



CITY OF SHASTA LAKE

2016-2026 WATER MASTER PLAN

FINAL • OCTOBER 2016



City of Shasta Lake
2016-2026 WATER MASTER PLAN
FINAL



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Abbreviations

AACE	Association for the Advancement of Cost Engineering
AC	Acre
ACID	Anderson Cottonwood Irrigation District
ADD	average day demand
AF	acre-feet
AFY	acre feet per year
AWWA	American Water Works Association
AWWA M-32	AWWA Manual on Distribution Network Analysis of Water Utilities
Carollo	Carollo Engineers, Inc.
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Plan
City	City of Shasta Lake
County	Shasta County
CII	commercial, industrial, and institutional
CIP	Capital Improvement Plan
CVP	Central Valley Project
CWP	Cold Water Pool
DOF	Department of Finance
DMM	demand management measures
DWR	Department of Water Resources
EDU	equivalent dwelling unit
EIR	Environmental Impact Report
ENR CCI	<i>Engineering News Record</i> Construction Cost Index
ETo	evapotranspiration
°F	degree Fahrenheit
ft/kft	feet per thousand feet
fps	feet per second
GIS	geographic information system
gpcd	gallons per capita per day

gpd	gallons per day
gpd/ac	gallons per day per acre
gpd/acct	gallons per day per account
gpd/DU	gallons per day per dwelling unit
gpm	gallons per minute
HGL	Hydraulic Grade Line
HP	horsepower
I-5	Interstate 5
Master Plan	2016-2026 Water Master Plan
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
MFR	multi-family residential
Mountain Gate	Mountain Gate at Shasta Development
NEPA	National Environmental Policy Act
PHD	peak hour demand
PRV	Pressure Reducing Valve
Psi	pounds per square inch
PUD	Public Utilities District
RWPS	Raw Water Pumping Station
SCADA	supervisory control and data acquisition
SCWA	Shasta County Water Agency
SFR	single-family residential
TWPS	Treated Water Pump Station
UFW	unaccounted for water
ULFT	ultra-low flush toilets
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
VFD	Variable Frequency Drive
WRCC	Western Regional Climate Center
WDF	Water Demand Factors
WRF	Water Reuse Facility
WTP	Water treatment plant

WUE Water Use Efficiency
WWD water works district

Executive Summary

2016-2026 WATER MASTER PLAN

The purpose of this 2016-2026 Water Master Plan (Master Plan) is to update the 1998 and 2003 Water Master Plans, to identify existing capacity deficiencies within the existing water distribution system, to develop feasible alternatives to correct these deficiencies, and plan the infrastructure that will serve future development projected by the City of Shasta Lake (City) General Plan Update.

ES.1 Introduction

The City is located north of Redding in western Shasta County (County). The City is located along the Interstate 5 (I-5) corridor, south of Lake Shasta and the Shasta Dam. The closest neighboring communities are Bella Vista, Redding, and Shasta to the south, Lakehead to the north, and French Gulch to the west.

The City, incorporated in 1993, provides water, sewer, recycled water, storm drain, and electric services to its customers. Water service is provided to all residential, commercial, and industrial customers, and for fire protection services. The City limits comprise 10.9 square miles. The water service area encompasses the entire City limits. In addition, the City provides water service to a portion of the City of Redding in their Buckeye service area.

ES.2 Study Area and Land Use

The study area for this Master Plan consists generally of the existing City limits. The City also provides water service to a small portion of the City of Redding within its Buckeye service area. Therefore, the study area for this Master Plan includes both the existing City limits and the portion of the Redding Buckeye Service area that is served by the City, as shown on Figure ES. 1.

The land use assumptions in this Master Plan were based on the projected future developments within the City limits from the City's 2035 General Plan Update, which is currently in progress. Should future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan recommendations would be necessary.

ES.3 Historical and Projected Population

The City's population increased by about 15 percent from 8,953 to 10,269 between 1996 and 2009. Since 2009, the City's population has been relatively stable and has decreased slightly to a population of 10,020 as of the year 2015. Based on input from the City's planning department, this Master Plan has assumed that the City's population will increase by approximately 1 percent per year through the year 2036. As shown in Table ES.1 the City's 2036 population is projected to increase to 12,349 people. Build-out of the City limits is projected to occur well into the future.

Table ES.1 Projected Population

Year	Projected Population ⁽¹⁾
2015	10,020
2016	10,120
2021	10,636
2026	11,179
2031	11,749
2036	12,349

Note:

(1) Projected Population assumes a 1% per year population growth.

ES.4 Water Service Area

Figure ES.2 illustrates the City's current water service area. The City's water system consists of approximately 79 miles of active water distribution system pipelines up to 20-inches in diameter, the Fisherman's Point Water Treatment Plant (WTP), ten storage tanks (nine treated water, one raw water), two booster pump stations (one raw water, and one finished water), 15 Pressure Reducing Valve (PRV) stations, and nine pressure zones. The Fisherman's Point WTP is located outside of the City limits, north of Fisherman's Point adjacent to Shasta Dam.

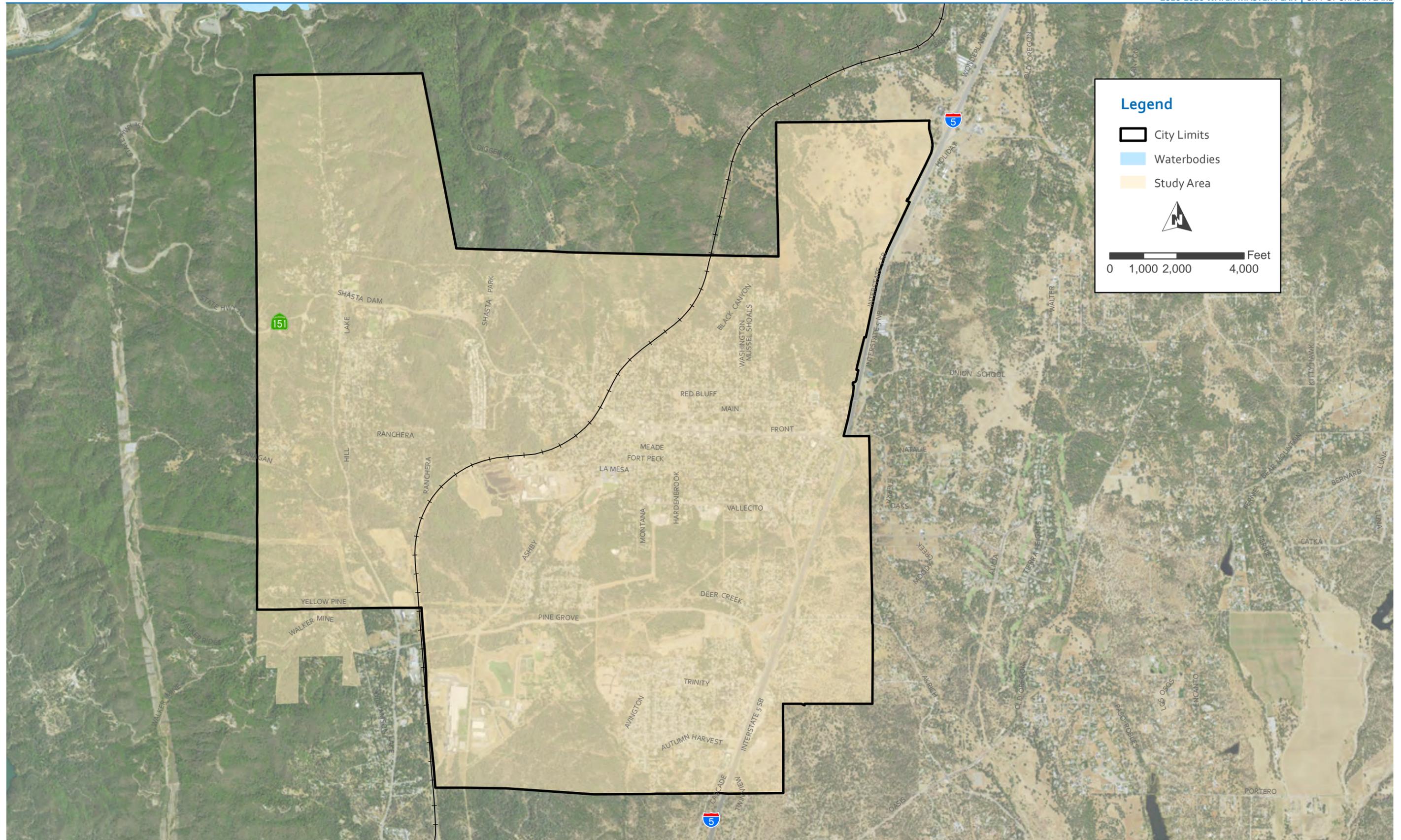
ES.5 Existing and Projected Water Demands

The average day demand (ADD) represents the daily average demand for the entire year. It is calculated by dividing the total water produced in any given year by the number of days per year. It has been estimated that the City's existing ADD was 2.35 million gallons per day (mgd) for the purposes of this Master Plan. It should be noted that the ADD in 2014 was significantly lower than 2.35 mgd (2015 data was not available during the preparation of this plan) as a result of mandatory water conservation measures implemented by the governor as a result of severe drought conditions. The existing ADD of 2.35 mgd is considered representative of current "non-drought" demand conditions.

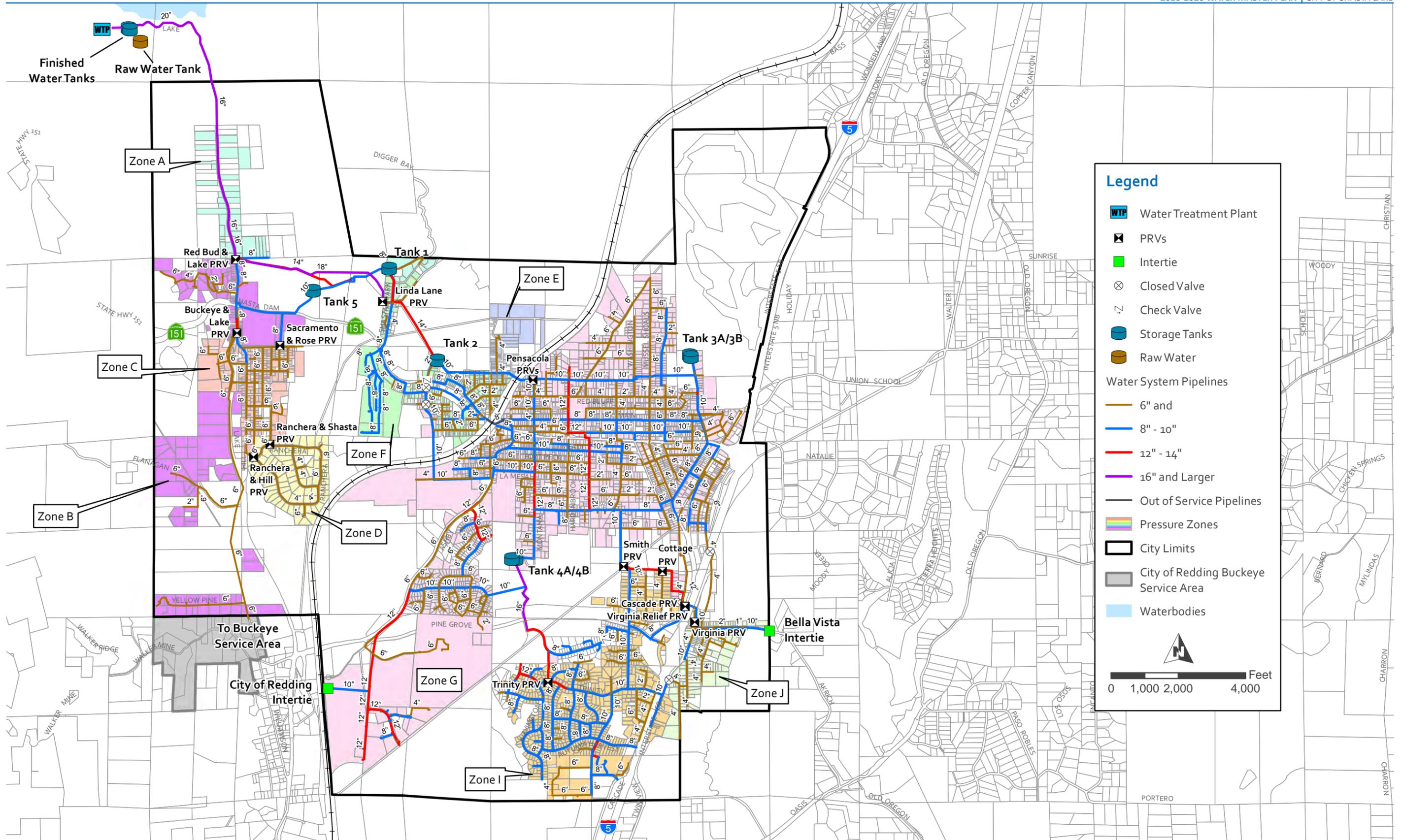
The maximum day demand (MDD) is an important demand condition, and is used to evaluate system supply, reservoir capacity, and pump station capacity. The MDD is defined as the highest production in one day in a given year, and usually occurs in the summer.

In order to develop future MDD projections, the historical MDD to ADD peaking factor was calculated for several recent years. The MDD peaking factor fluctuated between 1.92 in 2014 and 2.18 in 2011. Based on input from City staff, it was decided that the highest MDD/ADD peaking factor of 2.18 would be used to determine existing and future MDDs for this Master Plan.

Demand projections were developed for a 20-year planning year (year 2036) as well as for build-out demand conditions. Table ES.2 provides a summary of the City's existing, 2036, and build-out demand projections. As shown in Table ES.2, the City's ADD is projected to increase from an existing demand of 2.35 mgd to a 2036 ADD of 2.90 mgd. By build-out, the projected ADD could approach roughly 7.28 mgd.



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Table ES.2 Demand Projection Summary

Year	ADD (mgd)	MDD ⁽¹⁾ (mgd)
Existing (2015)	2.35	5.12
2036	2.90	6.32
Build-Out	7.28	15.86

Note:

(1) $MDD = 2.18 \times ADD$

ES.6 Capacity Evaluation and Proposed Improvements

The capacity analysis of the City's water distribution system consisted of the following:

- **Supply Analysis.** The supply capacity evaluation under existing and future demand conditions was performed by comparing the available water supplies to the projected water demands. As noted in Chapter 5 of this Master Plan, this study recommends that the City maintain a firm water supply capacity equal to the MDD. Demands in excess of the MDD will be met through storage. There are three facilities that were evaluated:
 - The firm capacity of the City's Raw Water Pump Station (RWPS).
 - The treatment capacity of the Fisherman's Point WTP.
 - The firm capacity of the City's Treated Water Pump Station (TWPS).
- **Storage Analysis.** The City currently has nine storage reservoirs for a total of 6.1 million gallons (MG) of treated water storage. These reservoirs provide the City with operational equalization storage to meet peak hour demand (PHD), fire flow storage, and emergency storage. The City currently has one active raw water tank with a volume of 0.17 MG, which allows for a consistent supply of raw water to the WTP. The required storage through year 2036 and build-out was calculated based on the projected MDD. The required storage was then compared to the City's current available storage capacity to determine the need for additional storage tanks. In addition, storage options were considered to increase the amount of raw water pumping capacity available to the City.
- **Distribution System Analysis.** The distribution system analysis consisted of system pressure analysis, fire flow analysis, and pipeline velocity analysis for the City's water distribution system under both existing and future conditions based on the evaluation criteria defined in Chapter 3. Improvement projects were identified in order to mitigate system deficiencies and to serve future growth.

Following the capacity analysis of the distribution system, capacity improvement projects were developed to mitigate the existing and future deficiencies. The capacity improvements included supply and pumping improvements, storage tank improvements, pipeline replacement projects, new developer funded pipeline projects, and new PRV stations.

In addition, improvement projects were developed based on recent visual inspection of the Fisherman's Point WTP and the City's storage tanks. A small diameter pipeline replacement program was also recommended as part of this Master Plan.

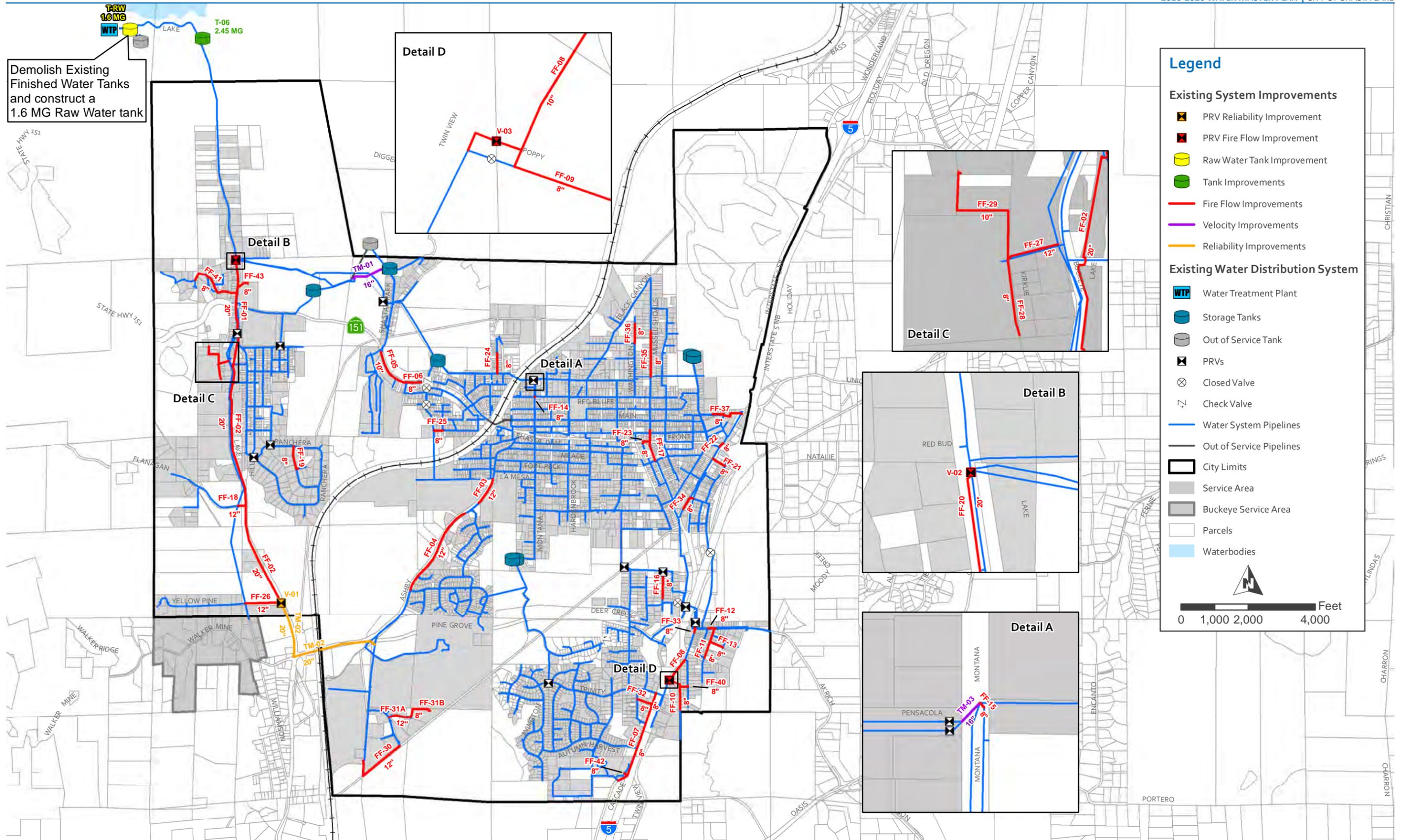
Figure ES.3, Figure ES.4, and Figure ES.5 show the recommended existing, year 2036, and build-out improvements that are recommended as part of this Master Plan. In total, this Master Plan has identified 143 individual projects to meet existing capacity deficiencies, increase system

reliability, address condition related issues, and to service future growth. The City's current water rate structure allows for the implementation of a select number of projects in the short term, and therefore it is important to identify the most critical projects that should be constructed as soon as possible, and those that are less critical. Based on discussions with City staff, as well as an assessment of risk within the City's system by Carollo Engineers, Inc. (Carollo), the following projects have been identified as the highest priority projects related to this Master Plan. These projects should be targeted for implementation as soon as possible:

- *Centimudi Tank (Project T-06)*: In order to provide additional emergency storage for the entire City service area, it is recommended that a new, 2.45 MG tank be constructed at the USFS site near the Centimudi boat ramp, which is currently used as a driftwood storage site. This site is located at the correct elevation to serve pressure Zone A, and is a relatively flat pad. The City would need to acquire approval from the USFS in order to construct this tank. This is a very high priority improvement.
- *New Raw Water Tank (Project T-RW)*: With the construction of the proposed Centimudi Tank, the City could demolish the existing finished water tanks and construct a new larger Raw Water Tank. It is estimated that a 1.6 MG tank could fit on the site. Once the new Raw Water Tank is constructed, the existing Raw Water Tank would be set aside as a standby tank for when the new Raw Water Tank is drained. This is a high priority improvement.
- *Raw Water Pump Station - Pump 6 (Project PS-01)*: To mitigate the existing capacity deficiency of the RWPS under existing low lake levels, it is recommended that a sixth pump be added to the RWPS at the spare can location. A new pump with a firm capacity of 2,500 gpm at 400 feet of head would provide enough additional capacity to meet 2036 demands.
- *Parallel Raw Water Transmission Main (Project TM-04)*: It is recommended that a parallel 20-inch diameter raw water transmission main be constructed to increase the reliability of the existing raw water transmission main. 1,700 feet of parallel pipeline is recommended.
- *Fisherman's Point WTP Projects (Projects WTP-01 through WTP-07, and RR-11)*: These projects are currently planned by the City, and include replacement of the sludge dewatering facility, Filter No. 1 and 2 Rehabilitation, demolition to the Toyon WTP, construction of a retaining wall, and other miscellaneous projects. Additionally, it is recommended that the City replace the existing plant water pump station with a higher capacity pump station.

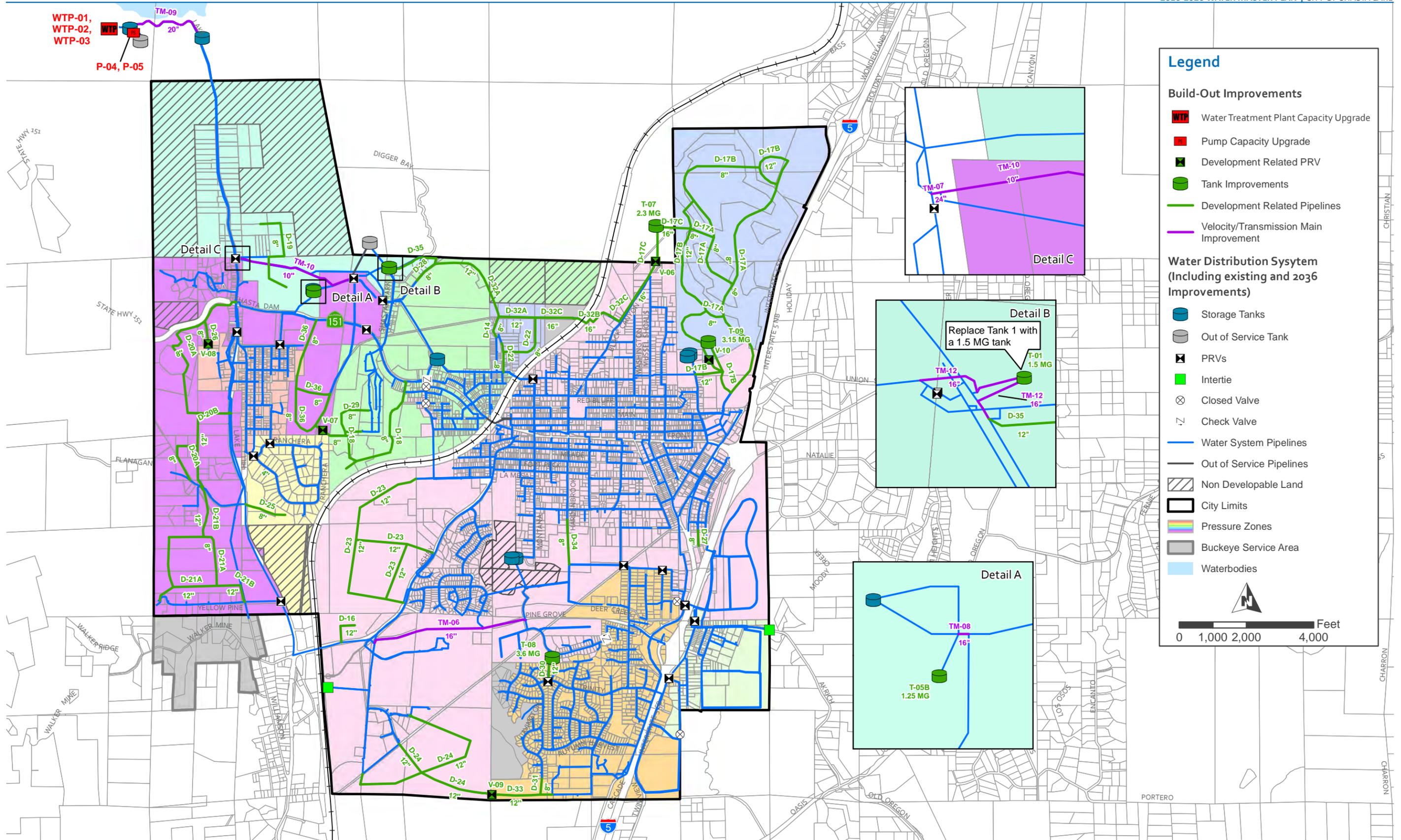
ES.7 Capital Improvement Plan

A summary of the capital project costs is presented in Chapter 7 of the Master Plan. Chapter provides detailed information related to the projects, a description of the project, identifies facility size, the capital improvement cost, and the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.



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The capital projects identified will allow the water distribution system to reliably serve the City's peak water demand through the year 2036 and ultimate build-out. The improvement projects were prioritized based on the following factors:

- Upgrading existing facilities to mitigate current capacity deficiencies, and increasing the reliability of existing facilities.
- Upgrading existing facilities to accommodate increased water demands for the 2036 and build-out planning years.
- Expanding the City's distribution system infrastructure to serve existing vacant land areas.
- Implementing condition assessment projects for the City's major water system facilities.
- Implementing a small diameter pipeline replacement program.

Based on these factors, each project was categorized as either an Existing, Future (Year 2036), or Build-Out project. This terminology defines the driver for each improvement project. Existing improvements are required to mitigate existing capacity deficiencies or to rehabilitate or repair an existing facility. Future (Year 2036) facilities are necessary to meet the projected peak demands in the year 2036. Build-Out improvements are necessary to accommodate demand increases that are projected to occur after the year 2036.

The capital improvements identified were phased according to the improvement categories described above into one of the following phases:

- *Phase 1 (2016-2021)*: This phase includes projects that are targeted as the highest priority Existing improvements.
- *Phase 2 (2022-2026)*: This phase generally includes medium priority Existing improvements, and any Future (Year 2036) projects that are triggered by growth.
- *Phase 3 (2027-2036)*: This phase includes low priority Existing improvements, and Future (Year 2036) projects that are triggered by growth prior to 2036.
- *Phase 4 (Post 2036)*: This phase includes Build-Out improvements triggered by growth that is projected to occur after year 2036.

Each project is itemized by phase in Chapter 7 and a summary by phase and project type is provided in Table ES.3. As shown in Table ES.3, out of the total \$96.3 million in capital projects, \$4.6 million (4.7 percent) are targeted for implementation in the first phase, and an additional \$17.8 million (18.5 percent) are targeted for phase 2. The remaining \$74.0 million of capital improvements has been included in either Phase 3 or Phase 4.

Figure ES.6 shows the distribution of capital costs by project type. As shown on Figure ES.6, Developer Related projects and Storage Related projects account for the largest portions of the capital improvement project costs at 36 percent and 20 percent, respectively. Small diameter pipeline replacement, fire flow projects, and other pipeline transmission projects account for roughly 12 percent, 11 percent, and 10 percent of the total Capital Improvement Plan (CIP) costs, respectively. The remaining 11 percent of the CIP costs are associated with pump stations, valves, projects at the Fisherman's Point WTP, and tank rehabilitation projects.

Table ES.3 CIP Cost by Project Type and Phase

Project Type	Phase 1 (2016-21) (\$)	Phase 2 (2022-26) (\$)	Phase 3 (2027-36) (\$)	Phase 4 (Post 2036) (\$)	Total (\$)
Capacity/Storage Improvements					
Fire Flow Related	-	9,442,000	755,000	-	10,197,000
Pipeline Related	-	2,783,000	3,221,000	3,709,000	9,713,000
Pump Station Related	216,000	-	-	1,150,000	1,366,000
Storage Related	3,046,000	1,989,000	-	14,731,000	19,766,000
Valve Related	0	249,000	166,000	415,000	830,000
WTP Related	1,260,000	-	-	6,102,000	7,362,000
Subtotal	4,522,000	14,463,000	4,142,000	26,107,000	49,234,000
Rehabilitation Improvements					
Pipeline Rehabilitation	-	2,099,000	9,171,000	-	11,270,000
Reservoir Rehabilitation	-	1,209,000	-	-	1,209,000
Plant Water PS Rehabilitation	33,000	-	-	-	33,000
Subtotal	33,000	3,308,000	9,171,000	-	12,512,000
Developer Related Improvements					
Developer Related	-	-	9,472,000	25,075,000	34,547,000
Subtotal	-	-	9,472,000	25,075,000	34,547,000
Grand Total	4,555,000	17,771,000	22,785,000	51,182,000	96,293,000

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182.

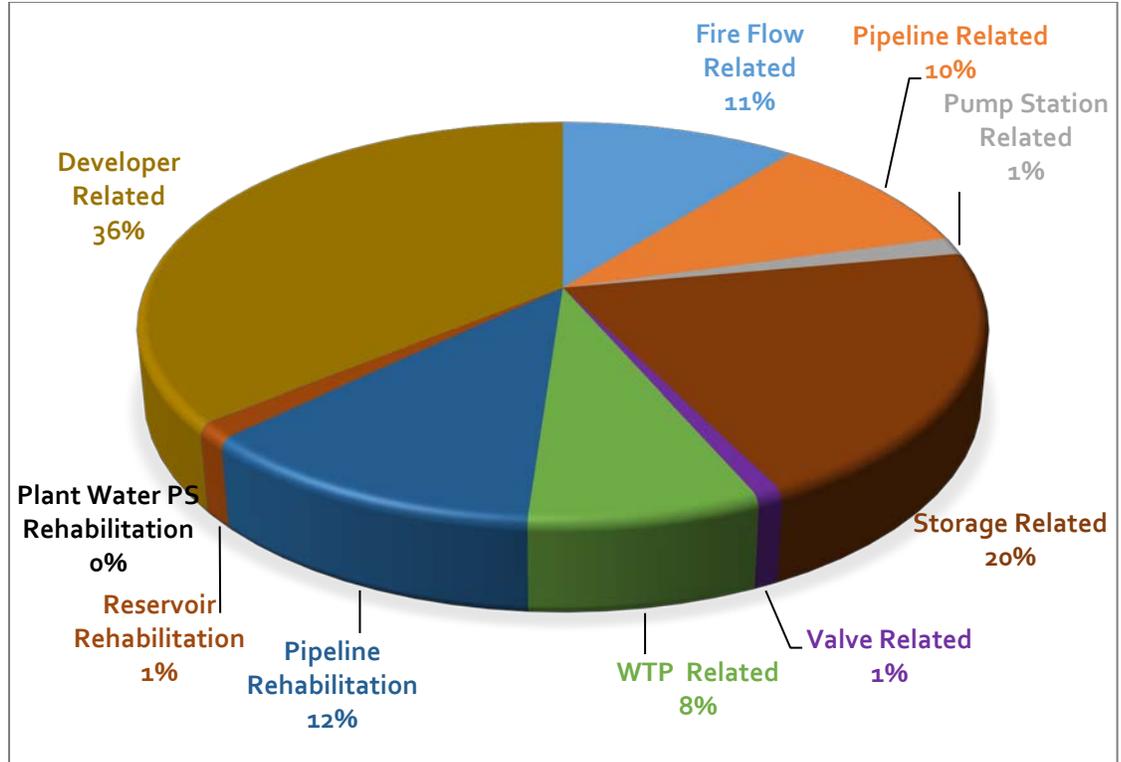


Figure ES.6 Capital Improvement Project Cost Summary by Project Type

The improvements proposed in this study either benefit existing users, or is required to service new development and future users. Some of the projects provide benefits to both existing and future users. An opinion of benefit to future users by project is included in Chapter 7. A summary of the existing and future user cost share for the proposed projects by phase is summarized in Table ES.4. As shown in Table ES.4, the total estimated cost for sewer collection system improvements through build-out is roughly \$96.3 million. The majority of improvement projects (\$68.3 million) are associated with future customers and the remaining \$28.0 million is allocated to existing customers.

Table ES.4 CIP Cost by Reimbursement Category

Reimbursement Category	Phase 1 (2016-21) (\$)	Phase 2 (2022-26) (\$)	Phase 3 (2027-36) (\$)	Phase 4 (Post 2036) (\$)	Total (\$)
Existing Customers	2,712,000	15,354,000	9,926,000	-	27,992,000
Future Customers	1,843,000	2,417,000	12,859,000	51,182,000	68,301,000
Grand Total	4,555,000	17,771,000	22,785,000	51,182,000	96,293,000

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182.

The distribution of project cost by project type by customer class is provided in Table ES.5.

Table ES.5 CIP Cost by Project Type and Reimbursement Category

Project Type	Existing Users (\$)	Future Users (\$)	Total (\$)
Capacity/Storage Improvements			
Fire Flow Related	8,686,000	1,511,000	10,197,000
Pipeline Related	1,918,000	7,795,000	9,713,000
Pump Station Related	173,000	1,193,000	1,366,000
Storage Related	3,512,000	16,254,000	19,766,000
Valve Related	207,000	623,000	830,000
WTP Related	984,000	6,378,000	7,362,000
Subtotal	15,480,000	33,754,000	49,234,000
Rehabilitation Improvements			
Pipeline Rehabilitation	11,270,000	-	11,270,000
Reservoir Rehabilitation	1,209,000	-	1,209,000
Plant Water PS Rehabilitation	33,000	-	33,000
Subtotal	12,512,000	-	12,512,000
Developer Related Improvements			
Developer Related	-	34,547,000	34,547,000
Subtotal	-	34,547,000	34,547,000
Grand Total	27,992,000	68,301,000	96,293,000

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182.

Chapter 1

INTRODUCTION

This chapter presents a brief summary of the City of Shasta Lake (City) water distribution system service area, the need for this 2016-2026 Water Master Plan (Master Plan), and the objectives of the study. A list of abbreviations is also provided to assist the reader in understanding the information presented.

1.1 Background

The City is located north of Redding in western Shasta County (County). The City is located along the Interstate 5 (I-5) corridor, south of Lake Shasta and the Shasta Dam (Figure 1.1). The closest neighboring communities are Bella Vista, Redding, and Shasta to the south, Lakehead to the north, and French Gulch to the west.

The City is located within the upper Churn Creek, Stillwater Creek, and Moody Creek watersheds. The developed areas of the City are gently rolling with numerous small creeks tributary to the three major watersheds. The southern portion of the City is flatter, which then becomes hilly with steep slopes towards the northern boundary. The northern portion of the City is generally undeveloped land. Elevations in the City range from a high of about 1,030 feet above sea level at the northern ridge to a low of about 660 feet at the southern boundary.

The City, incorporated in 1993, provides water, sewer, recycled water, storm drain, and electric services to its customers. Water service is provided to all residential, commercial, and industrial customers, and for fire protection services.

The City limits comprise 10.9 square miles. The water service area encompasses the entire City limits. In addition, the City provides water service to a portion of the City of Redding in their Buckeye service area.

1.2 Water Service Area

Figure 1.2 illustrates the City's current water service area. The City's water system consists of approximately 79 miles of active water distribution system pipelines up to 20-inches in diameter, its Water Treatment Plant (WTP), ten storage tanks (nine treated water, one raw water), two booster pump stations (one raw water, and one finished water), 15 Pressure Reducing Valve (PRV) stations, and nine pressure zones. The WTP is located outside of the City limits, north of Fisherman's Point adjacent to Shasta Dam.

The land use assumptions in this Master Plan were based on the projected future developments within the City limits from the City's 2035 General Plan Update, which is currently in progress. Should future planning conditions change from the assumptions stated in this Master Plan (i.e., accelerated growth, more intense developments, etc.), revisions and adjustments to the Master Plan recommendations would be necessary.

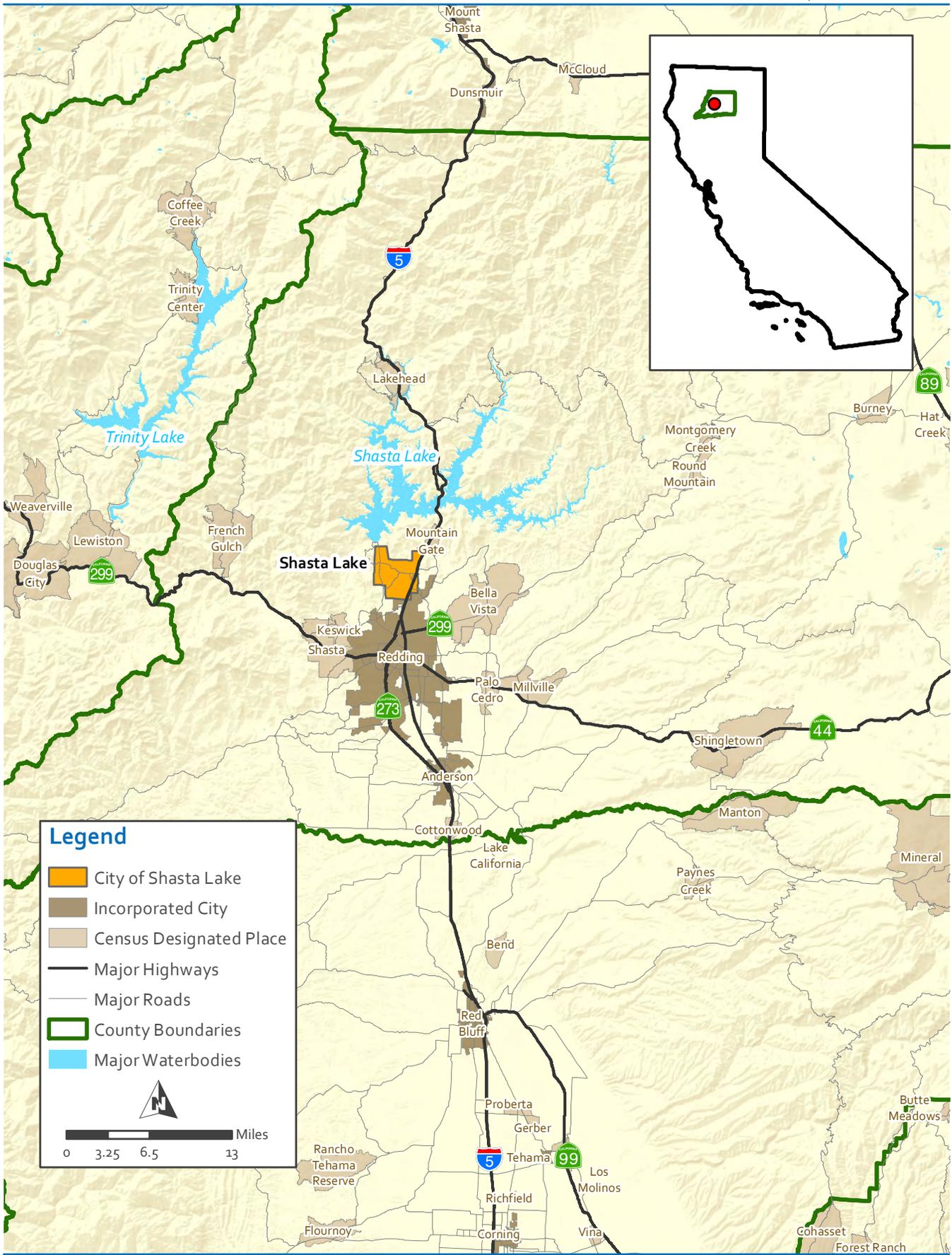
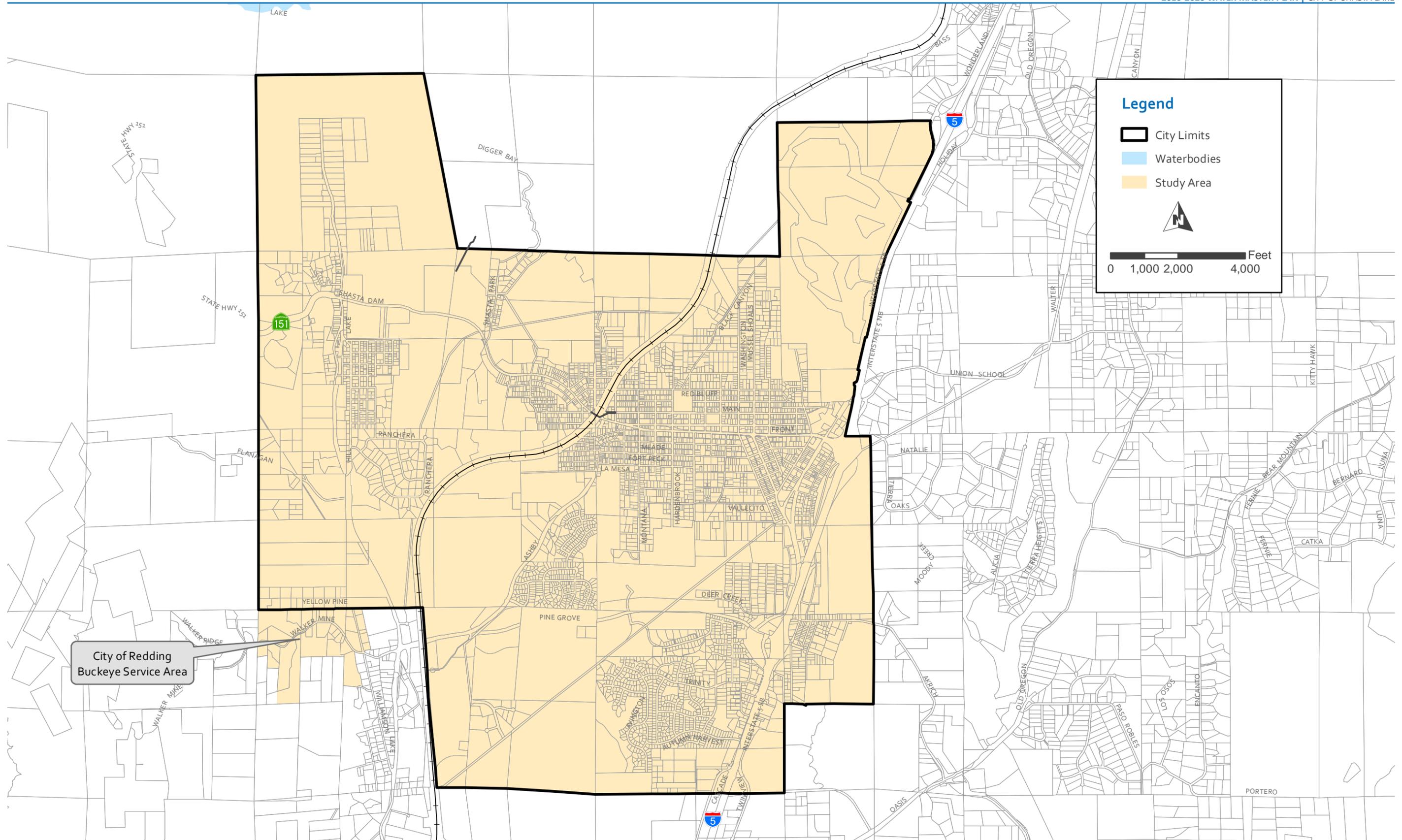


Figure 1.1
Regional Location Map



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1.3 Previous Master Plans

The City's previous Water Master Plan was developed in 1998 by Pace Civil, Inc. and was subsequently updated in 2003 by Pace. The objectives of the 1998 and 2003 Water Master Plans were to review the current water distribution system and to identify improvements required over a 20 year planning period, with a special emphasis on prioritizing improvements needed within the next 10 years. The Master Plans considered supply, storage, and distribution system needs to meet existing and projected water demands.

The 1998 and 2003 Master Plans included the development of a water system hydraulic model, developed in the H₂OMAP Water hydraulic modeling software application, which was developed by Innovyze (formerly MWH Soft).

1.4 Study Purpose, Scope, and Authorization

The purpose of this Master Plan is to update the 1998 and 2003 Water Master Plans, to identify existing capacity deficiencies within the existing water distribution system, to develop feasible alternatives to correct these deficiencies, and plan the infrastructure that will serve future development projected by the City of Shasta Lake General Plan Update.

In September 2015, the City approved a professional service agreement with Carollo Engineers, Inc. (Carollo), to prepare this Water Master Plan. The professional services agreement, includes the following main tasks:

- Task 1 - Project Management.
- Task 2 - Data Analysis and Distribution System Modeling.
- Task 3 - Development and Preparation of 2016-2026 Water Master Plan and 10 Year Water Capital Improvement Program.

1.5 Report Organization

The Master Plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

- *Chapter 1 - Introduction.* This chapter presents a brief summary of the City's water distribution system service area, the need for this Master Plan, and the objectives of the study.
- *Chapter 2 - Study Area Description.* This chapter presents a discussion of the City's planning area characteristics, land use classifications, and historical and projected population trends. Planned developments and information obtained on build-out land use will be discussed. The planning assumptions described in this chapter form the basis for the demand projections included in Chapter 3.
- *Chapter 3 - Water Demands.* This chapter summarizes the City's historical water consumption and production records used to determine the daily, monthly, and seasonal fluctuations experienced by the water system. Also summarized are the average Water Duty Factors (WDFs), peaking factors, and the projected demands through the year 2036 and ultimate build-out of the City limits.
- *Chapter 4 - Water Distribution System Facilities and Hydraulic Model.* This chapter summarizes the City's existing water distribution system infrastructure, including the

WTP, booster pump stations, pressure zones, storage tanks, PRV stations, and water mains. This chapter also describes the development and calibration of the City's water distribution system hydraulic model.

- *Chapter 5 - Planning and Evaluation Criteria.* This chapter presents the planning criteria that were used to evaluate the existing water distribution system to size future improvements and expansions.
- *Chapter 6 - Distribution System Evaluation and Proposed Improvements.* This chapter discusses the hydraulic evaluation of the water distribution system and the proposed projects that correct capacity deficiencies and serve future users. The results of the WTP and tank condition assessment are also discussed.
- *Chapter 7 - Capital Improvement Plan.* This chapter presents the capital improvement projects, a summary of the capital costs, and a basic assessment of the possible financial impacts on the City. This chapter presents the recommended Capital Improvement Plan (CIP) for the City and a summary of the capital costs.

1.6 Acknowledgements

We would like to thank the following City staff for their assistance and oversight of this project:

- Jeff Tedder, P.E.; Project Manager/City Engineer
- Tony Thomasy, Water Treatment Plant Superintendent
- Jose Castro, Public Works Supervisor
- Mark Juarez, Engineering Tech. II
- Chris Carr, Water Treatment Plant Operator

The following Carollo staff members were principally involved in this project:

- Scott Parker, P.E.; Principal In Charge
- Tim Loper, P.E.; Project Manager
- Ryan Orgill, P.E.; Project Engineer
- Mike Wetterau, E.I.T.; Staff Engineer
- Mike Dadik, P.E.; Condition Assessment/Structural
- Kevin Christensen, GIS/Graphics

1.7 Reference Material

The following documents were referenced in the preparation of this Master Plan:

- City of Shasta Lake 2010 Urban Water Management Plan, Carollo, August 2014
- City of Shasta Lake 1998 Water Master Plan, Pace, May 1999
- City of Shasta Lake Draft 2035 General Plan Land Use Map, City of Shasta Lake Planning Department, July 2015
- City of Shasta Lake Mountain Gate at Shasta Area Plan Draft Environmental Impact Report, PMC, April 2014
- City of Shasta Lake Reports of Findings From Diving Operations Conducted in January 2015, LiquiVision Technology Diving Services, January 2015
- City of Shasta Lake Update to 1998 Water Master Plan, Pace, January 2004

Chapter 2

STUDY AREA, LAND USE, AND POPULATION

This chapter presents a discussion of the City of Shasta Lake (City) planning area characteristics, the land use classifications, and historical and projected population trends. The planning assumptions described in this chapter form the basis for the demand projections included in Chapter 3.

2.1 Study Area

The study area for this Master Plan consists generally of the existing City limits. The City also provides water service to a small portion of the City of Redding within its Buckeye service area. Therefore, the study area for this Master Plan includes both the existing City limits and the portion of the Redding Buckeye Service area that is served by the City, as shown on Figure 2.1.

2.2 Planning Horizon

This Master Plan is intended to serve as the guiding document for the planning and implementation of water system improvements to accommodate future growth through the year 2036 (which is the planning horizon of the City's General Plan Update), as well as ultimate build-out of the study area. The population and land use projections included in the City's General Plan Update are summarized in this chapter, and set the foundation for the demand projections and water system infrastructure requirements identified in this Master Plan.

2.3 Climate and Topography

The City's climate is characterized by hot dry summers and mild winters with an average annual rainfall of approximately 61.82-inches. Approximately 79-percent of the average annual precipitation occurs between November and March. Evapotranspiration (ET_o) values, which serve as indicators of how much water is required to maintain healthy agriculture and landscaping, range from 1.04-inches in January to 8.73-inches in July. Table 2.1 summarizes the study area climate. The City's elevation ranges from approximately 660-feet above sea level in the southeastern corner of the City to approximately 1,030-feet in the northern portion of the City. The Fisherman's Point City's Water Treatment Plant (WTP), which is located outside the City Limits, is located at an elevation of roughly 1,200-feet.

2.4 Land Use

Land use information is an integral component in determining the water demand within a given service area. The type of land use in an area will affect the volume and character of the water demand. Adequately estimating water demands from various land use types is important in sizing and maintaining effective water system facilities.

The City's current General Plan was adopted in 1999. However, the City is currently in the process of updating their General Plan (General Plan Update). The City's Planning Department provided preliminary land use assumptions for the General Plan Update. The land use

assumptions provided by the City were used for the purposes of this Master Plan, which should ensure that the water demand projections and facilities required to serve future growth are consistent with the City’s guiding document on development.

Table 2.1 Study Area Climate

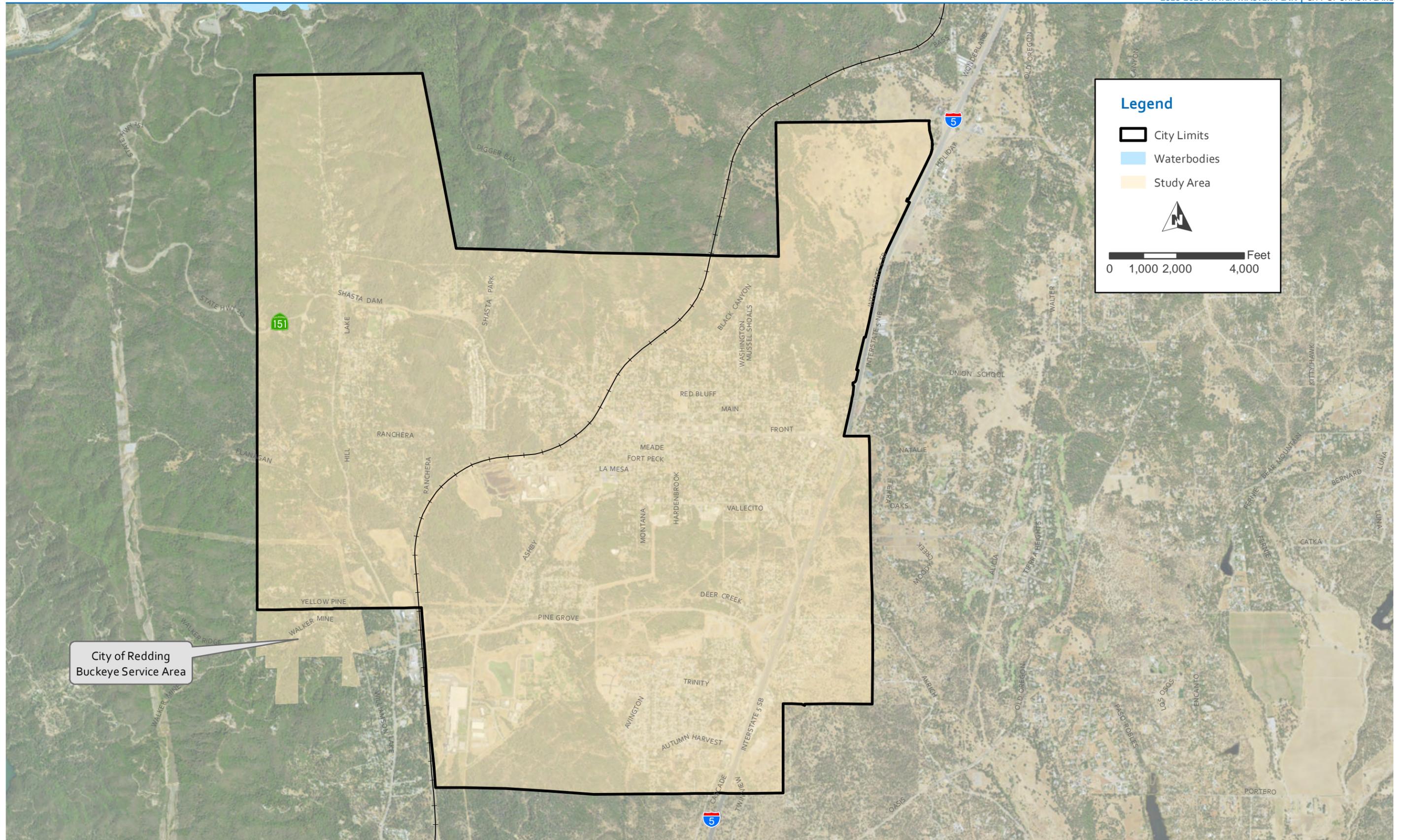
Month	Average Temperature ⁽¹⁾ (°F)		Monthly Average ETo ⁽²⁾ (inches)	Average Total Precipitation ⁽¹⁾ (inches)
	Min.	Max.		
January	38.9	52.5	1.04	11.12
February	41.0	56.7	1.81	10.05
March	43.0	61.3	3.46	8.74
April	47.7	68.5	5.03	4.37
May	54.8	77.5	6.62	2.58
June	62.2	86.0	7.91	1.30
July	68.3	95.2	8.73	0.20
August	66.6	93.7	7.4	0.40
September	62.3	87.8	5.75	1.05
October	54.4	72.2	4.06	3.40
November	45.6	60.5	1.80	7.86
December	40.1	53.1	1.13	10.74
Avg. or Total	52.1	72.3	54.74	61.82

Notes:

- (1) Source: Western Regional climate Center Shasta Dam (048135). Represents monthly average from January 1943 to January 2015.
- (2) Source: California Irrigation Management Information System (CIMIS) Station 224 Shasta College. Represents monthly average ETo from January 2013 to May 2014.

The City's General Plan Update identifies 14 land use categories as listed below. Descriptions of the categories are provided in Appendix A. The descriptions are excerpts from the General Plan.

- Rural Residential A
- Rural Residential B
- Suburban Residential
- Urban Residential
- Urban Residential High
- Commercial
- Mixed Use
- Village Mixed Use
- Industrial Light
- Industrial
- Community Park
- Federal Government
- Public facilities
- Open Space



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2.4.1 Existing Service Area Land Use

The City provides water distribution service to residents, businesses, and other institutions within its City limits. Figure 2.2 shows the City's existing land use map, as well as vacant parcels within the City's service area. Table 2.2 provides a summary, by land use, of the amount of developed and developable land within the study area. Also included in Figure 2.2 are the land use totals for the current water service area, and the breakdown between developed land, which generates water demand, and undeveloped land that will be developed and connected to the City's distribution system in the future.

Table 2.2 Study Area Land Use

Land Use Category	Area within the Water Service Area (acres)		
	Developed Land	Vacant Land	Total
<u>Residential</u>			
Rural Residential A	2	184	186
Rural Residential B	85	192	278
Suburban Residential	649	713	1,362
Urban Residential	841	380	1,220
Urban Residential High	80	17	98
<u>Commercial & Mixed Use</u>			
Commercial	75	60	135
Mixed Use	8	320	329
Village Mixed Use	58	13	71
Mtn. Gate ⁽²⁾	0	564	564
<u>Industrial</u>			
Industrial Light	1	19	20
Industrial	214	494	708
<u>Other</u>			
Community Parks	36	68	104
Federal Government	9	120	129
Public Facilities	279	10	289
Open Space	5	0	5
Total⁽¹⁾	2,343	3,154	5,497

Notes:

(1) Excludes right-of-way.

(2) Appendix B includes detailed land use information related to the proposed Mountain Gate Development.

(3) Excludes vacant land that is not anticipated to be connected to the water system in the future.

As shown in Table 2.2, there are approximately 2,343 acres of developed land within the City limits (excluding right-of-ways such as streets, highways, and railroads). Of the 2,343 developed acres, 1,658 acres (71-percent) are classified as residential, 141 acres (6-percent) are classified as commercial, 215 acres (9-percent) are classified as industrial, and the remaining 329 acres (14-percent) are associated with parks, public facilities/government land, or open space.

2.4.2 Future Service Area Land Use

At build-out of the Study Area, the City will encompass approximately 5,497 acres, excluding right-of-way. Build-out is defined as complete development of all lands within the City limits, excluding certain areas that are not anticipated to ever connect to the water distribution system. These areas are shown on Figure 2.3 along with the future land use map for the City. The breakdown of the different land use categories is provided in Table 2.2.

See Appendix C for detailed calculations of each water service pressure zone's acreage total by land use classification for developed land, developable land, and developable land that is not anticipated to be connected to the City's water service area.

2.5 General Plan Focus Areas/Specific Plans

As previously mentioned, the City is in the process of updating their General Plan. The City's Planning Department provided a preliminary land use map and expected 2036 household developments, which illustrates the City's potential developments and redevelopments for specific "focus areas" within the City limits.

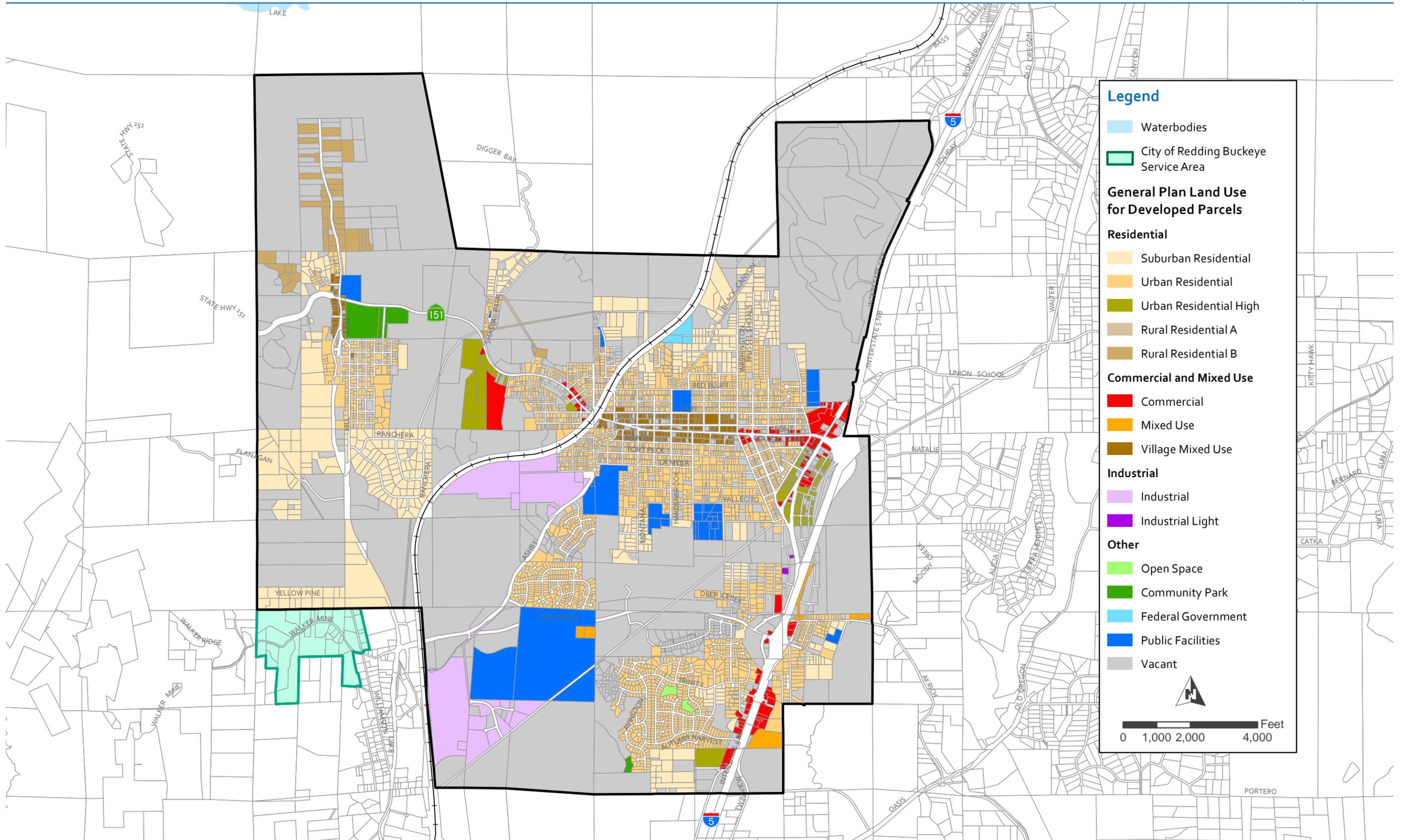
The City's Planning Department expects that a total of 356 dwelling units will be constructed within the 20 year planning horizon, which closely follows market conditions. A majority of the projected residential units are associated with infill of vacant land near currently developed areas. The approximate location of these developments is shown in Figure 2.4, while the number of units or size of the developments is summarize in Figure 2.3. The City was unable to provide commercial vacancies because the City does not track that information at this time.

One significant planned development is the proposed Mountain Gate at Shasta Development (Mountain Gate), which is located in the northeast corner of the City's service area. The General Plan Update classifies the Mountain Gate area simply as mixed use, however the Mountain Gate at Shasta Area Plan Draft Environmental Impact Report (EIR) includes a more detailed land use map for the area, which is summarized in Table 2.4. According to City staff, it is unknown when development within the Mountain Gate area will occur. Because the City's General Plan Update projects very modest growth by 2036 (1-percent per year population growth, as documented in Section 2.6), this Master Plan assumes that any demand increases associated with the Mountain Gate development would occur after 2036.

2.6 Historical and Projected Population

Table 2.5 summarizes the City's population from 1996 to 2015. As shown on Table 2.5, the City's population increased by about 15-percent from 8,953 to 10,269¹ between 1996 and 2009. Since 2009, the City's population has been relatively stable and has decreased slightly to a population of 10,020 as of the year 2015. Based on input from the City's planning department, this Master Plan assumed that the City's population will increase by approximately 1-percent per year through the year 2036. As shown in Table 2.6 and Figure 2.5, the City's 2036 population is projected to increase to 12,349 people.

¹ Source: California Department of Finance



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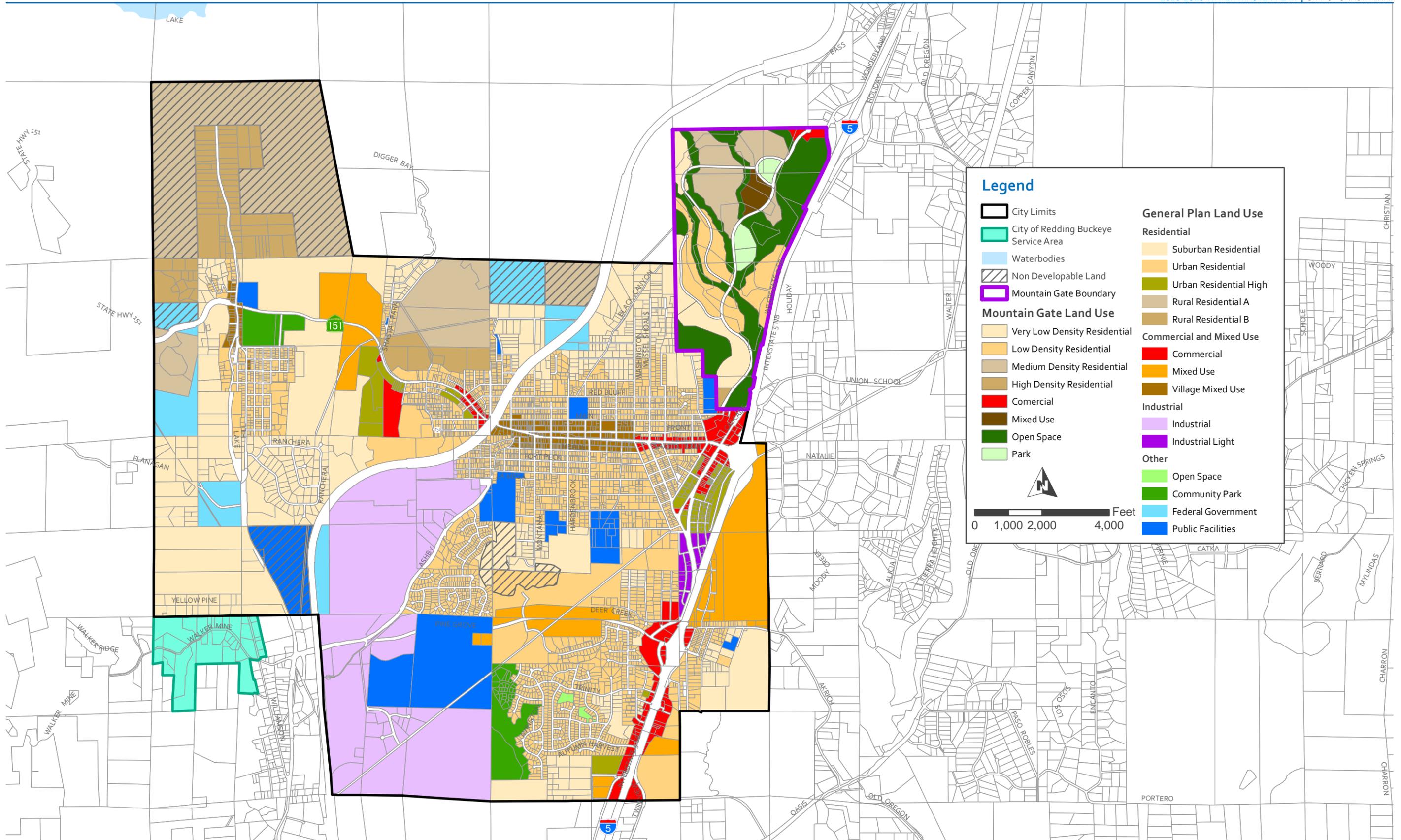


Figure 2.3
General Plan Land Use



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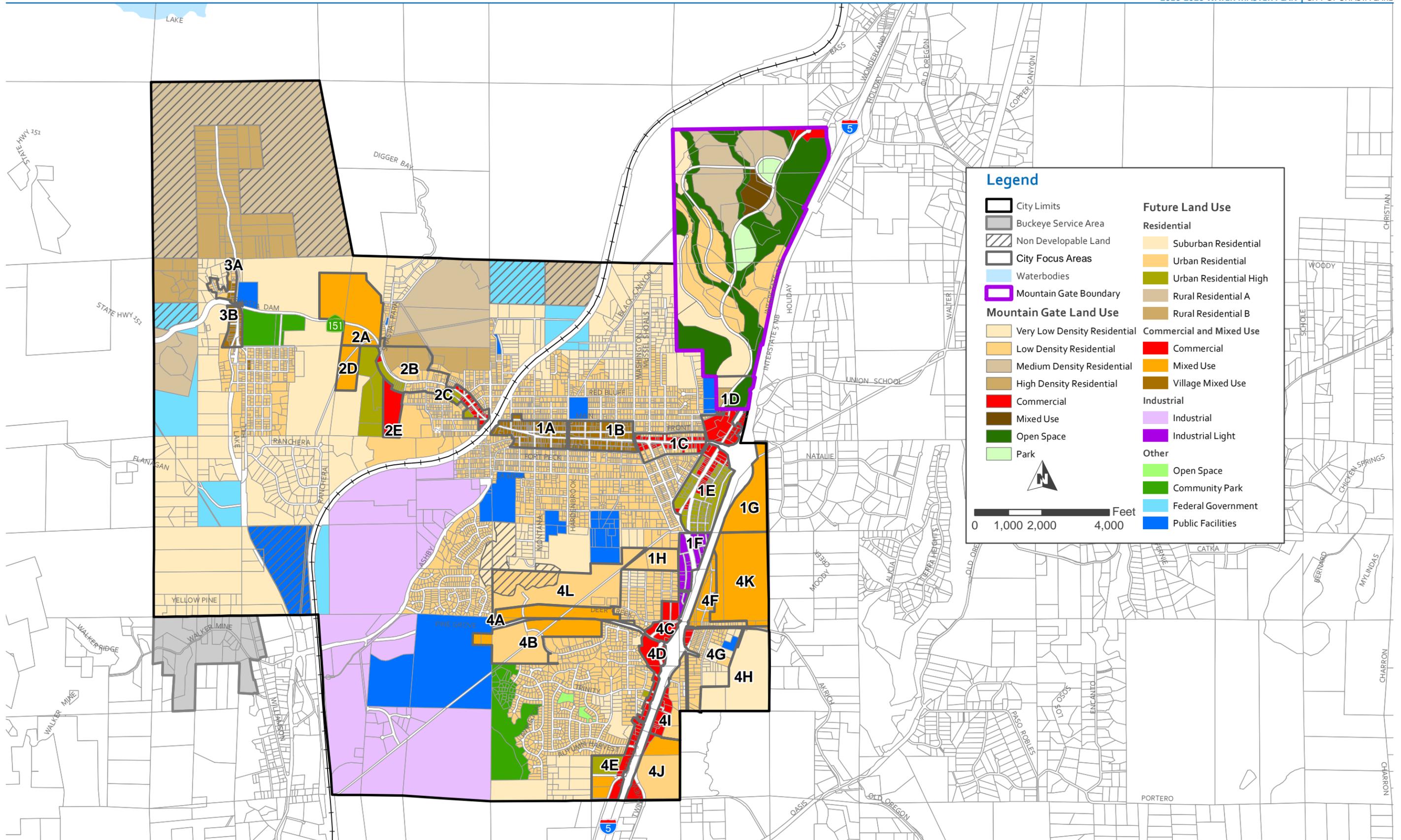


Figure 2.4
 General Plan Focus Areas



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Table 2.3 General Plan Focus Area Development Information (Year 2035 Conditions)

Focus Area	Land Use	Unit Type	Existing Units	Allocation Based On 2035 Market Conditions (Units)
1A	Village Mixed Use	MF	0	31.2
1B	Village Mixed Use	MF	0	17.8
1D	Mixed Use	SF/MF	0	13.4
1E	Urban Residential High	MF	137	4.5
1G	Mixed Use	SF/MF	0	13.4
1H	Urban Residential	SF	0	8.9
2A	Mixed Use	SF/MF	0	53.4
2B	Urban Residential High	MF	0	7.1
2B	Rural Residential A	SF	0	3.6
2C	Urban Residential High	MF	0	32
2D	Mixed Use	SF/MF	0	10.7
3A	Village Mixed Use	MF	0	4.5
3A	Urban Residential	SF	0	4.5
3B	Village Mixed Use	MF	0	8.9
4A	Urban Residential	SF	0	7.1
4A	Mixed Use	SF/MF	0	7.1
4B	Urban Residential	SF	0	7.1
4B	Mixed Use	SF/MF	0	7.1
4E	Urban Residential High	MF	0	3.6
4E	Mixed Use	SF/MF	0	3.6
4F	Mixed Use	SF/MF	0	14.2
4G	Urban Residential	SF	42	7.1
4H	Suburban Residential	SF	0	14.2
4I	Urban Residential	SF	24	7.1
4J	Urban Residential	SF	0	7.1
4J	Mixed Use	SF/MF	0	7.1
4K	Mixed Use	SF/MF	0	28.5
4L	Urban Residential	SF	0	21.4
Total				354

Table 2.4 Mountain Gate Land Use

Area	Land Use	Acres	Max Building Coverage	Potential Sq. Ft.	Probable Units
A	Commercial	11.2	0.25	121,968	0
B	Open Space	181.5	0.1	--	0
C	Park	7.3	0.1	--	0
D	Med. Density Res.	27.9	0.7	--	176
E	Med. Density Res.	22.5	0.7	--	142
F	Very Low Density Res.	16.3	0.5	--	30
G	Med. Density Res.	43.5	0.7	--	392
	Mixed Use Commercial	14.9	0.1	73,614	0
H	High Density Mixed Use		0.7	--	215
	Fire Station	2	0.7	--	0
I	Med. Density Res.	7.3	0.7	--	46
J	Med. Density Res.	8.1	0.7	--	51
K	Park	7.6	0.1	--	0
L	Low Density Res.	17.1	0.5	--	61
M	Community Park	13	1.5	--	0
	Low Density Res.	19.4	0.5	--	70
N	Low Density Res.	11.3	0.5	--	41
O	Low Density Res.	13.1	0.5	--	47
P	Low Density Res.	32.9	0.5	--	119
Q	Very Low Density Res.	10.4	0.5	--	19
	Electric Substation	2	0.7	--	0
R	High Density Res.	4.5	0.7	--	122
S	Very Low Density Res.	40.5	0.5	--	73
T	Open Space	5.9	0.1	--	0
U	Open Space	33.6	0.1	--	0
ROW	Right-of-Way	36.2	--	--	0
Total		590.0		195,584	1,604

Table 2.5 Historical Population

Year	Population ⁽¹⁾
1996	8,953
1997	8,910
1998	8,968
1999	8,946
2000	9,008
2001	9,289
2002	9,516
2003	9,875
2004	10,038
2005	10,180
2006	10,195
2007	10,237
2008	10,243
2009	10,269
2010	10,164
2011	10,098
2012	10,058
2013	10,064
2014	10,044
2015	10,020

Note:

(1) Source: California Department of Finance

Table 2.6 Projected Population

Year	Projected Population ⁽¹⁾
2016	10,120
2021	10,636
2026	11,179
2031	11,749
2036	12,349

Note:

(1) Projected Population assumes a 1% per year population growth.

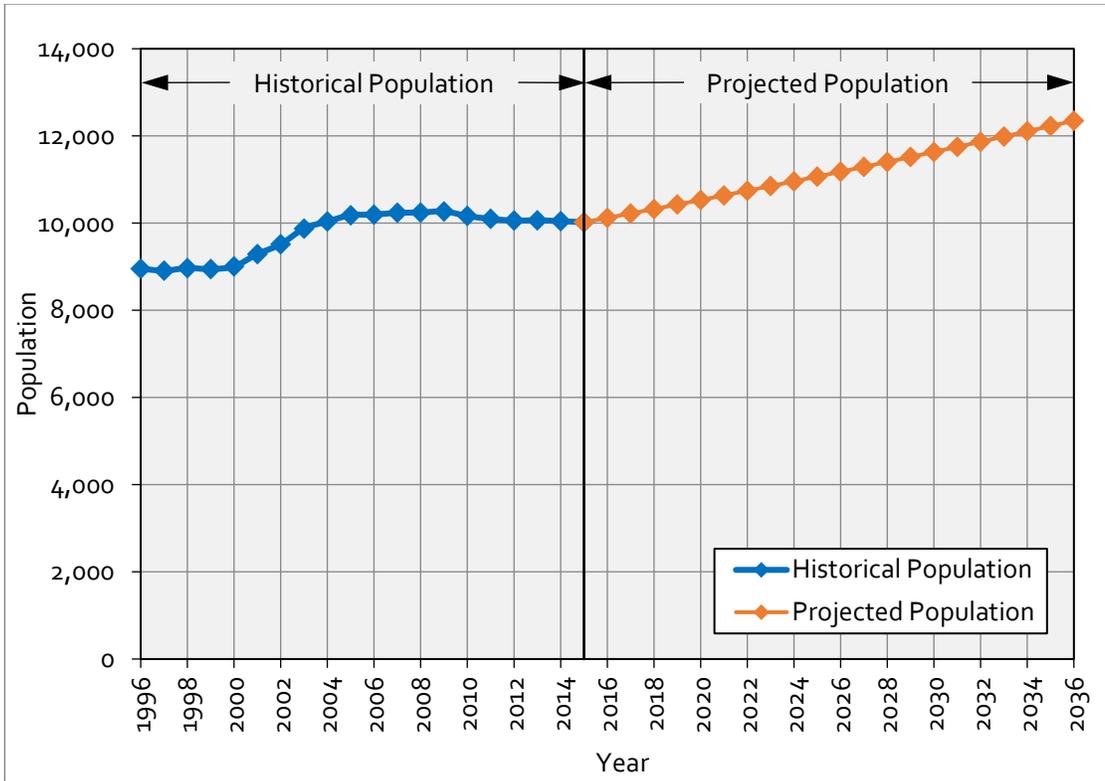


Figure 2.5 Historical and Projected Population

Chapter 3

WATER DEMANDS

This chapter summarizes the City of Shasta Lake's (City's) historical water consumption and production records used to determine the daily, monthly, and seasonal fluctuations experienced by the water system. Also summarized are the average Water Duty Factors (WDFs), peaking factors, and the projected demands through the year 2036 and ultimate build-out of the City limits.

3.1 Historical Water Demands

The City provided historical production data for the years 2010 through 2014, as well as metered consumption/account data for the years 2012 through 2014. The historical demand data were evaluated to characterize the unique water use patterns of the City's customers.

Several key demand parameters were generated. These parameters include peaking factors, typical single-family residential water use, typical water use by customer class, per capita water demands, and unaccounted-for-water (UFW). The parameters are used as the basis for the existing demand estimates and demand projections.

3.1.1 Historical Water Production

Water production varies annually in response to customer water usage, which is correlated to weather, development, economic conditions, population, and conservation activities. The City's total annual production, as shown in Table 3.1, has been somewhat variable since 2010, and has ranged from 650 million gallons (MG) in 2014 to 934 MG in 2012. Figure 3.1 illustrates the City's water production from 2010 to 2014. As shown on Figure 3.1, the City saw a significant drop in water production in 2014 attributable to water conservation associated with state mandates/extreme drought conditions.

Table 3.1 Historical Water Production

	Year					2010-13 Average
	2010	2011	2012	2013	2014	
Annual Production (MG) ^{(1),(2)}	865	774	934	858	650	858
Average Day Demand (mgd)	2.37	2.12	2.55	2.35	1.78	2.35
Maximum Day Demand (mgd)	5.02	4.62	5.03	4.54	3.42	4.80
Date of MDD	7/2	8/31	6/9	6/15	7/4	--
MDD/ADD Peaking Factor	2.12	2.18	1.97	1.93	1.92	2.05
Master Plan MDD/ADD Peaking Factor						2.18

Notes:

- (1) Source: City of Shasta Lake water treatment plant flow data.
- (2) Production totals exclude backwash recycle flows.
- (3) A MDD/ADD peaking factor of 2.18 was selected based on the highest daily peaking factor from 2010-2014.

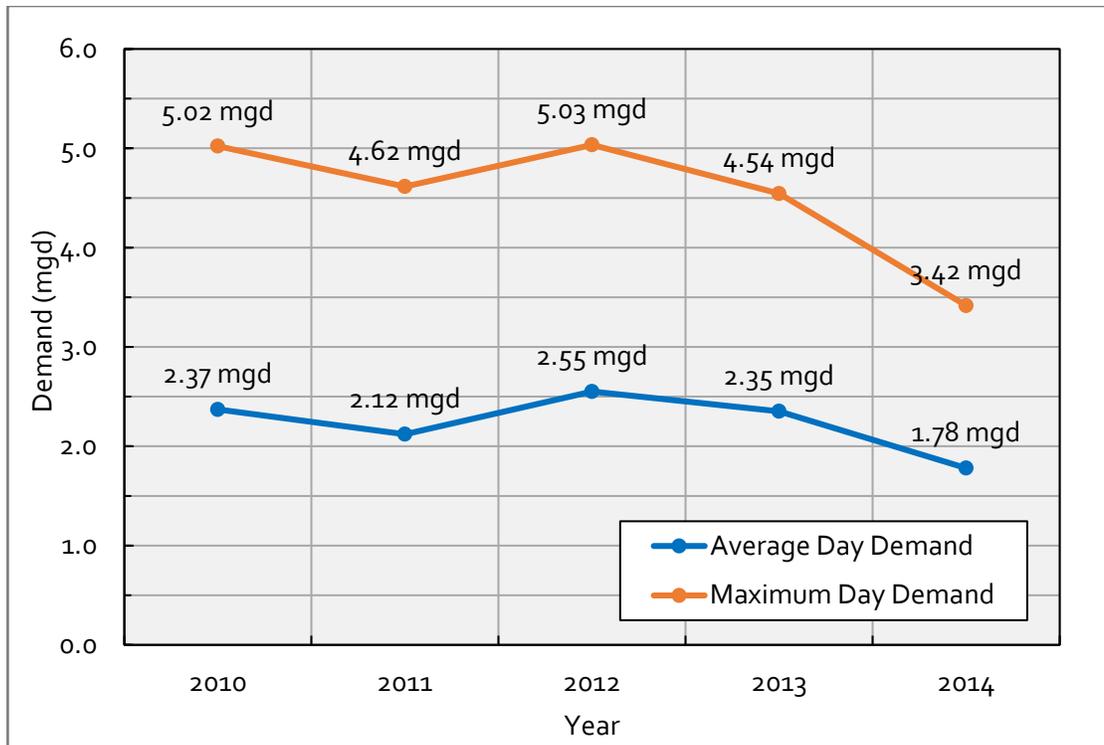


Figure 3.1 Historic Water Production

Table 3.1 also includes a four year average of the water production data from 2010-2013. 2014 data was excluded because the reduction in demand was not representative of typical demand conditions due to the drought.

3.1.2 Seasonal Demands and Peaking Factors

Peaking factors represent the seasonal and daily variations in water use, above or below the average day water demand. The various peaking conditions are either statistical concepts or numerical values established through a review of historical data and are, at times, adjusted to reflect a level of conservatism.

Peaking conditions that are of particular significance to hydraulic analysis of the water system include the average day demand (ADD), maximum day demand (MDD), and the peak hour demand (PHD). Peaking factors for expressing these demands as a function of the ADD were developed based on the City’s demand patterns. Figure 3.1 summarizes the ADD and the MDD from 2010 through 2014.

3.1.2.1 Average Day Demand

The ADD represents the daily average demand for the entire year. It is calculated by dividing the total water produced in any given year by the number of days per year. These values for the years 2010 through 2014 are presented in Table 3.1. As shown in this table, the minimum ADD during this period was 1.78 million gallons per day (mgd) in 2014, and the highest ADD was 2.55 mgd in 2012. Between 2010 and 2013, the City’s ADD was approximately 2.35 mgd. This value is considered representative of the “existing” 2015 ADD for the purposes of this Master Plan.

3.1.2.2 Maximum Day Demand

The MDD is an important demand condition, and is used to evaluate system supply, reservoir capacity, and pump station capacity. The MDD is defined as the highest production in one day in a given year, and usually occurs in the summer. Table 3.1 presents the historical MDD from 2010 through 2014, and includes the date of occurrence for each year (if available). The MDD has ranged from 3.42 mgd in 2014 to 5.03 mgd in 2012.

In order to develop future MDD projections, the historical MDD to ADD peaking factor was calculated, as shown in Table 3.1. The MDD peaking factor fluctuated between 1.92 in 2014 and 2.18 in 2011. On average, the MDD to ADD peaking factor was 2.05 from 2010 to 2013. Based on input from City staff, it was decided that the highest MDD/ADD peaking factor of 2.18 would be used to determine existing and future MDDs for this Master Plan. This is a somewhat conservative assumption, but is reasonable for similarly sized municipalities in California.

3.1.2.3 Peak Hour Demand

The PHD is the highest water demand during any one-hour period of the year. A normal day typically experiences two peak demands, in the morning and then evening. The PHD is expressed as a multiplier applied to the ADD. PHD simulates model high water use throughout the system and assist in identifying areas of the distribution system that experience low pressures.

The City's supervisory control and data acquisition (SCADA) data was used to develop a typical diurnal curve for the City's water system. The diurnal pattern was developed as part of this Master Plan is presented in Chapter 4. The calculated hourly diurnal peaking factor from this data was estimated to be 1.4.

The City's PHD/ADD peaking factor was developed by multiplying the MDD/ADD peaking factor of 2.18 by the typical daily diurnal peak of 1.4. This yields an estimated PHD/ADD peaking factor of 3.05.

3.1.3 Per Capita Water Demand

The per capita consumption rate is used for estimating the City's future water requirements, evaluating the adequacy of the supply source, and determining storage needs. The consumption rate, expressed in gallons per capita per day (gpcd), is applied to the projected population to yield future water requirements.

Historical City residential per capita water use is calculated by dividing the City's total production by the total population. Table 3.2 shows the historical water production and per capita consumption from 2010 to 2014. As shown in Table 3.2, the City's per capita demand ranged between 177 gpcd in 2014 to 254 gpcd in 2012, averaging 233 gpcd for 2010 through 2013.

3.1.4 Historical Connections

The City's customers are classified into one of the following nine categories:

- Single-family residential
- Multi-family residential
- Mobile-home
- Commercial
- Industrial
- City of Shasta Lake
- School
- Other Government
- Church

Table 3.2 Historical Per Capita Water Demand

Year	Population ⁽¹⁾	Average Day Demand ⁽²⁾ (mgd)	Per Capita Demand (gpcd)
2010	10,164	2.37	233
2011	10,098	2.12	210
2012	10,058	2.55	254
2013	10,064	2.35	234
2014	10,044	1.78	177
2010-2013 Average ⁽³⁾			235

Notes:

- (1) Source: California Department of Finance.
(2) Source: City of Shasta Lake water treatment plant flow data.
(3) 2010-2013 average was rounded up to the nearest 5.

The number of accounts for each customer category for the years 2012 through 2014 is summarized in Table 3.3. The data corresponds to the unique address associated with every account, thus eliminating the possibility of double counting addresses that may have switched its account holder during the same year.

Table 3.3 Historical Connections

Customer Class	Number of Connections by Year		
	2012	2013	2014
Single-Family Residential	3,369	3,368	3,387
Multi-Family Residential	101	100	100
Mobile-Home	69	67	59
Commercial	122	119	118
Industrial	8	8	8
City of Shasta Lake	31	31	31
School	8	8	8
Other Government	10	10	10
Church	17	17	17
Total	3,735	3,728	3,738

As shown in Table 3.3, the total number of meters by customer class has remained fairly stable during the period from 2012 through 2014.

3.1.5 Historical Metered Water Consumption

Historical metered water consumption data by customer class for the years 2012 through 2014 were obtained from the City's billing records and are presented in Table 3.4. Annual metered consumption by year was calculated by dividing the annual consumption sum for each customer class by the number of unique meter address of that customer class. Consumption of the City's ten largest customers is discussed below. As shown in Table 3.4, the City's total annual consumption for 2012 and 2013 was 2.15 mgd. Approximately 67-percent of the total

consumption (1.44 mgd) was associated with single-family residential customers. The City's metered consumption decreased significantly in 2014 along with the total production data. Again, this is associated with the extreme drought conditions in California in 2014.

Table 3.4 Historical Metered Water Consumption

Customer Class	Metered Consumption (mgd)			2012-13 Average ⁽¹⁾
	2012	2013	2014	
<u>Residential</u>				
Single-Family Residential	1.43	1.45	1.10	1.44
Multi-Family Residential	0.09	0.08	0.07	0.08
Mobile-Home	0.10	0.11	0.08	0.11
<u>Non-Residential</u>				
Commercial	0.08	0.07	0.07	0.08
Industrial	0.27	0.24	0.21	0.26
City of Shasta Lake	0.08	0.08	0.05	0.08
School	0.06	0.06	0.05	0.06
Other Government	0.03	0.03	0.02	0.03
Church	0.01	0.01	0.01	0.01
Total	2.14	2.15	1.65	2.15

Note:

(1) 2014 data was not used for analysis due to demands reductions associated with severe drought conservation mandates.

3.1.5.1 Large Customers

The demand trends for a city's large consumer are evaluated separately so that their demands can be allocated to their precise location in the water system. In 2013, the City's ten largest consumers consisted of two industrial accounts, one government account, one mobile home account, one multifamily account, two school accounts, and three City of Shasta Lake accounts (see Figure 3.2). Historical consumption for these accounts is shown in Table 3.5 for the year 2013. Appendix D contains historical consumption data associated with the top ten customers for the years 2012 and 2014.

In the future, the demand of these individual large consumers is not likely to grow, based on discussion with City Staff. Thus, it is predicted that the largest consumers' demand will remain constant according to their existing demands in the planning period years.

