data provided by the City were compared with 2009 data and found to be similar;
- Updated Well 1 and Well 25/28 system configurations to reflect current blending operations;
- Added new Well 38 (Eastgate);



- Compared the modeled pipeline network with the most recent AutoCAD drawing file for the City's water system (April 2008) to add in new pipeline projects;
- Spot-checked model elevations, using Google Earth mapping tools; and,
- Used network review/fix tools to identify and correct model configuration errors.

Figure 6-1 illustrates the existing system facilities included in the distribution system hydraulic model.

#### 6.3.3 Model Demand Allocation

As described in Chapter 3, unit water use factors were developed from historical billing and production data to estimate water use for the different land uses within the City. These unit use factors were used to spatially locate and allocate existing average daily demands to the model. Water demands were allocated using hydraulic model software tools that define Thiessen polygons around the model junctions, calculate the acreage of the different land use types within the polygon areas, and then compute the water use. H<sub>2</sub>ONET allows the use of up to ten (10) different fields to define demands. Seven were used to define the water use by land use type – three representing residential (low, medium and high density), and four representing non-residential water use (commercial/office, industrial, public, and parks).

Average daily demands were assigned to the model using the model demand allocation tools. Maximum day and peak hour demands were assigned to the model by uniformly scaling up the average daily demands. Demand assignments are based on the total demands shown in Table 6-1. These values include total system customer demand plus unaccounted for water.

#### 6.3.4 Hydraulic Model Verification

The City's hydraulic model was verified to confirm that the updated computer simulation model can accurately represent the operations of the existing water distribution system. Initially, the verification was to include an extended period simulation, in which the model would be set up with controls based on current facility operational controls, and run for an hourly time step over a 24-hour period to confirm that the model mimics hourly system operations. However, complete SCADA data for all well facilities could not be obtained for this comparison. Therefore, the model was set up to reproduce peak hour demand conditions experienced on June 25, 2009, when the system demand was approximately 20 mgd. This demand is between the baseline maximum day demand (17.4 mgd) and the baseline peak hour demand (28.0 mgd).

Hourly average pressures and flows at various wells and the Blaker tanks and booster station were provided by the City for the SCADA comparison. However, no reports were available for Wells 22, 23, 35 or 36 (Well 38 was not yet installed at this time). Total estimated hourly flow was 20.0 mgd, developed from a system-wide flow report and Blaker tank operations. The sum of the individual station flows was 18.1 mgd. Therefore, well operations had to be inferred, and Well 23 and Well 34 were also assumed to be operating. Well 16 and 34 reported the same flow and pressure throughout the day, suggesting that the SCADA readings from these locations may be in error.

## Chapter 6

### Evaluation of Existing Water System

---



In the model, the discharge pressure was varied at wells with variable frequency drives (Wells 1, 20, 21, 22, 23, and 32), to get the best match with observed flow, and pressures were then compared. For other wells, with fixed speed pumps, wells were turned on or off to match SCADA and both flow and pressure were compared.

Table 6-5 compares the model and SCADA flows and pressures. As the table shows, flows were in good agreement at all locations (all within 6 percent), except at Well 14, where flows were 25 percent off, but the observed well flow rate is small (230 gpm), and the difference in modeled and observed flow is only 60 gpm.

Modeled pressures at five locations were within 3 psi of the observed values. At three of the five remaining stations, SCADA data appears to be in error. Stations 16 and 34 recorded no change in readings over the course of the day. Station 1 has a low reported discharge pressure of 35 psi. For the two remaining stations, Well 28 has a modeled pressure that is 6 psi lower than the observed pressure, and Well 21 has a modeled pressure 7 psi higher than observed pressure. Model results indicate that the simulated pressures in the northern part of the system are in the low 40's at several locations (Well 34/36, Well 23, and Well 16).

The right hand columns of the table summarize the computed hydraulic gradient, in feet, at each of the pressure reporting locations. The gradient is calculated using local pressure, converted to pressure head, in feet, plus the local ground elevation (the assumed elevation for pressure sensors). The table shows that most gradients projected from the SCADA readings are slightly above or below 200 feet, with the exception of Wells 25 and 27, which are 225 and 220 feet, respectively. The gradient at these locations may be somewhat higher due to the current blending configuration for the wells. Well 25 does not discharge directly to the system. Flow is, instead, conveyed to Well 28, and the discharge pipeline of Well 28 serves as the common, or blended discharge pipeline for the two wells. However, even with this configuration, the gradient recorded by SCADA seems high. No other reliable SCADA readings are available in the northern part of the system for comparison with model results. Well 1 has an anomalously low gradient of 174 feet, 25 feet lower than predicted by the model.

Differences between model results and SCADA observations could be due to a number of reasons including SCADA sensors out of calibration, errors in assumed sensor elevations, different model demand distribution than actual demands, or model configuration errors.

The comparisons between SCADA and the model indicate that, in general, the model reasonably agrees with observed data, and is a suitable planning tool for master plan evaluation. The City's upgrades to its SCADA system, and implementation of the residential metering program will provide data that can be used in the future to further refine the model.

**Table 6-5. Comparison of Model and SCADA, June 25, 2009, 8 PM**

Location	Elev, ft	Flow, gpm		Pressure, psi			Gradient, ft		Notes
		Model	SCADA	% Difference	Model	SCADA	Difference	Model	
Well 1	93	960	980	2%	46	35	(11)	199	174 SCADA reading appears low
Well 14	92	180	230	22%	42	45	3	189	196
Well 16	98	220	230	4%	41	51	10	193	Possible SCADA error - no change in readings during the day
Well 20	88	1,510	1,610	6%	52	50	(2)	208	
Well 21	92	1,680	1,690	1%	48	41	(7)	203	187 SCADA reading appears low
Well 22	89	-	--	--	46	--	--	195	
Well 23	99	1,100	--	--	40	--	--	191	
Well 25	103	580	550	-5%	50	53	3	219	225
Well 27	89	1,340	1,340	0%	47	46	(1)	198	195
Well 28	104	1,270	1,260	-1%	44	50	6	206	220
Well 32	81	1,500	1,550	3%	54	54	-	206	206
Well 34	90	640	-	0%	42	57	15	187	Possible SCADA error - no change in readings during the day
Well 35	79	-	--	--	51	--	--	197	
Well 36	90	-	--	--	42	--	--	187	
Well 38	104	-	--	--	41	--	--	199	
Blaker Booster	83	3,120	3,110	0%	53	54	1	205	208
Total		14,100	12,550						



#### 6.4 EXISTING WATER SYSTEM PERFORMANCE EVALUATION

This section discusses the performance criteria for and results of the existing water distribution system evaluation.

##### 6.4.1 Existing Water System Performance Criteria

Steady state hydraulic analyses using the updated model were conducted to identify areas of the existing water system that do not meet the recommended system performance criteria as presented previously in Chapter 5. The results of the evaluation of the existing water system are presented in the subsequent sections, based on the following demand scenarios:

- Peak Hour Demand—A peak hour flow condition was simulated for the existing distribution facilities to evaluate their capability to meet a peak hour demand scenario. Peak hour demands are met by the combined flows from groundwater wells (firm groundwater pumping capacity) and the Blaker tanks.
- Maximum Day Demand plus Fire Flow—To evaluate the existing water system under the maximum day demand plus fire flow scenario, H<sub>2</sub>ONET's "*Available Fire Flow Analysis*" tool was used to determine the available fire flow while meeting the maximum day demand plus fire flow performance criteria within the existing water system. Maximum day plus fire flow demands are met by the combined flows from groundwater wells (firm groundwater pumping capacity) and the Blaker tanks.

###### 6.4.1.1 Peak Hour Demand Scenario

As shown in Table 6-1, the peak hour demand for the existing City service area was calculated to be 19,400 gpm (28.0 mgd). This peak hour demand represents a peaking factor of 2.9 times the average day demand. During a peak hour demand scenario, a minimum pressure of 40 psi must be maintained throughout the water system. In addition, in new systems, it is recommended that the maximum head loss per thousand feet of distribution main should not exceed 10 ft/kft and maximum velocities should not exceed 7 fps, to help minimize energy (pumping) costs due to undersized projects. Details of the system pressures as simulated in the model under the peak hour demand scenario are discussed below.

###### 6.4.1.2 Maximum Day Demand plus Fire Flow Scenario

As discussed in Chapter 5, fire flow requirements are provided based on the current fire flow standards used by the City. Improvements would generally not be made to existing system facilities solely to meet fire flow deficiencies, since existing structures within the City are assumed to have met the fire flow requirements in force at the time of construction. Consequently, the existing system was evaluated during a maximum day demand plus fire flow scenario only to determine the available fire flow, while meeting the maximum day demand within the existing water system. The results from this evaluation will help City staff identify areas within the City where fire flow could be improved, in conjunction with other projects, such as future main replacement projects.



H<sub>2</sub>ONET's "Available Fire Flow Analysis" tool was used to determine the available fire flow in the existing water system under existing maximum day demand conditions while meeting the minimum residual system pressure criterion of 20 psi.

#### 6.4.1.3 Recommended Improvements Criteria

The existing water system is expected to deliver peak hour flows and maximum day demand plus fire flow within the acceptable pressure, velocity and head loss ranges as identified in the performance criteria presented in Chapter 5. However, the system was evaluated using peak hour pressure as the primary criterion. Recommended system improvements were identified to address and fix any pressure deficiencies found. System improvements were not identified for pipelines that did not meet velocity or head loss criteria where no pressure problems were identified.

#### **6.4.2 Existing Water System Evaluation Results**

This section summarizes the results of the peak hour demand and maximum day demand plus fire flow analyses.

##### 6.4.2.1 Peak Hour Demand Scenario

A peak hour demand scenario was evaluated to assess distribution system performance. For the analysis, all existing active wells were assumed to be operating, except Well 32, adjacent to Blaker Booster station, and Well 36, which is reported to interfere with nearby Well 34 if operated together (Well 34 is the larger capacity well, and is assumed to be operating). Blaker booster station is also operating, with a discharge pressure of 60 psi (at elevation 83 feet).

Results indicate that the existing water system could not adequately deliver peak hour demands to meet the City's minimum pressure criterion of 40 psi to all sections of the City, as illustrated on Figure 6-2. For this scenario, system pressures range from 27 psi to 59 psi. Pressures are lowest in the northern part of the system, which are the highest service elevation areas, and also the areas furthest from Blaker Tanks. The highest customer service elevation areas are 20 to 25 feet higher in elevation than the lowest customer service elevation areas, so that if all the system were at the same gradient, the static pressure for these high-elevation areas, in the north part of the system, would be 9 to 11 psi lower than pressures in the lowest customer service areas. For the peak hour demand scenario, the maximum hydraulic gradient in the system is 220 feet at the Blaker booster station, and the minimum hydraulic gradient is 168 feet in the northern part of the system, indicating 52 feet (23 psi) of head differential across the system. This is a relatively high differential, indicating that there is a lack of transmission capacity to move water from the Blaker booster station to the northern part of the system.

The analysis indicates that while there is sufficient well capacity in the system overall, the system is short of capacity east of Highway 99. For the peak hour condition, the estimated demand in the area east of Highway 99 is 13,200 gpm, compared with a well supply capacity of 12,700 gpm with all active wells in service. A combination of new transmission capacity (across Highway 99) and new well capacity in the northern portion of the City's service area is required to improve pressures on the north side of the system.



As illustrated on Figure 6-2, not all the pipelines in the existing water system met the maximum velocity criterion during a peak hour demand scenario. Short segments of pipelines in the vicinity of Wells 1, 6 (out of service), 22 and 38 do not meet the velocity criterion. Additionally, 3 pipeline segments do not meet the head loss criterion of 10 ft/kft.

- The 290-foot long 6-inch diameter pipeline under Highway 99, connecting pipelines on Hil-Mor Drive and Richland Avenue has a head loss of 84 ft/kft (velocity = 24 fps).
- The 910-foot long 8-inch diameter pipeline running north and west from Well 1 to Moffett Road has a head loss ranging from 15 to 49 ft/kft. (velocity = 10 to 12 fps).
- The 610-foot long 6-inch diameter pipeline on Sixth Street north of Whitmore Avenue has a head loss of 17 ft/kft (velocity = 10 fps).

Because head loss is a secondary criterion, no improvements for pipelines exceeding the head loss criterion in the existing water system are recommended unless the primary criterion (pressure) is not met. Based on results of the peak hour simulation, only the 6-inch diameter pipeline under Highway 99 is recommended for improvement, since it helps to improve transmission capacity to the northeast part of the water system and pressures in the north part of the system.

#### 6.4.2.2 Maximum Day Demand plus Fire Flow Scenario

H<sub>2</sub>ONET's "Available Fire Flow Analysis" tool was used to determine the available fire flow (while meeting the maximum day demand plus fire flow performance criteria) at each junction within the existing water system under a maximum day demand scenario. Figure 6-3 and Figure 6-4 summarize the results of the analysis. Figure 6-3 shows the different fire flow requirements in the City, color-coded based on the requirements for different land use types (see Table 5-2 for requirements), and indicates locations where available fire flow is greater than the required fire flow (shown by green dots), and less than the available fire flow (red dots). Figure 6-4 summarizes the available fire flow at modeled junctions within the system, color-coded by available flow. Tabular results for the analysis are included as Appendix D.

As discussed earlier in this section, improvements would generally not be made to existing system facilities solely to meet fire flow deficiencies, since existing structures within the City are assumed to have met the fire flow requirements in force at the time of construction. However, five areas were identified where minor improvements could be made that would have significant fire flow benefit. These five locations are summarized in Table 6-6, and shown on Figure 6-5. Improvements for other deficient fire flow locations are evaluated in the future system analysis, so that the City can implement these projects in conjunction with other system improvements.



**Table 6-6. Existing System – Identified Fire Flow Improvements**

Project Identifier	Location	Land Use(s)	Description of Improvements
Existing FF 1	Herndon Road west of Grand View Avenue	Highway Commercial	Install 400 feet of 8-inch diameter main to complete looping with existing mains.
Existing FF 2	Pine Street, east of Central Avenue	Light Industrial, High Density Residential	Install 140 feet of new 10-inch main to interconnect existing 10-inch and 6-inch diameter main, or interconnect existing main to new 16-inch main in Central Avenue. Work could be coordinated with Central Avenue main improvement project.
Existing FF 3	Whitmore Avenue, Whitmore Plaza Shopping Center	Community Commercial	Install 60 feet of new 10-inch diameter main to interconnect existing 8-inch main and 10-inch main
Existing FF 4	Kinser Road, west of Central Avenue	General Industrial	Install 170 feet of new 12-inch diameter main on Kinser Avenue to interconnect with new 16-inch main on Central Avenue. Work could be coordinated with the Central Avenue main improvement project.
Existing FF 5	Paramount Avenue, Giddings Street	Low Density Residential	Interconnect existing 8-inch diameter main and 6-inch diameter main at intersection of Paramount Avenue and Giddings Street.

The City can use Figures 6-3 and 6-4 as a guide to identify other areas where replacement or upsizing of mains as part of other programs would also have fire flow benefits.

## 6.5 SUMMARY OF RECOMMENDED IMPROVEMENTS FOR THE EXISTING WATER SYSTEM

The recommended improvements needed to eliminate deficiencies identified in the evaluation of the existing water distribution system are summarized below and shown on Figure 6-5. With these improvements, at least 40 psi pressure can be maintained under peak hour conditions at all points in the distribution system, as shown on Figure 6-6.

### 6.5.1 Pipelines

- Install approximately 300 feet of new 16-inch diameter pipeline underneath Highway 99 to connect the existing 10-inch diameter pipelines on Hil-Mor Drive to the existing 10-inch diameter pipelines on Richland Avenue. This project is assumed to be included in the Public Facility Fee (PFF) report (PMC, 2010), which includes a Highway 99 crossing project, with specific location not identified.
- Install approximately 600 feet of new 12-inch diameter pipeline along Fiddleleaf Lane, between Hatch Road and Bougainvillea Drive to eliminate high head loss and velocity during peak hour conditions.
- Install approximately 10,600 feet of new 16-inch diameter pipeline along Central Avenue, from Service Road to Hatch Road, to improve transmission capacity from Blaker Tanks to the north part of the system. This pipeline is included in the PFF report as a 12-inch diameter pipeline, but should be upgraded to a 16-inch diameter.



- Install approximately 2,400 feet of new 16-inch diameter transmission on Hatch Road, between Eastgate Boulevard and Faith Home Road to reinforce backbone transmission from the proposed River Bluff Reservoir.
- Install approximately 200 feet of new 12-inch diameter pipeline on Faith Home Road to reinforce the system grid.
- Install approximately 900 feet of new mains to improve fire flow capacity and to increase looping, as enumerated in Table 6-6.

#### 6.5.2 Distribution System Programs

- **Main Replacement Program:** Replace 34,000 feet of 2-inch, 3-inch, and 4-inch diameter pipeline with 8-inch diameter pipeline. This program is a long-term program that would provide annual funding for smaller diameter main replacement to retire older mains, as needed, and improve system hydraulic capacity.
- **Water System Maintenance and Repair Program:** This program is a long-term program that would provide annual funding for repair and maintenance of water valves, fire hydrants, pumping station piping, and other facilities.
- **Large Meter Replacement Program:** This program is a long-term program that would provide annual funding for replacement of large meters, as needed, due to age.

#### 6.5.3 Wells

- Install two new wells (already planned), one as a replacement for Well 1, and another new well on the north side of the City (assumed at Riverview Park).

#### 6.5.4 Backup Power

- Install backup power at wells, with a total capacity of 2,200 gpm to meet emergency reliability needs. Backup power should be installed at planned or existing wells.