Table 3.5 Top Ten Customer Demand - 2013

Rank	Customer	Customer Class	Daily Average Metered Consumption (gpd)
1	Knauf Insulation GmbH	Industrial	143,097
2	Sierra Pacific Sawmill	Industrial	77,567
3	Twin Lakes	Mobile Home	71,103
4	City of Redding- Finance	Government	27,101
5	Gateway Unified School District	School	26,440
6	Tara Hills Garden Investors	Multifamily	19,536
7	Gateway Unified School District	School	17,044
8	Gateway	City of Shasta Lake	16,584
9	POLF Park Lights & Water	City of Shasta Lake	13,526
10	Little League Ballpark	City of Shasta Lake	12,940

3.1.6 Equivalent Dwelling Unit

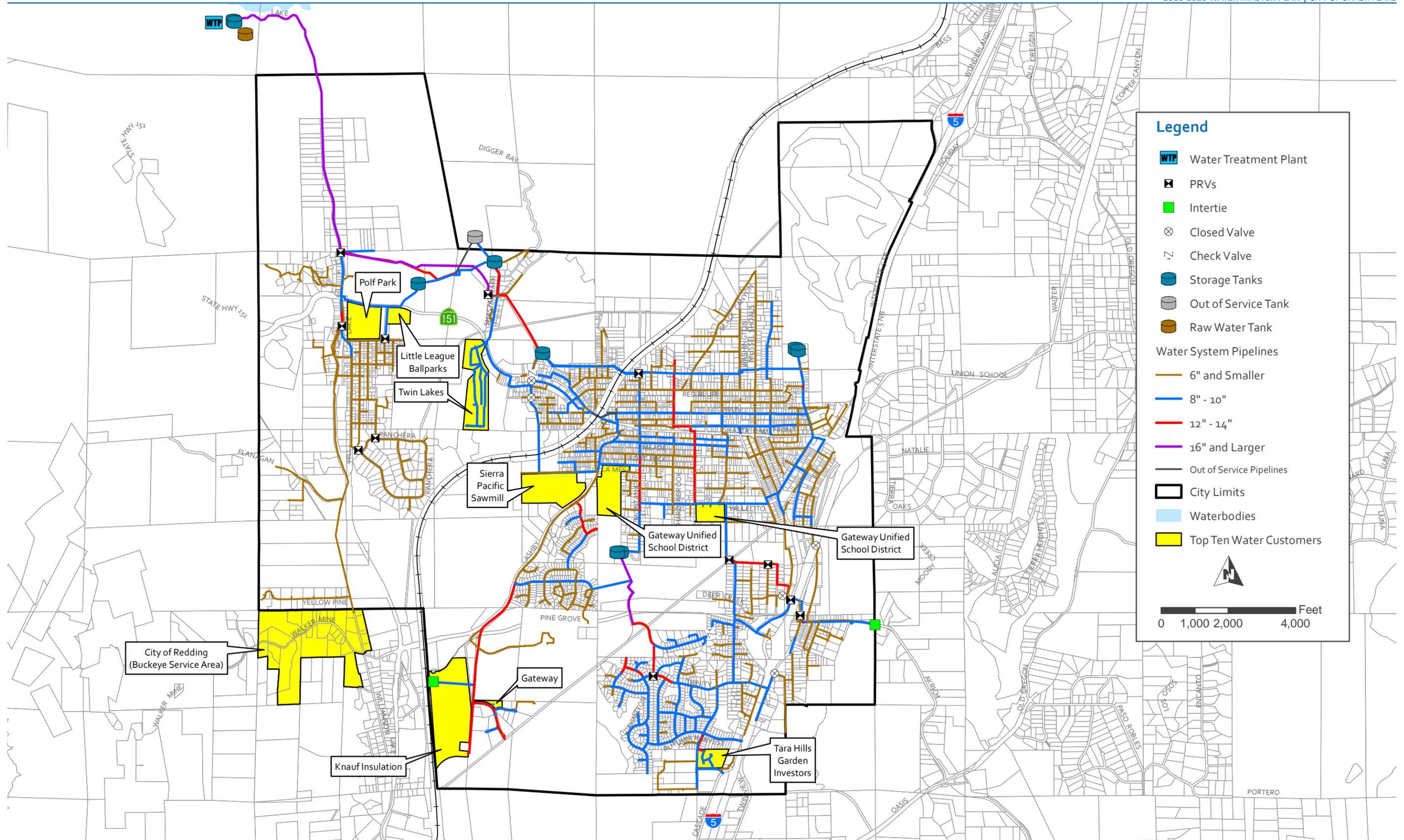
An equivalent dwelling unit (EDU) is used to express water use by non-residential customers as an equivalent number of single-family residential customers. An EDU is the amount of water consumed by a typical full-time single-family home.

Water use per EDU is calculated by dividing the total metered volume of water in the single-family home customer class by the total number of metered single-family residential accounts. This number defines the average water use per EDU.

The average daily consumption per account for each customer class for the years 2012 through 2014 is shown in Table 3.6. The 2012 through 2013 average metered water consumption per single-family residential connection was 427 gallons per day (gpd). 2014 data was excluded because the consumption rate of 326 gpd per account (gpd/acct) is an outlier due to drought.

It should be noted that the consumption values per connection that are identified in Table 3.6 do not account for UFW. Using an UFW percentage of 8.6-percent, the average EDU value would increase to approximately 467 gpd per dwelling unit (gpd/DU) for single family customers, which can be rounded to 470 gpd/DU for planning purposes. Therefore, demands for future residential customers can be estimated based on a water demand of 470 gpd/DU.

It should also be noted that the number of multi-family "connections" shown in Table 3.6 does not equate to the number of multi-family homes. The California Department of Finance (DOF) provides estimates of the number of multi-family homes. Using the DOF data, a typical multi-family home demand was estimated to be roughly 300 gpd/DU (including UFW).



Legend

- Water Treatment Plant
- PRVs
- Intertie
- Closed Valve
- Check Valve
- Storage Tanks
- Out of Service Tank
- Raw Water Tank

Water System Pipelines

- 6" and Smaller
- 8" - 10"
- 12" - 14"
- 16" and Larger
- Out of Service Pipelines

- City Limits
- Waterbodies
- Top Ten Water Customers

0 1,000 2,000 4,000 Feet

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Table 3.6 Historical Water Consumption per Connection

Customer Class	Metered Consumption (gpd/account)			2012-13 Average ⁽¹⁾	EDU/ account
	2012	2013	2014		
Residential					
Single-Family Residential	425	430	326	427	1.0
Multi-Family Residential	844	833	686	839	2.0
Mobile-Home	1,520	1,680	1,337	1600	3.7
Non-Residential					
Commercial	626	630	569	628	1.5
Industrial	33,509	30,212	26,429	31860	74.6
City of Shasta Lake	2,443	2,675	1,487	2559	6.0
School	7,144	8,025	6,012	7585	17.8
Other Government	2,855	3,046	1,922	2951	6.9
Church	573	626	535	599	1.4

Note:

(1) 2014 data was not used for analysis due to demands reductions associated with severe drought conservation mandates.

3.1.7 Unaccounted-For-Water

The difference between water production (or supply) and consumption (billed to customers) is defined as unaccounted for water (UFW), or water loss. Water loss may be attributed to leaking pipes, unmetered or unauthorized water use, inaccurate meters, treatment losses, or other events causing water to be withdrawn from the system and not measured. Specific events that cause water loss can include hydrant flushing, street cleaning, system flushing, and firefighting. The City's estimated unaccounted for water for the years 2012 through 2014 is summarized in Table 3.7. As shown in Table 3.7 there was a significant reduction in unaccounted for water between 2012 and 2013. The City noted that the reduction was the result of the City repairing a large leak along Pensacola Avenue in 2012. For this reason, future demand projections utilize the UWF percentage from 2013 (8.6-percent).

Table 3.7 Top Ten Customer Demand - 2013

Year	Metered Consumption (mgd)	Total Production (mgd)	Unaccounted-for-Water	
			(mgd)	(Percent of Production)
2012	2.14	2.55	0.42	16.3%
2013	2.15	2.35	0.20	8.6%
2014	1.65	1.78	0.13	7.2%

3.1.8 Water Demand Factors

A water demand factor (WDF) is defined as the estimated amount of water usage per area for a certain land use type. These factors are used to estimate the ADD for the potential development areas by multiplying the WDF with the total number of areas of each land use category. WDFs were developed as part of this Master Plan to project demands for developable vacant land. WDFs are typically determined from a combination of geocoded billing records and land use

information using spatial geographic information system (GIS) routines. The WDFs shown in Table 3.8 were developed by grouping the existing developed land use parcels by categories that correspond to the City's customer classes. The 2013 metered consumption for each customer class (adjusted up to account for UFW) was then divided by the developed land use area for that customer class. The resulting WDFs are expressed in the units of gallons per day per acre (gpd/ac).

Table 3.8 Water Demand Factors

Grouped Land Use	Area (acres)	Consumption (mgd)	Adjusted Consumption ⁽¹⁾ (mgd)	WDF ⁽²⁾ (gpd/ac)
Single-Family Residential	1,577.2	1.53	1.67	1,100
Multi-Family Residential	80.4	0.11	0.12	1,600
Commercial	141.2	0.07	0.08	600
Industrial	215.2	0.24	0.26	1,300
Other	329.4	0.19	0.21	700
Total	2,382.9	2.15	2.35	--

Notes:

(1) The adjusted consumption is scaled up to 2.35 mgd to match the existing ADD (which accounts for UFW)

(2) Water Demand Factor rounded to the nearest 100.

3.1.9 Existing Water Demands by Pressure Zone

In order to evaluate the capacity of the water system using the hydraulic model, demands associated with each individual connection were allocated into the hydraulic model to specific model nodes. The demands for specific model nodes were calculated by first geocoding the City's billing data using GIS techniques and then assigning the geocoded billing data into the hydraulic model. More information related to the allocation of water demands within the hydraulic model is provided in Chapter 4. The resulting demands by pressure zones are summarized in Table 3.9. As shown in Table 3.9, approximately 57-percent of the City's demands are associated with Pressure Zone G (see Chapter 4 for a pressure zone map of the City).

Table 3.9 Existing Demand by Pressure Zone

Pressure Zone	ADD (mgd)	MDD ⁽¹⁾ (mgd)	Percent of Total Demand (%)
Zone A	0.03	0.07	1%
Zone B	0.10	0.22	4%
Zone C	0.10	0.22	4%
Zone D	0.08	0.17	3%
Zone E	0.02	0.04	1%
Zone F	0.18	0.39	8%
Zone G	1.33	2.90	57%
Zone I	0.42	0.92	18%
Zone J	0.08	0.17	3%
Total	2.35	5.12	100%

Note:

(1) MDD = 2.18 x ADD

3.2 Demand Projections

This section summarizes the future 2036 and build-out of the City limits. The 2036 (20-year) and build-out demand projections were developed based on the planning assumptions documented in Chapter 2 of this report, as well as the existing water demand parameters identified in the previous sections.

3.2.1 2036 Demand Projections

Build-out of the City limits is not expected to occur until well after the planning horizon of this Master Plan. According to the City's planning department, only modest growth is expected within the next 20-years. For the purposes of this Master Plan, it was assumed that the City's population would grow at a rate of approximately 1-percent per year. With this assumption, the City's population is projected to increase to 12,349 people by year 2036.

Table 3.10 summarizes the projected demands through the year 2036. As shown in Table 3.10, the City's ADD and MDD are projected to approach 2.90 mgd and 6.32 mgd by 2036, respectively. The projected demands provided in Table 3.10 assume a per capita water demand of 235 gpcd, which is equal to the average per capita demand from 2010 to 2013. This is likely a conservative assumption, because the per capita water demand is expected to decrease in the future due to increased conservation measure and more water efficient construction associated with new development. Because the purpose of this Master Plan is to size infrastructure needs for the distribution system, it is appropriate to include a level of conservatism when planning future transmission, distribution, and storage needs.

The City's 2015 Urban Water Management Plan (UWMP) identified a 2020 per capita demand target of 215 gpcd and an interim 2015 per capita target was calculated of 241 gpcd. Figure 3.3 shows the projected ADD based on the 2010-2013 per capita demand of 235 gpcd. Additionally, the projected ADD based on the UWMP per capita target of 215 gpcd. As shown on Figure 3.3, assuming a per capita demand of 215 gpcd at 2036 would yield a projected ADD of approximately 2.65 mgd, which is approximately 9-percent lower than the more conservative ADD projection of 2.90 mgd identified in Table 3.10. For planning purposes, however, the higher ADD value of 2.90 mgd will be used to size future distribution system facilities. Table 3.11 summarizes the distribution of demands by pressure zone in 2036.

Table 3.10 Future Demand Projections through 2036

Year	Projected ADD ⁽¹⁾ (mgd)	Projected MDD ⁽²⁾ (mgd)
2015 (Existing)	2.35	5.12
2016	2.37	5.17
2021	2.49	5.44
2026	2.62	5.72
2031	2.76	6.01
2036	2.90	6.32

Notes:

(1) Projected Population assumes a 1% per year population growth

(2) MDD/ADD Peaking Factor = 2.18

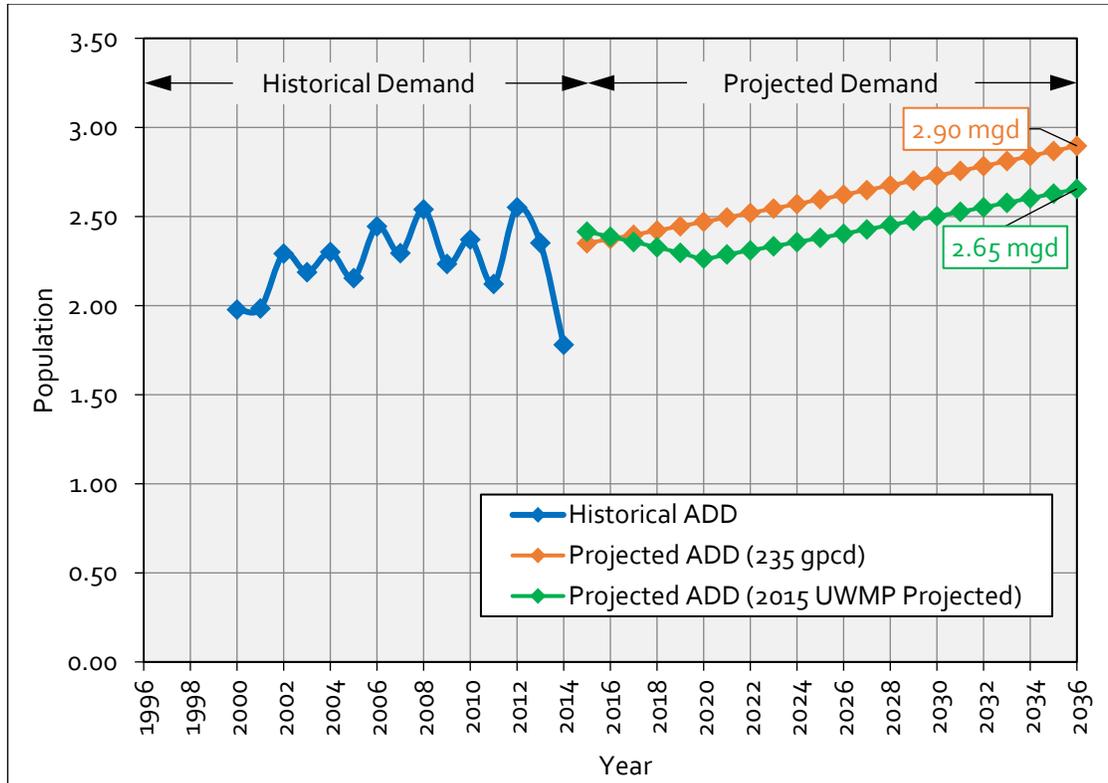


Figure 3.3 Projected Average Day Demand

Table 3.11 2036 Demand by Pressure Zone

Pressure Zone	ADD (mgd)	MDD ⁽¹⁾ (mgd)	Percent of Total Demand (%)
Zone A	0.03	0.08	1%
Zone B	0.15	0.34	5%
Zone C	0.10	0.22	3%
Zone D	0.08	0.18	3%
Zone E	0.03	0.06	1%
Zone F	0.21	0.46	7%
Zone G	1.63	3.56	56%
Zone I	0.50	1.08	17%
Zone J	0.16	0.34	5%
Total	2.90	6.32	100%

Note:

(1) MDD = 2.18 x ADD

As described in Chapter 2, the City has identified several "focus areas" in the City and has provided specific development information related to those areas. Table 3.12 includes demand estimates associated with each focus area.

Table 3.12 General Plan Focus Area Residential Development Information (Year 2035 Conditions)

Focus Area	Residential Demands			Non-Residential Demands		
	Dwell. Unit Allocation	Type	ADD (gpd)	Bldg. Sq. Footage	Type	ADD (gpd)
1A	17.8	MFR	5,340	1,872	Village Mixed Use	29
1B	17.8	MFR	5,340	1,872	Village Mixed Use	29
1C	0	-	0	6,240	Commercial	478
1D	13.35	MFR	4,005	33,696	Commercial	2,579
1E	17.8	MFR	5,340	6,240	Commercial	478
1F	0	-	0	22,000	Industrial Light	1,122
1G	13.35	MFR	4,005	15,600	Mixed Use	1,194
1H	8.9	SFR	4,183	0	--	0
2A	42.72	MFR	12,816	5,850	Mixed Use	448
2B	10.68	MFR	3,204	0	Commercial	0
2C	10.68	MFR	3,204	5,850	Commercial	448
2D	7.12	MFR	2,136	8,775	Mixed Use	671
2E	0		0	8,775	Mixed Use	671
3A	8.9	MFR	2,670	2,600	Village Mixed Use	40
3B	26.7	MFR	8,010	2,600	Village Mixed Use	40
4A	8.9	MFR	2,670	4,875	Mixed Use	373
4B	17.8	SFR/MFR	6,853	3,250	Mixed Use	249
4C	0		0	3,250	Commercial/Ind. Light	207
4D	0		0	4,875	Commercial	373
4E	17.8	MFR	5,340	3,250	Commercial/Mixed Use	249
4F	4.45	SFR	2,092	3,250	Mixed Use	249
4G	4.45	SFR	2,092	0	Commercial	0
4H	17.8	SFR	8,366	0	--	0
4I	8.9	SFR	4,183	4,875	Commercial	373
4J	17.8	SFR/MFR	6,853	1,625	Commercial	124
4K	35.6	MFR	10,680	3,250	Mixed Use	249
4L	26.7	SFR	12,549	0	--	0
Total	356		121,930	154,470		10,670

As shown in Table 3.12, the estimated demand associated with the focus areas is approximately 0.122 mgd for the projected residential development, and 0.011 mgd for the projected non-residential development. Appendix E includes more detailed information related to how the demand estimates for the focus areas were developed. These demands are assumed to be included in the 2036 demand projections provided in Table 3.10. As discussed in Chapter 2, it is not currently known when the proposed Mountain Gate at Shasta Development will come

online. For the purposes of this Master Plan, therefore, it was assumed that this project will be constructed after 2036.

3.2.2 Build-Out Demand Projections

Build-out demand projections were developed using a combination of General Plan land use information, specific plans, vacant land information, aerial photography, and water demand factors. This section summarizes the projected build-out demand projections.

In general, build-out demands were developed by multiplying the available developable land use area (in terms of parcel acreage) by a land use based WDF. The WDFs identified in Table 3.13 were developed based on a review of the City's existing WDFs (summarized in Table 3.8) and the City's General Plan Land Use designations described in Chapter 2.

Table 3.13 Build-Out Demands

Land Use Category	Build-Out Demands			
	Developable Land ^{(1),(3)} (acres)	WDF (gpd/ac)	ADD (mgd)	MDD (mgd)
<u>Existing (2015) Demands</u>	--	--	2.35	5.12
<u>Residential</u>				
Rural Residential A	184	100	0.02	0.04
Rural Residential B	192	300	0.06	0.13
Suburban Residential	713	1,500	1.07	2.33
Urban Residential	380	2,900	1.10	2.40
Urban Residential High	17	5,600	0.10	0.21
<u>Commercial & Mixed Use</u>				
Commercial	60	1,000	0.06	0.13
Mixed Use	320	2,500	0.80	1.75
Village Mixed Use	13	2,500	0.03	0.07
Mtn. Gate ⁽²⁾	564	varies	0.68	1.48
<u>Industrial</u>				
Industrial Light	19	1,000	0.02	0.04
Industrial	494	1,600	0.79	1.72
<u>Other</u>				
Community Parks	68	2,000	0.14	0.30
Federal Government	120	500	0.06	0.13
Public Facilities	10	500	0.005	0.011
Open Space	0	0	0.00	0.00
Total⁽¹⁾	3,154		7.28	15.86

Notes:

- (1) Excludes right-of-way.
- (2) Appendix A includes detailed land use information related to the proposed Mountain Gate Development.
- (3) Excludes vacant land that is not anticipated to be connected to the water system in the future.

As shown in Table 3.13, the City's build-out ADD and MDD are projected to be 7.28 mgd and 15.86 mgd, respectively. This represents an increase of approximately 209-percent above the current (year 2015) demand condition, which would take the City over 100 years to reach at an annual growth rate of 1-percent per year.

Table 3.14 provides a summary of the build-out demand projections by pressure zone. As shown in Table 3.14, Pressure Zone G will account for roughly half (48-percent) of the total projected build-out demands.

Table 3.14 Build-Out Demand by Pressure Zone

Pressure Zone	ADD (mgd)	MDD ⁽¹⁾ (mgd)	Percent of Total 15 Demand (%)
Zone A	0.23	0.51	3%
Zone B	0.74	1.63	10%
Zone C	0.14	0.30	2%
Zone D	0.13	0.28	2%
Zone E	0.06	0.14	1%
Zone F	0.59	1.30	8%
Zone G	3.53	7.70	48%
Zone I	0.98	2.14	13%
Zone J	0.22	0.47	3%
Zone K	0.66	1.43	9%
Total	7.28	15.86	100%

Note:

(1) MDD = 2.18 x ADD

3.2.3 Demand Projection Summary

Table 3.15 provides a summary of the City's existing, 2036, and build-out demand projections. As shown in Table 3.15, the City's ADD is projected to increase from an existing demand of 2.35 mgd to a 2036 ADD of 2.90 mgd. By build-out, the projected ADD is could approach roughly 7.28 mgd.

Table 3.15 Demand Projection Summary

Year	ADD (mgd)	MDD ⁽¹⁾ (mgd)
Existing (2015)	2.35	5.12
2036	2.90	6.32
Build-Out	7.28	15.86

Note:

(1) MDD = 2.18 x ADD

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Chapter 4

WATER DISTRIBUTION SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter summarizes the City of Shasta Lake's (City's) existing water distribution system infrastructure, including the water treatment plant (WTP), booster pump stations, pressure zones, storage tanks, pressure reducing valve (PRV) stations, and water mains. This chapter also describes the development and calibration of the City's water distribution system hydraulic model.

4.1 Existing Water Distribution System

This section presents an overview of the City's existing water distribution system, water supply, storage, and pumping facilities, as shown on Table 4.1. First, the City's water supply sources are described, followed by a description of the City's water distribution system and facilities.

4.1.1 Water Supply

The City's sole source of water is surface water diverted from Shasta Lake. The diversion point is at the face of the dam, where there are two intakes that draw water from elevations of 750-feet and 950-feet above sea level. Raw water is pumped to the City's Fisherman's Point WTP via a Raw Water Pumping Station (RWPS) operated by the United States Bureau of Reclamation (USBR), which is located at the base of Shasta Dam.

The City has the following long-term water contracts: 4,430 Acre-Feet (AF) via a Central Valley Project (CVP) contract with USBR; 2,000 AF via a transfer agreement with the Anderson Cottonwood Irrigation District (ACID); 325 AF and 132 AF of first right of refusal with MCM Inc.; and 50 AF with Shasta County Water Agency. The City also has emergency interties with Bella Vista Water District and City of Redding. The following conditions affect the City's ability to withdraw the full allocation allowed by contract:

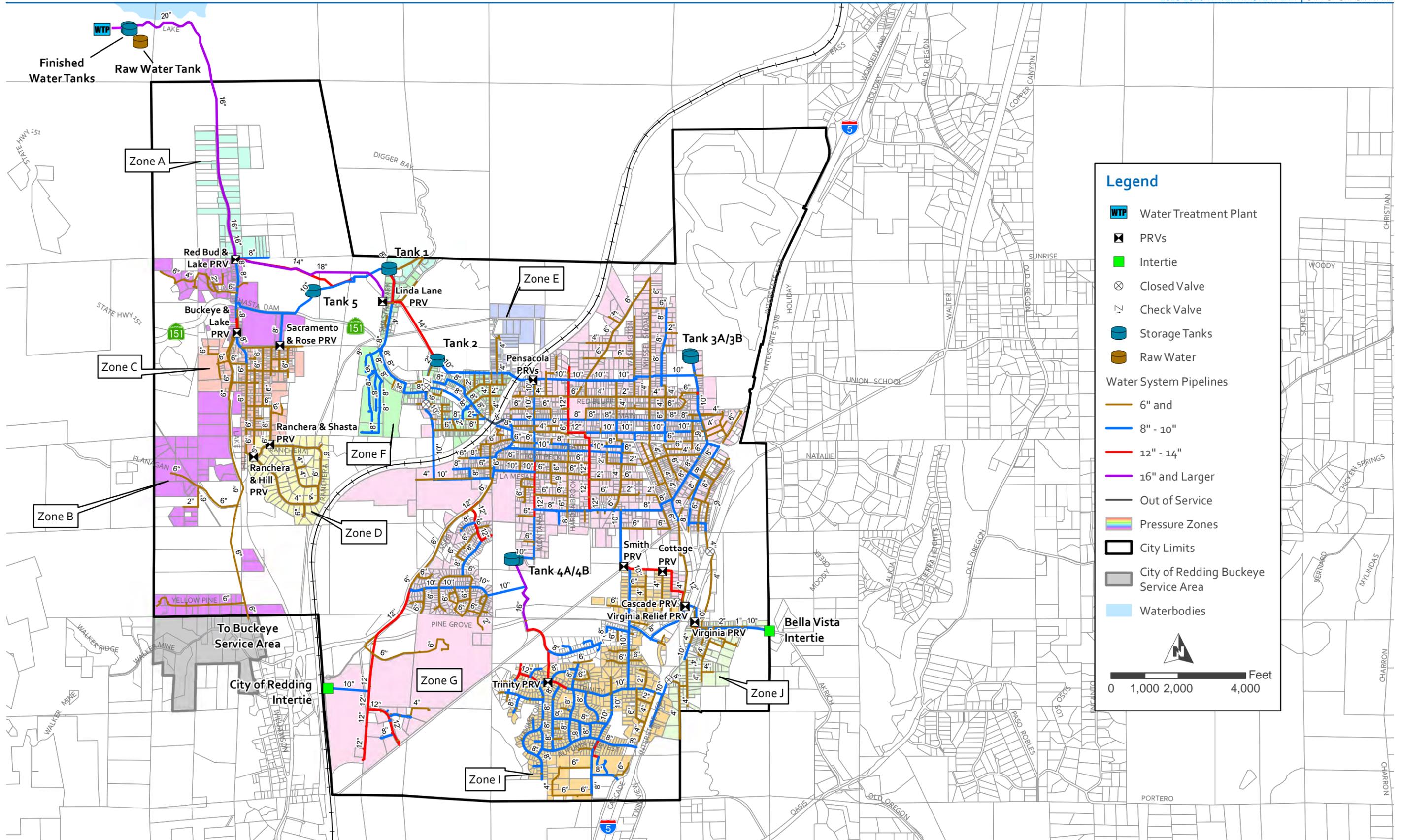
- **Cold Water Pool (CWP):** As noted above, the City's ability to withdraw contract water from its intakes in Shasta Dam is significantly impacted by the CWP. The CWP consists of a large layer of cold subsurface water that exists in Shasta Lake. In the spring months, a thermocline is established in Shasta Lake whereby the temperatures stabilize and stay fairly consistent through the summer months.
- **4430 AF (CVP):** The City currently uses about 60 percent of this allocation during an average year. However, during low precipitation years, the City's CVP allocation of 4,430 AF can be reduced drastically, depending on USBR water supply projections. The reduction is based on the historical average of the City's actual water usage over the prior three unconstrained or non-cutback water years. In 2014, the average water usage over the last three unconstrained or non-cutback years was 2,582 AF. The allocation reduction is 75 percent, resulting in approximately 645 AF being made available to the City (or 14 percent of the City's full CVP allocation).
- **2000 AF (ACID):** The City negotiated this 40-year take-or-pay water transfer with ACID in 2008, subject to USBR approval, in an attempt to secure a long-term supply solution and

to provide drought protection. The original diversion point of this transfer water was the ACID diversion structure in the Sacramento River just west of the SR299 overcrossing; this transfer would move the diversion point from the ACID diversion structure to the City's intakes inside Shasta Dam. Shortly after the contract was signed, USBR informed the City that withdrawals from the intakes within the Dam "...substantively affect the Cold Water Pool in Shasta Lake under some water supply scenarios and, in turn, affect the ability to control water temperatures downstream as required by State and Federal Law." Because of the relocation of the diversion point, to date USBR has approved a maximum withdrawal of 140 AF of the 2,000 AF available.

- *325 AF (MCM Inc.):* The City negotiated this right-of-first-refusal water transfer with MCM Inc., a private agricultural user in 2005, subject to USBR approval, in an attempt to secure a long-term supply solution and to provide drought protection. The original diversion point of this transfer water was from the Sacramento River south of Redding; this transfer would move the diversion point to the City's intakes inside Shasta Dam. The City refused the transfer from 2005 to 2008, because it was not needed. In 2008, USBR informed the City that withdrawals from the intakes within the Dam "...substantively affect the Cold Water Pool in Shasta Lake under some water supply scenarios and, in turn, affect the ability to control water temperatures downstream as required by State and Federal Law." Because of the relocation of the diversion point, to date USBR has not approved the transfer of the 325 AF from MCM Inc.
- *50 AF (Shasta County Water Agency [SCWA]):* Prior to the City's incorporation in 1993, the Shasta Dam Area Public Utilities District (PUD) had a CVP contract with USBR for an unknown amount of water that was administered by SCWA. Following incorporation, a portion of the PUD contract was allocated to the City, first as a shortage supply and then as a direct transfer. The City is currently looking into adding this contract into the larger City CVP contract on a permanent basis.

The City's contract with ACID and MCM Inc. requires approval by the USBR Contracting Officer before any water delivery can occur (that is, prior to the City actually receiving the water from the contracting agency). This approval would be a discretionary action by USBR, requiring National Environmental Policy Act (NEPA) compliance, which in turn requires USBR to maintain certain river temperatures at various compliance points in the Sacramento River and make a finding that withdrawal of the additional water at the City's intake location would result in "No Significant Impact" to these river temperatures. Upon review of the ACID and MCM Inc. contracts, USBR had concerns that allowing additional withdrawals from the City's intakes in Shasta Dam (generally at the 750 foot elevation) would negatively impact the CWP, and, in turn, the temperature targets in the River.

To validate these concerns, USBR ran computer simulations that modeled the additional water withdrawals contained in the City's contracts with ACID and MCM, Inc. from the City's intakes in Shasta Dam. USBR's paraphrased conclusion states: "The reduction in CWP volumes during drought periods can result in a release temperature increase of 0.1° – 0.5° F between July and September. This increase could measurably affect the ability of the project to meet temperature requirements at the downstream compliance locations." As a result, the agency was unable to make a finding that withdrawal of the additional water at the City's current intake location would result in "No Significant Impact" to the river temperatures, and was unable to sign off on the transfers.



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As noted above, during low precipitation (i.e., drought) years when the City's CVP allocation is reduced, the City is unable to withdraw water from existing water contracts that were entered into with the specific goal of securing the City's long-term supply and to provide drought protection because of CWP compliance issues that arose after those contracts were executed. As a result, the City is forced to purchase additional water from other sources to supplement the cutback supply. In Shasta County, the only unrestricted water contractor (meaning that its water allocations are not affected by the CWP) is the McConnell Foundation, and during cutback years the City ends up paying nearly 5 times as much for raw water as it does for water supplied through the CVP allocation.

4.1.2 Fisherman's Point WTP

In 1990, the City constructed the Fisherman's Point WTP. The WTP consists of three Micro-Floc Trident filters and disinfection with chlorine. The treatment process consists of coarse screening followed by coagulation, flocculation, and filtration. The WTP has a maximum production capacity of approximately 9.72 million gallons per day (mgd), and a firm capacity of about 6.5 mgd.

The original WTP was designed to incorporate orifice plates and actuated valves for flow measurements through each filter; however shortcomings in straight pipe lengths both ahead and behind plates have caused measurement inaccuracies from moderate to severe, depending on the filter combination being used. The City has recently upgraded its flow meters at the plant and therefore has been getting more reliable flow measurement in recent months. Additionally, recent telemetry problems have caused two chlorine alarms and various other Supervisory Control and Data Acquisition (SCADA) issues.

4.1.3 Pressure Zones

Water distribution systems that have varied topography are typically divided into different hydraulic regions, known as pressure zones. The purpose of pressure zones is to maintain adequate pressures throughout the distribution system in spite of the varying topography. A Hydraulic Grade Line (HGL) is established for each pressure zone and the high water levels in reservoirs are set to maintain these HGLs. The City's service area ranges in elevation from approximately 660 feet above sea level to about 1,030 feet.

The City's water distribution system has historically consisted of ten pressure zones, but currently consists of nine pressure zones, because Pressure Zone G was rezoned to include Pressure Zone H. The characteristics of the City's nine pressure zones are described in Table 4.1. Figure 4.2 shows the existing water distribution system, including pressure zone boundaries and distribution system pipelines color coded by pressure zone. Figure 4.3 is a hydraulic profile of the distribution system.

Treated water is supplied to the distribution system at the northwest corner of the City and conveys water to the lower areas of the City PRV stations. The City does not have booster stations throughout the distribution system, as discussed earlier. However, the City depends on booster stations to convey water from Shasta Lake to the WTP, and from the WTP to the finished water tanks.

Table 4.1 Pressure Zone Summary

Pressure Zone Name	Nominal HGL ⁽¹⁾ (ft)	Reservoirs	Supply Sources to Pressure Zone		
			Booster Pump Stations	PRV Stations	Supply Sources
A	1,255	Finished Tank 1/2	Treated Water PS	--	Fisherman's Point WTP
B	1,099	Tank 5	--	Lake/Red Bud	
C	1,060	--	--	Lake/Buckeye Sacramento/Rose	
D	1,005	--	--	Ranchera/Hill Ranchera/Shasta	
E	1,077	Tank 1	--	Linda Lane	
F	1,077	Tank 1	--	Linda Lane	
G	973	Tank 2	--	Tank 1 Pensacola New/Old	
I	940	Tank 3A/B	--	Smith Ave Cottage Trinity Cascade	
J	902	Tank 4A/B	--	Virginia Virginia Relief	

Note:

(1) Nominal HGL is defined by the tank overflow elevations or the PRV station setpoints for a given pressure zone.

4.1.4 Transmission and Distribution System

The City's distribution system consists of approximately 79 miles of pipeline ranging from 1 inch to 24 inches in diameter. This section describes the distribution of pipelines by diameter, material, age, and pressure zone. Figure 4.1 shows a map of the existing distribution system with pipe diameters, and alignments. The information presented on Figure 4.1 was developed based on a review and analysis of the City's most recent water system geographic information system (GIS) database.

Table 4.2 provides a breakdown of the water distribution system excluding laterals. Figure 4.4 present the information in Table 4.2 graphically. As shown in Table 4.2, roughly 74 percent of the City's distribution system is 8-inch in diameter or smaller. About 20 percent of the system is 10-inch or 12-inch in diameter, and six percent of the system is larger than 12-inch in diameter.

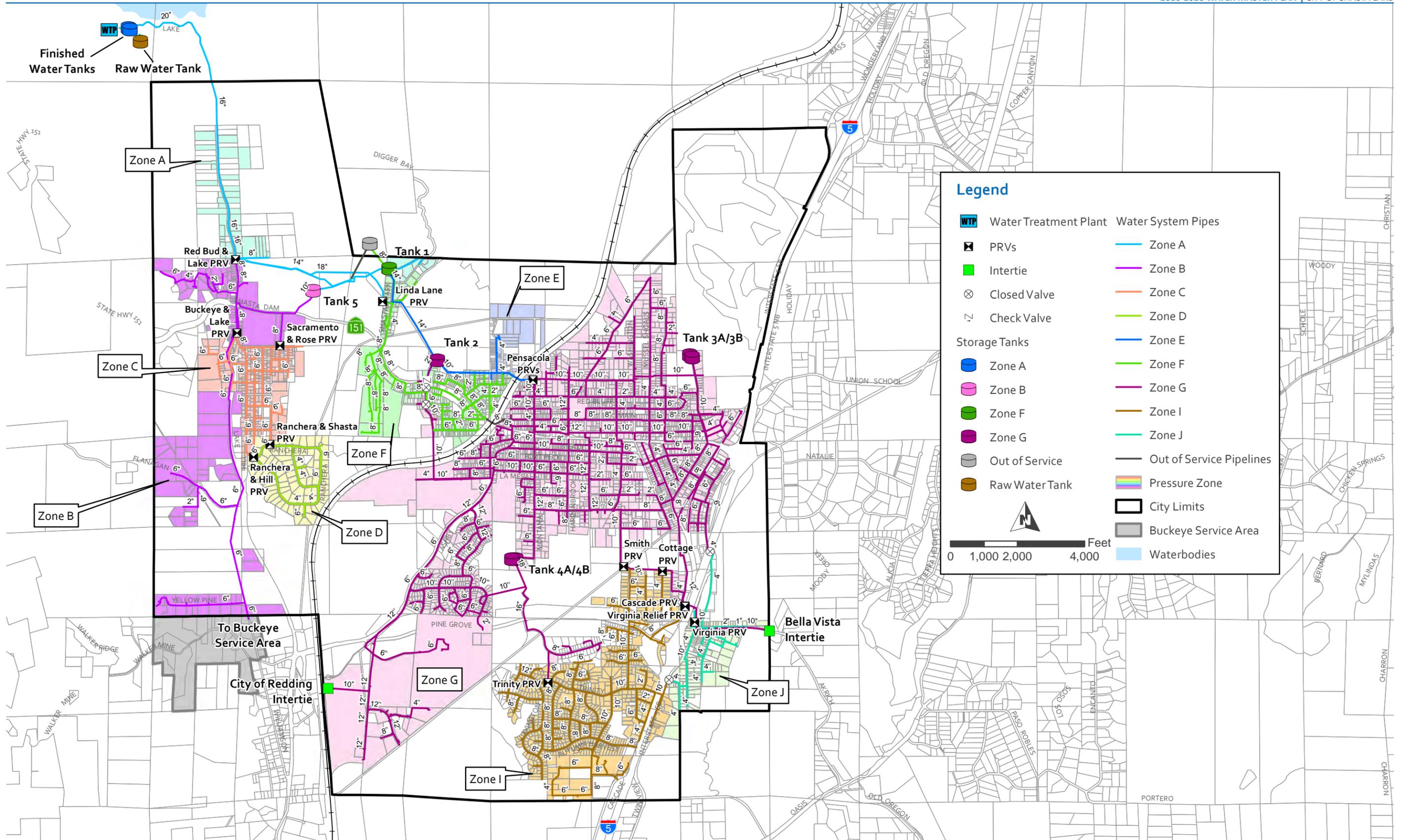
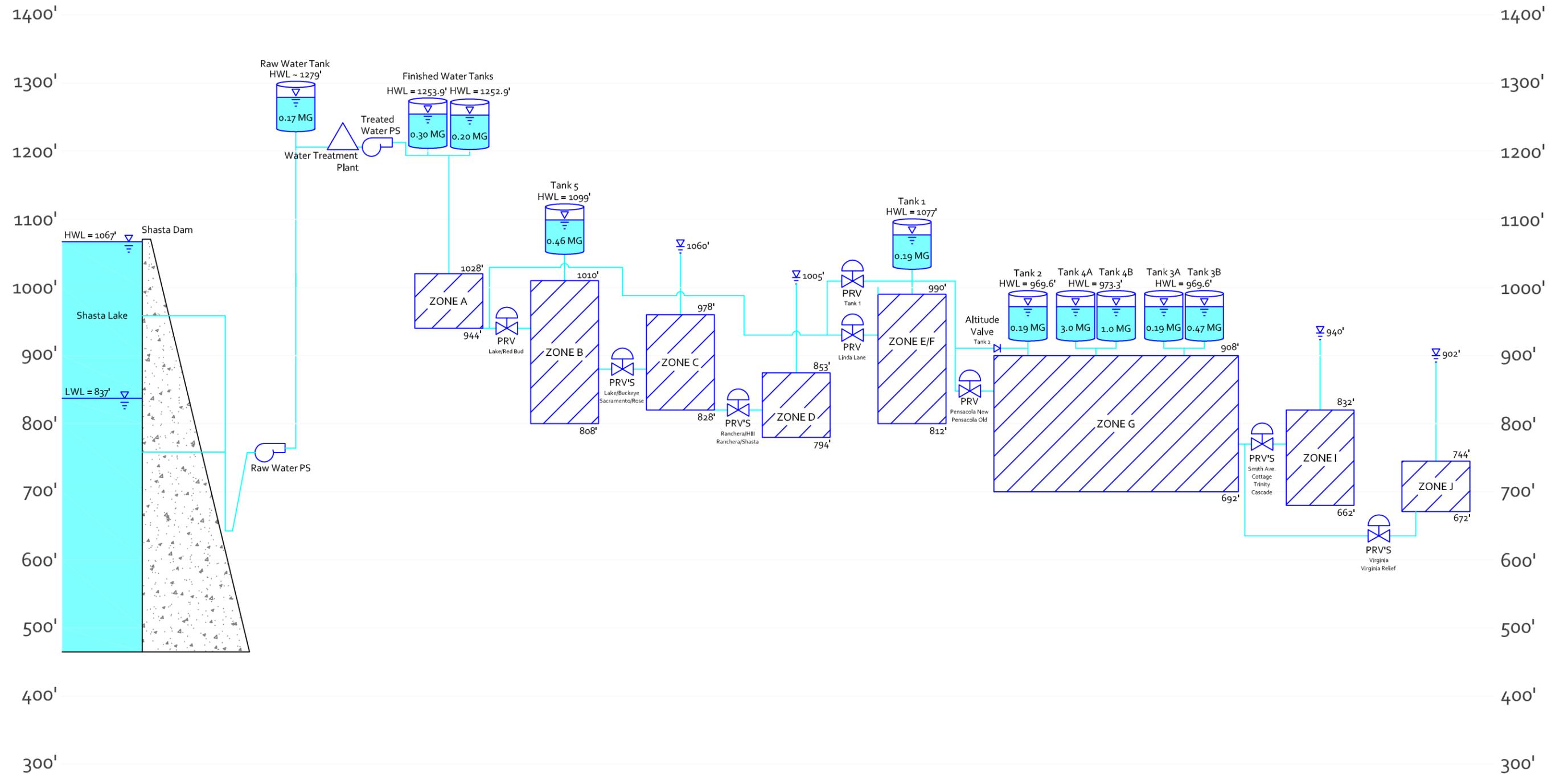


Figure 4.2
 Existing Water Distribution System
 by Pressure Zone



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LEGEND

- RESERVOIR
VOLUME INSIDE TANK
- PUMP STATION
- PRESSURE REDUCING VALVE STATION
- ALTITUDE VALVE
- PRESSURE ZONE
HIGH: HIGHEST ELEVATION SERVED IN ZONE
LOW: LOWEST ELEVATION SERVED IN ZONE
HGL: HYDRAULIC GRADE LINE FOR ZONE



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Table 4.2 Existing System Pipeline Summary, by Diameter

Diameter (inches)	Length ⁽¹⁾ (feet)	Length (miles)	Percent of System
< 6"	83,700	15.9	20%
6"	139,600	26.4	33%
8"	86,200	16.3	21%
10"	58,900	11.2	14%
12"	23,600	4.5	6%
14"	8,600	1.6	2%
16"	9,300	1.8	2%
18"	6,400	1.2	2%
20"	2,700	0.5	1%
24"	300	0.1	0%
Total	419,300	79.4	100%

Note:

(1) Source: City of Shasta Lake revised GIS database

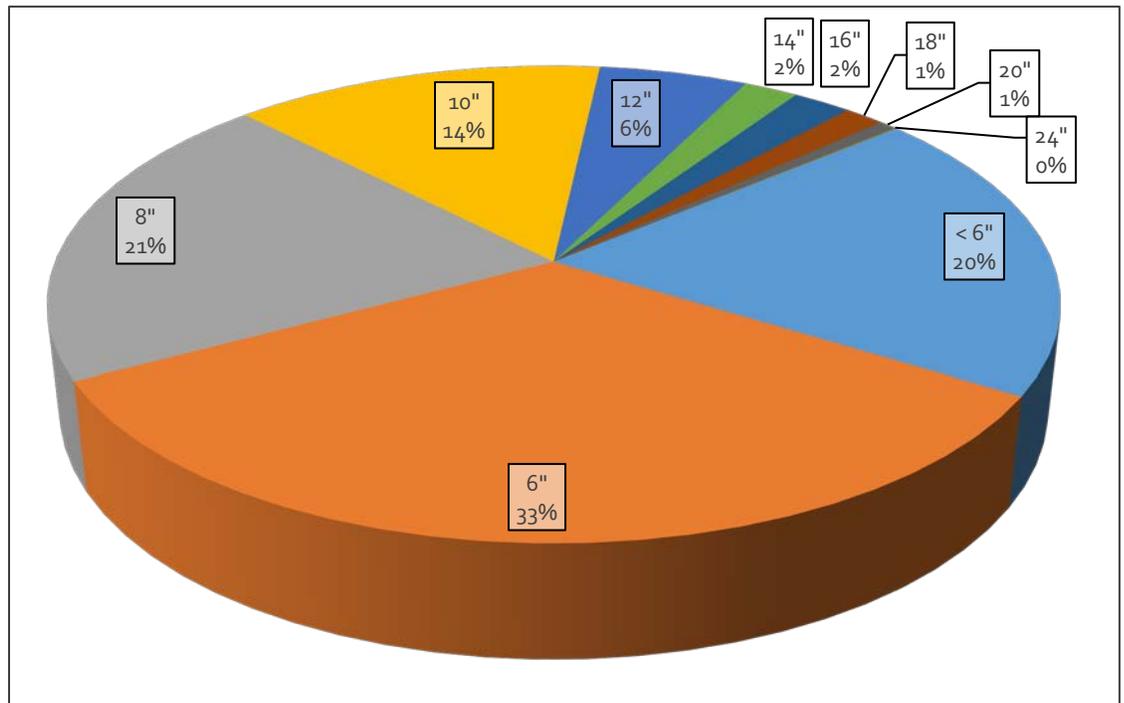


Figure 4.4 Existing System Pipeline Summary, by Diameter

4.1.5 Storage Tanks

Water distribution systems rely on stored water to help equalize daily fluctuations between supply and demand, to supply sufficient water for firefighting, and to meet demands during an emergency or an unplanned outage of a major source of supply.

The City's water system has nine active treated water reservoirs at six different sites totaling 6.01 Million Gallons (MG), and one active raw water reservoir totaling 0.17 MG. In addition, there is a 0.15 MG storage tank located at the old Central Valley Treatment Plant that is currently abandoned. The locations of the City's existing reservoirs are shown on Figure 4.1, while detailed information for the treated water reservoirs is summarized in Table 4.3.

Each of the City's storage reservoirs are ground-level reservoirs, ranging in volume from 0.19 to 3.0 MG each. The water level in the existing water distribution tanks are controlled in the following manner:

- *Tank No. 1:* One-way altitude valve.
- *Tank No. 2:* One-way altitude valve.
- *Tank No. 3A, 3B, 4A and 4B:* Two-way altitude valves that are controlled by the tank level setting of Tank 4A. These tanks are filled from higher pressure zones via the Pensacola PRVs. The Pensacola PRVs are unique for the City in the sense that the PRV station set points are adjusted up and down throughout the year. The purpose of this is to aid in the ability to fill Tanks 3A/3B and 4A/4B.
- *Tank No. 5:* A level switch automatically opens and closes the Red Bud and Lake PRV station.
- *Raw Water Tank:* The level in the Raw Water Tank is maintained by the RWPS based on level set points.
- *Finished Water Tanks 1 and 2:* The level in the Finished Water Tanks is maintained by the flow being discharged from the Fisherman's Point WTP. The flow from the plant is controlled based on the level in the finished water tanks. Treated water is stored in a small clear well on the upstream side before being pumped into the Finished Water Tanks by the Finished Water Pump Station.

4.1.6 Pump Stations

There are two pump stations that supply the City with water. The City's RWPS was constructed in 1948 and is operated by USBR. The existing RWPS consists of five pumping units: two 125 horsepower (HP) pumps, one 200 HP pump, one 350 HP pump, and one 400 HP pump. There is also a spare can for a future sixth pump at the RWPS site.

The RWPS is equipped with a hydropneumatic tank at the pump station site. Raw water is pumped from two intakes at 750 feet and 950 feet on Shasta Dam through a single 16-inch raw water transmission line up the hill to the City's Raw Water Tank. The RWPS pumping capacity can be affected by low water levels in Shasta Lake during drought conditions.

Table 4.3 Existing Storage Tank Summary

No.	Name	Year Inst.	Volume ⁽¹⁾ (MG)	Diameter ⁽¹⁾ (ft)	Height ⁽¹⁾ (ft)	High Water Line (ft)	Pressure Zone
1	Picard	1948	0.19	38	22	1,077.0	E
2	Rouge	1954	0.19	38	22	969.6	F
3A	Shasta Way A	1954	0.19	38	22	969.9	G
3B	Shasta Way B	1976	0.47	50	32	969.6	G
4A	Montana A	2005	3.0	126	32	973.3	G
4B	Montana B	1977	1.0	73	32	973.3	G
5	Toyon	1972	0.47	60	22	1,099.0	A
Raw	Raw Water	-	0.17	33	26	~1279	To WTP
FW 1	Finished Tank 1	1942	0.20	34	30	1253.9	A
FW 2	Finished Tank 2	1948	0.30	41	30	1252.9	A

Note:

(1) Source: Data provided by City staff based on recent tank measurements.

There are several issues/noteworthy items related to the RWPS, including the following:

- Pump 1 was recently out of service, and was rebuilt with the wrong impeller size. The City resolved this issue and Pump 1 is back in service with the proper impeller size.
- Pump 2 was recently out of service and has been rebuilt. It is back in service.
- With Pump 5 out of service, the City may have issues in meeting the supply needs of the City.
- Pump 5 is a 400 HP Variable Frequency Drive (VFD) that is unable to run during low demand conditions.
- The USBR recently obtained the money to add a new pump (Pump 6) which will mirror Pump 5.
- There is a need to increase the firm capacity of the pump station to provide the City with a more reliable pumping capacity.
- The City has had issues in the past with failures in the raw water transmission line from the pump station up to the Raw Water Tank. A failure of this line would result in a complete loss of water supply to the Fisherman's Point WTP and to the City. Furthermore, the City only has 0.17 MG of raw water storage, which increases the risk to the City of a failure to the raw water transmission main.

The existing Treated Water Pump Station (TWPS) was constructed in 1990, and is owned and operated by the City. The TWPS pumps treated water from the WTP's clear well to the Finished Water Tank 1 and Finished Water Tank 2. TWPS consists of three pumps each with a rated capacity of 4,000 gpm. Base on SCADA information from the City, the actual pumping rate of the two older pumps (pumps 1 and 2) appears to be roughly 3,000 gpm. The new pump (pump 3) is assumed to have a capacity of 4,000 gpm. Table 4.4 provides a summary of the City's pump stations.

Table 4.4 Existing Pump Station Summary

No.	Year Inst.	Power (HP)	Pump Capacity (gpm)	Design Head (ft)	Speed Type	Pump Elev. (ft)	From	To
Treated Water PS								
Pump 1	1990	60	4,000 ⁽¹⁾	49	Fixed	1,210	WTP	Zone A
Pump 2	1990	60	4,000 ⁽¹⁾	49	Fixed	1,210	WTP	Zone A
Pump 3	2007	60	4,000	50	Fixed	1,210	WTP	Zone A
Raw Water PS ⁽²⁾								
Pump 1	n/a	125	750	275	Fixed	764	Shasta Dam	WTP
Pump 2	n/a	125	850	275	Fixed	764	Shasta Dam	WTP
Pump 3	n/a	200	1,600	275	Fixed	764	Shasta Dam	WTP
Pump 4	n/a	350	3,300	275	Fixed	764	Shasta Dam	WTP
Pump 5	2007	400	2,500	470	Variable	764	Shasta Dam	WTP

Notes:

- (1) These pumps operate inefficiently and cannot pump at 4,000 gpm. Based on information provided by the City, it appears that these pump operate at around 3,000 gpm each.
- (2) This pump station is operated by the USBR.

4.1.7 PRV Stations

PRV stations allow distribution systems to transfer water from upper pressure zones to lower pressure zones without exceeding the allowable pressures in the lower zones or completely draining the pressure out of the higher zone. The water is transferred through a valve that reduces the pressure to a specified pressure setting, while maintaining the pressure in the upper pressure zones. PRV stations will often include several valves of various types, generally configured to use the smaller valves first and the larger valves when the smaller valve’s flow capacity is not sufficient for the intended function.

The City’s distribution system includes 20 active PRVs at 15 active PRV stations. Of the 15 active stations, five include two separate valves, whereas the remaining 10 PRV stations include only a single valve. The locations of these PRV stations are shown on Figure 4.1, while detailed information for PRS at each station is summarized in Table 4.5. It should be noted that specific customers in higher pressure areas of the City may be equipped with individual home site PRVs. Any such valves are not indicated on Figure 4.1 or in Table 4.5, because individual home site PRVs are owned and maintained by the individual homeowner.

The majority of the City's PRVs do not include operational controls, with the following exceptions:

- *Red Bud & Lake:* This PRV station includes on/off controls based on the levels in Tank 5, and is used to fill Tank 5 and provide water service to Zone B. The PRV controls are set to maintain the level in Tank 5 between 17-feet and 19-feet.
- *Pensacola:* This PRV station includes on/off controls based on the levels in Tank 4A/4B, and is used to fill Tanks 3A/3B and 4A/4B, as well as to provide water service to Zone G. The PRV controls are set to maintain the level in Tank 4A/4B between 23-feet and 25-feet.

Table 4.5 Existing PRV Station Summary

Name	Valve Size (in)	Elevation (ft)	Upstream Zone	Downstream Zone	Pressure Setting (psi)
Red Bud & Lake	6	941.7	A	B	78
Sacramento & Rose	6	899.8	B	C	70
Buckeye & Lake	6	882.4	B	C	74
Ranchera & Hill	6	841.1	C	D	70
Ranchera & Shasta	6	833.3	C	D	76
Pensacola New ⁽¹⁾	10	843.9	F	G	64
Pensacola Old	10	844.1	F	G	58
Smith Ave	10	773.4	G	I	73
Cottage	4	725	G	I	86
Trinity	3	784.4	G	I	69
	8	783.4			66
Tank 1	3	1,054.2	A	F	25
	10	1,054.2			27
Virginia	3	694.8	G	J	91
	6	694.8			88
Virginia Relief	6	694.8	G	J	90
Linda Lane	4	922.8	A	F	82
	14	921.8			80
Cascade	2	700.1	G	I	80
	8	700.1			80

Note:

(1) The pressure setting at Pensacola is adjusted throughout the year to ensure that Tanks 3A/3B and 4A/4B fill adequately.

4.1.8 Emergency Interconnections

Water distribution systems are often connected to neighboring water systems to allow the sharing of supplies during short-term emergencies or during planned shutdowns of a primary supply source.

The City has an emergency intertie with the Bella Vista Water District water distribution system on Akrich Avenue in the Southwest corner of the City's system. The intertie is manually activated and is only intended to be used in emergency conditions. The potential benefit of this intertie for the City use is limited by the fact that it is located at a lower pressure zone. The City's second emergency intertie is with the City of Redding off Ashby Road in the South side of the City's system. In addition to being an emergency connection for both cities, it provides a means for the City to purchase non-reclamation water to supplement its water supply.

4.2 Hydraulic Model Development

This section summarizes the process used to develop the hydraulic computer model of the City's water distribution system, including a summary of the previous model, modeling software selection, model development, and demand allocation process.

4.2.1 Previous Hydraulic Model

The City developed a water system hydraulic model as part of its previous Water Master Plan. The hydraulic model was developed using the H₂ONET hydraulic modeling software platform, developed by Innovyze (formerly MHWSoft). H₂ONET is an AutoCAD based hydraulic modeling software platform that uses the industry standard EPANET hydraulic engine. The trend in the industry since the City's water model was developed has been a move away from AutoCAD based hydraulic modeling software platforms to GIS based applications. Both stand-alone and ArcGIS based applications are commonly used.

The City's previous H₂ONET model is considered a "skeletonized" model, meaning it excluded many smaller diameter pipelines (typically smaller diameter mains).

4.2.2 Selected Hydraulic Modeling Software

In the time since the previous hydraulic model was originally developed, significant improvements have been made to the hydraulic modeling software available on the market. Most notably, improvements include enhanced graphical user interfaces (GUIs), the availability of add-on tools, and GIS compatibility. This Master Plan provided the City an opportunity to reexamine the software available on the market today and make a decision about continuing the use of H₂ONET or converting the model to one of the newer software packages.

It was ultimately agreed upon that the City's hydraulic model would be updated and calibrated using InfoWater, developed by Innovyze. InfoWater is a comprehensive hydraulic and dynamic water quality modeling software application that utilizes the same computational engine (EPANET) as H₂ONET (the City's previous hydraulic model). The advantage of the InfoWater package over the City's previous hydraulic modeling software (H₂ONET) or other stand-alone software platforms (such as H₂OMAP Water, also by Innovyze) is that it is run directly within the ArcGIS environment, and therefore offers an enhanced GUI and a variety of additional features and functionality not available in the AutoCAD based H₂ONET or other stand-alone products.

4.2.3 Previous Hydraulic Model Review

A thorough review of the City's previous H₂ONET hydraulic model was performed, as well as a review of the City's most current GIS database of the water distribution system. The purpose of this review was to determine the best approach to develop an updated water system hydraulic model for the City. Two approaches were considered. The first was to import the City's previous hydraulic model into a newer ArcGIS based software platform directly from H₂ONET, and then to add additional pipelines from the City's current GIS database to construct an "all-pipe" model for the City. The second approach was to build a new model directly from the City's most current GIS database.

Based on the review of the City's H₂ONET hydraulic model, and the City's current GIS database, it was determined that the second approach was the best choice for the City. There were several reasons for the selection of this approach, including:

- The City's H₂ONET hydraulic model was built from older AutoCAD based maps of the water distribution system, which did not "line up" well with the City's current GIS database.
- By using the City's current GIS database, the City's new hydraulic model will contain the latest available pipeline alignment and diameter information.

- Any pipeline replacement projects that have been implemented in the last decade would be included in the City's current GIS database, and would eliminate the need for manually comparing the old model pipeline data (e.g., diameter, etc.) with the new pipeline data (the City has recently replaced several small diameter pipelines as part of small diameter pipeline replacement grant from the USBR).

Following the model review process, Carollo provided the City with updated system maps, and tables summarizing the major facility data associated with the City's tanks and pump stations. The information obtained from City staff as part of this process was used to confirm that each modeled facility and the modeled system pipelines were represented as accurately as possible in the updated hydraulic model.

4.2.4 Modeled Water Distribution System

The City's modeled water distribution system consists of over 79 miles of pipelines up to 24-inches in diameter. The City's current GIS database was the main building block for developing the updated hydraulic model, and was supplemented by additional information where required (e.g., tank sizes, PRV station configuration, operational controls, etc.). The hydraulic model was constructed using this up-to-date database, and includes all known water main facilities at the time the updated model was developed. Figure 4.1 shows the modeled water distribution system.

4.2.5 Elements of the Hydraulic Model

The following provides a brief overview of the various elements of the hydraulic model and the required input parameters associated with each:

- *Junctions*. Locations where pipe sizes change, pipelines intersect, or where water demands are applied is represented by junctions in the hydraulic model. Required inputs for junctions include service elevation and water demands.
- *Pipes*. Water mains are represented as pipes in the hydraulic model. Input parameters for pipes include length, roughness (Hazen Williams C factor), diameter, and whether or not the pipe is a check valve (i.e., does not allow reverse flow).
- *Tanks*.
 - Cylindrical and Variable Area Tanks: Water tanks are included in the hydraulic model as either cylindrical tanks or variable area tanks, depending on the complexity of the tank geometry. Required input parameters for cylindrical tanks include bottom elevation, maximum level, initial level, and diameter. Required input parameters for variable area tanks include bottom elevation, maximum level, initial level, and a curve that varies the cross sectional area of the tank depending on the tank level (developed as appropriate based on As-built drawings).
 - Fixed Head Reservoirs: For water distribution system modeling, fixed head reservoirs are used to represent a water source with a constant HGL. Typically, fixed head reservoirs are used to represent water sources, such as groundwater or other sources of water. In the Case of Fisherman's Point WTP, the supply was modeled as a fixed head reservoir with a flow control valve that mimics water supplied from the filters to clear well.
- *Pumps*. Pumps are included in the hydraulic model as links. Input parameters for pumps include pump curves and operational controls.

- *Valves.* Certain types of valves, such as altitude valves and pressure reducing valves, are represented explicitly as valves in the hydraulic model. Required input parameters for valves include diameter, operational controls, and other settings or headloss curves depending on the type of valve.
- *Demands.* Water demands are applied at specific junctions in the hydraulic model. Up to ten different demands can be assigned at a particular junction.

4.2.6 Hydraulic Model Development

The City's hydraulic model combines information on the physical and operational characteristics of the distribution system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes.

The model update process consisted of eight steps, as described below:

- *Step 1:* The City's GIS database files, along with the previous model shapefiles, were combined to create one single, updated database.
- *Step 2:* The distribution system layer shapefiles were then imported into InfoWater using the "GIS Exchange" functionality of InfoWater.
- *Step 3:* The City's storage tanks and pump stations were then imported into the model using the "GIS Exchange" feature, and operational information, such as pump controls and altitude valve settings were input into the model manually based on information provided by the City.
- *Step 4:* Junctions, or areas where two pipelines meet in the model, are required at every pipe intersection and dead end, as well as other areas in the model where demands are applied. Junctions were added into the model using InfoWater's "Append Nodes" feature.
- *Step 5:* Elevations were applied to each modeled junction using the City's ground elevation contour file and the "Elevation Extractor" tool in InfoWater.
- *Step 6:* InfoWater includes several connectivity tools that are used to verify that each pipeline in the model is connected properly. The model flagged questionable pipelines and facilities, which were reviewed and corrected, if necessary.
- *Step 7:* The City's GIS database breaks pipelines at each gate valve location within the system. Because gate valves are not required in the hydraulic model, the modeled pipelines do not need to include individual short reaches of pipe associated with the gate valves. The hydraulic model skeletonizer tool was used to combine these types of multiple connected reaches of pipelines by using common features (i.e., diameter, age, and material). This process reduces model complexity, the number of modeled pipes in the system (thereby reducing model license fees), and minimizes model run times.
- *Step 8:* The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include run duration, time steps, reporting parameters, output units, and other technical parameters. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

4.2.7 Diurnal Pattern Development

As a part of the calibration process, the City provided 5-minute flow data for Fisherman's Point WTP, and tank level data. This data was used to establish a daily diurnal demand pattern by

balancing the total inflow into the water distribution system and the change in storage. The diurnal pattern is shown on Figure 4.5, and was applied into the hydraulic model for use in 24-hour model simulations.

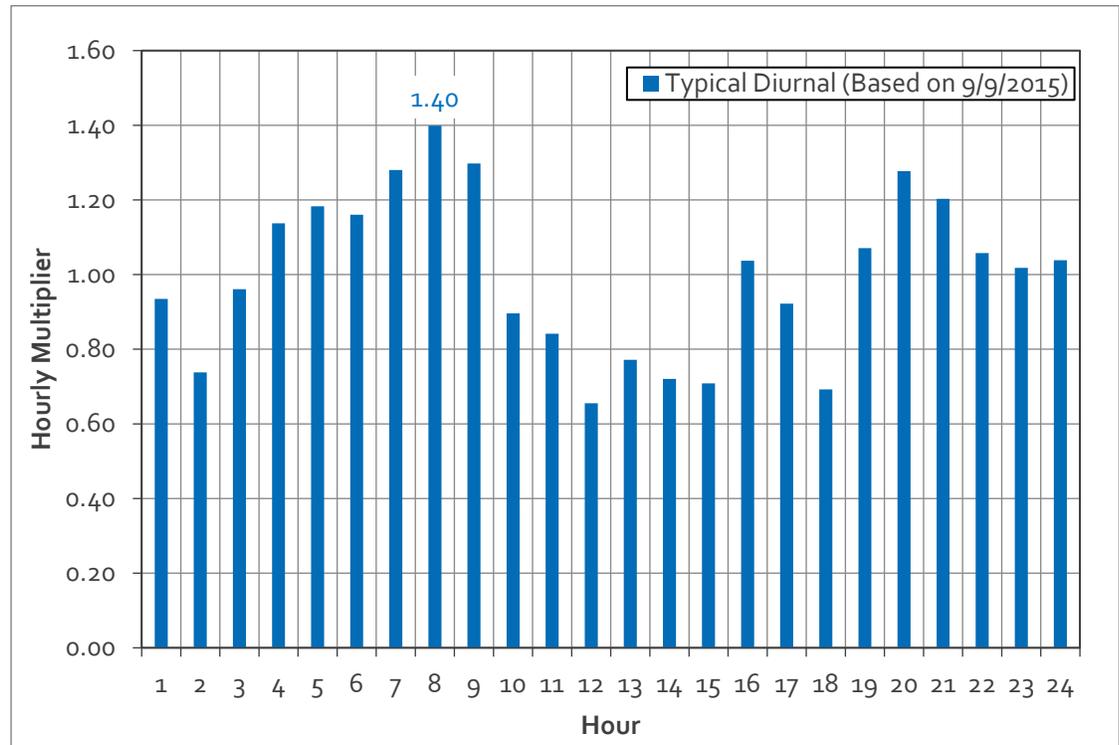


Figure 4.5 Citywide Diurnal Pattern

4.2.8 Water Demand Allocation

Allocation of water demands to appropriate nodes in the hydraulic model was accomplished in several steps using the City's water billing records. The City provide an MS Excel based database with monthly water consumption, by customer, for the years 2012 through 2014. The City's 2013 billing data was used as the basis for model demand allocation, because this data represented the most recent full year that was not subjected to water rationing due to the drought.

The City's 2013 water billing records were manipulated in excel to calculate the total average day consumption for each City customer. This billing data was then "geocoded" using GIS techniques to develop a point shapefile with the spatial location of each billing record with the annual consumption. This shapefile was used along with InfoWater's "Demand Allocator" tool to allocate the system demand into the model. It should be noted that the demands associated with the City's top ten water customers (see Chapter 3 for more detailed information related to the top ten customers) were allocated manually into the model to ensure that they were applied to the correct node in the model. Once the geocoded billing data was allocated into the hydraulic model, the model demands were "scaled up" to match the total 2013 average day demand (ADD), thereby accounting for the additional demand associated with unaccounted-for-water (UFW). Finally, diurnal patterns were input into the model (see Figure 4.5) to account for the temporal change in demands throughout the day. Separate diurnal patterns were developed for ADD and maximum day demand (MDD) conditions. The ADD and MDD diurnals are identical.

The only difference between the two is that the ADD diurnal is normalized to an average value of 1.0, whereas the MDD diurnal pattern is normalized to a value of 2.18 (which is the MDD/ADD peaking factor). Allocation of future water demands followed a similar procedure as the allocation of existing water demands.

4.3 Hydraulic Model Calibration

This section summarizes overall methodology employed to calibrate the City's water system hydraulic model and the calibration results, including a detailed description of each of the major components of the model calibration process.

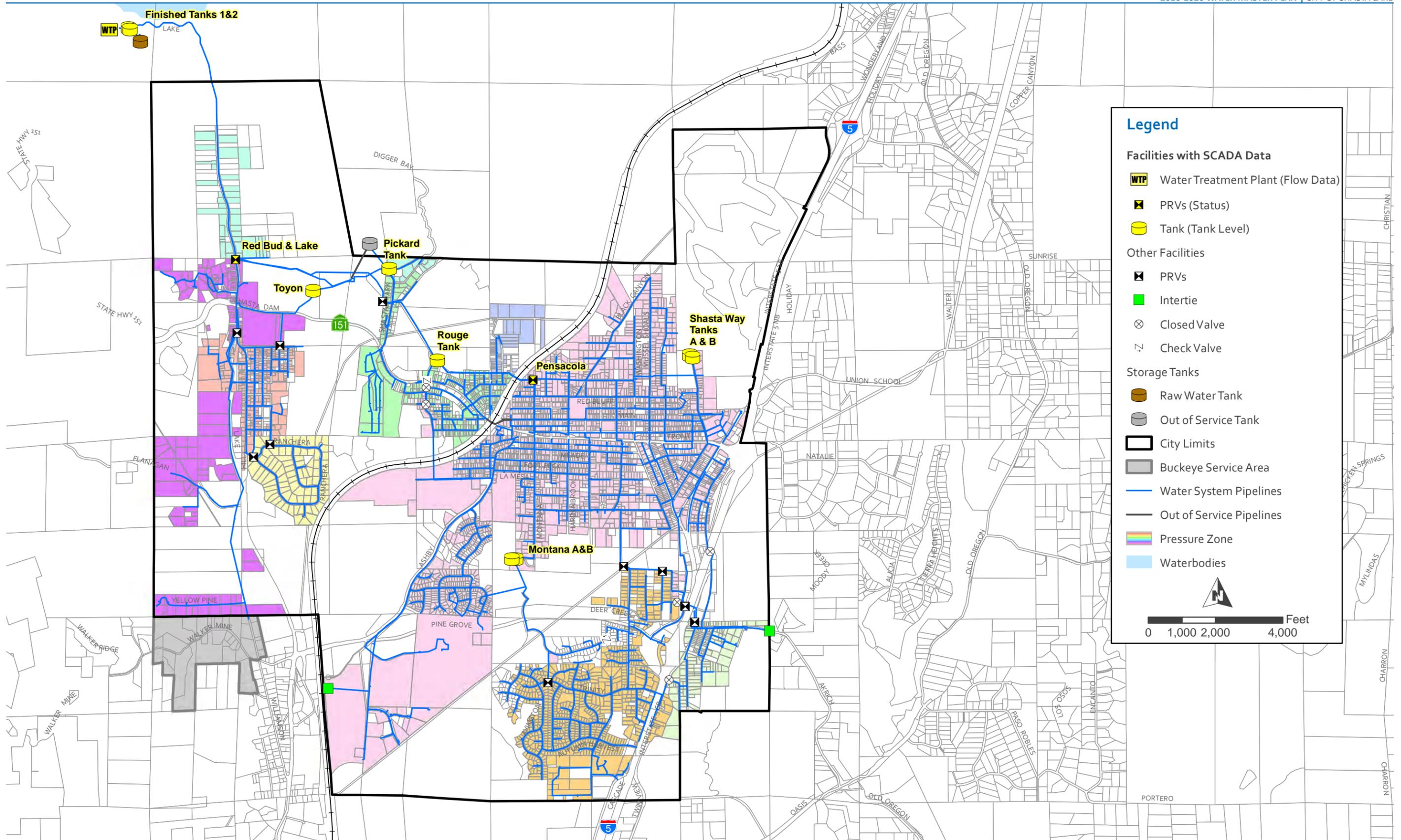
4.3.1 Model Calibration Data Collection

Carollo coordinated closely with City staff regarding the supervisory control and data acquisition (SCADA) and field data needs that were required to calibrate the hydraulic model. The required calibration data included site maps for specific fire flow test locations, pressure logger locations, and included a list of the SCADA data needs, durations, time intervals, and units. This section summarizes the data collection process that was conducted.

- *SCADA and Historical Fire Flow Data Gathering:* Field testing and data gathering for model calibration took place for two separate time periods :
 - Extended Period Simulation (EPS) Data Gathering Period: September 6 - 21, 2015
 - Historical Fire Flow Data Test Data Gathering Period: 2008 - 2014

For the EPS data gathering period, Carollo coordinated with City staff to obtain 5-minute data for all of the major SCADA points within the water distribution system, including reservoir levels, WTP flow data, and PRV station status (if available). The location of major facilities in the system where SCADA data were available is shown on Figure 4.6. This data was primarily used to generate the City's diurnal pattern and for EPS model calibration, but it was also used to identify boundary conditions for the fire flow calibration. Figure 4.1 identifies the SCADA data sources that were provided by the City. Figure 4.7 identifies historical fire flow tests conducted between 2008 and 2014. The data was primarily used to complete additional fire flow calibrations across the system.

- *Temporary Pressure Logger Installation:* In addition to the data obtained from the City's SCADA system from the major system facilities, Carollo also provided temporary pressure loggers to City staff that were attached to hydrants within the City's distribution system. The data obtained from the temporary pressure loggers consisted of 5-minute pressure data for the duration of the EPS data gathering periods. Figure 4.8 shows the hydrant locations where the temporary pressure loggers were installed. The pressure logger distribution in September 2015 was selected to get a good representation of system pressures throughout the City.



Legend

Facilities with SCADA Data

- WTP Water Treatment Plant (Flow Data)
- PRVs (Status)
- Tank (Tank Level)

Other Facilities

- PRVs
- Intertie
- Closed Valve
- Check Valve

Storage Tanks

- Raw Water Tank
- Out of Service Tank

City Limits

- Buckeye Service Area

Water System Pipelines

- Water System Pipelines
- Out of Service Pipelines

Pressure Zone

- Pressure Zone

Waterbodies

- Waterbodies

0 1,000 2,000 4,000 Feet

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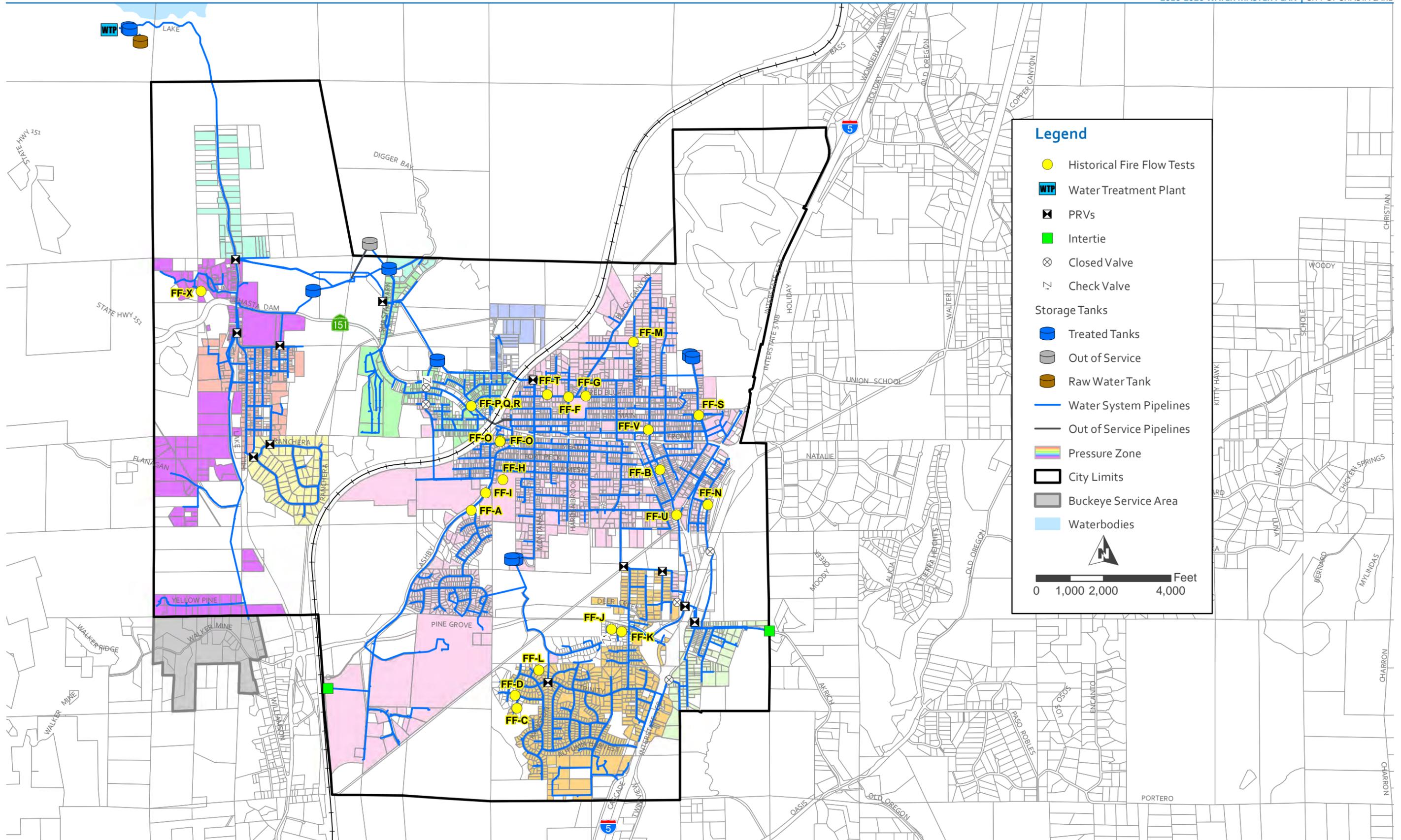
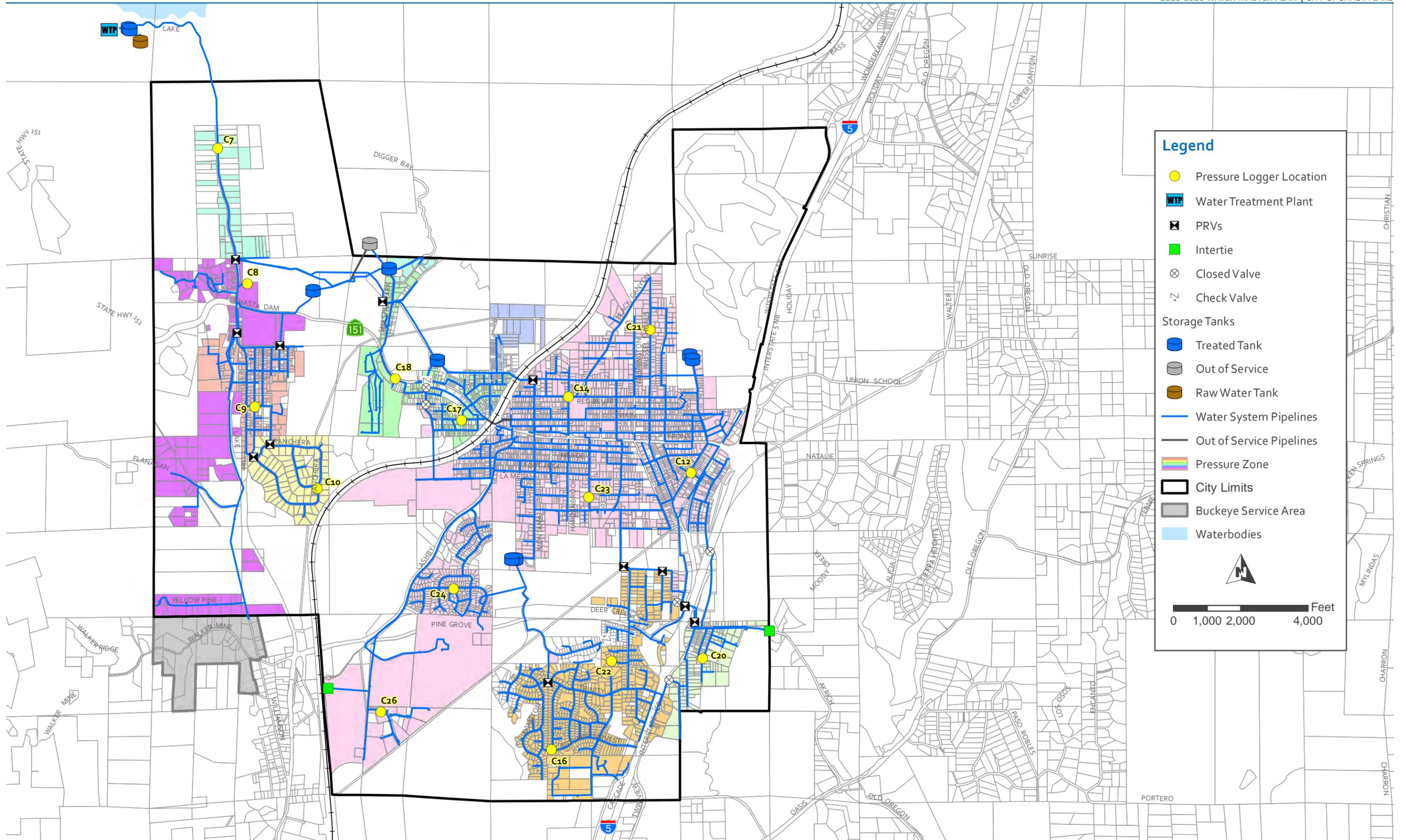


Figure 4.7
 Historical Fire Flow Test Locations



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Legend

- Pressure Logger Location
- WTP Water Treatment Plant
- ⊠ PRVs
- Intertie
- ⊗ Closed Valve
- ⌞ Check Valve

Storage Tanks

- Treated Tank
- Out of Service
- Raw Water Tank

- Water System Pipelines
- Out of Service Pipelines

Pressure Zone

- Pressure Zone

- City Limits
- Buckeye Service Area
- Waterbodies

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- *Supplemental Fire Flow Field Testing:* Carollo selected six fire flow testing sites, which are shown on Figure 4.9 to conduct additional fire flow field testing. These sites were selected to supplement the City's historical data in areas lacking historical tests. The supplemental tests were conducted on September 16, 2015 and September 17, 2015 at each of the six selected sites. In addition, the City performed follow up fire flow testing at one of the historical fire flow sites to obtain more recent testing data in areas with questionable historical fire flow data.

4.3.2 Model Calibration Methodology and Results

The purpose of a water system hydraulic model is to estimate, or predict, how the water distribution system will respond under a given set of conditions. One way to test the accuracy of the hydraulic model is to create a set of known conditions in the water system and then compare the results observed in the field against the results of the hydraulic model simulation using the same conditions. Flow tests conducted in the field on the water system can yield a profound tool in verifying data used in the hydraulic model and a greater understanding of how the water system operates.

Field testing can indicate errors in the data used to develop the hydraulic model, or show that a condition might exist in the field not otherwise known. Valves, which are reported as being open, might actually be closed (or vice versa), an obstruction could exist in a pipeline, or pressure settings for a PRV may be slightly different than noted. Field testing can also correct erroneous model data such as incorrect pipe diameters or connections.

Data obtained from the field tests can be used to determine appropriate roughness coefficients for each pipeline, as roughness coefficients can vary with age and pipe material. Other parameters can also be adjusted to generate a calibrated model.

The calibration process for the City's water distribution system hydraulic model consisted of three parts, a macro calibration, a fire flow test calibration, and an EPS calibration.

4.3.2.1 Macro Calibration

Initially, the model was run under existing demand conditions and necessary adjustments were made to produce reasonable system pressures. Such adjustments include modifications of pipeline connectivity, operational controls, ground elevations, and facility characteristics.

The macro calibration process involves several steps to ensure that the model produces reasonable results:

- *Transmission Main Connectivity.* Using the connectivity features of the modeling software, the connectivity of the transmission mains within the distribution system was verified. Problems found using the connectivity locators were reviewed to determine whether adjustments were needed to the connectivity of the model. Output reports of pipe flow characteristics, such as headloss (feet per thousand feet [ft/kft]) and velocity (feet per second [fps]) were also used to locate problem areas where additional adjustments may be necessary.
- *System Pressures.* The macro calibration compared the model output to the typical pressures observed within the distribution system in pounds per square inch (psi). This process was used to locate major errors in model creation, elevations, or connectivity, as

well as changes that reflect how operational controls of the system should be implemented in the model.

- *Facility Characteristics.* Hydraulic model results were compared to data provided by the City to verify that facility attributes entered into the model, such as the physical characteristics of the tanks and PRV stations, produced results comparable to what the City experiences.

4.3.2.2 Extended Period Simulation Calibration

The purpose of extended period simulation calibration is to demonstrate the hydraulic model's ability to accurately mimic the real world operations of the distribution system facilities, including pressure fluctuations, tank fill/drain cycles, PRV station operation, and pump station operations. The primary varied parameters for this calibration were operational controls and pipeline roughness coefficients, although other parameters were also adjusted as calibration results were generated.

The first step in the EPS calibration process is the selection of a calibration day. During the EPS calibration period, it was determined that Wednesday September 9, 2015 was the most appropriate calibration day. September 9, 2015 was chosen because it represented a typical higher demand day and because there were no unusual flow spikes or dips in the system-wide diurnal.

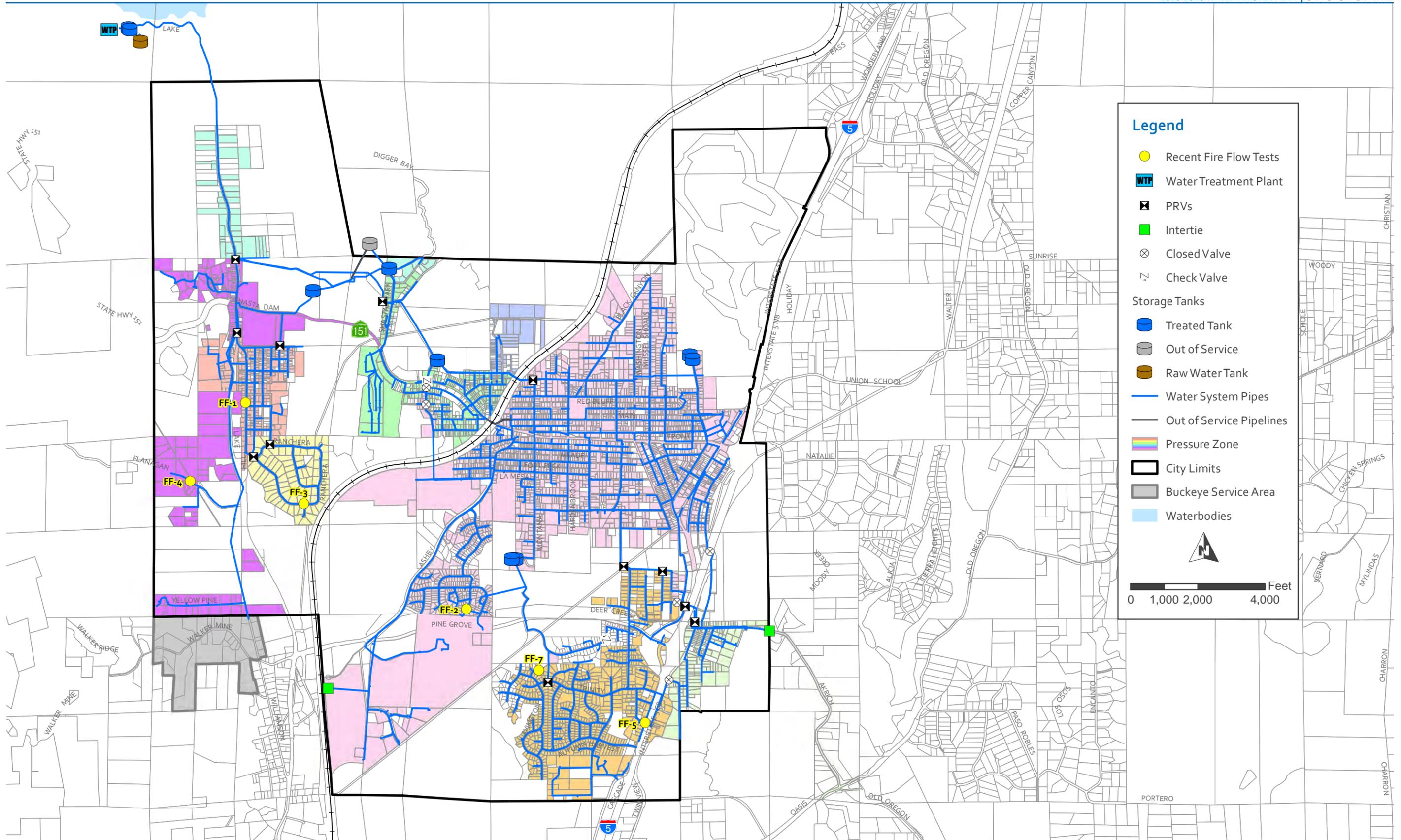
The calculated daily demand for the calibration day was estimated to be 2.14 mgd (1,486 gallons per minute [gpm]) for September 9, 2015. Therefore, the demands that were allocated in the hydraulic model were scaled to match a total demand of 2.14 mgd for the purposes of the EPS calibration scenario.

The EPS calibration compared model simulated pump station flows, tank levels, and PRV station status (if available) to the field measured data. In addition, model simulated pressures at the pressure logger locations were compared to the actual field pressures recorded during the calibration day.

A sample comparison of model results to observed field conditions for the Tank 1 Level and Pressure Logger C7 for the EPS calibration period is shown on Figure 4.10 and Figure 4.11, respectively. Similar model results for the remaining facilities are presented in Appendix F.

Overall, the trends seen in the field data are well predicted by the model, with the exception of a few pressure loggers. Some notable items from the EPS model calibration effort include:

- *Pressure Loggers C12, C14, and C18:* These pressure loggers were out of calibration during the time that they were installed on the City's hydrants. The pressure logger data reads low/high due to the calibration issues, however, the model simulation results are reasonable and in line with expectations given the other pressure loggers and expected hydraulic grades of each pressure zone. The City agreed with Carollo that the pressure logger data was suspect and that the model results appear to be correct.



Legend

- Recent Fire Flow Tests
- WTP Water Treatment Plant
- X PRVs
- Intertie
- ⊗ Closed Valve
- ⌞ Check Valve

Storage Tanks

- Treated Tank
- Out of Service
- Raw Water Tank

- Water System Pipes
- Out of Service Pipelines

Pressure Zone

- Pressure Zone

- City Limits
- Buckeye Service Area
- Waterbodies



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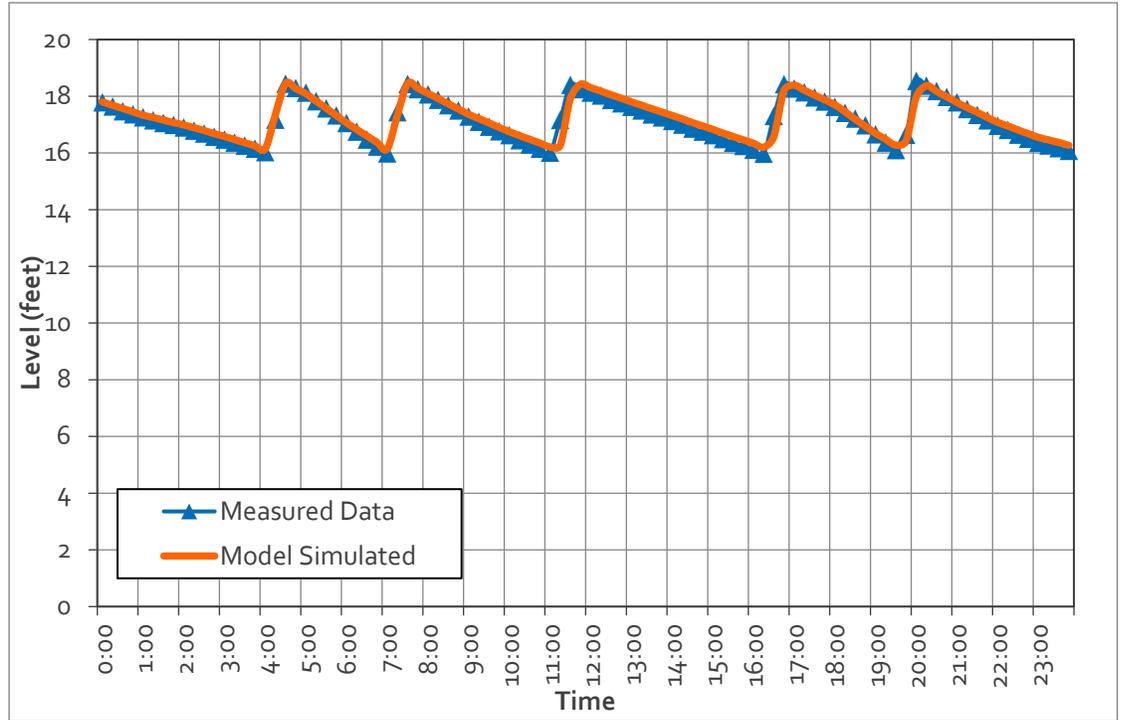


Figure 4.10 Example EPS Calibration Result - Tank 1 Level

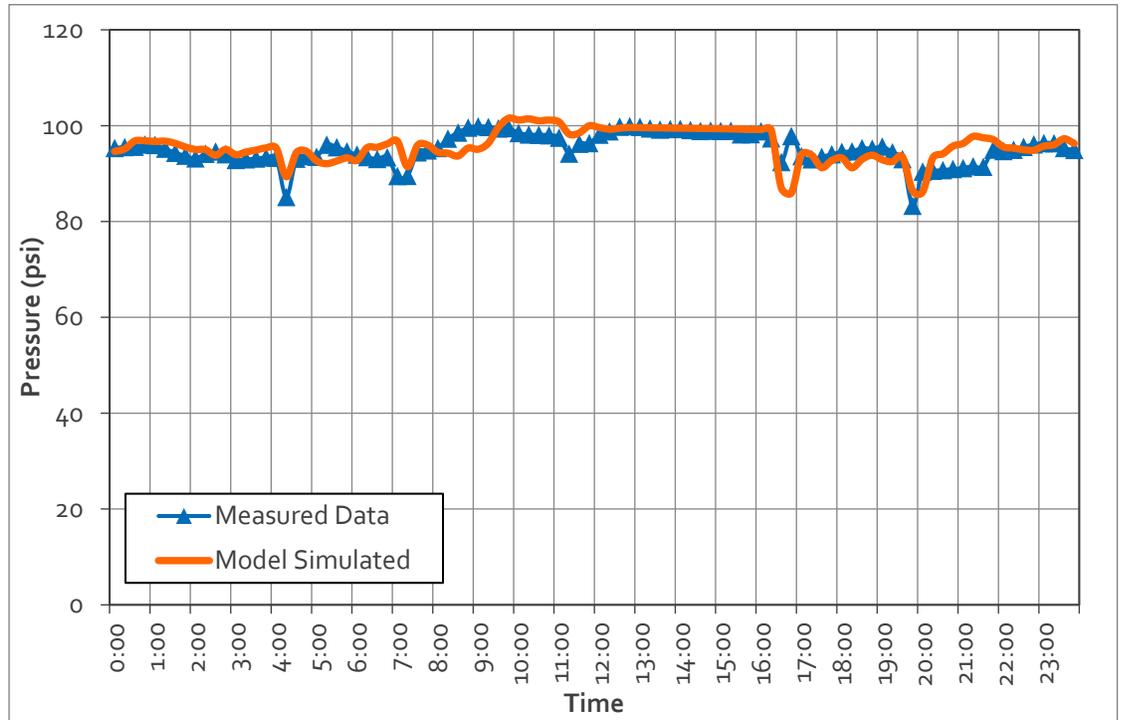


Figure 4.11 Example EPS Calibration Result - Pressure Logger C7

4.3.2.3 Fire Flow Test Calibration

The purpose of fire flow calibration is demonstrate the model's ability to accurately replicate the performance of the distribution system of extreme demand conditions, such as when fire hydrants are being operated. The primary varied parameter for this calibration is pipeline roughness coefficient, although other parameters can also be adjusted as calibration results are generated.

Hazen-Williams roughness coefficients, or C-factors, have industry accepted value ranges based on pipeline material, diameter, and age. Characteristics specific to the City water distribution system such as water quality, temperature, construction methodologies, material suppliers, and other factors may result in roughness coefficients that differ from the average of the industry accepted ranges. Fire flow calibration refines the initial estimation of the value of roughness coefficients that best indicate the conditions of the City's distribution system.

During average day flows, roughness coefficients have a relatively small effect on the operation of the distribution system. However, as the flows increase in the system on higher demand days, velocity within pipelines increase and roughness coefficients contribute more to overall system headloss. Fire flow tests artificially create high demand events to generate more headloss, allowing a better estimation of the pipeline roughness coefficients.

Fire flow tests stress the distribution system by creating a differential between the HGL at the point of hydrant flow and the system HGL at neighboring hydrants. This HGL differential increases the effect of the roughness coefficients on system losses and allows adjustments to the model to match model pressures to field pressures within an acceptable tolerance. As the model is adjusted to match system pressures, roughness coefficients should be adjusted only within a tolerance of industry accepted roughness coefficient ranges. If a model is unable to match the calibration results without leaving the acceptable range of roughness coefficient values for a given pipeline material and age, there may be cause for further investigation of a previously unknown field condition. Examples of such conditions, which typically arise during hydraulic model calibration, include closed valves, partially closed or malfunctioning valves, extreme corrosion within pipelines, connectivity, and diameter errors in GIS layers or record drawings, and diurnal patterns of large water users.

A separate hydraulic model scenario was created for each flow test for both the static and the dynamic, or flowing, condition. The flow observed at each fire flow hydrant was assigned as a demand to the model node at the location of the hydrant. Residual pressures were then read at each hydrant location while the hydrant was flowing. Model results were considered acceptable if they fall within a 10 percent tolerance or a 10 psi value. Table 4.6 shows a summary of the September 2015 fire test model calibration results and Table 4.7 shows a summary of the historical fire flow tests model calibration results. For complete fire flow test calibration results see Appendix F.

As shown in Table 4.6 and Table 4.7 the comparison of model results to observed field data are good. There are a few notable items from the fire flow calibration results:

- *Fire Flow Test L*: The model was not able to simulate the residual pressure drop at Test Site L (4159 Doyle Court), but tests in the same general area did match within acceptable tolerances. For this reason, the City reran this test in March of 2016. The

hydraulic model was able to reasonably match the new test data, and therefore the model results were considered acceptable at this location.

- *Historical Fire Flow Test S and Test V:* The hydraulic model was not able to replicate the residual pressures measured by City staff for Test S and Test V with a 4-inch diameter lateral. It is believed that these hydrants are old and possibly corroded. These are very old hydrants, and the City should consider replacing the hydrants and laterals with new hydrants to increase their available fire flow capacity. It is believed that the discrepancy between the modeled results and the field measured results is a result of localized high headlosses through the hydrant lateral or the hydrant itself, and therefore the model results for these sites are considered acceptable.
- *Historical Fire Flow Test Site R:* The test was one of three tests conducted on the same hydrant on the same day. It was decided that since the model met the established calibration criteria for two out of the three tests, the calibration results at this test site was considered acceptable.
- *Historical Fire Flow Test Site X:* The hydraulic model was not able to simulate the residual pressure recorded during this historical test. It is possible that the flow recorded on the fire flow test form was recorded incorrectly, or the network serving this hydrant is not accurately represented in the City's GIS. This test represents a localized branch of the system, and the anomalous results at this test site will not affect the overall model calibration.

Table 4.6 Fire Flow Test Calibration Results (September 2015/March 2016 Tests)

ID	Location	Date & Time	Field Measured Data			Modeled Data		% Difference ⁽¹⁾	
			Hydrant Flow (gpm)	Pressure (psi)		Pressure (psi)		Static	Resid.
				Static	Resid.	Static	Resid.		
1	13596 Hill Blvd.	9/16/15 14:20	969	80	68	86.0	72.2	7.5%	6.2%
2	2484 Cana Dr.	9/16/15 15:30	1,239	97	91	102.2	91.7	5.4%	0.8%
3	18002 Ranchera Rd.	9/16/15 14:40	533	82	65	84.3	60.4	2.8%	-7.1%
4	17549 Flanagan Rd.	9/16/15 15:00	631	103	33	107.0	30.1	3.9%	-8.8%
5	3256 Cascade Blvd.	9/17/15 13:15	735	113	95	118.0	93.1	4.4%	-2.0%
6	5312 Pine Grove Ave.	9/17/15 13:45	413	81	42	88.3	46.0	9.0%	9.5%
7	4159 Doyle Ct.	3/1/16 13:30	876	59	44	58.8	42.7	-0.4%	-3.0%

Note:

(1) Percent Difference = (Modeled - Measured)/Measured x 100

Table 4.7 Fire Flow Test Calibration Results (Historical Tests)

ID	Location	Date & Time	Field Measured Data			Modeled Data		% Difference ⁽¹⁾	
			Hydrant Flow (gpm)	Pressure (psi)		Pressure (psi)		Static	Resid.
				Static	Resid.	Static	Resid.		
A	Woodley Ave.	2/18/08 9:20	1,131	78	72	77.5	67.9	-0.6%	-5.7%
B	Bonneville/ Grand Coulee	2/4/09 12:55	924	82	54	83.1	51.4	1.3%	-4.8%
C	West Minster Ct.	6/26/09 12:50	969	50	34	50.4	33.7	0.9%	-0.9%
D	Pembroke Ln.	6/26/09 1:10	983	56	40	55.5	42.3	-0.8%	5.7%
E	2906 Avington	6/26/09 13:20	892	71	59	71.2	64.6	0.3%	9.5%
F	Harden-brook Ave.	7/24/09 9:30	1,093	68	66	71.6	69.0	5.3%	4.5%
G	4511 Red Bluff	7/24/09 9:45	1,131	76	72	79.6	69.8	4.8%	-3.1%
H ⁽²⁾	Central Valley Talon Hall	6/22/11 11:30	860	64	55	68.1	57.1	6.5%	3.8%
I	Central Valley High off Ashby Rd.	6/22/11 11:00	908	71	64	73.1	66.9	3.0%	4.5%
J	4689 Risstay Way	2/29/12 2:45	1,156	89	79	86.4	71.7	-2.9%	-9.2%
K	Jorzack & Risstay	2/29/12 3:00	1,093	94	84	97.6	88.3	3.8%	5.1%
L	4159 Doyle Ct.	6/11/12 8:15	791	54	39	58.7	50.5	8.6%	29.5%
M	Washington & Boca	8/18/15	843	69	36	71.8	38.4	4.1%	6.7%
N	Elizabeth & Joseph	1/21/15 14:00	969	88	60	84.7	61.7	-3.7%	2.8%
O	4037 Flowers	3/24/15	860	49	45	52.1	47.3	6.3%	5.1%
P	Red Ave. & Shasta Dam Blvd.	1/6/15 11:30	969	110	62	107.1	57.6	-2.6%	-7.1%
Q	Red Ave. & Shasta Dam Blvd.	1/6/15 13:45	998	108	60	107.1	57.2	-0.8%	-4.7%

Table 4.7 Fire Flow Test Calibration Results (Historical Tests) (Cont.)

ID	Location	Date & Time	Field Measured Data			Modeled Data		% Difference ⁽¹⁾	
			Hydrant Flow (gpm)	Pressure (psi)		Pressure (psi)		Static	Resid.
				Static	Resid.	Static	Resid.		
R ⁽³⁾	Red Ave. & Shasta Dam Blvd.	1/6/15 14:00	984	112	68	107.1	57.3	-4.4%	-15.7%
S ⁽⁴⁾	Grand Ave. & Shasta Way	5/29/14	791	85	33	81.4	31.2	-4.2%	-5.5%
T	Locust & Red Bluff	5/29/14	791	71	49	71.8	48.7	1.1%	-0.6%
U	Grand Coulee & Morning Star	5/29/14	1,228	105	90	103.8	87.9	-1.2%	-2.3%
V ⁽⁴⁾	1524 Mussel Shoals	5/29/14	533	92	35	87.8	36.5	-4.6%	4.3%
W	Lot #8 Deer Creek Manor	4/23/14 13:35	695	35	30	34.6	31.6	-1.3%	5.3%
X ⁽²⁾	Homer Lane	6/4/14	675	66	26	62.5	-67.9	-5.3%	-361%

Notes:

- (1) Percent Difference = (Modeled - Measured)/Measured x 100.
- (2) The City's GIS did not include a pipeline to this hydrant location. Pipelines were added into the model at the appropriate location to represent this test.
- (3) The hydraulic model reasonably matched the results of tests P and Q, but not R, even though they were at the same location. An unknown operational could have occurred during Test R.
- (4) The hydraulic model was not able to replicate the residual pressure measured by City staff with a 4-inch diameter hydrant lateral. A 2.5-inch diameter hydrant lateral was able to replicate the field results. These are very old hydrants and it is likely that the hydrant laterals induce a significant amount of headloss due to poor condition. These hydrants should be considered for replacement by the City.

4.3.3 Hydraulic Model Calibration Summary

In summary, the calibration results indicate the model predicts conditions similar to those observed in the field. Within a few isolated areas of the model, there some very minor discrepancies, but the overall distribution system is very well represented by the model.

Based on the results presented in this chapter, it can be concluded that the model is calibrated to steady state and extended period conditions. The model provides an accurate representation of the City's distribution system and system operations to a level suitable for this Master Plan and for the City's future hydraulic modeling needs.

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Chapter 5

PLANNING AND EVALUATION CRITERIA

This chapter presents the planning criteria that were used to evaluate the existing water distribution system and for sizing future water system infrastructure. The developed criteria address the water supply capacity, storage capacity, acceptable service pressures, and distribution main performance.

5.1 Water Supply Capacity

In accordance with industry standard practices, as well as the California Department of Public Health's (CDPH) 2008 Water Works Standards criteria for "New and Existing Source Capacity," the water system's water source shall have the capacity to meet the system's Maximum Day Demand (MDD). Demands in excess of the MDD required for Peak Hour Demand (PHD) or for fire flows are planned to come from storage.

The City of Shasta Lake 's (City's) sole source of supply is treated surface water from the Fisherman's Point Water Treatment Plant (WTP). Therefore, the WTP must be capable of treating and pumping the MDD. Demands in excess of the MDD would be supplied from treated water storage throughout the City's distribution system. The reliable supply capacity of the WTP currently is 6.2 million gallons per day (mgd).

5.2 Treated Water Storage Requirements

The principal function of storage is to provide a reserve supply of water for: 1) operational equalization; 2) fire reserve; and 3) emergency needs. Operational equalization storage is directly related to the amount of water necessary to meet peak demands. The intent of operational equalization storage is to provide the difference in quantity between the customer's peak demands and the system's reliable available supply. The volume of water allocated for emergency uses is decided based on the historical record of emergencies experienced, and on the amount of time which is expected to lapse before a hypothetical emergency can be corrected.

5.2.1 Operational Equalization Storage

This storage is the amount of desirable stored water in a system to regulate fluctuations in demand so that extreme variations will not be imposed on the source of supply. Operational equalization storage typically serves the peak demands exerted within the MDD. With operational equalization storage, system pressures are improved and stabilized to better serve customers throughout the service area. Operational equalization storage is commonly estimated between 10 percent and 50 percent of the MDD.

The American Water Works Association (AWWA) M-32 states that operational storage is typically between 10 to 15 percent of the MDD for large systems, but could exceed 30 percent for small systems or arid climates.

An operational equalization storage equal to 20 percent of the City's MDD is recommended by Carollo for this planning effort based on the size and configuration of the City's system. This criterion is also consistent with the City's previous Master Plan.

5.2.2 Fire Storage

Fire storage is the amount required to meet the necessary fire flow demands. In general, the recommended fire storage volume is determined by multiplying the highest required fire flow by its corresponding duration. For municipalities with multiple pressure zones, such as the City, the recommended fire storage is determined based on the largest required fire flow volume per pressure zone.

The recommended fire flows and durations used in this Master Plan are summarized in Section 5.6, and were developed based on input from City staff, including the City's Fire Marshall, and Carollo experience on similar projects. The maximum recommended fire flow and duration are 3,000 gallons per minute (gpm) for a duration of three hours. This provision equates to a storage requirement of 0.54 Million Gallons (MG).

5.2.2.1 Emergency Storage

This storage is the volume recommended to meet demands during emergency situations such as pipeline failures, major distribution main failures, pump failures, electrical power outages, or natural disasters. The amount of emergency storage included within a particular water distribution system is an owner option, based on an assessment of risk, the desired degree of system dependability, economic considerations, and water quality concerns. Emergency storage criteria are typically expressed as a multiplier of the MDD, and can range from 0 percent to 100 percent or more of the MDD. As part of the development of storage improvement alternatives, which are discussed in greater detail in Chapter 6, a range of emergency storage criteria were examined. The criteria considered were 25 percent, 50 percent, and 100 percent of the MDD. Ultimately, because of the vulnerability of the City's raw water pumping and transmission facilities (see Section 5.1.3 below), the recommended emergency storage is equal to 100 percent of the MDD.

5.2.3 Total Storage

The recommended minimum operational storage capacity for the City is equal to 20 percent of the MDD. The recommended fire storage capacity is determined by pressure zone, and is equal to the largest fire flow rate per pressure zone multiplied by the fire flow duration. For the City as a whole, the largest required fire flow volume is equivalent to 0.54 MG. The recommended emergency storage is equal to 100 percent of the MDD.

5.3 Raw Water Storage

Currently, the City has 0.17 MG of raw water storage, and any failure of either the Raw Water Pump Station (RWPS) or the raw water transmission main for any significant time period (more than a few hours) would force the City to shut down the WTP. The City has noted that there have been ongoing issues with the RWPS, which is operated and maintained by the United States Bureau of Reclamation (USBR), and the raw water transmission main from the RWPS to the Fisherman's Point WTP.

The City does not have a formal evaluation criteria for raw water storage, however it is recommended that the City maximize its raw water storage to the extent possible. Maximizing

the amount of available raw water storage will help to provide an additional buffer for the WTP to continue operating in the event of a temporary failure of the RWPS or the raw water transmission main.

5.4 Service Pressures

Pressures maintained within the distribution system vary depending on distribution system operations and pressure zone topography. It is essential that the water pressure in a consumer's residence or place of business be neither too high nor too low. Low pressures, below 40 pounds per square inch (psi), cause annoying flow reductions when more than one water-using appliance is used. High pressures may cause faucets to leak and valve seats to wear out quickly. Additionally, high service pressures usually result in wasted water and high water utility bills. It is recommended that the water pressures not exceed 120 psi at service connections, unless the service is provided with a pressure-reducing device.

The AWWA Manual on Distribution Network Analysis of Water Utilities (AWWA M-32), indicates that pressures between 30 psi and 90 psi are generally expected during the range of system water demands. For the purposes of this Master Plan, service pressures criteria were developed for various demand conditions, as summarized below.

- *Average Day Demand (ADD)*: It is recommended that the City install a pressure reducing valve (PRV) on laterals with pressures that exceeds 120 psi during a typical ADD condition.
- *Peak Hour Demand (PHD)*: In order to provide adequate service pressures, it is recommended that the City maintains a desirable service pressure of 40 psi during a typical PHD condition.
- *Maximum Day Demand (MDD) + Fire Flow*: This pressure criterion is related to fire flows and was devised to ensure adequate positive pressures during a fire. It is recommended that the City fire pressure criterion requires a minimum acceptable residual pressure of 20 psi at the connecting hydrant.

5.5 Distribution Mains

Transmission mains are generally sized to carry the greater of: 1) the PHD; or 2) the MDD plus fire flow. Other criteria related to the distribution piping include the maximum and minimum velocities and the maximum allowable friction losses.

High velocities may cause damage to the pipes and to their appurtenances. Normally, velocities of 10 feet per second (fps) (AWWA M-32), or higher, do not cause ill effects if they occur for a limited duration. It is normally good practice to limit pipe velocities to no more than 8 fps on a continuous basis.

New distribution/transmission system pipelines 12 inch in diameter or less should be sized for a maximum pipeline velocity of 5 fps, while new distribution system pipelines 16 inch in diameter or more should be sized for a maximum pipeline velocity of 4 fps.

Provided that the maximum velocity criteria and the pressure criteria are not exceeded, high pipeline head loss by itself is not a controlling factor. However, it may be an indication that the pipe is nearing the limit of its carrying capacity, and may not have sufficient capacity to perform under stringent conditions. Good practice dictates monitoring pipes that have a head loss in excess of 10 feet per 1,000 feet (AWWA M-32).

5.6 Fire Flow Criteria

Fire flows stress a water system in the area of the fire and often identify existing deficiencies. The deficiencies are generally associated with pipe sizes (diameter) or age (roughness) that results in high headloss and lower pressures. The fire flow criteria measures a system's ability to deliver a high rate of water while maintaining a minimum pressure.

To evaluate the effect of fire flows throughout the distribution system, large point demands are applied at fire hydrants. The fire flow demands are run concurrent with the maximum day demand. Simulating maximum day demand plus fire flows also demonstrates the performance of supply sources, booster pumps, and storage tanks operating under the upper limit high demand conditions.

The recommended fire flow criteria are summarized below by land use. These fire flow criteria were developed based on input from City staff, including the City's Fire Marshal, and Carollo experience on similar projects.

- *Single-Family Residential*: 1,000 gpm for a duration of two hours.
- *Multi-Family Residential*: 2,000 gpm for a duration of three hours.
- *Commercial*: 2,500 gpm for a duration of three hours.
- *Industrial/Business Park*: 3,000 gpm for a duration of three hours.
- *Public Facilities*: 3,000 gpm for a duration of three hours.

It should be noted that the recommended criteria flows are the minimum flows per land use type. Specific flow requirements for individual building sites may be higher depending on specific occupancy use, square footage, building height, and construction type used for the specific building (based on the currently adopted California Fire Code requirements). This Master Plan assumes that all required fire flows in excess of 3,000 gpm would be met through private onsite water supplies or supplemental storage. This approach is consistent with industry standard practice.

5.7 Planning Criteria Summary

Table 5.1 summarizes the recommended planning and evaluation criteria.

Table 5.1 Planning and Evaluation Criteria Summary

Storage		
The adequate Pressure Zone storage shall meet:	Operational Storage	= 20% x MDD
	Fire Flow Storage	= Largest Fire Flow Rate x Duration (determined by pressure zone)
	Emergency Storage	= 100% x MDD
Distribution Mains		
The distribution system should be sized to meet the:	Peak Hour Demand	
Criteria for judging the adequacy of existing pipelines:	Maximum Desirable Pipeline Velocity	= 8 fps
	Maximum Desirable Headloss	= 10 feet/1,000 feet
Criteria for Sizing New Pipelines:	Maximum Velocity	= 5 fps (12-inches and Smaller)
		= 4 fps (16-inches and Larger)
Service Pressures		
The recommended low pressures are as follows:	Minimum Pressure (PHD)	= 40 psi
	Minimum Residual Pressure (MDD + FF)	= 20 psi
Water Use Peaking Factors		
Fluctuations in water demands shall be based on:	Maximum Day Demand	= 2.2 x Average Day Demand
	Peak Hour Demand	= 3.1 x Average Day Demand
Fire Flows		
The system should be sized to accommodate the following fire flows:	Single Family Residential	= 1,000 gpm for 2 hours
	Mobile Home	= 1,000 gpm for 2 hours
	Multi-Family Residential	= 2,000 gpm for 3 hours
	Commercial	= 2,500 gpm for 3 hours
	Industrial	= 3,000 gpm for 3 hours
	Public Facility	= 3,000 gpm for 3 hours

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Chapter 6

DISTRIBUTION SYSTEM EVALUATION AND PROPOSED IMPROVEMENTS

This chapter discusses the hydraulic evaluation of the City of Shasta Lake (City) water distribution system, and the proposed projects that correct capacity deficiencies and serve future users. The results of the Fisherman's Point Water Treatment Plant (WTP) and tank condition assessment are also discussed.

6.1 Supply/Pumping Capacity Evaluation

The supply capacity evaluation under existing and future demand conditions was performed by comparing the available water supplies to the projected water demands. As noted in Chapter 5, this study recommends that the City maintain a firm water supply capacity equal to the maximum day demand (MDD). Demands in excess of the MDD will be met through storage.

Figure 6.1 shows a visual representation of how water is supplied to the distribution system. As shown on Figure 6.1, there are three facilities that need to be considered when evaluating the City's available supply capacity. These include:

- The firm capacity of the City's Raw Water Pump Station (RWPS)
- The treatment capacity of the Fisherman's Point WTP
- The firm capacity of the City's Treated Water Pump Station (TWPS)

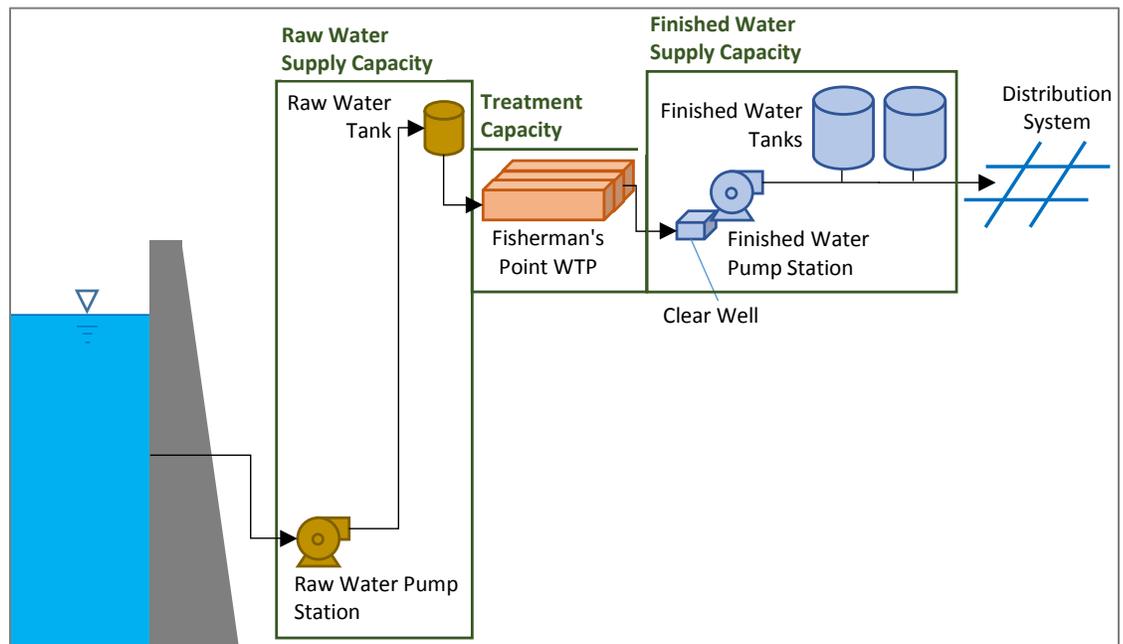


Figure 6.1 Supply Capacity Evaluation Schematic

These three facilities operate in series, meaning that each facility needs to have sufficient capacity to meet the City's existing and projected MDD.

6.1.1 Raw Water Pump Station Capacity Evaluation

As described in Chapter 4, the City's RWPS consists of five pumping units: two 125 horsepower (HP) pumps, one 200 HP pump, one 350 HP pump, and one 400 HP pump. There is also a spare can for a future sixth pump at the RWPS site. The capacity of the RWPS depends on the available suction head and the pump station, which is dependent on the level of Shasta Lake. The firm capacity of the pump station is significantly lower during drought conditions when the lake has been drawn down considerably. The City's previous Water Master Plan identified the available firm capacity of the RWPS for various lake levels. This analysis was performed for Pumps 1-4 (which were the pumps that were installed at the time), as well as with the new 400 HP Pump 5 (this pump has been installed since the previous Master Plan was published), and with the future Pump 6 (which has not yet been installed). Table 6.1 summarizes the results of the capacity evaluation of the RWPS. As shown on Table 6.1, the existing firm capacity of the RWPS (with Pumps 1-5 only) ranges from 3.02 million gallons per day (mgd) to 8.35 mgd, depending on the level in Shasta Lake. Under existing MDD conditions, the RWPS does not have sufficient firm capacity under the low lake level condition (Lake Level = 830').

Table 6.1 Raw Water Pump Station Capacity Evaluation

Planning Year	MDD (mgd)	Existing Firm Capacity ⁽¹⁾ (mgd)			Capacity Surplus/(Deficit) (mgd)		
		High Lake Level (1,069')	Int. Lake Level (993')	Low Lake Level (830')	High Lake Level (1,069')	Int. Lake Level (993')	Low Lake Level (830')
Existing	5.12	8.35	7.49	3.02	3.23	2.37	(2.10)
2036	6.32	8.35	7.49	3.02	2.03	1.17	(3.30)
Build-Out	15.86	8.35	7.49	3.02	(7.51)	(8.37)	(12.84)

Note:

(1) Assumes that Pumps 1-5 have been installed. The firm capacity of the RWPS will increase once Pump 6 is installed.

Figure 6.2 shows a comparison of the projected MDD through year 2036 to the firm capacity of the RWPS. As shown on Figure 6.2, the installation of a new 6th pump at the RWPS (with an estimated capacity of 2,500 gallons per minute [gpm] at 500-feet of head) would increase the City's firm capacity to 6.6 mgd. This would meet the City's projected MDD through year 2036. Additional pump replacements would be required by build-out.

6.1.2 Fisherman's Point WTP Capacity Evaluation

The Fisherman's Point WTP is currently rated to treat a maximum flow of up to 6.7 mgd. As shown in Table 6.2 and on Figure 6.3, the City's WTP has sufficient capacity to meet the projected 2036 MDD of 6.32 mgd. However, the capacity of the treatment plant will need to be expanded to meet the projected build-out MDD.

Table 6.2 Water Treatment Plant Capacity Evaluation

Planning Year	MDD (mgd)	Existing Treatment Capacity ⁽¹⁾ (mgd)	Capacity Surplus/(Deficit) (mgd)
Existing	5.12	6.70	1.58
2036	6.32	6.70	0.38
Build-Out	15.86	6.70	(9.16)

Note:

(1) Source: <http://www.ci.shasta-lake.ca.us/index.aspx?nid=913>

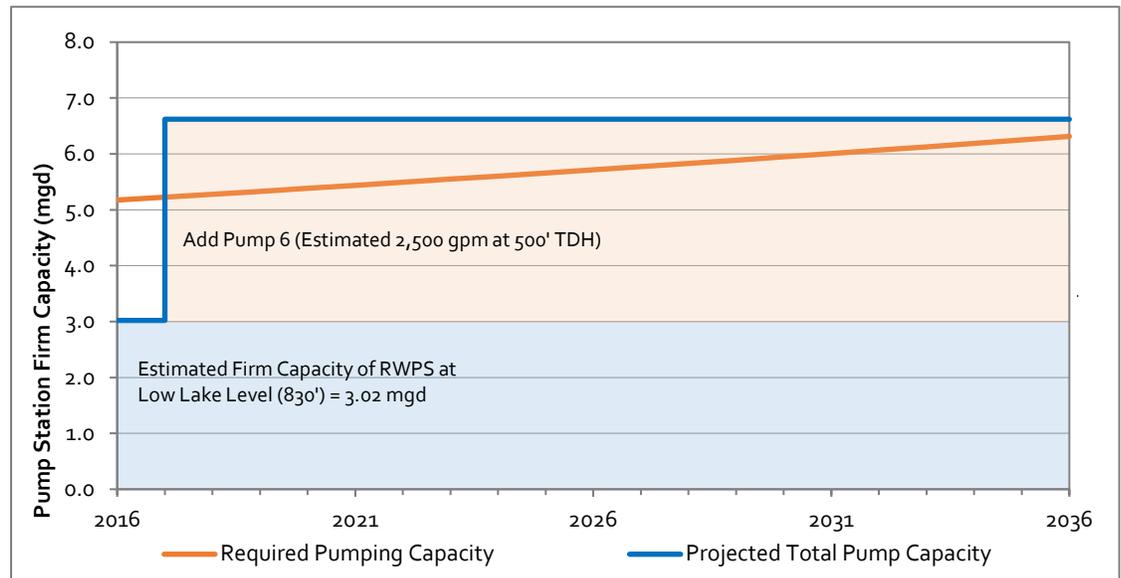


Figure 6.2 Raw Water Pump Station Capacity Evaluation at Low Lake Level

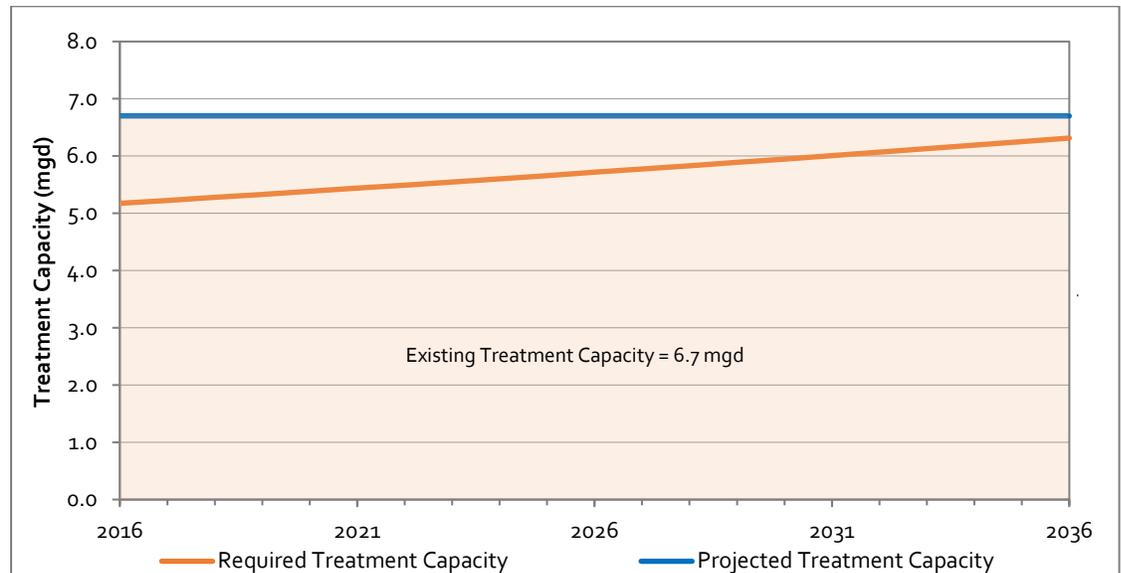


Figure 6.3 Water Treatment Plant Capacity Evaluation

6.1.3 Treated Water Pump Station Capacity Evaluation

The City pumps treated water from the Fisherman's Point WTP to the distribution system via the TWPS. As documented in Chapter 4, the TWPS has three pumps installed, each with a rated capacity of 4,000 gpm. However, the two older pumps (Pumps 1 and 2) do not pump at their rated capacity. Based on the flow data obtained from the City as part of model calibration, it has been estimated that Pumps 1 and 2 operate closer to 3,000 gpm. The third pump is assumed to run more efficiently, and closer to its design point of 4,000 gpm, however, this pump should be considered as the standby pump in the determination of the pump station's firm capacity. For this reason, the estimated firm capacity of the pump station is 6,000 gpm (8.64 mgd). Table 6.3 summarizes the capacity evaluation of the existing TWPS. Figure 6.4 shows a comparison of the projected MDD and the firm capacity of the TWPS (based on the estimated firm capacity, rather than the "rated" firm capacity). As shown on Table 6.3 and Figure 6.4, the City's TWPS has sufficient capacity to meet the 2036 MDD. However, additional pumping capacity would be required to meet the build-out MDD.

Table 6.3 Treated Water Pump Station Capacity Evaluation

Planning Year	MDD (mgd)	Existing Firm Capacity (mgd)		Capacity Surplus/(Deficit) (mgd)	
		Rated Capacity ⁽¹⁾	Estimated Firm Capacity ⁽²⁾	Rated Capacity	Estimated Firm Capacity
Existing	5.12	11.52	8.64	6.40	3.52
2036	6.32	11.52	8.64	5.20	2.32
Build-Out	15.86	11.52	8.64	(4.34)	(7.22)

Notes:

- (1) The Finished Water Pump Station includes three pumps with a rated capacity of 4,000 gpm each.
- (2) Based on SCADA information from the City, the actual pumping rate of the two older pumps (pumps 1 and 2) appears to be roughly 3,000 gpm. The newer pump (Pump 3) is assumed to have a capacity of 4,000 gpm, but would be a standby pump when considering the firm capacity of the pump station.

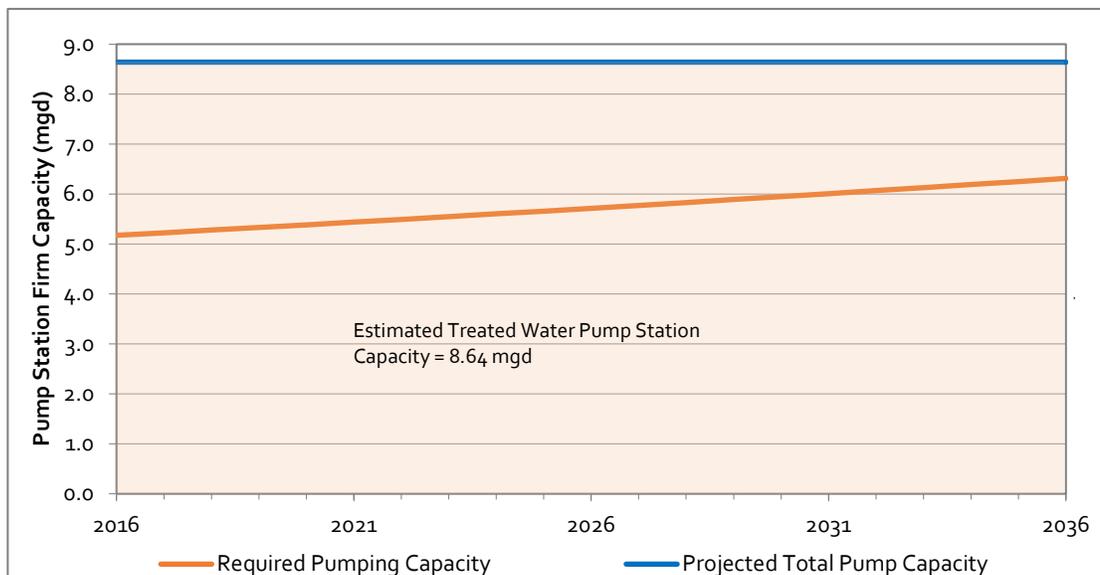


Figure 6.4 Treated Water Pump Station Capacity Evaluation

6.2 Storage Capacity Evaluation

The City currently has nine storage reservoirs for a total of 6.1 million gallons (MG) of treated water storage. These reservoirs provide the City with operational equalization storage to meet peak hour demand (PHD), fire flow storage, and emergency storage. The City currently has one active raw water tank with a volume of 0.17 MG, which allows for a consistent supply of raw water to the WTP. This section summarizes the capacity evaluation of the City's treated water and raw water storage capacity.

6.2.1 Treated Water Storage Capacity Evaluation

Treated water storage capacity criteria are defined in Chapter 5. The required operational storage is equal to 25 percent of MDD. The required fire flow storage is equal to the largest fire flow demand multiplied by the duration. In the case of Shasta Lake, the City-wide fire flow is equal to 3,000 gpm for a duration of three hours, which is equivalent to 0.54 MG.

As part of the development of storage capacity improvement alternatives, three separate criteria were considered for the amount of emergency storage that would be provided. The emergency storage criteria considered were 25 percent, 50 percent, and 100 percent of the MDD.

Appendix G includes the results of the storage capacity analysis for each of these criteria.

Ultimately, it was decided that the more conservative criteria of 100 percent of the MDD is most appropriate for the City due to the nature of the City's water supply. Therefore, the information presented in this section is based on an emergency storage criteria of 100 percent of the MDD.

In systems with multiple pressure zones, the storage evaluation is performed by pressure zone, meaning that each zone should be capable of providing the total required storage for that zone. In the case of the City, the lower zones can be supplied with water from the higher pressure zones, and therefore multiple zones were grouped for the purposes of evaluating existing and future storage capacity.

Table 6.4 summarizes the results of the existing system storage capacity evaluation. As shown on Table 6.4, there is currently a City-wide storage capacity deficiency of approximately 0.68 MG (assuming a required emergency storage of 100 percent of the MDD). Figure 6.5 shows a comparison of the projected required City-wide storage through year 2036 to the total available storage volume in the City. As shown on Figure 6.5, with the construction of a new 2.45 MG treated water storage reservoir at the existing United States Forest Service (USFS) driftwood storage pad near Centimudi Boat Ramp, and the demolition of the existing Finished Water storage tanks, the City should be capable of providing the required storage volume through roughly year 2035. Additional storage tanks would be required to meet the projected demands after 2035 through build-out. Table 6.5 and 6.6 summarize the results of the year 2036 and build-out system storage capacity evaluations, respectively. These tables assume that the proposed Centimudi Tank has been constructed. As shown in Table 6.5, the new Centimudi Tank is not quite sufficient to accommodate the required storage through 2036. However, because the projected deficiency is so small (less than 0.2 MG) the construction of a second new tank can mostly likely be pushed until after year 2036.

Table 6.4 Existing System Storage Evaluation

Evaluation Zones	ADD (mgd)	MDD (mgd)	Required Fire Flow ⁽²⁾		Required Storage				Tanks Available	Existing Available Storage (MG)	Surplus/ (Deficit) (MG)
			Fire Flow Demand (gpm)	Duration (hr)	Operational ⁽³⁾	Fire Flow	Emerg. ⁽⁴⁾	Total			
Zone A	0.03	0.08	1,000	2	0.02	0.12	0.08	0.21	Finished 1 and 2	0.50	0.29
Zone A-D ⁽¹⁾	0.32	0.69	3,000	3	0.14	0.54	0.69	1.37	Tank 5, Finished 1 and 2	0.96	(0.41)
Zone A, E/F ⁽¹⁾	0.24	0.51	2,500	3	0.10	0.45	0.51	1.07	Tank 1, Finished 1 and 2	0.69	(0.38)
Zone G, I, J	1.83	3.98	3,000	3	0.80	0.54	3.98	5.32	Tank 2, Tanks 3A/3B, Tank 4A/4B	4.85	(0.47)
City-wide	2.35	5.11	3,000	3	1.02	0.54	5.11	6.68	All Tanks	6.00	(0.68)

Notes:

- (1) Zones B through D and E&F are served by a single reservoir, and do not have enough available storage to meet fire flow volumes. However, these zones can pull water from upstream zones with excess storage. Therefore, the storage evaluation considered available and required storage from upstream zones.
- (2) Maximum required fire flow is the maximum for each zone/combined zone.
- (3) Operational storage = 20% of the Maximum Day Demand.
- (4) Emergency storage is 24 hours of the Maximum Day Demand, or 100% of the Maximum Day Demand.

Table 6.5 2036 System Storage Evaluation

Evaluation Zones	ADD (mgd)	MDD (mgd)	Required Fire Flow ⁽²⁾		Required Storage				Tanks Available ⁽⁵⁾	Existing Available Storage (MG)	Surplus/ (Deficit) (MG)
			Fire Flow Demand (gpm)	Duration (hr)	Operational ⁽³⁾	Fire Flow	Emerg. ⁽⁴⁾	Total			
Zone A	0.04	0.10	1,000	2	0.02	0.12	0.10	0.24	Centimudi	2.45	2.21
Zone A-D ⁽¹⁾	0.37	0.80	3,000	3	0.16	0.54	0.80	1.50	Tank 5, Centimudi	2.91	1.41
Zone A, E/F ⁽¹⁾	0.28	0.61	2,500	3	0.12	0.45	0.61	1.18	Tank 1, Centimudi	2.64	1.46
Zone A, G, I, J	2.33	5.08	3,000	3	1.03	0.54	5.08	6.64	Tank 2, Tanks 3A/3B, Tank 4A/4B	7.30	0.66
City-wide	2.90	6.32	3,000	3	1.26	0.54	6.32	8.13	All Tanks	7.95	(0.18)

Notes:

- (1) Zones B through D and E&F are served by a single reservoir, and do not have enough available storage to meet fire flow volumes. However, these zones can pull water from upstream zones with excess storage. Therefore, the storage evaluation considered available and required storage from upstream zones.
- (2) Maximum required fire flow is the maximum for each zone/combined zone.
- (3) Operational storage = 20% of the Maximum Day Demand.
- (4) Emergency storage is 24 hours of the Maximum Day Demand, or 100% of the Maximum Day Demand.
- (5) Assumes that the existing Finished Water Tanks have been demolished, and the proposed 2.45 MG Centimudi Tank has been constructed.

Table 6.6 Build-Out System Storage Evaluation

Evaluation Zones	ADD (mgd)	MDD (mgd)	Required Fire Flow ⁽²⁾		Required Storage				Tanks Available ⁽⁵⁾	Existing Available Storage (MG)	Surplus/ (Deficit) (MG)
			Fire Flow Demand (gpm)	Duration (hr)	Operational ⁽³⁾	Fire Flow	Emerg. ⁽⁴⁾	Total			
Zone A	0.23	0.50	2,500	3	0.1	0.45	0.50	1.06	Centimudi	2.45	1.39
Zones A-D(1)	1.24	2.70	3,000	3	0.54	0.54	2.69	3.78	Tank 5, Centimudi	2.91	(0.87)
Zones A, E/F(1)	0.89	1.94	2,500	3	0.39	0.45	1.93	2.78	Tank 1, Centimudi	2.64	(0.14)
Zones A, G, I, J	4.95	10.80	3,000	3	2.16	0.54	10.83	13.50	Centimudi, Tank 2, Tanks 3A/3B, Tank 4A/4B	7.30	(6.20)
Zone K	0.66	1.43	2,500	3	0.29	0.45	1.42	2.17	none	0.00	(2.17)
City-wide	7.28	15.86	3,000	3	3.17	0.54	15.86	19.58	All Tanks	7.95	(11.63)

Notes:

- (1) Zones B through D and E&F are served by a single reservoir, and do not have enough available storage to meet fire flow volumes. However, these zones can pull water from upstream zones with excess storage. Therefore, the storage evaluation considered available and required storage from upstream zones.
- (2) Maximum required fire flow is the maximum for each zone/combined zone.
- (3) Operational storage = 20% of the Maximum Day Demand.
- (4) Emergency storage is 24 hours of the Maximum Day Demand, or 100% of the Maximum Day Demand.
- (5) Assumes that the existing Finished Water Tanks have been demolished, and the proposed 2.45 MG Centimudi Tank has been constructed.

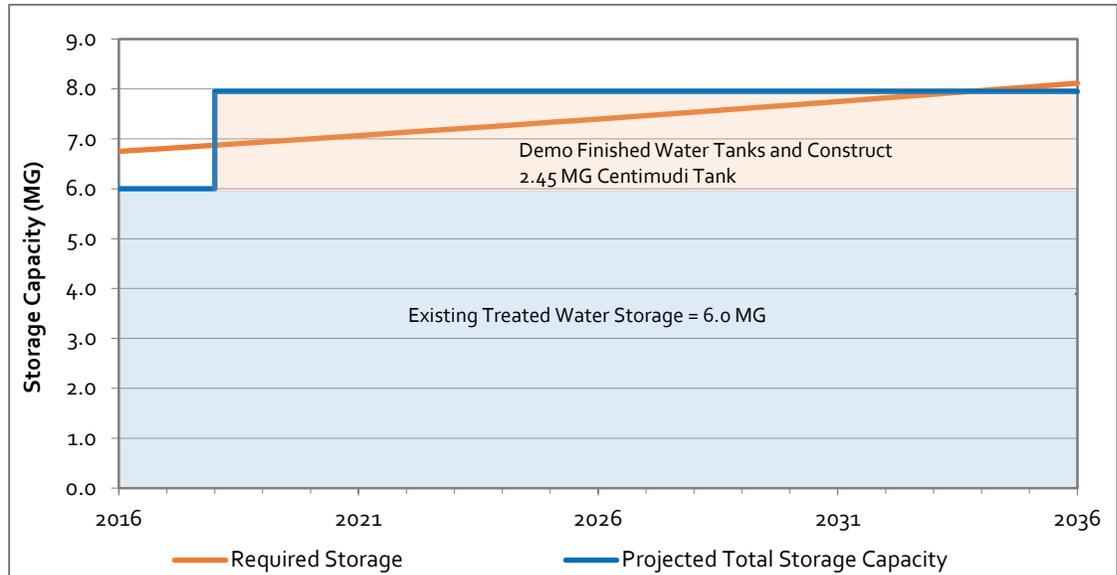


Figure 6.5 Treated Water Storage Capacity Evaluation

6.2.2 Raw Water Storage Capacity

As discussed in Chapter 5, the City has not developed a formal criteria for the amount of raw water storage that should be provided. Instead, the City's approach is to develop a raw water capital project that maximizes the amount of storage that can be constructed on the amount of land available to City.

Several alternatives were considered in the storage alternatives analysis provided in Appendix G. Based on the results of this analysis, it was determined that the best alternative for the City would be to demolish the existing Finished Water Storage Tanks and replace them with a new, larger Raw Water Storage Tank. Based on the site layout, it is estimated that this site could accommodate a tank that is approximately 1.6 MG.

It should be noted that the existing Raw Water Storage Tank is at a higher elevation than the new proposed Raw Water Storage Tank, and therefore the two tanks cannot be operated at the same time without the construction of a new pump station to pump from the new Raw Water Tank into the existing Raw Water Tank, or through valving that would break the head down into the new Raw Water Tank. For ease of operation, the City would like to utilize the existing tank as a standby tank for when the new tank is down for maintenance.

6.3 Distribution System Capacity Analysis

This section presents results of system pressure analysis, fire flow analysis, and pipeline velocity analysis for the City's water distribution system. Recommendations to address identified deficiencies are presented in the Section 6.5.

6.3.1 System Pressure Evaluation

In accordance with the criteria summarized in Chapter 5, system pressure analyses were performed using the hydraulic model for average day demand (ADD) and peak hour demand (PHD) conditions. This section summarizes the results of the analysis for existing and future demand conditions.

For the ADD and PHD demand conditions, the hydraulic model was used to identify service nodes within the distribution system with pressures that violate the established pressure criteria. For the ADD conditions, the City's maximum desirable pressure is 120 pounds per square inch (psi). Under PHD conditions, the minimum pressure criterion is 40 psi.

6.3.1.1 ADD Maximum Pressure Analysis

Figure 6.6 shows the maximum modeled system pressures under existing ADD conditions. As shown on Figure 6.6, the majority of the maximum pressures in the system are less than 100 psi. Nodes with model simulated pressures in excess of 120 psi are shown in red on Figure 6.6. These nodes account for approximately 2 percent of the nodes in the system, and were primarily located along main transmission lines. Therefore, they will likely not have an impact on customer pressures.

Due to the localized nature of the high pressure nodes (mostly along transmission lines), no improvement projects were identified to address high system pressures. It should be noted that, per current code requirements, it is recommended that any customer with a system pressure in excess of 80 psi be equipped with an individual service connection pressure reducing valve (PRV), if not already equipped.

A similar analysis was performed under year 2036 and build-out demand conditions. The 2036 and build-out analyses did not show any additional noteworthy high pressure areas.

6.3.1.2 PHD Minimum Pressure Analysis

Figure 6.7 shows the results of the PHD pressure analysis under existing demand conditions. Table 6.7 summarizes the information shown on Figure 6.7. The analysis showed that only 1.3 percent of low pressure nodes ranged between 30 psi to 40 psi and 2.5 percent below 30 psi under PHD conditions.

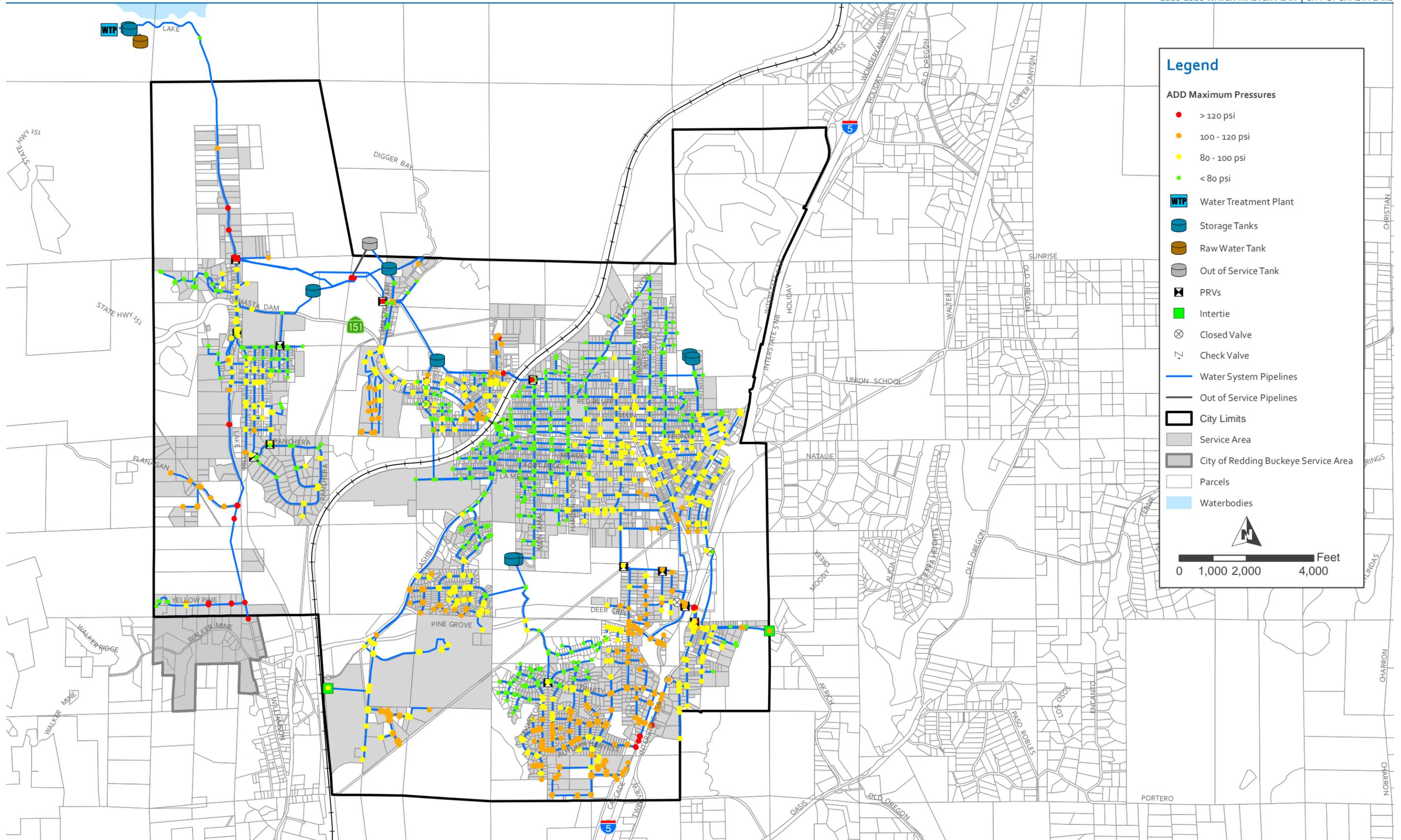
The areas that were identified as having pressures below 40 psi were due to high elevations in isolated portions of existing pressure zones. In many cases, there is not much that can be done to address the low pressure conditions, except for modifying the hydraulic grade line (HGL) of the pressure zone, or installing small booster pump stations to serve the affected properties. The City has not reported any pressure complaints from the areas shown on Figure 6.7, therefore no improvement projects were recommended to meet the minimum pressure criteria of 40 psi for these isolated areas of the system.

Under year 2036 and build-out demand conditions, there was not a noteworthy increase in the number of nodes with minimum pressures below 40 psi.

6.3.2 Fire Flow Analysis

The hydraulic model performs a steady state simulation at each node and reports the residual pressure at the node to evaluate impacts of fire flow demands on the system. Nodes with less than 20 psi of residual pressure were considered deficient.

Fire flow demands were simulated at all model nodes within the existing system that are associated with a fire hydrant. This process excluded model nodes without an associated fire hydrant (such as dead end pipes without fire hydrants and nodes near tank sites).



Legend

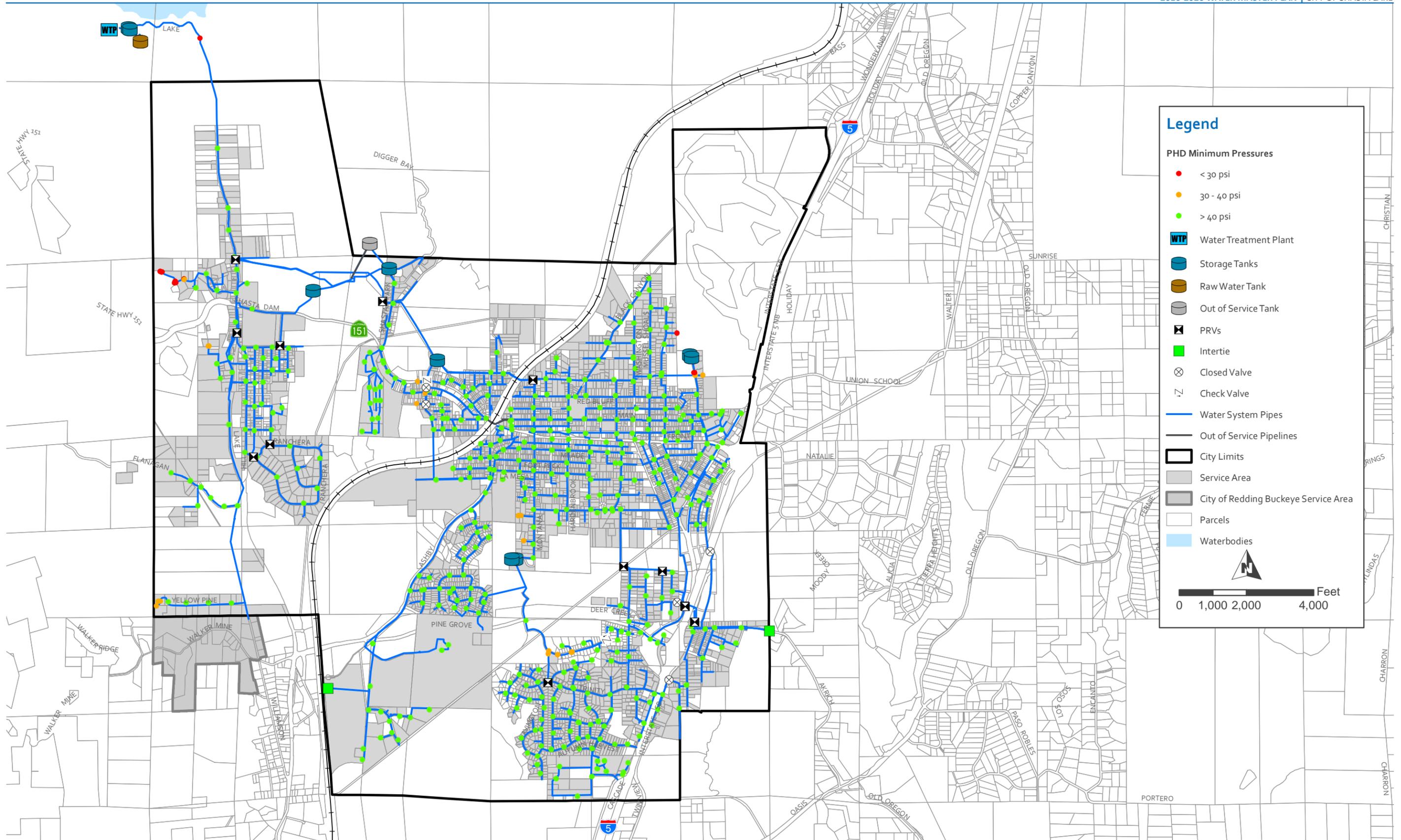
ADD Maximum Pressures

- > 120 psi
- 100 - 120 psi
- 80 - 100 psi
- < 80 psi

- WTP Water Treatment Plant
- Storage Tanks
- Raw Water Tank
- Out of Service Tank
- PRVs
- Intertie
- X Closed Valve
- Z Check Valve
- Water System Pipelines
- Out of Service Pipelines
- City Limits
- Service Area
- City of Redding Buckeye Service Area
- Parcels
- Waterbodies

N
0 1,000 2,000 4,000 Feet

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Legend

PHD Minimum Pressures

- < 30 psi
- 30 - 40 psi
- > 40 psi

- Water Treatment Plant
- Storage Tanks
- Raw Water Tank
- Out of Service Tank
- PRVs
- Intertie
- Closed Valve
- Check Valve
- Water System Pipes
- Out of Service Pipelines
- City Limits
- Service Area
- City of Redding Buckeye Service Area
- Parcels
- Waterbodies

Feet

 0 1,000 2,000 4,000

Figure 6.7
 Existing Peak Hour Demand
 Minimum Pressures



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Table 6.7 Low Pressure Nodes Under Existing PHD Conditions

Pressure Zone	Number of Nodes by Minimum Pressure Range ⁽¹⁾			
	30 psi - 40 psi	20 psi - 30 psi	<20 psi	Total
Zone A	0	2	2	4
Zone B	5	1	11	17
Zone C	3	0	0	3
Zone D	0	0	0	0
Zone E	0	0	0	0
Zone F	0	16	4	22
Zone G	20	4	17	41
Zone I	0	0	0	0
Zone J	0	0	0	0
Total	28	23	34	85
Percent of Modeled Nodes⁽¹⁾	1.3%	1.0%	1.5%	3.8%

Note:

(1) The total number of nodes that represent the water system within the model is approximately 2,220.

The fire flow simulations were performed using the hydraulic model's built in automated fire flow simulator. This eliminates the need to assign individual fire flow demands to all nodes, which would be extremely time consuming. Fire flow demands were assigned in the model by land use according to the fire flow demand criteria summarized in Chapter 5. Figure 6.8 shows the fire flow demand types that were assigned to each modeled system hydrant. The fire flow demands ranged from 1,000 gpm to 3,000 gpm.

The existing fire flow analysis showed that 457 hydrants (approximately 22 percent of the system) had a residual pressure less than 20 psi under MDD plus fire flow conditions. For deficient hydrants with multiple hydrants in close proximity, it is possible to split the fire flow demand with another hydrant. The fire flow analysis was repeated for deficient hydrants by using multiple hydrants. Distributing the fire flow over two adjacent hydrants typically results in a lower pressure drop compared with the use of one hydrant. Using this approach, the number of deficient hydrants was reduced to approximately 76 hydrants. Figure 6.9 depicts hydrants that meet the evaluation criteria, deficient hydrants that were mitigated through splitting fire flows with another hydrant, and deficient hydrants. Individual improvements to address these deficiencies are presented later in Section 6.5.

Similar analyses were conducted under year 2036 and build-out MDD plus fire flow conditions. No new fire flow deficiencies were identified. Section 6.5 provides more detailed information regarding the proposed improvements to mitigate the fire flow deficiencies.

6.3.3 Pipeline Velocity Analysis

Pipeline velocity analyses were performed based on the criteria provided in Chapter 5 using the hydraulic model for PHD conditions. As documented in Chapter 5, the pipeline velocity analysis

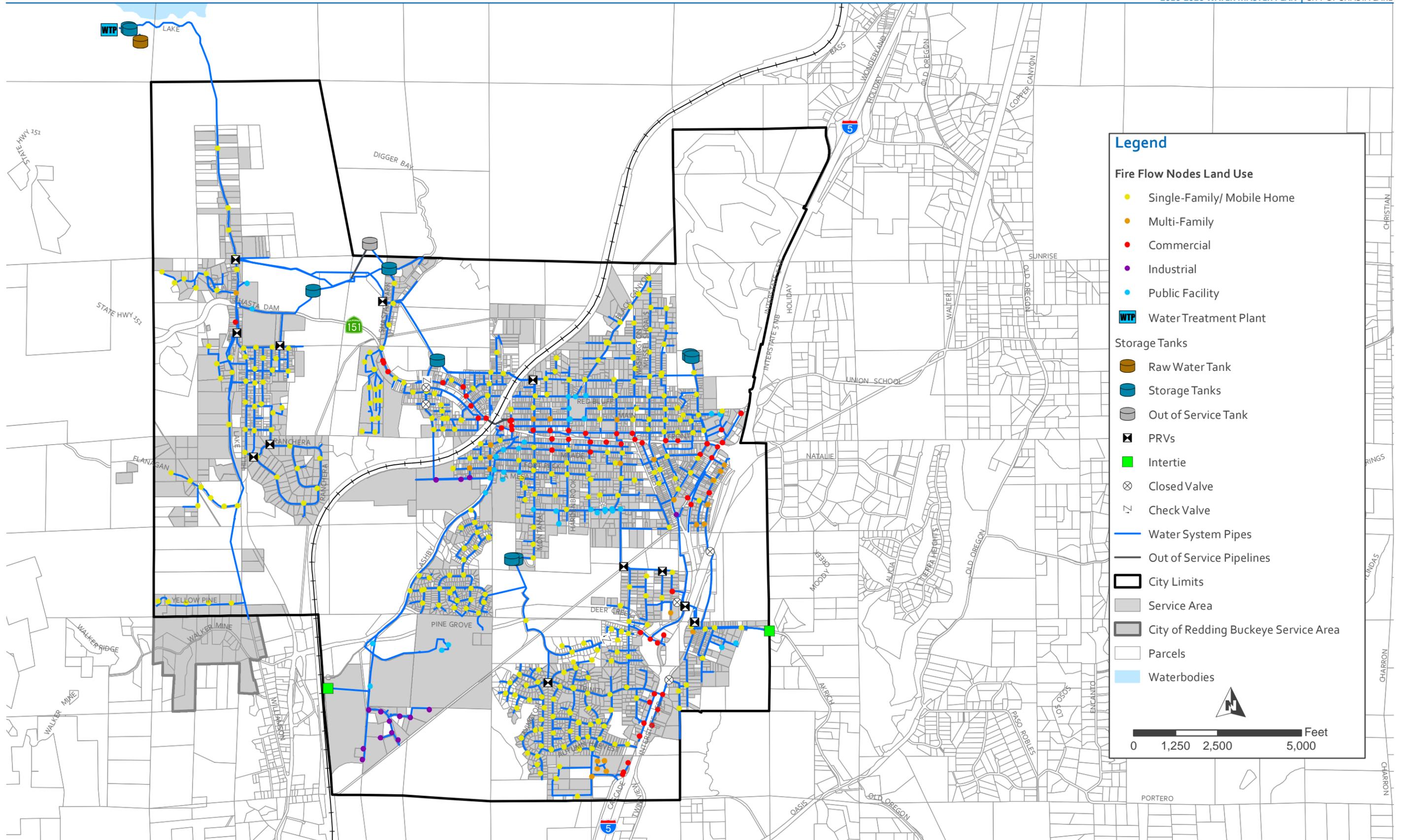
was performed to identify pipelines within the distribution system with velocities that exceed 8 feet per second (fps) under PHD conditions. Under existing PHD conditions, three pipelines were identified that exceeded the pipeline velocity criteria. By year 2036, one additional pipeline was identified. Six additional pipelines were identified at build-out.

The pipelines that exceeded the established maximum velocity criteria are shown on Figure 6.10 and summarized in Table 6.8. The proposed improvement projects to mitigate these deficiencies are discussed later in this chapter.

6.4 Condition Assessment of Major Facilities/Small Diameter Pipeline Replacement

The City, along with Carollo Engineers staff (including a Structural Engineer) conducted a visual inspection of the City's Fisherman's Point WTP, storage tanks, and RWPS on October 18 and 19, 2015. Additionally, the City provided Carollo with dive inspection reports of the City's storage tanks. The dive inspections were performed by LiquiVision Technology Diving Services on January 22 and 23, 2015. A copy of the dive inspection reports is included in Appendix H for reference. The following summarizes the findings of the visual inspection of the dive inspections:

- *Fisherman's Point WTP*: The Fisherman's Point WTP is in good condition, with only a few notable items.
 - In the recent past, the City experienced an issue with a pipe joint coming into the filter plant. At the time, a valve to the existing raw water tank was closed while the RWPS was in operation and the filter plant was not pulling water. This caused the joint to fail. Since that time, the City has implemented standard operating procedures to ensure that a similar incident does not occur in the future.
 - The plant water pump station is undersized and in need of replacement.
 - The City has currently budgeted for several improvements to the WTP, including installation of sludge dewatering facility, Filter No. 1 and 2 Rehabilitation, demolition of the Toyon WTP, construction of a retaining wall, and other miscellaneous projects.
- *Raw Water Tank*: The Raw Water Tank is in excellent condition, and no recommendations are provided except for periodic cleaning.
- *Finished Water Tank 1*: This tank is in need of a new interior coating, as well as a few minor maintenance items (such as installation of mesh screens on exterior vents, and weather stripping on the entry hatch). Additionally, this tank has a redwood cover. This tank is recommended to be demolished as part of the recommended storage capacity improvement alternative. Therefore, no costs were included in the City's capital improvement plan (CIP) to coat this tank.
- *Finished Water Tank 2*: This tank is in need of a new interior coating, as well as a few other additional items (replacement of the liquid level indicator float, and patching a hole in the ceiling). This tank is recommended to be demolished as part of the recommended storage capacity improvement alternative. Therefore, no costs were included in the City's CIP to coat this tank.



Legend

Fire Flow Nodes Land Use

- Single-Family/ Mobile Home
- Multi-Family
- Commercial
- Industrial
- Public Facility

Water Treatment Plant

Storage Tanks

- Raw Water Tank
- Storage Tanks
- Out of Service Tank

■ PRVs

■ Intertie

⊗ Closed Valve

⊥ Check Valve

— Water System Pipes

— Out of Service Pipelines

▭ City Limits

▭ Service Area

▭ City of Redding Buckeye Service Area

▭ Parcels

▭ Waterbodies

0 1,250 2,500 5,000 Feet

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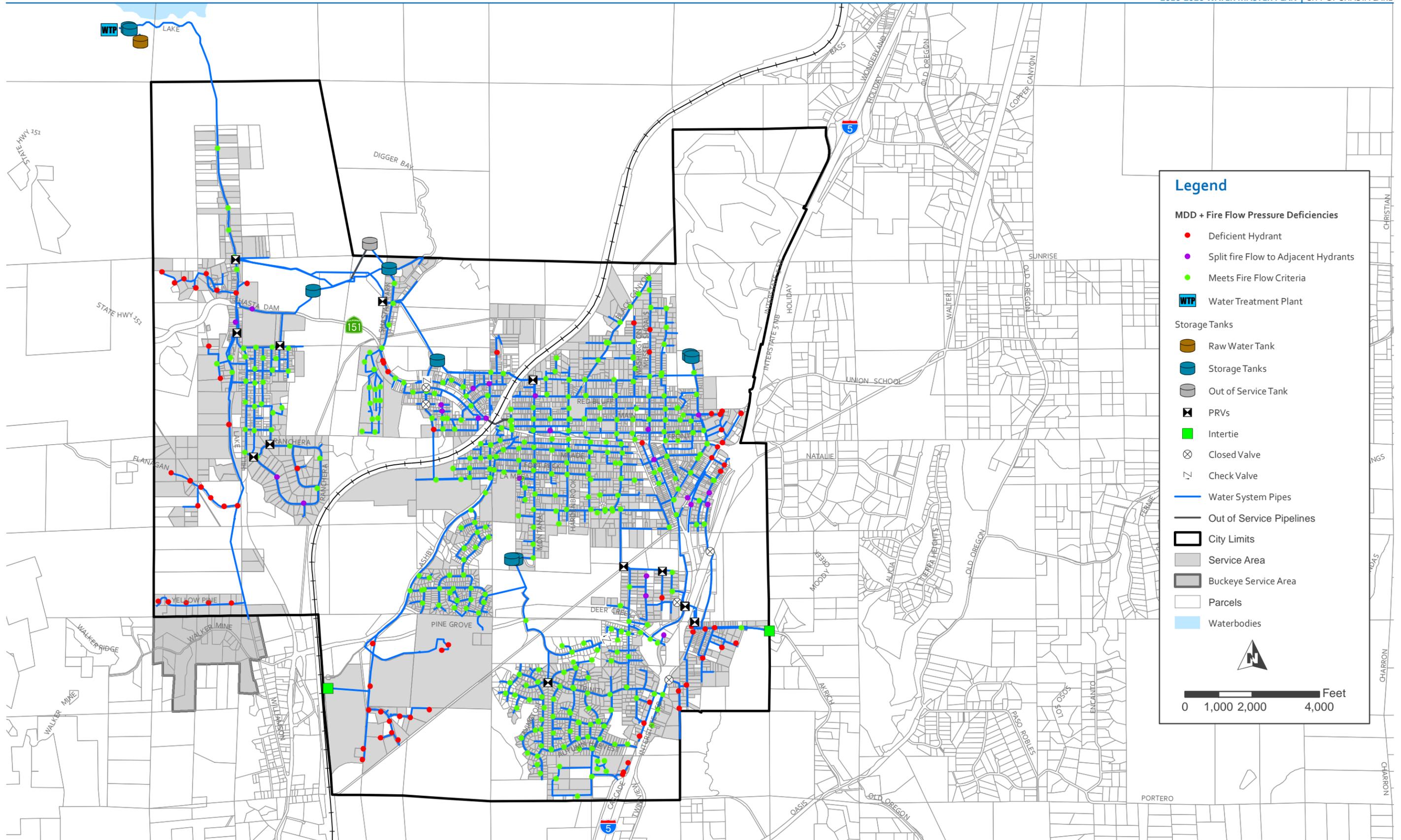


Figure 6.9
 Existing Maximum Day Demand Plus
 Fire Flow Analysis Results



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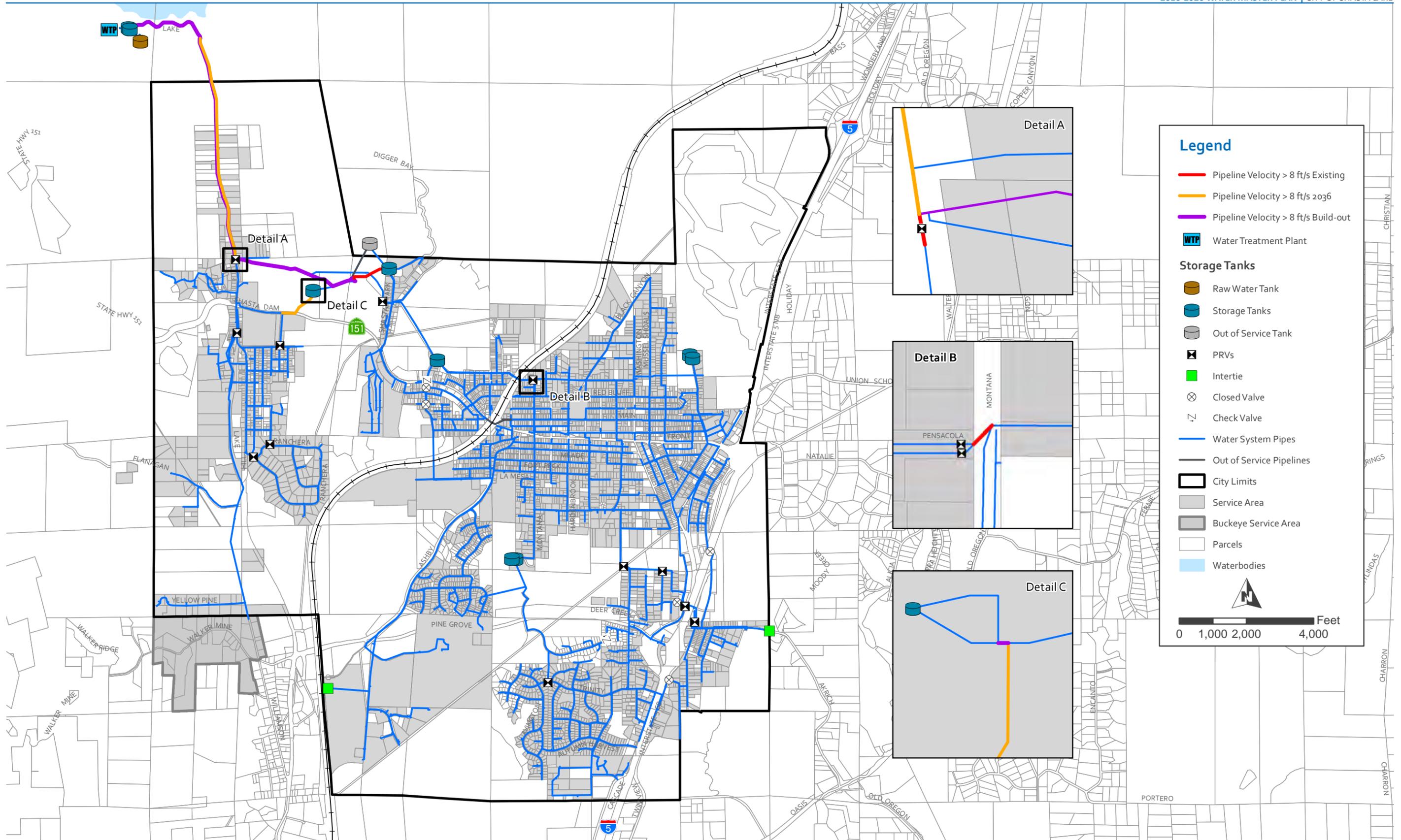


Figure 6.10
Peak Hour Demand Maximum
Velocities



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- *Tank 1 (Picard)*: This tank is in need of a new interior coating to address minor to heavy corrosion in the interior of the tank, as well replacement of the liquid level indicator float.
- *Tank 2 (Rouge)*: This tank is in good condition, and no recommendations are provided except for periodic cleaning.
- *Tank 3A (Shasta Way A)*: A blast and recoat of this tank is recommended.
- *Tank 3B (Shasta Way B)*: The interior of this tank showed a moderate to heavy amount of corrosion, and it is recommended that this tank be recoated.
- *Tank 4A (Montana A)*: This tank is in good condition with one small 2-inch spot of corrosion on the inside liner in need of repair.
- *Tank 4B (Montana B)*: This tank has a minor to moderate amount of corrosion on the inside liner. A new liner is recommended.
- *Tank 5 (Toyon)*: This tank is in need of a new interior coating, as well as a few minor maintenance items (such as installation of mesh screens on exterior vents, weather stripping on the entry hatch, and replacement of the liquid level indicator).
- *Raw Water Pump Station*: There are a number of issues with the RWPS that need to be addressed. These include capacity issues (as previously discussed), reliability, and condition issues. Appendix I includes a more detailed description of the issues related to the RWPS. In summary, the following is recommended:
 - An additional pump is needed for capacity purposes.
 - Many of the existing pumps are unreliable and leak. Some pumps have been rebuilt incorrectly, which has led to issues with the operation of the rebuilt pumps. It is recommended that the existing pumps be replaced over time to address these issues and to increase the pumping capacity of the pump station in the future.
 - The transmission main has failed in the past, and been out of service for extended periods of time. This is a major vulnerability for the City, as a failure of the transmission main would leave the City without water. A new parallel transmission line is recommended for reliability purposes.

In addition to the major facilities identified above, the City's water distribution system includes a significant amount of small diameter pipeline (less than 6-inches in diameter). The City has recently replaced a large amount of this pipe as part of a grant, however, a significant amount still remains in the ground. Excluding the replacement of fire flow capacity replacements (see Section 6.5 below), it is estimated that approximately 12.2 miles of small diameter pipeline would still be in the ground after the recommended fire flow capacity upgrades have been implemented.

6.5 Distribution System Improvements

Figure 6.11, Figure 6.12 and Figure 6.13 provide a graphical illustration of the improvements recommended to address existing capacity deficiencies, to meet the projected 2036 water demands, and to serve full build-out of the City service area, respectively. The improvements are itemized by project in Table 6.8 with a cross-referenced number system. The columns used in Table 6.8 refer to the following:

- *ID*: Assigned number that corresponds to the Proposed Improvements Table. This is an alphanumeric number that starts with one letter indicating the type of improvement (D = Development Related; FF = Fire Flow Related; PS= Pump Station;

RR = Rehabilitation Related; T = Tank, TM = Transmission Main/Velocity Related; V = Pressure Reducing Valve, WTP= Water Treatment Plant Related) and continues with a number.

- *Type of improvement:* Storage tanks, wells, pipelines, jacked steel casings, and booster pumps.
- *Reason:* Summarizes the reason that the improvement is needed.
- *Description/Street:* Street in which the improvement is proposed.
- *Description/Limits:* Description of the beginning and end of a proposed pipeline project.
- *Ex. Size/Diameter:* This is the size of the existing pipeline/facility. It represents the diameter of the existing pipelines (in inches), the size of the storage reservoirs (in MG), and the size of the wells and booster stations (in gpm).
- *New Size/Diameter:* This is the size of the proposed improvement. It represents the diameter of the proposed pipelines (in inches), the size of the storage tanks (in MG), and the size of the wells and booster stations (in gpm).
- *Length:* Estimated length of the proposed improvement (in feet), if applicable. It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions.

The following sections summarize the recommended improvements.

6.5.1 Existing Versus Future Improvements

An existing deficiency is one where the existing facility's capacity is insufficient to meet the planning criteria (e.g. pipeline upgrades required to meet fire flow criteria) for existing users. If a project was proposed to exclusively correct an existing deficiency, then existing users would be assigned 100 percent of the project's benefit, and therefore, 100 percent of the costs.

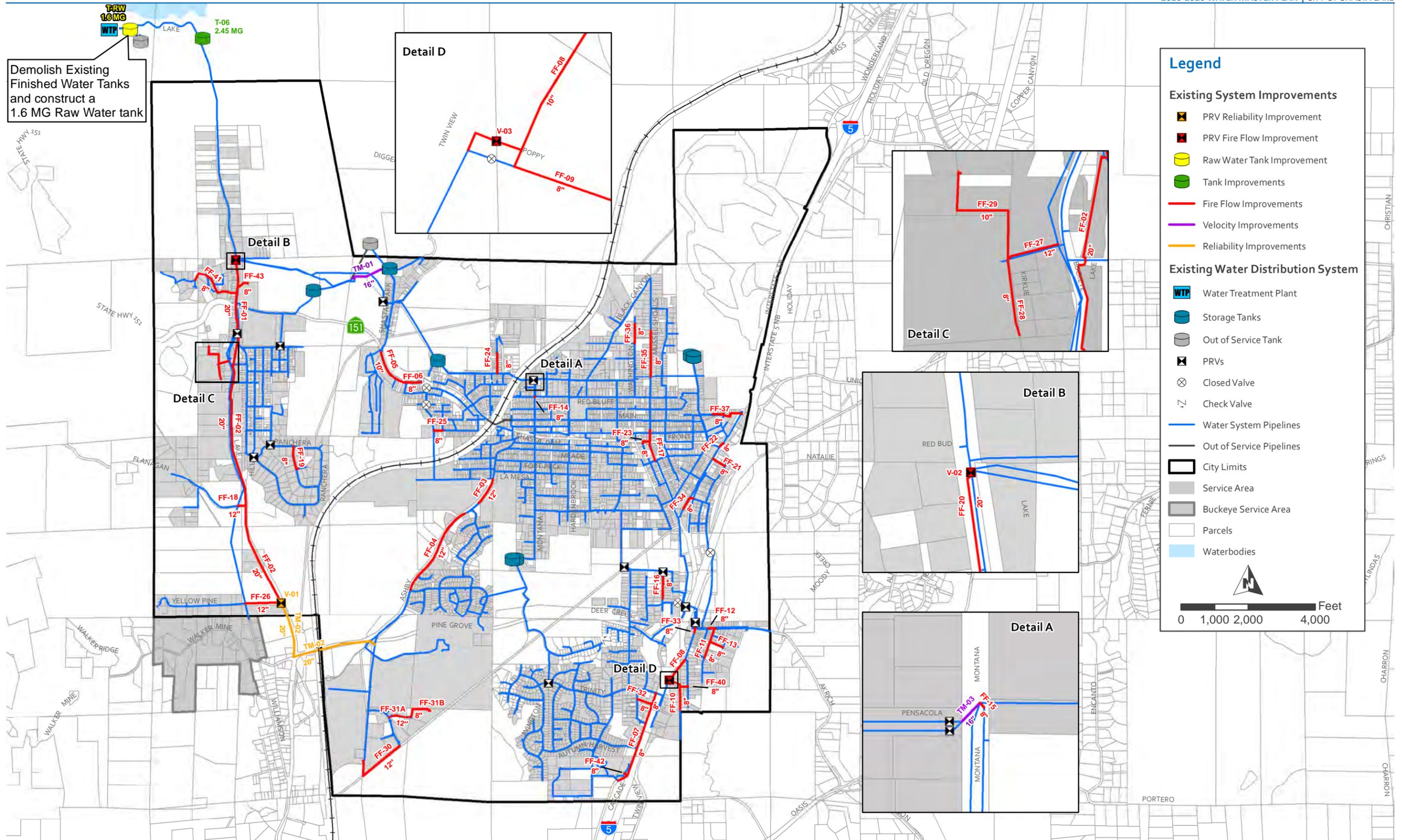
Future growth will trigger the construction of new facilities to support this growth (e.g., new distribution system pipelines to serve vacant areas within the City service area). If a specific project is needed to serve future growth exclusively, the future users will be assigned 100 percent of the future project's benefit and 100 percent of the costs.

In some cases, such as a proposed storage tank, projects are needed to mitigate existing deficiencies and to accommodate future growth. Where a project is needed to mitigate existing deficiencies and serve future growth, the future user benefit was determined based on the additional capacity necessary to serve future growth. More information on the breakdown in cost split between existing and future users and whether a proposed improvement is intended to correct an existing deficiency, to serve a future user, or both is provided in Chapter 7.

6.5.2 Supply/Pumping Improvements

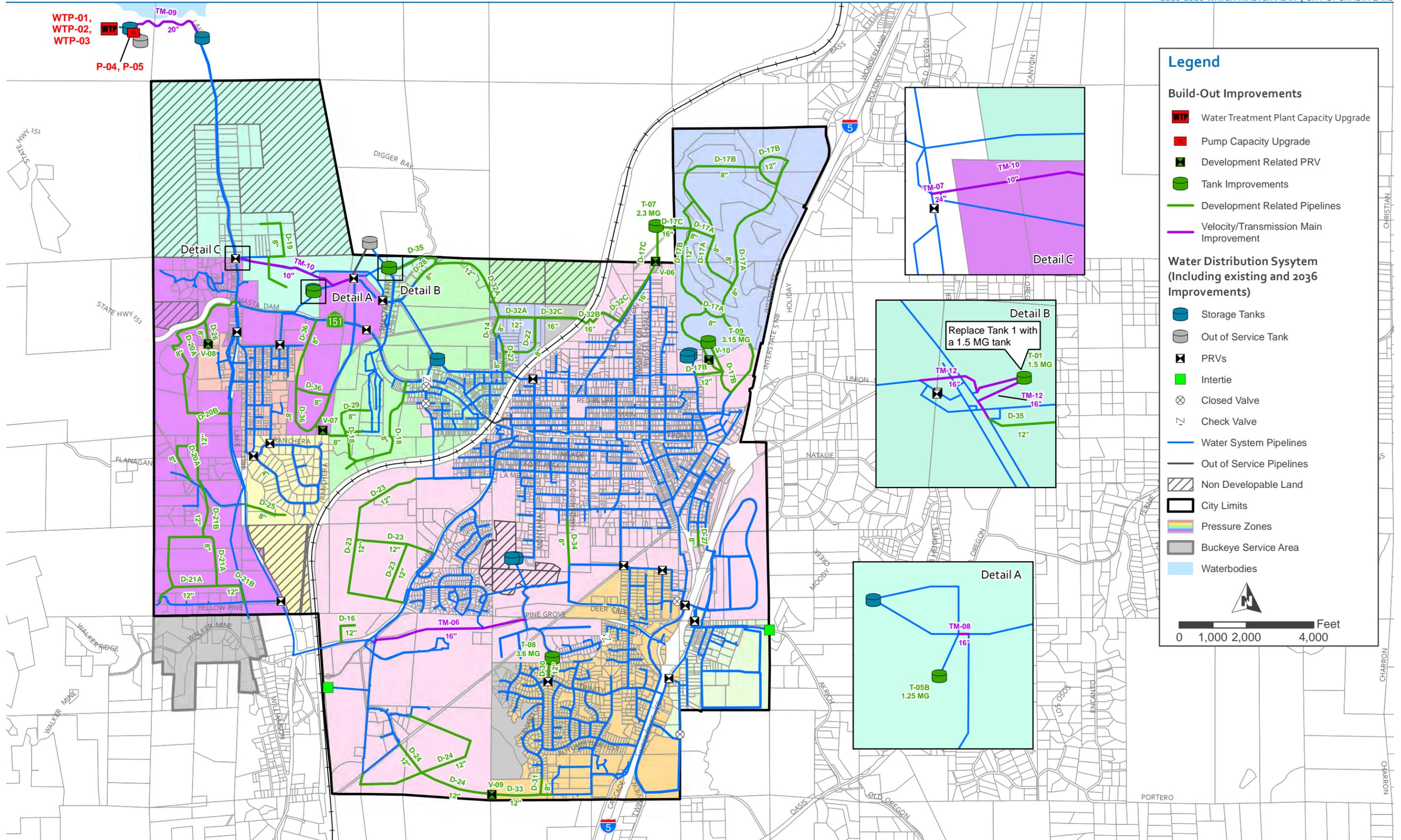
The following supply improvements are recommended:

- *Raw Water Pump Station - Pump 6 (Project PS-01):* To mitigate the existing capacity deficiency of the RWPS under existing low lake levels, it is recommended that a sixth pump be added to the RWPS at the spare can location. A new pump with a firm capacity of 2,500 gpm at 400 feet of head would provide enough additional capacity to meet 2036 demands.