#### 6.5.5 Storage Reservoir and Booster Pump Station

- Construct a new 2.0 MG storage reservoir (River Bluff Reservoir) on Hatch Road, between Faith Home Road and Gilbert Road, and an associated 4,200 gpm booster pump station.

See Chapter 8 for a discussion of the CIP costs associated with these improvements.

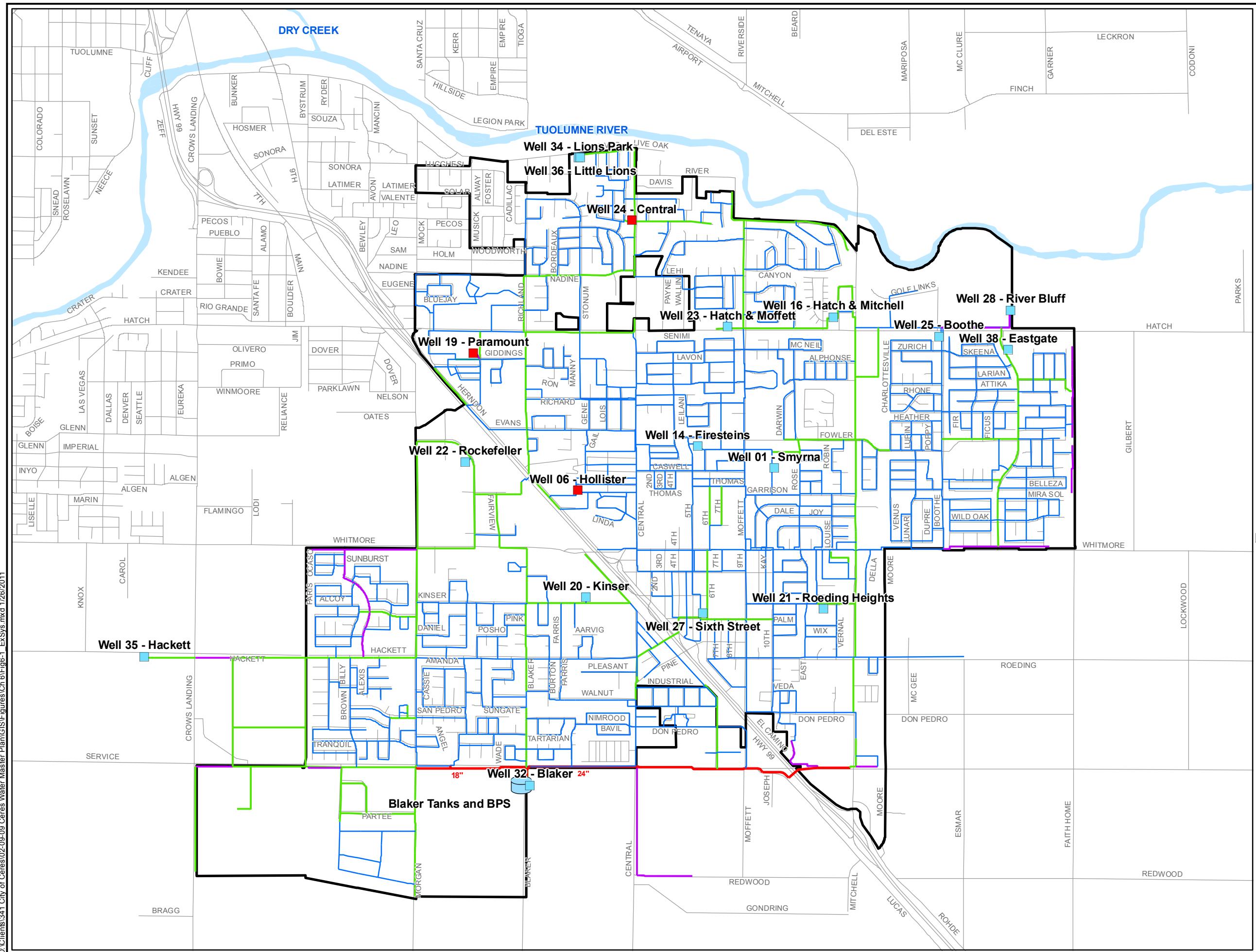
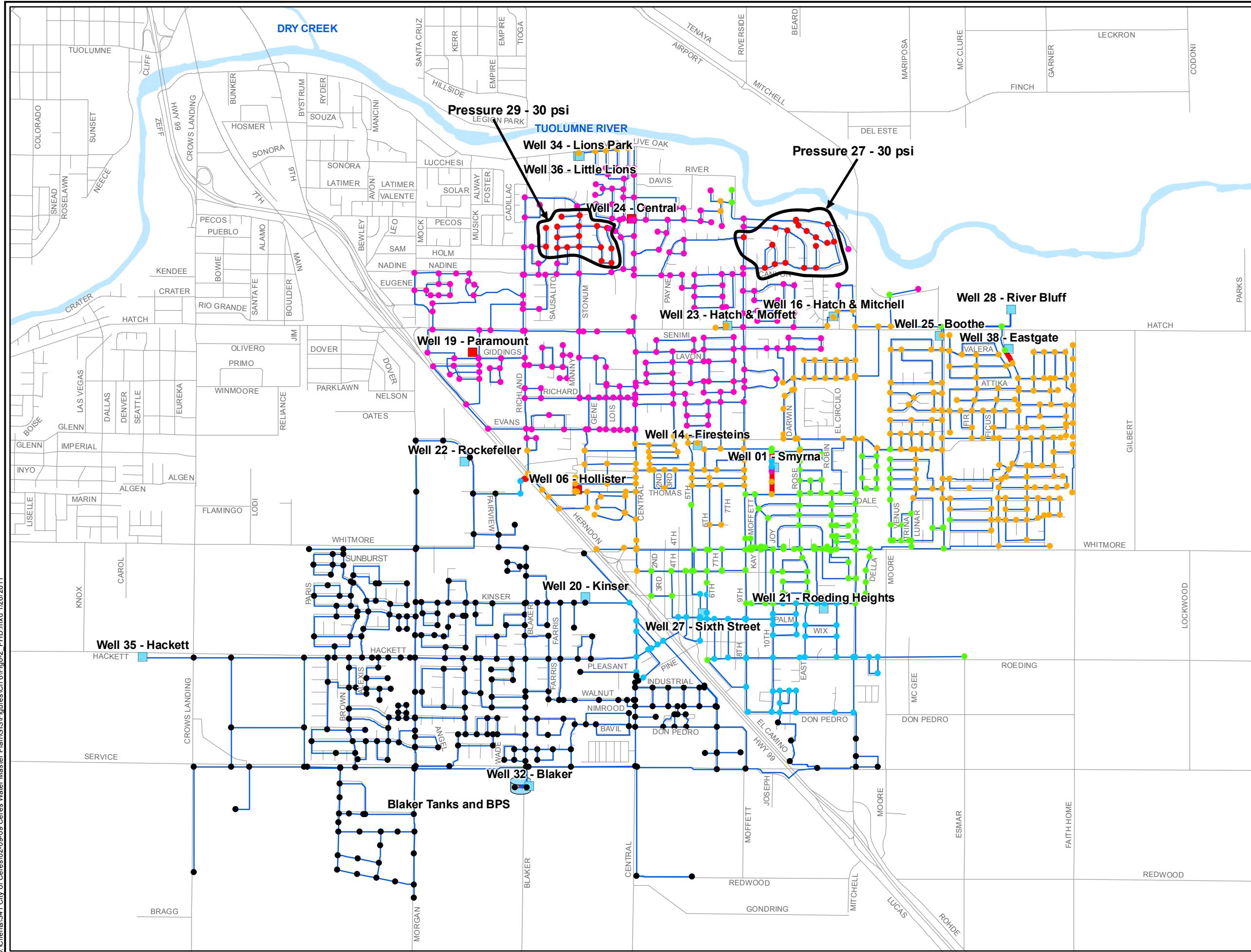
**FIGURE 6-1****City of Ceres  
Water Master Plan****EXISTING WATER  
SYSTEM**



FIGURE 6-2

City of Ceres  
Water Master Plan

EXISTING SYSTEM PEAK  
HOUR PRESSURES



**NOTES**

1. Existing peak hour demand = 28.0 mgd. Based on 2007 average daily production (9.7 mgd) times peak hour to average day peaking factor of 2.9.
2. All active wells operating except Well 32 (Blaker) and Well 36 (well operation interferes with Well 34).
3. Blaker booster station discharge pressure = 60 psi. Station flow = 9.7 mgd.

LEGEND

- Street
- Existing Well
- Inactive Well
- Existing Tank and Booster Pump Station
- Pressure < 30 psi
- 30 psi ≤ Pressure < 35 psi
- 35 psi ≤ Pressure < 40 psi
- 40 psi ≤ Pressure < 45 psi
- 45 psi ≤ Pressure < 50 psi
- Pressure ≥ 50 psi
- Velocity ≤ 7 fps
- Velocity > 7 fps





FIGURE 6-3

City of Ceres  
Water Master Plan

EXISTING SYSTEM  
COMPARISON OF  
AVAILABLE AND  
REQUIRED FIRE FLOW

Existing Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



0 1,250 2,500

Scale in Feet

Notes

1. Existing land use file provided by ECO:LOGIC on 05/05/10.
2. Existing City Limits file (Ctylimt01.dwg) provided by the City on 10/01/09.
3. Existing Maximum Day Demand = 17.4 mgd. Based on 2007 average daily production times maximum day to average day peaking factor of 1.8.
4. All active wells operating except Well 14 and Well 32.
5. Blaker booster station discharge pressure = 45 psi.
6. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.

LEGEND

■	City Limits
—	Street
—	Pipes
■	Existing Well
■	Inactive Well
■	Existing Tank and Booster Pump Station
■	Fire Flow Requirement = 1,500 gpm
■	Fire Flow Requirement = 2,000 gpm
■	Fire Flow Requirement = 2,750 gpm
■	Fire Flow Requirement = 3,500 gpm
●	Available fire flow is less than required fire flow
●	Available fire flow is greater than required fire flow

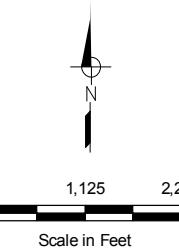


FIGURE 6-4

**City of Ceres  
Water Master Plan**

**EXISTING SYSTEM  
AVAILABLE FIRE FLOW**

Existing Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi

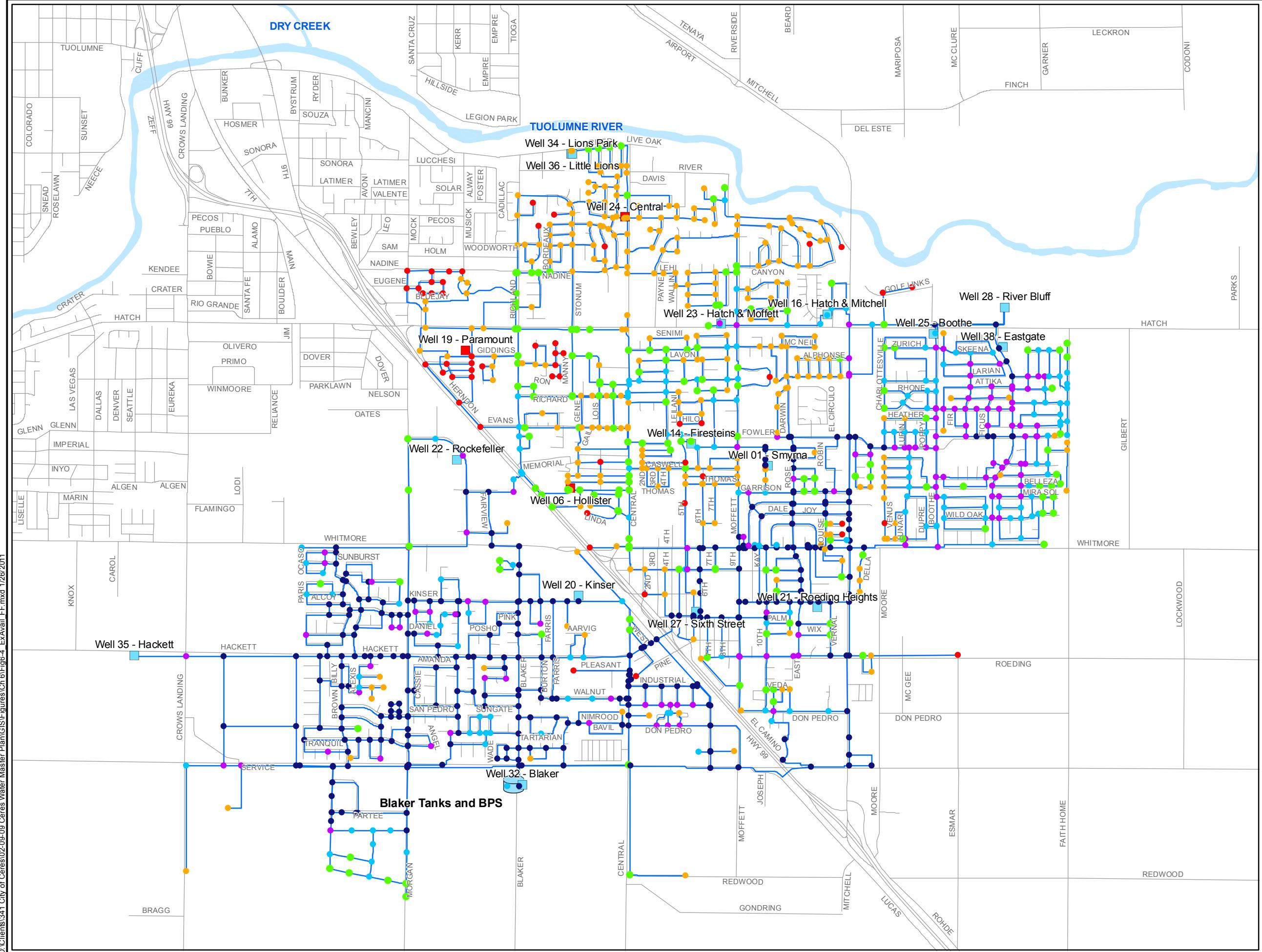


Notes

1. Existing Maximum Day Demand = 17.4 mgd. Based on 2007 average daily production times maximum day to average day peaking factor of 1.8.
2. All active wells operating except Well 14 and Well 32.
3. Blaker booster station discharge pressure = 45 psi.
4. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.

**LEGEND**

- Street
- Existing Well
- Inactive Well
- Existing Tank and Booster Pump Station
- Existing Pipeline
- Flow < 1,500 gpm
- 1,500 gpm ≤ Flow < 2,500 gpm
- 2,500 gpm ≤ Flow < 3,000 gpm
- 3,000 gpm ≤ Flow < 3,500 gpm
- 3,500 gpm ≤ Flow < 4,000 gpm
- Flow ≥ 4,000 gpm



WEST YOST  
ASSOCIATES  
Consulting Engineers



FIGURE 6-5

**City of Ceres  
Water Master Plan**

**EXISTING SYSTEM  
RECOMMENDED  
IMPROVEMENTS**

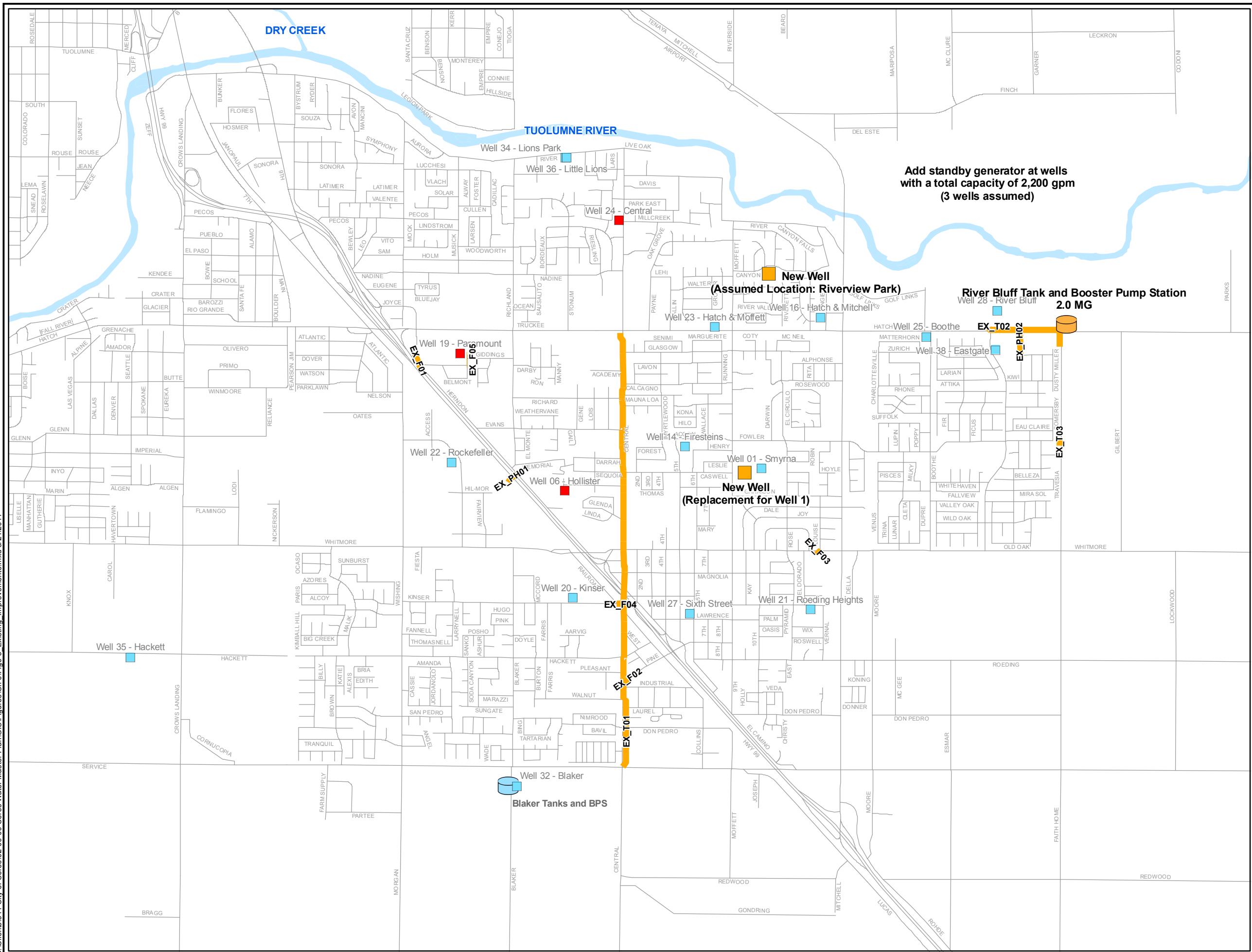
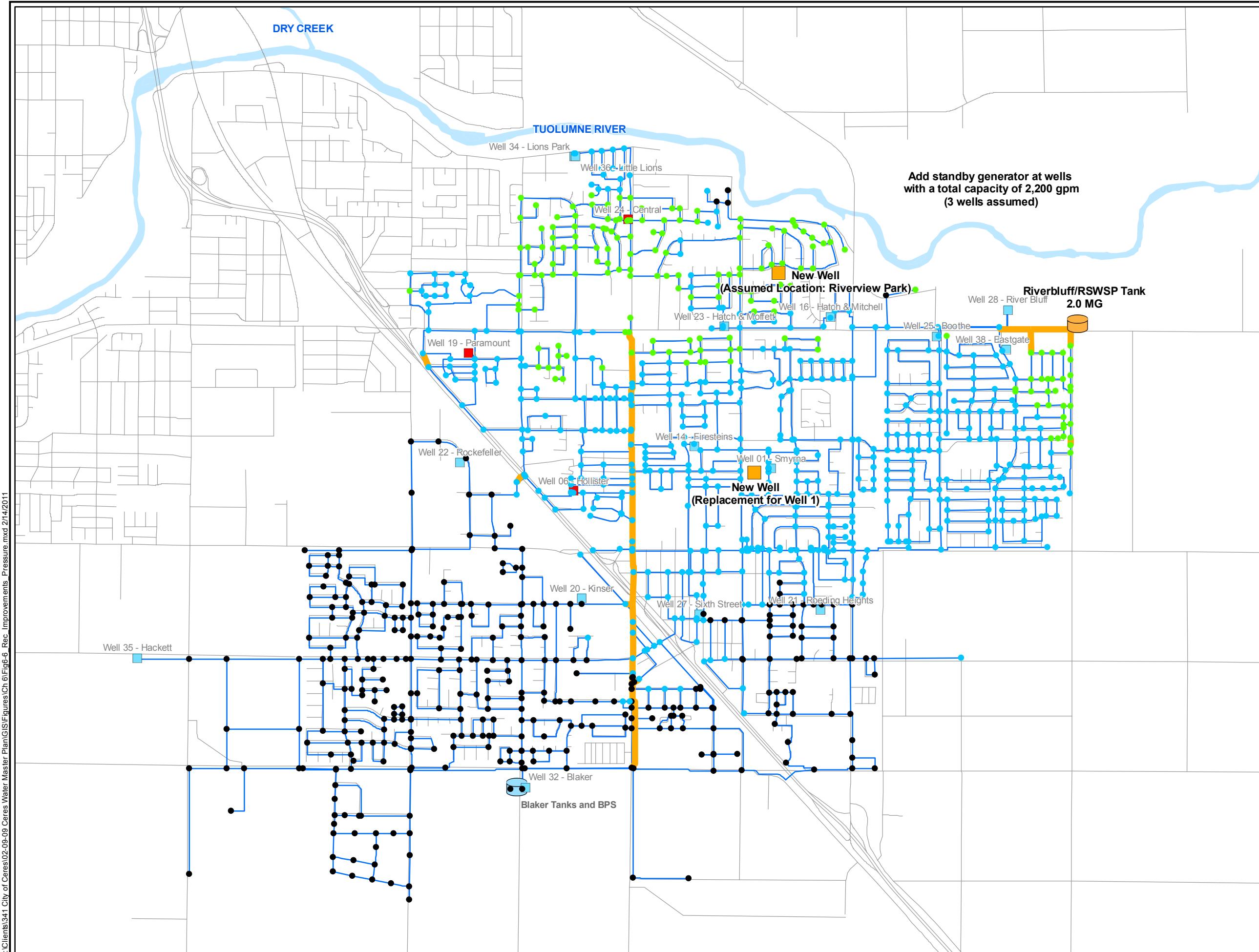




FIGURE 6-6

City of Ceres  
Water Master Plan

EXISTING SYSTEM  
WITH RECOMMENDED  
IMPROVEMENTS - PEAK  
HOUR PRESSURES



NOTES

1. Existing peak hour demand = 28.0 mgd. Based on 2007 average daily production (9.7 mgd) times peak hour to average day peaking factor of 2.9.
2. All active wells operating except Well 32 (Blaker) and Well 36 (well operation interferes with Well 34).
3. Blaker booster station discharge pressure = 60 psi. Station flow = 9.7 mgd.
4. Improvements as shown on Figure 6-5.

LEGEND

- Street
- Existing Well
- Inactive Well
- New Well
- Existing Tank and Booster Pump Station
- New Tank and Booster Pump Station
- Existing Pipeline
- New Pipe
- 40 psi ≤ Pressure < 45 psi
- 45 psi ≤ Pressure < 50 psi
- Pressure ≥ 50 psi



## CHAPTER 7

### Evaluation of Future Water System

---



This chapter presents an overview of the evaluation of the City's future water distribution system and its ability to meet the City's recommended performance and planning criteria under future demand conditions. Two future demand scenarios are evaluated: 1) 2015 demand conditions; and 2) buildout demand conditions.

The future system evaluation includes an analysis of water storage capacity, pumping capacity, and the future water system's ability to meet recommended operational and design criteria under maximum day demand plus fire flow and peak hour demand scenarios.

This chapter includes evaluation, findings and recommendations for supporting projected 2015 and buildout water demands and addressing any deficiencies identified within the water backbone transmission and distribution system. Recommendations were used to develop a CIP, which includes an estimate of probable construction costs. The recommended water system CIP is described further in Chapter 8.

The following topics are reviewed in this chapter:

- Future Water Demands – summarizes demands used for the evaluation;
- Future Water System Configuration – summarizes key assumptions for the future distribution system network;
- Future Water System Facility Evaluation – evaluates storage, peak supply capacity and peak pumping capacity needs to meet future system requirements;
- Future Water System Performance Evaluation – assesses the hydraulic performance of the water system under future peak hour and maximum day plus fire flow conditions; and
- Summary of Recommended Improvements for the Future Water System.

#### 7.1 FUTURE WATER DEMANDS

Table 7-1 summarizes the City water demands used for the future system hydraulic evaluation. The future water demands for the City's water system were spatially located in the hydraulic model using historically-based unit use factors and general plan land use data at buildout provided by the City (see Chapter 3 for more detail). Average daily demands were estimated for the 2015 and buildout scenarios. Peak water demands were computed by scaling up the average daily use to represent maximum day demand, and peak hour demand, based on the adopted Master Plan peaking factors.



**Table 7-1. Water Demands for the Future System Analysis**

Demand Scenario	Demand			
	2015		Buildout	
	gpm	mgd	gpm	mgd
Average Day <sup>(a)</sup>	6,600	9.6 (10,700 af/yr)	12,200	17.6 (19,700 af/yr)
Maximum Day <sup>(b)</sup>	11,900	17.2	22,000	31.7
Peak Hour <sup>(c)</sup>	19,200	27.7	35,400	51.0

(a) Average day demand is based on average annual total water production (see Table 3-13).  
 (b) Maximum day demand calculated using a peaking factor of 1.8 times the average day demand, based on the average peaking factor for 2005 through 2009.  
 (c) Peak hour demand is 2.9 times the average day demand. This peaking factor was adopted based on peak diurnal water use developed from June 2009 operational data.

## 7.2 FUTURE WATER SYSTEM FACILITY AND NETWORK ASSUMPTIONS

The 2015 demand scenario assumes full development of infill (vacant) properties within the City limits (see Figure 3-3 for interim land uses). The distribution network will not require expansion beyond existing service area boundaries to meet 2015 demands. Facilities recommended in the Existing System Analysis are assumed to be in service for the 2015 analysis.

The buildout demand scenario assumes development within the primary and secondary spheres of influence (see Figure 3-4 for buildout land uses). Figure 7-1 shows the initial buildout system distribution network. The buildout pipeline network, well, and storage locations used input from the following three sources: 1) transmission pipeline locations and diameters, as identified in the Public Facilities Fee study (PMC, 2010); 2) West Landing Specific Plan planning information; and 3) RSWSP planning information. The West Landing Specific Plan and RSWSP assumptions are discussed below.

Future transmission system improvements were assumed to be either parallel to existing facilities, with tie-ins at key locations to improve fire flows, or replacement facilities where there are currently only smaller diameter pipelines (10-inch diameter mains or smaller).

### 7.2.1 West Landing Specific Plan Facilities

West Landing Specific Plan, formerly the West Ceres Specific Plan, is a planned area on the west side of Ceres, west of Crow's Landing Road which is currently undergoing environmental review. The draft Environmental Impact Report for the specific plan was completed in August 2010, and public comments were received from August 2010 through early October 2010.

For this Water Master Plan, the West Landing Specific Plan pipeline, well and storage tank facility locations were based on the conceptual layout Backbone Water by Phase, from the West Ceres Specific Plan. Based on consultations with the City, the project developer will be required to install three wells for the area, two to be used as duty wells, and one to be a standby well. A 1.6 MG storage reservoir will also be constructed for the development to assist in the phased development of this planned specific plan area.



#### 7.2.2 RSWSP

This Water Master Plan strongly recommends the City's future participation in the RSWSP, which would provide treated surface water to the communities of Hughson, Ceres, Turlock and South Modesto. The City is currently evaluating participation in Phase 1 of the project, which would provide a supply with a planned year-round delivery capacity of 6 MGD. Locations of RSWSP transmission pipelines and storage reservoirs that would supply water from TID are based on alignments as presented in the RSWSP joint city council special study session on March 24, 2010. One storage reservoir is planned for the City at the terminal end of the proposed TID supply transmission main that would receive water from the RSWSP, located near the intersection of Whitmore Avenue and Morgan Road, at a site that would co-locate storage for both the City of Ceres and the City of Modesto. This tank has been sized at 4 MG, and is assumed to be a ground-level tank that would receive water from the RSWSP, but could also be replenished by system wells. The tank would provide peak storage capacity to the system via booster pump stations that would boost water from the tank to match the system hydraulic gradient. As part of this Master Plan, 2.0 MG of new ground-level storage is also proposed at River Bluff Park. In past RSWSP evaluations, a turnout was proposed near this location. Given this site's proximity to the RSWSP transmission line, it would also be used to deliver water from the RSWSP to the City system.

#### 7.3 FUTURE WATER SYSTEM FACILITY EVALUATION

To evaluate the future water system, the following analyses were conducted:

- Maximum Supply Capacity,
- Water Storage Capacity, and
- Peak Pumping Capacity.

The results of the future water system facility analyses under 2015 and buildout demand conditions are discussed below.

##### 7.3.1 Maximum Supply Capacity

The City's maximum supply capacity criterion is to provide sufficient supply capacity to equal maximum day demand. The City's current sole supply source is groundwater. For the future system analysis, the 2015 analysis assumes that maximum day demand must be met from firm groundwater supply capacity, where firm groundwater supply capacity is defined as the total supply capacity from all wells, with the largest supply well offline. The buildout analysis assumes that the maximum day demand is met from a combination of groundwater supply capacity and the RSWSP, assuming that Phase 1 of the RSWSP has been implemented, with a 6 mgd maximum day and peak hour delivery to the City.

Table 7-2 summarizes the 2015 and buildout maximum day demands, and compares them with the firm well capacity of existing and planned wells (planned wells are those that are currently budgeted but not yet implemented, as identified in Chapter 6). As the table shows, in 2015, there is a supply surplus of 2,200 gpm or 3.1 mgd. By buildout, there is a supply deficit of 3,7+00 gpm (5.4 mgd), which would need to be met by installing new wells. Four new wells are assumed,

## Chapter 7

### Evaluation of Future Water System



with a supply capacity of 900 gpm each. If the RSWSP is not implemented, there is a supply deficit of 7,900 gpm (11.4 mgd), requiring eight new wells.

The West Ceres Specific Plan proposes to install three new wells, two duty wells, and one standby well. This analysis assumes that two of the wells would provide the needed future capacity for the system, and two additional wells would be required.

**Table 7-2. Comparison of Overall City Required and Available Supply Capacity to Meet Maximum Day Demand**

Parameter	Required or Available Supply Capacity			
	2015		Buildout	
	gpm	mgd	gpm	mgd
Maximum Day Demand <sup>(a)</sup>	11,900	17.2	22,000	31.7
Existing Firm Well Capacity <sup>(b)</sup>	12,700	18.3	12,700	18.3
Maximum Supply Capacity Surplus (Deficit)	800	1.1	(9,300)	(13.4)
Additional Capacity Provided by Planned Wells <sup>(c)</sup>	1,400	2.0	1,400	2.0
Maximum Supply Capacity Provided by RSWSP <sup>(d)</sup>	--	--	4,200	6.0
Maximum Supply Capacity Surplus (Deficit) with Planned Wells and RSWSP	2,200	3.1	(3,700)	(5.4)
Maximum Supply Capacity Surplus (Deficit) with Planned Wells and no RSWSP	2,200	3.1	(7,900)	(11.4)

<sup>(a)</sup> Maximum Day Demand is 1.8 times the average daily demand.  
<sup>(b)</sup> Defined as the total active well capacity minus the largest well. Capacities are based on 2010 pump test data, as reported in Table 2-1.  
<sup>(c)</sup> The Capital Improvement Program includes two new wells: a planned replacement well for Well 1 (budgeted FY 2009/10), and one other well, to be located at Riverview Park, based on results of the Existing System analysis. Wells have an assumed capacity of 900 gpm each; however 400 gpm of well capacity would be lost with the retirement of Well 1, for a net new capacity of 1,400 gpm.  
<sup>(d)</sup> Assumes implementation of Phase 1 of RSWSP, which has a Ceres proposed participation amount of 6 mgd supply.

#### 7.3.2 Water Storage Capacity

The principal advantages that storage provides for the water system are the ability to equalize demands on supply sources, production facilities, and distribution system mains; to provide emergency storage in case of supply failure; and to provide water to fight fires.

## Chapter 7

### Evaluation of Future Water System



The City's criterion for storage is to provide for operational, fire and emergency storage needs, with the required volume for each storage component detailed below:

- Operational Storage: Volume equal to 30 percent of maximum day demand, to meet demands in excess of the average maximum day demand,
- Fire Flow: Volume of water necessary to supply a single fire flow for the most critical land use within the system (0.72 MG for Industrial/Public/Institutional land use (3,000 gpm for 4-hour duration), assuming sprinklered system), and
- Emergency Storage: Volume equal to two times average day demand to provide water during emergencies.

An Emergency Storage Credit is included in calculations to account for wells equipped with standby power that would provide reliability equivalent to emergency storage. The storage credit is defined as:

- Emergency Storage Credit – Equal to the groundwater supply of potable water that can be reliably accessed in the event of a power outage or any other emergency that would interrupt system-wide operations. In the case of the City, these facilities would include wells that are equipped with on-site auxiliary power. The minimum credit is equal to zero, and the maximum credit is equal to the required emergency storage capacity or two average days demand.

Table 7-3 summarizes storage requirements for 2015 and buildout conditions. Calculations for both scenarios assume that future wells will be equipped with standby generators that provide reliable supply during an emergency, and can be used to offset the need for emergency storage.

**Table 7-3. Comparison of Available and Required Storage Capacity**

Scenario	Available Storage Capacity, MG			Required Storage Capacity, MG			Storage Capacity Surplus (Deficit) <sup>(b)</sup> , MG	
	Reservoir Capacity	Groundwater Credit <sup>(a)</sup>	Total	Operational	Fire	Emergency		
2015	3.8	19.2	23.0	5.2	0.7	19.2	25.1	(2.1)
Buildout	3.8	35.2	39.0	9.5	0.7	35.2	45.1	(6.4)

<sup>(a)</sup> For 2015, equal to the Emergency Storage Requirement. The Emergency Storage Credit, calculated as the sum of the well capacity of all wells with standby power (Wells 20, 21, 23, 34, 35 36, and three planned wells) minus the largest well (Well 21) is 20.7 MG, which exceeds the Emergency Storage Requirement of 19.8 MG. Therefore 19.8 MG is used for the groundwater credit. For buildout, it is assumed that all new and replacement wells will have standby power and that all emergency needs can be met from wells with standby generators.

<sup>(b)</sup> Equal to required storage minus available storage.



As shown in Table 7-3, a total of 2.1 MG of storage is needed to meet 2015 storage requirements, and a total of 6.4 MG of storage is needed to meet buildout requirements, even with the construction of all planned wells, and allowance for appropriate groundwater credit.

The Existing System evaluation recommended construction of 2.0 MG of a new storage reservoir in River Bluff Park to meet operational storage needs. For future system needs, 1.6 MG of storage is planned for the West Landing project and 4.0 MG is proposed for the RSWSP. Therefore, these planned storage projects will provide a total of 7.6 MG of storage, which will satisfy the storage deficit of 6.4 MG. Although planned storage exceeds the calculated need, a total of 7.6 MG of storage is recommended, based on the phasing and timing for implementation of the various projects. The 2.0 MG storage reservoir in River Bluff Park is needed to support system pressure on the north side of the system. The 1.6 MG storage proposed for West Landing Project is required to meet proposed phased development requirements. The 4.0 MG proposed for the RSWSP will be needed to provide terminal storage for RSWSP deliveries, as well as for balancing storage for the system.