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Table 6.8 Proposed Improvements

ID	Type of Improv.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size			
						Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)
Capacity/Storage Related Projects									
Fire Flow Improvements									
FF-01	Pipe	Fire Flow	Lake Blvd.	Red Bud Lake PRV to north of Buckeye St.	Existing	--	20	New	2,160
FF-02	Pipe	Fire Flow	Lake Blvd.	Buckeye St. to south of Buckeye Dump Rd.	Existing	--	20	New	8,550
FF-03	Pipe	Fire Flow	Los Flores St. / Ashby Rd.	El Cajon Ave. to north of Woodley Ave.	Existing	4/6	12	Replace	850
FF-04	Pipe	Fire Flow	Ashby Rd.	Coeur D'Alene Ave. to south of Woodley Ave.	Existing	6	12	Replace	2,860
FF-05	Pipe	Fire Flow	Shasta Dam Blvd.	Shasta Park Dr. to Poplar St.	Existing	8	10	Replace	1,230
FF-06	Pipe	Fire Flow	Shasta Dam Blvd.	Poplar St. to Rouge Rd.	Existing	--	8	New	730
FF-07	Pipe	Fire Flow	Cascade Blvd.	Crystal St. to Riddle Rd.	Existing	4	8	New/Replace	2,890
FF-08	Pipe	Fire Flow	Twin View Blvd.	Virginia Ave. to Poppy Ln.	Existing	--	10	New	770
FF-09	Pipe	Fire Flow	Poppy Ln.	Twin View Blvd. to Larkin Ave.	Existing	4	8	Replace	310
FF-10	Pipe	Fire Flow	Larkin Ave.	Poppy Ln. to hydrant M705FH lateral	Existing	4	8	Replace	750
FF-11	Pipe	Fire Flow	Leona Ave.	Akrich St. to Pine Grove Ave.	Existing	4	8	Replace	900
FF-12	Pipe	Fire Flow	Akrich St.	Marilyn Ave. to Leona Ave.	Existing	4	8	Replace	220
FF-13	Pipe	Fire Flow	Webster St.	Leona Ave. to Park Ln.	Existing	6	8	Replace	420
FF-14	Pipe	Fire Flow	Red Bluff St. & Montana Ave.	make a loop	Existing	--	8	New	20
FF-15	Pipe	Fire Flow	Pensacola St. & Montana Ave.	make a loop	Existing	--	8	New	10
FF-16	Pipe	Fire Flow	Cottage Ave.	Cottage PRV to south of Fell St. (or north of Deer Creek Ave.)	Existing	4	8	Replace	830
FF-17	Pipe	Fire Flow	Grand Coulee Blvd. / Mussel Shoals Ave.	Fort Peck St. to north of Front St.	Existing	4	8	Replace	950
FF-18	Pipe	Fire Flow	Flanagan Rd.	Lake Blvd. to west of Lake Blvd. (parallel pipeline)	Existing	--	12	New	240
FF-19	Pipe	Fire Flow	Kokanee Dr.	Ranchera Rd. to Latigo Way	Existing	4	8	Replace	670
FF-20	Pipe	Fire Flow	Latigo Way	Kokanee Dr. to hydrant H207FH lateral	Existing	2	8	Replace	50
FF-21	Pipe	Fire Flow	Second St.	Cascade Blvd. to Parallel St.	Existing	4/6	8	Replace	420
FF-22	Pipe	Fire Flow	Cascade Blvd. & Shasta Dam Blvd.	make a loop	Existing	--	8	New	150
FF-23	Pipe	Fire Flow	Shasta Dam Blvd.	Mussel Shores Ave. to east of Washington Ave.	Existing	--	8	New	260
FF-24	Pipe	Fire Flow	Forest St.	Pensacola St. to Arrow Rock St.	Existing	4	8	Replace	590
FF-25	Pipe	Fire Flow	Olive St.	Rouge Rd. to Renovo Ave.	Existing	2	8	Replace	280
FF-26	Pipe	Fire Flow	East of Yellow Pine Rd.	Lake Blvd. to Belt Line Rd.	Existing	--	12	New	1,070
FF-27	Pipe	Fire Flow	Jankanish Rd.	Kirklie Ln. to Buckeye St.	Existing	6	12	Replace	310
FF-28	Pipe	Fire Flow	Kirklie Ln.	Jankanish Rd. to south of Jankanish Rd.	Existing	4	8	Replace	450
FF-29	Pipe	Fire Flow	Kirklie Ln. / Montego Rd.	Jankanish Rd. to hydrant F101FH lateral (on Montego Rd.)	Existing	4/6	10	Replace	830
FF-30	Pipe	Fire Flow	Complete loop at end	Ashby Rd. to Shasta Gateway Dr.	Existing	--	12	New	1,850
FF-31A	Pipe	Fire Flow	Iron Ct.	Shasta Gateway Dr. to dead end east of Shasta Hate Way Dr.	Existing	8	12	Replace	630
FF-31B	Pipe	Fire Flow	Field Northeast of Iron Ct.	Iron Ct. to Hydrant M403FH	Existing	4	8	Replace	850
FF-32	Pipe	Fire Flow	Mulberry St.	West St. to Cascade Blvd.	Existing	2	8	New/Replace	480
FF-33	Pipe	Fire Flow	Virginia Ave.	Virginia PRV Station to south of Akrich St. (or north of Pine Grove Ave.)	Existing	4	8	Replace	340
FF-34	Pipe	Fire Flow	Morning Star Way	Cascade Blvd & Joseph St. to north of Gran Coulee Blvd.	Existing	--	8	New	470
FF-35	Pipe	Fire Flow	Mussel Shoals Ave.	North of Red Bluff St. to south of Koch St.	Existing	4	8	Replace	1,380
FF-36	Pipe	Fire Flow	Washington Ave.	Boca St. to north of Boca St.	Existing	4	8	Replace	590
FF-37	Pipe	Fire Flow	Grand Ave.	Buena Vista St. to west of Shasta Way	Existing	--	8	New	430
FF-38	Pipe	Fire Flow	East of Grand Ave.	Buena Vista St. to Cascade Blvd.	Existing	--	8	New	650
FF-39	Pipe	Fire Flow	Shasta Dam Blvd. & Shasta St.	Make a loop	Existing	--	8	New	60
FF-40	Pipe	Fire Flow	Private Property at corner of Larkin Ave. & Poppy Ln.	Larkin Ave. to Virginia Ave.	Existing	4	8	Replace	270
FF-41	Pipe	Fire Flow	Duval Dr. / Duval Ln.	Lake Blvd. to Targa Ln.	Existing	4/6	8	Replace	1,700
FF-42	Pipe	Fire Flow	Cascade Blvd. to northwest towards Oasis (mini golf)	Make a loop	Existing	--	8	New	110
FF-43	Pipe	Fire Flow	Between Duval Dr. and Mason Dr.	Make a Loop at private property off Lake Blvd	Existing	--	8	New/Replace	360
Transmission & Distribution Main									
TM-01	Pipe	Velocity	Woods	Tank 1 to Holly Ave. & Third St.	Existing	10	16	Replace	1,200
TM-02A	Pipe	Reliability	Lake Blvd. / Pine Grove Ave.	South of Buckeye Dump Rd. to Newtown Rd.	Existing	--	20	New	2,010
TM-02B	Pipe	Reliability	Pine Grove Ave.	Newtown Rd. to Ashby Rd.	Existing	--	20	New	2,190
TM-03	Pipe	Velocity	Pensacola St.	Pensacola PRVs to Montana Ave.	Existing	10	20	Replace	40
TM-04	Pipe	Reliability	Parallel raw water transmission main	From Raw Water PS to New Raw Water Storage Tank	Existing	--	20	New	1,700
TM-05	Pipe	Velocity	Lake Blvd.	Centimudi Tank to Red Bud Ln.	Future	--	24	New	6,770
TM-06	Pipe	Operations	Pine Grove Ave.	Ashby Rd. to Coeur D'Alene Ave.	Buildout	--	16	New	4,640
TM-07	Pipe	Velocity	Red Bud Ln. & Lake Blvd.	Connects to 14" and 18" pipelines	Buildout	14	24	Replace	10
TM-08	Pipe	Velocity	Runs Partially on Shasta Dam Blvd.	Sacramento St. to Tank 5 Site	Buildout	10	16	Replace	10
TM-09	Pipe	Velocity	WTP Drive Way / Lake Blvd.	Treated Water Pump Station to Centimudi Tank	Buildout	--	20	New	3,000
TM-10	Pipe	Velocity	Parallel to existing 14" pipeline from Redbud Ln. & Lake Blvd.	Red Bud Ln. & Lake Blvd. to north of Third St.	Buildout	--	10	New	3,670
TM-11	Pipe	Velocity	Upsize Tank 1 pipelines, completer with project T-01	Tank 1 site	Buildout	8/10	16	Replace	210
TM-12	Pipe	Velocity	Upsize Tank 2 pipelines	Tank 2 site	Buildout	10	14	Replace	10

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Table 6.8 Proposed Improvements

ID	Type of Improv.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size			
						Existing Size/ Diameter/ (in)	Proposed Size/ Diameter/ (in)	Replace/ New	Length (ft)
Pump Stations¹									
PS-01	Pump	Capacity	Raw Water PS	Add a sixth pump with a capacity of 2,500 gpm at 500 feet	Existing	--	400 HP	New ⁽⁵⁾	--
PS-02	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 1 with a pump with a capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--
PS-03	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 2 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--
PS-04	Pump	Capacity	Treated Water PS	Add a fourth pump with a capacity of 3,000 gpm at 80 feet	Buildout	--	75 HP	New	--
PS-05	Pump	Capacity	Treated Water PS	Add a fifth pump each with a capacity of 3,000 gpm at 80 feet	Buildout	--	75 HP	New	--
PS-06	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 3 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--
PS-07	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 4 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--
Storage/Reservoir									
T-06	Reservoir	Storage	Construct a 2.45 MG reservoir at Centimudi Site (40' x 102')	Centimudi Tank (aka Tank 6)	Existing	--	2.45 MG	New	--
T-RW	Reservoir	Storage	Demo Finished Water Tanks 1 & 2 and construct a 1.6 MG Raw Water Tank (30' x 95')	New raw water tank	Existing	--	1.60 MG	Replace	--
T-01	Reservoir	Storage	Demo existing Tank 1 and construct a 1.50 MG reservoir @ Tank 1 Site (22' x 108')	New Tank 1	Buildout	--	1.50 MG	Replace	--
T-05B	Reservoir	Storage	Construct a 1.25 MG reservoir tank 5 Site, Feeds Zone B (22' x 98')	Tank 5B	Buildout	--	1.25 MG	New	--
T-07	Reservoir	Storage	Construct a 2.35 MG reservoir that feeds Zone K (40' x 100')	Tank 7	Buildout	--	2.35 MG	New	--
T-08	Reservoir	Storage	Construct a 3.6 MG reservoir that feeds Zones I & J @ Risstay Way Site (40' x 124')	Tank 8	Buildout	--	3.60 MG	New	--
T-09	Reservoir	Storage	Construct a 3.15 MG reservoir that feeds Zone G @ Mtn. Gate Site (36' x 122')	Tank 9	Buildout	--	3.15 MG	New	--
Valves									
V-01	Valve	Reliability	Install a 16" PRV along Lake Blvd.	Allows Zone B to move water to Zone G	Existing	--	20"	New	--
V-02	Valve	Velocity	Upsize Redbud Lake PRV with a 16" PRV	Allows Zone A to move water to Zone B	Existing	--	20"	Replace	--
V-03	Valve	Reliability	Install a 10" PRV at Twin View Blvd. & Poppy Ln.	Allows Zone I to move water to Zone J	Existing	--	10"	New	--
V-04	Valve	Reliability	Install a 10" PRV along Shasta Dam Blvd.	Allows Zone B to move water to Zone E/F	Future	--	12"	New	--
V-05	Valve	Pressure	Install a 10-inch PRV at Holly Ave. & Third St.	Allows Zone A to move water to Zone B	Future	--	10"	New	--
V-06	Valve	Reliability	Install a 16" PRV along Black Canyon Rd.	Allows Zone E/F to move water to Zone K	Buildout	--	16"	New	--
V-07	Valve	Reliability	Install an 8" PRV new development between Ranchera Rd. and Shasta Dam Blvd.	Allows Zone B to move water to Zone E/F	Buildout	--	8"	New	--
V-08	Valve	Velocity	Install an 8" PRV along Montego Rd.	Allows Zone B to move water to Zone C	Buildout	--	8"	New	--
V-09	Valve	Reliability	Install a 12" PRV between South Industrial Park and Arrowhead Ave.	Allows Zone G to move water to Zone I	Buildout	--	12"	New	--
V-10	Valve	Reliability	Install a 12" PRV in Mtn. Gate Development	Allows Zone K to move water to Zone G	Buildout	--	12"	New	--
Water Treatment Plant									
WTP-01	WTP	Capacity	Sludge Dewatering Facility	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-02	WTP	Reliability	Filter No. 2 Rehabilitation	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-03	WTP	Rehabilitation	Toyon Water Treatment Plant Demolition	Toyon Water Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-04	WTP	Rehabilitation	WTP Retaining Wall	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-05	WTP	Reliability	Filter No. 1 Rehabilitation	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-06	WTP	Reliability	No.1 Filtered Water Pump Replacement	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--
WTP-07	WTP	Reliability	Capital Project Allocation (Water Meter, HVAC, Master Plan)	Varies	Existing	--	-	Replace ⁽⁵⁾	--
WTP-08	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 6.5 MGD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--
WTP-09	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 9.75 MDD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--
WTP-10	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 13.0 MGD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--
Rehabilitation Related Projects									
Transmission & Distribution Main									
RR-01	Rehabilitation	Rehabilitation	Small Diameter Pipeline Replacement (Less than 6") Phase 1		Existing	< 6"	8	R/R	2.26 miles
RR-02	Rehabilitation	Rehabilitation	Small diameter Pipeline Replacement (Less than 6") Phase 2		Future	<6"	8	R/R	9.89 miles
Storage/Reservoir									
RR-03	Rehabilitation	Reservoir	Tank 1 Rehabilitation Projects		Existing	--	--	R/R	--
RR-04	Rehabilitation	Reservoir	Tank 4B Rehabilitation Projects		Existing	--	--	R/R	--
RR-05	Rehabilitation	Reservoir	Tank 3A Rehabilitation Projects		Existing	--	--	R/R	--
RR-06	Rehabilitation	Reservoir	Tank 3B Rehabilitation Projects		Existing	--	--	R/R	--
RR-07	Rehabilitation	Reservoir	Tank 5 Rehabilitation Projects		Existing	--	--	R/R	--
Water Treatment Plant									
RR-11	Rehabilitation	WTP	Rehabilitation Plant Water PS		Existing	--	--	R/R	--

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Table 6.8 Proposed Improvements

ID	Type of Improv.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size			
						Existing Size/ Diameter (in)	Proposed Size/ Diameter (in)	Replace/ New	Length (ft)
Developer Specific Projects									
D-01A	Pipe	Development	Future road	North of Pine Grove Ave. and east of Smith Ave.	Future	--	8	New	800
D-01B	Pipe	Development	Future road	North of Pine Grove Ave. and east of Smith Ave.	Future	--	12	New	3,430
D-02A	Pipe	Development	Future road	East of Interstate 5 NB and north of Akrich St.	Future	--	8	New	10,910
D-02B	Pipe	Development	Future road	East of Interstate 5 NB and north of Akrich St.	Future	--	12	New	820
D-03	Pipe	Development	Future roads, runs partially along Akrich St., Leona Ave. and Alpine St.	South of Akrich St. and east of Leona Ave.	Future	--	8	New	6,730
D-04	Pipe	Development	Cascade Blvd.	Pine Grove Ave. to Trinity St.	Future	--	8	New	1,740
D-05	Pipe	Development	Future road	South of Pine Grove Ave. and west of Risstay Way	Future	--	8	New	2,170
D-06	Pipe	Development	Future road	South of Pine Grove Ave. and east of Risstay Way	Future	--	12	New	1,520
D-07	Pipe	Development	Twin View Blvd. / Larkin Ave.	South of Medocino St. to north of Crooked Oak Ln.	Future	--	8	New	5,640
D-08	Pipe	Development	Shasta Dam Blvd.	Sacramento St. to Shasta Park Dr.	Future	--	10	New	3,390
D-09	Pipe	Development	Future roads	South of Shasta Dam Blvd.	Future	--	8	New	2,220
D-10	Pipe	Development	Runs partially along Third St. and Holly Ave.	Shasta Dam Blvd. to Sixth St.	Future	--	12	New	2,220
D-11	Pipe	Fire Flow	Akrich St.	Leona Ave. to Akrich Park Ave.	Future	1-4	8	Replace	860
D-12	Pipe	Development	Extend Buena Vista St. northeast	Grand Ave. to Mtn. Gate development	Future	--	12	New	690
D-13	Pipe	Development	Twin View Blvd. / Larkin Ave.	South of Medocino St. to north of Crooked Oak Ln.	Future	--	8	New	5,650
D-14	Pipe	Development	Forest St.	Oliver St. to Arrow Rock St.	Buildout	--	8	New	660
D-15	Pipe	Development	Future road	West of Avington Way and south of Pembroke Ln.	Buildout	--	8	New	840
D-16	Pipe	Development	Industrial Park Central	North of Pine Grove Ave.	Buildout	--	12	New	930
D-17A	Pipe	Development	Future road	Mtn. Gate development	Buildout	--	8	New	11,890
D-17B	Pipe	Development	Future road	Mtn. Gate development	Buildout	--	12	New	15,050
D-17C	Pipe	Development	Future Transmission Main	Mtn. Gate development	Buildout	--	16	New	2,730
D-18	Pipe	Development	Runs partially along Poplar St.	South of Shasta Dam Blvd.	Buildout	--	8	New	5,610
D-19	Pipe	Development	Future roads	Extend Red Bud Ln. east	Buildout	--	8	New	3,280
D-20A	Pipe	Development	Runs partially along Shasta Dam Blvd. and Belt Line Rd.	Lake Blvd. to Flanagan Rd.	Buildout	--	8	New	7,020
D-20B	Pipe	Development	Runs partially along Shasta Dam Blvd. and Belt Line Rd.	Lake Blvd. to Flanagan Rd.	Buildout	--	12	New	3,300
D-21A	Pipe	Development	Runs partially along west of Lake Blvd. and Carpet Creek Way	North of Yellow Pine Rd. and South of Carpet Creek Way	Buildout	--	8	New	6,150
D-21B	Pipe	Development	Huckleberry Rn.	South of Flanagan Rd.	Buildout	--	12	New	2,770
D-22	Pipe	Development	Runs partially along Central Ave. and Montana Ave.	Red Bluff Ave. to Oliver St.	Buildout	--	8	New	2,740
D-23	Pipe	Development	Industrial Park North	Extend El Cajon Ave. and east of Ashby Rd.	Buildout	--	12	New	10,210
D-24	Pipe	Development	Industrial Park South	Extend Shasta Gateway Dr. to PRV Project V-11	Buildout	--	12	New	9,350
D-25	Pipe	Development	Future road	East of Lake Blvd. and north of Buckeye Dump Rd.	Buildout	--	8	New	1,250
D-26	Pipe	Development	Montego Rd.	Shasta Dam Blvd. to proposed PRV	Buildout	--	8	New	730
D-27	Pipe	Development	Extend Rosamond St. south	East of Cascade Blvd.	Buildout	--	8	New	460
D-28	Pipe	Development	White Way	Tank 2 Service Road to Cypress Ave.	Buildout	--	8	New	730
D-29	Pipe	Development	Extend Oak Hill Dr.	Creekside Way to Creekside Way	Buildout	--	8	New	1,890
D-30	Pipe	Development	North of Trinity St.	Trinity St. to Tank 8	Buildout	--	12	New	800
D-31	Pipe	Development	Avington Way	South of Ashwick Ct.	Buildout	--	8	New	490
D-32A	Pipe	Development	Cypress Ave. / Olive St. / Black Canyon Rd. /	White Way to Rail Road Crossing	Buildout	--	12	New	3,980
D-32B	Casing	Development	Railroad crossing	Oliver St. to Walker Ln.	Buildout	--	16/30	New	460
D-32C	Pipe	Development	Walker Ln. / Black Canyon Rd.	Railroad crossing to Mtn. Gate Development	Buildout	--	12	New	3,910
D-33	Pipe	Development	Arrowhead Ave.	East of Tomahawk Trl.	Buildout	--	12	New	1,800
D-34	Pipe	Development	Future road	Extend Hardenbrook Ave. south to future roads	Buildout	--	8	New	1,340
D-35	Pipe	Development	Pickard St.	Tank 1 to Cypress Ave.	Buildout	--	12	New	1,720
D-36	Pipe	Development	Future roads	South of Shasta Dam Blvd.	Buildout	--	8	New	6,250

Notes:

(1) Assumes replacement pumps operate at 80% efficiency. Pump replacements include motor replacement.

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- *Raw Water Pump Station - Pump 1 - 4 Replacement (Projects PS-02, PS-03, PS-06, and PS-07)*: It is recommended that the smaller existing pumps at the RWPS be replaced in order to provide sufficient capacity to serve build-out demands. These pump replacements can be staged to occur as City demands increase.
- *Fisherman's Point WTP (Projects WTP-01 through WTP-07, and RR-11)*: These projects are currently planned by the City, and include installation of sludge dewatering facility, Filter No. 1 and 2 Rehabilitation, demolition to the Toyon WTP, construction of a retaining wall, and other miscellaneous projects. Additionally, it is recommended that the City replace the existing plant water pump station with a higher capacity pump station.
- *Fisherman's Point WTP Upgrade (Projects WTP-08 through WTP-10)*: Additional treatment trains will be required to meet build-out (post 2036) demands. To meet ultimate build-out, three additional treatment trains with a capacity of 3.25 mgd each would be necessary.
- *Treated Water Pump Station (Projects PS-04 and PS-05)*: Two additional pumps will be required to meet build-out (post 2036) demands. It is assumed that two new 3,000 gpm pumps will be constructed.

6.5.3 Storage Improvements

As discussed in Section 6.2, the City will need to construct additional storage to meet the existing, 2036, and build-out demand requirements. A total of seven new or replacement tanks are recommended based on the analysis conducted for this Master Plan. Additionally, rehabilitation projects are recommended for five of the City's existing tanks.

Similar to the City's current storage tanks, each tank will be located at ground level. The locations of the proposed tanks were identified based on input from City staff and local topography. A more detailed tank siting analysis should be performed during preliminary design of each tank. Below is a summary of the location and purpose of each of the proposed tanks.

- *Centimudi Tank (Project T-06)*: In order to provide additional emergency storage for the entire City service area, it is recommended that a new, 2.45 MG tank be constructed at the USFS site near the Centimudi boat ramp, which is currently used as a driftwood storage site. This site is located at the correct elevation to serve pressure Zone A, and is a relatively flat pad. The City would need to acquire approval from the USFS in order to construct this tank. This is a very high priority improvement.
- *New Raw Water Tank (Project T-RW)*: With the construction of the proposed Centimudi Tank, the City could demolish the existing finished water tanks and construct a new larger Raw Water Tank. It is estimated that a 1.6 MG tank could fit on the site. Once the new Raw Water Tank is constructed, the existing Raw Water Tank would be set aside as a standby tank for when the new Raw Water Tank is drained. This is a high priority improvement.
- *Tanks Required to Meet Build-Out (Post 2036) Demands (Projects T-01, T-05B, T-07, T-08, and T-09)*: Several additional tanks are recommended to serve the increase in demands associated with post 2036 demands. These projects are development driven, and should be constructed based on the rate at which development occurs in the City.

- *Tank Rehabilitation (Projects RR-03 through RR-07):* It is recommended that the City implement the tank rehabilitation projects identified in Section 6.4, which include mostly tank lining projects. Projects are recommended for Tank 1, 3A, 3B, 4B, and 5. Tank lining is not recommended for the existing Finished Water Tanks unless the proposed Centimudi Tank is significantly delayed.

6.5.4 Fire Flow Improvements

As discussed previously, a number of deficient fire flow nodes (residual pressures below 20 psi) were identified as part of the fire flow capacity analysis. To mitigate these deficiencies, recommendations for pipeline improvements were developed. These improvements generally consist of replacement of smaller diameter (≤ 6 inches) pipelines with larger (8 to 12 inch) diameter pipelines. In total, approximately 39,940 linear feet (7.6 miles) of fire flow improvements are recommended. Table 6.8 provides additional detail related to each fire flow improvement.

6.5.5 Transmission/Velocity Improvements

As discussed in Section 6.3.3, two pipelines were identified that exceeded the pipeline velocity criteria under existing PHD conditions. By year 2036, one additional pipeline was identified, and six additional pipelines were identified at build-out. Several other transmission system improvements are recommended to either improve system operations or to increase system reliability. These projects are described below:

- *Tank 1 Pipeline Velocity Improvement (Project TM-01):* To mitigate an existing velocity deficiency, it is recommended that 1,200 feet of 10-inch diameter pipeline from Tank 1 site to the corner of Holly Ave. & Third St. be replaced with a 20-inch diameter pipeline.
- *Zone B to Zone G Transmission Main (Project TM-02):* The City's main transmission pipeline to Zone G, which is a parallel 10-inch diameter main along Pensacola Boulevard, is constructed of thin walled steel, and a portion of these pipelines are above grade. For reliability purposes, it is recommended that a new transmission main be constructed to supply water to Zone G. The recommended project would connect to fire flow project FF-01 and FF-02, and would consist of constructing a new 4,200 feet 20-inch diameter pipeline along Lake Blvd. and Pine Grove Ave. to connect Zone B and G. A new PRV (project V-02) would be required to break pressure from Zone B to Zone G.
- *Pensacola Pipe Replacement (Project TM-03):* To mitigate an existing velocity deficiency, it is recommended that a short 40 foot reach of a 10-inch diameter pipeline be replaced with a 16-inch diameter pipeline along Pensacola Ave. between the Pensacola New PRV and Montana Ave.
- *Parallel Raw Water Transmission Main (Project TM-04):* It is recommended that a parallel 20-inch diameter raw water transmission main be constructed to increase the reliability of the existing raw water transmission main. 1,700 feet of parallel pipeline is recommended.
- *WTP Parallel Transmission Main (Project TM-5):* In order to mitigate a 2036 velocity deficiency, it is recommended that a new parallel, 6,800 foot long, 24-inch diameter pipeline be constructed along Lake Boulevard from the Centimudi Tank site to Red Bud Lane.
- *Transmission Improvements Required to Service Build-Out (Post 2036) Demands (Projects TM-06 through TM-12):* Several additional pipeline transmission improvements are

recommended to meet maximum velocity criteria and to aid in filling tanks that are associated with post 2036 demands. These projects are development driven, and should be constructed based on the rate at which development occurs in the City. In total, roughly 11,550 feet (2.2 miles) of pipe are recommended.

- *Development Funded Pipelines (Projects D-01 through D-36)*: The vast majority of pipeline improvements are recommended to provide water service at build-out to areas that are currently vacant and not connected to the City's system. These projects will be constructed by individual developers as development occurs through 2036 and build-out. Roughly 29.8 miles of developer funded pipelines have been identified as part of this Master Plan, with diameters ranging from 8-inches to 16-inches in diameter.

6.5.6 PRV Station Improvements

PRV Station improvement projects were developed to mitigate system deficiencies and to improve reliability. Table 6.8 provides additional details related to each improvement. The recommended PRV station improvements are described below:

- *Lake PRV (Project V-01)*: It is recommended that a new PRV station be constructed to break pressure from Zone B into Zone G along the proposed new transmission main project along Lake and Pine Grove (Project TM-02).
- *Red Bud/Lake PRV Replacement (Project V-02)*: A major fire flow improvement (Projects FF-01 and FF-02) is recommended to mitigate fire flow deficiencies in Pressure Zone B. This project consists of replacing the existing water main along Lake Boulevard with a larger pipeline. This will also require that the existing Red Bud/Lake PRV Station be upsized accordingly.
- *Twin View/Poppy PRV (Project V-03)*: A new PRV station near Twin View Boulevard and Poppy Lane is recommended to improve fire flow capacity in Zone J. The proposed valve would supply water from Zone I into Zone J.
- *Shasta Dam Blvd PRV (Project V-04)*: It is recommended that a new PRV station be constructed along Shasta Dam Boulevard that allows Zone B to move water to Zone E/F. This improvement project is associated with development project D-08, and would be required to meet projected 2036 demands.
- *Holly PRV (Project V-05)*: This project will allow for more efficient movement of water from Zone A to Zone B to meet projected year 2036 demands. It is recommended that a new PRV station be constructed at Holly Avenue and Third Street.
- *PRV Stations Required to Service Build-Out (Post 2036) Demands (Projects V-06 through V-10)*: Several additional PRV stations are recommended to serve the projected post 2036 demands. These projects are development driven, and should be constructed based on the rate at which development occurs in the City. Five additional PRV stations are recommended.

6.5.7 Small Diameter Pipeline Replacement

As previously discussed, the City's water distribution system includes a significant amount of small diameter pipeline (less than 6-inches in diameter). The City has recently replaced a large amount of this pipe as part of a grant, however, a significant amount still remains in the ground. It is recommended that the City implement a program to replace all pipelines smaller than 6-inches. This small diameter replacement program will be phased according to the availability of City funding or the availability of grant funding. In total, approximately 12.2 miles of small

diameter pipeline replacement is recommended in addition to the pipeline replacement projects identified in the previous section.

6.5.8 Highest Priority Projects

This Master Plan has identified a total of 143 individual projects to meet existing capacity deficiencies, increase system reliability, address condition related issues, and to service future growth. The City's current water rate structure allows for the implementation of a select number of projects in the short term, and therefore it is important to identify the most critical projects that should be constructed as soon as possible, and those that are less critical. Based on discussions with City staff, as well as an assessment of risk within the City's system by Carollo, the following projects have been identified as the highest priority projects related to this Master Plan. These projects should be targeted for implementation as soon as possible:

- Centimudi Tank (Project T-06).
- New Raw Water Tank (Project T-RW).
- Raw Water Pump Station - Pump 6 (Project PS-01.)
- Parallel Raw Water Transmission Main (Project TM-04).
- Fisherman's Point WTP Project Currently in the City's Budget (Projects WTP-01 through WTP-07, and RR-11).

Chapter 7

CAPITAL IMPROVEMENT PLAN

This chapter presents the City of Shasta Lake (City) capital improvement projects, a summary of the capital costs, and a basic assessment of the possible financial impacts on the City. This chapter is organized to assist the City in making financial decisions. The Capital Improvement Plan (CIP) is based on the evaluation of the City's water distribution system as described in Chapter 6.

7.1 Project Prioritization

As discussed in Chapter 6, the capital projects identified will allow the water distribution system to reliably serve the City's peak water demand through the year 2036 and ultimate build-out. The improvement projects were prioritized based on the following factors:

- Upgrading existing facilities to mitigate current capacity deficiencies, and increasing the reliability of existing facilities.
- Upgrading existing facilities to accommodate increased water demands for the 2036 and build-out planning years.
- Expanding the City's distribution system infrastructure to serve existing vacant land areas.
- Implementing condition assessment projects for the City's major water system facilities.
- Implementing a small diameter pipeline replacement program.

Based on these factors, each project was categorized as either an Existing, Future (Year 2036), or Build-Out project. This terminology defines the driver for each improvement project. Existing improvements are required to mitigate existing capacity deficiencies or to rehabilitate or repair an existing facility. Future (Year 2036) facilities are necessary to meet the projected peak demands in the year 2036. Build-Out improvements are necessary to accommodate demand increases that are projected to occur after the year 2036.

7.2 Capital Improvement Project Costs

The capacity upgrades and other water system capital improvements set the foundation for the City's water distribution system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, Inc. (Carollo) experience on other projects. The costs are based on an *Engineering News Record* Construction Cost Index (ENR CCI) 20-City Average of 10,182 (March 2016).

7.3 Cost Estimating Accuracy

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope,

implementation schedule, and other variable factors such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate, deemed appropriate for master plan studies, as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.4 Construction Unit Costs

The construction costs are representative of water distribution system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction.

7.4.1 Pipeline Unit Costs

Water distribution system pipeline improvements range in size from 8-inches to 30-inches in diameter in this master plan. Pipeline unit costs for relevant sized upgrades are shown in Table 7.1. The unit costs are for “typical” field conditions with construction in stable soil.

Table 7.1 Pipeline Unit Costs

Pipe Size (inches)	Replacement Unit Construction Cost ⁽¹⁾ (\$/linear foot)
8	106
10	133
12	158
14	184
16	211
18	216
20	240
24	287
30	359

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182

7.4.2 Storage Tank, Booster Pump, and PRV Station Unit Costs

The City provided Carollo with local tank cost estimates from approximately \$0.51 to \$0.59 per gallon, and only included the construction of the tank itself. In order to account for site work and other associated costs, a planning value of \$0.75 per gallon was assumed for new storage tank construction. The estimated construction costs were developed on a case-by-case basis for booster pump stations depending on the type of work that would be required (e.g., installing a new pump vs. constructing a brand new pump station). A unit cost of \$50,000 was assumed for new Pressure Reducing Valve (PRV) stations.

7.5 Project Costs and Contingencies

Project cost estimates are calculated based on elements, such as the project location, size, length, and other factors. Allowances for project contingencies consistent with an “Order of Magnitude” estimate are also included in the project costs prepared as part of this study, as outlined in this section.

7.5.1 Baseline Construction Cost

Baseline Construction Cost is the total estimated construction cost, in dollars, of the proposed improvements for pipelines, storage tanks, booster pump stations, and wells. Baseline Construction Costs were developed using the following criteria:

- *Pipelines*: Calculated by multiplying the estimated length by the unit cost.
- *Storage Tanks*: Calculated by multiplying the tank volume by the unit cost.
- *Booster Pump Stations*: Calculated on a case-by-case basis depending on the type of work that is required.

7.5.2 Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Factors such as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, contingency costs will be added to the planning budget as percentages of the total construction cost, divided into two categories: Estimated Construction Cost and Capital Improvement Cost.

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 30 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 30 percent contingency was used to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects.

7.5.3 Capital Improvement Cost

Other project construction contingency costs include costs associated with project engineering, construction phase professional services, and project administration. Engineering services associated with new facilities include preliminary investigations and reports, Right of Way (ROW) acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. Construction phase professional services cover items such as construction management, engineering services, materials testing, and inspection during construction. Finally, there are project administration costs, which cover items such as legal fees, environmental/California Environmental Quality Act (CEQA) compliance requirements, financing expenses, administrative costs, and interest during construction.

The cost of these items can vary, but for the purpose of this study, it is assumed that the other project contingency costs will equal approximately 27.5 percent of the Estimated Construction Cost.

As shown in the following sample calculation of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 65.8 percent of the Baseline Construction Cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 65.8 percent is the overall mark-up on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	\$1,000,000
Construction Contingency (30%)	\$300,000
Estimated Construction Cost	\$1,300,000
Engineering Cost (10%)	\$130,000
Construction Management (10%)	\$130,000
Project Administration (7.5%)	\$97,500
Capital Improvement Cost	\$1,657,500

A summary of the capital project costs is presented in Table 7.2. This table identifies the projects, provides a brief description of the project, identifies facility size (e.g. pipe diameter and length), and provides the capital improvement cost. The table also shows the probable phase in which the project would be implemented. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

7.6 Capital Improvement Project Implementation

As outlined in Chapter 6, the proposed capital improvements are prioritized based on their urgency to mitigate existing deficiencies and condition issues and for servicing future growth. The capital improvements were phased according to the improvement categories described in Section 7.1 into one of the following phases:

- *Phase 1 (2016-2021):* This phase includes projects that are targeted as the highest priority Existing improvements.
- *Phase 2 (2022-2026):* This phase generally includes medium priority Existing improvements, and any Future (Year 2036) projects that are triggered by growth.
- *Phase 3 (2027-2036):* This phase includes low priority Existing improvements, and Future (Year 2036) projects that are triggered by growth prior to 2036.
- *Phase 4 (Post 2036):* This phase includes Build-Out improvements triggered by growth that is projected to occur after year 2036.

Each project is itemized by phase in Table 7.2 and a summary by phase and project type is provided in Table 7.3. As shown in Table 7.3, out of the total \$96.3 million in capital projects, \$4.6 million (4.7 percent) are targeted for implementation in the first phase, and an additional \$17.8 million (18.5 percent) are targeted for phase 2. The remaining \$74.0 million of capital improvements has been included in either Phase 3 or Phase 4.

Table 7.2 Water System Capacity Improvement Plan

ID	Type of Improve.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size and Cost				Capital Improvement Cost ^{(1),(2),(3)} (\$)	Phasing				Future Users Benefit (\$)	Reimbursement Category	
						Ex. Size/ Diam. (in)	Proposed Size/ Diam. (in)	Replace/ New	Length (ft.)		Phase 1 (2016-2021) (\$)	Phase 2 (2022-2026) (\$)	Phase 3 (2027-2036) (\$)	Phase 4 (Post 2036) (\$)		Existing Users (\$)	Future Users (\$)
Capacity/Storage Related Projects																	
Fire Flow Improvements																	
FF-01	Pipe	Fire Flow	Lake Blvd.	Red Bud Lake PRV to north of Buckeye St.	Existing	--	20	New	2,160	\$ 859,000	\$ -	\$ 859,000	\$ -	\$ -	35%	\$ 558,000	\$ 301,000
FF-02	Pipe	Fire Flow	Lake Blvd.	Buckeye St. to south of Buckeye Dump Rd.	Existing	--	20	New	8,550	\$ 3,401,000	\$ -	\$ 3,401,000	\$ -	\$ -	35%	\$ 2,211,000	\$ 1,190,000
FF-03	Pipe	Fire Flow	Los Flores St. / Ashby Rd.	El Cajon Ave. to north of Woodley Ave.	Existing	4/6	12	Replace	850	\$ 223,000	\$ -	\$ 223,000	\$ -	\$ -	0%	\$ 223,000	\$ -
FF-04	Pipe	Fire Flow	Ashby Rd.	Coeur D'Alene Ave. to south of Woodley Ave.	Existing	6	12	Replace	2,860	\$ 749,000	\$ -	\$ 749,000	\$ -	\$ -	0%	\$ 749,000	\$ -
FF-05	Pipe	Fire Flow	Shasta Dam Blvd.	Shasta Park Dr. to Poplar St.	Existing	8	10	Replace	1,230	\$ 271,000	\$ -	\$ 271,000	\$ -	\$ -	0%	\$ 271,000	\$ -
FF-06	Pipe	Fire Flow	Shasta Dam Blvd.	Poplar St. to Rouge Rd.	Existing	--	8	New	730	\$ 128,000	\$ -	\$ 128,000	\$ -	\$ -	0%	\$ 128,000	\$ -
FF-07	Pipe	Fire Flow	Cascade Blvd.	Crystal St. to Riddle Rd.	Existing	4	8	New/Replace	2,890	\$ 508,000	\$ -	\$ 508,000	\$ -	\$ -	0%	\$ 508,000	\$ -
FF-08	Pipe	Fire Flow	Twin View Blvd.	Virginia Ave. to Poppy Ln.	Existing	--	10	New	770	\$ 170,000	\$ -	\$ 170,000	\$ -	\$ -	0%	\$ 170,000	\$ -
FF-09	Pipe	Fire Flow	Poppy Ln.	Twin View Blvd. to Larkin Ave.	Existing	4	8	Replace	310	\$ 54,000	\$ -	\$ 54,000	\$ -	\$ -	0%	\$ 54,000	\$ -
FF-10	Pipe	Fire Flow	Larkin Ave.	Poppy Ln. to hydrant M705FH lateral	Existing	4	8	Replace	750	\$ 132,000	\$ -	\$ 132,000	\$ -	\$ -	0%	\$ 132,000	\$ -
FF-11	Pipe	Fire Flow	Leona Ave.	Akrich St. to Pine Grove Ave.	Existing	4	8	Replace	900	\$ 158,000	\$ -	\$ 158,000	\$ -	\$ -	0%	\$ 158,000	\$ -
FF-12	Pipe	Fire Flow	Akrich St.	Marilyn Ave. to Leona Ave.	Existing	4	8	Replace	220	\$ 39,000	\$ -	\$ 39,000	\$ -	\$ -	0%	\$ 39,000	\$ -
FF-13	Pipe	Fire Flow	Webster St.	Leona Ave. to Park Ln.	Existing	6	8	Replace	420	\$ 74,000	\$ -	\$ -	\$ 74,000	\$ -	0%	\$ 74,000	\$ -
FF-14	Pipe	Fire Flow	Red Bluff St. & Montana Ave.	make a loop	Existing	--	8	New	20	\$ 4,000	\$ -	\$ 4,000	\$ -	\$ -	0%	\$ 4,000	\$ -
FF-15	Pipe	Fire Flow	Pensacola St. & Montana Ave.	make a loop	Existing	--	8	New	10	\$ 2,000	\$ -	\$ 2,000	\$ -	\$ -	0%	\$ 2,000	\$ -
FF-16	Pipe	Fire Flow	Cottage Ave.	Cottage PRV to south of Fell St. (or north of Deer Creek Ave.)	Existing	4	8	Replace	830	\$ 146,000	\$ -	\$ 146,000	\$ -	\$ -	0%	\$ 146,000	\$ -
FF-17	Pipe	Fire Flow	Grand Coulee Blvd. / Mussel Shoals Ave.	Fort Peck St. to north of Front St.	Existing	4	8	Replace	950	\$ 167,000	\$ -	\$ 167,000	\$ -	\$ -	0%	\$ 167,000	\$ -
FF-18	Pipe	Fire Flow	Flanagan Rd.	Lake Blvd. to west of Lake Blvd. (parallel pipeline)	Existing	--	12	New	240	\$ 63,000	\$ -	\$ 63,000	\$ -	\$ -	0%	\$ 63,000	\$ -
FF-19	Pipe	Fire Flow	Kokanee Dr.	Ranchera Rd. to Latigo Way	Existing	4	8	Replace	670	\$ 118,000	\$ -	\$ 118,000	\$ -	\$ -	0%	\$ 118,000	\$ -
FF-20	Pipe	Fire Flow	Latigo Way	Kokanee Dr. to hydrant H207FH lateral	Existing	2	8	Replace	50	\$ 9,000	\$ -	\$ 9,000	\$ -	\$ -	0%	\$ 9,000	\$ -
FF-21	Pipe	Fire Flow	Second St.	Cascade Blvd. to Parallel St.	Existing	4/6	8	Replace	420	\$ 74,000	\$ -	\$ 74,000	\$ -	\$ -	0%	\$ 74,000	\$ -
FF-22	Pipe	Fire Flow	Cascade Blvd. & Shasta Dam Blvd.	make a loop	Existing	--	8	New	150	\$ 26,000	\$ -	\$ 26,000	\$ -	\$ -	0%	\$ 26,000	\$ -
FF-23	Pipe	Fire Flow	Shasta Dam Blvd.	Mussel Shores Ave. to east of Washington Ave.	Existing	--	8	New	260	\$ 46,000	\$ -	\$ -	\$ 46,000	\$ -	0%	\$ 46,000	\$ -
FF-24	Pipe	Fire Flow	Forest St.	Pensacola St. to Arrow Rock St.	Existing	4	8	Replace	590	\$ 104,000	\$ -	\$ -	\$ 104,000	\$ -	0%	\$ 104,000	\$ -
FF-25	Pipe	Fire Flow	Olive St.	Rouge Rd. to Renovo Ave.	Existing	2	8	Replace	280	\$ 49,000	\$ -	\$ 49,000	\$ -	\$ -	0%	\$ 49,000	\$ -
FF-26	Pipe	Fire Flow	East of Yellow Pine Rd.	Lake Blvd. to Belt Line Rd.	Existing	--	12	New	1,070	\$ 280,000	\$ -	\$ 280,000	\$ -	\$ -	0%	\$ 280,000	\$ -
FF-27	Pipe	Fire Flow	Jankanish Rd.	Kirklie Ln. to Buckeye St.	Existing	6	12	Replace	310	\$ 81,000	\$ -	\$ 81,000	\$ -	\$ -	25%	\$ 61,000	\$ 20,000
FF-28	Pipe	Fire Flow	Kirklie Ln.	Jankanish Rd. to south of Jankanish Rd.	Existing	4	8	Replace	450	\$ 79,000	\$ -	\$ 79,000	\$ -	\$ -	0%	\$ 79,000	\$ -
FF-29	Pipe	Fire Flow	Kirklie Ln. / Montego Rd.	Jankanish Rd. to hydrant F103FH lateral (on Montego Rd.)	Existing	4/6	10	Replace	830	\$ 183,000	\$ -	\$ 183,000	\$ -	\$ -	0%	\$ 183,000	\$ -
FF-30	Pipe	Fire Flow	Complete loop at end	Ashby Rd. to Shasta Gateway Dr.	Existing	--	12	New	1,850	\$ 484,000	\$ -	\$ 484,000	\$ -	\$ -	0%	\$ 484,000	\$ -
FF-31A	Pipe	Fire Flow	Iron Ct.	Shasta Gateway Dr. to dead end east of Shasta Hate Way Dr.	Existing	8	12	Replace	630	\$ 165,000	\$ -	\$ -	\$ 165,000	\$ -	0%	\$ 165,000	\$ -
FF-31B	Pipe	Fire Flow	Field Northeast of Iron Ct.	Iron Ct. to Hydrant M403FH	Existing	4	8	Replace	850	\$ 149,000	\$ -	\$ 149,000	\$ -	\$ -	0%	\$ 149,000	\$ -
FF-32	Pipe	Fire Flow	Mulberry St.	West St. to Cascade Blvd.	Existing	2	8	New/Replace	480	\$ 84,000	\$ -	\$ 84,000	\$ -	\$ -	0%	\$ 84,000	\$ -
FF-33	Pipe	Fire Flow	Virginia Ave.	Virginia PRV Station to south of Akrich St. (or north of Pine Grove Ave.)	Existing	4	8	Replace	340	\$ 60,000	\$ -	\$ 60,000	\$ -	\$ -	0%	\$ 60,000	\$ -
FF-34	Pipe	Fire Flow	Morning Star Way	Cascade Blvd & Joseph St. to north of Gran Coulee Blvd.	Existing	--	8	New	470	\$ 83,000	\$ -	\$ -	\$ 83,000	\$ -	0%	\$ 83,000	\$ -
FF-35	Pipe	Fire Flow	Mussel Shoals Ave.	North of Red Bluff St. to south of Koch St.	Existing	4	8	Replace	1,380	\$ 242,000	\$ -	\$ 242,000	\$ -	\$ -	0%	\$ 242,000	\$ -
FF-36	Pipe	Fire Flow	Washington Ave.	Boca St. to north of Boca St.	Existing	4	8	Replace	590	\$ 104,000	\$ -	\$ 104,000	\$ -	\$ -	0%	\$ 104,000	\$ -
FF-37	Pipe	Fire Flow	Grand Ave.	Buena Vista St. to west of Shasta Way	Existing	--	8	New	430	\$ 76,000	\$ -	\$ -	\$ 76,000	\$ -	0%	\$ 76,000	\$ -
FF-38	Pipe	Fire Flow	East of Grand Ave.	Buena Vista St. to Cascade Blvd.	Existing	--	8	New	650	\$ 114,000	\$ -	\$ -	\$ 114,000	\$ -	0%	\$ 114,000	\$ -
FF-39	Pipe	Fire Flow	Shasta Dam Blvd. & Shasta St.	Make a loop	Existing	--	8	New	60	\$ 11,000	\$ -	\$ -	\$ 11,000	\$ -	0%	\$ 11,000	\$ -
FF-40	Pipe	Fire Flow	Private Property at corner of Larkin Ave. & Poppy Ln.	Larkin Ave. to Virginia Ave.	Existing	4	8	Replace	270	\$ 47,000	\$ -	\$ 47,000	\$ -	\$ -	0%	\$ 47,000	\$ -
FF-41	Pipe	Fire Flow	Duval Dr. / Duval Ln.	Lake Blvd. to Targa Ln.	Existing	4/6	8	Replace	1,700	\$ 299,000	\$ -	\$ 299,000	\$ -	\$ -	0%	\$ 299,000	\$ -
FF-42	Pipe	Fire Flow	Cascade Blvd. to northwest towards Oasis (mini golf)	Make a loop	Existing	--	8	New	110	\$ 19,000	\$ -	\$ -	\$ 19,000	\$ -	0%	\$ 19,000	\$ -
FF-43	Pipe	Fire Flow	Between Duval Dr. and Mason Dr.	Make a Loop at private property off Lake Blvd	Existing	--	8	New/Replace	360	\$ 63,000	\$ -	\$ -	\$ 63,000	\$ -	0%	\$ 63,000	\$ -
Transmission & Distribution Main																	
TM-01	Pipe	Velocity	Woods	Tank 1 to Holly Ave. & Third St.	Existing	10	16	Replace	1,200	\$ 420,000	\$ -	\$ 420,000	\$ -	\$ -	25%	\$ 315,000	\$ 105,000
TM-02A	Pipe	Reliability	Lake Blvd. / Pine Grove Ave.	South of Buckeye Dump Rd. to Newtown Rd.	Existing	--	20	New	2,010	\$ 800,000	\$ -	\$ 800,000	\$ -	\$ -	35%	\$ 520,000	\$ 280,000
TM-02B	Pipe	Reliability	Pine Grove Ave.	Newtown Rd. to Ashby Rd.	Existing	--	20	New	2,190	\$ 871,000	\$ -	\$ 871,000	\$ -	\$ -	35%	\$ 566,000	\$ 305,000
TM-03	Pipe	Velocity	Pensacola St.	Pensacola PRVs to Montana Ave.	Existing	10	20	Replace	40	\$ 16,000	\$ 10,000	\$ 16,000	\$ -	\$ -	35%	\$ 10,000	\$ 6,000
TM-04	Pipe	Reliability	Parallel raw water transmission main	From Raw Water PS to New Raw Water Storage Tank	Existing	--	20	New	1,700	\$ 676,000	\$ -	\$ 676,000	\$ -	\$ -	25%	\$ 507,000	\$ 169,000
TM-05	Pipe	Velocity	Lake Blvd.	Centimudi Tank to Red Bud Ln.	Future	--	24	New	6,770	\$ 3,221,000	\$ -	\$ -	\$ 3,221,000	\$ -	100%	\$ -	\$ 3,221,000
TM-06	Pipe	Operations	Pine Grove Ave.	Ashby Rd. to Coeur D'Alene Ave.	Buildout	--	16	New	4,640	\$ 1,623,000	\$ -	\$ -	\$ -	\$ 1,623,000	100%	\$ -	\$ 1,623,000
TM-07	Pipe	Velocity	Red Bud Ln. & Lake Blvd.	Connects to 14" and 18" pipelines	Buildout	14	24	Replace	10	\$ 5,000	\$ -	\$ -	\$ -	\$ 5,000	100%	\$ -	\$ 5,000
TM-08	Pipe	Velocity	Runs Partially on Shasta Dam Blvd.	Sacramento St. to Tank 5 Site	Buildout	10	16	Replace	10	\$ 3,000	\$ -	\$ -	\$ -	\$ 3,000	100%	\$ -	\$ 3,000
TM-09	Pipe	Velocity	WTP Drive Way / Lake Blvd.	Treated Water Pump Station to Centimudi Tank	Buildout	--	20	New	3,000	\$ 1,193,000	\$ -	\$ -	\$ -	\$ 1,193,000	100%	\$ -	\$ 1,193,000
TM-10	Pipe	Velocity	Parallel to existing 14" pipeline from Redbud Ln. & Lake Blvd.	Red Bud Ln. & Lake Blvd. to north of Third St.	Buildout	--	10	New	3,670	\$ 809,000	\$ -	\$ -	\$ -	\$ 809,000	100%	\$ -	\$ 809,000
TM-11	Pipe	Velocity	Upsize Tank 1 pipelines, completer with project T-01	Tank 1 site	Buildout	8/10	16	Replace	210	\$ 73,000	\$ -	\$ -	\$ -	\$ 73,000	100%	\$ -	\$ 73,000
TM-12	Pipe	Velocity	Upsize Tank 2 pipelines	Tank 2 site	Buildout	10	14	Replace	10	\$ 3,000	\$ -	\$ -	\$ -	\$ 3,000	100%	\$ -	\$ 3,000
Pump Stations																	
PS-01	Pump	Capacity	Raw Water PS	Add a sixth pump with a capacity of 2,500 gpm at 500 feet	Existing	--	400 HP	New ⁽⁵⁾	--	\$ 216,000	\$ 216,000	\$ -	\$ -	\$ -	20%	\$ 173,000	\$ 43,000
PS-02	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 1 with a pump with a capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--	\$ 223,000	\$ -	\$ -	\$ -	\$ 223,000	100%	\$ -	\$ 223,000
PS-03	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 2 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--	\$ 223,000	\$ -	\$ -	\$ -	\$ 223,000	100%	\$ -	\$ 223,000
PS-04	Pump	Capacity	Treated Water PS	Add a fourth pump with a capacity of 3,000 gpm at 80 feet	Buildout	--	75 HP	New	--	\$ 129,000	\$ -	\$ -	\$ -	\$ 129,000	100%	\$ -	\$ 129,000
PS-05	Pump	Capacity	Treated Water PS	Add a fifth pump each with a capacity of 3,000 gpm at 80 feet	Buildout	--	75 HP	New	--	\$ 129,000	\$ -	\$ -	\$ -	\$ 129,000	100%	\$ -	\$ 129,000
PS-06	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 3 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--	\$ 223,000	\$ -	\$ -	\$ -	\$ 223,000	100%	\$ -	\$ 223,000
PS-07	Pump	Capacity	Raw Water PS	Replace Raw Water Pump 4 with a pump with the capacity of 2,250 gpm at 500 feet	Buildout	--	360 HP	Replace	--	\$ 223,000	\$ -	\$ -	\$ -	\$ 223,000	100%	\$ -	\$ 223,000

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Table 7.2 Water System Capacity Improvement Plan

ID	Type of Improve.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size and Cost				Phasing				Future Users Benefit (\$)	Reimbursement Category		
						Ex. Size/ Diam. (in)	Proposed Size/ Diam. (in)	Replace/ New	Length (ft.)	Capital Improvement Cost ^{(1),(2),(3)} (\$)	Phase 1 (2016-2021) (\$)	Phase 2 (2022 - 2026) (\$)	Phase 3 (2027-2036) (\$)		Phase 4 (Post 2036) (\$)	Existing Users (\$)	Future Users (\$)
Storage/Reservoir																	
T-06	Reservoir	Storage	Construct a 2.45 MG reservoir at Centimudi Site (40' x 102')	Centimudi Tank (aka Tank 6)	Existing	--	2.45 MG	New	--	\$ 3,046,000	\$ 3,046,000	\$ -	\$ -	\$ -	50%	\$ 1,523,000	\$ 1,523,000
T-RW	Reservoir	Storage	Demo Finished Water Tanks 1 & 2 and construct a 1.6 MG Raw Water Tank (30' x 95')	New raw water tank	Existing	--	1.60 MG	Replace	--	\$ 1,989,000	\$ -	\$ 1,989,000	\$ -	\$ -	0%	\$ 1,989,000	\$ -
T-01	Reservoir	Storage	Demo existing Tank 1 and construct a 1.50 MG reservoir @ Tank 1 Site (22' x 108')	New Tank 1	Buildout	--	1.50 MG	Replace	--	\$ 1,865,000	\$ -	\$ -	\$ -	\$ 1,865,000	100%	\$ -	\$ 1,865,000
T-05B	Reservoir	Storage	Construct a 1.25 MG reservoir tank 5 Site, Feeds Zone B (22' x 98')	Tank 5B	Buildout	--	1.25 MG	New	--	\$ 1,554,000	\$ -	\$ -	\$ -	\$ 1,554,000	100%	\$ -	\$ 1,554,000
T-07	Reservoir	Storage	Construct a 2.35 MG reservoir that feeds Zone K (40' x 100')	Tank 7	Buildout	--	2.35 MG	New	--	\$ 2,921,000	\$ -	\$ -	\$ -	\$ 2,921,000	100%	\$ -	\$ 2,921,000
T-08	Reservoir	Storage	Construct a 3.60 MG reservoir that feeds Zones I & J @ Ristay Way Site (40' x 124')	Tank 8	Buildout	--	3.60 MG	New	--	\$ 4,475,000	\$ -	\$ -	\$ -	\$ 4,475,000	100%	\$ -	\$ 4,475,000
T-09	Reservoir	Storage	Construct a 3.15 MG reservoir that feeds Zone G @ Mtn. Gate Site (36' x 122')	Tank 9	Buildout	--	3.15 MG	New	--	\$ 3,916,000	\$ -	\$ -	\$ -	\$ 3,916,000	100%	\$ -	\$ 3,916,000
Valves																	
V-01	Valve	Reliability	Install a 16" PRV along Lake Blvd.	Allows Zone B to move water to Zone G	Existing	--	20"	New	--	\$ 83,000	\$ -	\$ 83,000	\$ -	\$ -	25%	\$ 62,000	\$ 21,000
V-02	Valve	Velocity	Upsize Redbud Lake PRV with a 16" PRV	Allows Zone A to move water to Zone B	Existing	--	20"	Replace	--	\$ 83,000	\$ -	\$ 83,000	\$ -	\$ -	25%	\$ 62,000	\$ 21,000
V-03	Valve	Reliability	Install a 10" PRV at Twin View Blvd. & Poppy Ln.	Allows Zone I to move water to Zone J	Existing	--	10"	New	--	\$ 83,000	\$ -	\$ 83,000	\$ -	\$ -	0%	\$ 83,000	\$ -
V-04	Valve	Reliability	Install a 10" PRV along Shasta Dam Blvd.	Allows Zone B to move water to Zone E/F	Future	--	12"	New	--	\$ 83,000	\$ -	\$ -	\$ 83,000	\$ -	100%	\$ -	\$ 83,000
V-05	Valve	Pressure	Install a 10-inch PRV at Holly Ave. & Third St.	Allows Zone A to move water to Zone B	Future	--	10"	New	--	\$ 83,000	\$ -	\$ -	\$ 83,000	\$ -	100%	\$ -	\$ 83,000
V-06	Valve	Reliability	Install a 16" PRV along Black Canyon Rd.	Allows Zone E/F to move water to Zone K	Buildout	--	16"	New	--	\$ 83,000	\$ -	\$ -	\$ -	\$ 83,000	100%	\$ -	\$ 83,000
V-07	Valve	Reliability	Install an 8" PRV new development between Ranchera Rd. and Shasta Dam Blvd.	Allows Zone B to move water to Zone E/F	Buildout	--	8"	New	--	\$ 83,000	\$ -	\$ -	\$ -	\$ 83,000	100%	\$ -	\$ 83,000
V-08	Valve	Velocity	Install an 8" PRV along Montego Rd.	Allows Zone B to move water to Zone C	Buildout	--	8"	New	--	\$ 83,000	\$ -	\$ -	\$ -	\$ 83,000	100%	\$ -	\$ 83,000
V-09	Valve	Reliability	Install a 12" PRV between South Industrial Park and Arrowhead Ave.	Allows Zone G to move water to Zone I	Buildout	--	12"	New	--	\$ 83,000	\$ -	\$ -	\$ -	\$ 83,000	100%	\$ -	\$ 83,000
V-10	Valve	Reliability	Install a 12" PRV in Mtn. Gate Development	Allows Zone K to move water to Zone G	Buildout	--	12"	New	--	\$ 83,000	\$ -	\$ -	\$ -	\$ 83,000	100%	\$ -	\$ 83,000
Water Treatment Plant																	
WTP-01	WTP	Capacity	Sludge Dewatering Facility	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 250,000	\$ 250,000	\$ -	\$ -	\$ -	50%	\$ 125,000	\$ 125,000
WTP-02	WTP	Reliability	Filter No. 2 Rehabilitation	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 175,000	\$ 175,000	\$ -	\$ -	\$ -	50%	\$ 87,000	\$ 88,000
WTP-03	WTP	Rehabilitation	Toyon Water Treatment Plant Demolition	Toyon Water Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 125,000	\$ 125,000	\$ -	\$ -	\$ -	0%	\$ 125,000	\$ -
WTP-04	WTP	Rehabilitation	WTP Retaining Wall	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 125,000	\$ 125,000	\$ -	\$ -	\$ -	50%	\$ 62,000	\$ 63,000
WTP-05	WTP	Reliability	Filter No. 1 Rehabilitation	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 200,000	\$ 200,000	\$ -	\$ -	\$ -	0%	\$ 200,000	\$ -
WTP-06	WTP	Reliability	No.1 Filtered Water Pump Replacement	Fisherman's Point Water Treatment Plant	Existing	--	-	Replace ⁽⁵⁾	--	\$ 75,000	\$ 75,000	\$ -	\$ -	\$ -	0%	\$ 75,000	\$ -
WTP-07	WTP	Reliability	Capital Project Allocation (Water Meter, HVAC, Master Plan)	Varies	Existing	--	-	Replace ⁽⁵⁾	--	\$ 310,000	\$ 310,000	\$ -	\$ -	\$ -	0%	\$ 310,000	\$ -
WTP-08	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 6.5 MGD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--	\$ 2,034,000	\$ -	\$ -	\$ -	\$ 2,034,000	100%	\$ -	\$ 2,034,000
WTP-09	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 9.75 MDD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--	\$ 2,034,000	\$ -	\$ -	\$ -	\$ 2,034,000	100%	\$ -	\$ 2,034,000
WTP-10	WTP	Capacity	Construct a 3.25 mgd Parallel Filter when MDD > 13.0 MGD	Fisherman's Point Water Treatment Plant	Buildout	--	3.25	New	--	\$ 2,034,000	\$ -	\$ -	\$ -	\$ 2,034,000	100%	\$ -	\$ 2,034,000
Capacity Related Projects Subtotal										\$ 49,234,000	\$ 4,522,000	\$ 14,463,000	\$ 4,142,000	\$ 26,107,000	--	\$ 15,480,000	\$ 33,754,000
Rehabilitation Related Projects																	
Transmission & Distribution Main																	
RR-01	Rehabilitation	Rehabilitation	Small Diameter Pipeline Replacement (Less than 6") Phase 1		Existing	<6"	8	R/R	2.26 miles	\$ 2,099,000	\$ -	\$ 2,099,000	\$ -	\$ -	0%	\$ 2,099,000	\$ -
RR-02	Rehabilitation	Rehabilitation	Small diameter Pipeline Replacement (Less than 6") Phase 2		Future	<6"	8	R/R	9.89 miles	\$ 9,171,000	\$ -	\$ -	\$ 9,171,000	\$ -	0%	\$ 9,171,000	\$ -
Storage/Reservoir																	
RR-03	Rehabilitation	Reservoir	Tank 1 Rehabilitation Projects		Existing	--	--	R/R	--	\$ 149,000	\$ -	\$ 149,000	\$ -	\$ -	0%	\$ 149,000	\$ -
RR-04	Rehabilitation	Reservoir	Tank 4B Rehabilitation Projects		Existing	--	--	R/R	--	\$ 414,000	\$ -	\$ 414,000	\$ -	\$ -	0%	\$ 414,000	\$ -
RR-05	Rehabilitation	Reservoir	Tank 3A Rehabilitation Projects		Existing	--	--	R/R	--	\$ 149,000	\$ -	\$ 149,000	\$ -	\$ -	0%	\$ 149,000	\$ -
RR-06	Rehabilitation	Reservoir	Tank 3B Rehabilitation Projects		Existing	--	--	R/R	--	\$ 325,000	\$ -	\$ 325,000	\$ -	\$ -	0%	\$ 325,000	\$ -
RR-07	Rehabilitation	Reservoir	Tank 5 Rehabilitation Projects		Existing	--	--	R/R	--	\$ 172,000	\$ -	\$ 172,000	\$ -	\$ -	0%	\$ 172,000	\$ -
Water Treatment Plant																	
RR-11	Rehabilitation	WTP	Rehabilitation Plant Water PS		Existing	--	--	R/R	--	\$ 33,000	\$ 33,000	\$ -	\$ -	\$ -	0%	\$ 33,000	\$ -
Rehab Related Projects Subtotal										\$ 12,512,000	\$ 33,000	\$ 3,308,000	\$ 9,171,000	\$ -	--	\$ 12,512,000	\$ -
Developer Specific Projects																	
D-01A	Pipe	Development	Future road	North of Pine Grove Ave. and east of Smith Ave.	Future	--	8	New	800	\$ 141,000	\$ -	\$ -	\$ 141,000	\$ -	100%	\$ -	\$ 141,000
D-01B	Pipe	Development	Future road	North of Pine Grove Ave. and east of Smith Ave.	Future	--	12	New	3,430	\$ 898,000	\$ -	\$ -	\$ 898,000	\$ -	100%	\$ -	\$ 898,000
D-02A	Pipe	Development	Future road	East of Interstate 5 NB and north of Akrich St.	Future	--	8	New	10,910	\$ 1,927,000	\$ -	\$ -	\$ 1,927,000	\$ -	100%	\$ -	\$ 1,927,000
D-02B	Pipe	Development	Future road	East of Interstate 5 NB and north of Akrich St.	Future	--	12	New	820	\$ 215,000	\$ -	\$ -	\$ 215,000	\$ -	100%	\$ -	\$ 215,000
D-03	Pipe	Development	Future roads, runs partially along Akrich St., Leona Ave. and Alpine St.	South of Akrich St. and east of Leona Ave.	Future	--	8	New	6,730	\$ 1,182,000	\$ -	\$ -	\$ 1,182,000	\$ -	100%	\$ -	\$ 1,182,000
D-04	Pipe	Development	Cascade Blvd.	Pine Grove Ave. to Trinity St.	Future	--	8	New	1,740	\$ 306,000	\$ -	\$ -	\$ 306,000	\$ -	100%	\$ -	\$ 306,000
D-05	Pipe	Development	Future road	South of Pine Grove Ave. and west of Ristay Way	Future	--	8	New	2,170	\$ 381,000	\$ -	\$ -	\$ 381,000	\$ -	100%	\$ -	\$ 381,000
D-06	Pipe	Development	Future road	South of Pine Grove Ave. and east of Ristay Way	Future	--	12	New	1,520	\$ 398,000	\$ -	\$ -	\$ 398,000	\$ -	100%	\$ -	\$ 398,000
D-07	Pipe	Development	Twin View Blvd. / Larkin Ave.	South of Medocino St. to north of Crooked Oak Ln.	Future	--	8	New	5,640	\$ 991,000	\$ -	\$ -	\$ 991,000	\$ -	100%	\$ -	\$ 991,000
D-08	Pipe	Development	Shasta Dam Blvd.	Sacramento St. to Shasta Park Dr.	Future	--	10	New	3,390	\$ 747,000	\$ -	\$ -	\$ 747,000	\$ -	100%	\$ -	\$ 747,000
D-09	Pipe	Development	Future roads	South of Shasta Dam Blvd.	Future	--	8	New	2,220	\$ 390,000	\$ -	\$ -	\$ 390,000	\$ -	100%	\$ -	\$ 390,000
D-10	Pipe	Development	Runs partially along Third St. and Holly Ave.	Shasta Dam Blvd. to Sixth St.	Future	--	12	New	2,220	\$ 581,000	\$ -	\$ -	\$ 581,000	\$ -	100%	\$ -	\$ 581,000
D-11	Pipe	Fire Flow	Arkrich St.	Leona Ave. to Akrich Park Ave.	Future	1-4	8	Replace	860	\$ 151,000	\$ -	\$ -	\$ 151,000	\$ -	100%	\$ -	\$ 151,000
D-12	Pipe	Development	Extend Buena Vista St. northeast	Grand Ave. to Mtn. Gate development	Future	--	12	New	690	\$ 181,000	\$ -	\$ -	\$ 181,000	\$ -	100%	\$ -	\$ 181,000
D-13	Pipe	Development	Twin View Blvd. / Larkin Ave.	South of Medocino St. to north of Crooked Oak Ln.	Future	--	8	New	5,650	\$ 993,000	\$ -	\$ -	\$ 993,000	\$ -	100%	\$ -	\$ 993,000
D-14	Pipe	Development	Forest St.	Oliver St. to Arrow Rock St.	Buildout	--	8	New	660	\$ 116,000	\$ -	\$ -	\$ -	\$ 116,000	100%	\$ -	\$ 116,000
D-15	Pipe	Development	Future road	West of Avington Way and south of Pembroke Ln.	Buildout	--	8	New	840	\$ 148,000	\$ -	\$ -	\$ -	\$ 148,000	100%	\$ -	\$ 148,000
D-16	Pipe	Development	Industrial Park Central	North of Pine Grove Ave.	Buildout	--	12	New	930	\$ 244,000	\$ -	\$ -	\$ -	\$ 244,000	100%	\$ -	\$ 244,000
D-17A	Pipe	Development	Future road	Mtn. Gate development	Buildout	--	8	New	11,890	\$ 2,089,000	\$ -	\$ -	\$ -	\$ 2,089,000	100%	\$ -	\$ 2,089,000
D-17B	Pipe	Development	Future road	Mtn. Gate development	Buildout	--	12	New	15,050	\$ 3,941,000	\$ -	\$ -	\$ -	\$ 3,941,000	100%	\$ -	\$ 3,941,000
D-17C	Pipe	Development	Future Transmission Main	Mtn. Gate development	Buildout	--	16	New	2,730	\$ 955,000	\$ -	\$ -	\$ -	\$ 955,000	100%	\$ -	\$ 955,000
D-18	Pipe	Development	Runs partially along Poplar St.	South of Shasta Dam Blvd.	Buildout	--	8	New	5,610	\$ 986,000	\$ -	\$ -	\$ -	\$ 986,000	100%	\$ -	\$ 986,000
D-19	Pipe	Development	Future roads	Extend Red Bud Ln. east	Buildout	--	8	New	3,280	\$ 576,000	\$ -	\$ -	\$ -	\$ 576,000	100%	\$ -	\$ 576,000

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Table 7.2 Water System Capacity Improvement Plan

ID	Type of Improve.	Reason	Description/Street	Description/ Limits	CIP Reason	Project Length/Size and Cost				Phasing				Future Users Benefit (\$)	Reimbursement Category		
						Ex. Size/ Diam. (in)	Proposed Size/ Diam. (in)	Replace/ New	Length (ft.)	Capital Improvement Cost ^{(1),(2),(3)} (\$)	Phase 1 (2016-2021) (\$)	Phase 2 (2022 - 2026) (\$)	Phase 3 (2027-2036) (\$)		Phase 4 (Post 2036) (\$)	Existing Users (\$)	Future Users (\$)
D-20A	Pipe	Development	Runs partially along Shasta Dam Blvd. and Belt Line Rd.	Lake Blvd. to Flanagan Rd.	Buildout	--	8	New	7,020	\$ 1,233,000	\$ -	\$ -	\$ -	\$ 1,233,000	100%	\$ -	\$ 1,233,000
D-20B	Pipe	Development	Runs partially along Shasta Dam Blvd. and Belt Line Rd.	Lake Blvd. to Flanagan Rd.	Buildout	--	12	New	3,300	\$ 864,000	\$ -	\$ -	\$ -	\$ 864,000	100%	\$ -	\$ 864,000
D-21A	Pipe	Development	Runs partially along west of Lake Blvd. and Carpet Creek Way	North of Yellow Pine Rd. and South of Carpet Creek Way	Buildout	--	8	New	6,150	\$ 1,081,000	\$ -	\$ -	\$ -	\$ 1,081,000	100%	\$ -	\$ 1,081,000
D-21B	Pipe	Development	Huckleberry Rn.	South of Flanagan Rd.	Buildout	--	12	New	2,770	\$ 725,000	\$ -	\$ -	\$ -	\$ 725,000	100%	\$ -	\$ 725,000
D-22	Pipe	Development	Runs partially along Central Ave. and Montana Ave.	Red Bluff Ave. to Oliver St.	Buildout	--	8	New	2,740	\$ 481,000	\$ -	\$ -	\$ -	\$ 481,000	100%	\$ -	\$ 481,000
D-23	Pipe	Development	Industrial Park North	Extend El Cajon Ave. and east of Ashby Rd.	Buildout	--	12	New	10,210	\$ 2,674,000	\$ -	\$ -	\$ -	\$ 2,674,000	100%	\$ -	\$ 2,674,000
D-24	Pipe	Development	Industrial Park South	Extend Shasta Gateway Dr. to PRV Project V-11	Buildout	--	12	New	9,350	\$ 2,449,000	\$ -	\$ -	\$ -	\$ 2,449,000	100%	\$ -	\$ 2,449,000
D-25	Pipe	Development	Future road	East of Lake Blvd. and north of Buckeye Dump Rd.	Buildout	--	8	New	1,250	\$ 220,000	\$ -	\$ -	\$ -	\$ 220,000	100%	\$ -	\$ 220,000
D-26	Pipe	Development	Montego Rd.	Shasta Dam Blvd. to proposed PRV	Buildout	--	8	New	730	\$ 128,000	\$ -	\$ -	\$ -	\$ 128,000	100%	\$ -	\$ 128,000
D-27	Pipe	Development	Extend Rosamond St. south	East of Cascade Blvd.	Buildout	--	8	New	460	\$ 81,000	\$ -	\$ -	\$ -	\$ 81,000	100%	\$ -	\$ 81,000
D-28	Pipe	Development	White Way	Tank 2 Service Road to Cypress Ave.	Buildout	--	8	New	730	\$ 128,000	\$ -	\$ -	\$ -	\$ 128,000	100%	\$ -	\$ 128,000
D-29	Pipe	Development	Extend Oak Hill Dr.	Creekside Way to Creekside Way	Buildout	--	8	New	1,890	\$ 332,000	\$ -	\$ -	\$ -	\$ 332,000	100%	\$ -	\$ 332,000
D-30	Pipe	Development	North of Trinity St.	Trinity St. to Tank 8	Buildout	--	12	New	800	\$ 210,000	\$ -	\$ -	\$ -	\$ 210,000	100%	\$ -	\$ 210,000
D-31	Pipe	Development	Avington Way	South of Ashwick Ct.	Buildout	--	8	New	490	\$ 86,000	\$ -	\$ -	\$ -	\$ 86,000	100%	\$ -	\$ 86,000
D-32A	Pipe	Development	Cypress Ave. / Olive St. / Black Canyon Rd. /	White Way to Rail Road Crossing	Buildout	--	12	New	3,980	\$ 1,042,000	\$ -	\$ -	\$ -	\$ 1,042,000	100%	\$ -	\$ 1,042,000
D-32B	Casing	Development	Railroad crossing	Oliver St. to Walker Ln.	Buildout	--	16/30	New	460	\$ 1,008,000	\$ -	\$ -	\$ -	\$ 1,008,000	100%	\$ -	\$ 1,008,000
D-32C	Pipe	Development	Walker Ln. / Black Canyon Rd.	Railroad crossing to Mtn. Gate Development	Buildout	--	12	New	3,910	\$ 1,024,000	\$ -	\$ -	\$ -	\$ 1,024,000	100%	\$ -	\$ 1,024,000
D-33	Pipe	Development	Arrowhead Ave.	East of Tomahawk Trl.	Buildout	--	12	New	1,800	\$ 471,000	\$ -	\$ -	\$ -	\$ 471,000	100%	\$ -	\$ 471,000
D-34	Pipe	Development	Future road	Extend Hardenbrook Ave. south to future roads	Buildout	--	8	New	1,340	\$ 235,000	\$ -	\$ -	\$ -	\$ 235,000	100%	\$ -	\$ 235,000
D-35	Pipe	Development	Pickard St.	Tank 1 to Cypress Ave.	Buildout	--	12	New	1,720	\$ 450,000	\$ -	\$ -	\$ -	\$ 450,000	100%	\$ -	\$ 450,000
D-36	Pipe	Development	Future roads	South of Shasta Dam Blvd.	Buildout	--	8	New	6,250	\$ 1,098,000	\$ -	\$ -	\$ -	\$ 1,098,000	100%	\$ -	\$ 1,098,000
Developer Specific Projects Subtotal										\$ 34,547,000	\$ -	\$ -	\$ 9,472,000	\$ 25,075,000	--	\$ -	\$ 34,547,000
CIP Total										\$ 96,293,000	\$ 4,555,000	\$ 17,772,000	\$ 22,785,000	\$ 51,182,000	--	\$ 27,992,000	\$ 68,301,000

Notes:

1. Estimated Construction Cost to account for unforeseen events and unknown conditions (30%).
2. Additional markups include engineering, management, environmental, and legal (27.5%)
3. Total Contingency Markup = 65.8% (130% x 127.5%-100%). ENR CCI of 10,182 (20 City Average, March 2016)
4. Costs associated with near term condition assessment recommendations are included in the CIP for the near term.
5. Assumes replacement pumps operate at 80% efficiency. Pump replacements include motor replacement.
6. Capital costs from City's existing rate study

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Table 7.3 CIP Cost by Project Type and Phase

Project Type	Phase 1 (2016-21) (\$)	Phase 2 (2022-26) (\$)	Phase 3 (2027-36) (\$)	Phase 4 (Post 2036) (\$)	Total (\$)
Capacity/Storage Improvements					
Fire Flow Related	-	9,442,000	755,000	-	10,197,000
Pipeline Related	-	2,783,000	3,221,000	3,709,000	9,713,000
Pump Station Related	216,000	-	-	1,150,000	1,366,000
Storage Related	3,046,000	1,989,000	-	14,731,000	19,766,000
Valve Related	0	249,000	166,000	415,000	830,000
WTP Related	1,260,000	-	-	6,102,000	7,362,000
Subtotal	4,522,000	14,463,000	4,142,000	26,107,000	49,234,000
Rehabilitation Improvements					
Pipeline Rehabilitation	-	2,099,000	9,171,000	-	11,270,000
Reservoir Rehabilitation	-	1,209,000	-	-	1,209,000
Plant Water PS Rehabilitation	33,000	-	-	-	33,000
Subtotal	33,000	3,308,000	9,171,000	-	12,512,000
Developer Related Improvements					
Developer Related	-	-	9,472,000	25,075,000	34,547,000
Subtotal	-	-	9,472,000	25,075,000	34,547,000
Grand Total	4,555,000	17,771,000	22,785,000	51,182,000	96,293,000

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182

Table 7.1 shows the distribution of capital costs by project type. As shown on Figure 7.1, Developer Related projects and Storage Related projects account for the largest portions of the capital improvement project costs at 36 percent and 20 percent, respectively. Small diameter pipeline replacement, fire flow projects, and other pipeline transmission projects account for roughly 12 percent, 11 percent, and 10 percent of the total CIP costs, respectively. The remaining

11 percent of the CIP costs are associated with pump stations, valves, projects at the Fisherman's Point Water Treatment Plant (WTP), and tank rehabilitation projects.

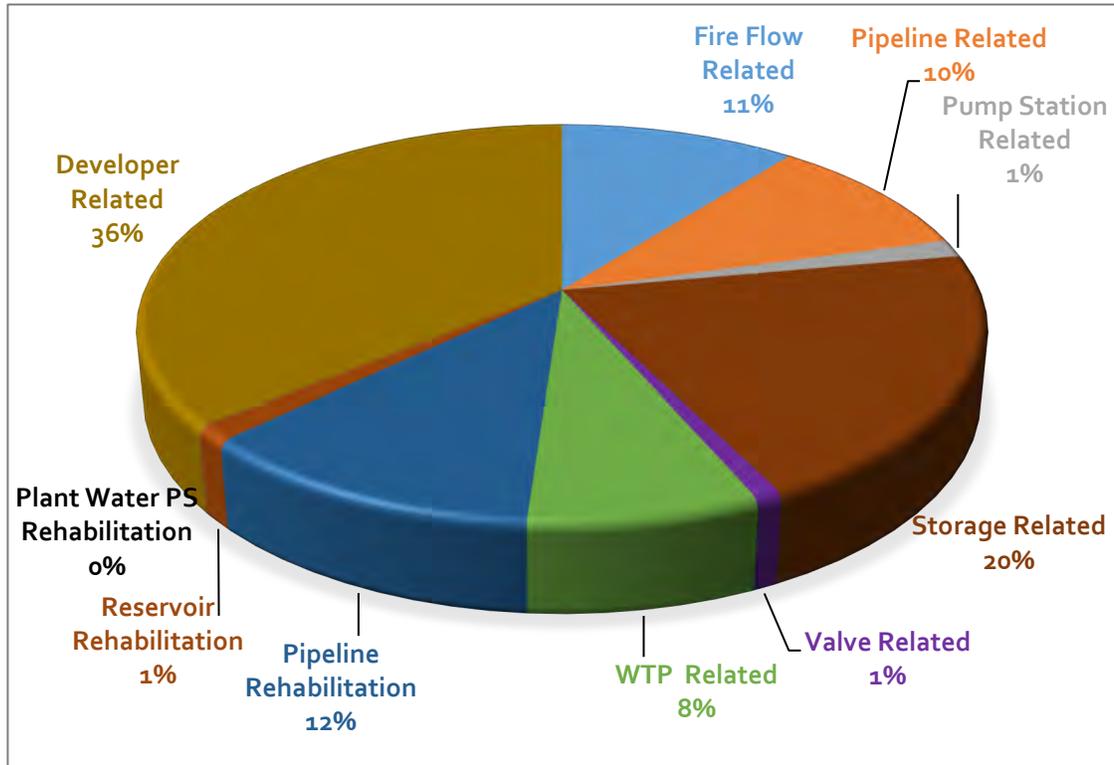


Figure 7.1 Capital Improvement Project Cost Summary by Project Type

7.7 Existing Versus Future Users Cost Share

The improvements proposed in this study either benefit existing users, or is required to service new development and future users. Some of the projects provide benefits to both existing and future users. An opinion of benefit to future users by project is included in Table 7.2. A summary of the existing and future user cost share for the proposed projects by phase is summarized in Table 7.4. As shown in Table 7.4, the total estimated cost for sewer collection system improvements through build-out is roughly \$96.3 million. The majority of improvement projects (\$68.3 million) are associated with future customers and the remaining \$28.0 million is allocated to existing customers.

Table 7.4 CIP Cost by Reimbursement Category

Reimbursement Category	Phase 1 (2016-21) (\$)	Phase 2 (2022-26) (\$)	Phase 3 (2027-36) (\$)	Phase 4 (Post 2036) (\$)	Total (\$)
Existing Customers	2,712,000	15,354,000	9,926,000	-	27,992,000
Future Customers	1,843,000	2,417,000	12,859,000	51,182,000	68,301,000
Grand Total	4,555,000	17,771,000	22,785,000	51,182,000	96,293,000

Note:
 (1) ENR CCI 20 City average used for estimating (March 2016) = 10,182

The distribution of project cost by project type by customer class is provided in Table 7.5.

Table 7.5 CIP Cost by Project Type and Reimbursement Category

Project Type	Existing Users (\$)	Future Users (\$)	Total (\$)
Capacity/Storage Improvements			
Fire Flow Related	8,686,000	1,511,000	10,197,000
Pipeline Related	1,918,000	7,795,000	9,713,000
Pump Station Related	173,000	1,193,000	1,366,000
Storage Related	3,512,000	16,254,000	19,766,000
Valve Related	207,000	623,000	830,000
WTP Related	984,000	6,378,000	7,362,000
Subtotal	15,480,000	33,754,000	49,234,000
Rehabilitation Improvements			
Pipeline Rehabilitation	11,270,000	-	11,270,000
Reservoir Rehabilitation	1,209,000	-	1,209,000
Plant Water PS Rehabilitation	33,000	-	33,000
Subtotal	12,512,000	-	12,512,000
Developer Related Improvements			
Developer Related	-	34,547,000	34,547,000
Subtotal	-	34,547,000	34,547,000
Grand Total	27,992,000	68,301,000	96,293,000

Note:

(1) ENR CCI 20 City average used for estimating (March 2016) = 10,182

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Appendix A

GENERAL PLAN LAND USE DESCRIPTIONS

City of Shasta Lake - Land Use Classification Descriptions

LU Classification	Description	Density / Intensity
Rural Residential A	<i>Living environments characterized as receiving no urban services except for electric, adjacent to areas classified as public or timber, and with issues such as extreme fire hazard or inaccessibility to public roads. Parcels and access roads must meet Grading Ordinance requirements and Construction Standards.</i>	1 DU*/ 5 Acres
Rural Residential B	<i>Living environments with large lot sizes receiving some or no urban services (such as sewer, gas, water, or electric) and with accessibility to public roads where the roads and parcels will have no slope over 20%. Parcels and access roads must meet Grading Ordinance requirement with not more than 50% of parcel and access over 20% slope and Construction Standards.</i>	1 DU/ 2 Acres
Suburban Residential	<i>Living environments receiving full urban services while maintaining lower population densities.</i>	3 DU/ Acre
Urban Residential	<i>Single Family dwelling units on small lots receiving full urban services. This includes accessory dwelling units.</i>	6 DU/ Acre
Urban Residential High A	<i>High-density multi-family developments including apartments, condominiums, and townhouses.</i>	20 units/ Acre
Urban Residential High B	<i>Highest density multi-family residential development including apartments, condominiums, and town houses.</i>	30 units/ Acre
Commercial	<i>Retail and business development including general retail, restaurants, personal service, offices, hotel/motels, shopping centers and other similar uses.</i>	1.5 FAR
Village Center Mixed Use	<i>A mixture of commercial and residential uses oriented toward pedestrian activity. Characterized by street oriented buildings and a "Main Street" feel.</i>	3.0 FAR
Industrial	<i>Classification includes heavy manufacturing, warehouse, production, logistics and distribution and materials processing. May allow large amount of area for outdoor operations. Can include heavy commercial.</i>	0.5 to 1.0 FAR
Industrial Light	<i>Areas for light industrial uses which do not have light, air quality or noise impacts and without outdoor storage. May include heavy commercial uses which are wholly interior uses</i>	1.0 FAR
Mixed Use	<i>Provides for residential, commercial, industrial, and recreational uses developed together within a planned community.</i>	6-30 DU/Acre 1.0 FAR
Natural Resources Protection - Habitat	<i>Used for the protection of wildlife habitat resources.</i>	N/A
Natural Resources – Protection Community Parks	<i>Used for the protection of wildlife habitat resources but allows for parks where the resources will not be impacted.</i>	N/A
Parks	<i>Community recreation facilities including open space play areas and equipment, recreation fields, community gardens and public golf courses.</i>	N/A
Public Facilities	<i>Provides for public facilities including but not limited to schools, parks, and public utilities and facilities. Such facilities may also be in any of the Residential Areas with an Administrative permit.</i>	N/A

DU = Dwelling Unit

FAR = Floor Area Ratio

Appendix B

MOUNTAIN GATE BY SHASTA AREA PLAN

Area Plan

2.0 AREA PLAN

1. Purpose Statement

The purpose of the Mountain Gate at Shasta Area Plan (Area Plan) is to guide and regulate the land use and development of the Mountain Gate at Shasta property (Plan Area) as described in Shasta Lake General Plan Implementation Measure LU-(11).

The Area Plan includes a description of required infrastructure (water, sewer, electric, storm drainage, streets, etc.); services (law enforcement, fire protection, schools, parks and trails); a phasing plan; finance mechanisms for construction and maintenance, architectural and design standards; and other required criteria.

The Area Plan strives to balance the need for a coherent long-term vision with the equally important need to provide flexibility to accommodate changes in community needs and State and Federal environmental regulations. The Plan also seeks to address specific site conditions and accommodate other factors that will influence development during the buildout of the Plan Area.

This Area Plan is also a regulatory document. The Area Plan designations shown in Table 2-1 are intended to provide guidance for implementation of the Mountain Gate at Shasta Planned Development (PD) Zone District. The development performance standards in this Area Plan and PD Zone District supersede any similar zoning districts or design standards in the City, and these standards were specifically designed and adopted by the City to apply to the property within the Plan Area.

2. Area Plan Related Documents

Related documents, incorporated herein by reference, include:

- **Mountain Gate at Shasta Planned Development (PD) Zone District** (Shasta Lake Municipal Code Chapter 17.63), which implements the Area Plan and provides the City of Shasta Lake (City), current and future property owners, interested agencies, and the public with assurances as to the long-term development plan for the property;
- **Development Agreement** by and between the City and Mountain Gate Meadows, LLC (the "Development Agreement"), which sets forth the property owner's obligations related to the construction and financing of infrastructure and public services, including financial contributions for infrastructure maintenance. The Development Agreement will vest the

property with the right to proceed with development subject to the limitations and obligations of the Development Agreement and the Area Plan.

- **Mountain Gate at Shasta Area Plan Final Environmental Impact Report (FEIR)**, State Clearinghouse Number SCH 2012-042010, which addresses the environmental impacts and includes mitigation measures applicable to development within the Plan Area.
- **Large Lot Tentative Subdivision Map**, which subdivides the 590-acre property into twenty-one (21) parcels in support of the Area Plan and includes conditions of approval adopted by City Council.

The following actions are anticipated concurrently with or subsequent to the adoption of this Area Plan.

- **Tentative Subdivision Maps:** Future subdivision of parcels in support of the Area Plan.
- **Improvement Plans and Grading Permits:** Engineered plans for all infrastructure improvements and grading will be required.
- **Use Permits, Administrative Permits, Zoning Permits, Design Review, Building Permits:** Land Use Permits and Design Review will be required for certain uses within the Area Plan. Building permits will be required for all construction pursuant to the California Building Standards Codes.
- **Regulatory Agency Permits:** **Regional Water Quality Control Board** Waste Discharge Permit, National Pollutant Discharge Elimination System Permit, Storm Water Pollution Prevention Program and Water Quality Certification or Waiver (Sections 401 and 402 of the Clean Water Act); **U.S. Army Corps of Engineers** Section 404 of the Clean Water Act; California Department of Fish and Wildlife Streambed Alteration Agreement; **Shasta County Air Quality Management District** Dust Control Plan and Equipment Emissions Reduction program for construction activities; **Shasta County** Encroachment Permit; **California Department of Transportation (Caltrans)** Encroachment Permit.

3. Objectives

The Mountain Gate at Shasta project has been designed to ensure the project will have positive benefits for the community. The following objectives have been identified:

- Provide a comprehensively planned project that is sensitive to environmental issues including wetlands, flood protection, the City's hillside grading concerns, and tree preservation.
- Protect the highest quality natural features and resources of the site.
- Conform to General Plan policies that designate the project site for urban development through implementation of the Area Plan.
- Promote compact mixed-use development that strives to provide a balance of uses, diverse housing and transportation choices, and contributes to a jobs-to-housing balance within the region.

- Provide a balanced mix of land uses that will allow a self-sufficient community, thereby reducing demands on regional roadways and services.
- Provide for a full range of housing densities and product choices affordable to a broad spectrum of income levels.
- Provide a master-planned community on a suitable site of sufficient size in proximity to an existing freeway, with access from existing interchange facilities.
- Establish a circulation system that meets local and regional transportation needs and accommodates a variety of transportation modes, including off-street trail systems and on-street bicycle lanes.
- Establish a pedestrian-friendly community that provides a continuous system of trails to link neighborhoods together and provide safe routes to parks and community-serving areas.
- Provide required park facilities sized to meet the needs of residents in the Area Plan and located as neighborhood focal elements.
- Provide a comprehensively planned infrastructure system (e.g., water treatment and distribution systems, sewer treatment and collection systems, electrical distribution systems, fire suppression facilities, general government facilities) to serve the needs of future residents of the development area.
- Provide adequate infrastructure improvements without adversely affecting existing levels of service.
- Phase development and infrastructure to respond to market demand while requiring new development to provide the infrastructure and public facilities necessary to serve the developing area.
- Establish financial mechanisms to ensure that the full range of services needed to serve the Plan Area are funded by the community and not by existing city residents.
- Provide revenue for the maintenance of public open space areas and park facilities, infrastructure, and public services within the development area.

4. Area Plan Administration

The Development Services Director or his/her designee (Director) is responsible for the administration, implementation and enforcement of this Area Plan. The PD Zone District delegates various implementing decisions for consideration to the Director.

5. Development Standards within the Area Plan

The Area Plan, PD Zone District and Development Agreement shall govern development, improvements, and construction within the Plan Area and supersede conflicting standards in the Zoning and Subdivision Ordinances.

6. Development Plan

The intended and preferred development is shown on **Figure 2-1**, Schematic Land Plan.