#### 7.3.3 Peak Pumping Capacity

The peak pumping capacity criterion for the City, described in additional detail in Chapter 5, requires the City's water system to have sufficient pumping capacity to meet maximum day demand plus fire flow, or peak hour demand, whichever is greater. Peak pumping capacity can be provided from a combination of wells and booster stations that access ground-level storage.

The fire flow requirement for assessing peak capacity is based on the land use with the highest requirement. Industrial and Public/Institutional land uses both have a 3,500 gpm fire flow requirement for a 4-hour duration for sprinklered buildings. For both the 2015 and buildout scenario, peak hour demand exceeds the maximum day plus fire flow demand so peak hour conditions would govern.

The City's pumping capacity was evaluated to assess its ability to deliver a reliable firm capacity to the service area. The firm capacity includes the total groundwater pumping capacity plus the Blaker booster pump station capacity, with the largest well and booster pump out of service, to account for pumps out of service due to mechanical breakdowns, maintenance, water quality, or other operational issues. The results of the pumping capacity evaluation are summarized in Table 7-4. The pumping capacity analysis includes the capacity of the three planned wells identified in the Existing System analysis, but does not include new capacity at the tank recommended in the River Bluff area.

As the table shows, for 2015 conditions, there is a pumping capacity surplus of 3,300 gpm (4.7 mgd). By buildout, there is a pumping capacity deficit of 12,900 gpm (18.6 mgd). This pumping capacity deficit will be met from a combination of future wells, and booster pump stations located at new storage facilities.



**Table 7-4. Evaluation of Total Firm Pumping Capacity to Meet Peak Hour Demand**

Available or Required Capacity	Capacity			
	2015		Buildout	
	gpm	mgd	gpm	mgd
Groundwater Wells	15,000	21.6	15,000	21.6
Blaker Booster Station	7,500	10.8	7,500	10.8
Total Available Pumping Capacity <sup>(a)</sup>	22,500	32.4	22,500	32.4
Peak Hour Demand <sup>(b)</sup>	19,200	27.7	35,400	51.0
Pumping Capacity Surplus (Deficit)	3,300	4.7	(12,900)	(18.6)

(a) Defined as the total active well capacity minus the largest well. Includes planned wells recommended in the Existing System analysis.  
(b) Peak hour demand is 2.9 times the average daily demand.

## 7.4 FUTURE WATER SYSTEM PERFORMANCE EVALUATION

This section discusses the performance criteria for and results of the future water distribution system evaluation.

### 7.4.1 Future Water System Performance Criteria

Steady state hydraulic analyses were conducted using the updated model to identify areas of the future water system that do not meet the recommended system performance criteria as presented previously in Chapter 5. The results of the evaluation of the existing water system are presented in the subsequent sections, based on the following demand scenarios:

- Peak Hour Demand—A peak hour flow condition was simulated for the future distribution facilities to evaluate their capability to meet a peak hour demand scenario. Peak hour demands are met by the combined flows from groundwater wells (firm groundwater pumping capacity) and the Blaker tanks.
- Maximum Day Demand plus Fire Flow—To evaluate the existing water system under the maximum day demand plus fire flow scenario, H<sub>2</sub>ONET's "Available Fire Flow Analysis" tool was used to determine the available fire flow while meeting the maximum day demand plus fire flow performance criteria within the existing water system. Maximum day plus fire flow demands are met by the combined flows from groundwater wells (firm groundwater pumping capacity), the Blaker tanks and future storage tanks.

#### 7.4.1.1 Peak Hour Demand Scenario

As shown in Table 7-1, the peak hour demand for the City service area was calculated to be 19,200 gpm (27.7 mgd) for 2015 and 35,400 gpm (51 mgd) by buildout. These peak hour demands represent a peaking factor of 2.9 times the projected average day demand. During a peak hour demand scenario, a minimum pressure of 40 psi must be maintained throughout the



water system. In addition, in new development areas, it is recommended that the maximum head loss per thousand feet of distribution main should not exceed 10 ft/kft and maximum velocities should not exceed 7 fps, to help minimize energy (pumping) costs due to undersized projects. Details of the system pressures as simulated in the model under the peak hour demand scenario are discussed below.

#### 7.4.1.2 Maximum Day Demand plus Fire Flow Scenario

As discussed in Chapter 5, fire flow requirements are provided based on the current fire flow standards used by the City. For future scenarios, fire flows would be improved as the transmission grid is reinforced. Additionally, other fire flow improvements could be expected as pipelines are replaced over time. For the 2015 scenario, fire flow availability is reported to show the impacts of the recommended capital projects within the 2015 time frame. For the buildup scenario, additional fire flow improvements have been recommended to eliminate fire flow deficiencies except at subdivision-level dead end mains or interior loops. The maps from these evaluations can be compared with the existing system analysis maps to help City staff identify the potential benefits of different pipeline projects on improving fire flow capability.

H<sub>2</sub>ONET's "Available Fire Flow Analysis" tool was used to determine the available fire flow in the future water system under future maximum day demand conditions while meeting the minimum residual system pressure criterion of 20 psi.

#### 7.4.1.3 Recommended Improvements Criteria

The water system is expected to deliver peak hour flows and maximum day demand plus fire flow within the acceptable pressure, velocity and head loss ranges as identified in the performance criteria presented in Chapter 5. However, the system was evaluated using peak hour pressure as the primary criterion. Recommended system improvements were identified to address and fix any pressure deficiencies found. System improvements were not identified for pipelines that did not meet velocity or head loss criteria where no pressure problems were identified.

### **7.4.2 2015 Water System Evaluation Results**

This section summarizes the results of the peak hour demand and maximum day demand plus fire flow analyses for the 2015 water demand scenario. The 2015 demand scenario assumes development of infill (vacant) properties within the City limits, with no expansion of the distribution network beyond existing current service area boundaries to meet 2015 demands. Improvements identified in the Existing System analysis are assumed to be on-line for the 2015 scenario.

#### 7.4.2.1 2015 Peak Hour Demand Scenario

A 2015 peak hour demand scenario was evaluated to assess distribution system performance. For the baseline analysis, all existing active wells were assumed to be operating, except Well 32, adjacent to Blaker Booster station, and Well 36, which is reported to interfere with nearby Well 34 if operated together (Well 34 is the larger capacity well, and is assumed to be operating). Well 1 replacement and a new well in Riverview Park were also assumed to be operational.



With the proposed River Bluff area storage tank on-line, flows are distributed between the storage reservoirs. Completion of the 16-inch diameter transmission line along Hatch Road, from near the tank to Central Avenue would provide adequate capacity from the new tank, and complete the transmission main looping to the recommended 16-inch transmission main on Central, from Hatch Road to Service Road, through the central part of the system to hydraulically connect both reservoirs.

Figure 7-2 shows recommended 2015 improvements, and corresponding 2015 peak hour system pressures.

#### 7.4.2.2 2015 Maximum Day Demand plus Fire Flow Scenario

H<sub>2</sub>ONET's “*Available Fire Flow Analysis*” tool was used to determine the available fire flow (while meeting the maximum day demand plus fire flow performance criteria) at each junction within the 2015 water system under a maximum day demand scenario. Figures 7-3 and 7-4 summarize the results of the analysis. Figure 7-3 shows the different fire flow requirements in the City, color-coded based on the requirements for different land use types (see Table 5-2 for requirements), and indicates locations where available fire flow is greater than the required fire flow (shown by green dots), and less than the available fire flow (red dots). Figure 7-4 summarizes the available fire flow at modeled junctions within the system, color-coded by available flow. These two figures show fire flow results, with the construction of improvements recommended for the existing system and for the 2015 analysis. The existing system analysis (see section 6.4.2.2) identified 130 locations that have fire flows that are less than required fire flows. With the Existing System and 2015 capital improvements constructed, as assumed for Figures 7-3 and 7-4, the number of deficient locations drops from 130 to 62. The buildout analysis recommends additional improvements that could be implemented along with future renewal and replacement or other main construction projects to eliminate remaining fire flow deficiencies.

The City can use Figures 7-3 and 7-4 to compare with Figures 6-3 and 6-4, to see the impact of including the CIP improvements on fire flow capability.

#### **7.4.3 Buildout Water System Evaluation Results**

This section summarizes the results of the peak hour demand and maximum day demand plus fire flow analyses for the buildout water demand scenario. The buildout demand scenario assumes development within the primary and secondary spheres of influence, and a water supply that includes the RWSWP at 6 mgd operated in conjunction with existing and new wells. The buildout pipeline network, well, and storage locations are shown on Figure 7-1.

##### 7.4.3.1 Buildout Peak Hour Demand Scenario

A buildout peak hour demand scenario was evaluated to assess distribution system performance. For the baseline analysis, all existing active wells were assumed to be operating, except Well 32, adjacent to Blaker Booster station, and Well 36, which is reported to interfere with nearby Well 34 if operated together (Well 34 is the larger capacity well, and is assumed to be operating). Well 1 replacement, and new wells at Riverview Park, Roeding and Esmar, Redwood and Central, Crow's Landing and Central, and one West Landing well were also assumed to be



operational. Three future tanks, at West Landing, River Bluff, and a joint Modesto Tank are all assumed to be operating.

Figure 7-5 shows recommended buildout improvements, and corresponding buildout peak hour system pressures.

#### 7.4.3.2 Buildout Maximum Day Demand plus Fire Flow Scenario

H<sub>2</sub>ONET's “*Available Fire Flow Analysis*” tool was used to determine the available fire flow (while meeting the maximum day demand plus fire flow performance criteria) at each junction within the 2015 water system under a maximum day demand scenario. Figures 7-6 and 7-7 summarize the results of the analysis. Figure 7-6 shows the different fire flow requirements in the City, color-coded based on the requirements for different land use types (see Table 5-2 for requirements), and indicates locations where available fire flow is greater than the required fire flow (shown by green dots), and less than the available fire flow (red dots). Figure 7-7 summarizes the available fire flow at modeled junctions within the system, color-coded by available flow.

For the buildout analysis, several improvements were identified to remedy deficiencies, except for deficient locations on dead-end mains. These are improvements that the City can consider and implement, as needed, with other main replacement and new main construction projects. Table 7-5 and Figure 7-8 summarize identified projects:

## Chapter 7

### Evaluation of Future Water System



**Table 7-5. Buildout System – Identified Fire Flow Improvements**

Project Identifier	Location	Land Use(s)	Description of Improvements
Buildout FF 1	Farm Supply Drive and Marchy Lane	Industrial	New 300 feet of 8-inch diameter main to connect to future transmission and complete looping.
Buildout FF 2	Downtown Area	Commercial – Office, Downtown Commercial, School, Parks	<p>Install a total of 6,900 feet of 8-inch new and replacement main to complete looping and upgrade pipelines in the downtown area:</p> <ul style="list-style-type: none"> <li>• 1,100 feet on Second Street between Whitmore Avenue and North Street.</li> <li>• 2,300 feet on Magnolia Avenue, between Central Avenue and Ninth Street.</li> <li>• 500 feet on Fourth Street.</li> <li>• 500 feet on Fifth Street.</li> <li>• 500 feet on Seventh Street.</li> <li>• 1,400 feet on North Street between Second and Sixth.</li> <li>• 600 feet on Park Street, west of Sixth, and Sixth Street between Park Street and Roeding Road.</li> </ul>
Buildout FF 3	Darrah Street, Sequoia Street, Memorial Drive	Neighborhood Commercial, Low Density Residential, High Density Residential, Community Facilities	Install a total of 4,300 feet of 8-inch new and replacement main to complete looping and upgrade pipelines.
Buildout FF 4	Grand View Ave, Belmont Avenue	Community Commercial, Highway Commercial, Low Density Residential,	<p>Install 600 feet of 10-inch replacement main from north of Grand Avenue to West of Belmont Avenue to improve looping.</p> <p>Install 500 feet of 8-inch main on Belmont Avenue west of Paramount to complete looping.</p>
Buildout FF 5	Fifth Street	Low Density Residential	Install 500 feet of 8-inch replacement main to replace existing 4-inch main on Fifth Street, south of Thomas.
Buildout FF 6	Sixth Street	Commercial – Office, Low Density Residential	Install 200 feet of 8-inch main to complete looping on Sixth Street between Thomas Avenue and Caswell Avenue
Buildout FF 7	Golf Links Drive	Commercial Recreation, Very Low Density Residential	Install 1,600 feet of 10-inch diameter main on Golf Links Drive to East Hatch Road to complete looping.
Buildout FF 8	Colleen Drive, Della Drive	Community Commercial, High Density Residential	Install 1,400 feet of 12-inch diameter replacement main on Della Drive and Colleen Drive.
Buildout FF 9	Central Avenue, north of Hatch	Neighborhood Commercial, Low Density Residential	1,000 feet of 10-inch diameter main to complete looping for fire flow.
Buildout FF 10	Rosewood Avenue	Low Density Residential	200 feet of 8-inch diameter main to complete looping for fire flow.
Buildout FF 11	Mitchell Road, north of Hatch	Low Density Residential	900 feet of 10-inch diameter main to complete looping for fire flow.

With these fire flow improvements, there are only 10 deficient fire flow locations under buildout conditions.



## 7.5 SUMMARY OF RECOMMENDED IMPROVEMENTS FOR THE FUTURE WATER SYSTEM

The recommended improvements needed to eliminate deficiencies identified in the evaluation of the future water distribution system are summarized below, shown on Figure 7-8 and itemized on Table 7-6. With these improvements, at least 40 psi pressure can be maintained under peak hour conditions at all points in the distribution system, as shown on Figure 7-6. Fire flows can also be met at all except a small number of dead end main locations.

### 7.5.1 Pipelines

#### 7.5.1.1 2015 Time Frame

- Install approximately 9,000 feet of new 16-inch diameter transmission on Hatch Road and Faith Home Road to reinforce backbone transmission from the proposed River Bluff Reservoir.

#### 7.5.1.2 Buildout Time Frame

- Install approximately 18,000 feet of new and replacement main to improve fire flows, as enumerated in Table 7-6.
- Install approximately 174,000 feet of new transmission to reinforce the system grid, as enumerated in Table 7-6.
- Install approximately 24,000 feet of new transmission to serve the West Landing Specific Plan area. New transmission main will be located on Whitmore Avenue, Ustick Road, Service Road and Crow's Landing Road.
- Upsize 6,700 feet of planned subdivision piping from 8-inch to 12-inch for West Landing Specific Plan area in the vicinity of the proposed West Landing tank.

### 7.5.2 Wells

#### 7.5.2.1 2015 Time Frame

- No recommended improvements

#### 7.5.2.2 Buildout Time Frame

- Install two new wells to meet future distribution system needs. These well recommendations assume that two new duty wells (three wells total, with one reserved as a standby) will be constructed for the West Landing project. New wells were assumed to be developed in the general areas of Redwood Avenue and Central Avenue, and Crow's Landing Road and Central Avenue.
- Install backup power at future new and replacement wells so that emergency needs can be met from wells.

**Table 7-6. Future System Recommended Pipeline Improvements**

Project	CIP Reason	Location	Timeframe	Diameter		Quantity
				PFF Recommended	MP Recommended	
15_T01	Future Transmission	Hatch Road between Central Avenue and Faith Home Road	2015	16	16	9,000
BO_F01	Fire Flow	Farm Supply Drive and Marchy Lane	Buildout	0	8	300
BO_F02	Fire Flow	Downtown Area	Buildout	0	8	6,900
BO_F03	Fire Flow	Darrah Street, Sequoia Street, Memorial Drive	Buildout	0	8	4,300
BO_F04	Fire Flow	Grand View Avenue, Belmont Avenue	Buildout	0	8	1,100
BO_F05	Fire Flow	Fifth Street	Buildout	0	8	500
BO_F06	Fire Flow	Sixth Street	Buildout	0	8	200
BO_F07	Fire Flow	Golf Links Drive	Buildout	0	10	1,600
BO_F08	Fire Flow	Colleen Drive, Della Drive	Buildout	0	12	1,400
BO_F09	Fire Flow	Central Avenue, north of Hatch	Buildout	0	10	1,000
BO_F10	Fire Flow	Rosewood Avenue	Buildout	0	8	200
BO_F11	Fire Flow	Mitchell Road, north of Hatch Road	Buildout	0	10	900
Total - Buildout Fire Flow Improvements						18,400
BO_T01	Transmission	Whitmore Avenue, Central Avenue to Faith Home Road	Buildout	14	16	10,600
BO_T02	Transmission	Service Road between Mitchell Road and Faith Home Road	Buildout	14	12	4,700
BO_T03	Transmission	Service Road between Crows Landing Road and Morgan Road	Buildout	12	16	5,400
BO_T04	Transmission	Mitchell Road between Hatch Road and Service Road	Buildout	16	16	10,900
BO_T05	Transmission	Morgan Road between Hatch Road and Whitmore Avenue	Buildout	14	16	5,500
BO_T06	Transmission	Morgan Road between Whitmore Avenue and Kinser Road	Buildout	12	16	5,300
BO_T07	Transmission	Hatch Road between Morgan Road and Central Avenue	Buildout	16	16	6,200
BO_T08	Transmission	Faith Home Road between Hatch Road and Whitmore Avenue	Buildout	14	16	5,100
BO_T09	Transmission	Faith Home Road between Whitmore Avenue and Redwood Avenue	Buildout	14	12	8,000
BO_T10A	Transmission	New Transmission, various locations	Buildout	0	16	26,200
BO_T10B <sup>(a)</sup>	Transmission	New Transmission, various locations	Buildout	12	12	86,000
Total - Buildout Transmission Improvements						173,900
WL-T01	Future Development	New Transmission to serve West Landing Specific Plan Area	Buildout	0	16	18,800
WL-T02	Future Development	New Transmission to serve West Landing Specific Plan Area	Buildout	0	12	5,200
WL-M01	Future Development	Upsize Proposed Mains for West Landing Specific Plan Area	Buildout	0	12	6,700
Total West Landing Improvements <sup>(b)</sup>						30,700

<sup>(a)</sup> Public Facilities Fee (PFF) report designates 79,500 feet of 12-inch diameter transmission at miscellaneous locations. The Master Plan includes 26,200 feet of 16-inch and 86,000 ft of 12-inch, for a total of 112,200 ft. The Master Plan includes transmission grid in secondary sphere- of-influence areas not considered in the PFF report.

<sup>(b)</sup> West Landing transmission improvements include pipelines designated for major roads (Whitmore Avenue, Ustick Road, Service Road and Crows Landing Road). Only subdivision mains recommended for upsizing are shown in table. Other planned subdivision mains are not included in totals.



#### 7.5.3 Storage Reservoirs and Booster Pump Stations

##### 7.5.3.1 2015 Time Frame

- No recommended improvements

##### 7.5.3.2 Buildout Time Frame

- Construct a new 1.6 MG storage reservoir and an associated booster pump station for the West Landing Specific Plan area.
- Construct a new 4.0 MG storage reservoir and an associated booster pump station, at a proposed site at Whitmore Avenue and Morgan Road. This tank has been budgeted as part of the RSWSP. Booster pump station sizing is assumed at 8,300 gpm, which would allow evacuation of the tank in 8 hours.

See Chapter 8 for a discussion of the CIP costs associated with these improvements. These new wells are planned and budgeted as standard municipal production wells; however, as future site-specific ASR well siting studies are conducted, the feasibility of installing ASR wells in lieu of production only wells should be re-evaluated.

FIGURE 7-1

**City of Ceres  
Water Master Plan**

**BUILDOUT WATER  
SYSTEM**

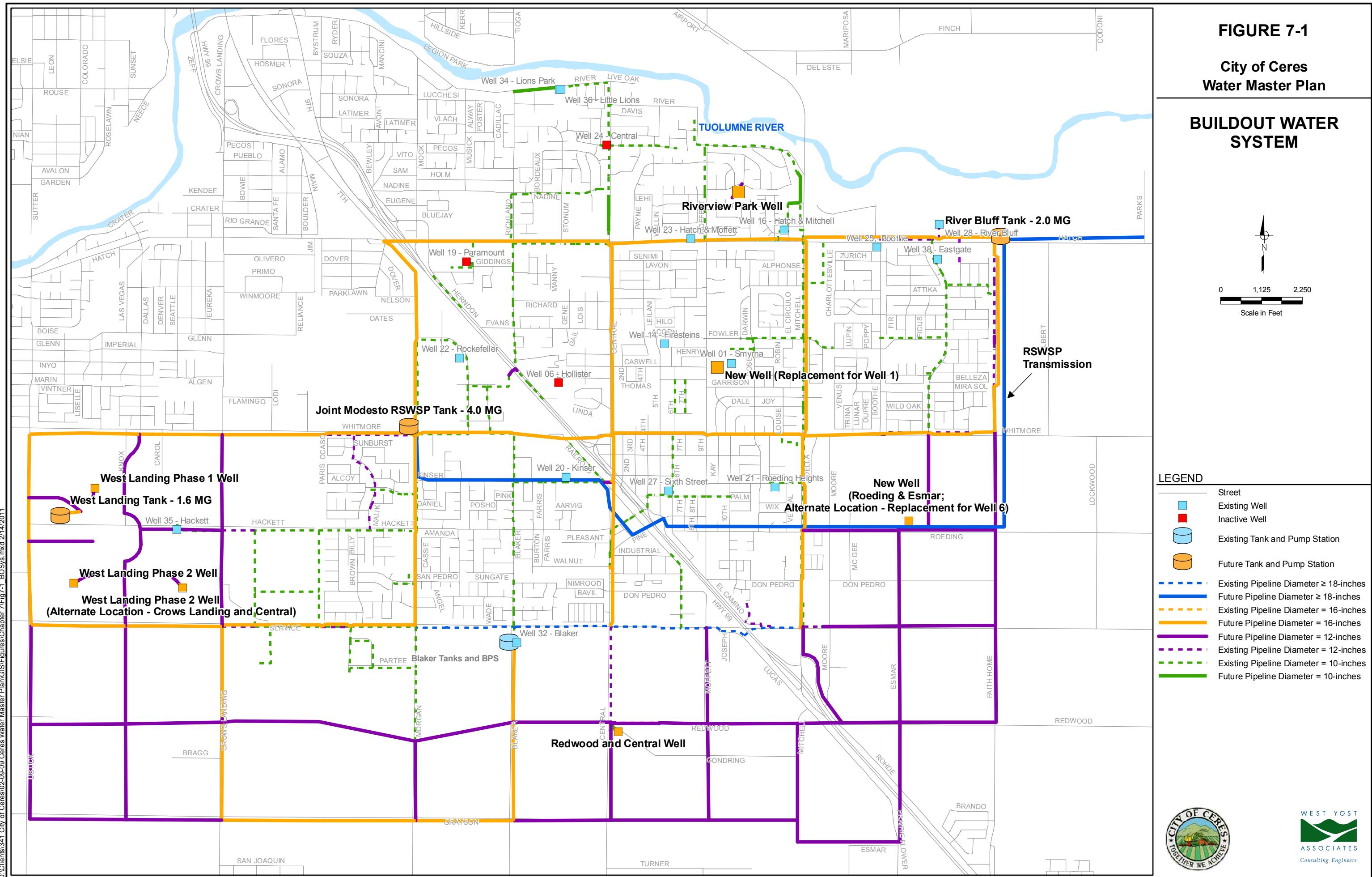




FIGURE 7-2

City of Ceres  
Water Master Plan

2015 SYSTEM PEAK  
HOUR PRESSURES  
WITH RECOMMENDED  
IMPROVEMENTS

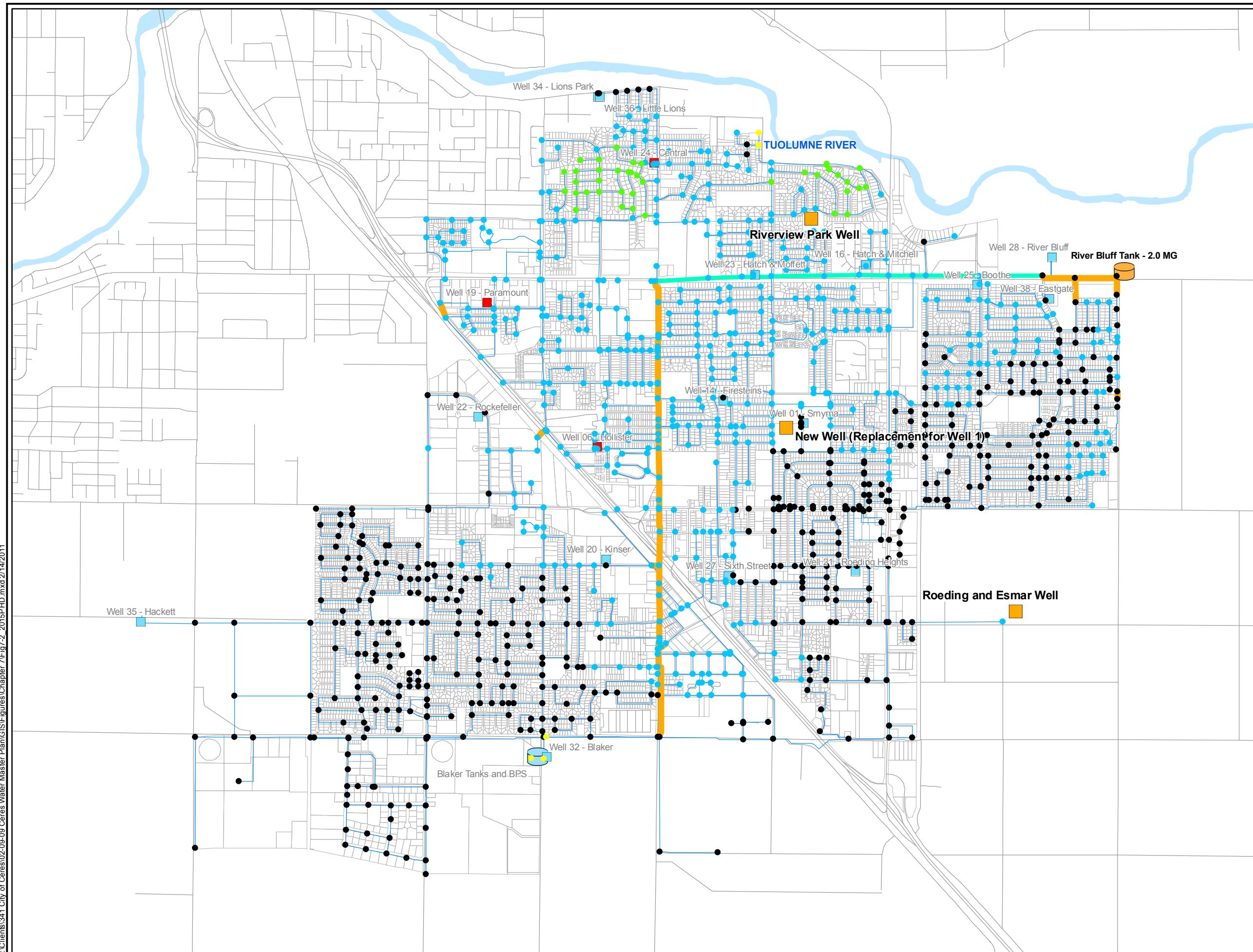




FIGURE 7-3

**City of Ceres  
Water Master Plan**

**2015 SYSTEM  
COMPARISON OF  
AVAILABLE AND  
REQUIRED FIRE FLOW  
WITH RECOMMENDED  
IMPROVEMENTS**

2015 Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



0 1,125 2,250  
Scale in Feet

**NOTES**

1. 2015 Maximum Day Demand = 17.8 mgd.
2. All active wells operating except Well 32 (Blaker), Well 36 (well operation interferes with Well 34), Well 1 Replacement, and River Bluff Well.
3. Blaker and River Bluff booster stations' discharge pressure = 45 psi.  
Station flow = 6.8 mgd.
4. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.

**LEGEND**

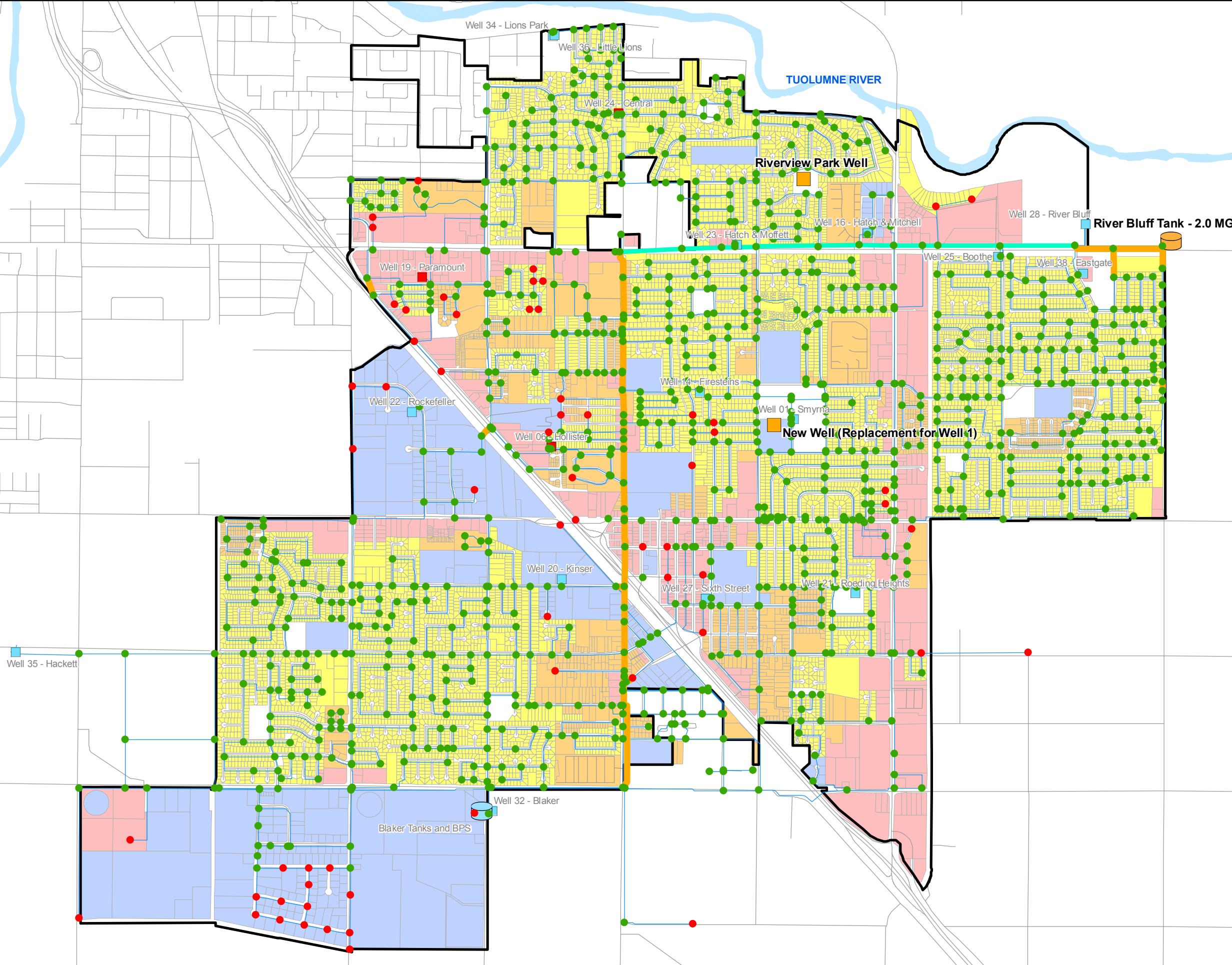


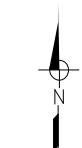


FIGURE 7-4

**City of Ceres  
Water Master Plan**

**2015 SYSTEM  
AVAILABLE FIRE FLOW  
WITH RECOMMENDED  
IMPROVEMENTS**

2015 Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



0 1,125 2,250  
Scale in Feet

**NOTES**

1. 2015 Maximum Day Demand = 17.8 mgd.
2. All active wells operating except Well 32 (Blaker), Well 36 (well operation interferes with Well 34), Well 1 Replacement, and River Bluff Well.
3. Blaker and River Bluff booster stations' discharge pressure = 45 psi.  
Station flow = 6.8 mgd.
4. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.

**LEGEND**

- City Limit
- Parcel
- Street
- Existing Well
- Inactive Well
- Existing Tank and Booster Pump Station
- Existing Scenario Recommended Facility
- Flow < 1,500 gpm
- 1,500 gpm ≤ Flow < 2,500 gpm
- 2,500 gpm ≤ Flow < 3,000 gpm
- 3,000 gpm ≤ Flow < 3,500 gpm
- 3,500 gpm ≤ Flow < 4,000 gpm
- Flow ≥ 4,000 gpm