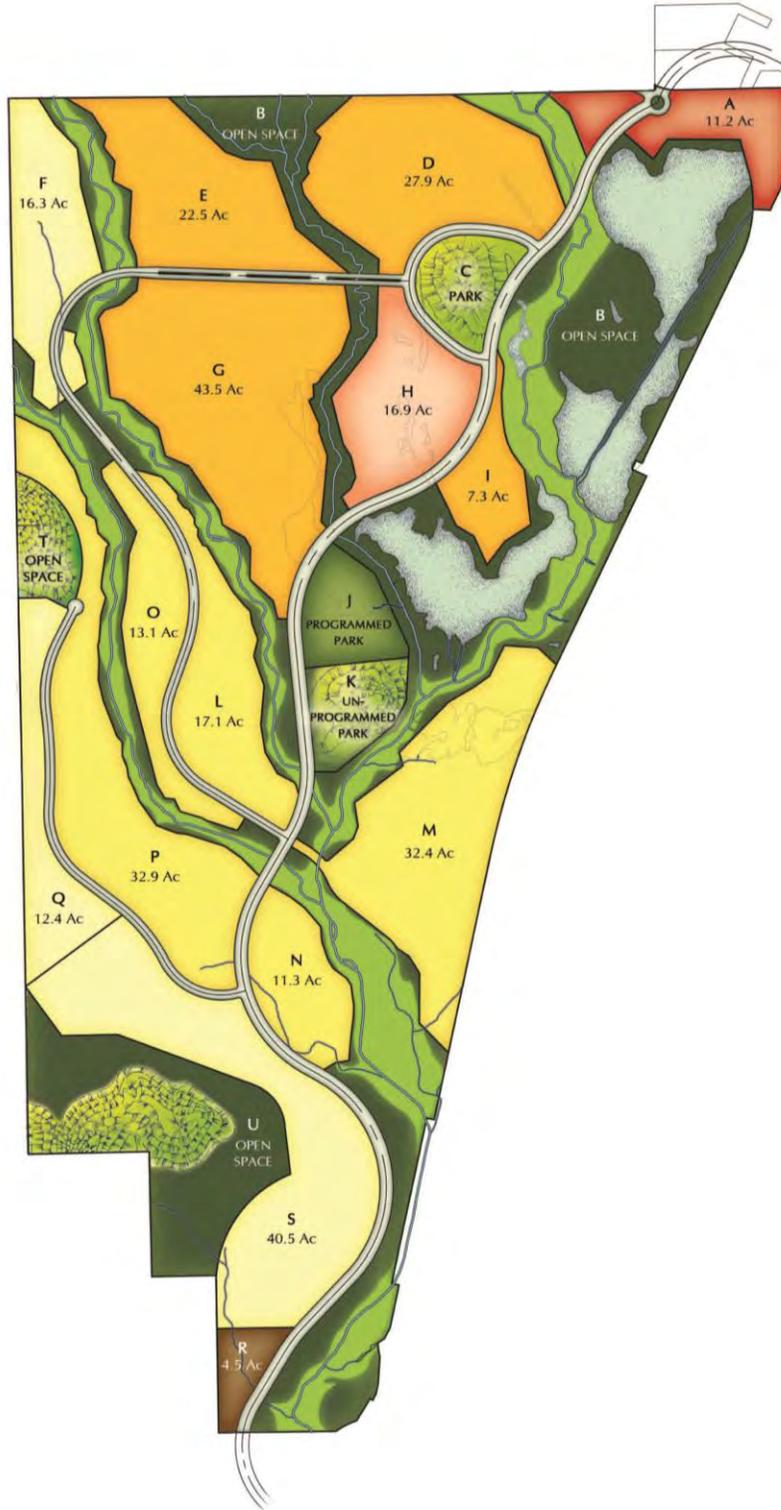


Figure 2-1
Schematic Land Plan

Table 2-1 summarizes the land use categories shown in Figure 2-1 and implemented by the Mountain Gate PD Zone District. The Unit Range column in Table 2-1 represents the maximum number of units possible in each land use designation. The calculations do not take into account site-specific characteristics or other factors that will reduce the maximum density from the upper values shown in Table 2-1.

Some development may be clustered and designed to ensure that anticipated densities are achieved while still providing preservation of on-site hillsides, sensitive biological habitat and cultural resources. To this end, the PD Zone District allows for density transfers, reduced or modified site development standards, such as lot size, and additional administrative modifications.

Housing types are expected to vary in each of the Plan Areas as project design incorporates the project site topography and site amenities. Several different housing types can occur in each of the plan areas as described in Section 2.4; however, the Area Plan limits overall density in each area. Housing types for each of the areas will be determined at the time of submittal of subsequent tentative subdivision maps.

The anticipated residential yield from this Area Plan is between 873 and 1,799 residential units of varying types. Due to certain development constraints (topography, wetlands, floodplain, sensitive biological habitat, etc.), the probable maximum residential units is 1,604. The Mixed Use commercial areas are not expected to develop into the maximum potential unit yield. The ranges shown are considered a maximum and may be less than shown but will not exceed the upper range.

Nonresidential land uses are concentrated in areas A and H as shown in **Figure 2-1** and **Table 2-1**. Area A allows for conventional highway-oriented commercial development; however, the uses in this area would be limited by the PD Zone District for the Plan Area. Area H is intended as a mixed-use urban center and would contain both residential and nonresidential uses. This area may also contain live-work units with commercial and residential uses in the same buildings.

A Community Park is identified in Areas J and K as indicated in **Table 2-1**. A Neighborhood Parks is identified for Area C.

**Table 2-1
MOUNTAIN GATE AT SHASTA AREA PLAN LAND USE
Proposed Density**

Area ¹	Primary Land Use ²	Acres ³	Max. FAR ⁴ or Building Coverage	Potential Sq.Ft. ⁵	Density Range	Unit Range	Probable Maximum Units ⁶
A	Commercial	11.2	0.25	121,968	-	-	0
B	Open Space	181.5	0.1	-	-	-	0
C	Neighborhood Park	7.3	0.1	-	-	-	0
D	Medium Density Residential	27.9	0.7	-	4 - 7	112 - 195	176
E	Medium Density Residential	22.5	0.7	-	4 - 7	90 - 158	142
F	Very Low Density Residential	16.3	0.5	-	1 - 2	16 - 33	30
G	Medium Density Residential	43.5	0.7	-	4 - 11	206 - 492	443
H	Mixed Use Commercial	14.9	0.1	73,616	-	-	0
	High Density Mixed Use		0.7	-	11 - 20	131 - 238	215
	Fire Station	2	0.7	-	-	-	0
I	Medium Density Residential	7.3	0.7	-	4 - 7	29 - 51	46
J	Community Park	8.1	1.5	-	0	0	0
K	Community Park	7.6	0.1	-	-	-	0
L	Low Density Residential	17.1	0.5	-	2 - 4	34 - 68	61
M	Low Density Residential	32.4	0.5	-	2 - 4	39 - 78	70
N	Low Density Residential	11.3	0.5	-	2 - 4	23 - 45	41
O	Low Density Residential	13.1	0.5	-	2 - 4	26 - 52	47
P	Low Density Residential	32.9	0.5	-	2 - 4	66 - 132	119
Q	Very Low Density Residential	10.4	0.5	-	1 - 2	10 - 21	19
	Electric Substation	2	0.7	-			0
R	High Density Residential	4.5	0.7	-	11 - 30	50 - 135	122
S	Very Low Density Residential	40.5	0.5	-	1 - 2	41 - 81	73
T	Open Space	5.9	0.1	-	-	—	0
U	Open Space	33.6	0.1	-	-	—	0
R.O.W.	Rights-Of-Way	36.2	-	-	-	—	0
Totals		590.0	—	195,584	—	873 - 1,779	1,604

¹See Figure 2-1 for the location of land use areas.

²Several identified public uses (i.e., parks, fire station, electric substation) are likely to occur as indicated; however, it is possible that public uses will be located in other development areas, other land in the City, or removed from the Area Plan. In this instance, the development potential of the property formerly intended for the public use shall be equal to that of the lowest density in the same development area provided the overall number of units does not exceed 1,604 as shown in the table.

³All acreages are estimates.

⁴Floor area ratio for non-residential uses only, Maximum building coverage for residential uses.

⁵Maximum potential square footage of all structures within the land use designation.

⁶Topography and site constraints would limit the overall density. Approximately 1,604 units is considered the development limit of the site

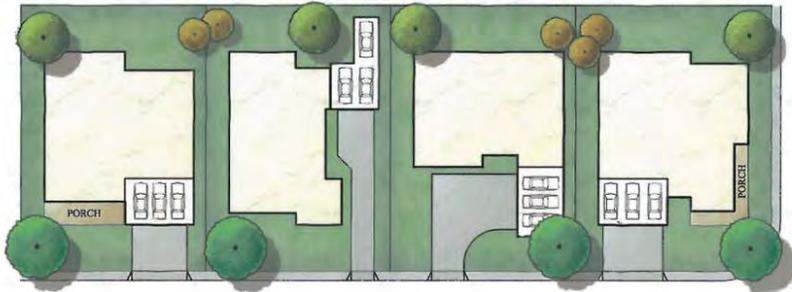
7. Land Use

The Area Plan provides for the following land use designations:

Residential. This land use designation has five density ranges within the Plan Area: Very-Low, Low, Medium, High, and High / Mixed-Use. Generally, each of the designations is intended to address a specific housing need.

Density	Density Range Units Per Acre	Description
Very-Low	1 – 2	This housing type will be used in areas which would not be able to accommodate a more intense development pattern due to wetlands, sensitive biological resources, or topography. This designation is consistent with the Large Lot design (Figure 2-2) .
Low	2 - 4	The Low Density Residential areas are intended for single-family detached, half-plex units and similar and compatible uses. This designation is consistent with the Medium and Large Lot design (Figure 2-2) .
Medium	4 - 7	Homes in this designation will provide the majority of the housing opportunity within the Area Plan. Similar in intensity to other housing development in the City, this housing type will take advantage of the areas of the site largely unconstrained by wetlands, biological habitat or topography. This designation can accommodate the Large Lot design (Figure 2-2) , as well as Medium and Small Lot, Alley Loaded and Green Court designs (Figure 2-3) .
High	11 – 30	This housing type is intended to provide a variety of design options. Possible housing designs included in this designation include: Town Home, Apartments, Duplex, Triplex
High Density- Mixed Use	11 – 20	This designation is an integral part of the mixed-use Area H, intended to support a mix of residential and non-residential uses. The density range encourages different housing designs with a wide range of housing costs. (See Figure 2-3) .

Note: Figures are representative. Individual floor plans and lotting considerations will be determined at the project level by individual developers during review and approval of each subsequent tentative subdivision map or other discretionary approval.

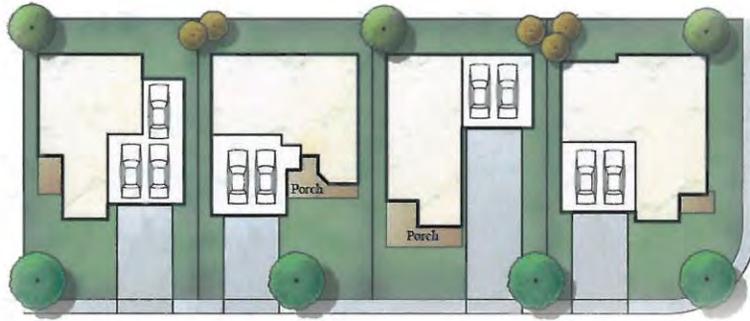


Large Lots

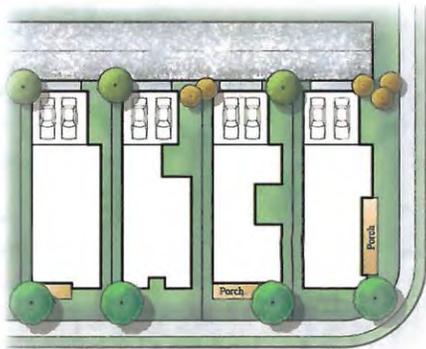


Medium Lots

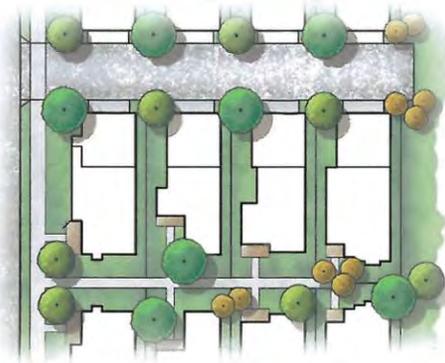
Figure 2-2
Very Low and Low Density Residential Lot Exhibits



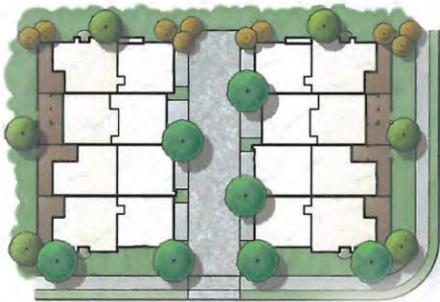
Small Lots



Alley Loaded



Green Court



Town Homes



Apartments

Figure 2-3
 Medium and High Density Residential Lot Exhibits

Commercial

There are two commercial areas within the Plan Area: Areas A and H. Area A is intended to support conventional commercial uses including retail stores, movie theaters, grocery stores, banks, health clubs, etc., that address the commercial needs of both the residents of the Area Plan, and the City as a whole. Area A, located nearer to the Mountain Gate Interchange at I-5, is also suited for freeway-oriented businesses such as hotel/motel, fast food and gasoline/fueling stations.

Mixed-Use

Area H is intended to provide design flexibility leading to the creation of a focal point for the Area Plan. By allowing a mix of residential and non-residential uses, the Area Plan envisions unique housing styles combined with specialty retail uses catering primarily to the Area Plan residents. Uses in this area might include professional offices, medical services, coffee shops, book stores, dry cleaners, and other service uses. Housing types may range from small lot single family detached to townhomes or apartments located over street-front commercial uses, and live-work units. The maximum intensity of development for these areas is 20 units per acre for residential use and 73,616 square feet for non-residential use.

Park and Trail System

There is one community park and one neighborhood park identified in the Area Plan and are more specifically described in Section 3.0 (Area Plan Policies). The parks are part of a larger open space and trail system intended to link the residential uses along roadways and water courses, to commercial and recreational uses. **(Figure 2-4)**

Wetland and Open Space

The Area Plan has a number of special biological, wetland and topographical features that add character to the site and are incorporated into the design concept. Much of these areas will be undisturbed during construction and left as open space after completion. Because of the sensitivity of some of the areas, there may be no improvements at all. However, portions of these areas will have minimal improvements largely limited to trails, small structures at trail crossings, maintenance equipment storage, or picnic areas as appropriate, etc. No significant buildings or structured use is planned within these areas.

Public Facilities

Public facilities are not shown on the land use map but may occur at any location within the Plan Area boundaries. Facilities can include water tanks, pump stations, wastewater lift stations, power substations, fire hydrants, street lights, parks, bike paths, trails, fire stations, schools, and similar facilities needed to serve the residents within the Plan Area. Specific needs and locations will be determined during review of subsequent tentative subdivision maps or other discretionary approvals for the project.

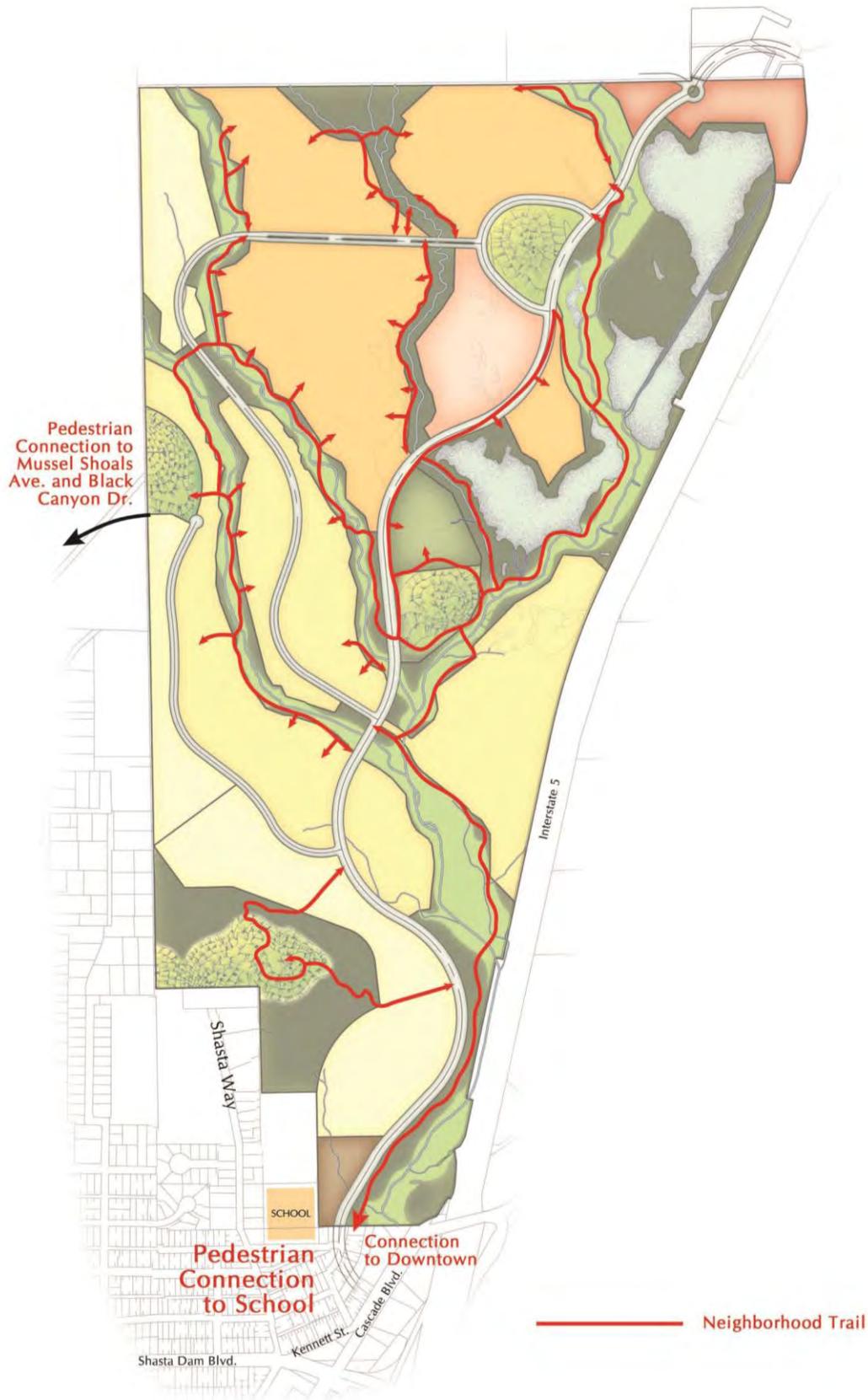


Figure 2-4

Neighborhood Trail System

Appendix C

LAND USE AREAS BY PRESSURE ZONE

Table 1 Existing Land Use by Pressure Zone Summary

Land Use	Pressure Zone Area (acres)										Total
	A	B	C	D	E	F	G	I	J	K	
Residential											
Rural Residential A	0	0	0	0	0	2	0	0	0	0	2
Rural Residential B	66	16	0	0	0	3	0	0	0	0	85
Suburban Residential	14	223	32	101	35	10	161	54	20	0	649
Urban Residential	0	13	70	0	6	57	439	206	47	0	841
Urban Residential High	0	0	0	0	0	44	25	11	0	0	80
Commercial & Mixed Use											
Commercial	0	0	0	0	0	22	26	25	2	0	75
Mixed Use	0	0	0	0	0	0	5	0	3	0	8
Village Mixed Use	0	10	1	0	0	0	48	0	0	0	58
Mtn. Gate Development ⁽²⁾	0	0	0	0	0	0	0	0	0	0	0
Industrial											
Industrial Light	0	0	0	0	0	0	1	0	0	0	1
Industrial	0	0	0	0	0	0	214	0	0	0	214
Other											
Community Parks	0	33	0	0	0	0	0	2	0	0	36
Federal Government	0	0	0	0	0	0	9	0	0	0	9
Public Facilities	0	10	0	0	1	0	265	0	3	0	279
Open Space	0	0	0	0	0	0	0	5	0	0	5
TOTAL	80	306	103	101	42	140	1,193	303	76	0	2,343

Notes:

(1) Excludes Right-of-Ways

(2) See Table 3 for proposed Mtn. Gate Development's land use.

Table 2 **Developable Vacant Land Use by Pressure Zone Summary**

Land Use	Pressure Zone Area (acres)										Total
	A	B	C	D	E	F	G	I	J	K	
Residential											
Rural Residential A	0	49	0	0	0	135	0	0	0	0	184
Rural Residential B	114	24	0	0	0	54	0	0	0	0	192
Suburban Residential	108	268	1	28	15	65	110	40	78	0	713
Urban Residential	0	3	12	0	4	73	199	83	5	0	380
Urban Residential High	0	0	0	0	0	5	12	1	0	0	17
Commercial & Mixed Use											
Commercial	0	0	0	0	0	3	22	35	0	0	60
Mixed Use	0	70	0	0	0	18	198	31	3	0	320
Village Mixed Use	0	2	1	0	0	0	10	0	0	0	13
Mtn. Gate Development ⁽²⁾	0	0	0	0	0	0	26	0	0	538	564
Industrial											
Industrial Light	0	0	0	0	0	0	19	0	0	0	19
Industrial	0	0	0	0	0	0	494	0	0	0	494
Other											
Community Parks	0	0	0	0	0	0	0	68	0	0	68
Federal Government	0	78	0	0	0	19	23	0	0	0	120
Public Facilities	0	0	0	0	0	0	10	0	0	0	10
Open Space	0	0	0	0	0	0	0	0	0	0	0
TOTAL	223	494	13	28	19	371	1,122	260	86	538	3,154

Notes:

(1) Excludes Right-of-Ways

(2) See Table 3 for proposed Mtn. Gate Development's land use.

Table 3 Mtn. Gate Development Summary

Land Use	Area ⁽²⁾ (acres)
Residential	
High Density Residential	4
Medium Density Residential	101
Low Density Residential	110
Very Low Density Residential	69
Commercial & Mixed Use	
Commercial	7
Mixed Use	17
Other	
Community Parks	23
Open Space	233
TOTAL	564

Notes:

- (1) Excludes Right-of-Ways
(2) Mtn. Gate Development is in Zones G and K

Table 4 **Developable Land that is Not Anticipated to be Connected to Water Service**

	Undevelopable Area within the Current City Limits (acres)										Total	
	A	B	C	D	E	F	G	I	J	K		
Residential												
Rural Residential A	472	0	0	0	0	45	0	0	0	0	0	517
Rural Residential B	0	0	0	0	0	0	0	0	0	0	0	0
Suburban Residential	0	0	0	0	0	0	63	0	0	0	0	63
Urban Residential	0	0	0	0	0	0	82	0	0	0	0	82
Urban Residential High	0	0	0	0	0	0	0	0	0	0	0	0
Commercial & Mixed Use												
Commercial	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Use	0	0	0	0	0	0	0	0	0	0	0	0
Village Mixed Use	0	0	0	0	0	0	0	0	0	0	0	0
Mtn. Gate Development ⁽²⁾	0	0	0	0	0	0	0	0	0	0	0	0
Industrial												
Industrial Light	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0
Other												
Community Parks	0	0	0	0	0	0	0	0	0	0	0	0
Federal Government	0	22	0	0	0	49	0	0	0	0	0	72
Public Facilities	0	1	0	74	0	0	0	0	0	0	0	75
Open Space	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	472	23	0	74	0	94	145	0	0	0	0	808

Notes:

(1) Excludes Right-of-Ways

(2) See Table 3 for proposed Mtn. Gate Development's land use.

Table 5 Total Buildout Land Use

Land Use	Pressure Zone Limits (acres)										Total (acres)
	A	B	C	D	E	F	G	I	J	K	
Residential											
Rural Residential A	0	49	0	0	0	137	0	0	0	0	186
Rural Residential B	180	40	0	0	0	57	0	0	0	0	278
Suburban Residential	122	491	33	129	50	74	271	94	98	0	1,362
Urban Residential	0	16	82	0	10	131	639	290	52	0	1,220
Urban Residential High	0	0	0	0	0	49	37	12	0	0	98
Commercial & Mixed Use											
Commercial	0	0	0	0	0	25	48	60	2	0	135
Mixed Use	0	70	0	0	0	18	202	31	6	0	329
Village Mixed Use	0	12	2	0	0	0	57	0	0	0	71
Mtn. Gate Development ⁽²⁾	0	0	0	0	0	0	26	0	0	538	564
Industrial											
Industrial Light	0	0	0	0	0	0	20	0	0	0	20
Industrial	0	0	0	0	0	0	708	0	0	0	708
Other											
Community Parks	0	33	0	0	0	0	0	71	0	0	104
Federal Government	0	78	0	0	0	19	32	0	0	0	129
Public Facilities	0	10	0	0	1	0	274	0	3	0	289
Open Space	0	0	0	0	0	0	0	5	0	0	5
TOTAL	303	800	116	129	61	511	2,315	562	162	538	5,497

Notes:

(1) Excludes Right-of-Ways

(2) See Table 3 for proposed Mtn. Gate Development's land use.

Appendix D

TOP 10 LARGEST CUSTOMER CONSUMPTION DATA

**Table 1 2012 - Top 10 Annual Consumption Accounts
2016-2026 Water Master Plan Update
City of Shasta Lake**

Rank	Name	Address	Type	Daily Average Consumption (gpd)
1	KNAUF INSULATION GmbH	3100 ASHBY RD	IND	131,580
2	SIERRA PACIFIC SAWMILL	3736 EL CAJON SAWMILL	IND	114,179
3	TWIN LAKES	3304 SHASTA DAM BL WW	MOB	63,612
4	CITY OF REDDING- FINANCE	BELTLINE RD	GOV	20,931
5	GATEWAY UNIFIED SCH DIST	4062 LA MESA AVE	SCH	25,148
6	COSL- AKARD PARK SPRINKLERS	2723 PARK LN	CI	20,989
7	TARA HILLS GARDEN INVESTORS	4555 RIDDLE	MUL	17,984
8	GATEWAY UNIFIED SCH DIST	4620 VALLECITO ST	SCH	13,042
9	PREMIERE BRAND MEATS	3555 IRON CT	IND	12,818
10	COSL-POLF PARK LIGHTS & WATER	SHASTA DM/SACRAMENTO	CI	11,100

Notes:

1. Source: City annual consumption data, by account

**Table 2 2013 - Top 10 Annual Consumption Accounts
2016-2026 Water Master Plan Update
City of Shasta Lake**

Rank	Name	Address	Type	Daily Average Consumption (gpd)
1	KNAUF INSULATION GmbH	3100 ASHBY RD	IND	143,097
2	SIERRA PACIFIC SAWMILL	3736 EL CAJON SAWMILL	IND	77,567
3	TWIN LAKES	3304 SHASTA DAM BL WW	MOB	71,103
4	CITY OF REDDING- FINANCE	BELTLINE RD	GOV	27,101
5	GATEWAY UNIFIED SCH DIST	4062 LA MESA AVE	SCH	26,440
6	TARA HILLS GARDEN INVESTORS	4555 RIDDLE RD	MUL	19,536
7	GATEWAY UNIFIED SCH DIST	4620 VALLECITO ST	SCH	17,044
8	COSL-GATEWAY	IRON CT & GATEWAY DR	CI	16,584
9	COSL-POLF PARK LIGHTS & WATER	SHASTA DM/SACRAMENTO	CI	13,526
10	COSL-LITTLE LEAGUE	SACRAMENTO ST	CI	12,940

Notes:

1. Source: City annual consumption data, by account

**Table 3 2014 - Top 10 Annual Consumption Accounts
2016-2026 Water Master Plan Update
City of Shasta Lake**

2014 Top 10 Annual Consumption Accounts				
Rank	Name	Address	Type	Daily Average Consumption (gpd)
1	KNAUF INSULATION GmbH	3100 ASHBY RD	IND	143,771
2	SIERRA PACIFIC SAWMILL	3736 EL CAJON SAWMILL	IND	50,783
3	TWIN LAKES	3304 SHASTA DAM BL WW	MOB	46,867
4	GATEWAY UNIFIED SCH DIST	4062 LA MESA AVE	SCH	19,276
5	CITY OF REDDING- FINANCE	BELTLINE RD	GOV	17,149
6	TARA HILLS GARDEN INVESTORS	4555 RIDDLE RD	MUL	16,055
7	GATEWAY UNIFIED SCH DIST	4620 VALLECITO ST	SCH	13,298
8	COSL-GATEWAY	IRON CT & GATEWAY DR	CI	11,827
9	COSL-POLF PARK LIGHTS & WATER	SHASTA DM/SACRAMENTO	CI	11,308
10	TOOR ENTERPRISES	17776 RED BUD LN	MOB	10,061

Notes:

1. Source: City annual consumption data, by account

Appendix E
FOCUS AREA DEMAND ESTIMATES

Table 1 Residential Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Unit Type	Unit Allocation Based Upon Market Condition (UNITS)	Unit Demand (gpd/DU)	Projected Demand (gpd)
1						
1A						
	Urban Residential		SF	-	470.0	-
					-	-
	Village Mixed Use		MF	17.8	300.0	5,340.0
					-	-
					-	-
1B						
	Urban Residential				-	-
			SF	-	470.0	-
					-	-
	Village Mixed Use				-	-
			MF	17.8	300.0	5,340.0
					-	-
					-	-
					-	-
1C						
	Urban Residential				-	-
			SF	-	470.0	-
					-	-
	Urban Residential High A				-	-
			MF	-	300.0	-
	Village Mixed Use				-	-
			MF	-	300.0	-
1D						
	Mixed Use				-	-
			MF	13.4	300.0	4,005.0
	Urban Residential				-	-
			SF	-	470.0	-
1E						
	Urban Residential High A				-	-
			MF	8.9	300.0	2,670.0
	Urban Residential High B				-	-
			MF	8.9	300.0	2,670.0
					-	-
					-	-
1G						

Table 1 Residential Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Unit Type	Unit Allocation Based Upon Market Condition (UNITS)	Unit Demand (gpd/DU)	Projected Demand (gpd)
		Mixed Use	MF	13.4	300.0	4,005.0
	1H				-	-
		Urban Residential	SF	8.9	470.0	4,183.0
					-	-
2						
	2A					
		Mixed Use	MF	42.7	300.0	12,816.0
					-	-
	2B					
		Rural Residential A	SF	-	470.0	-
					-	-
		Urban Residential	SF	-	470.0	-
					-	-
		Urban Residential High B	MF	10.7	300.0	3,204.0
					-	-
					-	-
	2C					
		Urban Residential	SF	-	470.0	-
					-	-
		Urban Residential High B	MF	10.7	300.0	3,204.0
					-	-
	2D					
		Mixed Use	MF	7.1	300.0	2,136.0
					-	-
	2E					
		Urban Residential	SF	-	470.0	-
					-	-
3						
	3A					
		Urban Residential	SF	-	470.0	-
					-	-
			MF	8.9	300.0	2,670.0
		Village Mixed Use			-	-
					-	-
					-	-
	3B					
		Urban Residential			-	-

Table 1 Residential Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Unit Type	Unit Allocation Based Upon Market Condition (UNITS)	Unit Demand (gpd/DU)	Projected Demand (gpd)
					-	-
		Village Mixed Use			-	-
			MF	17.8	300.0	5,340.0
4						
	4A					
		Mixed Use			-	-
			MF	8.9	300.0	2,670.0
					-	-
	4B					
		Mixed Use	SF	8.9	470.0	4,183.0
					-	-
					-	-
		Urban Residential			-	-
			MF	8.9	300.0	2,670.0
					-	-
	4E					
		Mixed Use			-	-
					-	-
		Urban Residential High B	MF	17.8	300.0	5,340.0
					-	-
	4F					
		Mixed Use	MF	-	300.0	-
					-	-
					-	-
		Urban Residential			-	-
			SF	4.5	470.0	2,091.5
					-	-
	4G					
		Urban Residential			-	-
					-	-
					-	-
	4H					
		Urban Residential			-	-
			SF	17.8	470.0	8,366.0
					-	-
	4I					
		Urban Residential	SF	8.9	470.0	4,183.0
					-	-
	4J					

Table 1 Residential Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Unit Type	Unit Allocation Based Upon Market Condition (UNITS)	Unit Demand (gpd/DU)	Projected Demand (gpd)
		Mixed Use	MF	8.9	300.0	2,670.0
					-	-
		Urban Residential	SF	8.9	470.0	4,183.0
					-	-
	4K					
		Mixed Use	MF	35.6	300.0	10,680.0
					-	-
	4L					
		Urban Residential	SF	26.7	470.0	12,549.0

Table 2 Residential Focus Area Demand Summary

Focus Area	Dwelling Unit Allocation	Dwelling Unit Type	Average Day Demand (gpd)
1A	17.8	MFR	5,340
1B	17.8	MFR	5,340
1C	0	-	0
1D	13.35	MFR	4,005
1E	17.8	MFR	5,340
1F	0	-	0
1G	13.35	MFR	4,005
1H	8.9	SFR	4,183
2A	42.72	MFR	12,816
2B	10.68	MFR	3,204
2C	10.68	MFR	3,204
2D	7.12	MFR	2,136
2E	0		0
3A	8.9	MFR	2,670
3B	26.7	MFR	8,010
4A	8.9	MFR	2,670
4B	17.8	SFR/MFR	6,853
4C	0		0
4D	0		0
4E	17.8	MFR	5,340
4F	4.45	SFR	2,092
4G	4.45	SFR	2,092
4H	17.8	SFR	8,366
4I	8.9	SFR	4,183
4J	17.8	SFR/MFR	6,853
4K	35.6	MFR	10,680
4L	26.7	SFR	12,549
Total	356		121,930

Table 3 Commercial Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Building Area Allocation Based Upon Market Condition (SF)	F.A.R.	Site Area (SF)	Site Area (ac)	Water Demand Factor (gpd/acre)	Projected Demand (gpd)
1								
	1A							
		Village Mixed Use	1,872	2	1,248	0.029	1,000	29
	1B							
		Village Mixed Use	1,872	2	1,248	0.029	1,000	29
	1C							
		Commercial	6,240	0	20,800	0.478	1,000	478
		Village Mixed Use		2	-	0.000	1,000	-
	1D							
		Commercial	33,696	0	112,320	2.579	1,000	2,579
		Mixed Use		0	-	0.000	1,000	-
	1E							
		Commercial	6,240	0	20,800	0.478	1,000	478
	1F							
		Industrial Light	22,000	0	48,889	1.122	1,000	1,122
	1G							
		Mixed Use	15,600	0	52,000	1.194	1,000	1,194
2								
	2A							
		Mixed Use	5,850	0	19,500	0.448	1,000	448

Table 3 Commercial Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Building Area Allocation Based Upon Market Condition		Site Area (SF)	Site Area (ac)	Water Demand Factor (gpd/acre)	Projected Demand (gpd)
			(SF)	F.A.R.				
2B								
		Commercial	-	0	-	0.000	1,000	-
2C								
		Commercial	5,850	0	19,500	0.448	1,000	448
2D								
		Mixed Use	8,775	0	29,250	0.671	1,000	671
2E								
		Mixed Use	8,775	0	29,250	0.671	1,000	671
3								
3A								
		Village Mixed Use	2,600	2	1,733	0.040	1,000	40
3B								
		Village Mixed Use	2,600	2	1,733	0.040	1,000	40
4								
4A								
		Mixed Use	4,875	0	16,250	0.373	1,000	373
4B								
		Mixed Use	3,250	0	10,833	0.249	1,000	249
4C								
		Commercial	1,625	0	5,417	0.124	1,000	124
		Industrial Light	1,625	0	3,611	0.083	1,000	83
4D								
		Commercial	4,875	0	16,250	0.373	1,000	373

Table 3 Commercial Focus Area Demands

Focus Area	Sub-Focus Area	2035 Land Use	Building Area Allocation Based Upon Market Condition (SF)	F.A.R.	Site Area (SF)	Site Area (ac)	Water Demand Factor (gpd/acre)	Projected Demand (gpd)
4E								
		Commercial	1,625	0	5,417	0.124	1,000	124
		Mixed Use	1,625	0	5,417	0.124	1,000	124
4F								
		Mixed Use	3,250	0	10,833	0.249	1,000	249
4G								
		Commercial	-	0	-	0.000	1,000	-
4I								
		Commercial	4,875	0	16,250	0.373	1,000	373
4J								
		Commercial	1,625	0	5,417	0.124	1,000	124
		Mixed Use	-	0	-	0.000	1,000	-
4K								
		Mixed Use	3,250	0	10,833	0.249	1,000	249

Table 4 Commercial Focus Area Demand Summary

Focus Area	Bldg. Square Footage	Land Use Type	Average Day Demand (gpd)
1A	1,872	Village Mixed Use	29
1B	1,872	Village Mixed Use	29
1C	6,240	Commercial	478
1D	33,696	Commercial	2,579
1E	6,240	Commercial	478
1F	22,000	Industrial Light	1,122
1G	15,600	Mixed Use	1,194
1H	0	--	0
2A	5,850	Mixed Use	448
2B	0	Commercial	0
2C	5,850	Commercial	448
2D	8,775	Mixed Use	671
2E	8,775	Mixed Use	671
3A	2,600	Village Mixed Use	40
3B	2,600	Village Mixed Use	40
4A	4,875	Mixed Use	373
4B	3,250	Mixed Use	249
4C	3,250	Commercial/Industrial Lig	207
4D	4,875	Commercial	373
4E	3,250	Commercial/Mixed Use	249
4F	3,250	Mixed Use	249
4G	0	Commercial	0
4H	0	--	0
4I	4,875	Commercial	373
4J	1,625	Commercial	124
4K	3,250	Mixed Use	249
4L	0	--	0
Total	154,470	--	10,670

Appendix F

HYDRAULIC MODEL CALIBRATION RESULTS



2016-2026 Water Master Plan

Hydraulic Model Calibration Packet

City of Shasta Lake

October 2016

Job No: 10037A.00





2016-2026 Water Master Plan

Extended Period Simulation (EPS) Calibration

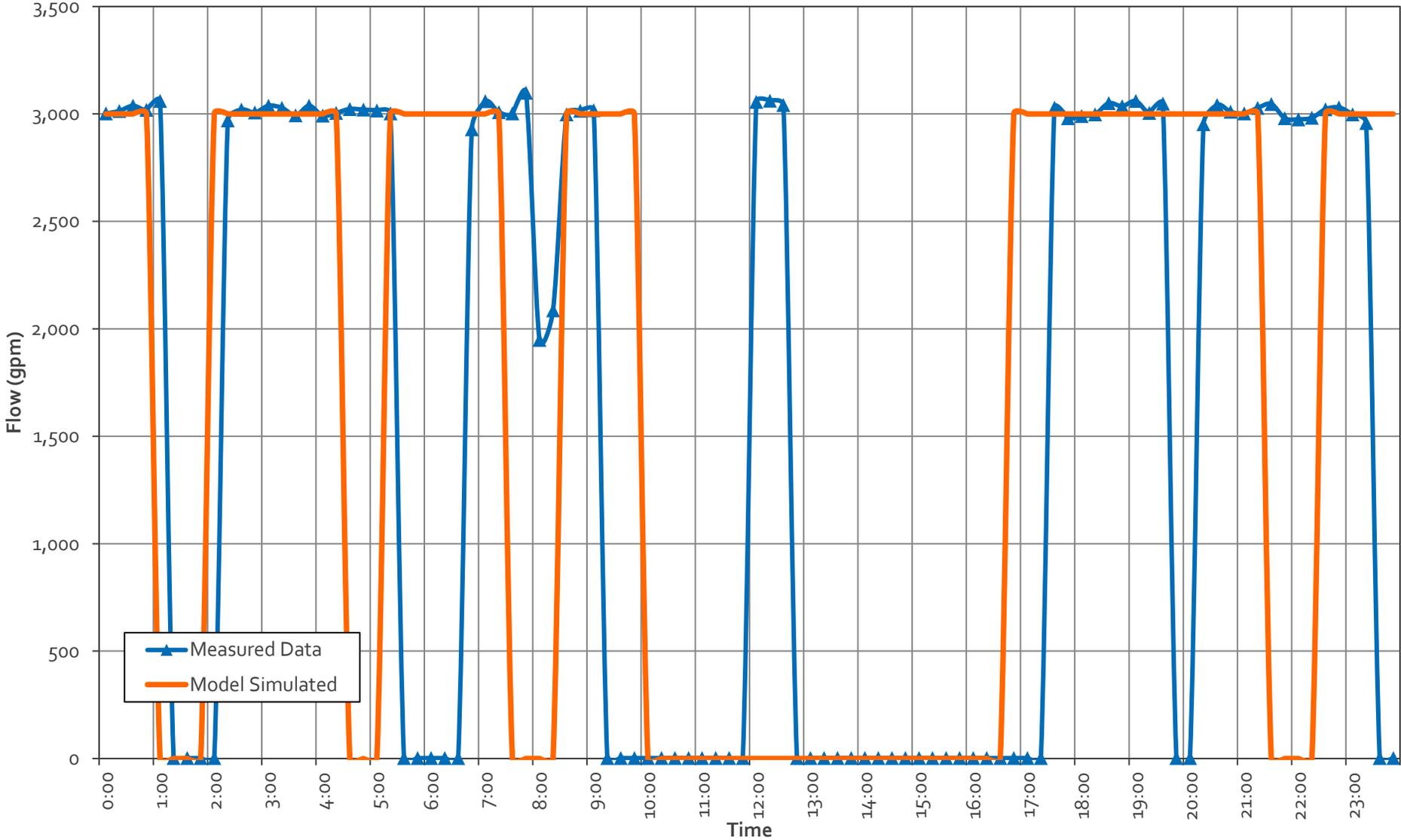
Based on September 2015 Field Data

City of Shasta Lake

October 2016

Job No: 10037A.00

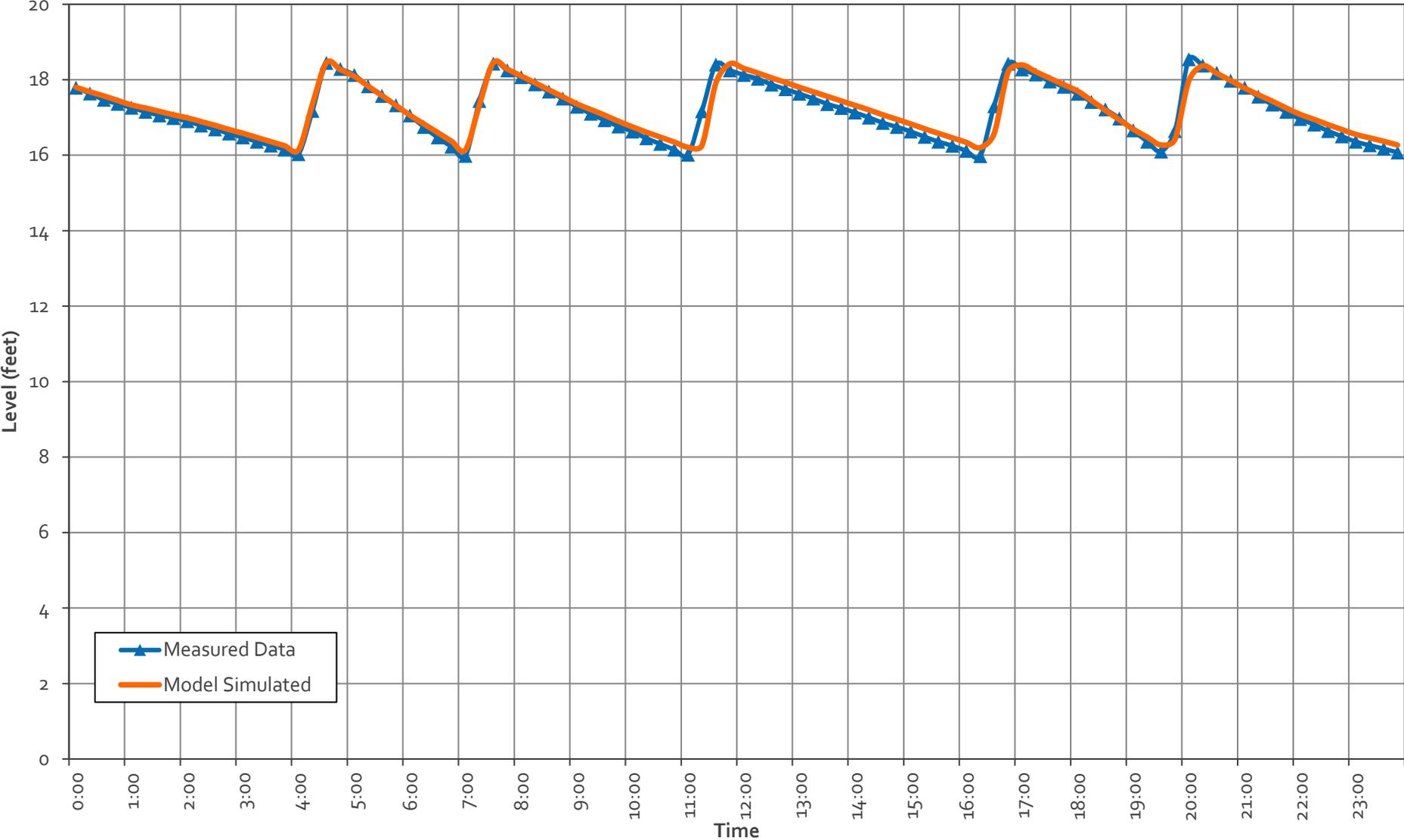




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
WTP Discharge Flow

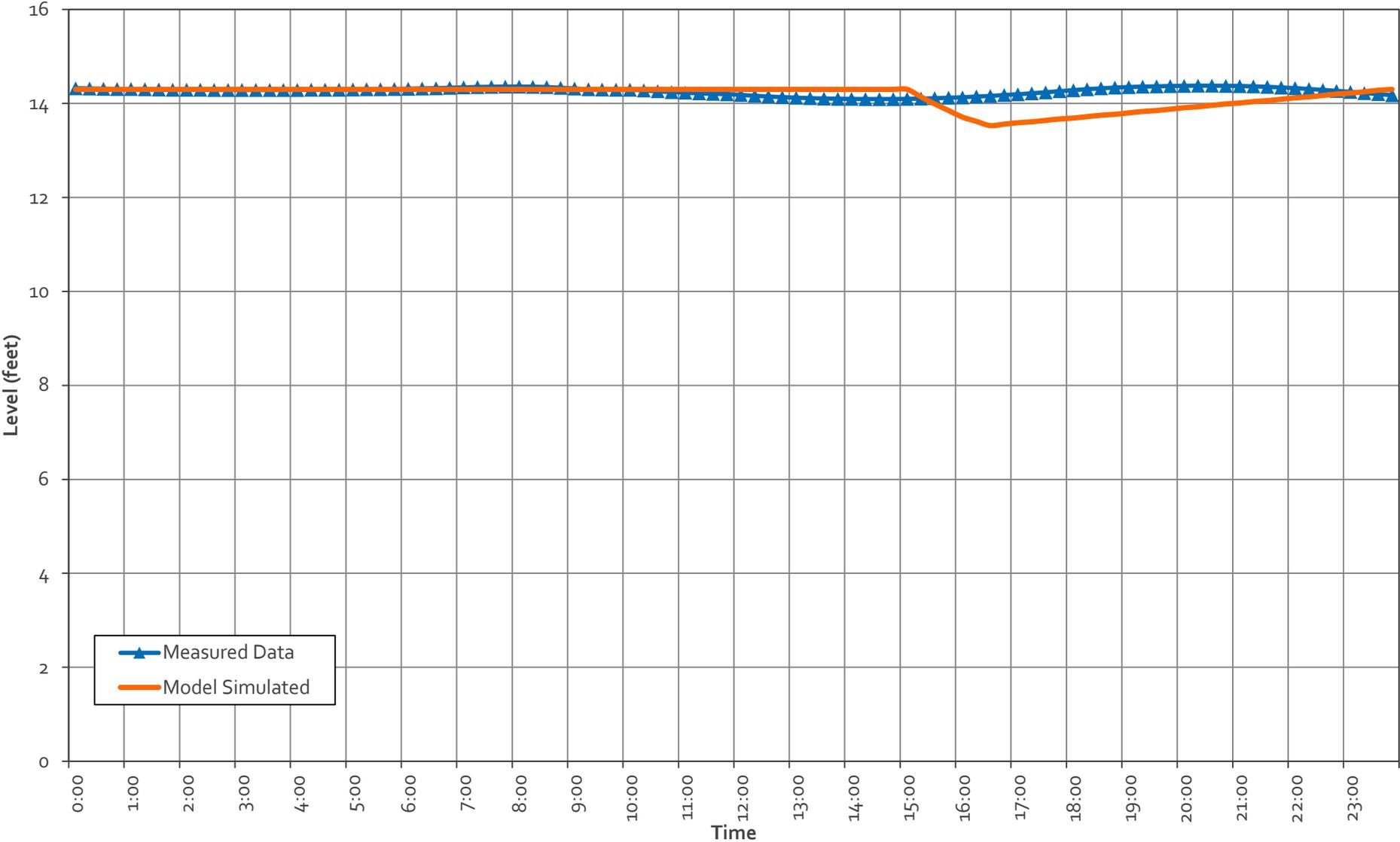




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 1 Level

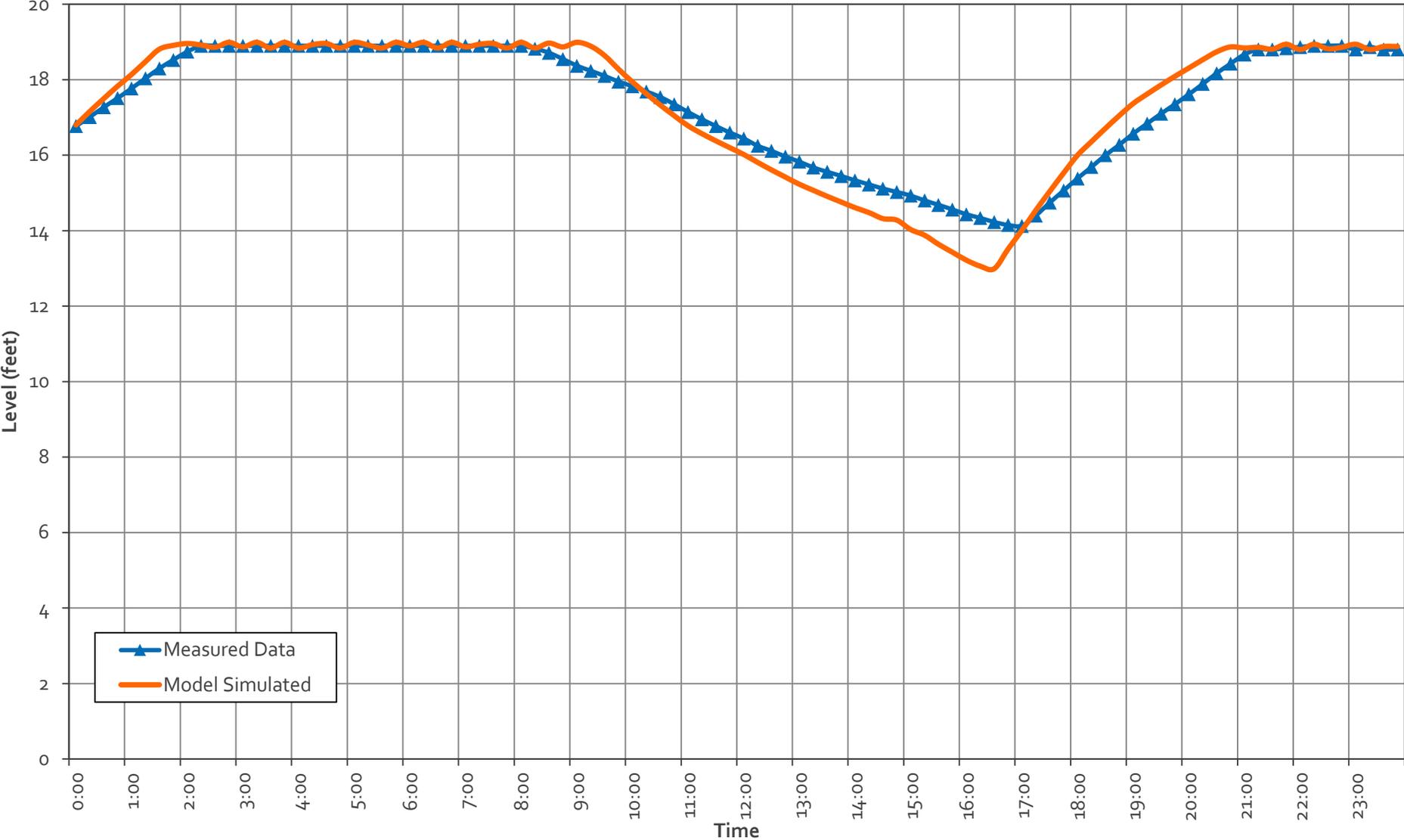




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 2 Level

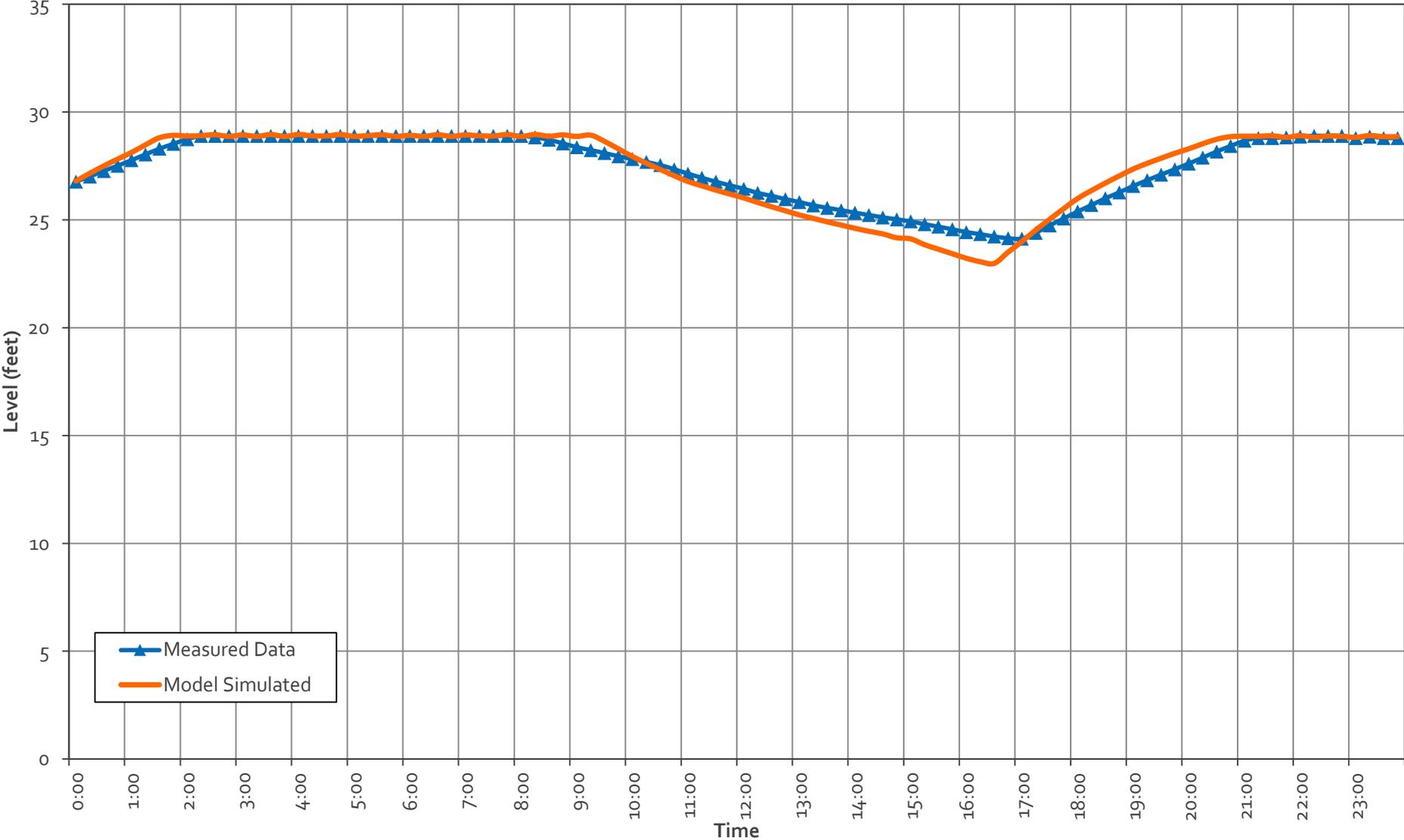




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 3A Level

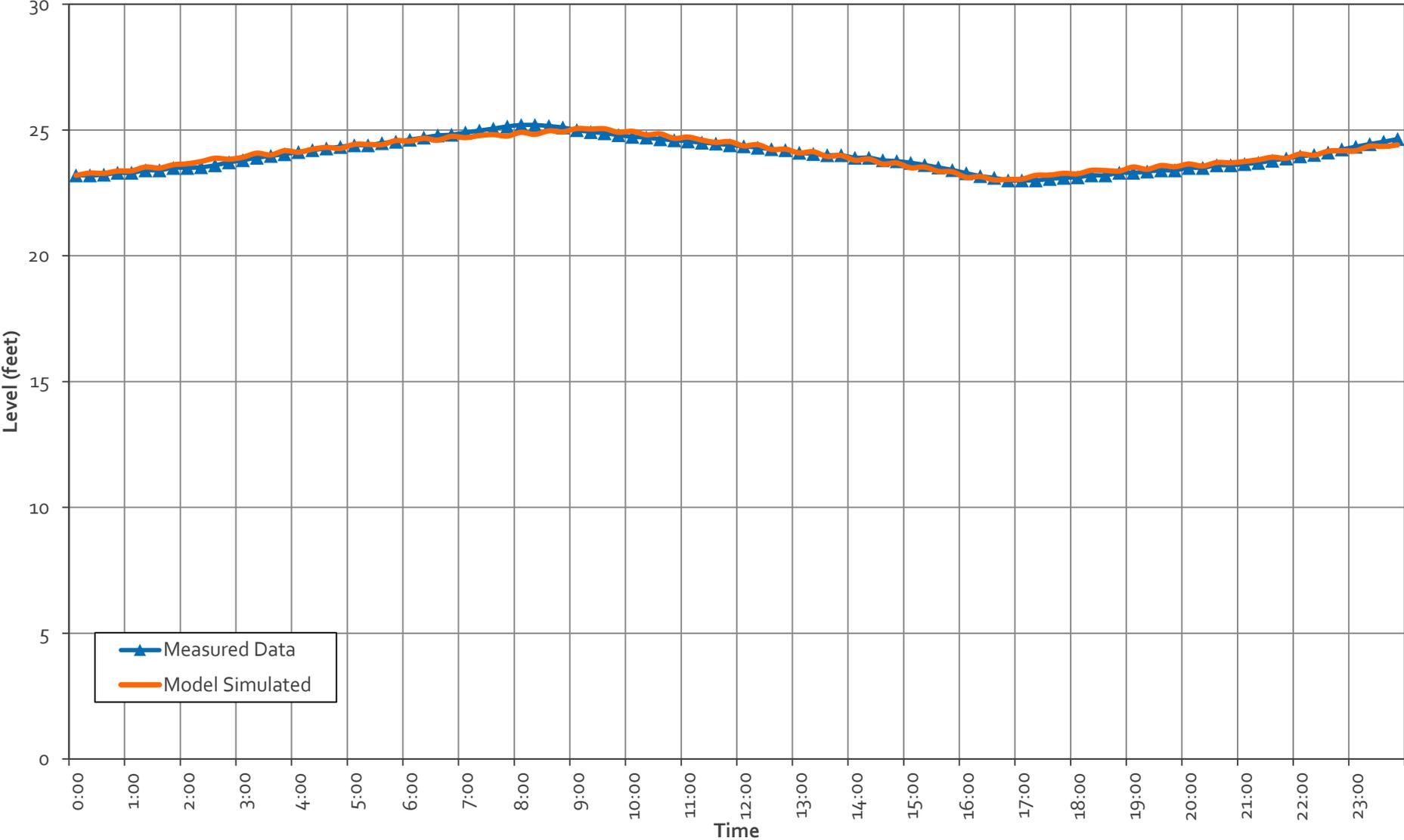




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 3B Level

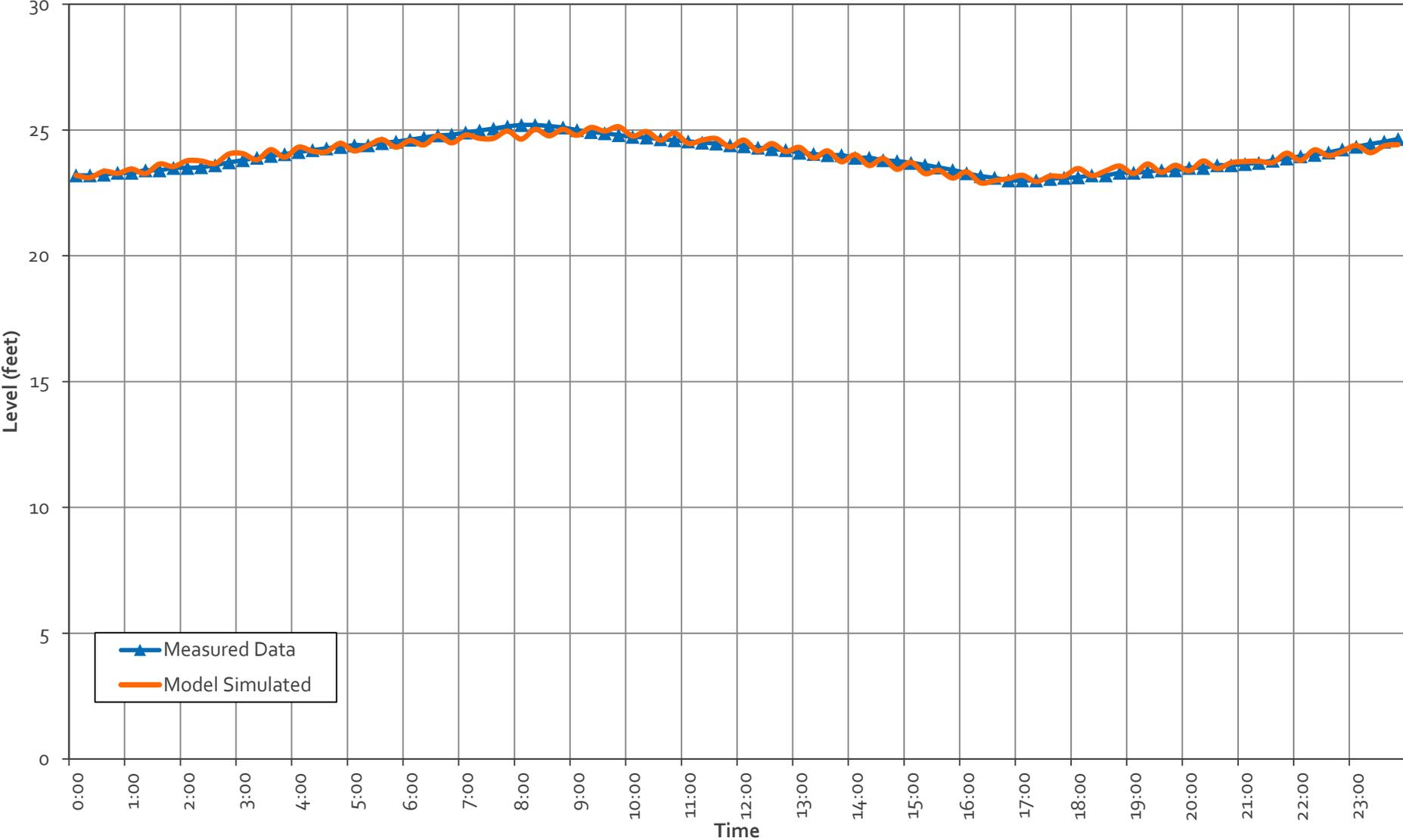




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 4A Level

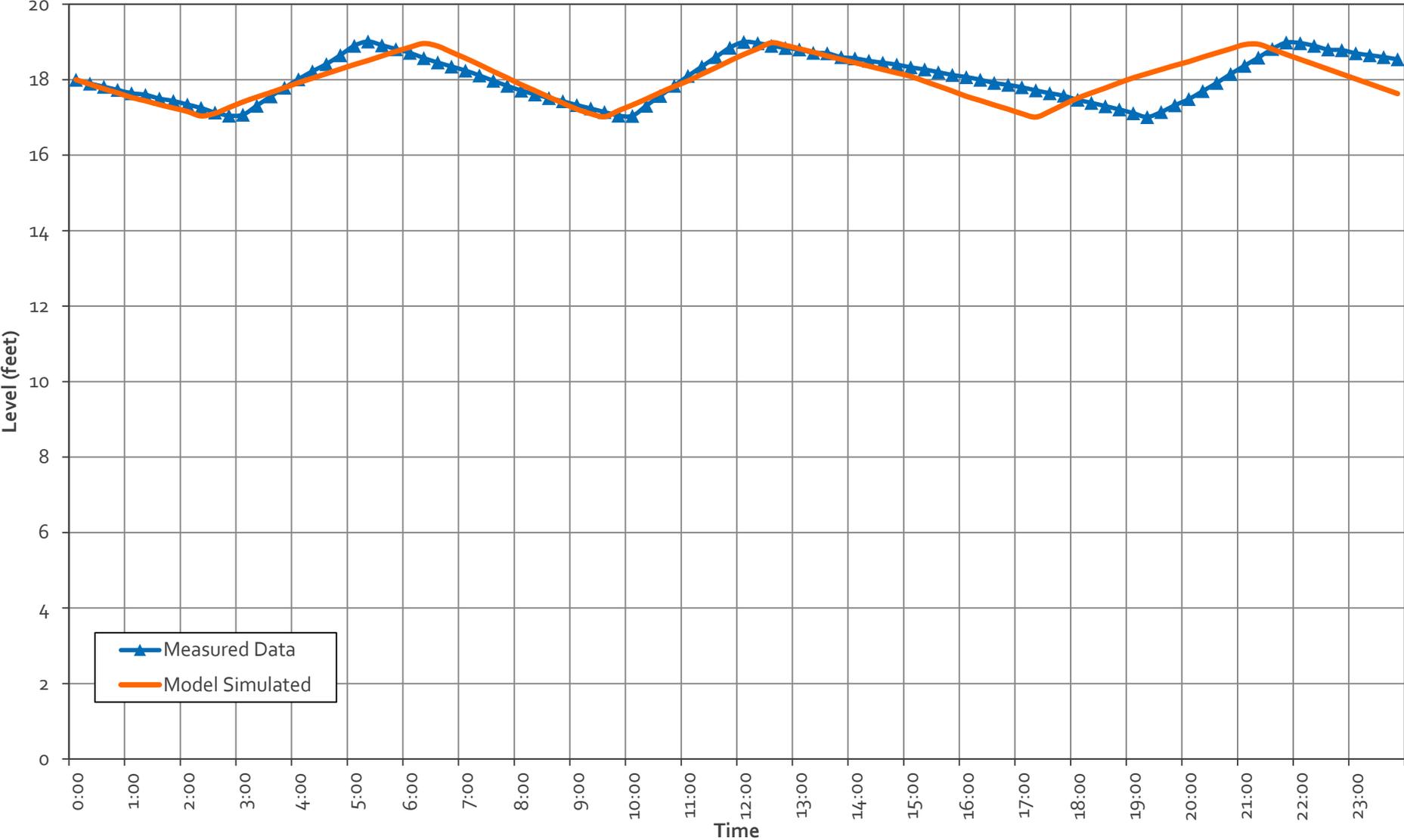




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 4B Level

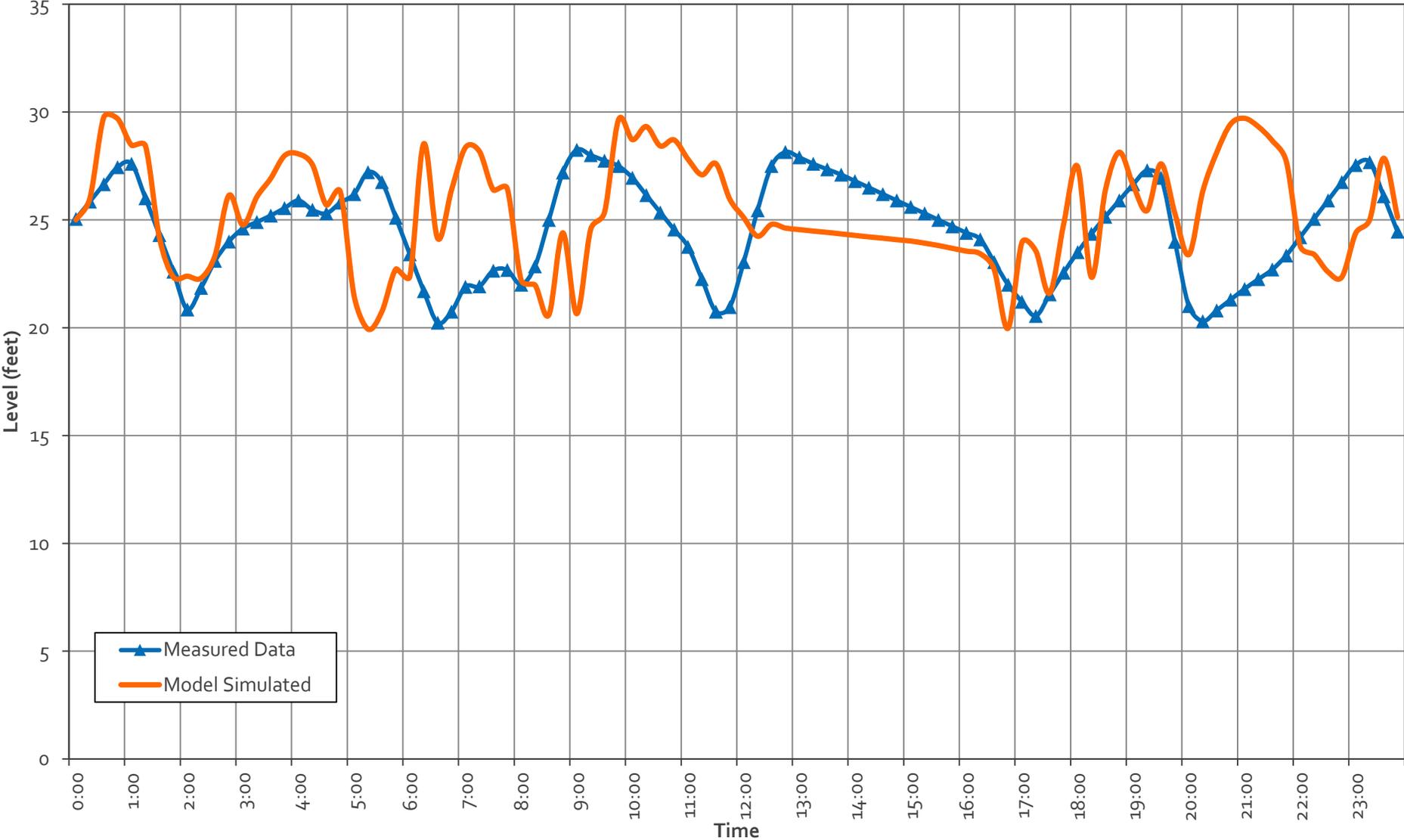




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Tank 5 Level

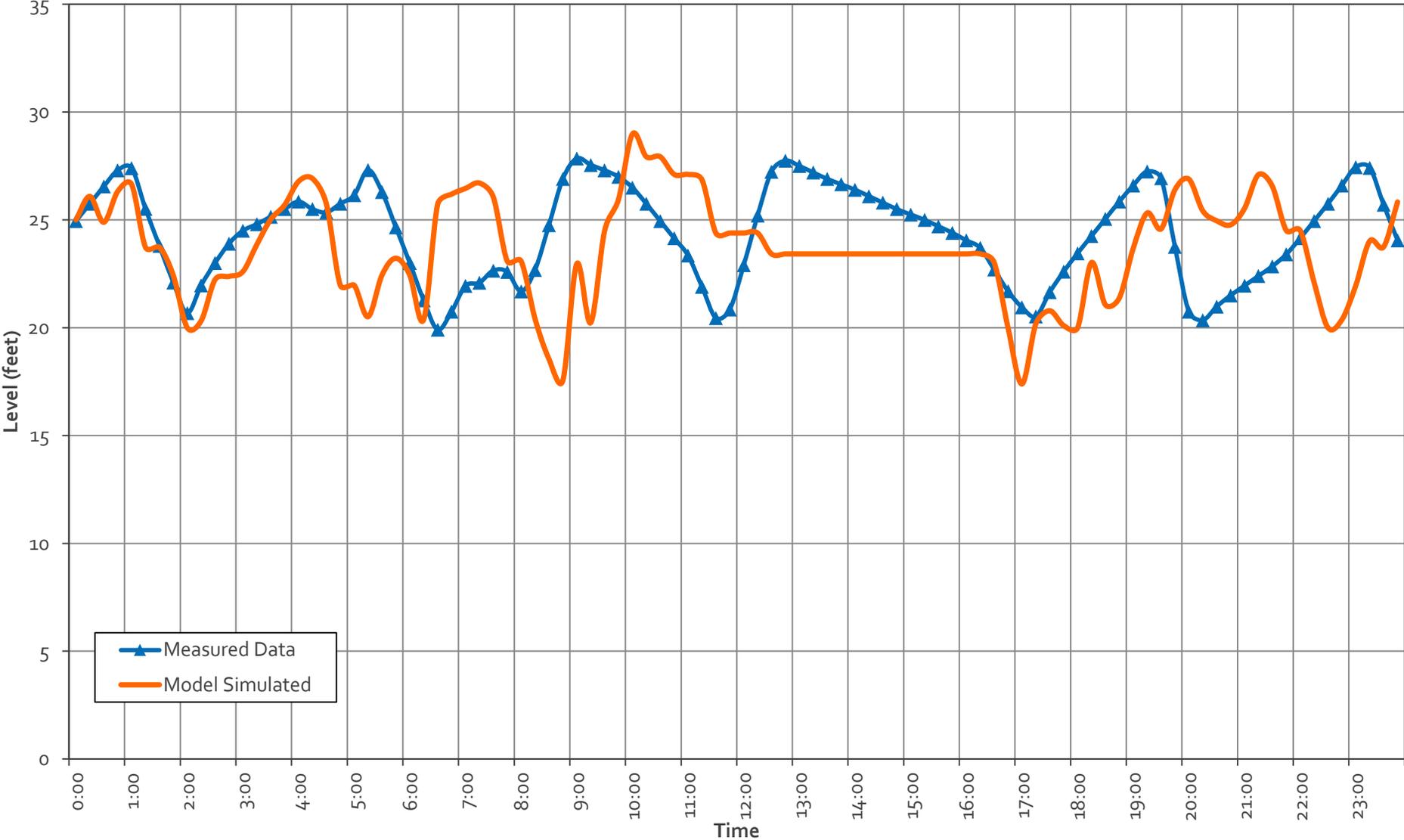




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Finished Water Tank 1 Level

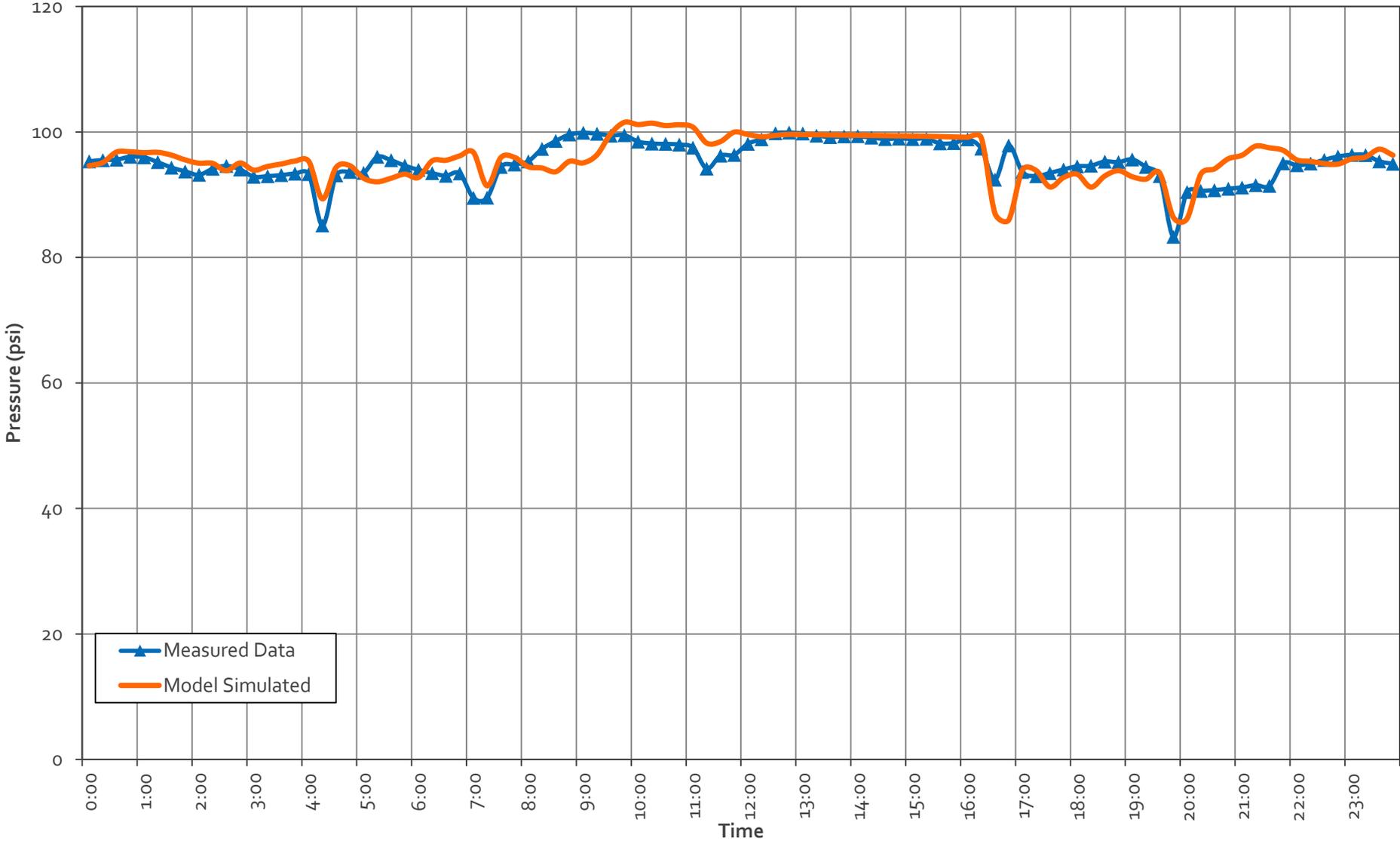




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Finished Water Tank 2 Level

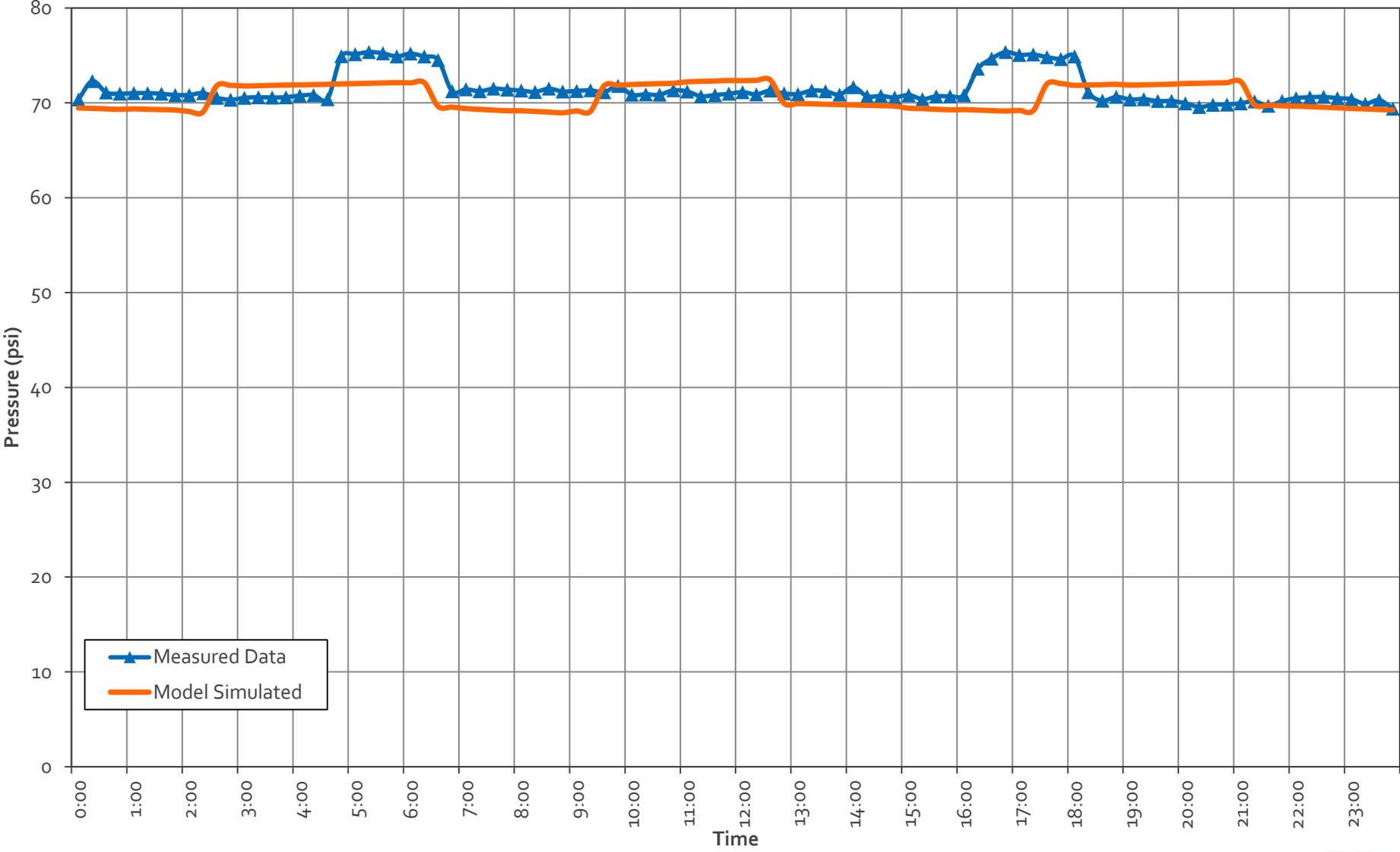




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C7

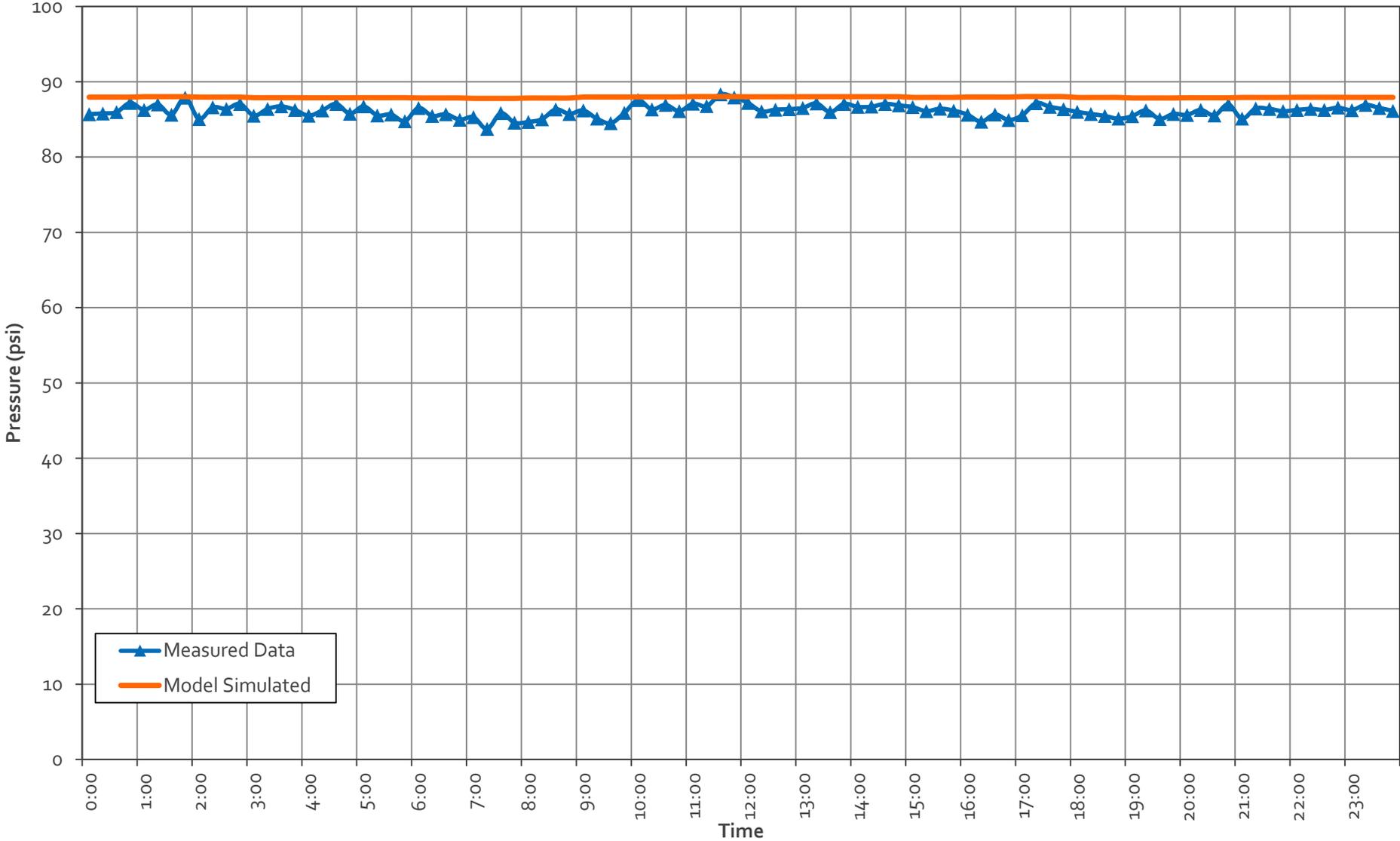




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C8

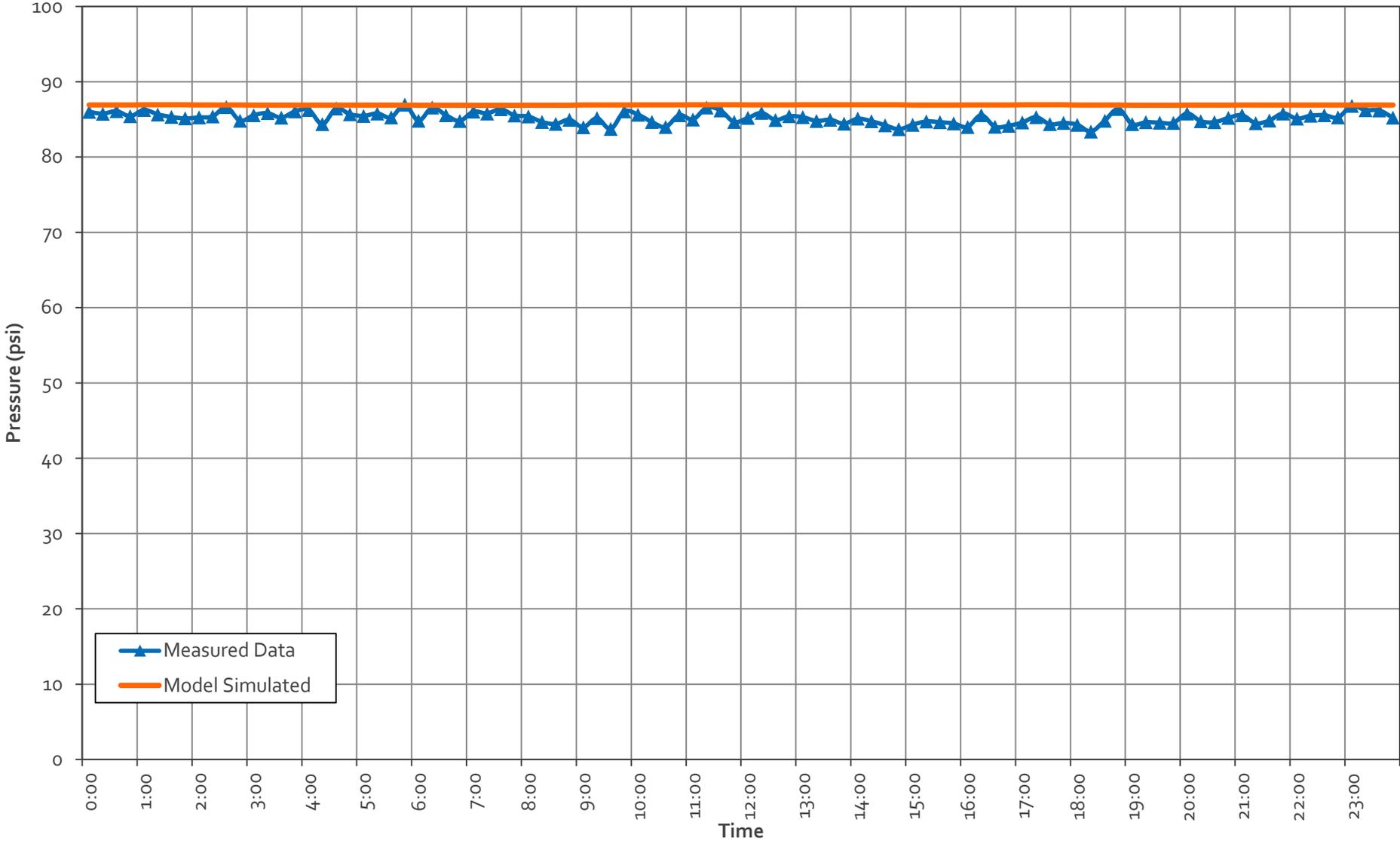




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C9

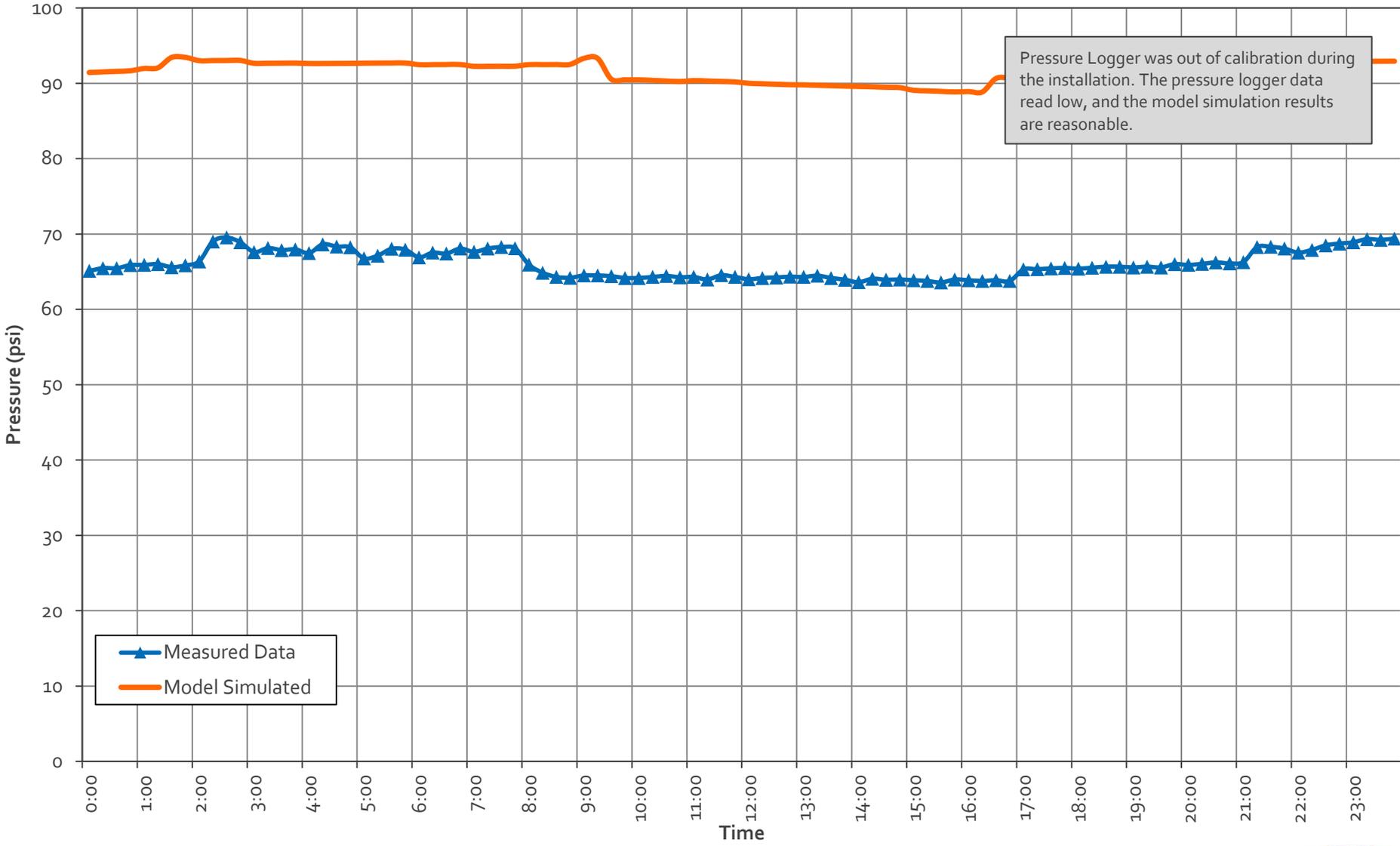




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C10





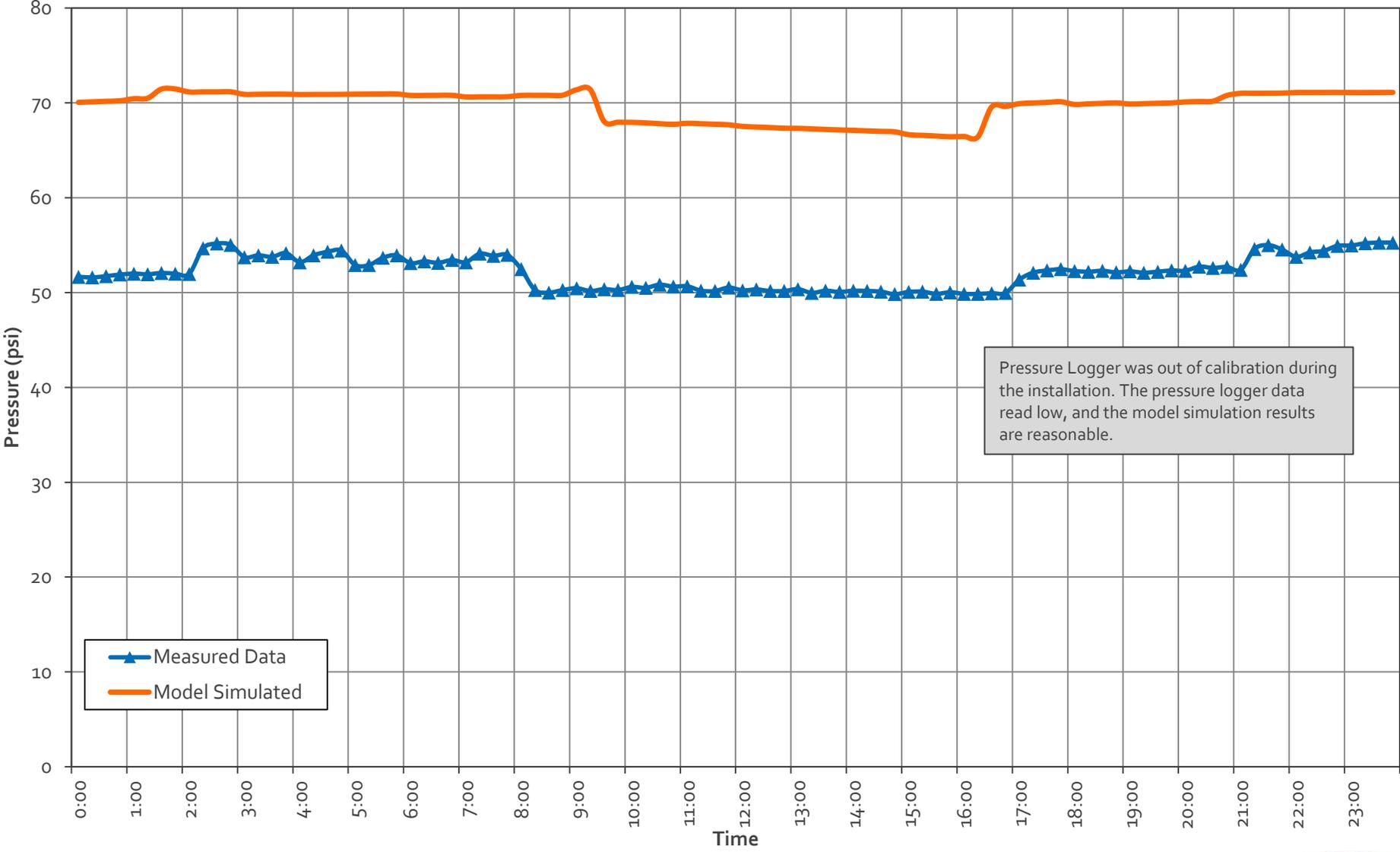
Pressure Logger was out of calibration during the installation. The pressure logger data read low, and the model simulation results are reasonable.