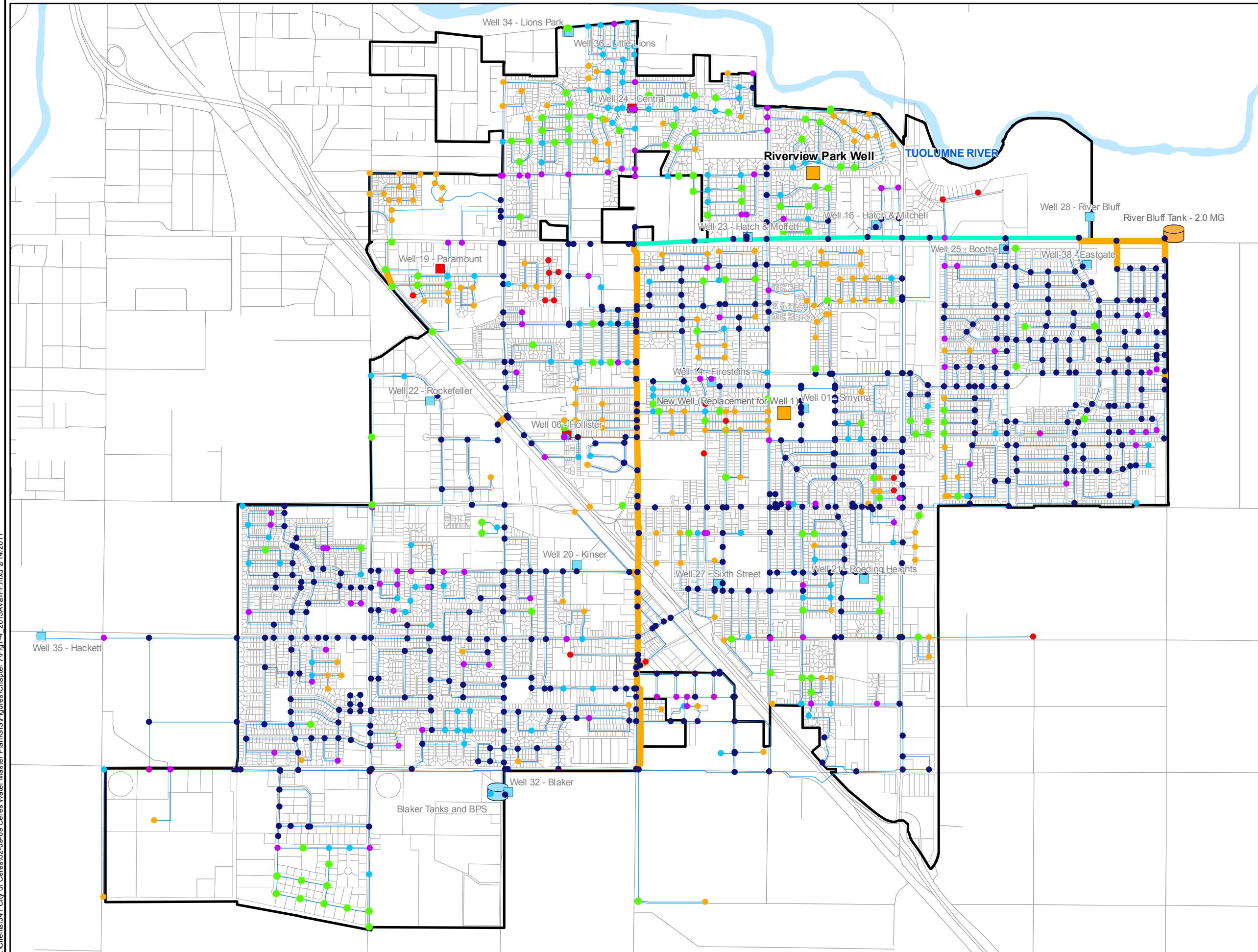




FIGURE 7-5

City of Ceres  
Water Master Plan

**BUILDOUT SYSTEM PEAK  
HOUR PRESSURES  
WITH RECOMMENDED  
IMPROVEMENTS**

Buildout Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



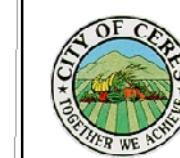
0 1,125 2,250  
Scale in Feet

Notes

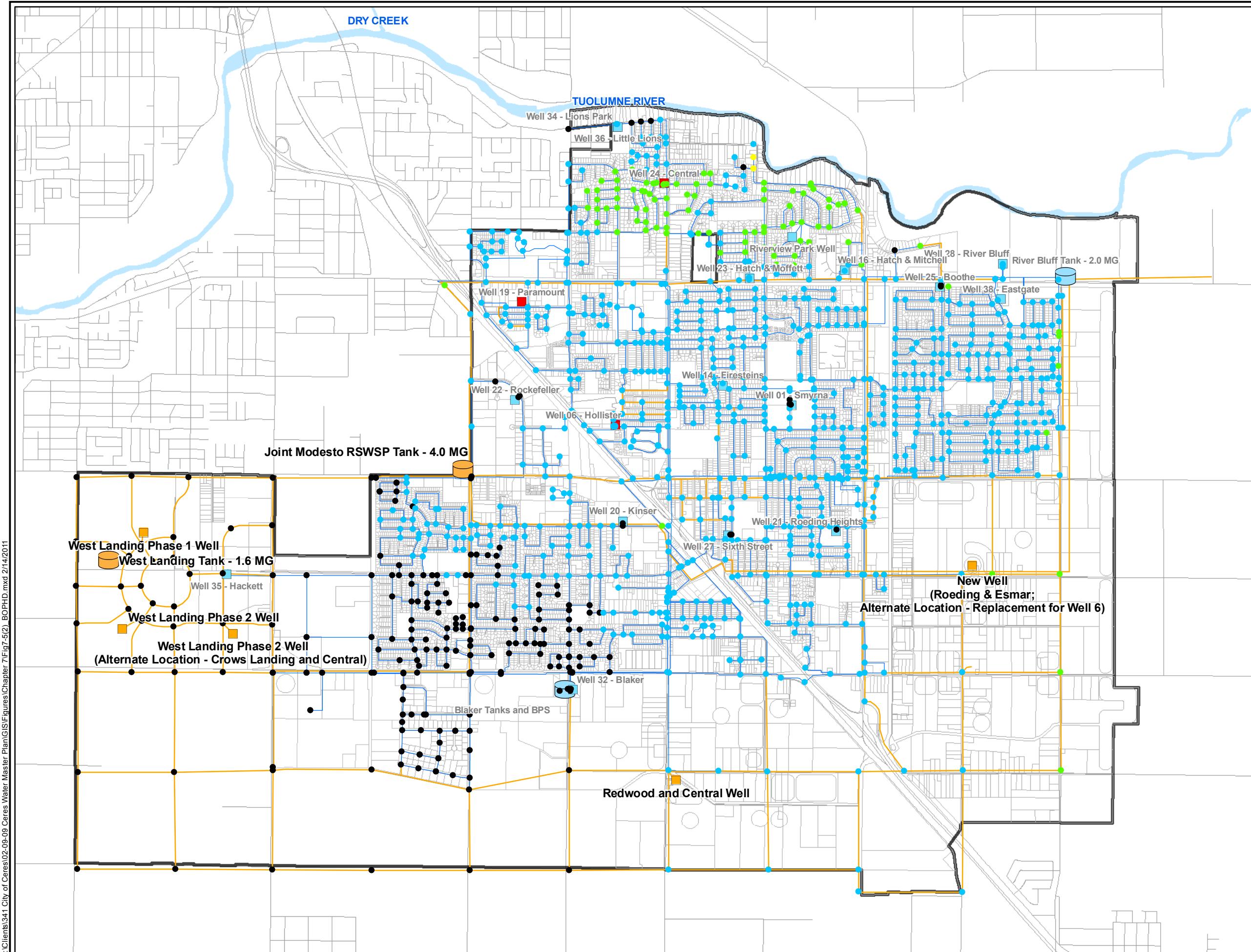
1. Buildout Maximum Day Demand = 31.7 mgd.
2. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.
3. RSWSP = 6mgd; Well supply = 25.7 mgd.
4. Facilities recommended in the Existing System Analysis are shown as existing facilities.

**LEGEND**

- Water Master Plan Study Area
- Parcel
- Street
- Existing Pipeline
- Future Pipeline
- Existing Well
- Inactive Well
- Future Well
- Existing Scenario Recommended Facility
- Future Tank and Pump Station
- 40 psi  $\leq$  Pressure  $<$  45 psi
- 45 psi  $\leq$  Pressure  $<$  50 psi
- 50 psi  $\leq$  Pressure  $<$  55 psi
- Pressure  $\geq$  55 psi



WEST YOST  
ASSOCIATES  
Consulting Engineers



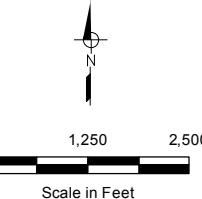


## FIGURE 7-6

# **City of Ceres Water Master Plan**

# BUILDOUT SYSTEM COMPARISON OF AVAILABLE AND REQUIRED FIRE FLOW WITH RECOMMENDED IMPROVEMENTS

Buildout Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



tes  
Buildout Maximum Day Demand = 31.7 mgd.  
Fire flow requirements of 2750 gpm and 3500 gpm assume  
sprinkler system installed.  
RSWSP = 6mgd; Well supply = 25.7 mgd.  
Facilities recommended in the Existing System Analysis  
are shown as existing facilities.

## LEGEND

**LEGEND**

- Water Master Plan Study Area
- Street
- Existing Pipeline
- Future Pipeline
- Existing Well
- Inactive Well
- Future Well
- Existing Tank and Pump Station
- Future Tank and Pump Station
- Area Served by City of Modesto
- Fire Flow Requirement = 1,500 gpm
- Fire Flow Requirement = 2,000 gpm
- Fire Flow Requirement = 2,750 gpm
- Fire Flow Requirement = 3,500 gpm
- Available fire flow is less than required fire flow
- Available fire flow is greater than required fire flow





FIGURE 7-7

**City of Ceres  
Water Master Plan**

**BUILDOUT SYSTEM  
AVAILABLE FIRE FLOW**

Buildout Maximum Day Demand  
Plus Fire Flow Scenario,  
Residual Pressure = 20 psi



0 1,125 2,250  
Scale in Feet

Notes

1. Buildout Maximum Day Demand = 31.7 mgd.
2. Fire flow requirements of 2750 gpm and 3500 gpm assume sprinkler system installed.
3. RSWSP = 6mgd; Well supply = 25.7 mgd.
4. Future facilities recommended in the Existing System Analysis are shown as existing facilities.

**LEGEND**

- Water Master Plan Study Area
- Parcel
- Street
- Existing Well
- Inactive Well
- Future Well
- Existing Tank and Pump Station
- Future Tank and Pump Station
- Existing Pipeline
- Future Pipeline
- Flow < 1,500 gpm
- 1,500 gpm ≤ Flow < 2,500 gpm
- 2,500 gpm ≤ Flow < 3,000 gpm
- 3,000 gpm ≤ Flow < 3,500 gpm
- 3,500 gpm ≤ Flow < 4,000 gpm
- Flow ≥ 4,000 gpm





## FIGURE 7-8

# City of Ceres Water Master Plan

# **FUTURE WATER SYSTEM RECOMMENDED IMPROVEMENTS TO SERVE BUILDOUT AND 2015**

**Add standby generator at wells with a total capacity of 5,500 gpm (6 wells assumed)**

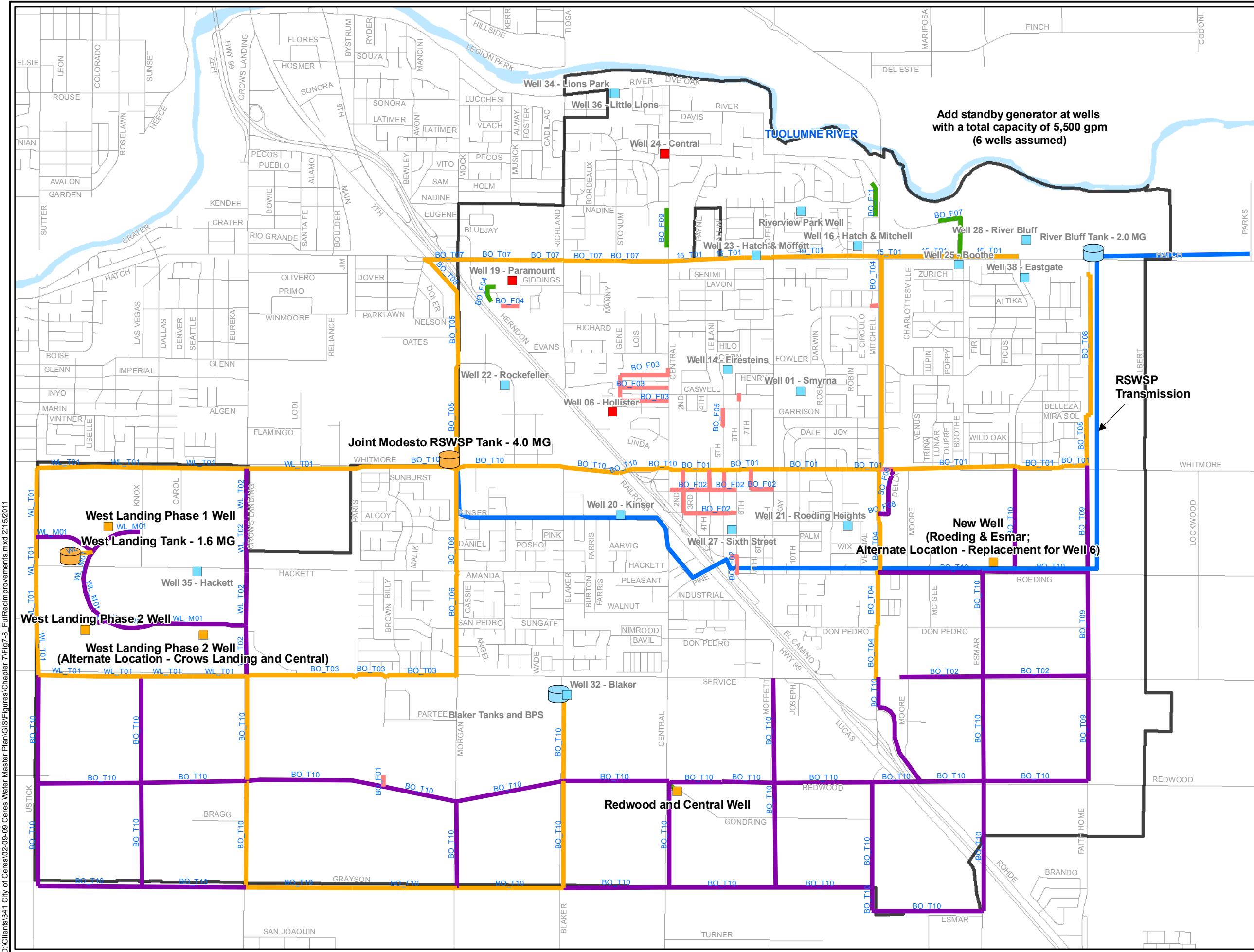
1,125 2,250

## NOTES

1. Future facilities recommended in the Existing System Analysis are shown as existing facilities.
2. All improvements are included in the buildout timeframe except for Project 15-T01, new transmission on Hatch Road.

RSWSP  
Transmission  
LIBERT

# New Well Boeding & Esmar; Section - Replacement for Well 6



The logo for West Yost Associates Consulting Engineers. It features the company name in a serif font above a stylized graphic of three green overlapping waves. Below the waves, the word 'ASSOCIATES' is written in a bold, sans-serif font, and underneath that, 'Consulting Engineers' is written in a smaller, italicized, sans-serif font.

## CHAPTER 8

# Recommended Capital Improvement Program

---



### 8.1 OVERVIEW

This chapter presents the recommended CIP for the City's existing and future water system to support water supply and distribution system needs through buildout of the General Plan. Recommendations for improvements to the existing and future potable water system were described previously in Chapters 6 and 7, respectively. It should be noted that the recommended CIP only identifies improvements at a master plan level and does not constitute a design of such improvements. Subsequent detailed design is required to determine the exact sizes and locations of these proposed improvements. The Master Plan also identifies improvements at a larger scale consistent with major streets within the City. As specific developments are implemented in the future, detailed improvements will need to be identified and evaluated as part of the development approval process.

This chapter provides a summary of the recommended capital improvement projects, along with estimates of probable construction costs. Probable construction cost estimates are developed individually for each proposed improvement project. An Engineer's Report is being prepared as part of this Water Master Plan, which will allocate costs to existing rate payers and new development based on the need for the proposed improvement. That document is included in the Water Master Plan as Appendix E. A financial analysis will also be performed to evaluate the potential impacts of the Water Master Plan improvements on existing customer rates.

Construction costs are presented in December 2010 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 8952 (20-City Average). Construction costs were developed based on bids on other water facilities design projects and from standard cost estimating guides. The total CIP cost includes mark-ups equal to 60 percent of the estimated base construction costs to allow for design, permitting, regulatory compliance, CEQA, construction management, program implementation, and project construction contingency as listed below:

- Project Construction Contingency: 25 percent
- Design: 10 percent
- Permitting, Regulatory Compliance, CEQA: 10 percent
- Construction Management: 10 percent
- Program Implementation: 5 percent

For this Water Master Plan, it is assumed that developers will dedicate land for the buildout of required facilities or facilities will be developed on public property; therefore, land acquisition costs have not been included. In addition, the proposed construction costs do not include costs for annual operation and maintenance. A complete description of the assumptions used in the development of the estimated probable construction costs is provided in Appendix F.



The following sections of this chapter describe the components of the potable water system capital improvement program developed for this Water Master Plan:

- Recommended Water System Capital Improvement Program
  - Water Supply Improvements
  - Water Distribution System Improvements
- Capital Improvement Program Implementation

#### **8.2 RECOMMENDED POTABLE WATER SYSTEM CAPITAL IMPROVEMENT PROGRAM**

Recommended water system capital improvement projects include water supply improvements and water distribution improvements. Water supply and distribution improvements, shown in Table 8-1, will help the City eliminate existing system deficiencies and support projected future water demands.

##### **8.2.1 Water Supply Improvements**

This section presents summaries of the recommended water supply improvements for the existing and future potable water system. Preliminary capital cost estimates for the recommended existing and future potable water system improvements are presented in *Section 8.2.3 Recommended Potable Water System CIP Costs*.

Chapter 4 provides a summary of the evaluation of the City's existing and future water supply. Based on water supply evaluation for the existing system, the following water supply improvements are recommended:

###### **8.2.1.1 Existing Water Supply Improvements**

- Wells
  - Install two new wells to provide additional pumping capacity to meet existing demand, as shown on Figure 8-1. One of these new wells is a replacement well for Well 1, which is close to the end of its design useful life.
  - Replace existing wells as they reach the end of their useful lives. It is estimated that 11 replacement wells will be needed through buildout of the Water Master Plan. The average production for new wells is assumed to be 900 gpm. Replacement wells are assumed to all have backup generators to meet emergency needs. Nine wells are included in the line item budget shown in Table 8-1. Well 1 and Well 6 replacements are budgeted separately.
  - Provide wellhead treatment for replacement wells, as needed. Six wells are assumed to require treatment using oxidation/filtration treatment.
- Backup Power
  - Install backup power at wells with a total capacity of 2,200 gpm (three wells assumed for budgeting purposes), to improve supply reliability during power outage emergencies.

Table 8-1. Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP<sup>(a,b)</sup>

Improvement Type	Improvement Description	CIP ID	Quantity	Estimated Construction Cost	Capital Cost (includes mark-ups) <sup>(c,d)</sup>
<b>Supply Improvements</b>					
<b>Existing Time Frame</b>					
Well	Install replacement for Well 1	EX_SU01	1	LS	(e)
Well	Install new well on north side of City (assumed at Riverview Park)	EX_SU02	1	LS	750,000
Backup Power	Install standby generator at wells with a total capacity of 2,200 gpm (3 wells assumed)	EX_SU03	3	LS	600,000
Well <sup>(f)</sup>	Install replacement wells as existing wells are retired	EX_SU04	9	LS	6,750,000
Well	Wellhead treatment for replacement wells (assumes oxidation/filtration treatment)	EX_SU05	6	LS	6,000,000
				<b>Subtotal</b>	\$ 22,560,000
<b>Buildout Time Frame</b>					
Well <sup>(f,g)</sup>	Install new well near Redwood Avenue and Central Avenue with ASR capability	BO_SU01	1	LS	937,500
Well <sup>(f,g)</sup>	Install new well near Roeding Road and Esmar Road with ASR capability (alternate location - Well 6 replacement)	BO_SU02	1	LS	937,500
Well <sup>(h)</sup>	Install 2 new wells in the West Landing Specific Plan Area	BO_SU03	2	LS	1,500,000
Well	Wellhead treatment for new wells (assumes ion exchange treatment)	BO_SU04	2	LS	5,600,000
Backup Power	Install standby generator at wells with a total capacity of 5,500 gpm (6 wells assumed)	BO_SU05	6	LS	1,200,000
Surface Water <sup>(i)</sup>	Participation in Phase I Regional Surface Water Supply Project	BO_SU06	1	LS	--
				<b>Subtotal</b>	\$ 67,680,000
				<b>Total, Supply Improvements</b>	\$ 90,240,000
<b>Distribution System Improvements</b>					
<b>Existing Time Frame</b>					
Pipeline	Install 8-inch dia. pipes along Herndon Road, west of Grand View Avenue	EX_F01	400	If	60,000
Pipeline	Install 10-inch dia. pipes along Pine Street, east of Central Avenue	EX_F02	100	If	17,000
Pipeline	Install 10-inch dia. pipes along Whitmore Avenue, between Louise Avenue and Charlotte Avenue	EX_F03	100	If	17,000
Pipeline	Install 12-inch dia. pipes along Kinser Road, west of Central Avenue	EX_F04	200	If	40,000
Pipeline	Install 8-inch dia. pipes along Paramount Avenue, south of Giddings Street	EX_F05	100	If	15,000
Pipeline	Install 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	10,600	If	2,756,000
Jack and Bore <sup>(j)</sup>	Jack and bore 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	600	If	324,000
Pipeline	Install 16-inch dia. pipes along Hatch Road between Eastgate Boulevard and Faith Home Road	EX_T02	2,400	If	624,000
Pipeline	Install 12-inch dia. pipes along Faith Home Road, south of Helen Perry Road	EX_T03	200	If	40,000
Pipeline	Install 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	78,000
Jack and Bore <sup>(j)</sup>	Jack and bore 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	If	162,000
Pipeline	Install 12-inch dia. pipes along Fiddleleaf Lane between Hatch Road and Bougainvillea Drive	EX_PH02	600	If	120,000
Main Replacement Program	Replace 2-inch, 3-inch, and 4-inch diameter pipes with 8-inch diameter pipes	EX_F06	34,000	If	5,100,000
Water System Maintenance and Repair Program	Repair & maintenance of water valves, fire hydrants, pumping station piping, and other facilities	EX_DS01	1	LS	--
Large Meter Replacement Program	Changeout of large meters based on age most recent testing data	EX_DS02	1	LS	--
Storage	Construct new 2.0 MG storage reservoir	EX_S01	1	LS	2,300,000
Pump Station	Construct 4200 gpm booster pump station for new 2.0 MG storage reservoir	EX_S01	1	LS	1,700,000
				<b>Subtotal</b>	\$ 29,364,000
<b>2015 Time Frame</b>					
Pipeline	Install 16-inch dia. pipes along Hatch Road between Central Avenue and Faith Home Road	15_T01	9,000	If	2,340,000
				<b>Subtotal</b>	\$ 3,744,000
<b>Buildout Time Frame</b>					
Pipeline	Install 8-inch dia. pipes along Farm Supply Drive and Marchy Lane	BO_F01	300	If	45,000
Pipeline	Install 8-inch dia. pipes in Downtown Area	BO_F02	6,900	If	1,035,000
Pipeline	Install 8-inch dia. pipes along Darrah Street, Sequoia Street, Memorial Drive	BO_F03	4,300	If	645,000
Pipeline	Install 8-inch dia. pipes along Grand View Avenue, Belmont Avenue	BO_F04	1,100	If	165,000
Pipeline	Install 8-inch dia. pipes along Fifth Street	BO_F05	500	If	75,000
Pipeline	Install 8-inch dia. pipes along Sixth Street	BO_F06	200	If	30,000
Pipeline	Install 10-inch dia. pipes along Golf Links Drive	BO_F07	1,600	If	272,000
Pipeline	Install 12-inch dia. pipes along Colleen Drive, Della Drive	BO_F08	1,400	If	280,000



**Table 8-1. Summary of Probable Construction Costs by Improvement for the Recommended Existing and Future Potable Water System CIP<sup>(a,b)</sup>**

Improvement Type	Improvement Description	CIP ID	Quantity		Estimated Construction Cost	Capital Cost (includes mark-ups) <sup>(c,d)</sup>
Pipeline	Install 10-inch dia. pipes along Central Avenue, north of Hatch Road	BO_F09	1,000	lf	170,000	272,000
Pipeline	Install 8-inch dia. pipes along Rosewood Avenue	BO_F10	200	lf	30,000	48,000
Pipeline	Install 10-inch dia. pipes along Mitchell Road north of Hatch Road	BO_F11	900	lf	153,000	245,000
Pipeline	Install 16-inch dia. pipes along Whitmore Avenue, Central Avenue to Faith Home Road	BO_T01	10,600	lf	2,756,000	4,410,000
Pipeline	Install 12-inch dia. pipes along Service Road between Mitchell Road and Faith Home Road	BO_T02	4,700	lf	940,000	1,504,000
Pipeline	Install 16-inch dia. pipes along Service Road between Crows Landing Road and Morgan Road	BO_T03	5,400	lf	1,404,000	2,246,000
Pipeline	Install 16-inch dia. pipes along Mitchell Road between Hatch Road and Service Road	BO_T04	10,900	lf	2,834,000	4,534,000
Pipeline	Install 16-inch dia. pipes along Morgan Road between Hatch Road and Whitmore Avenue	BO_T05	5,500	lf	1,430,000	2,288,000
Pipeline	Install 16-inch dia. pipes along Morgan Road between Whitmore Avenue and Kinser Road	BO_T06	5,300	lf	1,378,000	2,205,000
Pipeline	Install 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	6,200	lf	1,612,000	2,579,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	300	lf	162,000	259,000
Pipeline	Install 16-inch dia. pipes along Faith Home Road between Hatch Road and Whitmore Avenue	BO_T08	5,100	lf	1,326,000	2,122,000
Pipeline	Install 12-inch dia. pipes along Faith Home Road between Whitmore Avenue and Redwood Avenue	BO_T09	8,000	lf	1,600,000	2,560,000
Pipeline	Install 16-inch dia. pipes at various locations (New Transmission)	BO_T10A	26,200	lf	6,812,000	10,899,000
Jack and Bore <sup>(i)</sup>	Jack and bore 16-inch dia. pipes at various locations (New Transmission)	BO_T10A	300	lf	162,000	259,000
Pipeline	Install 12-inch dia. pipes at various locations (New Transmission)	BO_T10B <sup>(k)</sup>	86,000	lf	12,900,000	20,640,000
Jack and Bore <sup>(i)</sup>	Jack and bore 12-inch dia. pipes at various locations (New Transmission)	BO_T10B <sup>(k)</sup>	900	lf	423,000	677,000
Pipeline	Install 16-inch dia. pipes to serve West Landing Specific Plan Area (New Transmission)	WL-T01	18,800	lf	4,888,000	7,821,000
Pipeline	Install 12-inch dia. pipes to serve West Landing Specific Plan Area (New Transmission)	WL-T02	5,200	lf	1,040,000	1,664,000
Pipeline	Install 12-inch dia. pipes along Upsize Proposed Mains for West Landing Specific Plan Area	WL-M01	6,700	lf	1,340,000	<sup>(l)</sup>
Storage	Construct a new 4.0 MG storage reservoir at Whitmore Avenue and Morgan Road Site	BO_S01	1	LS	<sup>(m)</sup>	<sup>(m)</sup>
Pump Station	Construct booster pump station for new 4.0 MG storage reservoir	BO_S01	1	LS	<sup>(n)</sup>	<sup>(n)</sup>
Storage	Construct a new 1.6 MG storage reservoir for the West Landing Project	BO_S02	1	LS	2,819,000	4,510,000
Pump Station	Construct 3300 gpm booster pump station for new 1.6 MG storage reservoir	BO_S02	1	LS	1,562,000	2,499,000
					<b>Subtotal</b>	\$ 78,316,000
					<b>Total, Distribution Improvements</b>	\$ 111,424,000
					<b>GRAND TOTAL</b>	\$ 201,664,000

<sup>(a)</sup> Costs shown are presented in December 2010 dollars based on an ENR CCI of 8952 (20-City Average).

<sup>(b)</sup> Costs do not include land acquisition costs. It is assumed that land for buildout facilities will be dedicated by the developer(s) or constructed on land already owned by the City.

<sup>(c)</sup> Costs include mark-ups equal to 60 percent (Design: 10 percent; Permitting, Regulatory, CEQA: 10 percent; Construction Management: 10 percent; Program Implementation: 5 percent; and Project Construction Contingency: 25 percent).

<sup>(d)</sup> Total rounded to nearest \$1,000.

<sup>(e)</sup> No dollar amount is shown because this project has already been funded in the FY 2009/10 CIP.

<sup>(f)</sup> Eleven replacement wells are assumed in the Master Plan time frame, including two planned wells - replacement for Well 1, and new well at Roeding/Esmar with alternate location at Well 6. These two wells are budgeted under a separate budget line item. Nine wells are budgeted under the replacement category.

<sup>(g)</sup> Costs are increased by 25 percent to include provision for ASR.

<sup>(h)</sup> Costs for a third well, reserved as a standby well in the West Landing Specific Plan Area, is not included, since this standby well is assumed to be funded by the developer as an in-tract improvement.

<sup>(i)</sup> RSWSP costs for the City of Ceres share of regional treatment and transmission facilities were estimated by project proponents as \$49M in April 2009 dollars. Costs are assumed to be capital costs and are escalated to December 2010 \$.

<sup>(j)</sup> Jack and bore costs are for casing pipe only, and do not include conductor pipe, which is included in pipe totals.

<sup>(k)</sup> The Public Facilities Fee (PFF) report designates 79,500 feet of 12-inch diameter transmission with a capital cost of \$8.3M at miscellaneous locations not specifically identified. The Master Plan includes 112,000 feet of new transmission pipelines (86,000 feet of 12-inch and 26,000 feet of 16-inch) in locations not specifically identified in the PFF. The Master Plan includes transmission grid in secondary sphere-of-influence areas not considered in the PFF report. 12-inch diameter lines under project BO\_T10B use undeveloped area pipeline costs.

<sup>(l)</sup> These 12-inch lines are assumed to be in-tract improvements paid for by the developer, and not funded by developer impact fees.

<sup>(m)</sup> Storage cost is included in the RSWSP cost estimate listed in Supply Improvements.

<sup>(n)</sup> Pump station cost is included in the RSWSP cost estimate listed in Supply Improvements.



#### 8.2.1.2 Future Water Supply Improvements

##### *8.2.1.2.1 2015 Time Frame*

- No improvements identified

##### *8.2.1.2.2 Buildout Time Frame*

- Wells
  - Install two new wells to meet future distribution system needs. One new well is assumed to be in the general area of Roeding Road and Esmar Road, or a replacement well at Well 6, as an alternate location, and the other is assumed to be in the general area of Redwood Avenue and Central Avenue. These well recommendations also assume that two new duty wells (three wells total, with one reserved as a standby) will be constructed for the West Landing project. The locations of the new wells are shown in Figure 8-2. New wells are assumed to have backup generators.
  - Provide wellhead treatment for two of the new wells. Ion exchange treatment is assumed.
- Supply
  - Participate in Phase 1 of the RSWSP, with a planned delivery rate of 6 mgd.

#### **8.2.2 Water Distribution System Improvements**

This section summarizes the recommended water distribution system improvements for the existing and future potable water system. Preliminary capital cost estimates for the recommended existing and future potable water system improvements are presented in *Section 8.2.3 Recommended Potable Water System CIP Costs*.

#### 8.2.2.1 Existing Water Distribution System Improvements

Chapter 6 provides a summary of the evaluation of the City's existing potable water system and its ability to meet the recommended water system operational and design criteria described in Chapter 5. Based on the existing potable water system evaluation, improvements are recommended to eliminate existing system deficiencies, as listed in the following sections.

- Pipeline Improvements
  - Install approximately 300 feet of new 16-inch diameter pipeline underneath Highway 99 to connect the existing 10-inch diameter pipelines on Hil-Mor Drive to the existing 10-inch diameter pipelines on Richland Avenue.
  - Install approximately 600 feet of new 12-inch diameter pipeline along Fiddleleaf Lane, between Hatch Road and Bougainvillea Drive to eliminate high head loss and velocity during peak hour conditions.



- Install approximately 10,600 feet of new 16-inch diameter pipeline along Central Avenue, from Service Road to Hatch Road, to improve transmission capacity from Blaker Tanks to the north part of the system. This pipeline is included in the PFF report as a 12-inch diameter pipeline, but should be upgraded to a 16-inch diameter.
- Install approximately 2,400 feet of new 16-inch diameter transmission on Hatch Road, between Eastgate Boulevard and Faith Home Road to reinforce backbone transmission from the proposed River Bluff Reservoir.
- Install approximately 200 feet of new 12-inch diameter transmission on Faith Home Road to reinforce the system grid.
- Install approximately 900 feet of new main to improve fire flow capacity and to increase looping.
- Main Replacement Program
  - Replace 34,000 feet of 2-inch, 3-inch, and 4-inch diameter pipeline with 8-inch diameter pipeline.
- Storage and Booster Pump Station
  - Construct a new 2.0 MG storage reservoir (River Bluff Reservoir) on Hatch Road, between Faith Home Road and Gilbert Road, and an associated 4,200 gpm booster pump station.
- Provide regular funding for two long-term programs, the Water System Maintenance and Repair Program for repair and maintenance of water valves, fire hydrants, pumping station piping and other facilities, and the Large Meter Replacement Program to replace large meters, as needed, due to age.

The locations of the recommended existing potable water distribution system improvement projects are shown on Figure 8-1.

#### 8.2.2.2 Future Water Distribution System Improvements

Chapter 7 provides a summary of the evaluation of the City's future potable water system and its ability to meet the recommended water system operational and design criteria described in Chapter 5. Based on the buildup potable water system evaluation, backbone water system improvements, fire flow improvements, and peak hour improvements, are recommended to meet projected future potable water demands, as listed in the following section.

- Pipeline Improvements

##### *2015 Time Frame*

- Install approximately 9,000 feet of new 16-inch diameter transmission on Hatch Road and Faith Home Road, as shown in Figure 8-2, to reinforce backbone transmission from the proposed River Bluff Reservoir.



#### *Buildout Time Frame*

- Install approximately 18,000 feet of new and replacement main to improve fire flows.
- Install approximately 174,000 feet of new transmission to reinforce the system grid.
- Install approximately 24,000 feet of new transmission to serve the West Landing Specific Plan area. New transmission main will be located on Whitmore Avenue, Ustick Road, Service Road and Crow's Landing Road.
- Upsize 6,700 feet of planned subdivision piping from 8-inch to 12-inch for West Landing Specific Plan area in the vicinity of the proposed West Landing tank. These pipelines are assumed to be developer in-tract improvements and the costs are not included in the capital improvement program.
- Storage and Booster Pump Station

#### *Buildout Timeframe*

- Construct a new 4.0 MG storage reservoir and an associated booster pump station, at the site owned jointly with City of Modesto, at Whitmore Avenue and Morgan Road.
- Construct a new 1.6 MG storage reservoir and associated booster pump station for the West Landing Project.

The locations of the recommended 2015 and buildout potable water distribution system improvement projects are shown on Figure 8-2. Improvements shown for the Existing, 2015 and buildout timeframes are required for the City to have sufficient supply reliability and maintain adequate pressures for its customers.

#### **8.2.3 Recommended Potable Water System CIP Costs**

Preliminary capital cost estimates for the recommended existing and future water system improvements are presented in Table 8-1. The total preliminary cost of potable water system improvements to support the City's existing and future potable water demands is estimated to be approximately \$201.7 million. As shown, the water supply improvements CIP cost is estimated to be \$22.6 million for the existing water system and \$67.7 million for the buildout water system. The water distribution system improvements CIP cost is estimated to be \$29.4 million for existing water system, \$3.7 million for the 2015 water system, and \$78.3 million for the buildout water system.

As discussed previously, an analysis to evaluate the cost allocation to existing and future customers is included as Appendix E.



#### 8.3 CAPITAL IMPROVEMENT PROGRAM IMPLEMENTATION

Table 8-2 presents a recommended implementation schedule for capital improvements, showing capital expenditures by year through 2015, over the 2016 through 2020 time frame, and long-term. Projects are placed on the schedule based on their priority.

Highest priority projects for implementation include the three planned wells, and the Central Avenue pipeline improvements to increase hydraulic capacity out of Blaker Tanks. These projects are followed by storage in the River Bluff area, and associated transmission improvements. For the major transmission and storage improvements, costs are shown over two years, with 10 percent of the expenditure for design occurring in year 1, and the remaining cost in year 2.

For implementation of the RSWSP, expenditures equal to 15 percent of the construction cost were assumed from 2012 through 2015 (3 percent in 3 years, 6 percent in 2015) to complete studies, environmental, permitting and design and other approvals, and construction is assumed to be completed in the 2016-2020 time frame.