▲ Measured Data
— Model Simulated

Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C12





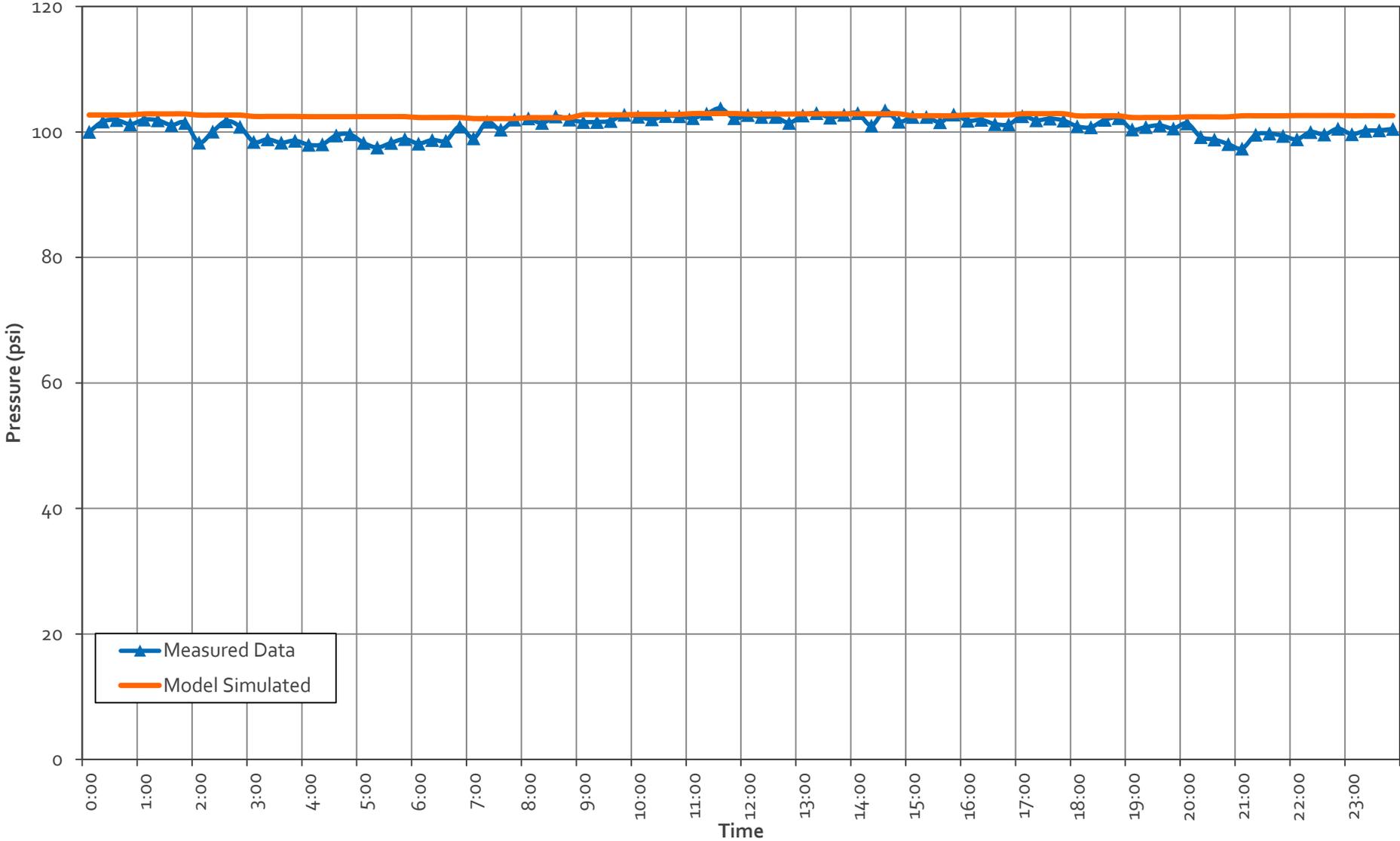
Pressure Logger was out of calibration during the installation. The pressure logger data read low, and the model simulation results are reasonable.

Measured Data
Model Simulated

Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C14

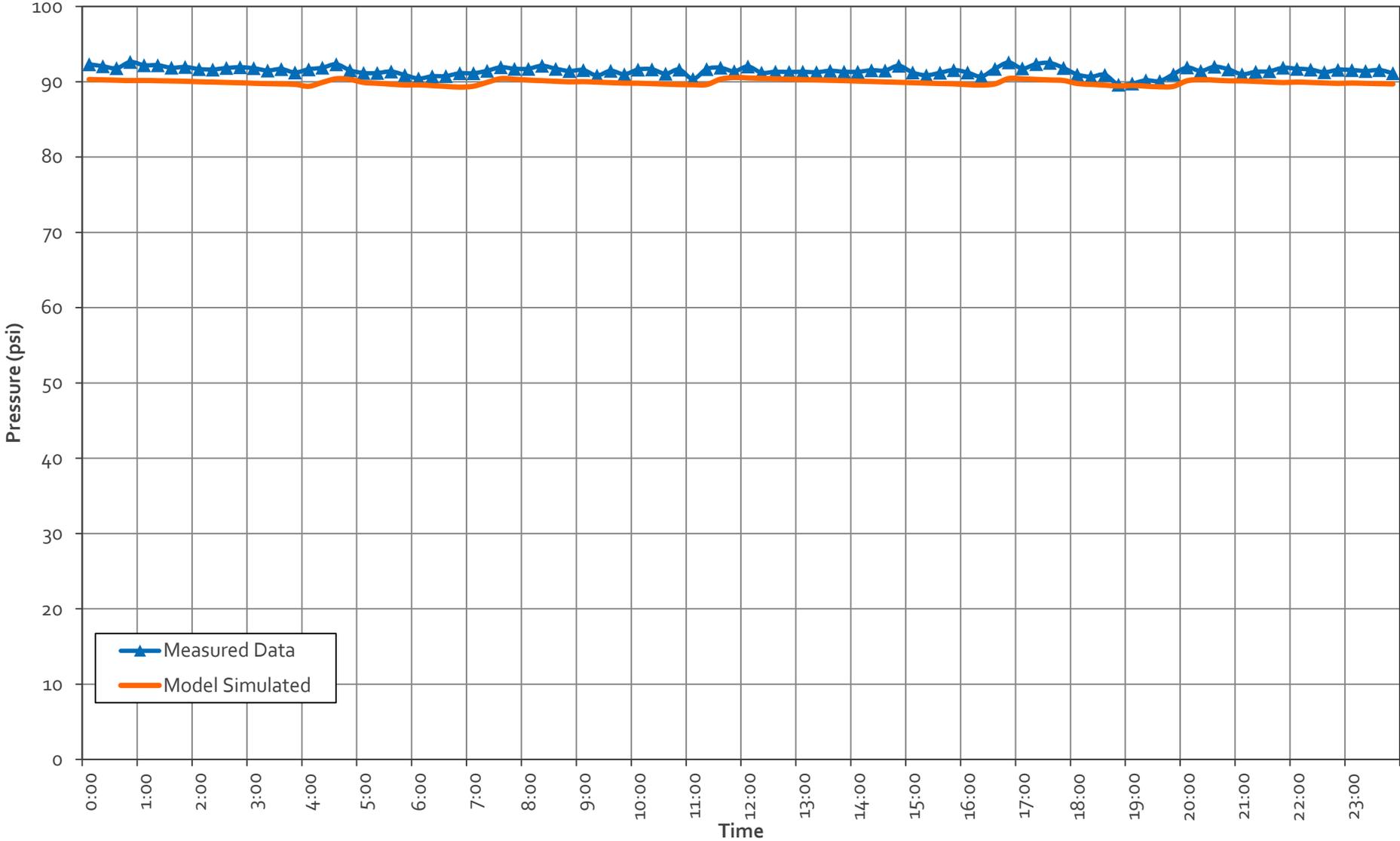




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C16

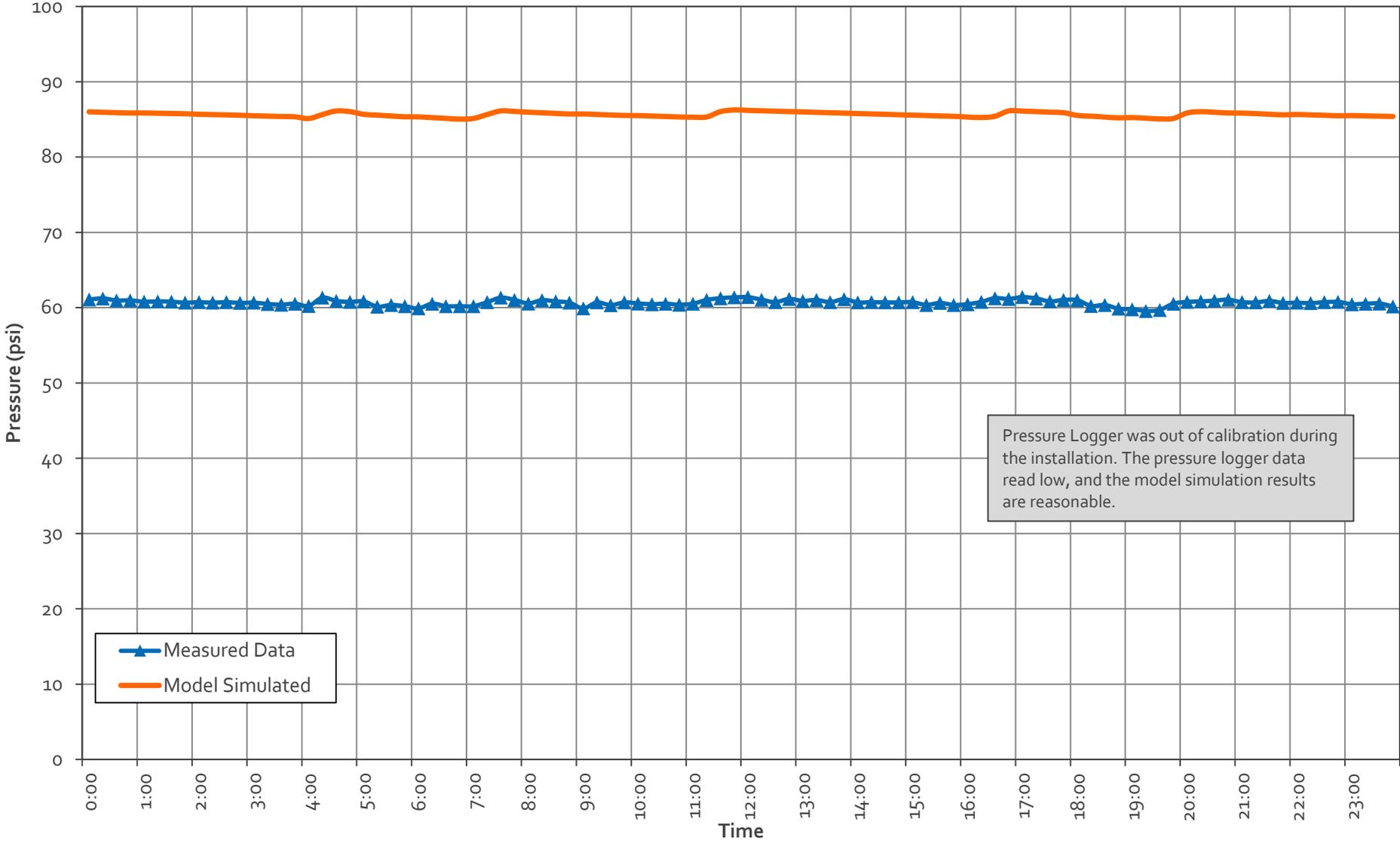




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C17

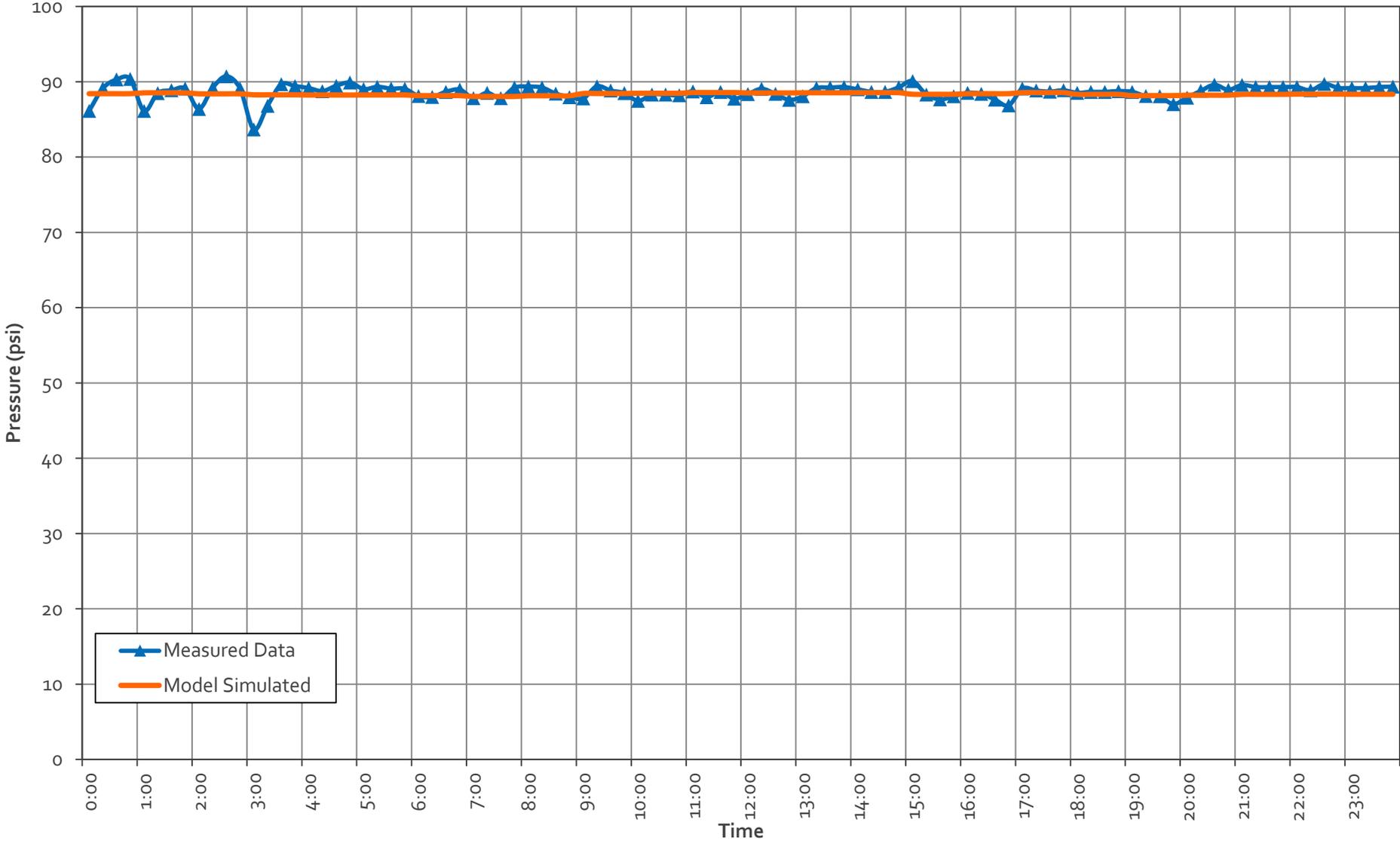




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C18

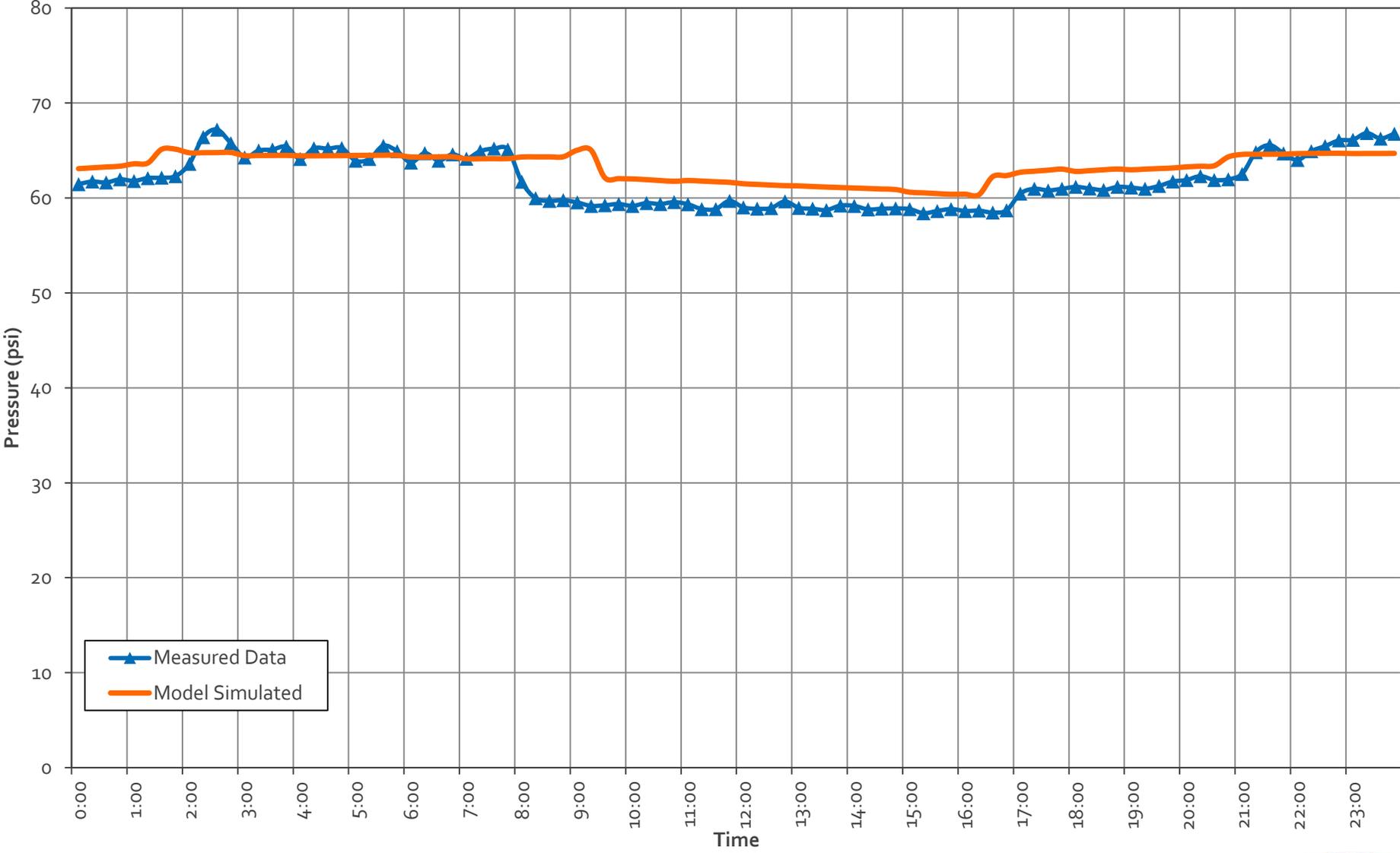




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C2o

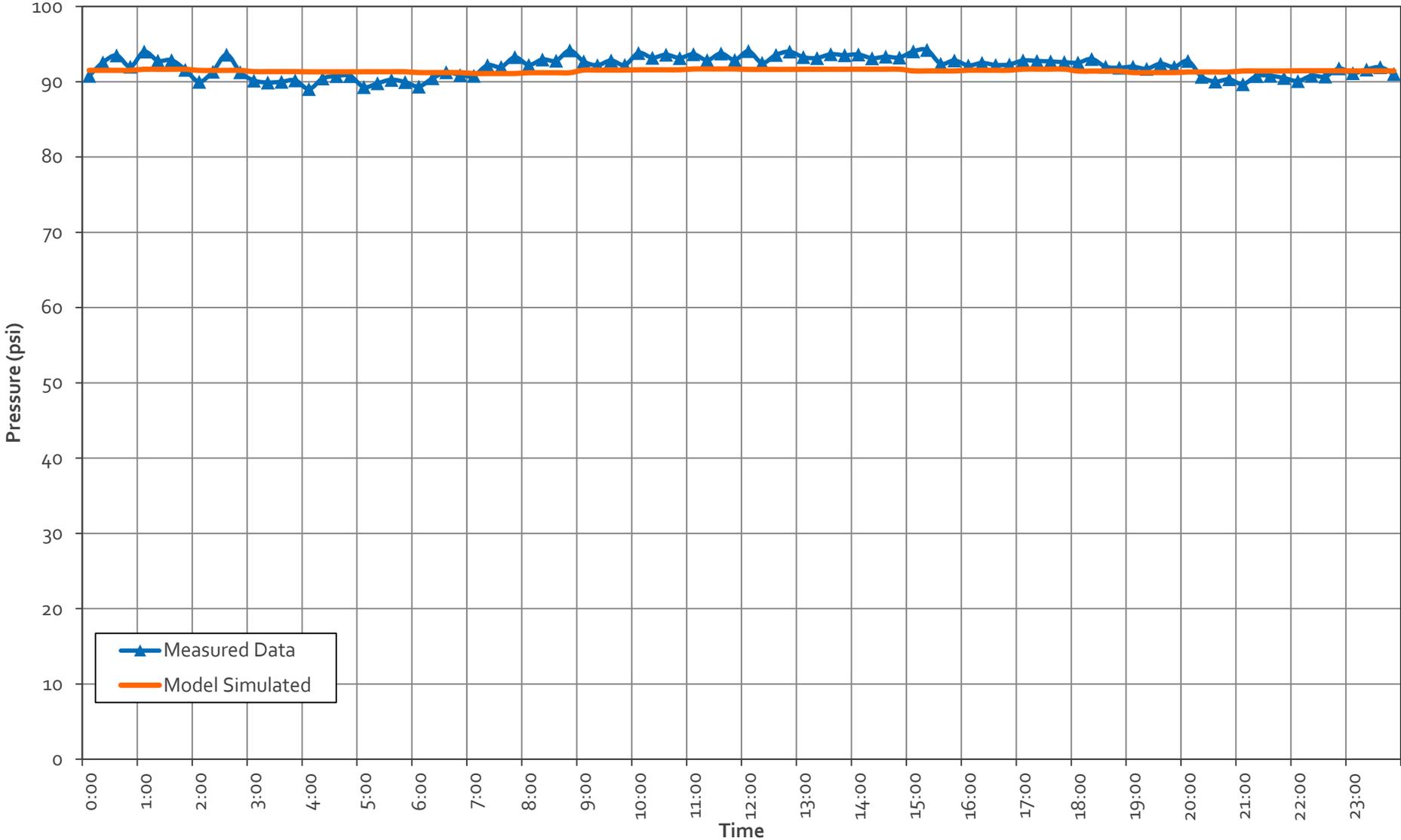




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C21

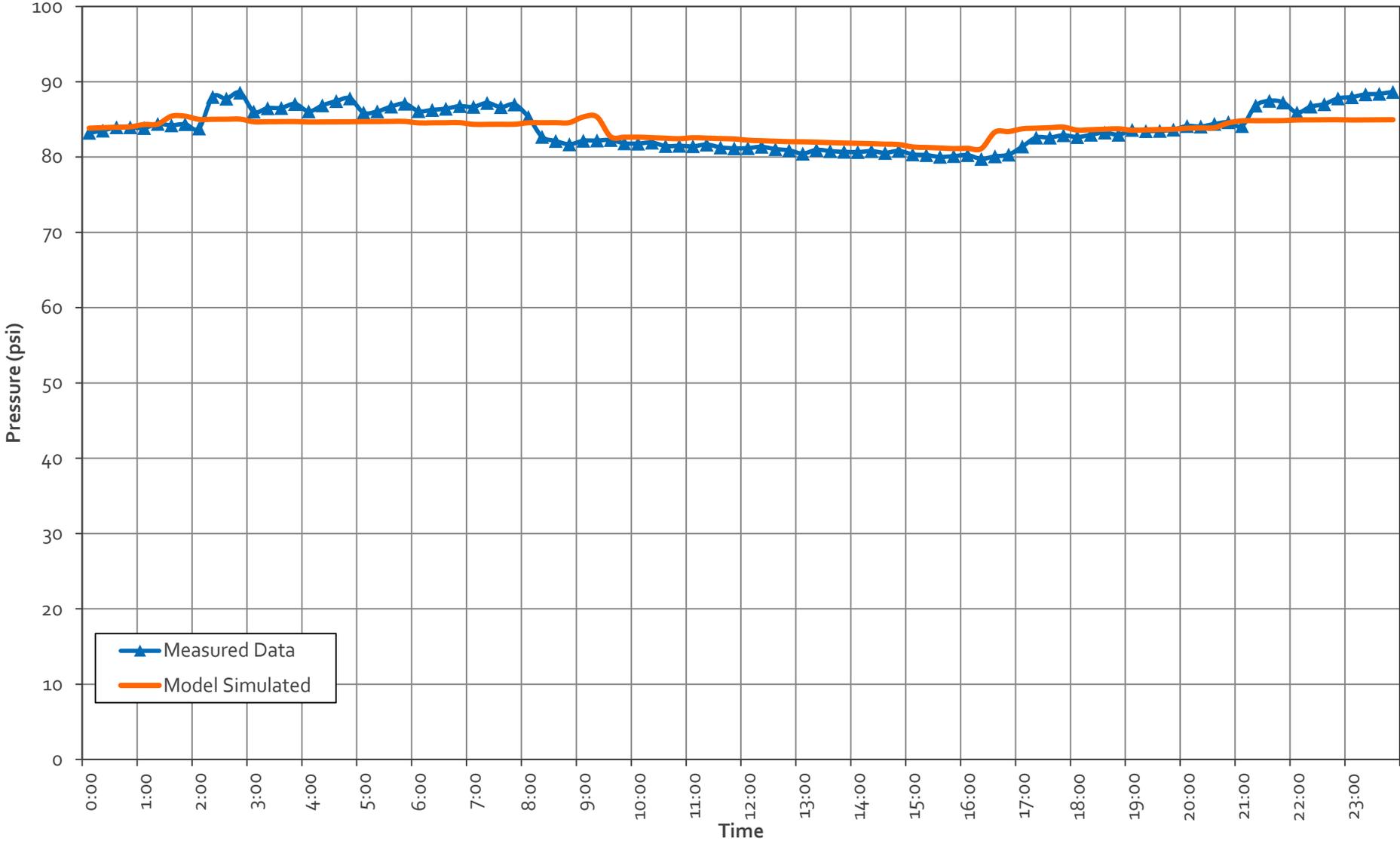




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C22

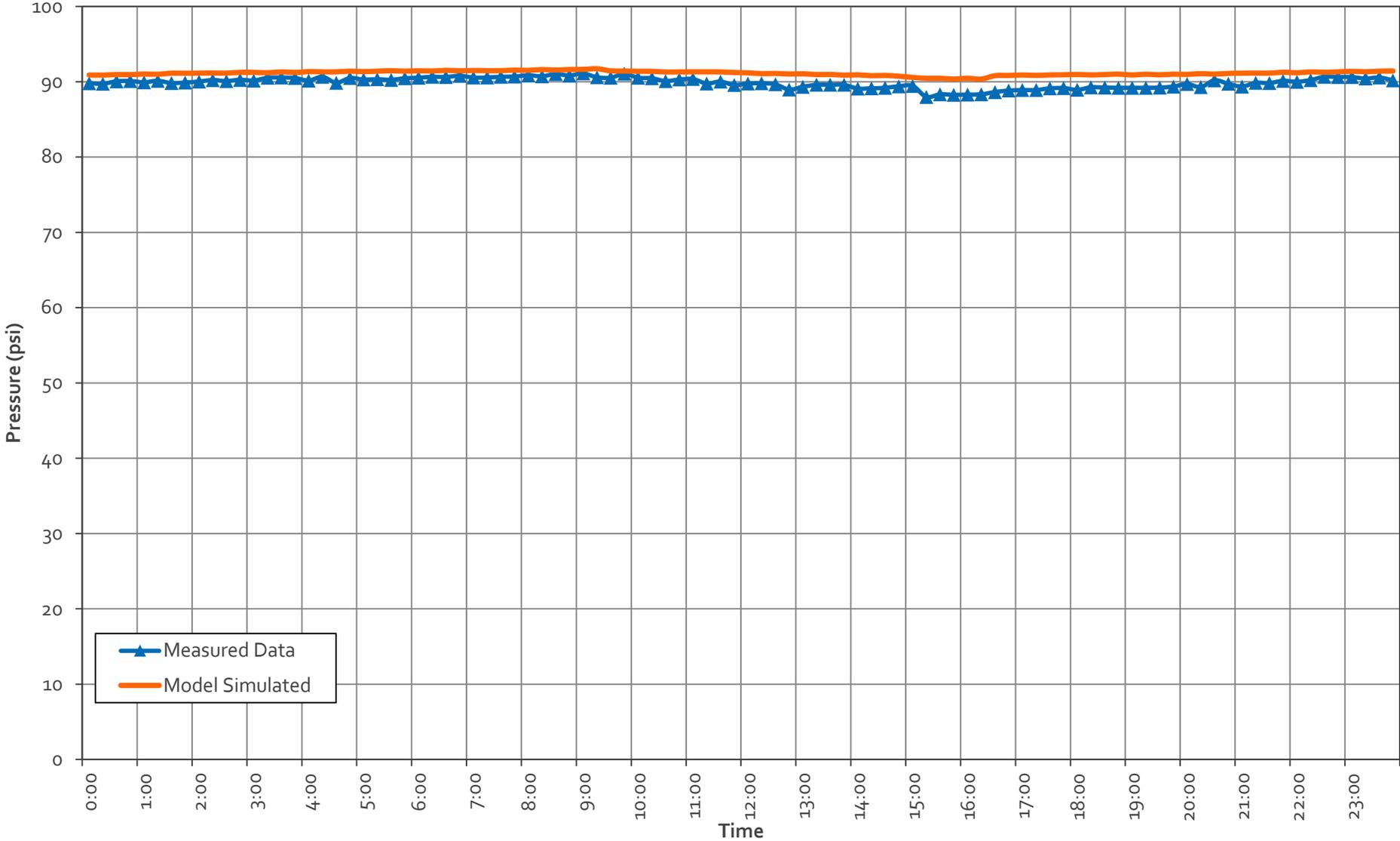




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C23

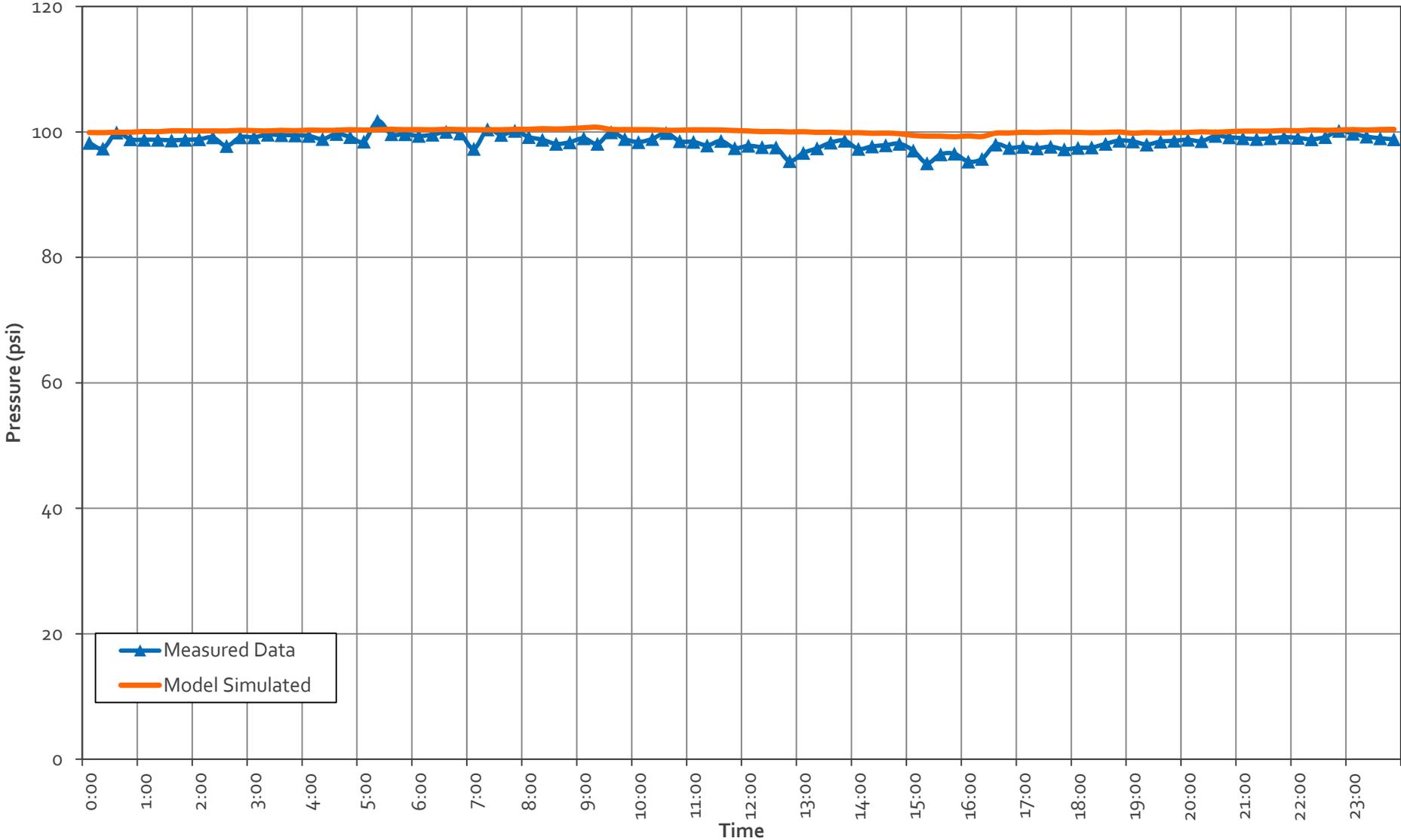




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C24

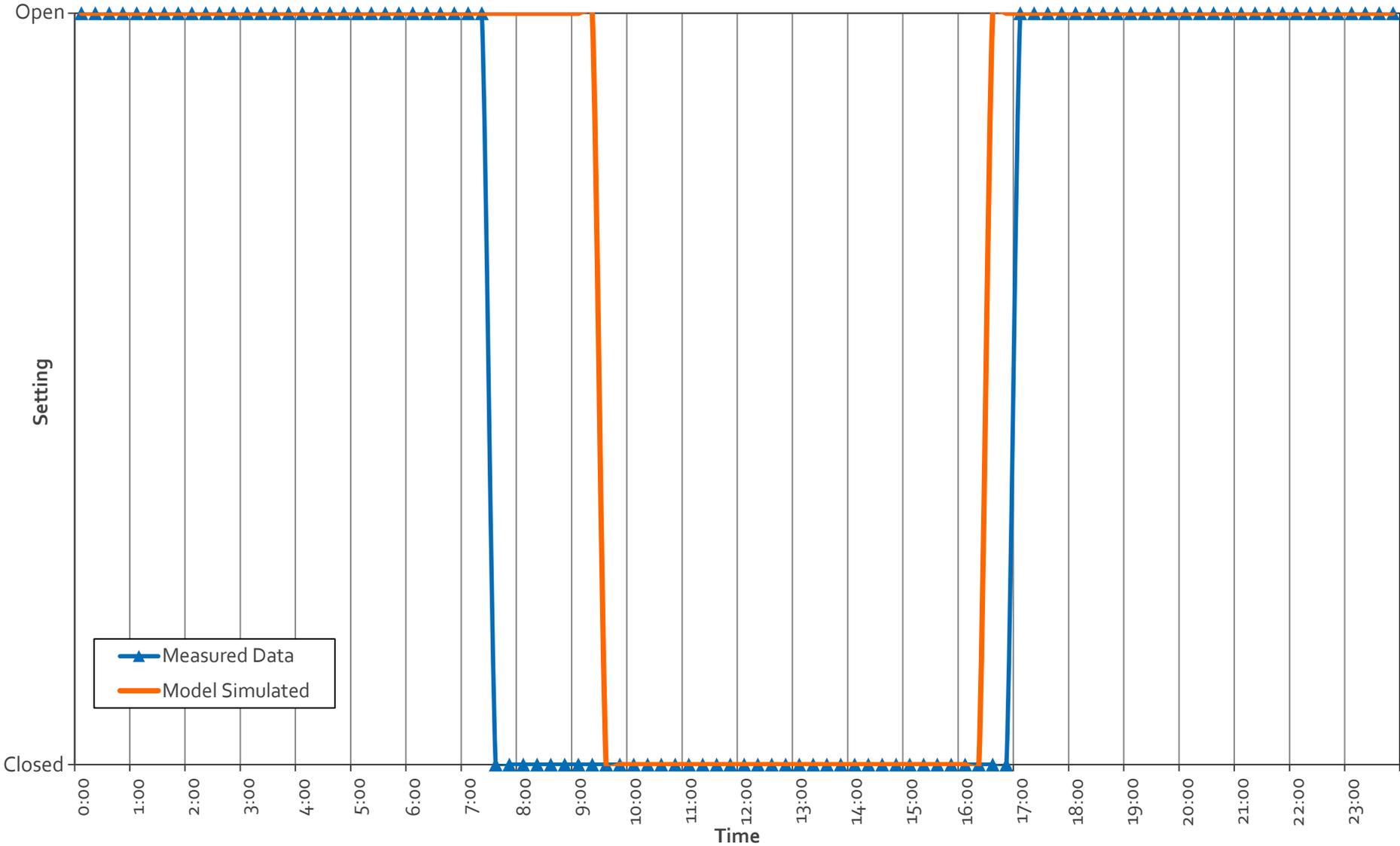




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pressure Logger C26

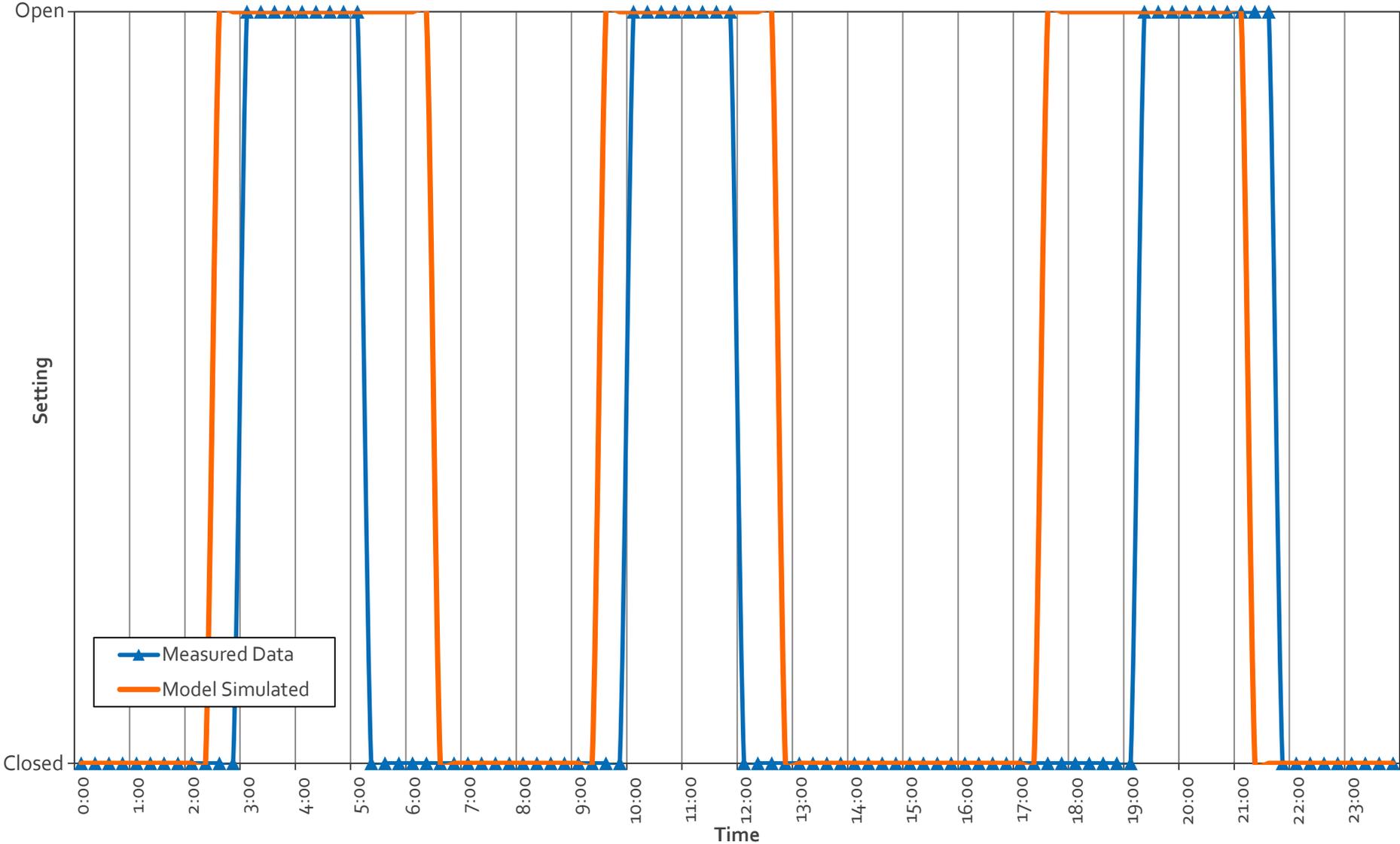




Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Pensacola North PRV





Model calibration was performed based on 9/9/2015 Field Data

EPS Calibration Plot
Red Bud PRV





2016-2026 Water Master Plan

Fire Flow (FF) Calibration

Based on September 2015 Field Data

City of Shasta Lake

October 2016

Job No: 10037A.00



Table 1 Fire Flow Test Calibration Results, Historical Fire Flow Tests (2008-2014)

Test ID	Location	Test Date	Test Time	Field Measured Data			Model Simulated Data		Percent Difference ⁽¹⁾	
				Hydrant Flow (gpm)	Hydrant Pressure (psi) Static	Residual	Hydrant Pressure (psi) Static	Residual	Static	Residual
A	Woodley Avenue	2/18/08	9:20	1,131	78	72	77.5	67.9	-0.6%	-5.7%
B	Bonneville/Grand Coulee	2/4/09	12:55	924	82	54	83.1	51.4	1.3%	-4.8%
C	3163 West Minster Court	6/26/09	12:50	969	50	34	50.4	33.7	0.9%	-0.9%
D	4085 Pembroke Lane	6/26/09	1:10	983	56	40	55.5	42.3	-0.8%	5.7%
E	2906 Avington	6/26/09	13:20	892	71	59	71.2	64.6	0.3%	9.5%
F	1300 Hardenbrook Avenue	7/24/09	9:30	1,093	68	66	71.6	69.0	5.3%	4.5%
G	4511 Red Bluff	7/24/09	9:45	1,131	76	72	79.6	69.8	4.8%	-3.1%
H ⁽²⁾	Central Valley Talon Hall	6/22/11	11:30	860	64	55	68.1	57.1	6.5%	3.8%
I	Central Valley High off Ashby Road	6/22/11	11:00	908	71	64	73.1	66.9	3.0%	4.5%
J	4689 Risstay Way	2/29/12	2:45	1,156	89	79	86.4	71.7	-2.9%	-9.2%
K	Jorzack and Risstay	2/29/12	3:00	1,093	94	84	97.6	88.3	3.8%	5.1%
L	4159 Doyle Court	6/11/10	8:15	791	54	39	58.7	50.5	8.6%	29.5%
M	Washington and Boca	8/18/15	-	843	69	36	71.8	38.4	4.1%	6.7%
N	Elizabeth and Joseph	1/21/15	14:00	969	88	60	84.7	61.7	-3.7%	2.8%
O	4037 Flowers	3/24/15	-	860	49	45	52.1	47.3	6.3%	5.1%
P	Red Avenue and Shasta Dam Boulevard	1/6/15	11:30	969	110	62	107.1	57.6	-2.6%	-7.1%
Q	Red Avenue and Shasta Dam Boulevard	1/6/15	13:45	998	108	60	107.1	57.2	-0.8%	-4.7%
R ⁽³⁾	Red Avenue and Shasta Dam Boulevard	1/6/15	14:00	984	112	68	107.1	57.3	-4.4%	-15.7%
S ⁽⁴⁾	Grand Avenue and Shasta Way	5/29/14	-	791	85	33	81.4	31.2	-4.2%	-5.5%
T	Locust and Red Bluff	5/29/14	-	791	71	49	71.8	48.7	1.1%	-0.6%
U	Grand Coulee and Morning Star	5/29/14	-	1,228	105	90	103.8	87.9	-1.2%	-2.3%
V ⁽⁴⁾	1524 Mussel Shoals	5/29/14	-	533	92	35	87.8	36.5	-4.6%	4.3%
W	Lot #8 Deer Creek Manor	4/23/14	13:35	695	35	30	34.6	31.6	-1.3%	5.3%
X ⁽²⁾	Homer Lane	6/4/14	-	675	66	26	62.5	-67.9	-5.3%	-361.2%

Notes:

1. Percent Difference = (Modeled - Measured)/Measured x 100
2. The City's GIS did not include a pipeline to this hydrant location. An assumed pipeline was added into the model to represent this test.
3. The hydraulic model reasonably matched the results of tests P and Q, but not R, even though they were at the same location. An unknown operational could have occurred during Test R.
4. The hydraulic model was not able to replicate the residual pressure measured by City staff with a 4-inch diameter hydrant lateral. A 2.5-inch diameter hydrant lateral was able to replicate the field results.



Table 2 Fire Flow Test Calibration Results, September 2015 Tests

Test ID	Location	Test Date	Test Time	Field Measured Data			Model Simulated Data		Percent Difference ⁽¹⁾	
				Hydrant Flow (gpm)	Hydrant Pressure (psi) Static	Residual	Hydrant Pressure (psi) Static	Residual	Static	Residual
1	13596 Hill Boulevard	9/16/15	14:20	969	80	68	86.0	72.2	7.5%	6.2%
2	2484 Cana Drive	9/16/15	15:30	1,239	97	91	102.2	91.7	5.4%	0.8%
3	18002 Ranchera Road	9/16/15	14:40	533	82	65	84.3	60.4	2.8%	-7.1%
4	17549 Flanagan Road	9/16/15	15:00	631	103	33	107.0	30.1	3.9%	-8.8%
5	3256 Cascade Boulevard	9/17/15	13:15	735	113	95	118.0	93.1	4.4%	-2.0%
6	5312 Pine Grove Avenue	9/17/15	13:45	413	81	42	88.3	46.0	9.0%	9.5%
7	4159 Doyle Ct.	3/1/16	13:30	876	59	44	58.8	42.7	-0.4%	-3.0%

Notes:

1. Percent Difference = (Modeled - Measured)/Measured x 100

Appendix G
STORAGE IMPROVEMENT ALTERNATIVES
ANALYSIS

Table 1 Existing Finished Water Storage Alternatives Summary

Evaluation Zone(s)	MDD (mgd)	Required Storage (MG)	Emergency Storage = 100% of MDD Surplus/ (Deficit) (MG)									
			Existing	1A	1B	2A	2B	3A	3B	4A	4B	5
Zone A	0.08	0.21	0.29	0.99	2.24	0.99	2.24	0.97	2.47	2.07	2.07	0.97
Zone A-D ⁽¹⁾	0.69	1.37	(0.41)	0.48	1.73	0.48	1.73	0.27	1.77	1.37	1.37	0.27
Zone A, E/F ⁽¹⁾	0.51	1.07	(0.38)	0.32	1.57	0.32	1.57	0.30	1.80	1.40	1.40	0.30
Zone G, I, J	3.98	5.32	(0.47)	0.73	1.98	0.73	1.98	0.21	1.71	0.21	0.21	0.71
Citywide	5.11	6.68	(0.68)	0.02	1.27	0.02	1.27	0.00	1.50	1.10	1.10	0.00

Notes:

1. Balances assumed an emergency storage equal to 100% MDD

Table 2 Existing Raw Water Storage Alternatives Summary

Storage Alternative	ADD (MG)	MDD (MG)	Raw Water Storage (MG)	Percent of ADD	Percent of MDD
Existing	2.35	5.11	0.17	7%	3%
Alt 1	2.35	5.11	1.77	75%	35%
Alt 2	2.35	5.11	0.67	29%	13%
Alt 3	2.35	5.11	2.62	111%	51%
Alt 4	2.35	5.11	2.62	111%	51%
Alt 5	2.35	5.11	0.17	7%	3%



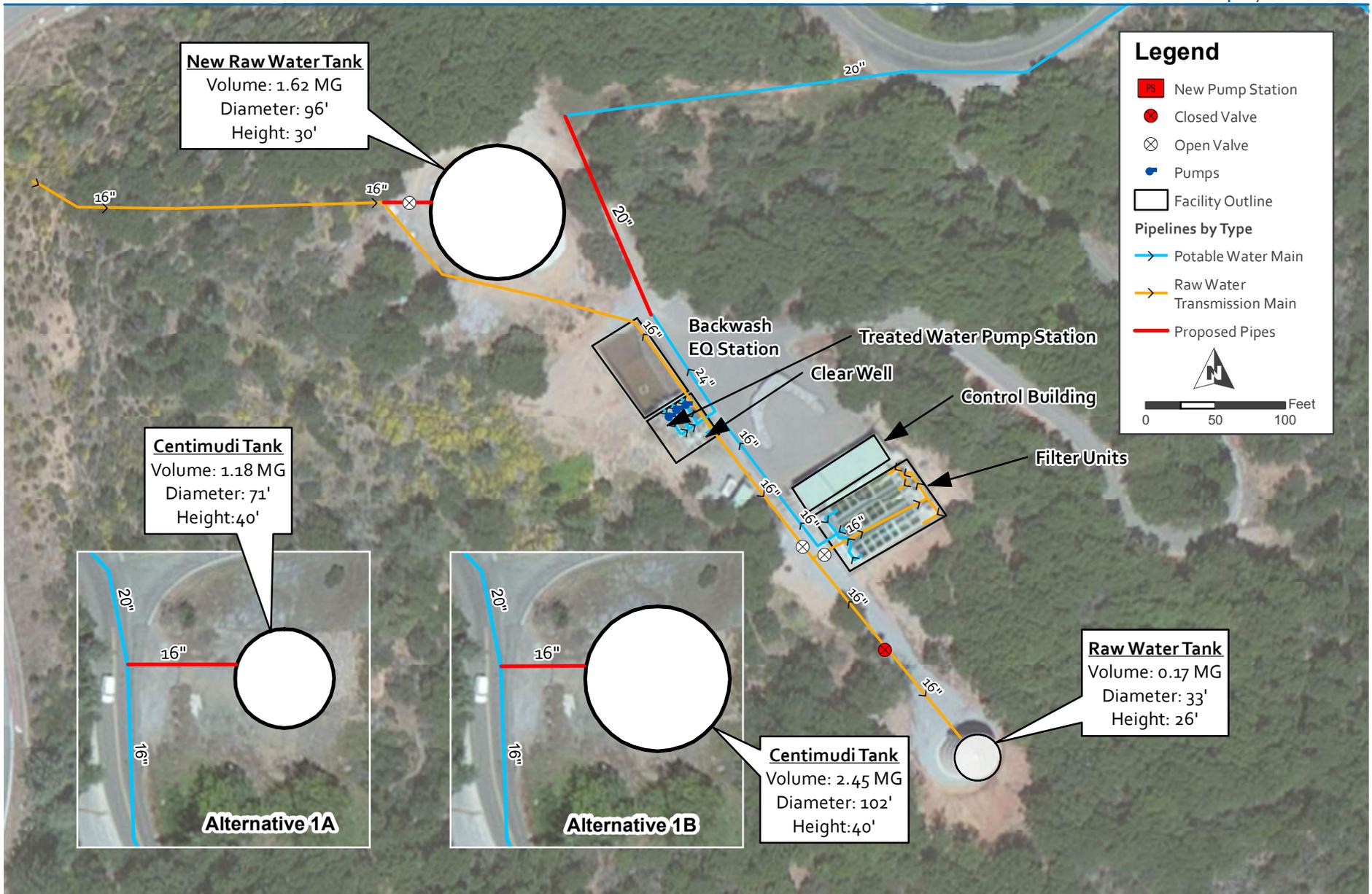


Figure 1
 Alternative 1

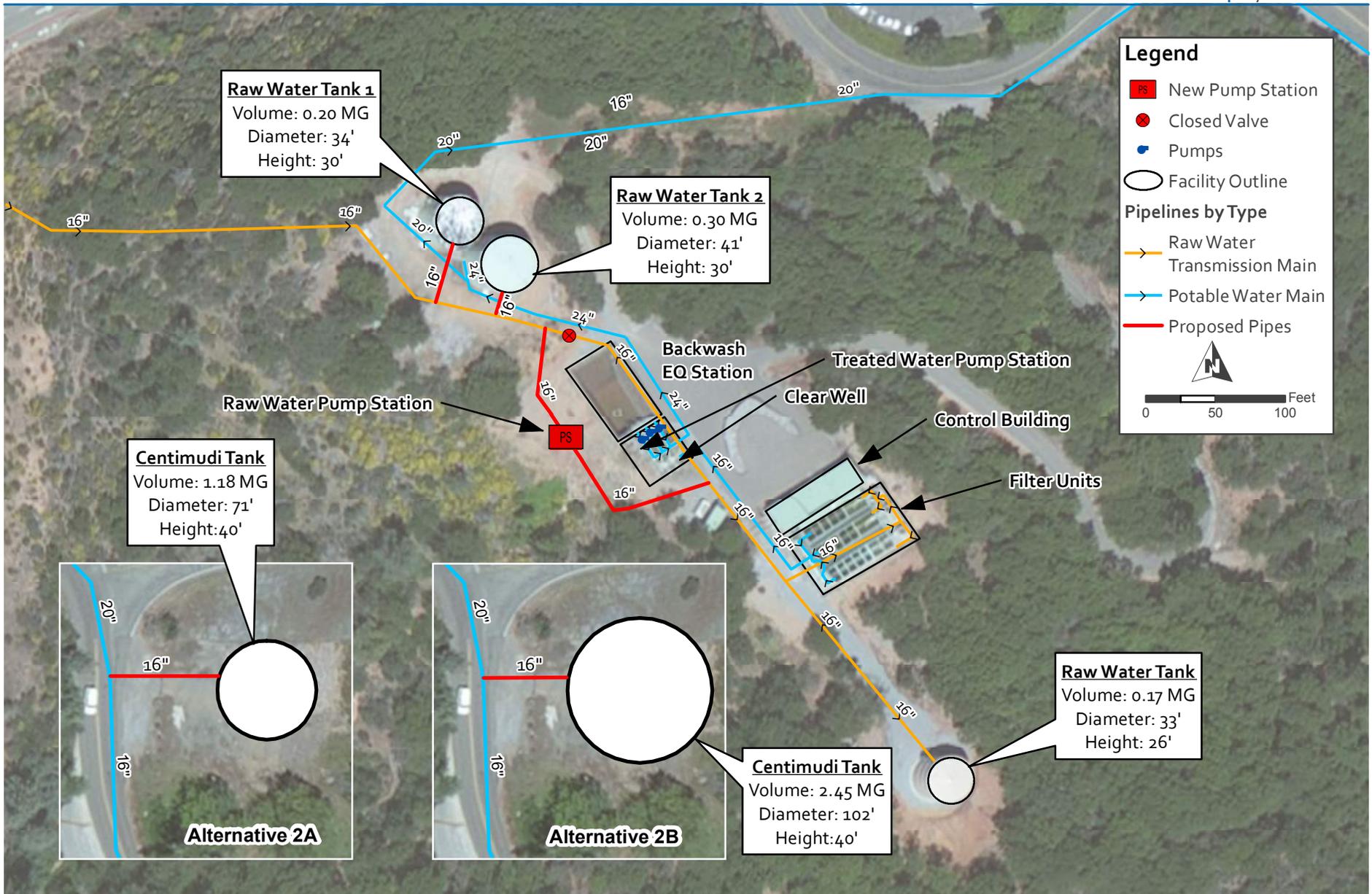


Figure 2
Alternative 2



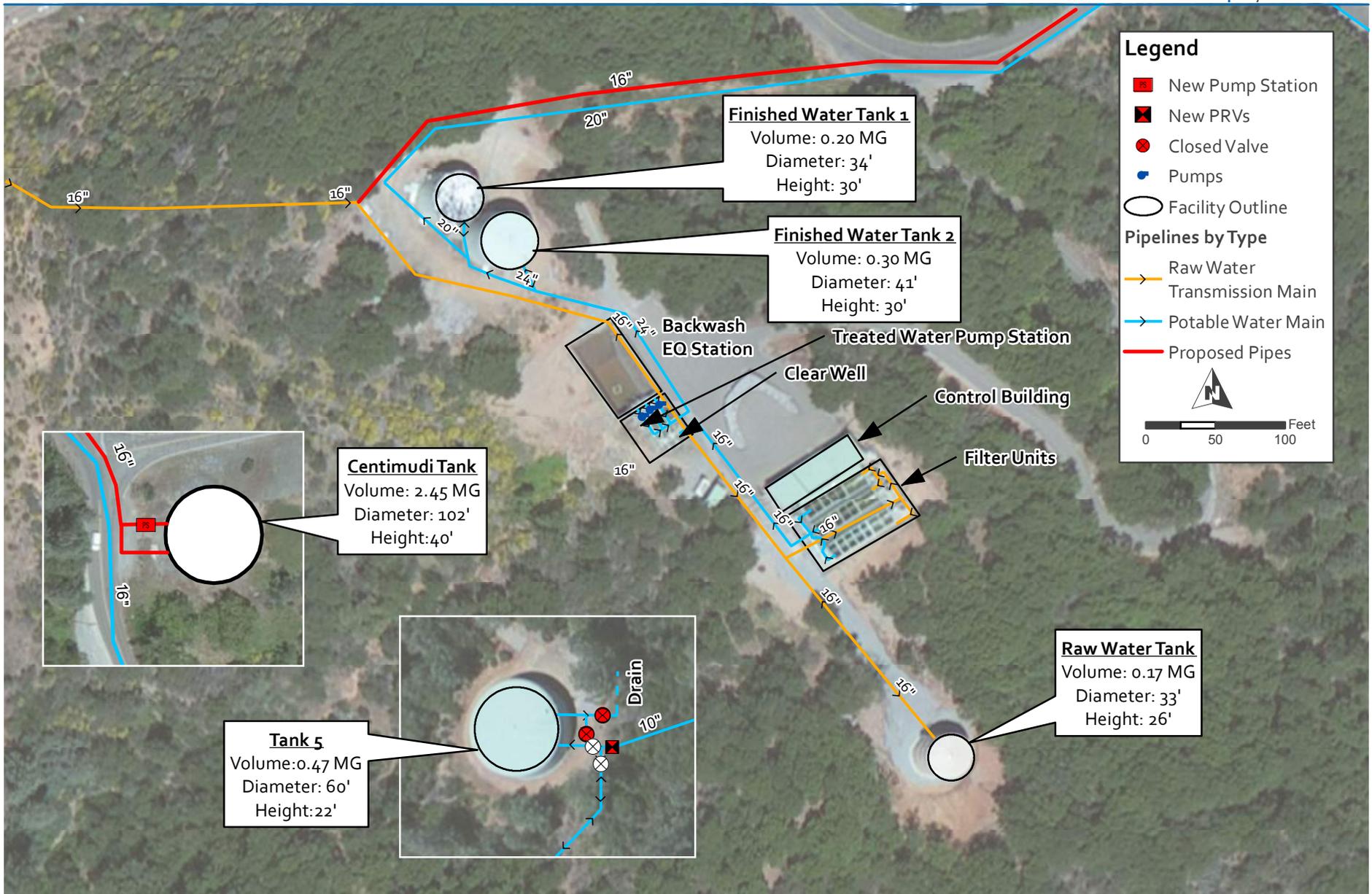


Figure 3
Alternative 3 

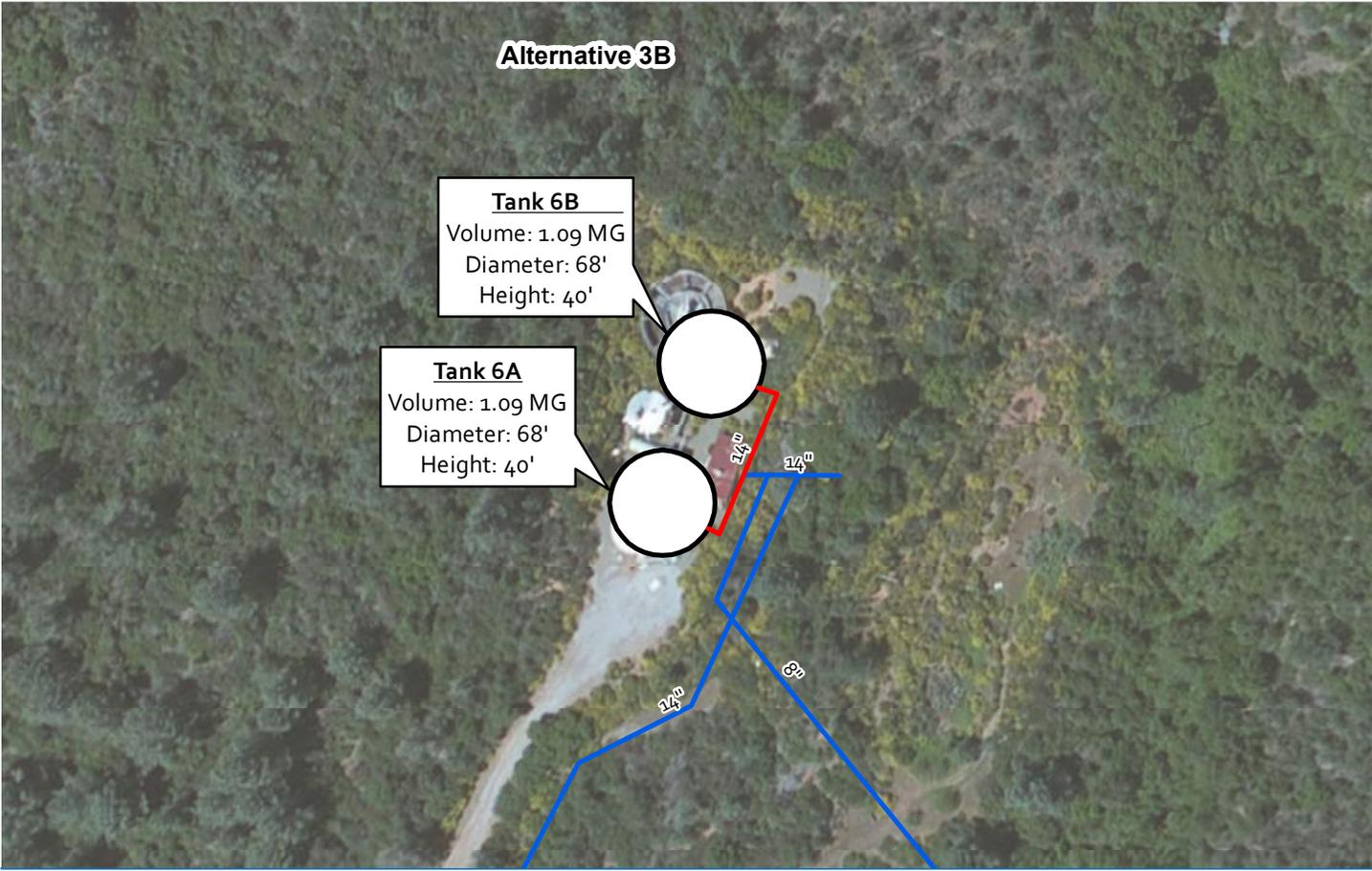
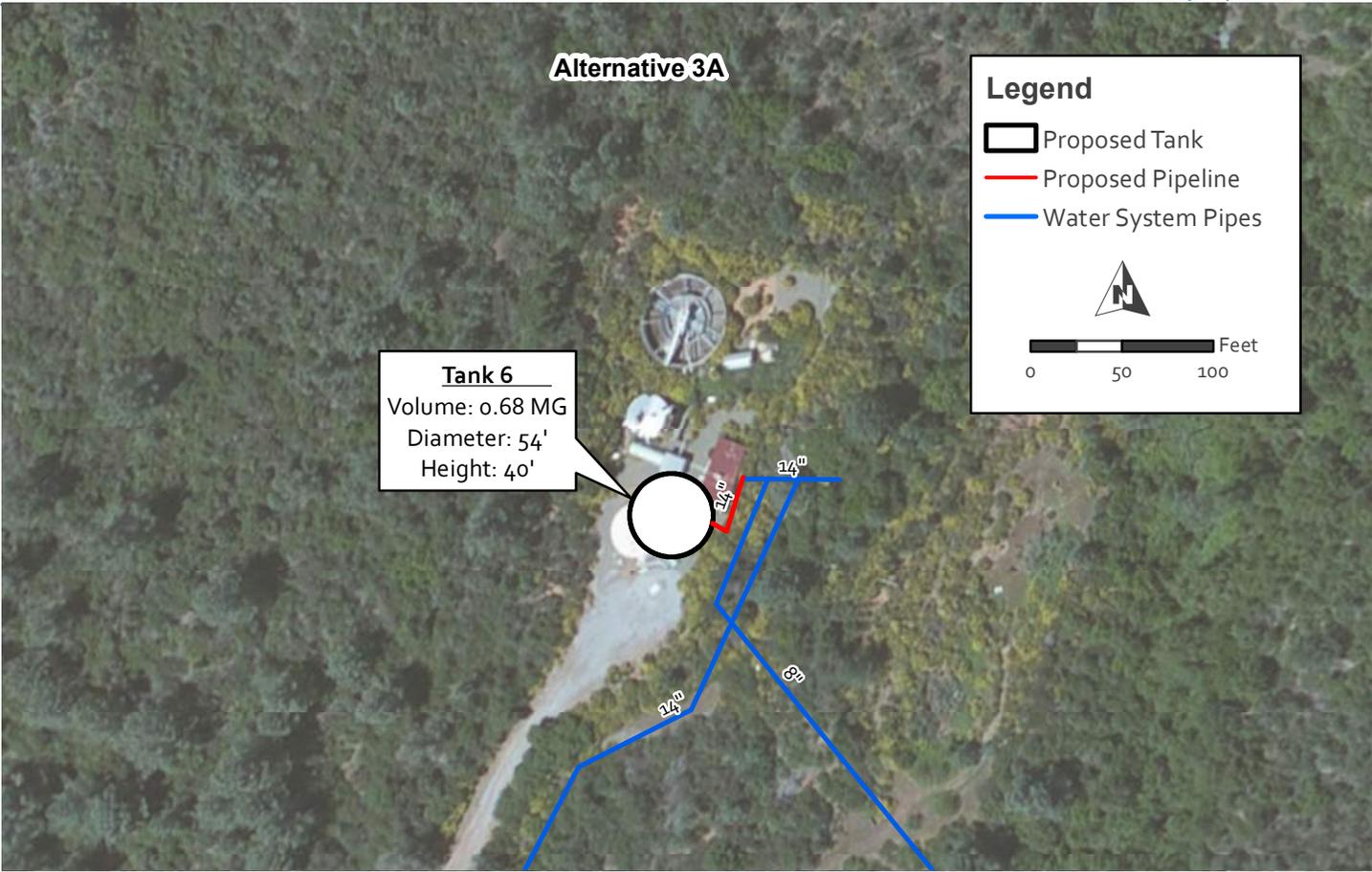


Figure 4
Alternative 3



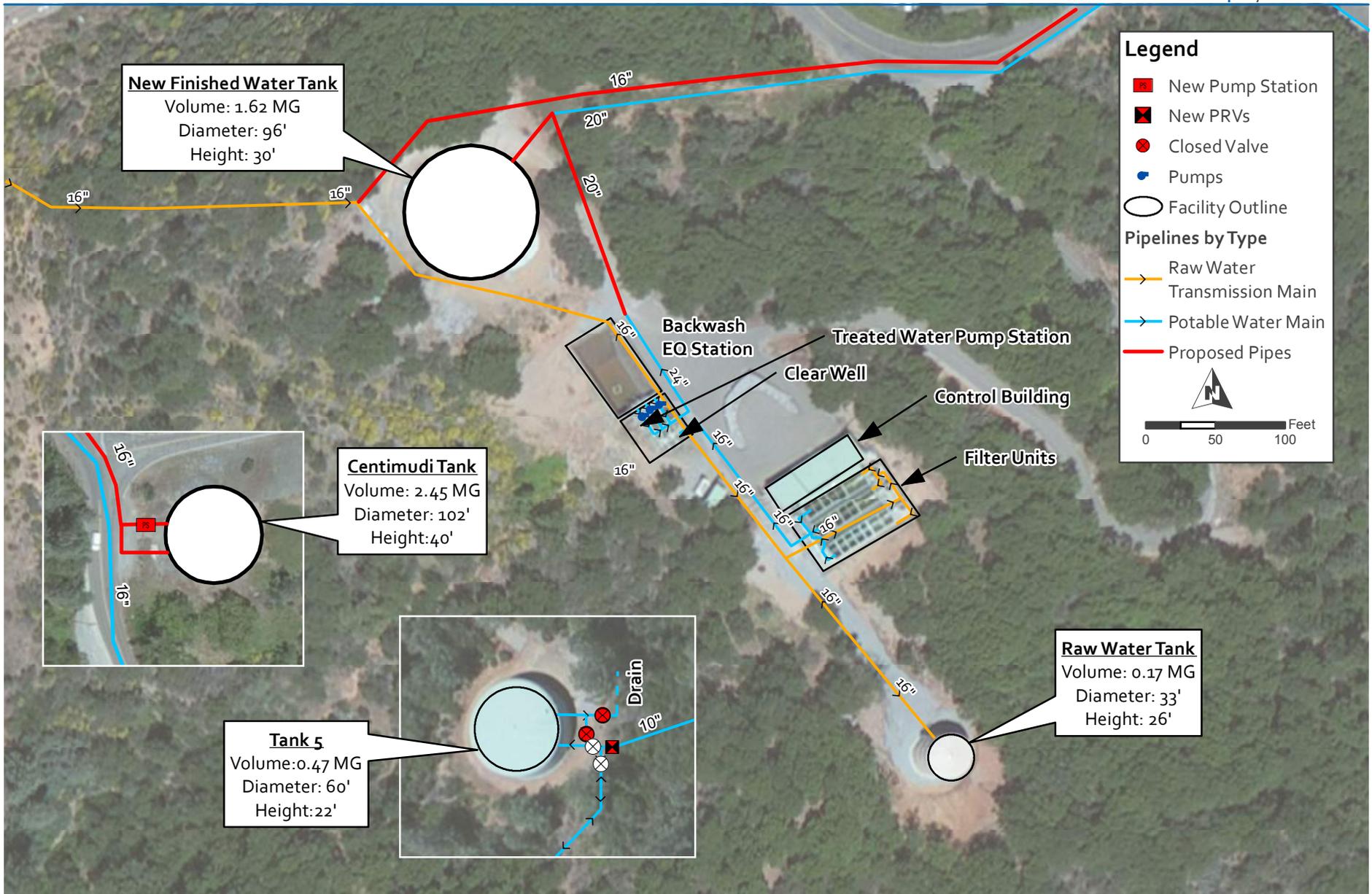


Figure 5
 Alternative 4

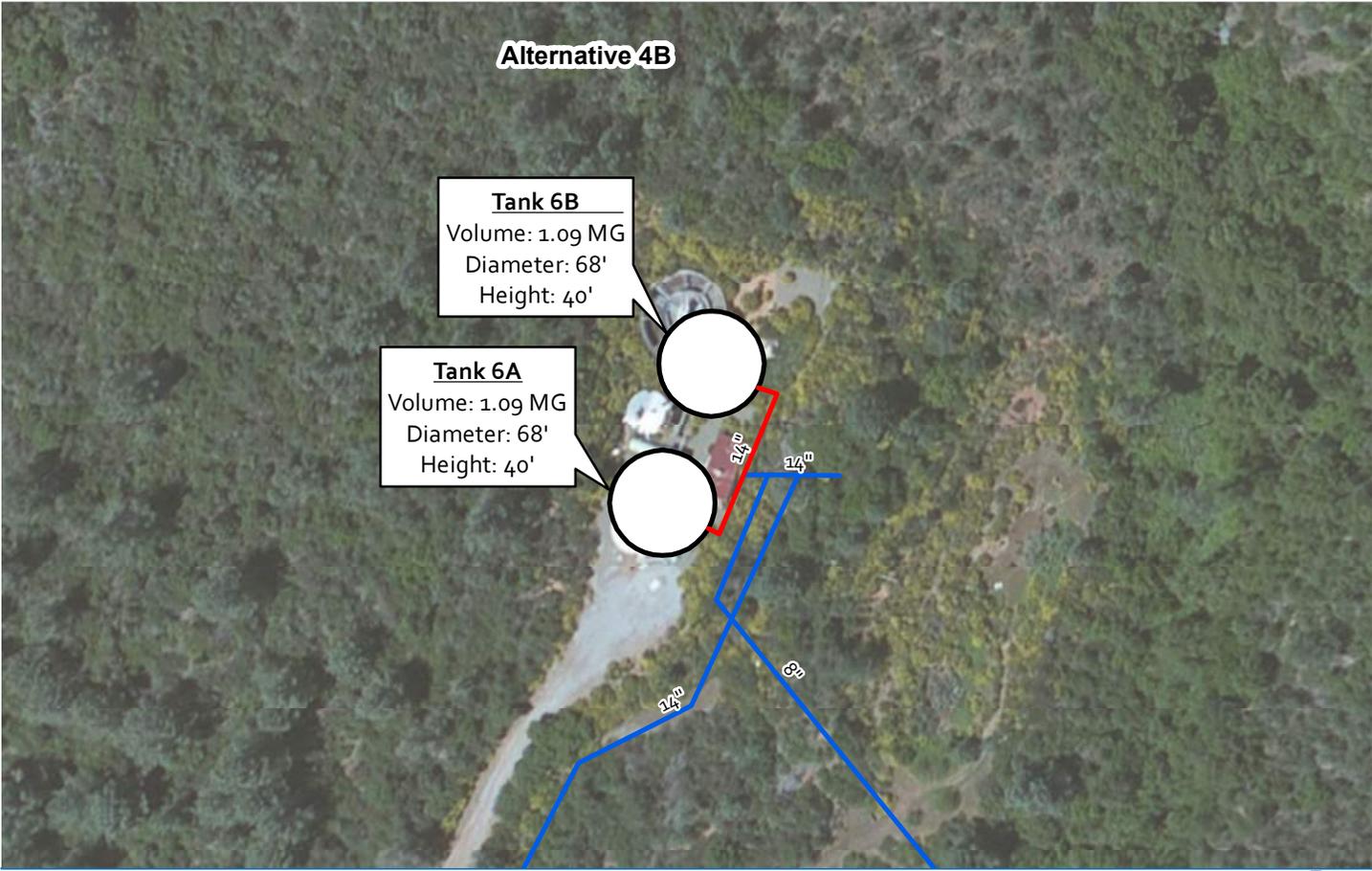
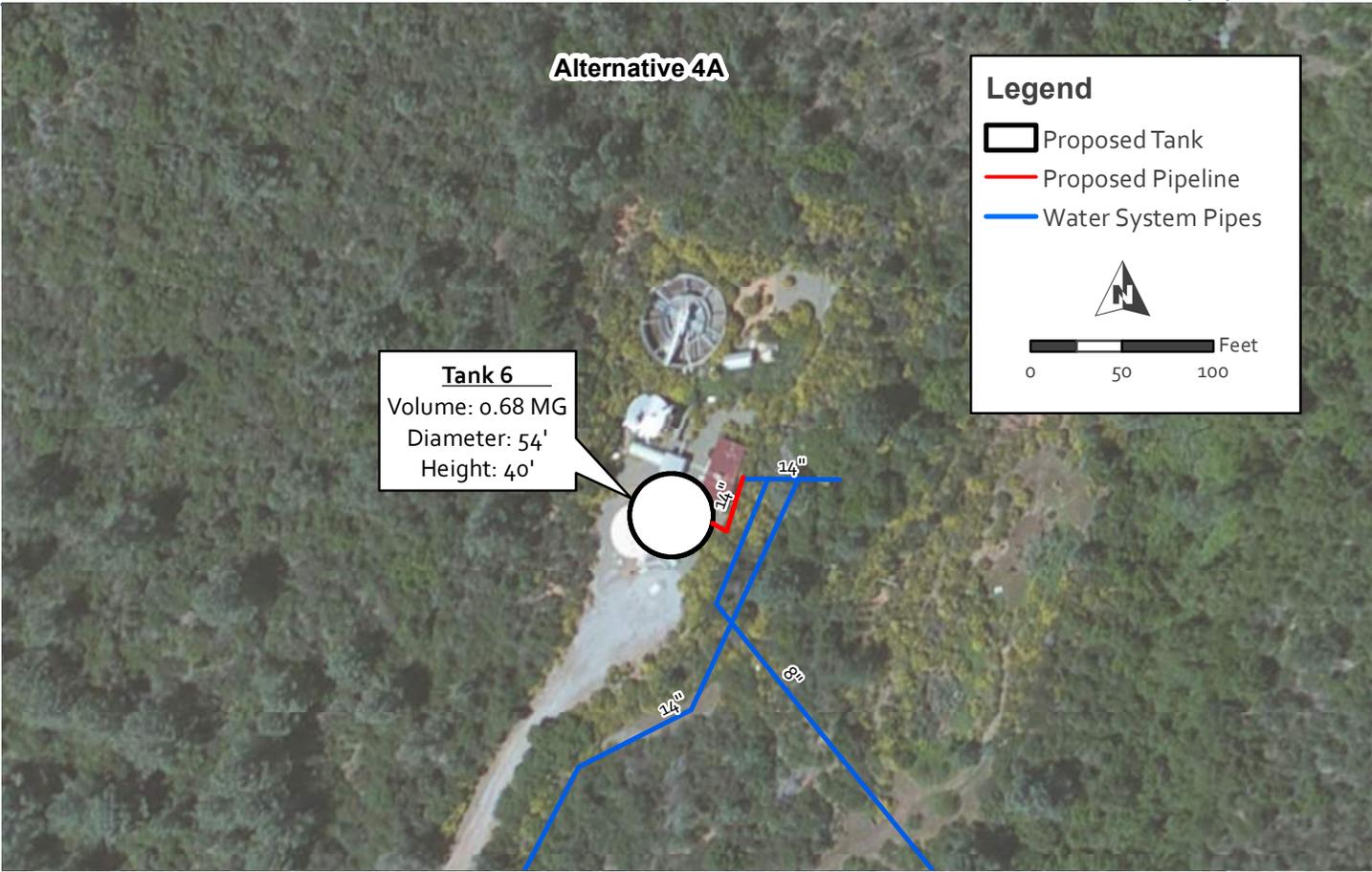


Figure 6
Alternative 4



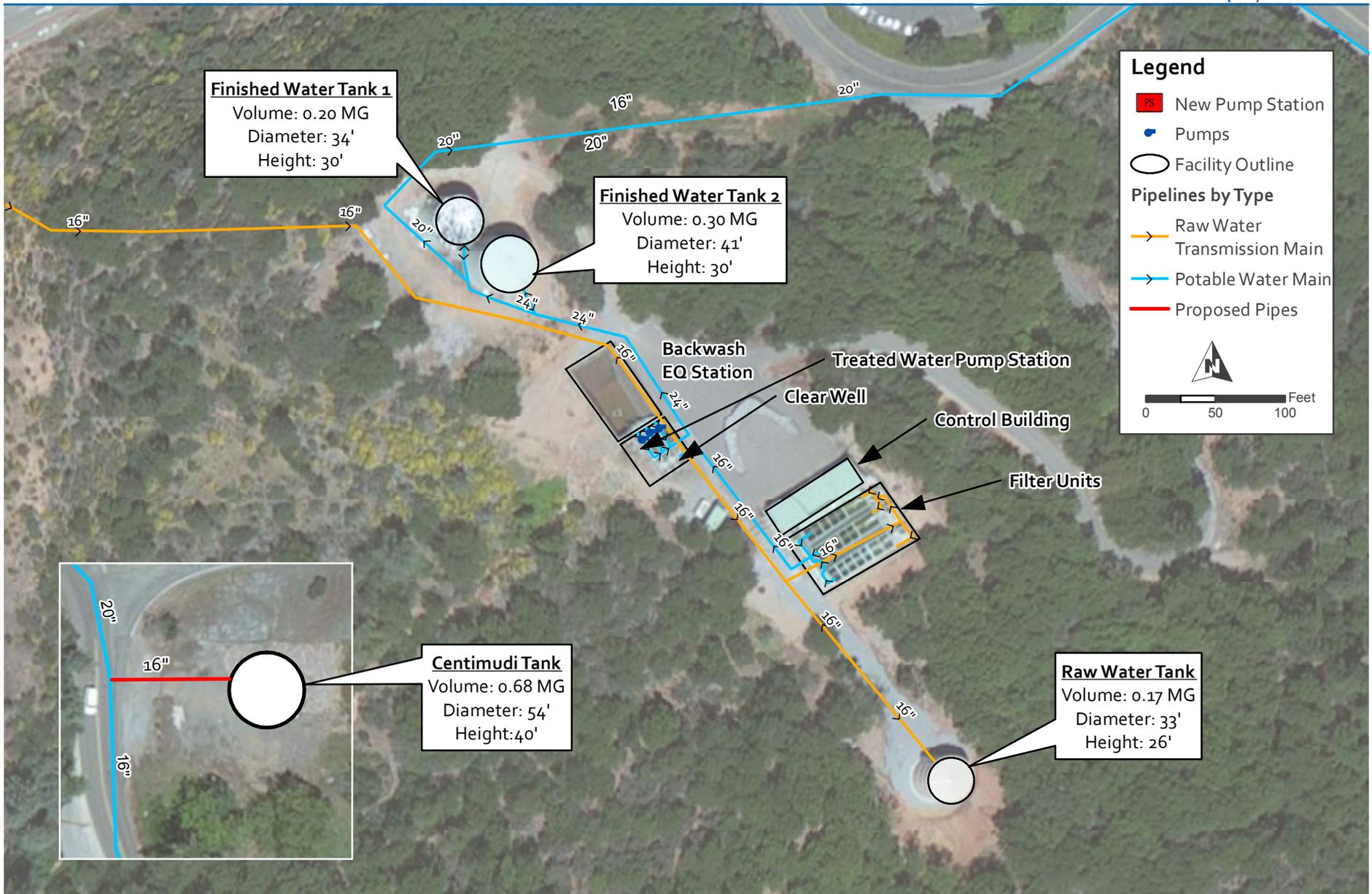


Figure 7
 Alternative 5

Table 3 Existing Storage Alternatives Analysis - Score

Criteria	Weight	Alternative's Weighted Score																			
		Existing		1A		1B		2A		2B		3A		3B		4A		4B		5	
		Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.	Raw	Adj.
Total Water Storage	60%	0	0.0	4	2.4	7	4.2	2	1.2	5	3.0	6	3.6	9	5.4	8	4.8	10	6.0	1	0.6
Operations & Maintenance	15%	4	0.6	8	1.2	8	1.2	8	1.2	8	1.2	2	0.3	2	0.3	2	0.3	2	0.3	8	1.2
Constructability	10%	5	0.5	8	0.8	8	0.8	8	0.8	8	0.8	6	0.6	6	0.6	6	0.6	6	0.6	8	0.8
Property/Easement Acquisition	10%	5	0.5	4	0.4	4	0.4	4	0.4	4	0.4	2	0.2	2	0.2	2	0.2	2	0.2	4	0.4
Permitting/Environmental	5%	5	0.3	6	0.3	6	0.3	6	0.3	6	0.3	6	0.3	6	0.3	6	0.3	6	0.3	6	0.3
Weighted Score Total	100%	19	1.9	30	5.1	33	6.9	28	3.9	31	5.7	22	5.0	25	6.8	24	6.2	26	7.4	27	3.3
Estimated Cost (\$ Millions)	--	\$	-	\$	2.23	\$	3.17	\$	2.35	\$	3.28	\$	5.20	\$	6.37	\$	6.49	\$	7.66	\$	0.57
Ratio (Score/Cost)	--	Fatal Flaw		2.28		2.18		1.66		1.74		0.96		1.07		0.96		0.97		5.78	

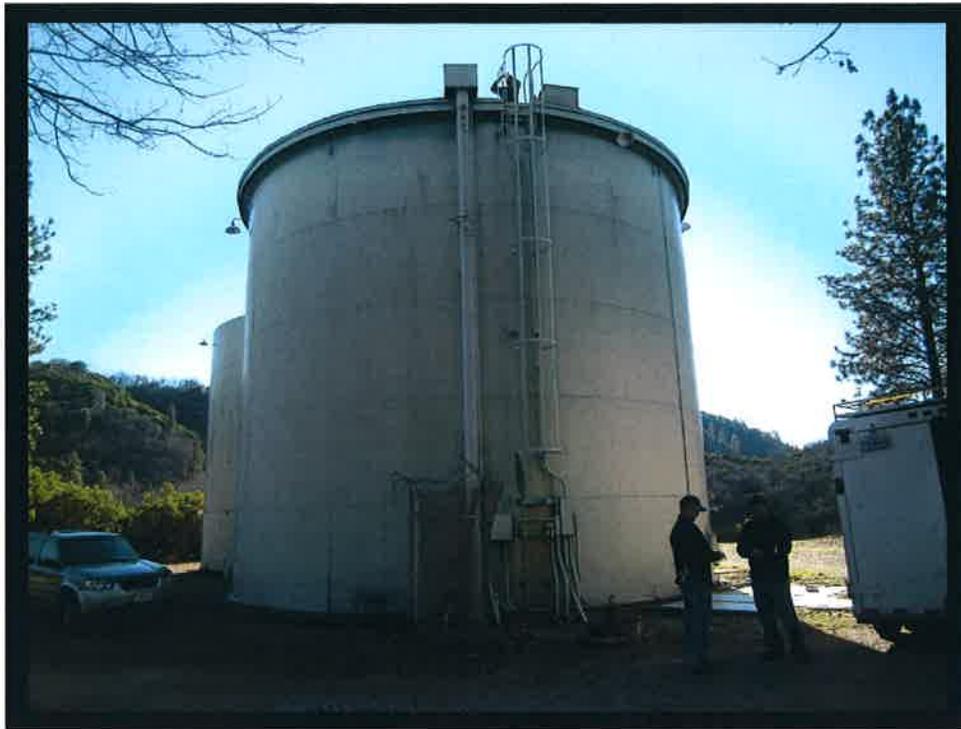
Notes:

1. Estimated Construction Cost to account for unforeseen events and unknown conditions (30%).
2. Additional markups include engineering, management, environmental, and legal (27.5%)
3. Total Contingency Markup = 65.8% (130% x 127.5% - 100%). ENR CCI = 10,182 (Average, March 2016)
4. Assumed pumps operate at 80% efficiency.
5. Estimated costs do not include demolition costs

Appendix H

TANK DIVE INSPECTION REPORTS

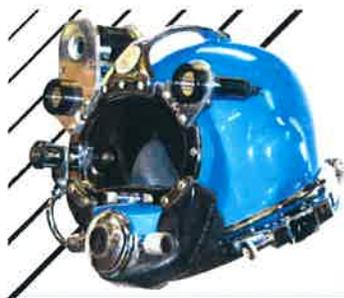
(Included in the electronic version of report. Not included in this bound printed copy.)