The recommended distribution system programs (pipeline renewal and replacement program, maintenance and repair program, and large meter replacement program) are assumed to be funded over a 40-year period, with annual expenditures of \$200,000, \$100,000 and \$100,000 respectively.

The construction of the capital improvements for the future potable water system should be coordinated with the proposed schedules of new development to ensure that the required infrastructure will be in place and operational to serve future customers. If the future improvements are based on addressing deficiency in fire flows, emergency storage, or reliability issues, they should be the City's and developers' first priority.

Table 8-2. Recommended Implementation Schedule for Improvements in the Master Plan CIP

Improvement Type	Improvement Description	CIP ID	Quantity	Capital Cost	Recommended Implementation Timeframe								
					FY 2011/12	FY 2012/13	FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17 - FY 2020/21			
<b>Supply Improvements</b>													
Well	Install replacement for Well 1	EX_SU01	1	LS	(a)	(a)							
Well	Install new well on north side of City (assumed at Riverview Park)	EX_SU02	1	LS	\$ 1.2		\$ 1.2						
Backup Power	Install standby generator at wells with a total capacity of 2,200 gpm (3 wells assumed)	EX_SU04	3	LS	\$ 1.0	\$ 0.5	\$ 0.5						
Well	Install replacement wells as existing wells are retired <sup>(b)</sup>	EX_SU06	9	LS	\$ 10.8			1.2		\$ 4.8			
Well	Wellhead treatment for replacement wells (assumes oxidation/filtration treatment)	EX_SU07	6	LS	\$ 9.6					\$ 9.6			
Well	Install new well near Redwood Avenue and Central Avenue	BO_SU01	1	LS	\$ 1.5					\$ 1.5			
Well	Install new well near Roeding Road and Esmar Road (alternate location - Well 6 replacement)	BO_SU02	1	LS	\$ 1.5	\$ 1.5							
Well	Install 3 new wells in the West Landing Specific Plan Area <sup>(c)</sup>	BO_SU03	2	LS	\$ 2.4			\$ 0.2	\$ 2.2				
Well	Wellhead treatment for new wells (assumes ion exchange treatment)	BO_SU04	2	LS	\$ 9.0			\$ 3.0		\$ 6.0			
Backup Power	Install standby generator at wells with a total capacity of 5,500 gpm (6 wells assumed)	BO_SU05	6	LS	\$ 1.9					\$ 1.9			
Surface Water	Participation in Phase I Regional Surface Water Supply Project	BO_SU06	1	LS	\$ 51.4	\$ 1.5	\$ 1.5	\$ 1.5	\$ 3.1	\$ 43.7			
					<b>TOTAL</b>	<b>\$ 90.2</b>	<b>\$ 0.5</b>	<b>\$ 4.7</b>	<b>\$ 3.0</b>	<b>\$ 6.7</b>	<b>\$ 3.1</b>	<b>\$ 48.5</b>	<b>\$ 23.8</b>
<b>Distribution System Improvements</b>													
Pipeline	Install 8-inch dia. pipes along Herndon Road, west of Grand View Avenue	EX_F01	400	lf	\$ 0.1			\$ 0.10					
Pipeline	Install 10-inch dia. pipes along Pine Street, east of Central Avenue	EX_F02	100	lf	\$ 0.0			\$ 0.03					
Pipeline	Install 10-inch dia. pipes along Whitmore Avenue, between Louise Avenue and Charlotte Avenue	EX_F03	100	lf	\$ 0.0			\$ 0.03					
Pipeline	Install 12-inch dia. pipes along Kinser Road, west of Central Avenue	EX_F04	200	lf	\$ 0.1			\$ 0.06					
Pipeline	Install 8-inch dia. pipes along Paramount Avenue, south of Giddings Street	EX_F05	100	lf	\$ 0.0			\$ 0.02					
Pipeline	Install 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	10,600	lf	\$ 4.4	0.44	\$ 3.97						
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Central Avenue, between Hatch Road and Service Road	EX_T01	600	lf	\$ 0.5	0.05	\$ 0.47						
Pipeline	Install 16-inch dia. pipes along Hatch Road between Eastgate Boulevard and Faith Home Road	EX_T02	2,400	lf	\$ 1.0			\$ 0.1	\$ 0.9				
Pipeline	Install 12-inch dia. pipes along Faith Home Road, south of Helen Perry Road	EX_T03	200	lf	\$ 0.1			\$ 0.1					
Pipeline	Install 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	lf	\$ 0.1			\$ 0.1					
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Herndon Road, south of Memorial Drive	EX_PH01	300	lf	\$ 0.3			\$ 0.3					
Pipeline	Install 12-inch dia. pipes along Fiddleleaf Lane between Hatch Road and Bougainvillea Drive	EX_PH02	600	lf	\$ 0.2			\$ 0.2					
Main Replacement Program	Replace 2-inch, 3-inch, and 4-inch diameter pipes with 8-inch diameter pipes	EX_F06	34,000	lf	\$ 8.2	\$ 0.20	\$ 0.20	\$ 0.20	\$ 0.20	\$ 0.2	\$ 1.0	\$ 6.1	
Maintenance and Repair Program	Repair & maintenance of water system facilities including but not limited to: main water valves, fire hydrants, pumping station piping	EX_DS01	1	LS	\$ 4.0	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.5	\$ 3.0	
Large Meter Replacement Program	The City currently has 443 meters that are 1 1/2" and larger. Changeouts will be based on age most recent testing data	EX_DS02	1	LS	\$ 4.0	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.10	\$ 0.5	\$ 3.0	
Storage	Construct new 2.0 MG storage reservoir	EX_S01	1	LS	\$ 3.7			\$ 0.4	\$ 3.3				
Pump Station	Construct 4200 gpm booster pump station for new 2.0 MG storage reservoir	EX_S01	1	LS	\$ 2.7			\$ 0.3	\$ 2.4				
Pipeline	Install 16-inch dia. pipes along Hatch Road between Central Avenue and Faith Home Road	15_T01	9,000	lf	\$ 3.7						\$ 3.7		
Pipeline	Install 8-inch dia. pipes along Farm Supply Drive and Marchy Lane	BO_F01	300	lf	\$ 0.1						\$ 0.1		
Pipeline	Install 8-inch dia. pipes in Downtown Area	BO_F02	6,900	lf	\$ 1.7						\$ 1.7		
Pipeline	Install 8-inch dia. pipes along Darrah Street, Sequoia Street, Memorial Drive	BO_F03	4,300	lf	\$ 1.0						\$ 1.0		
Pipeline	Install 8-inch dia. pipes along Grand View Avenue, Belmont Avenue	BO_F04	1,100	lf	\$ 0.3						\$ 0.3		
Pipeline	Install 8-inch dia. pipes along Fifth Street	BO_F05	500	lf	\$ 0.1						\$ 0.1		
Pipeline	Install 8-inch dia. pipes along Sixth Street	BO_F06	200	lf	\$ 0.0						\$ 0.0		
Pipeline	Install 10-inch dia. pipes along Golf Links Drive	BO_F07	1,600	lf	\$ 0.4						\$ 0.4		
Pipeline	Install 12-inch dia. pipes along Colleen Drive, Della Drive	BO_F08	1,400	lf	\$ 0.4						\$ 0.4		
Pipeline	Install 10-inch dia. pipes along Central Avenue, north of Hatch Road	BO_F09	1,000	lf	\$ 0.3						\$ 0.3		
Pipeline	Install 8-inch dia. pipes along Rosewood Avenue	BO_F10	200	lf	\$ 0.0						\$ 0.0		
Pipeline	Install 10-inch dia. pipes along Mitchell Road north of Hatch Road	BO_F11	900	lf	\$ 0.2						\$ 0.2		
Pipeline	Install 16-inch dia. pipes along Whitmore Avenue, Central Avenue to Faith Home Road	BO_T01	10,600	lf	\$ 4.4						\$ 4.4		
Pipeline	Install 12-inch dia. pipes along Service Road between Mitchell Road and Faith Home Road	BO_T02	4,700	lf	\$ 1.5						\$ 1.5		
Pipeline	Install 16-inch dia. pipes along Service Road between Crows Landing Road and Morgan Road	BO_T03	5,400	lf	\$ 2.2						\$ 2.2		



Table 8-2. Recommended Implementation Schedule for Improvements in the Master Plan CIP

Improvement Type	Improvement Description	CIP ID	Quantity		Capital Cost	Recommended Implementation Timeframe						
			FY 2011/12	FY 2012/13		FY 2013/14	FY 2014/15	FY 2015/16	FY 2016/17 - FY 2020/21	Long-term		
Pipeline	Install 16-inch dia. pipes along Mitchell Road between Hatch Road and Service Road	BO_T04	10,900	lf	\$ 4.5					\$ 4.5		
Pipeline	Install 16-inch dia. pipes along Morgan Road between Hatch Road and Whitmore Avenue	BO_T05	5,500	lf	\$ 2.3					\$ 2.3		
Pipeline	Install 16-inch dia. pipes along Morgan Road between Whitmore Avenue and Kinser Road	BO_T06	5,300	lf	\$ 2.2					\$ 2.2		
Pipeline	Install 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	6,200	lf	\$ 2.6					\$ 2.6		
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia. pipes along Hatch Road between Morgan Road and Central Avenue	BO_T07	300	lf	\$ 0.3					\$ 0.3		
Pipeline	Install 16-inch dia. pipes along Faith Home Road between Hatch Road and Whitmore Avenue	BO_T08	5,100	lf	\$ 2.1					\$ 2.1		
Pipeline	Install 12-inch dia. pipes along Faith Home Road between Whitmore Avenue and Redwood Avenue	BO_T09	8,000	lf	\$ 2.6					\$ 2.6		
Pipeline	Install 16-inch dia pipes at various locations (New Transmission)	BO_T10A	26,200	lf	\$ 10.9					\$ 2.20		
Jack and Bore <sup>(d)</sup>	Jack and bore 16-inch dia pipes at various locations (New Transmission)	BO_T10A	300	lf	\$ 0.3					\$ 0.3		
Pipeline	Install 12-inch dia pipes at various locations (New Transmission)	BO_T10B	86,000	lf	\$ 20.6					\$ 20.6		
Jack and Bore <sup>(d)</sup>	Jack and bore 12-inch dia pipes at various locations (New Transmission)	BO_T10B	900	lf	\$ 0.7					\$ 0.7		
Pipeline	Install 16-inch dia. pipes along New Transmission to serve West Landing Specific Plan Area	WL-T01	18,800	lf	\$ 7.8					\$ 7.8		
Pipeline	Install 12-inch dia. pipes along New Transmission to serve West Landing Specific Plan Area	WL-T02	5,200	lf	\$ 1.7					\$ 1.7		
Pipeline	Install 12-inch dia. pipes along Upsize Proposed Mains for West Landing Specific Plan Area	WL-M01	6,700	lf	(e)					(e)		
Storage	Construct a new 4.0 MG storage reservoir at Whitmore Avenue and Morgan Road Site	BO_S01	1	LS	(f)					(f)		
Pump Station	Construct booster pump station for new 4.0 MG storage reservoir	BO_S01	1	LS	(g)					(g)		
Storage	Construct a new 1.6 MG storage reservoir for the West Landing Project	BO_S02	1	LS	\$ 4.5					\$ 4.5		
Pump Station	Construct 3300 gpm booster pump station for new 1.6 MG storage reservoir	BO_S02	1	LS	\$ 2.5					\$ 2.5		
					<b>TOTAL</b>	\$ 111.4	\$ 0.9	\$ 4.8	\$ 0.6	\$ 1.1	\$ 7.7	\$ 8.0
					<b>GRAND TOTAL</b>	\$ 201.7	\$ 1.4	\$ 9.6	\$ 3.6	\$ 7.8	\$ 10.8	\$ 56.5
											\$ 112.0	

<sup>(a)</sup> No dollar amount is shown because this project has already been funded in the FY 2009/10 CIP.

<sup>(b)</sup> Eleven replacement wells are assumed in the Master Plan time frame, including two of the planned wells in the Existing Time Frame. The two are budgeted under Planned Wells (Well 1 and 6), Well 14 is assumed replaced in 2013, Wells 16, 20, 21, and 22 in the 2016-2020 timeframe, and remaining wells after 2020.

<sup>(c)</sup> Costs for a 3rd well, reserved as a standby well in the West Landing Specific Plan Area, is not included, since the standby well would be funded by the developer as an in-tract improvement. Timing is approximate, and dependent on developer approvals.

<sup>(d)</sup> Jack and bore costs are for casing pipe only, and do not include conductor pipe, which is included in pipe totals.

<sup>(e)</sup> These 12-inch lines are assumed to be in-tract improvements paid for by the developer, and not funded by developer impact fees.

<sup>(f)</sup> Storage cost is included in the RSWSP cost estimate listed in Supply Improvements.

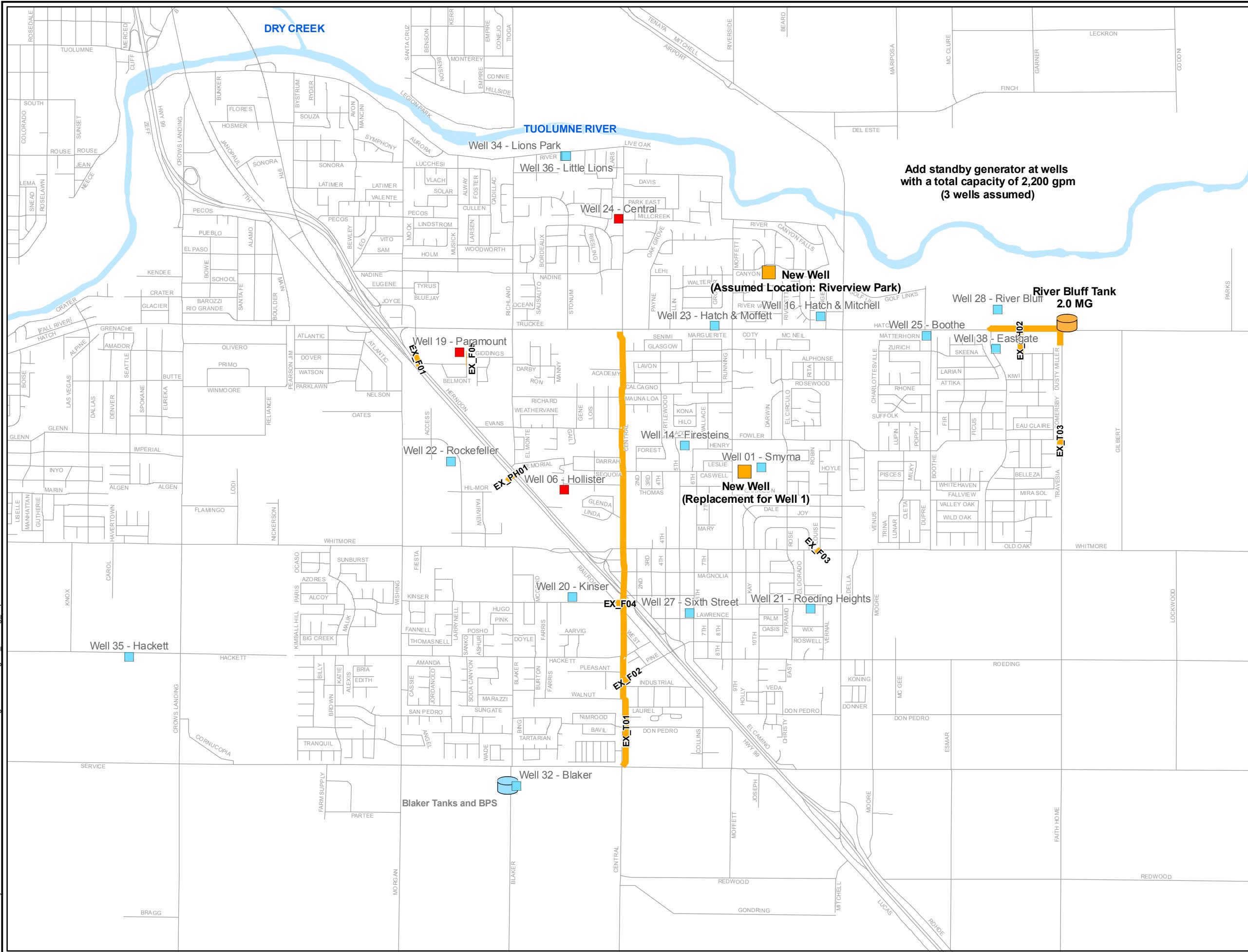
<sup>(g)</sup> Pump station cost is included in the RSWSP cost estimate listed in Supply Improvements.



FIGURE 8-1

City of Ceres  
Water Master Plan

EXISTING WATER  
SYSTEM RECOMMENDED  
IMPROVEMENTS





## FIGURE 8-2

## **City of Ceres Water Master Plan**

## **FUTURE WATER SYSTEM RECOMMENDED IMPROVEMENTS**

Add standby generator at wells  
with a total capacity of 5,500 gpm  
(6 wells assumed)

## OTES

Future facilities recommended in the Existing System Analysis are shown as existing facilities.  
All improvements are included in the buildup timeframe except for Project 15-T01, new transmission on Hatch Road.

## EGEND

- Water Master Plan Study Area
- Street
- Existing Well
- Inactive Well
- Existing Tank and Pump Station
- Future Tank and Pump Station
- Recommended Future Pipeline Diameter = 8-inches
- Recommended Future Pipeline Diameter = 10-inches
- Recommended Future Pipeline Diameter = 12-inches
- Recommended Future Pipeline Diameter = 16-inches
- Recommended Future Pipeline Diameter  $\geq$  24-inches