**Finished 1 Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on**

January 23, 2015

By



**LiquiVision
Technology
DIVING SERVICES**



LiquiVision
D I V I N G

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711 Market Street
Klamath Falls, OR 97601
www.divinoservices.com

TECHNOLOGY
S E R V I C E S

Western Operations
835 Market Street
Klamath Falls, OR 97601

Toll Free: (800) 229-8959
Phone: (541) 883-6473
Fax: (541) 883-1361
to uivision@divinoservices.com

Underwater Inspection of Finished 1 Tank

January 23, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Finished 1 Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Finished 1 Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Finished 1 Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R9T3	Capacity (gal.):	296,135
Date of Inspection:	January 23, 2015	Diameter or L x W:	41'
Report Writer:	Chase Hornaday	Height:	30'
Diver:	Bobby Barnicoat	Floor Square FT:	1,320.2
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

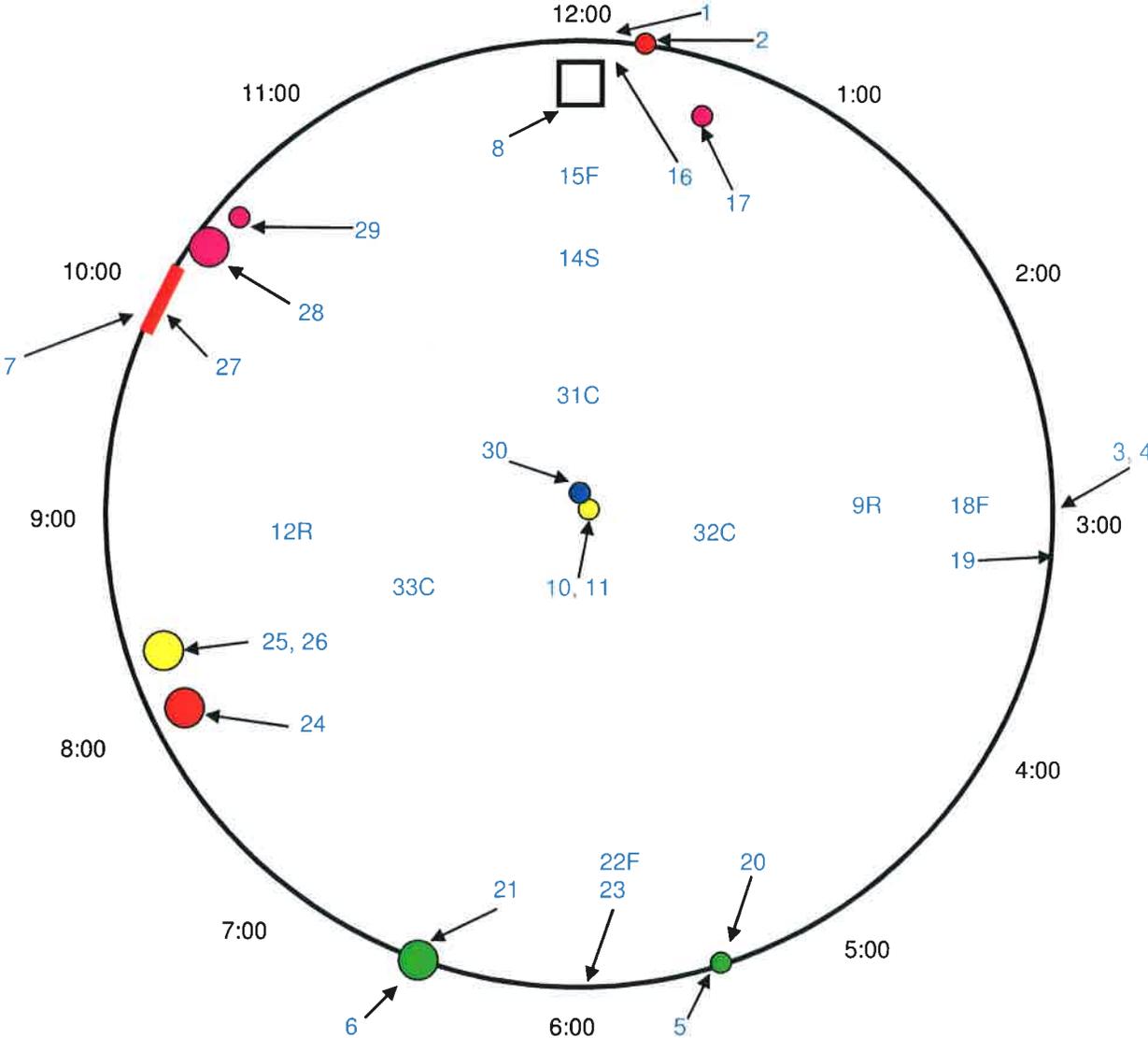
Finished 1 Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Repair and/or install fine mesh screens on exterior vents to limit the risk of bugs and other matter from entering the storage tank.	1.0
Install weather stripping on entry hatch to limit the risk of bugs and other matter from entering the storage tank.	1.0
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	Please contact our sales office for an estimate.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Finished 1 Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Water Tap
	Outlet		Telemetry		Air Vent
	Drain/Scour		Capped Off Penetration		

Finished 1 Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Water Tap 12:05

Condition:
Rust Grade¹ 9.

Description:
Water Tap appeared to be in good condition with a minor amount of corrosion.



Finished 1 Tank

Image #3

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Image #4

Exterior Base 3:00

Condition:
Concrete Deform³ CK.

Description:
Exterior Base
appeared to be in good
condition with a minor
amount of cracking.



Finished 1 Tank

Image #5

Capped Off Penetration
5:30

Condition:
Rust Grade 9.

Description:
Capped Off
Penetration appeared to
be in good condition
with a minor amount of
corrosion.



Image #6

Inlet 6:30

Condition:
Rust Grade 9.

Description:
12" Inlet appeared to
be in good condition
with a minor amount of
corrosion.



Finished 1 Tank

Image #7

Man Way 10:00

Condition:
Rust Grade¹ 7.

Description:
24" Man Way appeared to be in fair condition with a minor amount of corrosion.



Image #8

Entry Hatch 12:00

Description:
24" x 24" Wooden Entry Hatch appeared to be in good condition with a minor amount of deterioration observed.



Finished 1 Tank

Image #9

Roof 3:00

Description:
Wooden Roof appeared to be in good condition with moderate deterioration of the coating observed.



Image #10

Vent Center

Condition:
Rust Grade¹ 8.

Description:
24" Vent appeared to be in fair condition with a minor amount of corrosion.



Finished 1 Tank

Image #11

Vent Screen Center

Condition:
Rust Grade¹ 5.

Description:
Fine Mesh Vent Screen appeared to be in poor condition with several large holes observed and minor corrosion observed. Medium mesh screen appeared to be in fair condition with minor corrosion observed.

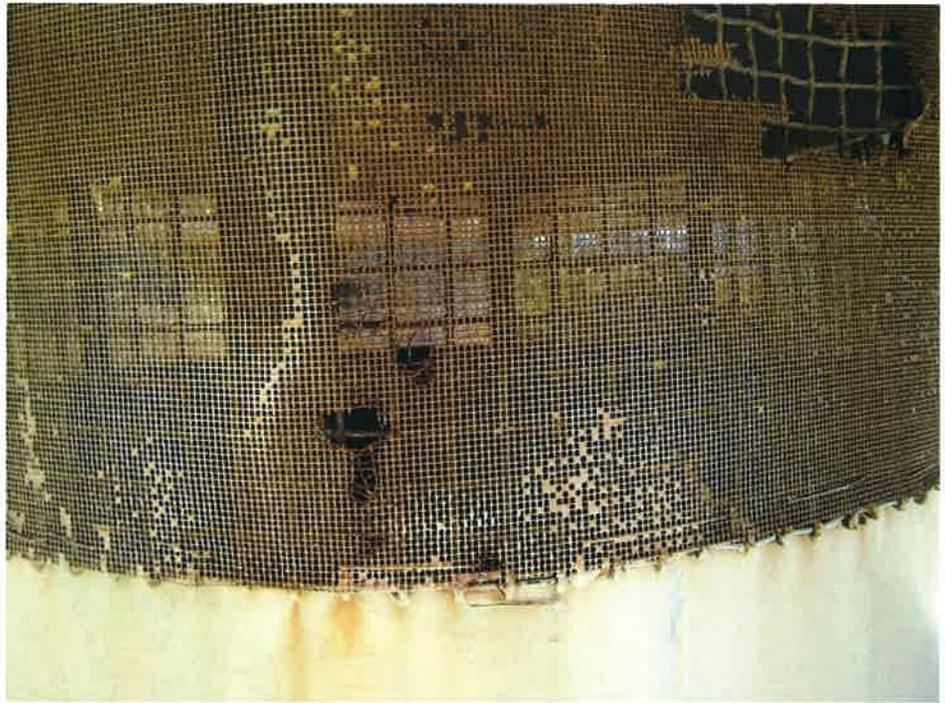


Image #12

Roof 9:00

Description:
Wooden Roof appeared to be in fair condition with moderate-to-severe deterioration of the coating observed.



Finished 1 Tank

Image #13

Diver



Image #14

Sediment

Description:
1/32" of sediment was
removed from
reservoir floor.



Finished 1 Tank

Image #15

Floor 12:00

Condition:
Rust Grade¹ 4.

Description:
Coal tar coated floor appeared to be in fair condition with moderate corrosion observed.



Image #16

Wall 12:00

Condition:
Rust Grade¹ 3.

Description:
Coal tar coated Wall appeared to be in poor condition with a moderate amount of cracking of the coating and corrosion observed.



Finished 1 Tank

Image #17

*Abandoned Telemetry
Pipe 12:30*

Condition:
Rust Grade¹ 3

Description:
Abandoned Telemetry
Pipe appeared to be in
poor condition with a
heavy amount of
corrosion.



Image #18

Floor 3:00

Condition:
Rust Grade¹ 4

Description:
Coal tar coated floor
appeared to be in fair
condition with
moderate corrosion
observed.



Finished 1 Tank

Image #19

Wall 3:00

Condition:
Rust Grade¹ 3.

Description:
Coal Tar coated Wall appeared to be in poor condition with a moderate amount of cracking of the coating and corrosion observed.



Image #20

Capped Off Penetration
5:30

Condition:
Rust Grade¹ 3.

Description:
8" Capped Off Penetration appeared to be in poor condition with a moderate amount of corrosion.



Finished 1 Tank

Image #21

Inlet 6:30

Condition:
Rust Grade¹ 8.

Description:
Inlet appeared to be in good condition with a minor amount of corrosion.



Image #22

Floor 6:00

Condition:
Rust Grade¹ 4.

Description:
Coal tar coated floor appeared to be in fair condition with moderate corrosion observed.



Finished 1 Tank

Image #23

Wall 6:00

Condition:
Rust Grade¹ 3.

Description:
Coal tar coated Wall appeared to be in fair condition with a moderate amount of cracking of the coating and corrosion observed.



Image #24

Drain 8:00

Condition:
Rust Grade¹ 4.

Description:
8" Drain appeared to be in fair condition with a heavy amount of corrosion.



Finished 1 Tank

Image #25

Overflow 8:10

Condition:
Rust Grade 6.

Description:
8" Overflow appeared to be in fair condition with a moderate amount of corrosion.



Image #26

Overflow Bell 8:10

Condition:
Rust Grade 7.

Description:
12" Overflow Bell appeared to be in good condition with a minor amount of corrosion.



Finished 1 Tank

Image #27

Man Way 10:00

Condition:
Rust Grade¹ 6.

Description:
24" Man Way appeared to be in fair condition with a moderate amount of corrosion.



Image #28

Outlet 10:15

Condition:
Rust Grade¹ 4.

Description:
10" Outlet appeared to be in fair condition with a moderate amount of corrosion.



Finished 1 Tank

Image #29

Abandoned Telemetry
10:30

Description:
Abandoned Telemetry appeared to be in poor condition with a heavy amount of corrosion.



Image #30

Column Center

Condition:
Rust Grade 3.

Description:
10" Column appeared to be in fair condition with a heavy amount of corrosion.



Finished 1 Tank

Image #31

Ceiling 12:00

Description:
Wooden Ceiling
appeared to be in good
condition with no
major discrepancies
observed.



Image #32

Ceiling 3:00

Description:
Wooden Ceiling
appeared to be in good
condition with no
major discrepancies
observed.



Finished 1 Tank

Image #33

Ceiling 9:00

Description:
Wooden Ceiling
appeared to be in good
condition with no
major discrepancies
observed.



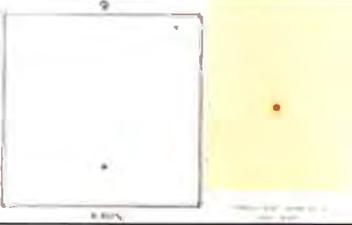
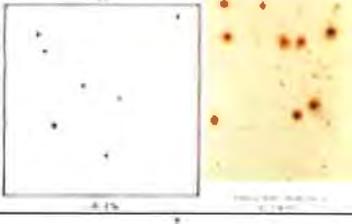
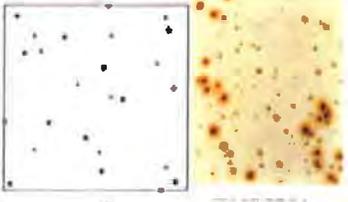
Finished 1 Tank

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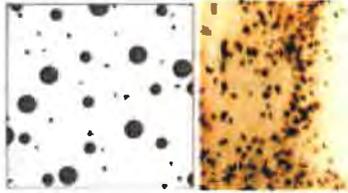
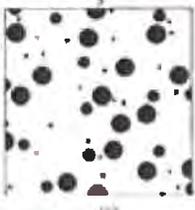
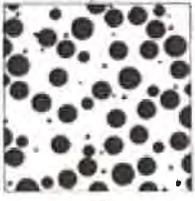
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Finished 1 Tank

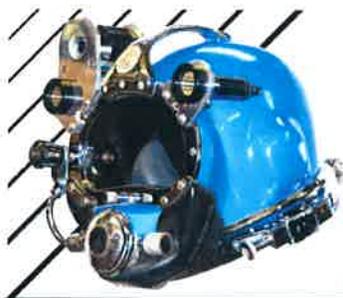
5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



**Finished 2 Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on**

January 23, 2015

By



**LiquiVision
Technology
DIVING SERVICES**



LiquiVision
D I V I N G

Office/Mailing Address
711 Market Street
Klamath Falls, OR 97601
www.divinoservices.com

TECHNOLOGY
S E R V I C E S

Western Operations
835 Market Street
Klamath Falls, OR 97601

Toll Free: (800) 229-6959
Phone: (541) 883-6473
Fax: (541) 883-1361
liquivision@divinoservices.com

Underwater Inspection of Finished 2 Tank

January 23, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Finished 2 Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Finished 2 Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Finished 2 Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R10T3	Capacity (gal.):	203,648
Date of Inspection:	January 23, 2015	Diameter or L x W:	34'
Report Writer:	Chase Hornaday	Height:	30'
Diver:	Bobby Barnicoat	Floor Square FT:	907.9
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

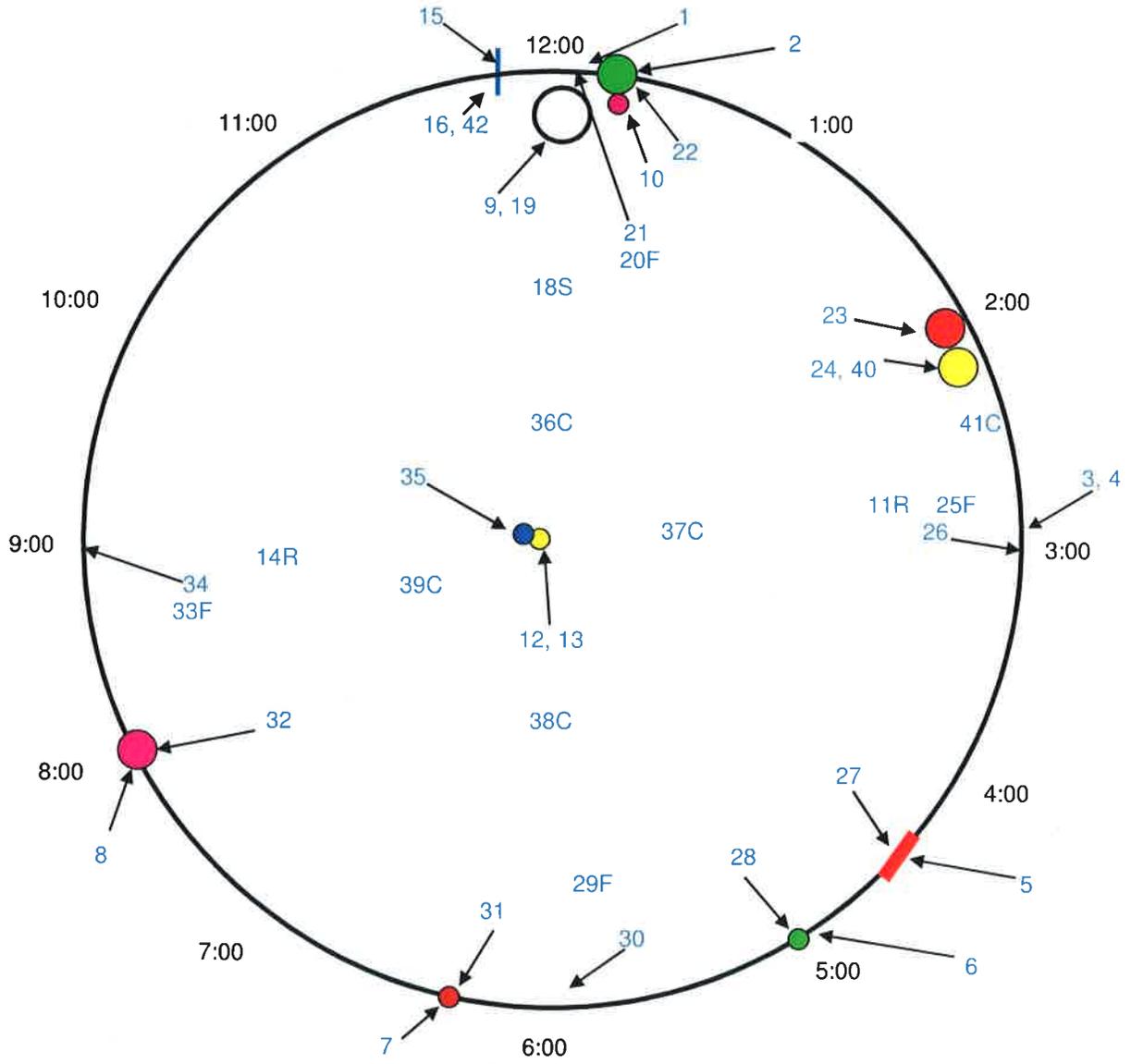
Finished 2 Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Replace liquid level indicator float with a more durable stainless steel type float.	Please contact our sales office for an estimate.
Patch hole observed during interior inspection of ceiling located at 2:05, picture #41 immediately.	Please contact our sales office for an estimate.
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	LiquiVision Technology does not perform this service.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Finished 2 Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Water Tap
	Outlet		Liquid Level Indicator		Air Vent
	Drain/Scour		Outlet to Bureau		Telemetry

Finished 2 Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Inlet 12:05

Condition:
Rust Grade¹ 9.

Description:
16" Inlet appeared to be in good condition with a minor amount of corrosion.



Finished 2 Tank

Image #3

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Image #4

Exterior Base 3:00

Condition:
Concrete Deform³ GC.

Description:
Exterior Base
appeared to be in good
condition with no
concrete problems.



Finished 2 Tank

Image #5

Man Way 4:30

Condition:
Rust Grade! 9.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.

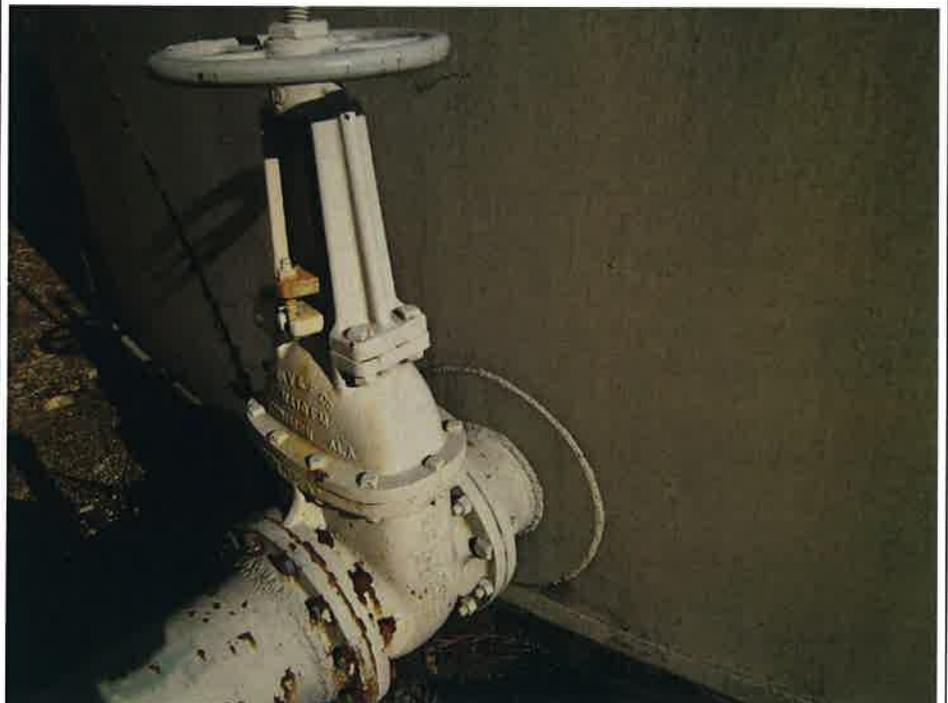


Image #6

Outlet to Bureau 5:00

Condition:
Rust Grade! 8.

Description:
Outlet to Bureau appeared to be in good condition with a minor amount of corrosion.



Finished 2 Tank

Image #7

Water Tap 6:15

Condition:
Rust Grade¹ 8.

Description:
2" Water Tap appeared to be in good condition with a minor amount of corrosion.



Image #8

Outlet 8:00

Condition:
Rust Grade¹ 9.

Description:
18" Outlet appeared to be in good condition with a minor amount of corrosion.



Finished 2 Tank

Image #9

Entry Hatch 12:00

Condition:
Rust Grade! 8.

Description:
20" Entry Hatch
appeared to be in good
condition with a minor
amount of corrosion.



Image #10

Telemetry Penetration
12:05

Condition:
Rust Grade! 9.

Description:
1" Telemetry
Penetration appeared to
be in good condition
with a minor amount of
corrosion.



Finished 2 Tank

Image #11

Roof 3:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in condition with a minor amount of corrosion.



Image #12

Center Vent

Condition:
Rust Grade¹ 9.

Description:
8" Vent appeared to be in good condition with a minor amount of corrosion.



Finished 2 Tank

Image #13

Vent Screen Center

Condition:
Rust Grade! 9.

Description:
Medium Vent Screen appeared to be in good condition with a minor amount of corrosion.

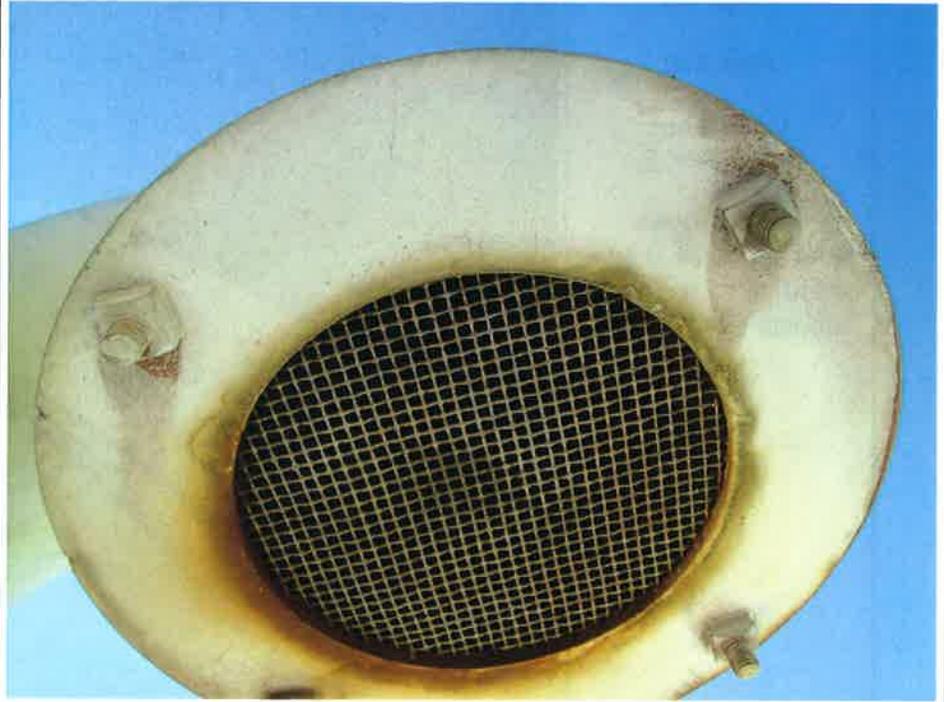


Image #14

Roof 9:00

Condition:
Rust Grade! 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Finished 2 Tank

Image #15

*Liquid Level Indicator
Penetration 11:55*

Condition:
Rust Grade¹ 9.

Description:
1" Liquid Level
Indicator Penetration
appeared to be in good
condition with a minor
amount of corrosion.



Image #16

*Liquid Level Indicator
Reader Board 11:55*

Condition:
Rust Grade¹ 9.

Description:
Liquid Level Indicator
Reader Board appeared
to be in good working
condition with a minor
amount of corrosion.



Finished 2 Tank

Image #17

Diver



Image #18

Sediment

Description:

A heavy amount of rust scale and debris was removed from reservoir floor.



Finished 2 Tank

Image #19

Interior Ladder 12:00

Condition:
Rust Grade¹ 6.

Description:
Interior Ladder appeared to be in fair condition with a minor amount of corrosion.

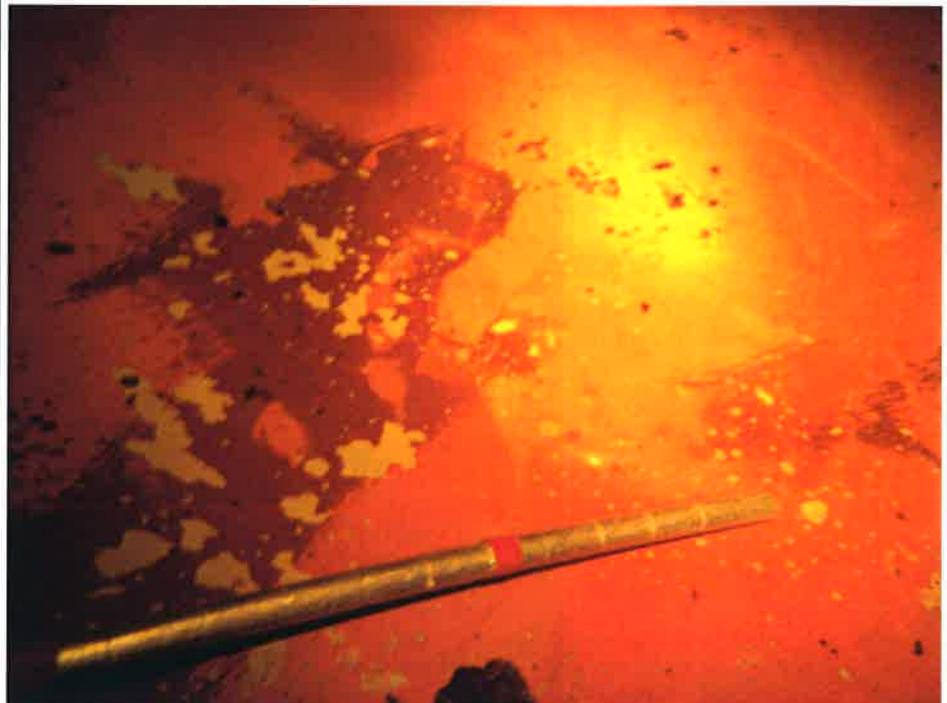


Image #20

Floor 12:00

Condition:
Rust Grade¹ 8.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #21

Wall 12:00

Condition:
Rust Grade¹ 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion.

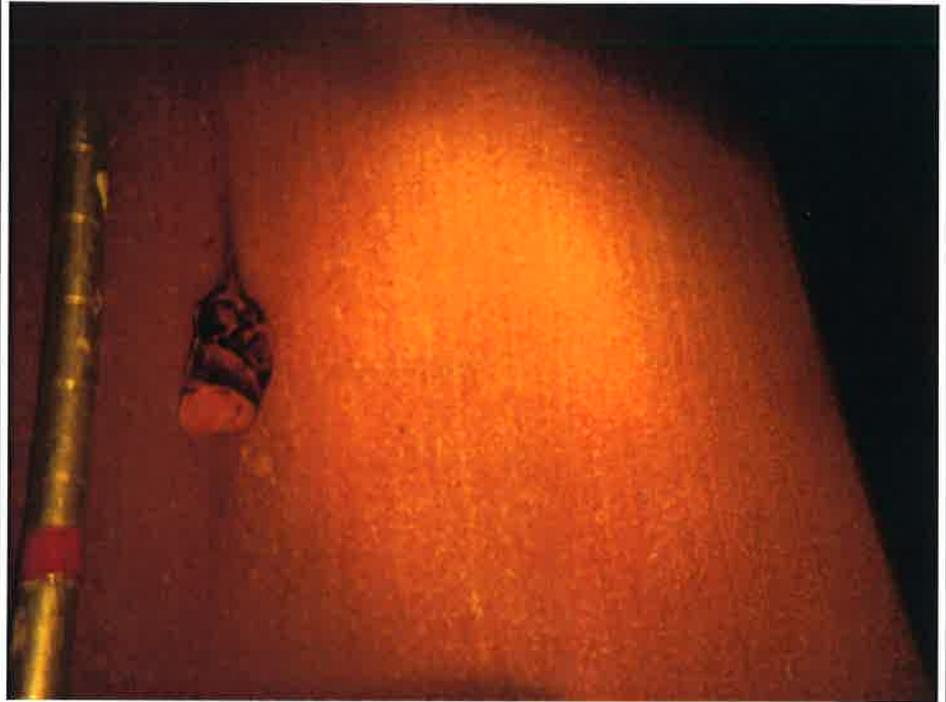
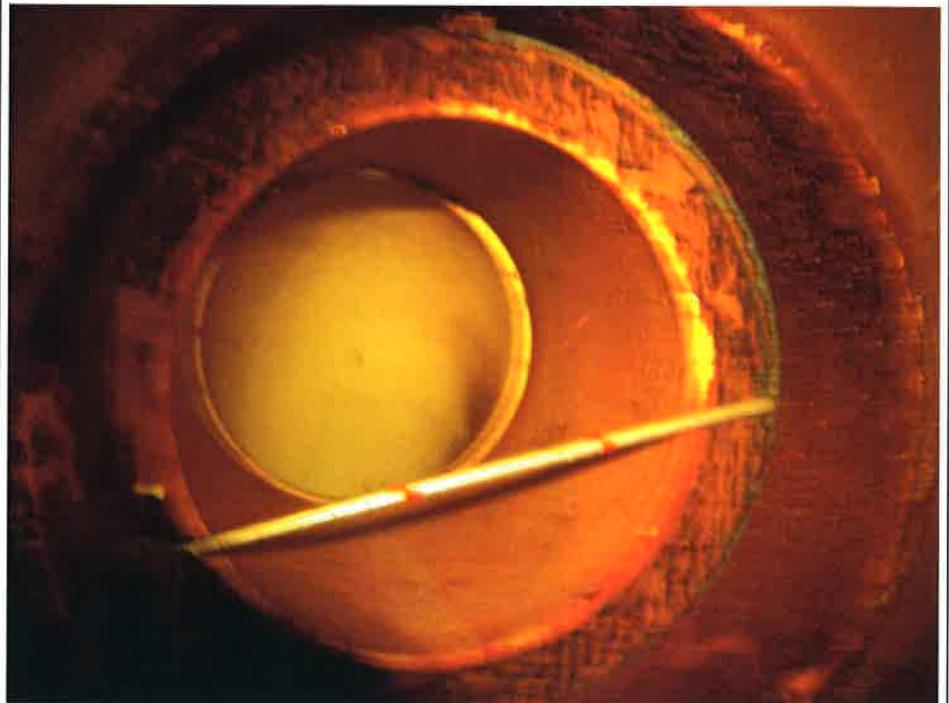


Image #22

Inlet 12:05

Condition:
Rust Grade¹ 8.

Description:
16" Inlet appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #23

Drain 2:00

Condition:
Rust Grade' 8.

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.

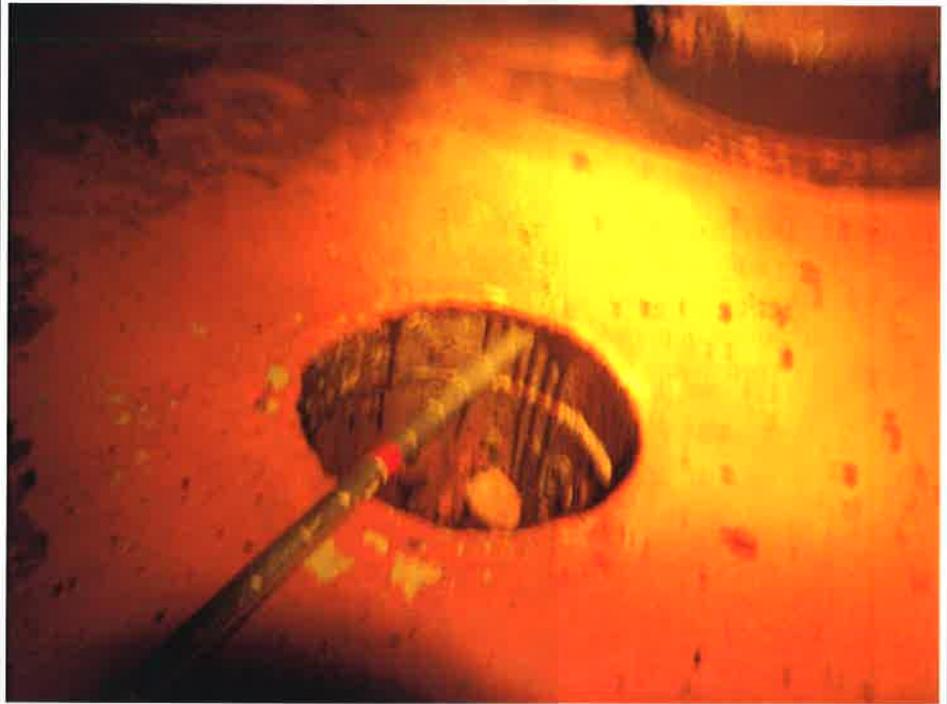


Image #24

Overflow 2:05

Condition:
Rust Grade' 6.

Description:
8" Overflow appeared to be in fair condition with a moderate amount of corrosion.



Finished 2 Tank

Image #25

Floor 3:00

Condition:
Rust Grade¹ 8.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion.



Image #26

Wall 3:00

Condition:
Rust Grade¹ 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #27

Man Way 4:30

Condition:
Rust Grade' 4.

Description:
Man Way appeared to be in fair condition with a moderate amount of corrosion.

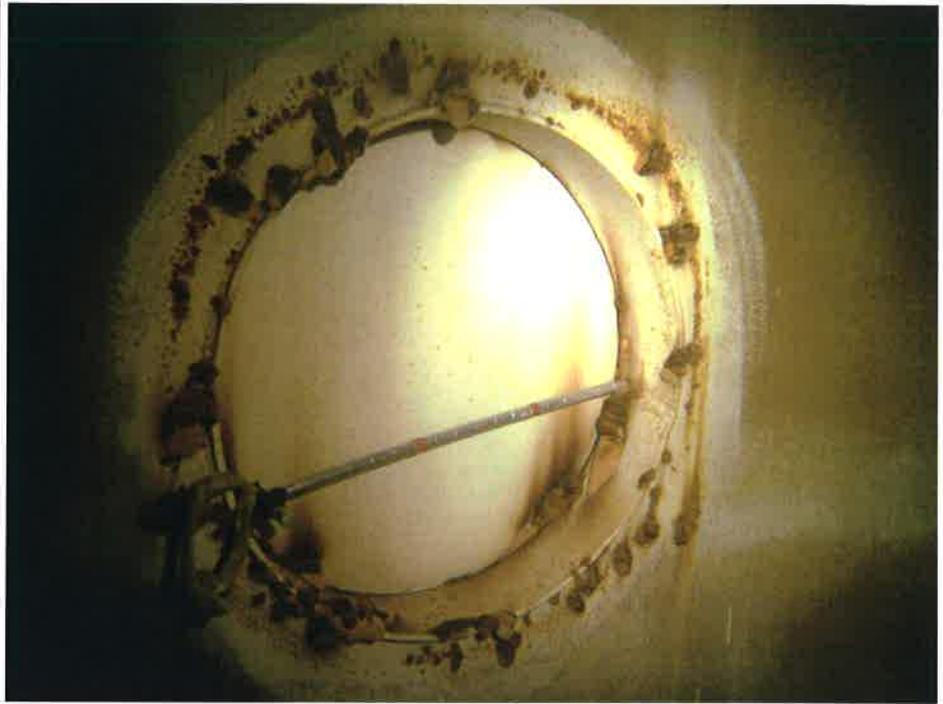
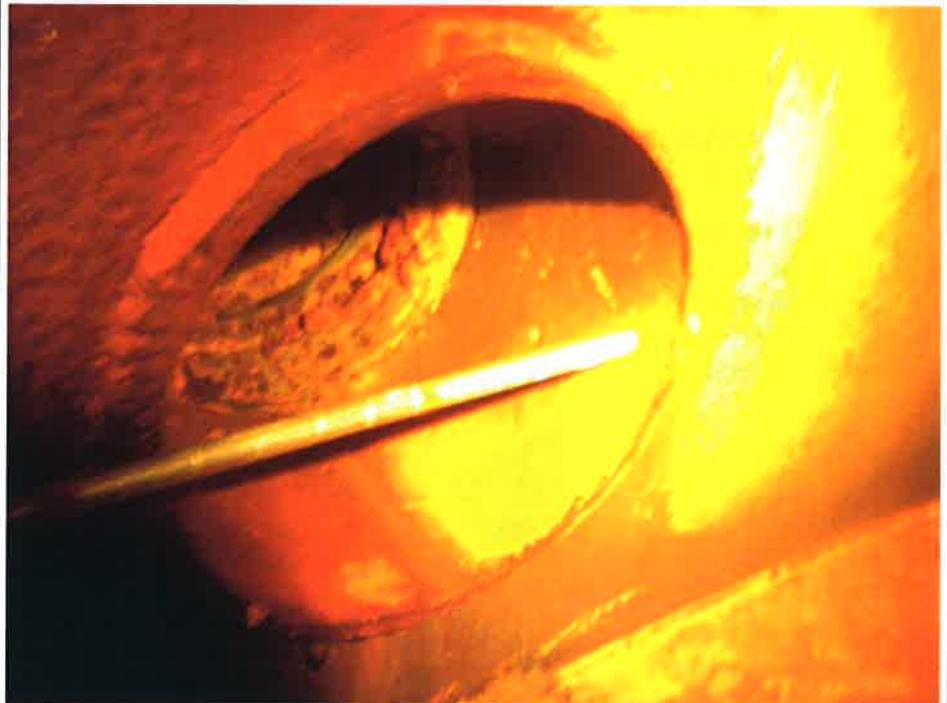


Image #28

Outlet to Bureau 5:00

Condition:
Rust Grade' 7.

Description:
10" Outlet to Bureau appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #29

Floor 6:00

Condition:
Rust Grade! 7.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion.

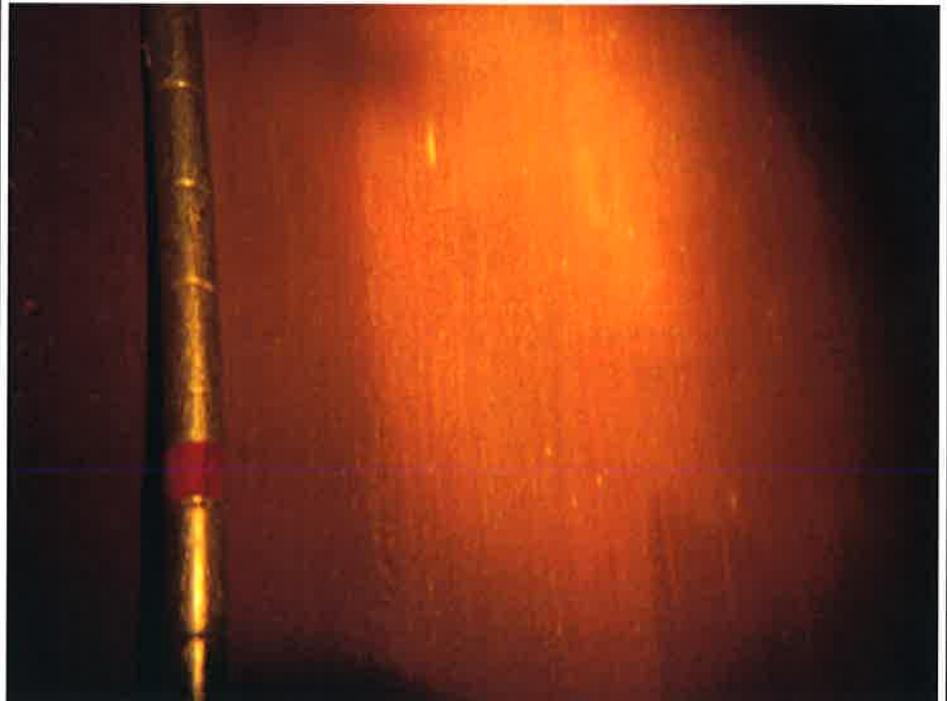


Image #30

Wall 6:00

Condition:
Rust Grade! 7.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #31

Water Tap 6:15

Condition:
Rust Grade' 0.

Description:
2" Water Tap appeared to be in poor condition with a heavy amount of corrosion.

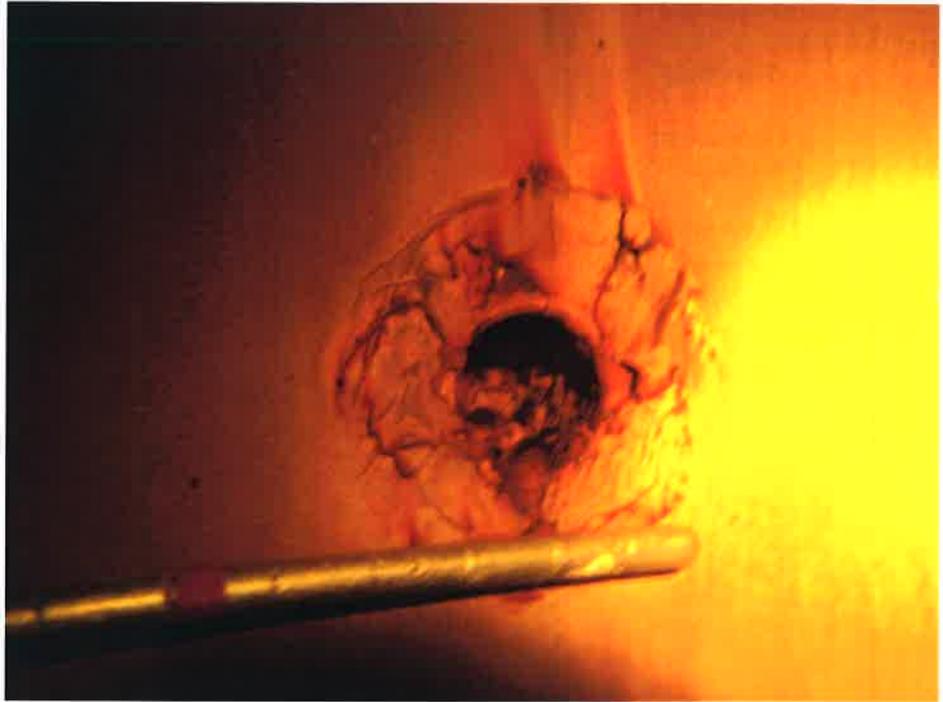
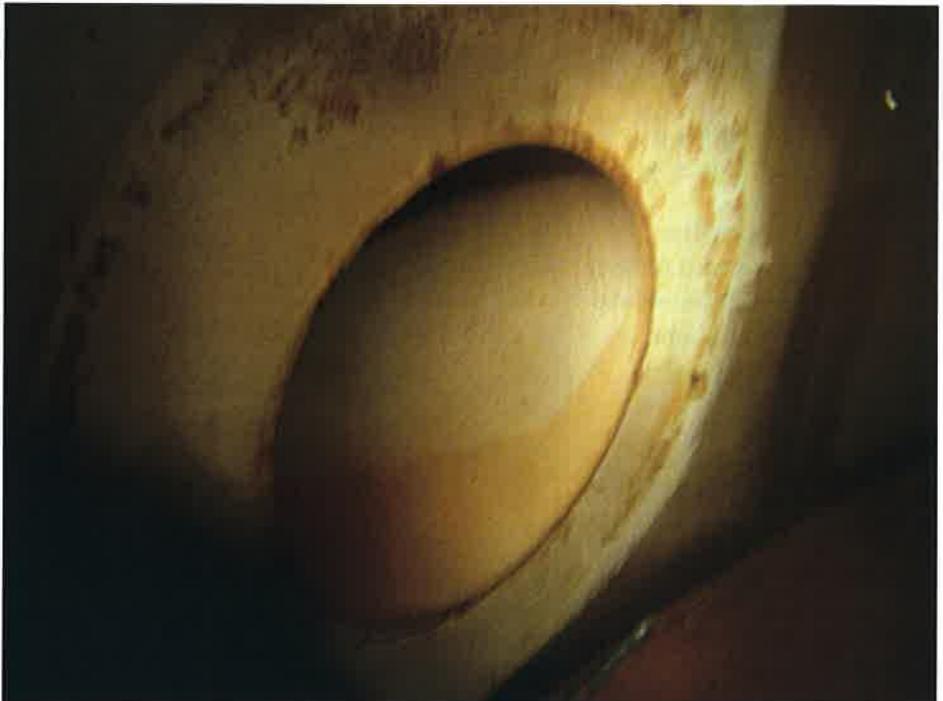


Image #32

Outlet 8:00

Condition:
Rust Grade' 7.

Description:
Outlet appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #33

Floor 9:00

Condition:
Rust Grade! 8.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion.

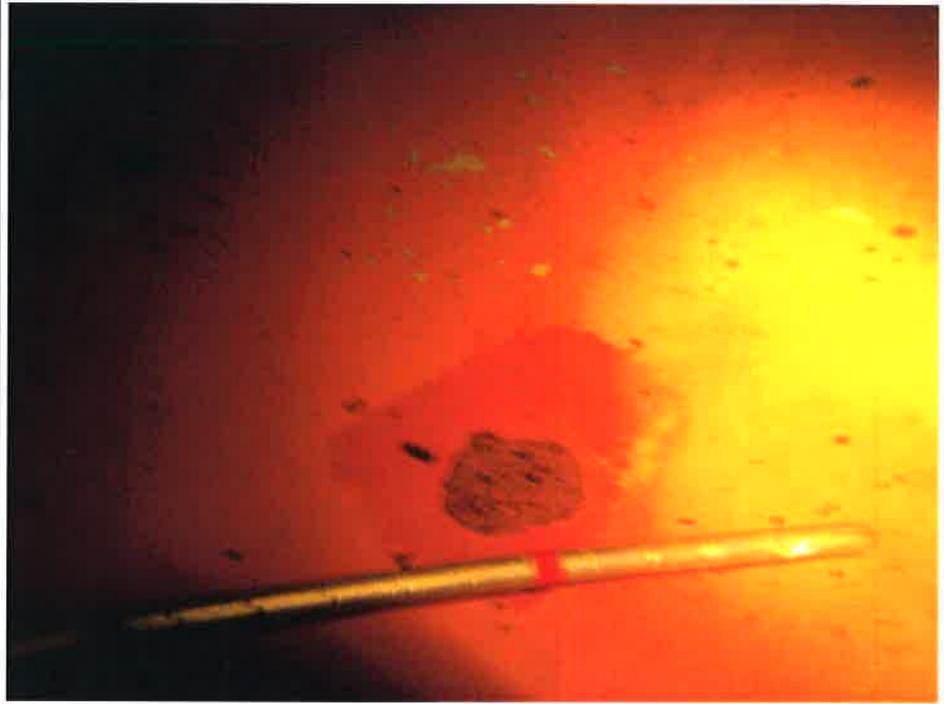


Image #34

Wall 9:00

Condition:
Rust Grade! 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #35

Column Center

Condition:
Rust Grade' 3.

Description:
8" Column appeared to be in fair condition with a heavy amount of corrosion.

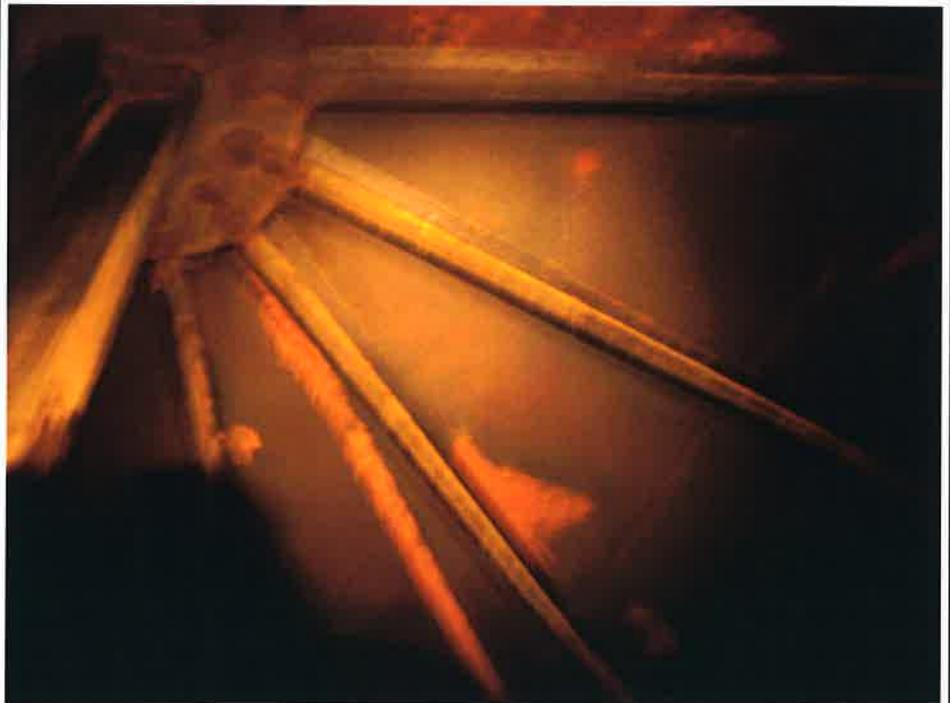


Image #36

Ceiling 12:00

Condition:
Rust Grade' 2.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion.



Finished 2 Tank

Image #37

Ceiling 3:00

Condition:
Rust Grade' 2.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion.

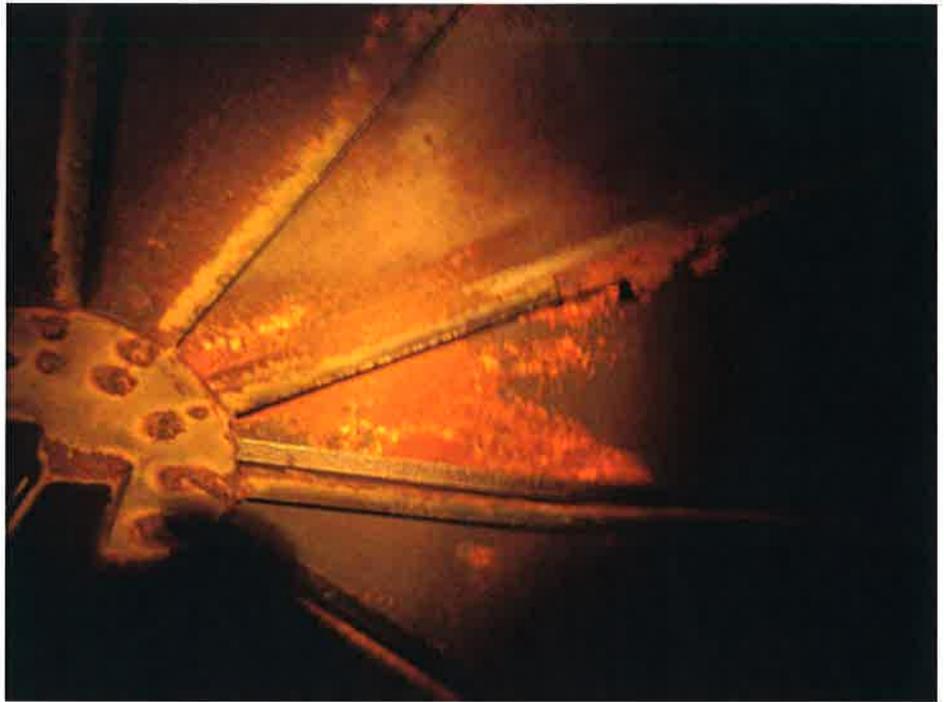


Image #38

Ceiling 6:00

Condition:
Rust Grade' 2.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion.



Finished 2 Tank

Image #39

Ceiling 9:00

Condition:
Rust Grade' 2.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion.



Image #40

Overflow Bell 2:05

Condition:
Rust Grade' 8.

Description:
16" Overflow Bell appeared to be in fair condition with a minor amount of corrosion.



Finished 2 Tank

Image #41

Hole in the ceiling 2:05

Condition:
Rust Grade' 0.

Description:
2" Hole in ceiling was observed and should be patched immediately.



Image #42

*Liquid Level Indicator
Float 11:55*

Description:
Liquid Level Indicator
Float appeared to be in
fair condition and
suspended properly.



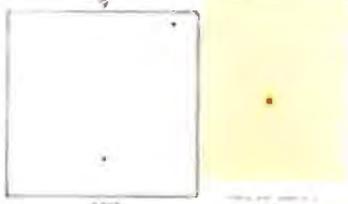
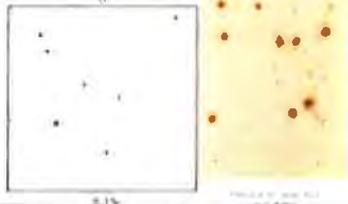
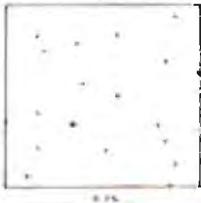
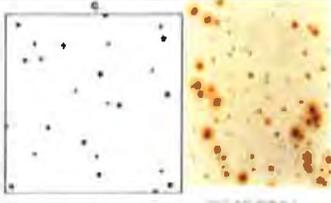
Finished 2 Tank

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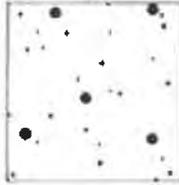
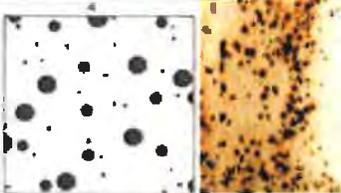
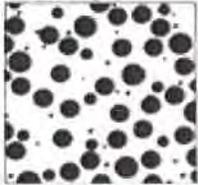
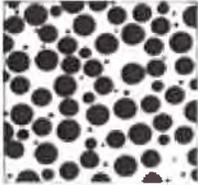
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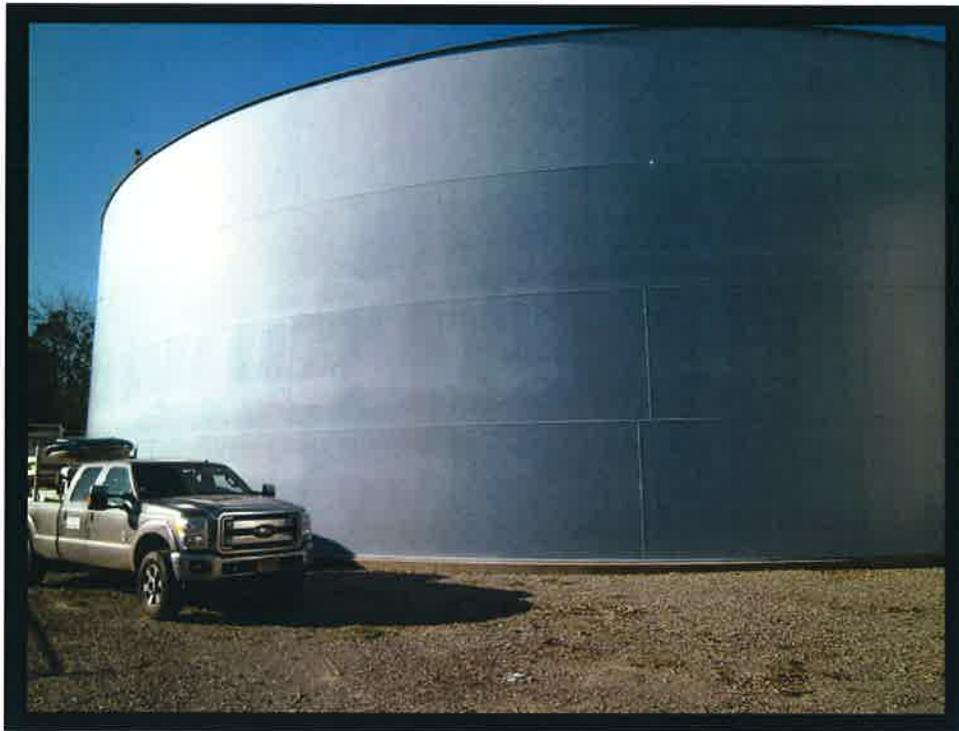
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1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Finished 2 Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



Montana A Tank City of Shasta Lake

**Report of Findings
From the
Diving Operations
Conducted on**

January 22, 2015

By



**LiquiVision
Technology
DIVING SERVICES**



Underwater Inspection of Montana A Tank

January 22, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Montana A Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Montana A Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Montana A Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R5T3	Capacity (gal.):	2,983,000
Date of Inspection:	January 22, 2015	Diameter or L x W:	126'
Report Writer:	Chase Hornaday	Height:	32'
Diver:	Bobby Barnicoat	Floor Square FT:	12,468.6
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

Montana A Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Repair coating failure on interior fixtures, floor and walls. Repairs below the water line can be accomplished utilizing divers, the proper tools and specially formulated two-part epoxy.	2.0
Total Estimated Hours	

Montana A Tank

Image #1

Exterior Ladder 6:30

Condition:
Rust Grade¹ 9.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Man Way 6:45

Condition:
Rust Grade¹ 9.

Description:
30" Man Way appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #3

Exterior Wall 8:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Image #4

Exterior Base 8:00

Condition:
Concrete Deform³ GC.

Description:
Exterior Base
appeared to be in good
condition with no
concrete problems.



Montana A Tank

Image #5

Man Way 12:45

Condition:
Rust Grade! 10.

Description:
30" Man Way appeared to be in good condition with no signs of corrosion.

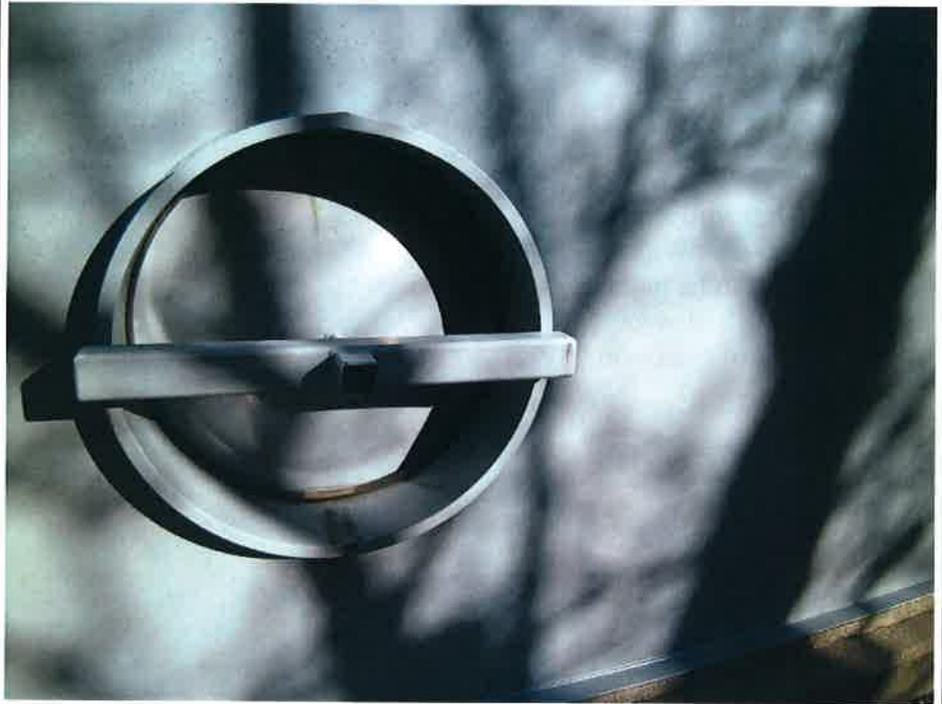


Image #6

Entry Hatch 12:00

Condition:
Rust Grade! 9.

Description:
36"x36" Entry Hatch appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #7

Side Vent 1:30

Condition:
Rust Grade' 9.

Description:
24" Side Vent appeared to be in good condition with a minor amount of corrosion and delamination observed.

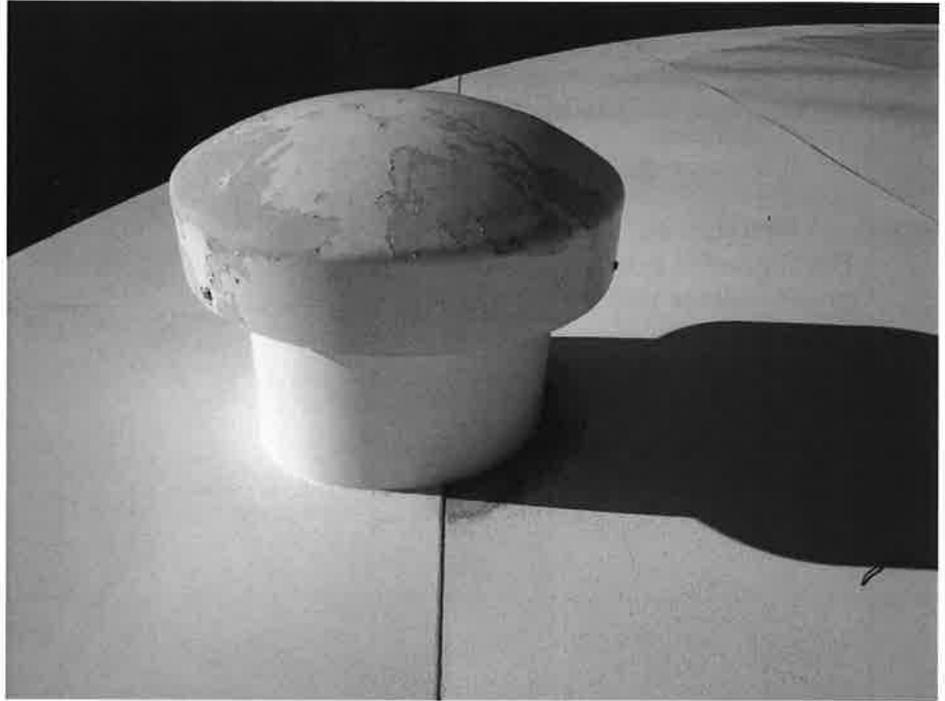


Image #8

Vent Screen 1:30

Condition:
Rust Grade' 9.

Description:
Large and Fine Mesh Vent Screens appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #9

Roof 3:00

Condition:
Rust Grade¹ 8.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and delamination observed.

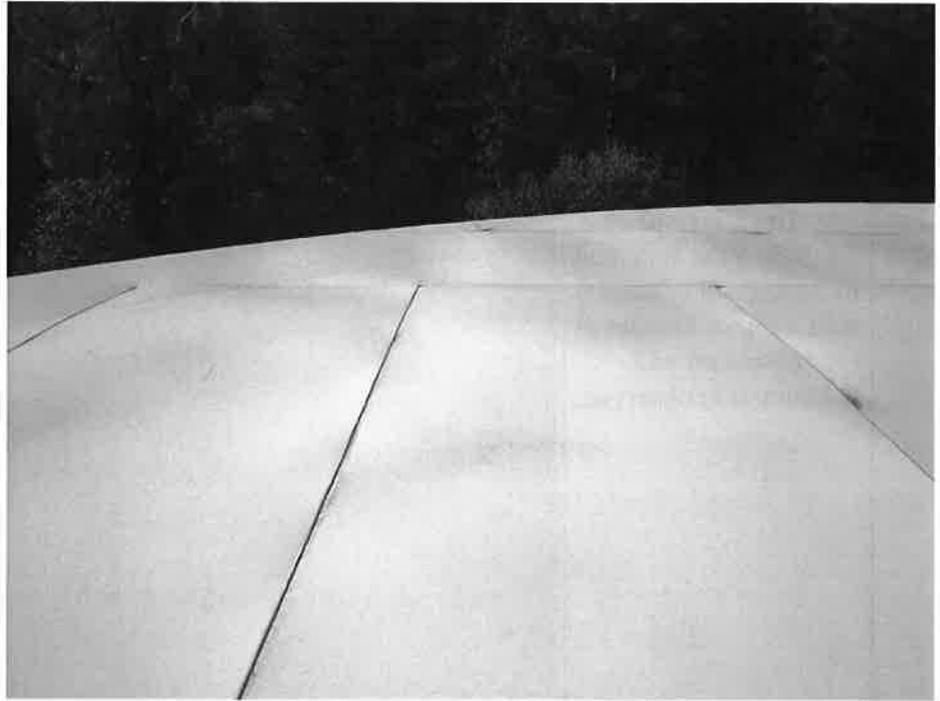
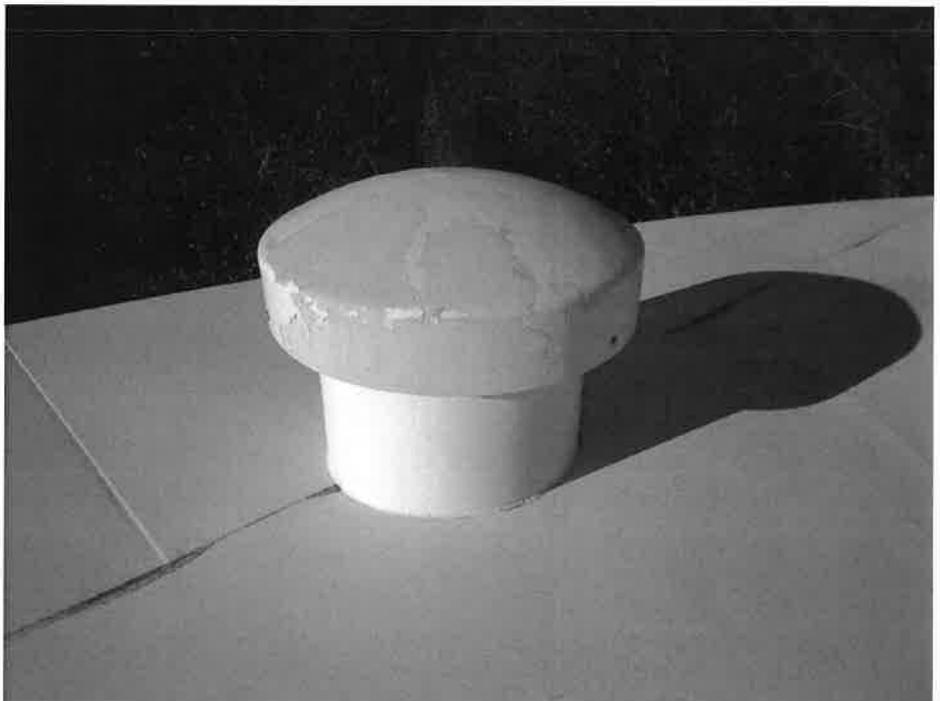


Image #10

Side Vent 4:30

Condition:
Rust Grade¹ 9.

Description:
Side Vent appeared to be in good condition with a minor amount of corrosion with a moderate amount of delamination observed.



Montana A Tank

Image #11

Vent Screen 4:30

Condition:
Rust Grade' 10.

Description:
Large and Fine Mesh Vent Screens appeared to be in good condition with no signs of corrosion.



Image #12

Side Vent 7:30

Condition:
Rust Grade' 9.

Description:
24" Side Vent appeared to be in good condition with a minor amount of corrosion and minor amount of delamination observed.



Montana A Tank

Image #13

Vent Screen 7:30

Condition:
Rust Grade! 10.

Description:
Large and Fine Mesh Vent Screens appeared to be in good condition with a minor amount of corrosion.

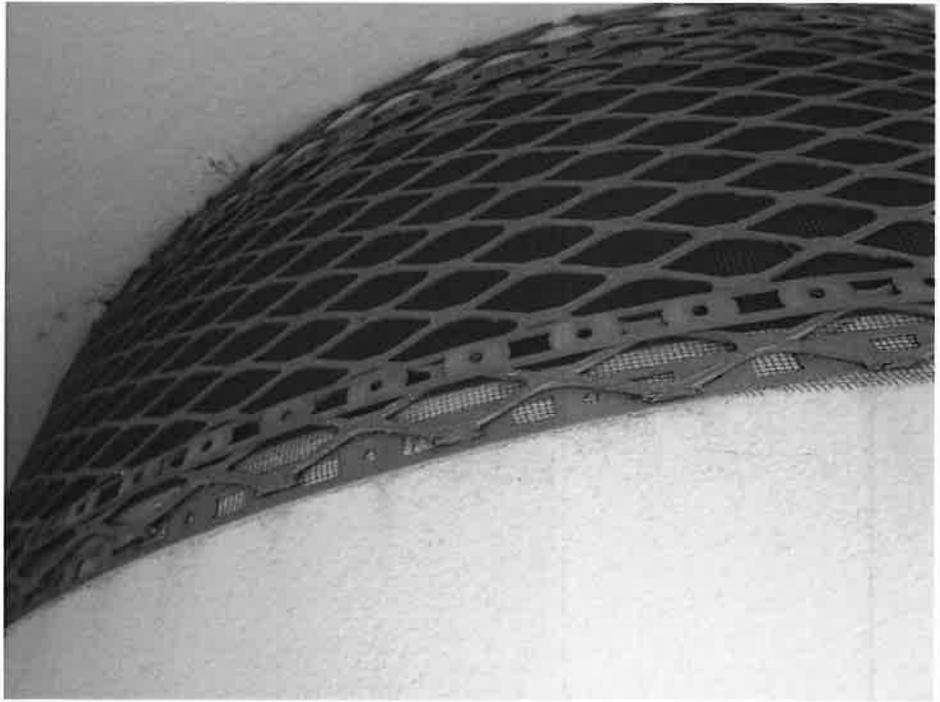
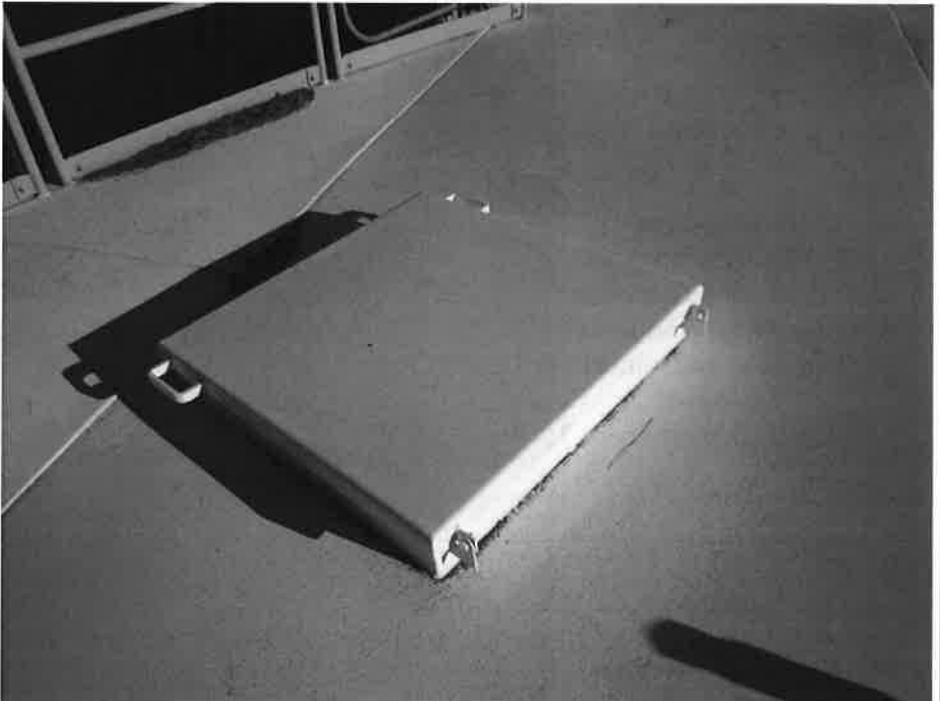


Image #14

Entry Hatch 8:00

Condition:
Rust Grade! 9.

Description:
36"x36" Entry Hatch appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #15

Side Vent 10:30

Condition:
Rust Grade' 9.

Description:
24" Side Vent appeared to be in good condition with a minor amount of corrosion.

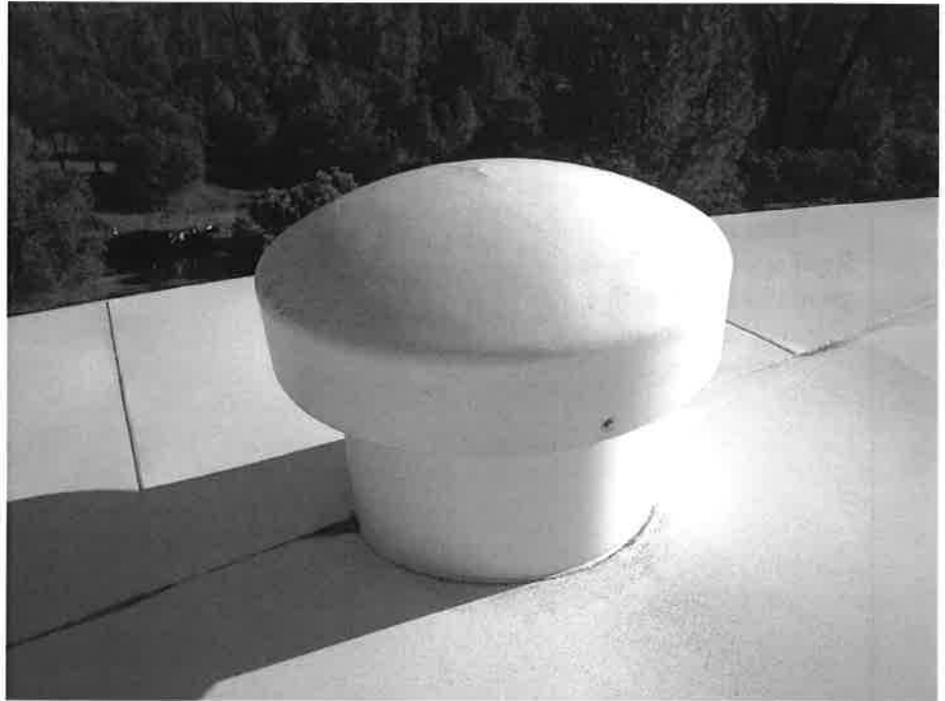
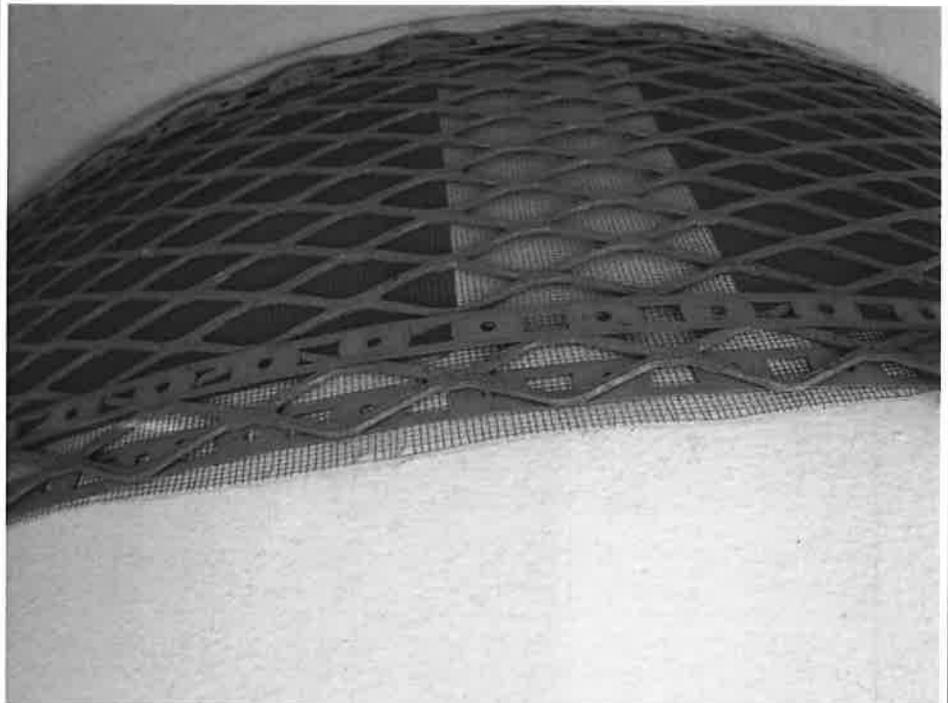


Image #16

Vent Screen 10:30

Condition:
Rust Grade' 10.

Description:
Large and Fine Mesh Vent Screens appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #17

Roof 9:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.

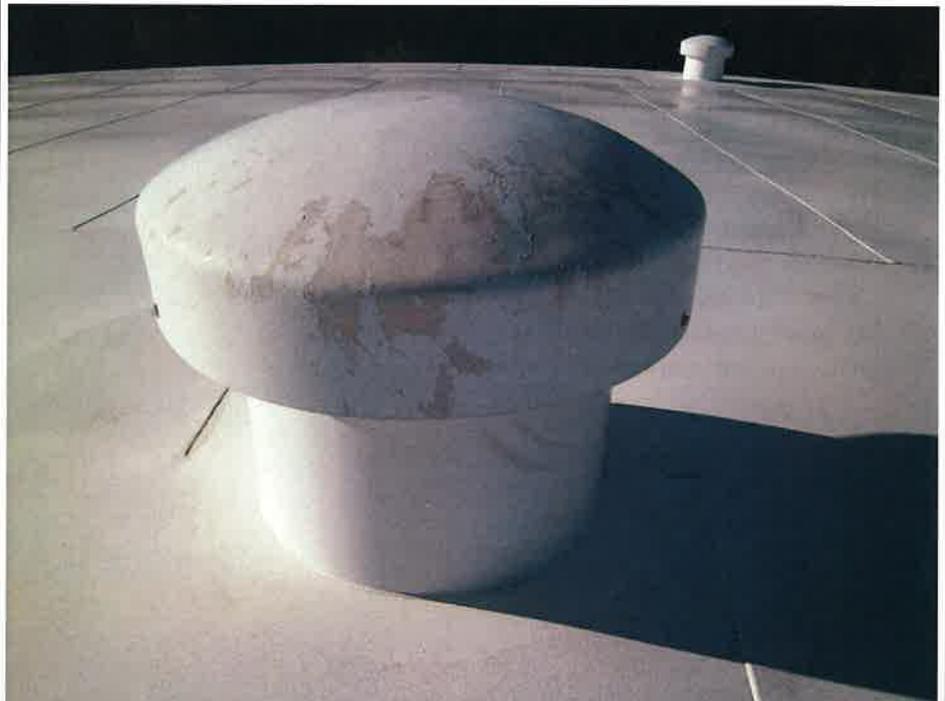


Image #18

Vent Center

Condition:
Rust Grade¹ 9.

Description:
24" Vent appeared to be in good condition with a minor amount of corrosion and delamination observed.



Montana A Tank

Image #19

Vent Screen Center

Condition:
Rust Grade¹ 10.

Description:
Large and Fine Mesh Vent Screens appeared to be in good condition with a minor amount of corrosion.



Image #20

Diver



Montana A Tank

Image #21

Sediment

Description:
1/32" of sediment was removed from reservoir floor.

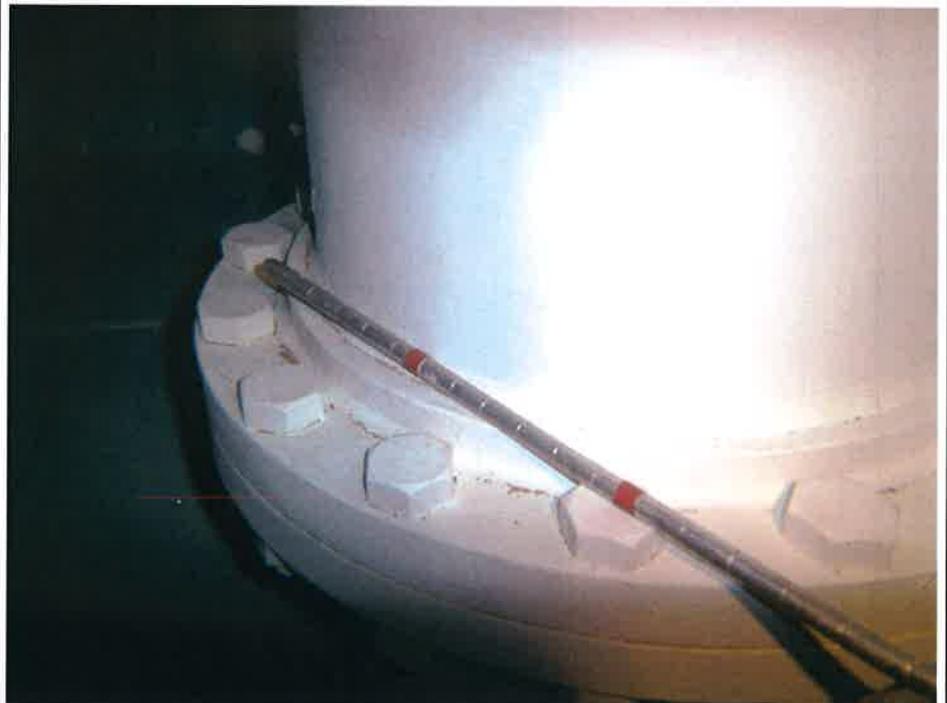


Image #22

Overflow 12:05

Condition:
Rust Grade¹ 10.

Description:
20" Overflow appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #23

Floor 12:00

Condition:
Rust Grade' 10.

Description:
Floor appeared to be in good condition with no signs of corrosion.



Image #24

Wall 12:00

Condition:
Rust Grade' 10.

Description:
Wall appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #25

Floor 3:00

Condition:
Rust Grade¹ 10.

Description:
Floor appeared to be in good condition with no signs of corrosion.



Image #26

Wall 3:00

Condition:
Rust Grade¹ 10.

Description:
Wall appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #27

Ceiling 3:00

Condition:
Rust Grade' 7.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Image #28

Floor 6:00

Condition:
Rust Grade' 10.

Description:
Floor appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #29

Wall 6:00

Condition:
Rust Grade¹ 10.

Description:
Wall appeared to be in good condition with no signs of corrosion.

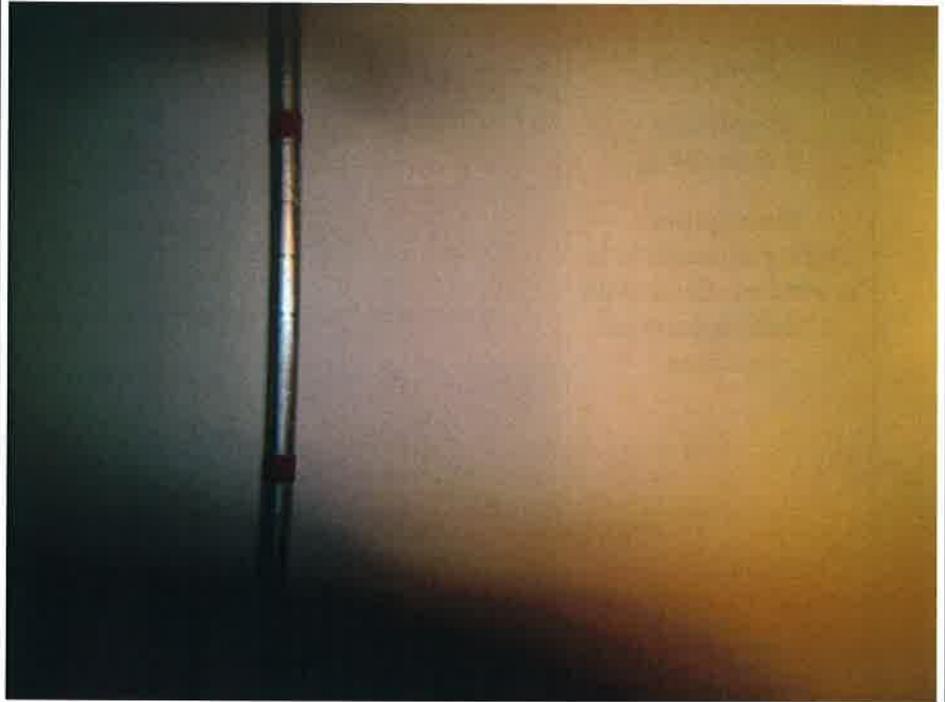


Image #30

Ceiling 6:00

Condition:
Rust Grade¹ 7.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #31

Upper Wall 7:00

Condition:
Rust Grade' 6.

Description:
Upper Wall appeared to be in good condition with a moderate amount of corrosion.

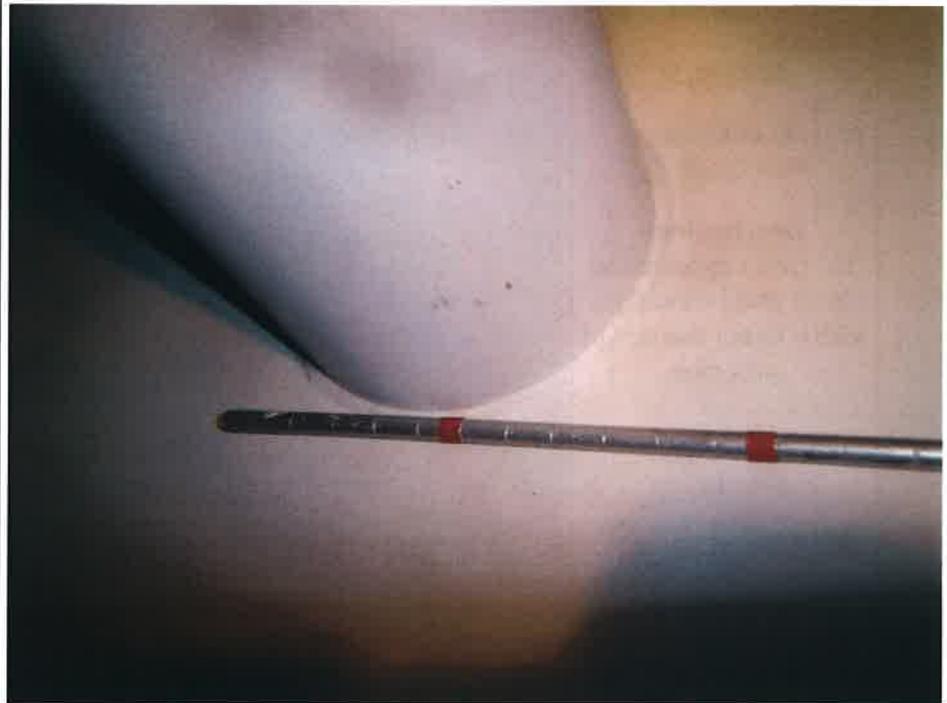


Image #32

Column 6:00

Condition:
Rust Grade' 10.

Description:
8" Column appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #33

Column 4:00

Condition:
Rust Grade¹ 10.

Description:
8" Column appeared to be in good condition with no signs of corrosion.

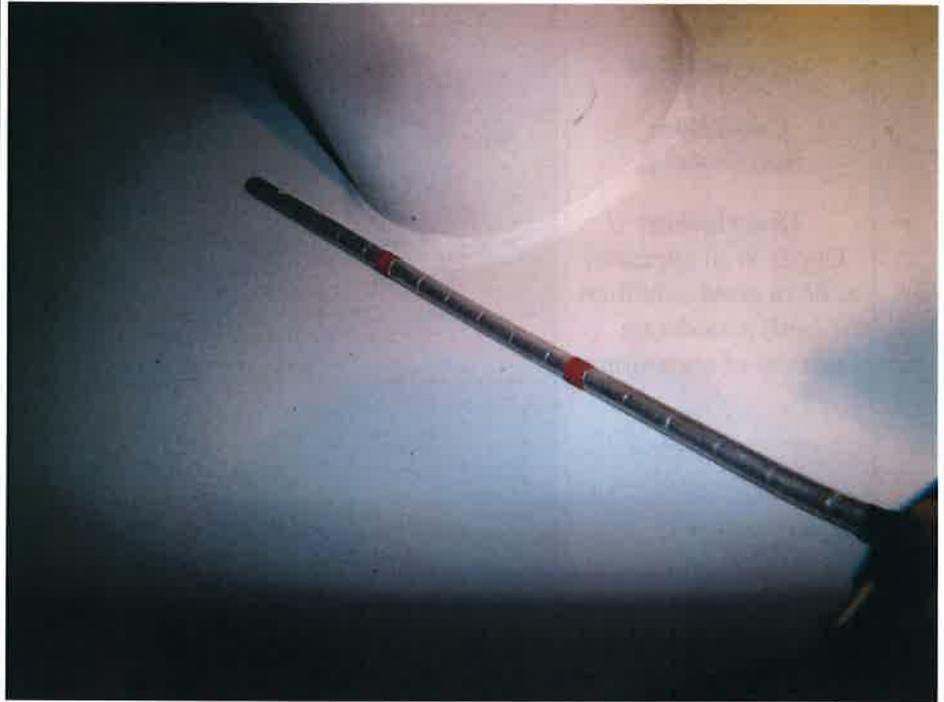


Image #34

Drain 11:55

Condition:
Rust Grade¹ 9.

Description:
18" Drain appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #35

Floor 9:00

Condition:
Rust Grade¹ 10.

Description:
Floor appeared to be in good condition with no signs of corrosion.

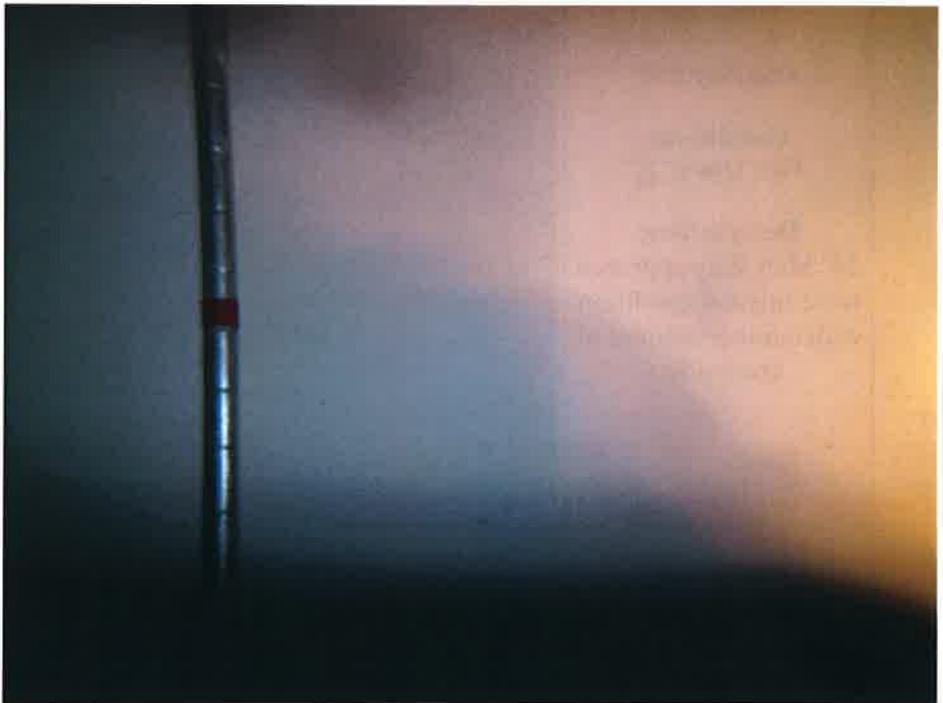


Image #36

Wall 9:00

Condition:
Rust Grade¹ 10.

Description:
Wall appeared to be in good condition with no signs of corrosion.



Montana A Tank

Image #37

Ceiling 9:00

Condition:
Rust Grade¹ 8.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Image #38

Man Way 6:45

Condition:
Rust Grade¹ 7.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.



Montana A Tank

Image #39

Inlet / Outlet 5:30

Condition:
Rust Grade' 8.

Description:
18" Inlet / Outlet
appeared to be in good
condition with a minor
amount of corrosion.

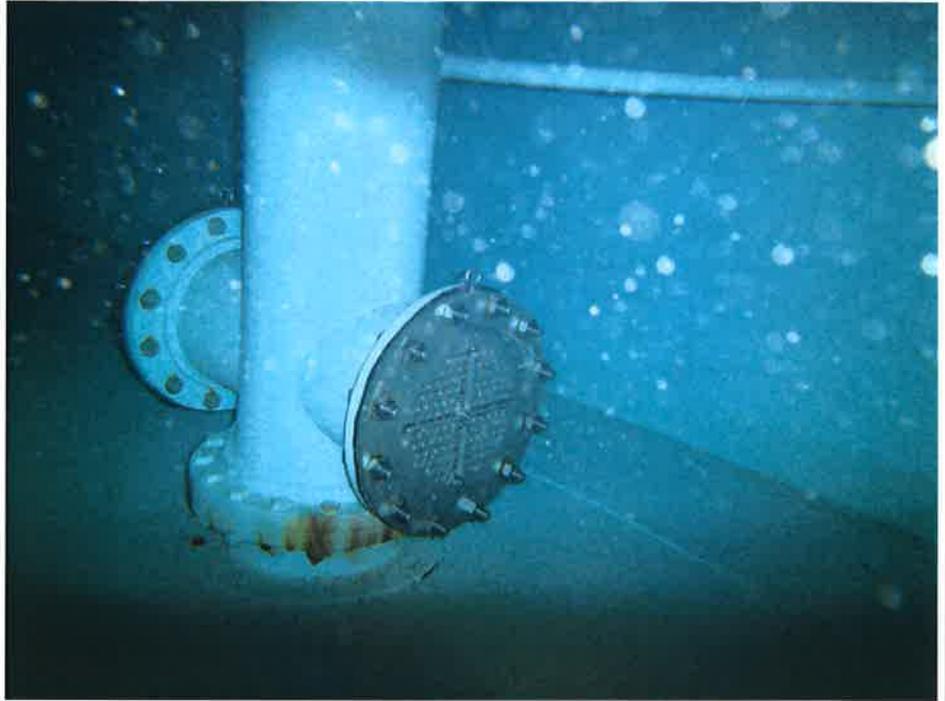
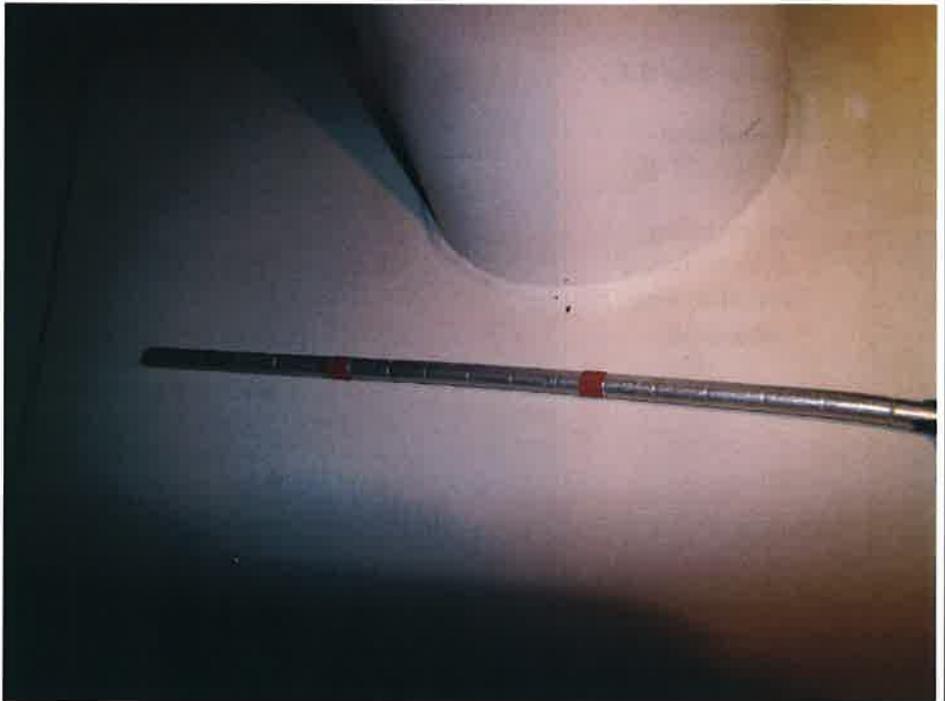


Image #40

Column 8:00

Condition:
Rust Grade' 10.

Description:
8" Column appeared to
be in good condition
with no signs of
corrosion.



Montana A Tank

Image #41

Column Center

Condition:
Rust Grade¹ 10.

Description:
18" Column appeared to be in good condition with no signs of corrosion.

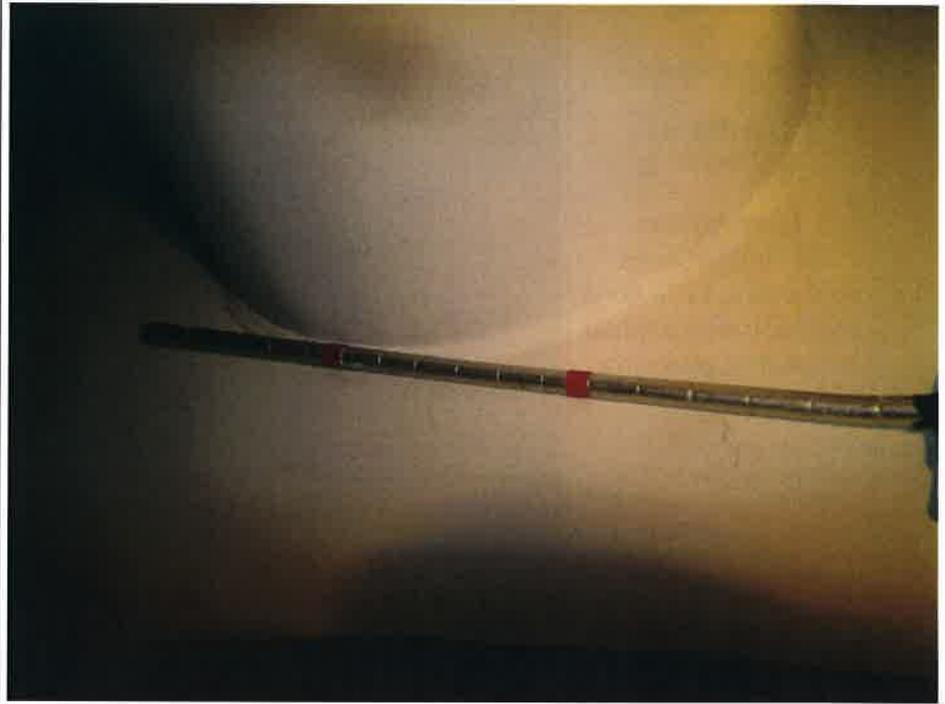


Image #42

Corrosion Spot 8:30

Condition:
Rust Grade¹ 0.

Description:
2" Spot of heavy corrosion was observed.



Montana A Tank

Image #43

Overflow Bell 12:05

Condition:
Rust Grade¹ 10.

Description:
24" Overflow Bell
appeared to be in good
condition with no signs
of corrosion.



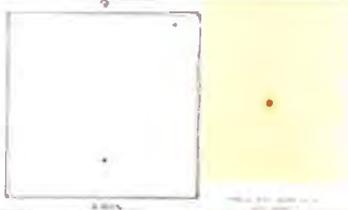
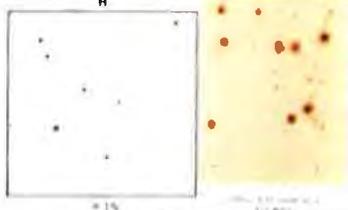
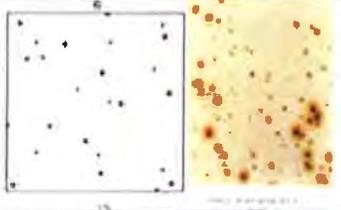
Montana A Tank

REFERENCES:

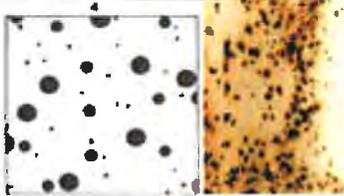
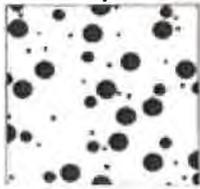
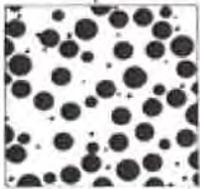
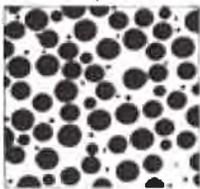
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Montana A Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



**Montana B Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on**

January 22, 2015

By



**LiquiVision
Technology
DIVING SERVICES**



LiquiVision

D I V I N G

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Klamath Falls, OR 97601

www.divinoservices.com

TECHNOLOGY

S E R V I C E S

Western Operations
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Klamath Falls, OR 97601

www.divinoservices.com

Toll Free: (800) 229-6959
Phone: (541) 883-6473
Fax: (541) 883-1361

liquivision@divinoservices.com

Underwater Inspection of Montana B Tank

January 22, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Montana B Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Montana B Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Montana B Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R6T3	Capacity (gal.):	1,001,376
Date of Inspection:	January 22, 2015	Diameter or L x W:	73'
Report Writer:	Chase Hornaday	Height:	32'
Diver:	Cameron Hagerman	Floor Square FT:	4,185.3
Tender:	Bobby Barnicoat	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
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7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

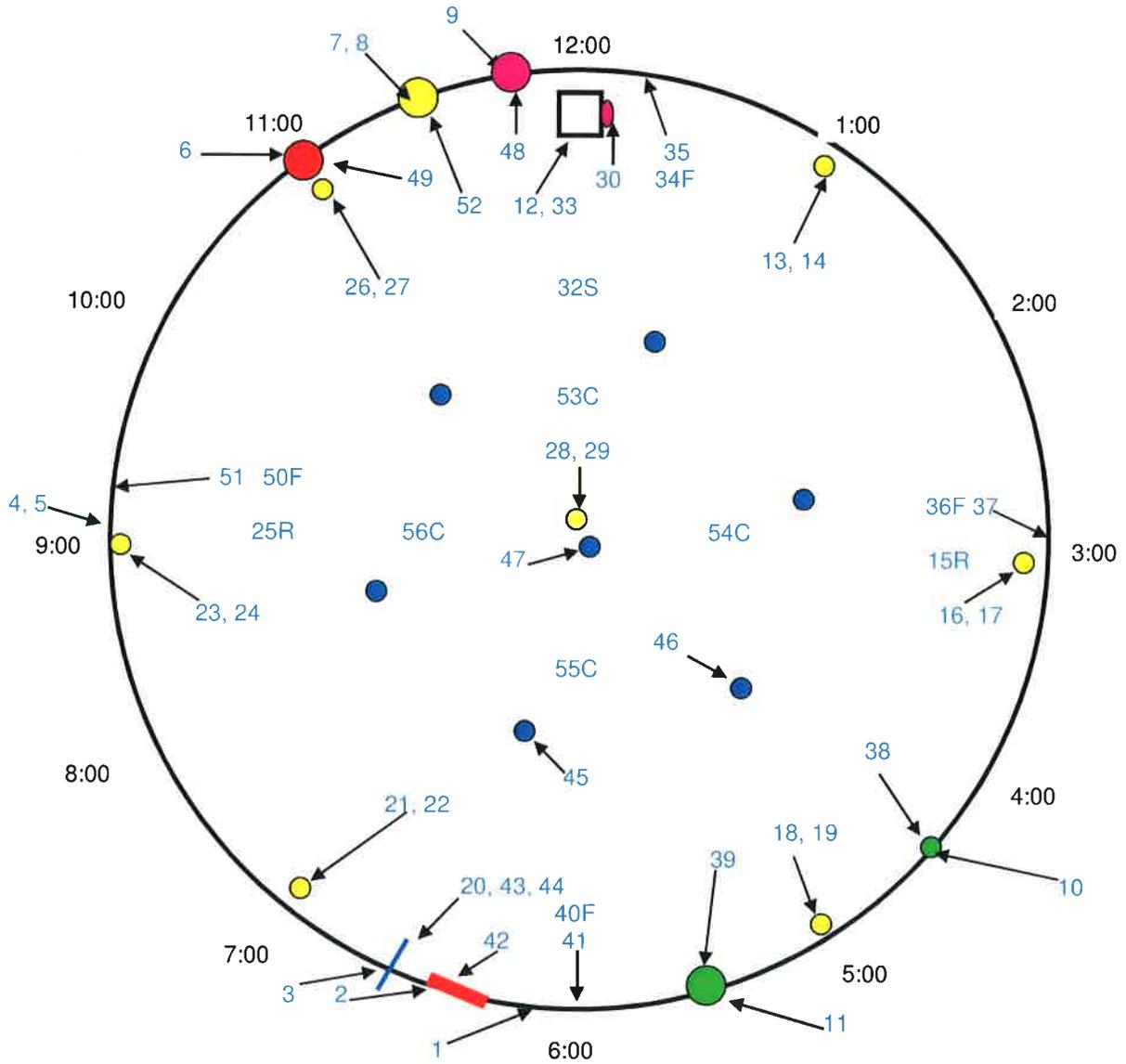
Montana B Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	LiquiVision Technology does not perform this service.
Total Estimated Hours	

Montana B Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Air Vent
	Outlet		Liquid Level Indicator		Capped off penetration
	Drain/Scour		Telemetry		

Montana B Tank

Image #1

Exterior Ladder 6:00

Condition:
Rust Grade' 8.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Man Way 6:10

Condition:
Rust Grade' 7.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #3

*Liquid Level Indicator
Reader Board 6:30*

Condition:
Rust Grade' 8.

Description:
Liquid Level Indicator
Reader Board appeared
to be in good condition
with a minor amount of
corrosion.



Image #4

Exterior Wall 9:00

Condition:
Rust Grade' 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Montana B Tank

Image #5

Exterior Base 9:00

Condition:
Concrete Deform³ GC.

Description:
Exterior Base appeared to be in good condition with no major discrepancies observed.



Image #6

Drain 11:00

Condition:
Rust Grade¹ 8.

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #7

Overflow 11:30

Condition:
Rust Grade¹ 9.

Description:
8" Overflow appeared to be in good condition with a minor amount of corrosion.



Image #8

Overflow Screen 11:30

Condition:
Rust Grade¹ 7.

Description:
Medium Mesh
Overflow Screen
appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #9

Outlet 11:45

Condition:
Rust Grade¹ 9.

Description:
12" Outlet appeared to be in good condition with a minor amount of corrosion.



Image #10

Capped Off Penetration
4:30

Condition:
Rust Grade¹ 9.

Description:
10" Capped Off Penetration appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #11

Inlet 5:30

Condition:
Rust Grade¹ 8.

Description:
10" Outlet appeared to be in good condition with a minor amount of corrosion.



Image #12

Entry Hatch 12:00

Condition:
Rust Grade¹ 5.

Description:
20" Entry Hatch appeared to be in fair condition with a minor amount of corrosion.



Montana B Tank

Image #13

Side Vent 1:00

Condition:
Rust Grade¹ 9.

Description:
30"x10" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.

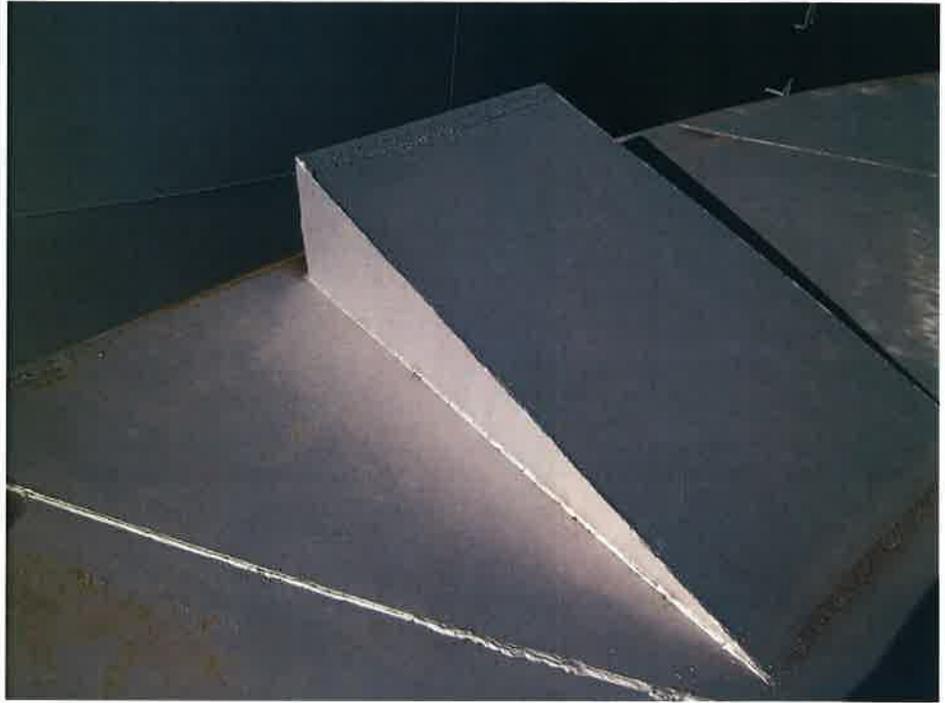


Image #14

Vent Screen 1:00

Condition:
Rust Grade¹ 7.

Description:
Medium Mesh Vent
Screen appeared to be
in good condition with
a minor amount of
corrosion.



Montana B Tank

Image #15

Roof 3:00

Condition:
Rust Grade¹ 8.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.

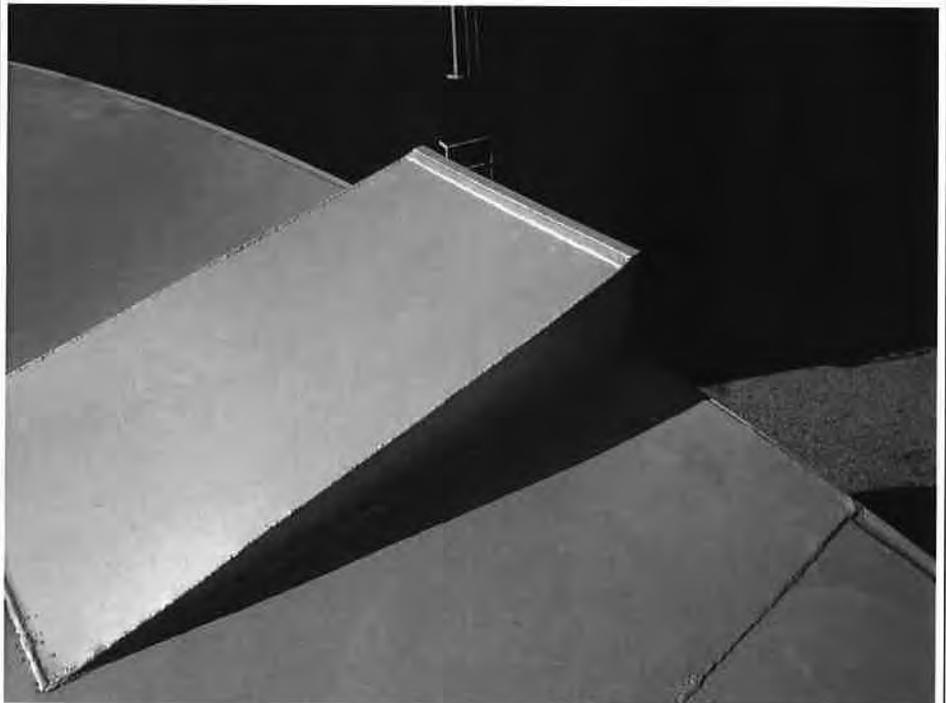


Image #16

Vent 3:00

Condition:
Rust Grade¹ 9.

Description:
30"x10" Vent appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #17

Vent Screen 3:00

Condition:
Rust Grade' 8.

Description:
Medium Mesh Vent
Screen appeared to be in good
condition with a minor amount of
corrosion.

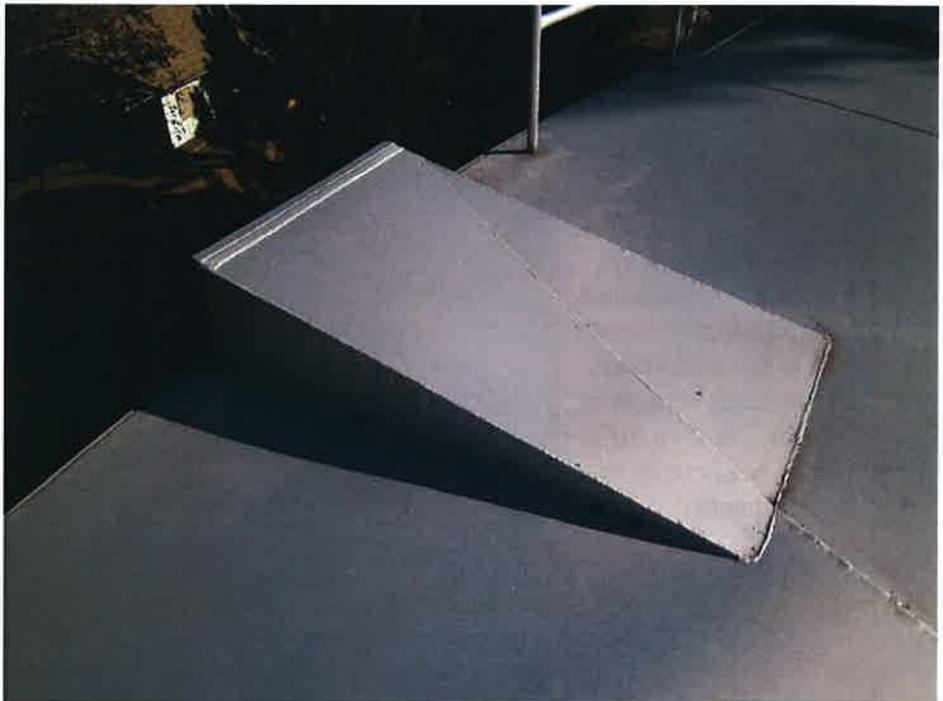


Image #18

Side Vent 5:00

Condition:
Rust Grade' 9.

Description:
30"x10" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Montana B Tank

Image #19

Vent Screen 5:00

Condition:
Rust Grade! 9.

Description:
Medium Mesh Vent
Screen appeared to be
in good condition with
a minor amount of
corrosion.



Image #20

*Liquid Level Indicator
Penetration 6:30*

Condition:
Rust Grade! 6.

Description:
Liquid Level Indicator
Penetration appeared to
be in fair condition
with a minor amount of
corrosion. Cap for
pulley needs to be re-
attached.



Montana B Tank

Image #21

Side Vent 7:00

Condition:
Rust Grade' 9.

Description:
30"x10" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #22

Vent Screen 7:00

Condition:
Rust Grade' 8.

Description:
Medium Mesh Vent
Screen appeared to be
in good condition with
a minor amount of
corrosion.



Montana B Tank

Image #23

Side Vent 9:00

Condition:
Rust Grade¹ 9.

Description:
30"x10" Side Vent appeared to be in good condition with a minor amount of corrosion.



Image #24

Vent Screen 9:00

Condition:
Rust Grade¹ 9.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #25

Roof 9:00

Condition:
Rust Grade' 8.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.

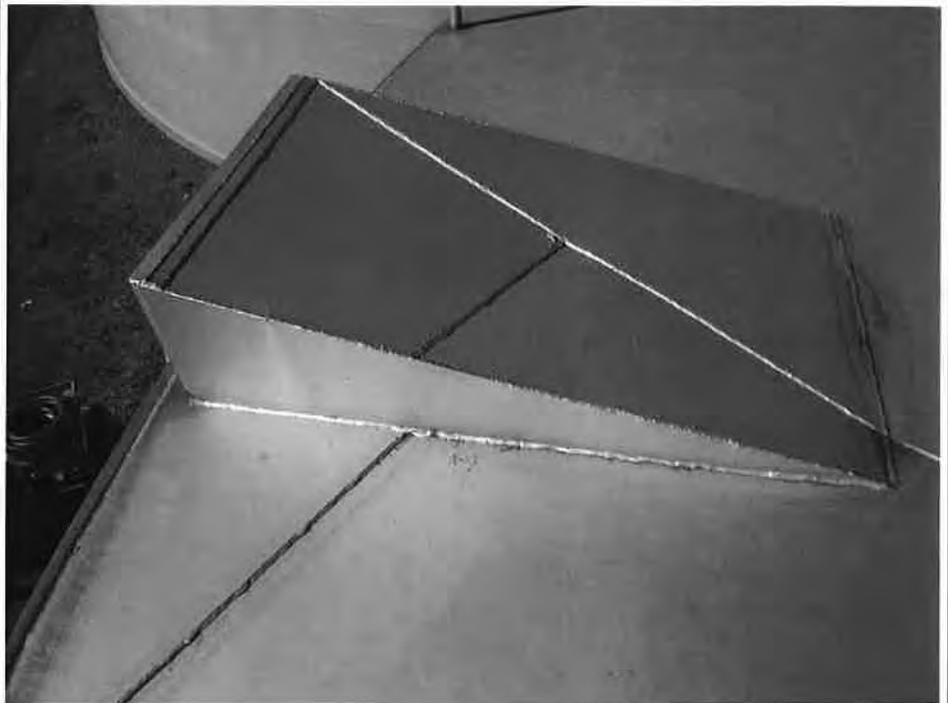


Image #26

Side Vent 11:00

Condition:
Rust Grade' 9.

Description:
30"x10" Side Vent appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #27

Vent Screen 11:00

Condition:
Rust Grade¹ 8.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #28

Vent Center

Condition:
Rust Grade¹ 9.

Description:
40" Vent appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #29

Vent Screen Center

Condition:
Rust Grade¹ 8.

Description:
Medium and Fine Mesh Vent Screens appeared to be in good condition with a minor amount of corrosion.

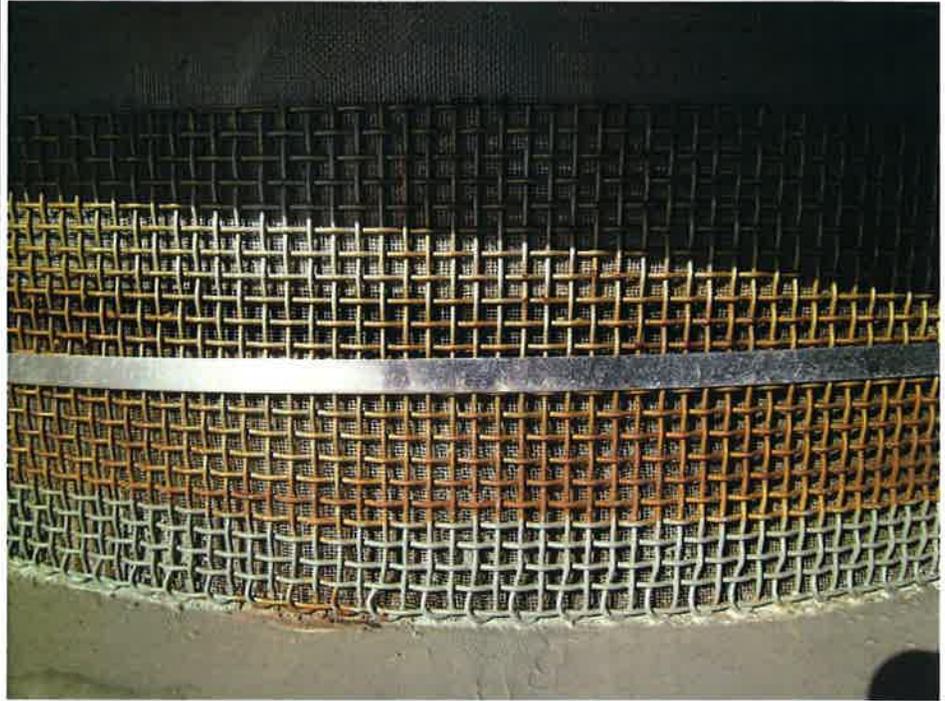


Image #30

*Telemetry Penetration
12:00*

Condition:
Rust Grade¹ 7.

Description:
1" Telemetry Penetration appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #31

Diver



Image #32

Sediment

Description:
1/32" of sediment was removed from reservoir floor.



Montana B Tank

Image #33

Interior Ladder 12:00

Condition:
Rust Grade¹ 7.

Description:
Interior Ladder appeared to be in good condition with a minor amount of corrosion.

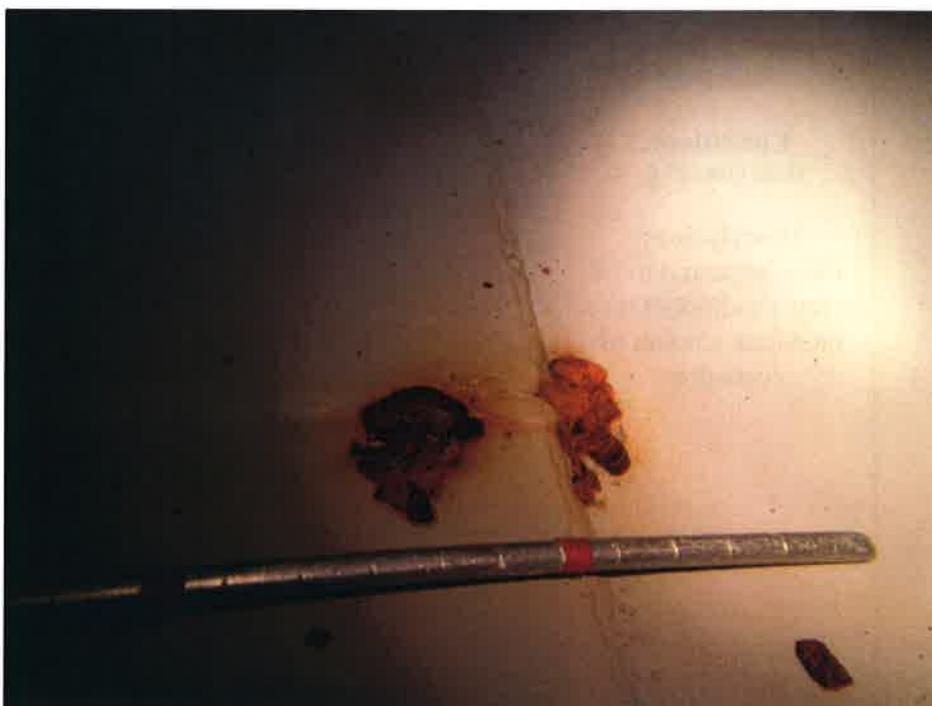


Image #34

Floor 12:00

Condition:
Rust Grade¹ 6.

Description:
Floor appeared to be in fair condition with a moderate amount of corrosion.



Montana B Tank

Image #35

Wall 12:00

Condition:
Rust Grade! 6.

Description:
Wall appeared to be in fair condition with a moderate amount of corrosion.

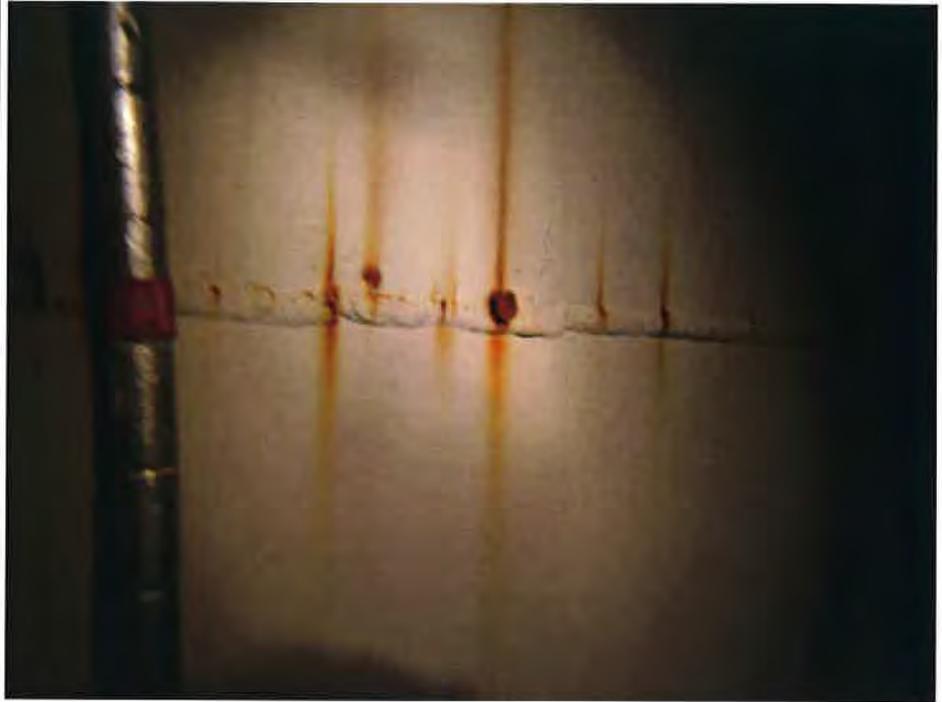


Image #36

Floor 3:00

Condition:
Rust Grade! 6.

Description:
Floor appeared to be in fair condition with a moderate amount of corrosion.



Montana B Tank

Image #37

Wall 3:00

Condition:
Rust Grade¹ 6.

Description:
Wall appeared to be in fair condition with a moderate amount of corrosion.

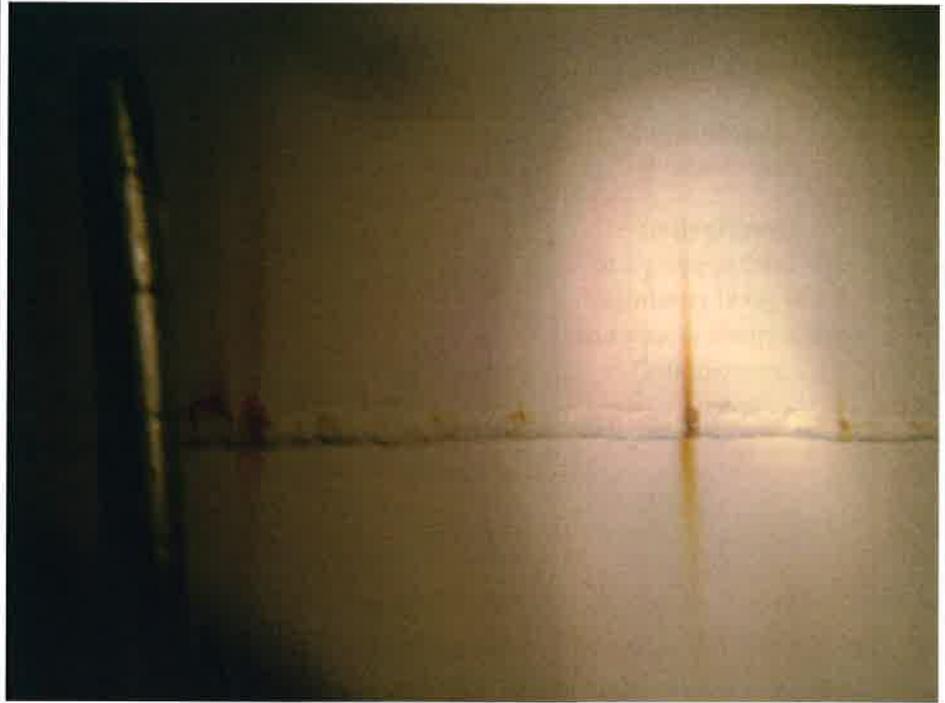


Image #38

Capped Off Penetration
4:30

Condition:
Rust Grade¹ 7.

Description:
10" Capped Off Penetration appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #39

Inlet 5:30

Condition:
Rust Grade¹ 9.

Description:
10" Inlet appeared to be in good condition with a minor amount of corrosion.



Image #40

Floor 6:00

Condition:
Rust Grade¹ 6.

Description:
Floor appeared to be in fair condition with a moderate amount of corrosion.



Montana B Tank

Image #41

Wall 6:00

Condition:
Rust Grade' 6.

Description:
Wall appeared to be in fair condition with a moderate amount of corrosion.



Image #42

Man Way 6:10

Condition:
Rust Grade' 6.

Description:
24" Man Way appeared to be in fair condition with a moderate amount of corrosion.



Montana B Tank

Image #43

*Liquid Level Indicator
Base 6:30*

Condition:
Rust Grade! 1.

Description:
Liquid Level Indicator
Base appeared to be in
fair condition with a
heavy amount of
corrosion.

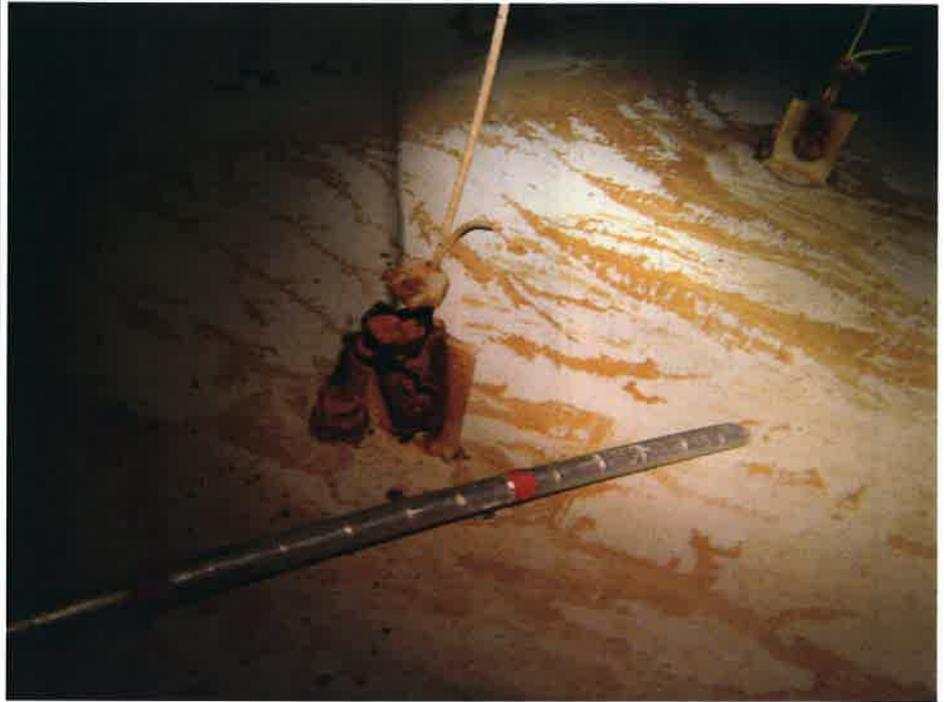


Image #44

*Liquid Level Indicator
Float 6:30*

Condition:
Rust Grade! 9.

Description:
Liquid Level Indicator
Float appeared to be in
good condition with a
minor amount of
corrosion.



Montana B Tank

Image #45

Column 6:30

Condition:
Rust Grade 7.

Description:
8" Column appeared to be in good condition with a minor amount of corrosion.

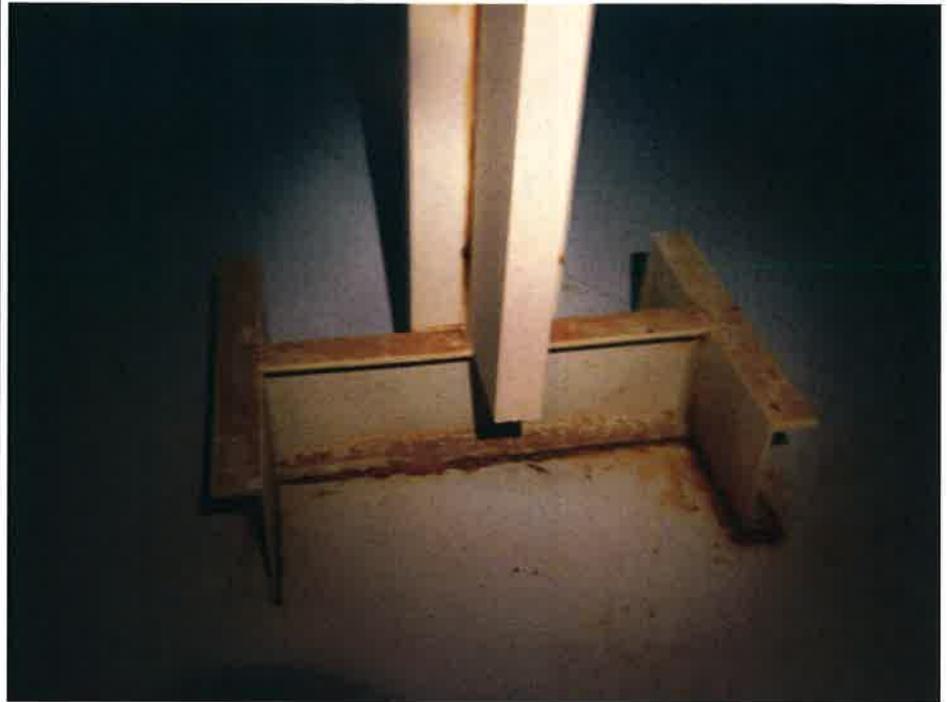


Image #46

Column 4:30

Condition:
Rust Grade 7.

Description:
8" Column appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #47

Center Column

Condition:
Rust Grade¹ 7.

Description:
8" Column appeared to be in good condition with a minor amount of corrosion.

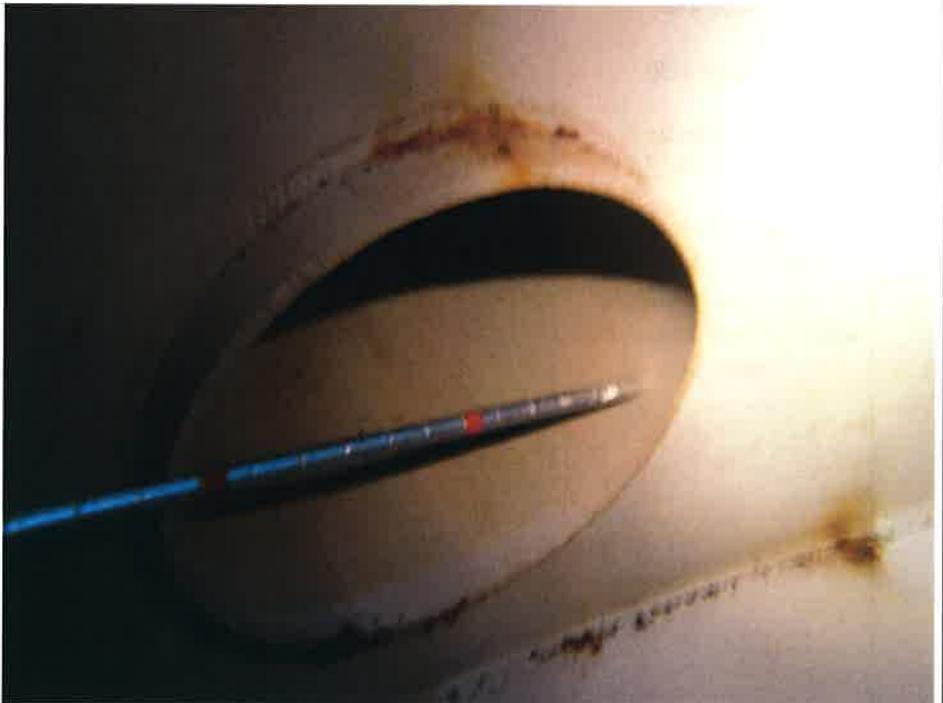


Image #48

Outlet 11:45

Condition:
Rust Grade¹ 7.

Description:
12" Outlet appeared to be in good condition with a minor amount of corrosion.



Montana B Tank

Image #49

Drain 11:00

Condition:
Rust Grade¹ 6.

Description:
8" Drain appeared to be in good condition with a moderate amount of corrosion.

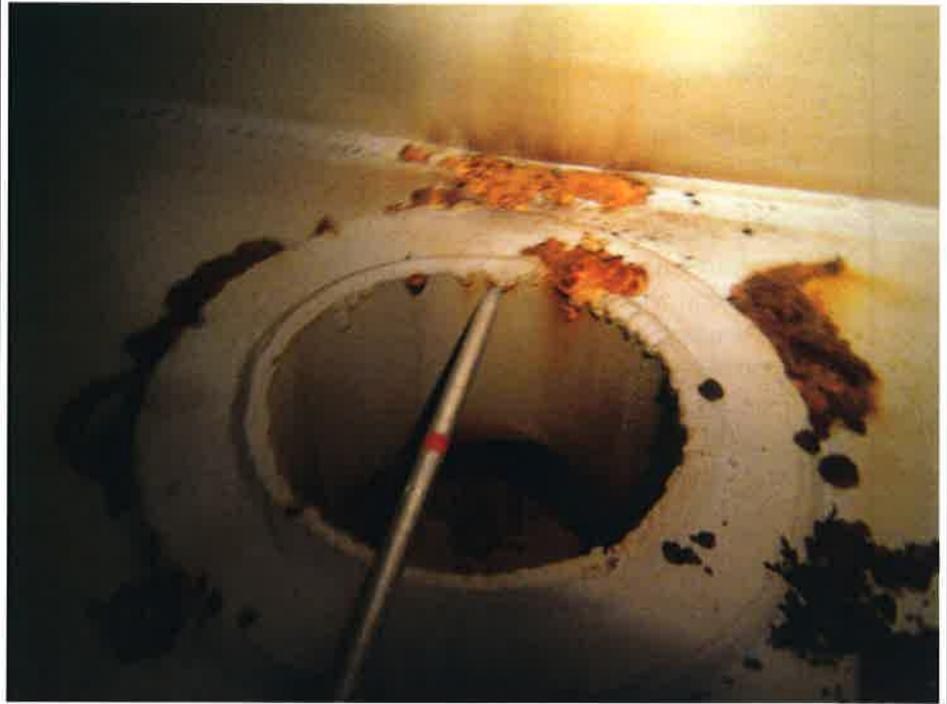
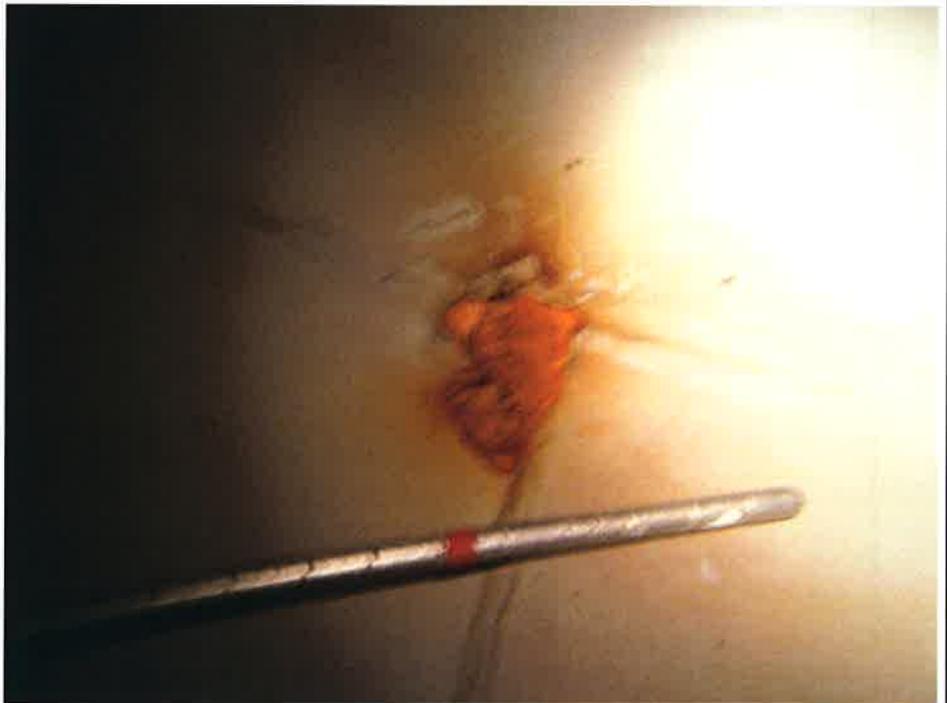


Image #50

Floor 9:00

Condition:
Rust Grade¹ 6.

Description:
Floor appeared to be in fair condition with a moderate amount of corrosion.



Montana B Tank

Image #51

Wall 9:00

Condition:
Rust Grade' 6.

Description:
Wall appeared to be in fair condition with a moderate amount of corrosion.

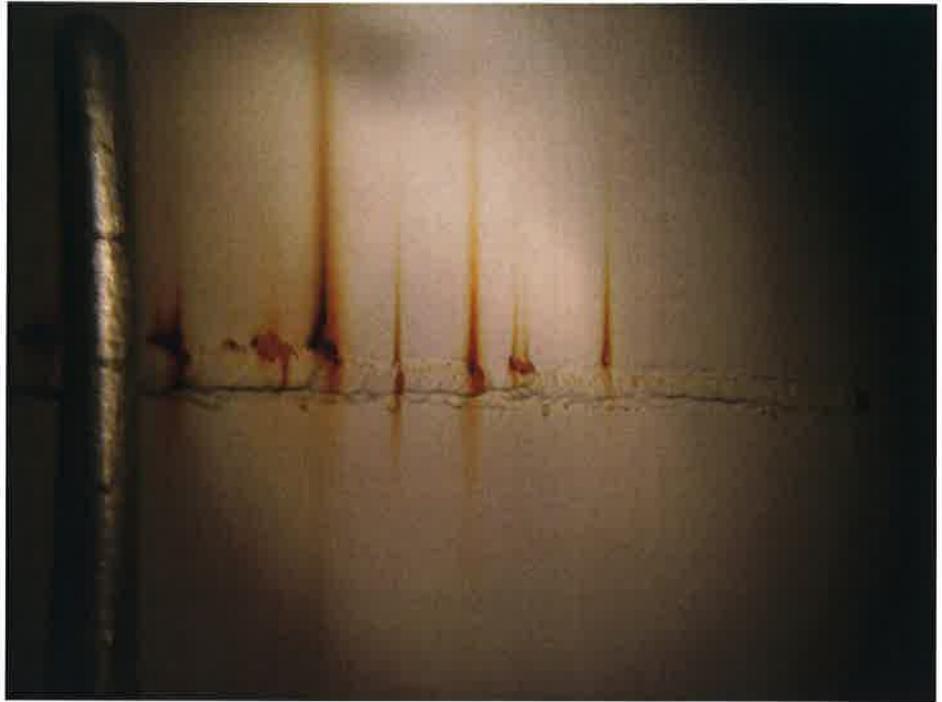


Image #52

Overflow 11:30

Condition:
Rust Grade' 7.

Description:
8'' Overflow appeared to be in good condition with a minor amount of corrosion.



Fair 7

Montana B Tank

Image #53

Ceiling 12:00

Condition:
Rust Grade¹ 6.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Image #54

Ceiling 3:00

Condition:
Rust Grade¹ 6.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Montana B Tank

Image #55

Ceiling 6:00

Condition:
Rust Grade¹ 6.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Image #56

Ceiling 9:00

Condition:
Rust Grade¹ 6.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



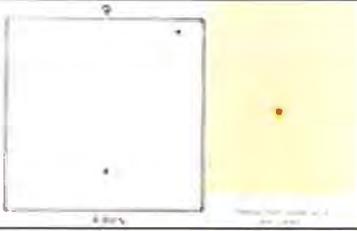
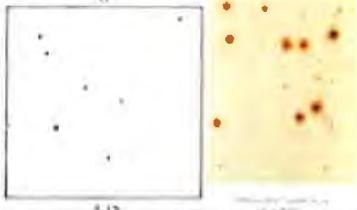
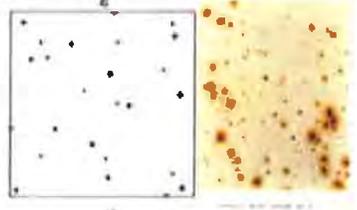
Montana B Tank

REFERENCES:

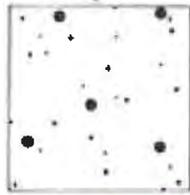
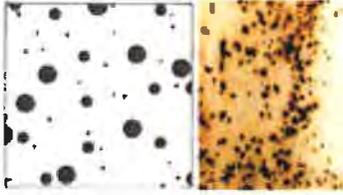
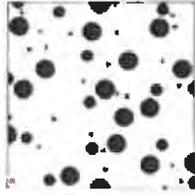
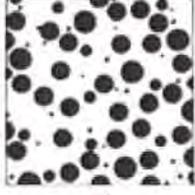
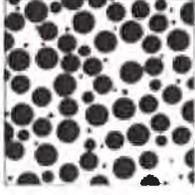
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces
 – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

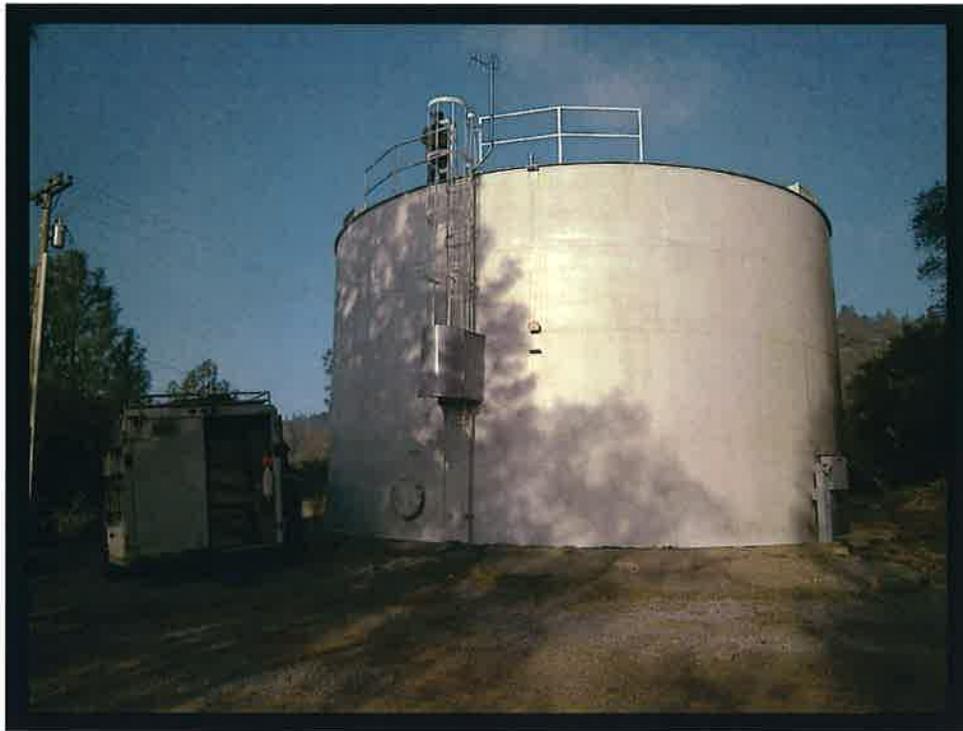
The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Montana B Tank

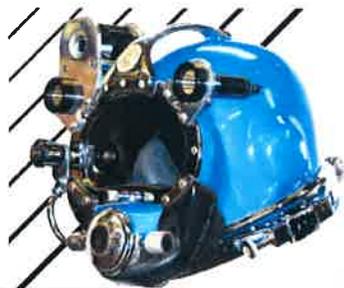
5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



Picard Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on

January 22, 2015

By



LiquiVision
Technology
DIVING SERVICES



LiquiVision
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liquivision@divinoservices.com

Toll Free: (800) 228-6959
Phone: (541) 883-5473
Fax: (541) 883-1361

Underwater Inspection of Picard Tank

January 22, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Picard Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Picard Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Picard Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R1T3	Capacity (gal.):	186,548
Date of Inspection:	January 22, 2015	Diameter or L x W:	38'
Report Writer:	Chase Hornaday	Height:	22'
Diver:	Cameron Hagerman	Floor Square FT:	1,134.1
Tender:	Bobby Barnicoat	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

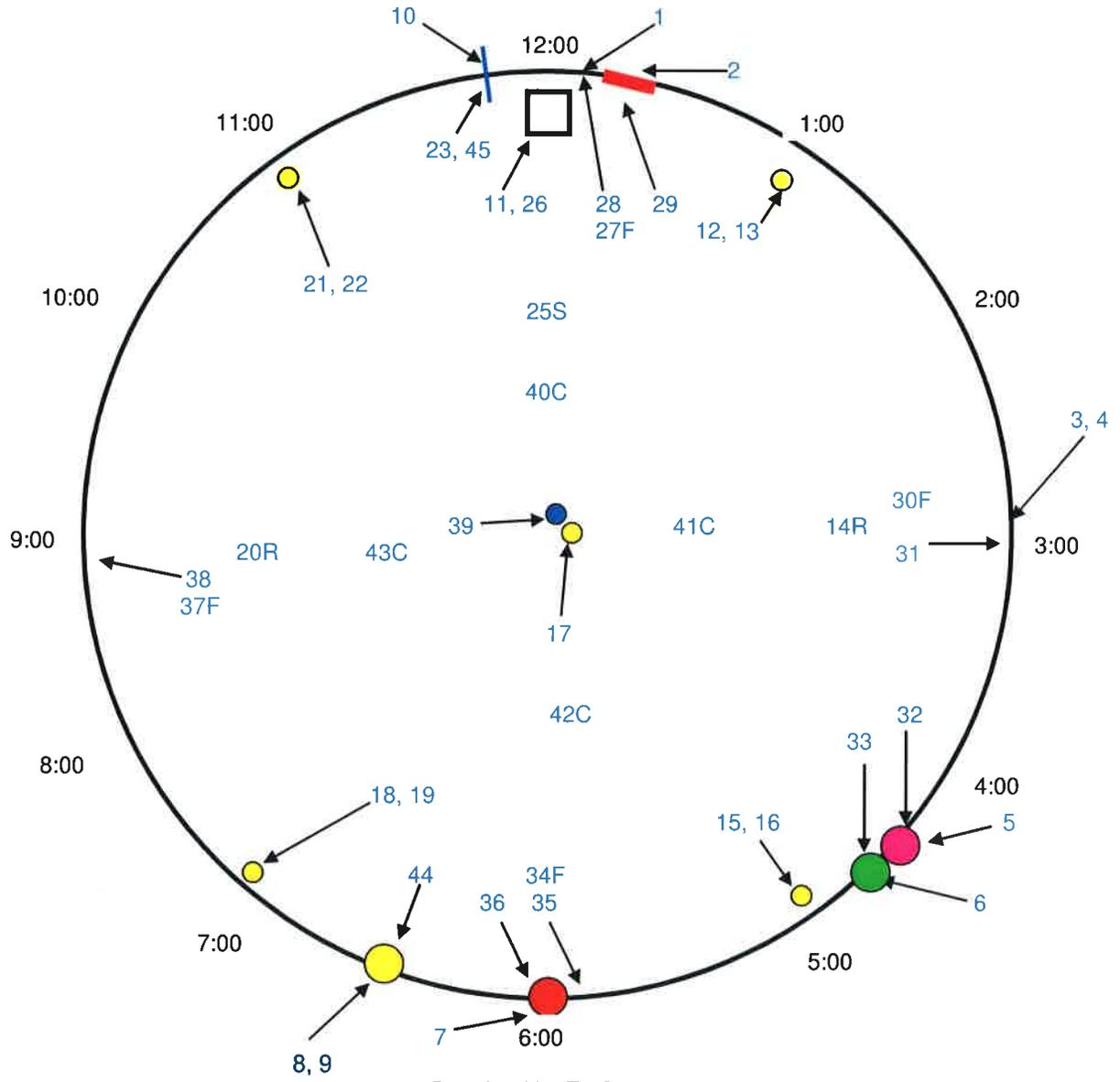
Picard Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Replace liquid level indicator float with a more durable stainless steel type float. Consider replacing the liquid level indicator reader board with a more legible one. If the liquid level indicator is not needed then you may want to consider removing it instead.	Please contact our sales office for an estimate.
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	LiquiVision Technology does not perform this service.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Picard Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Drain/Scour
	Outlet		Liquid Level Indicator		Air Vent

Picard Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.

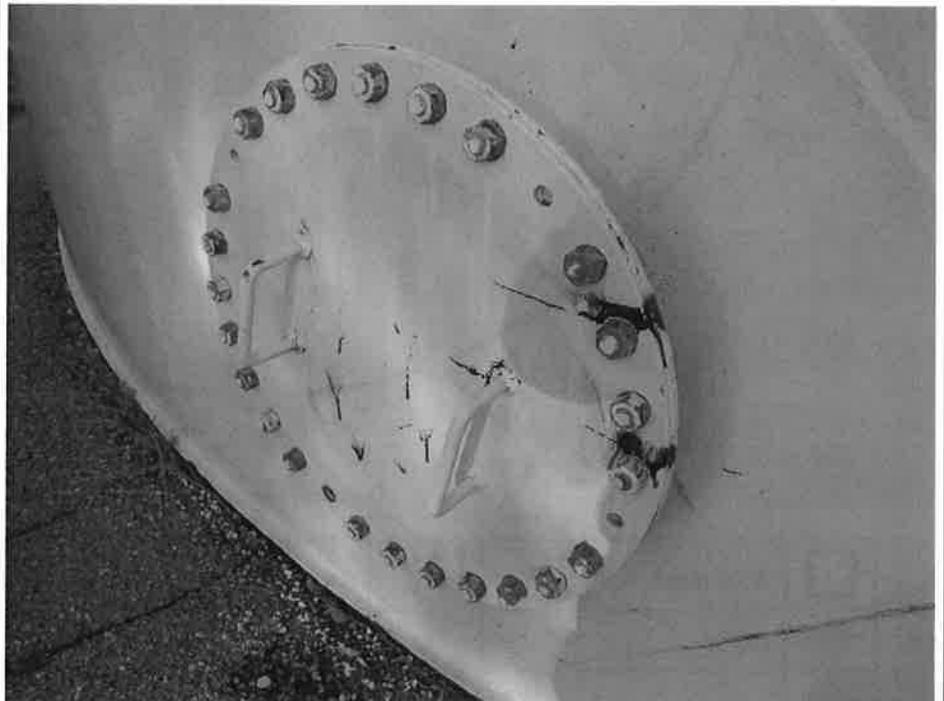


Image #2

Man Way 12:05

Condition:
Rust Grade¹ 8.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #3

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Image #4

Exterior Base 3:00

Condition:
Concrete Deform³ CK.

Description:
Exterior Base
appeared to be in fair
condition with a
moderate amount of
cracking.



Picard Tank

Image #5

Outlet 4:30

Condition:
Rust Grade 9.

Description:
8" Outlet appeared to be in good condition with a minor amount of corrosion.



Image #6

Inlet 4:35

Condition:
Rust Grade 9.

Description:
10" Inlet appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #7

Drain 6:00

Condition:
Rust Grade' 7.

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.



Image #8

Overflow 6:30

Condition:
Rust Grade' 9.

Description:
8" Overflow appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #9

Overflow Screen 6:30

Condition:
Rust Grade¹ 6.

Description:
Medium Mesh
Overflow Screen
appeared to be in good
condition with a
moderate amount of
corrosion.

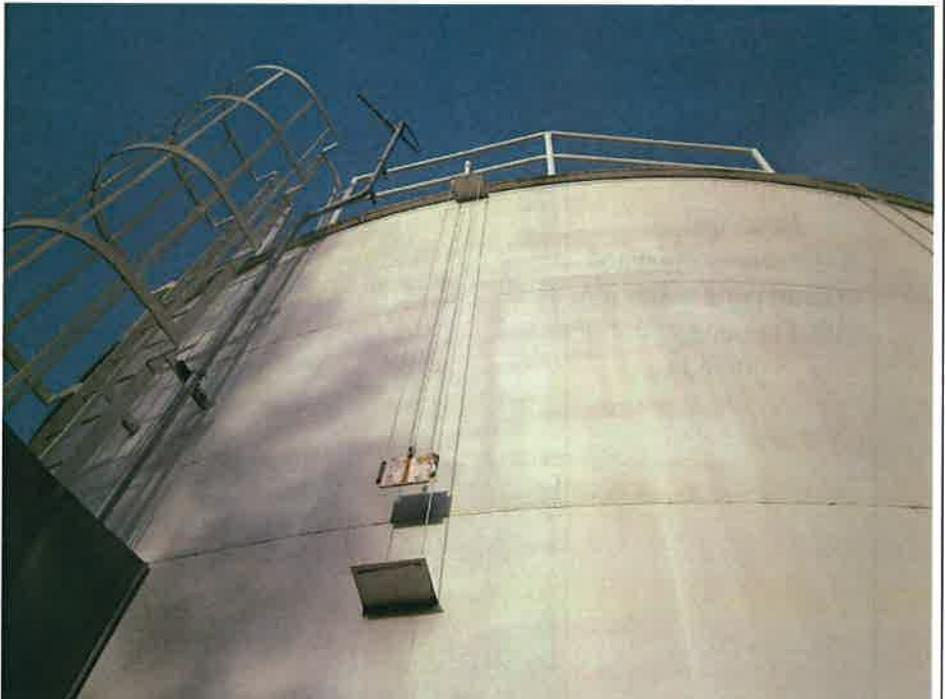


Image #10

*Liquid Level Indicator
Reader Board 11:55*

Condition:
Rust Grade¹ 8.

Description:
Liquid Level Indicator
Reader Board appeared
to be in good condition
with a minor amount of
corrosion.



Picard Tank

Image #11

Entry Hatch 12:00

Condition:
Rust Grade' 8.

Description:
24"x24" Entry Hatch appeared to be in good condition with a minor amount of corrosion.



Image #12

Side Vent 1:00

Condition:
Rust Grade' 9.

Description:
30"x8" Side Vent appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #13

Vent Screen 1:00

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #14

Roof 3:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.



Picard Tank

Image #15

Side Vent 5:00

Condition:
Rust Grade' 9.

Description:
30"x8" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.

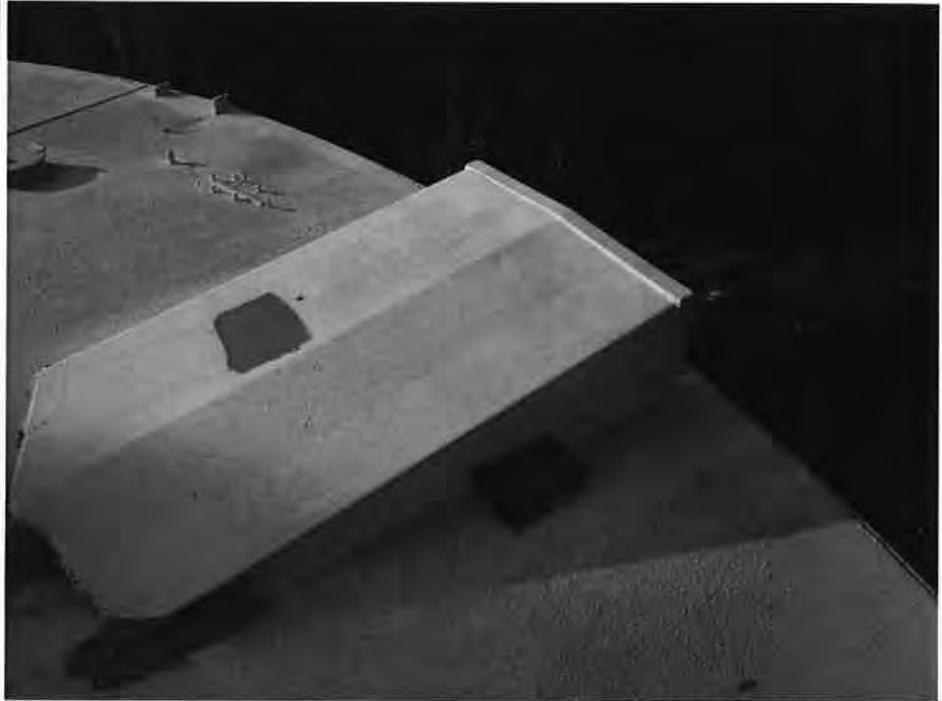


Image #16

Vent Screen 5:00

Condition:
Rust Grade' 8.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Picard Tank

Image #17

Vent Center

Condition:
Rust Grade' 8.

Description:
40" Vent appeared to be sealed and no longer in working condition.

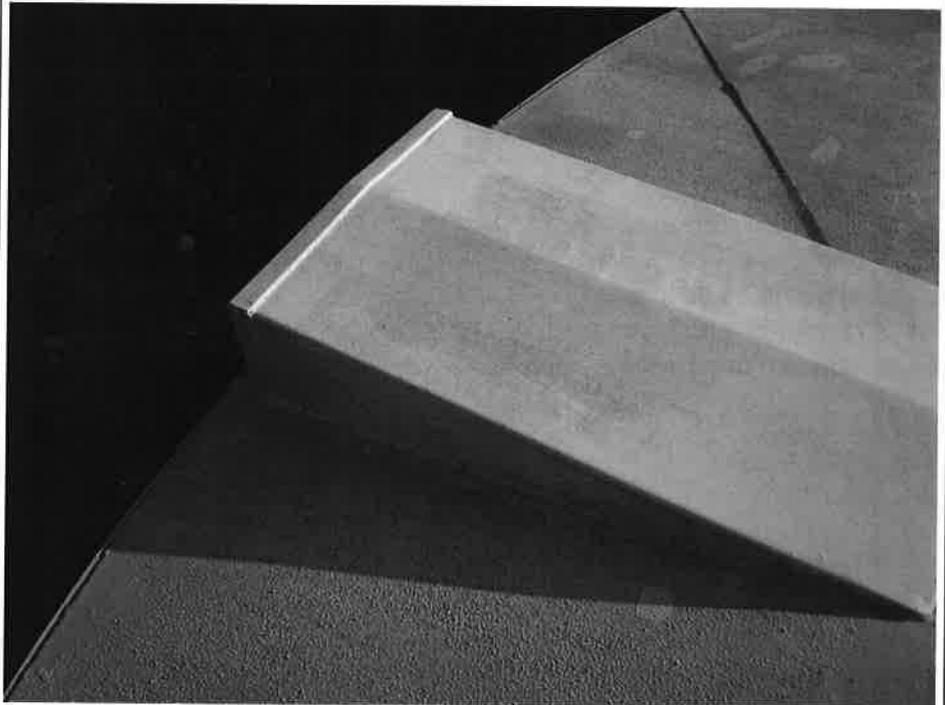


Image #18

Side Vent 7:00

Condition:
Rust Grade' 9.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #19

Vent Screen 7:00

Condition:
Rust Grade' 9.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #20

Roof 9:00

Condition:
Rust Grade' 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.



Picard Tank

Image #21

Side Vent 11:00

Condition:
Rust Grade' 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #22

Vent Screen 11:00

Condition:
Rust Grade' 8.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Picard Tank

Image #23

*Liquid Level Indicator
Penetration 11:55*

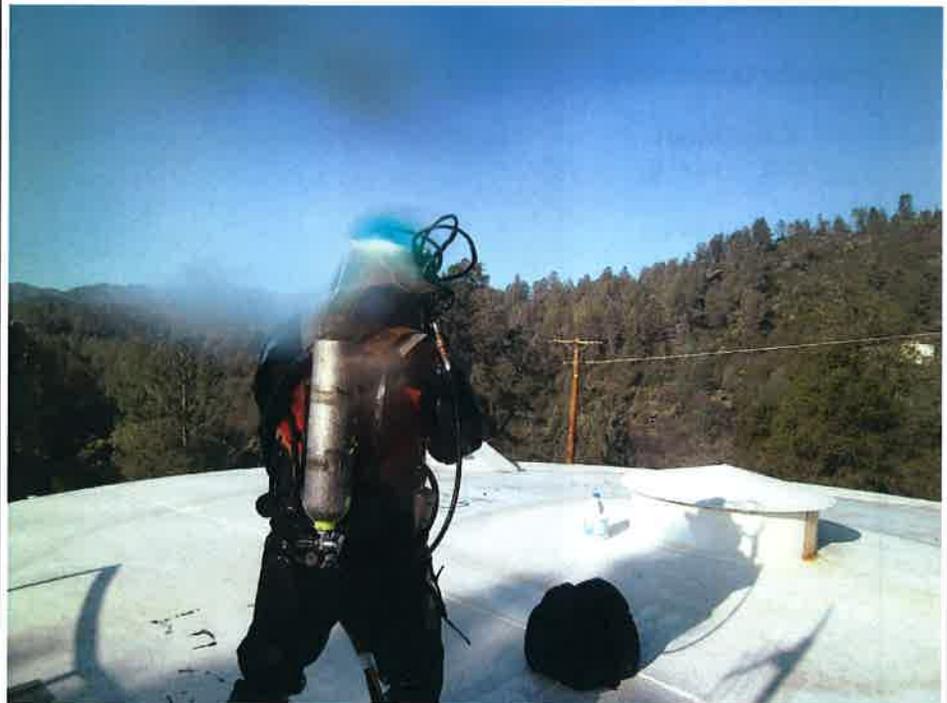
Condition:
Rust Grade¹ 9.

Description:
1" Liquid Level
Indicator Penetration
appeared to be in good
condition with a minor
amount of corrosion.



Image #24

Diver



Picard Tank

Image #25

Sediment

Description:
1/32" of sediment was removed from reservoir floor.



Image #26

Interior Ladder 12:00

Condition:
Rust Grade¹ 6.

Description:
Interior Ladder appeared to be in good condition with a moderate amount of corrosion.



Picard Tank

Image #27

Floor 12:00

Condition:
Rust Grade' 7.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Image #28

Wall 12:00

Condition:
Rust Grade' 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Picard Tank

Image #29

Man Way 12:05

Condition:
Rust Grade' 8.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion. Moderate amounts of corrosion were observed on Wall surrounding Man Way.

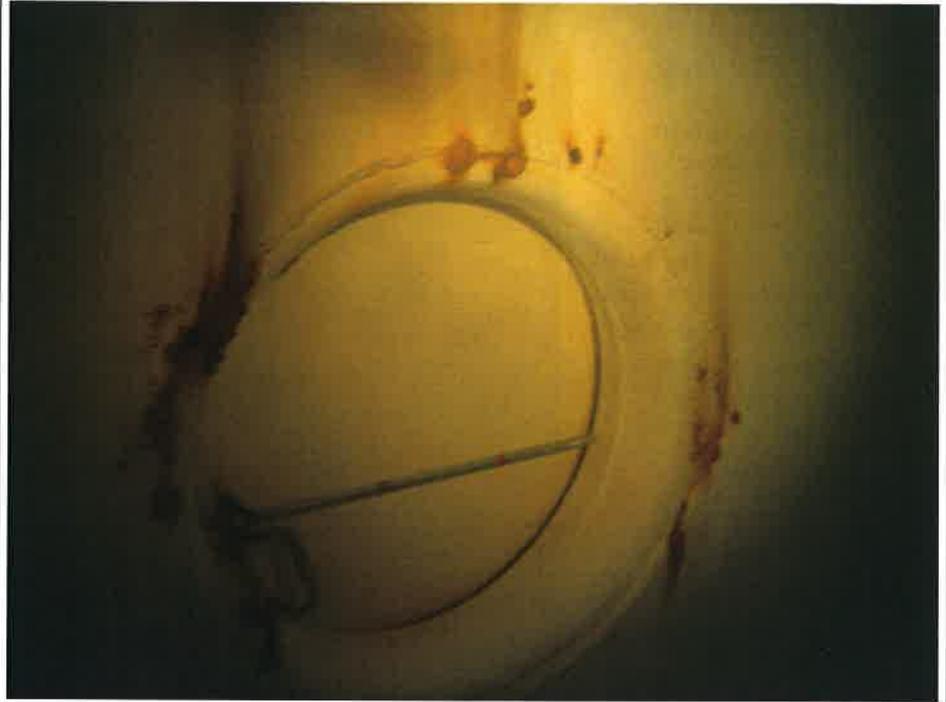


Image #30

Floor 3:00

Condition:
Rust Grade' 7.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Picard Tank

Image #31

Wall 3:00

Condition:
Rust Grade¹ 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Image #32

Outlet 4:30

Condition:
Rust Grade¹ 7.

Description:
8" Outlet appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #33

Inlet 4:35

Condition:
Rust Grade' 7.

Description:
10" Inlet appeared to be in good condition with a minor amount of corrosion.

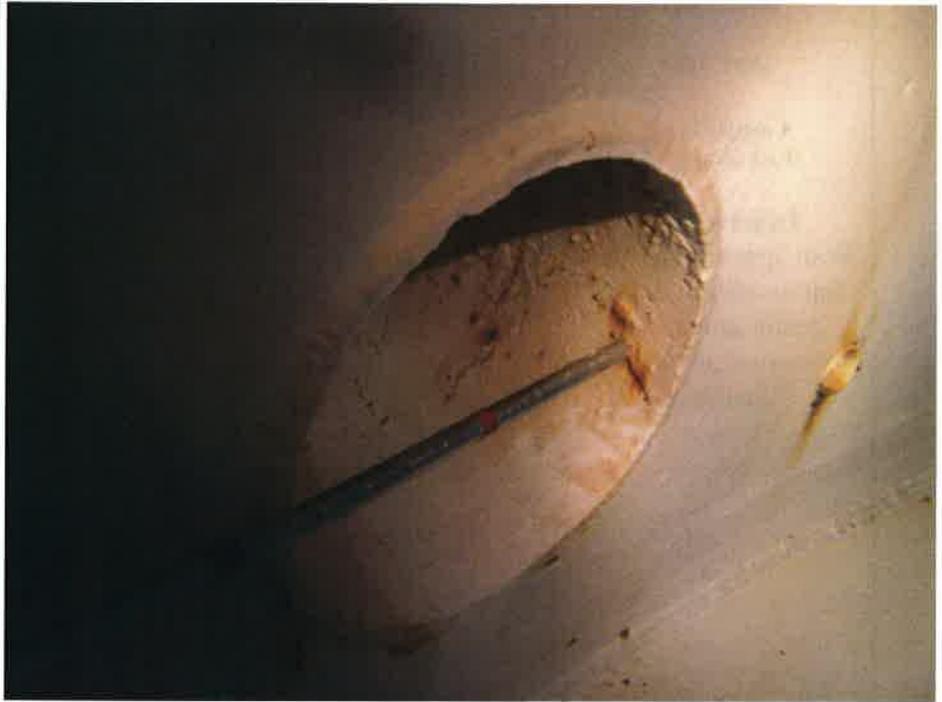
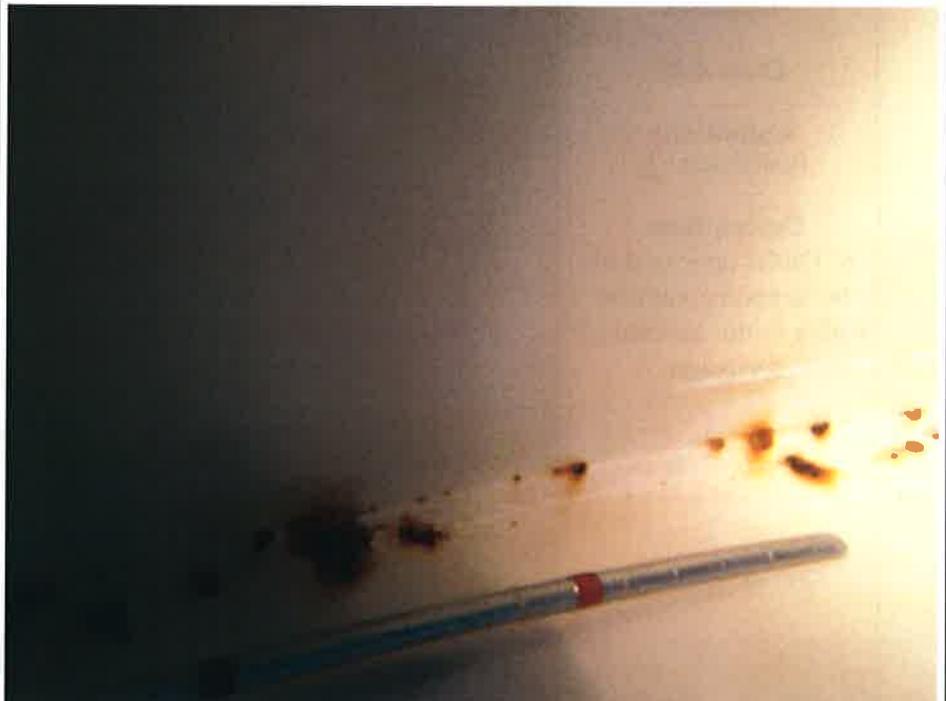


Image #34

Floor 6:00

Condition:
Rust Grade' 7.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Picard Tank

Image #35

Wall 6:00

Condition:
Rust Grade' 7.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Image #36

Drain 6:00

Condition:
Rust Grade' 1.

Description:
6" Drain appeared to be in fair condition with a heavy amount of corrosion.



Picard Tank

Image #37

Floor 9:00

Condition:
Rust Grade¹ 7.

Description:
Floor appeared to be in fair condition with a minor amount of corrosion and heavy chalking.

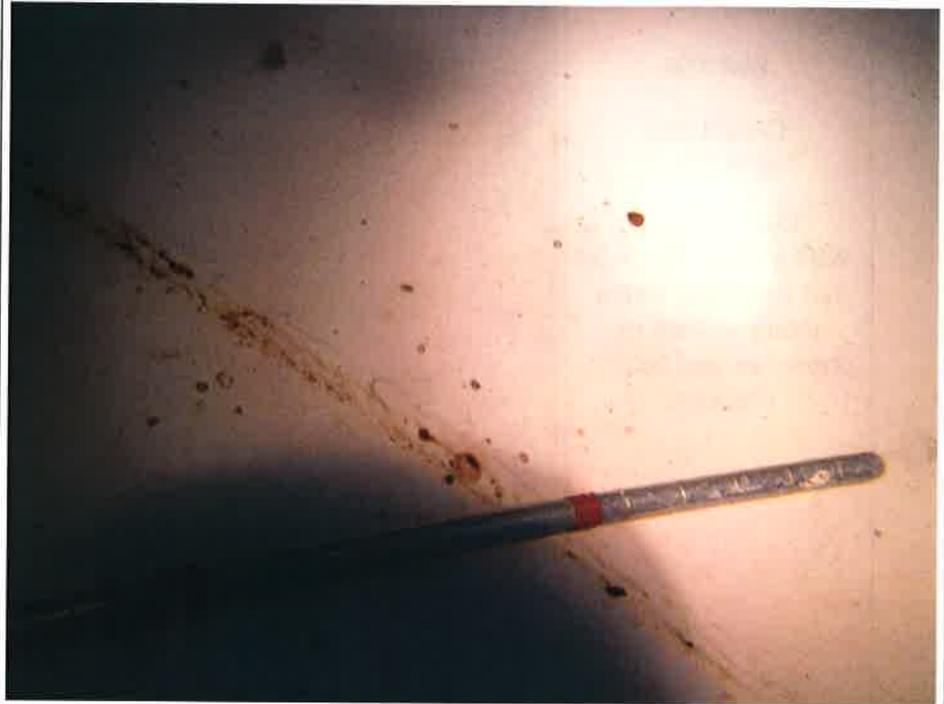


Image #38

Wall 9:00

Condition:
Rust Grade¹ 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and heavy chalking.



Picard Tank

Image #39

Column Center

Condition:
Rust Grade¹ 6.

Description:
6" Column appeared to be in fair condition with a moderate amount of corrosion.

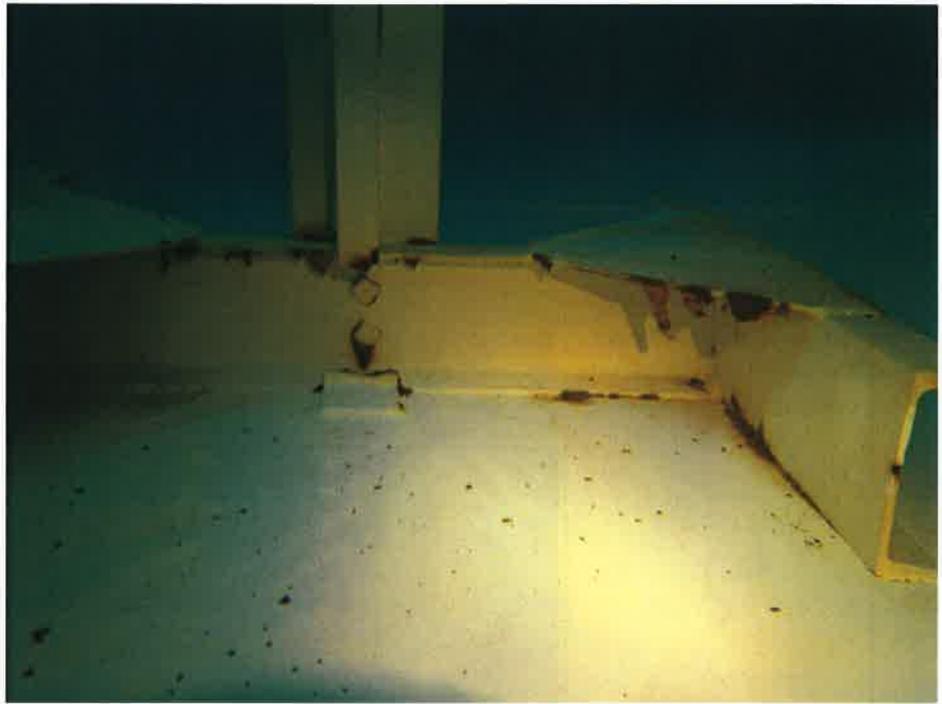


Image #40

Ceiling 12:00

Condition:
Rust Grade¹ 1.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion and moderate delamination observed.



Picard Tank

Image #41

Ceiling 3:00

Condition:
Rust Grade¹ 1.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion and moderate delamination observed.

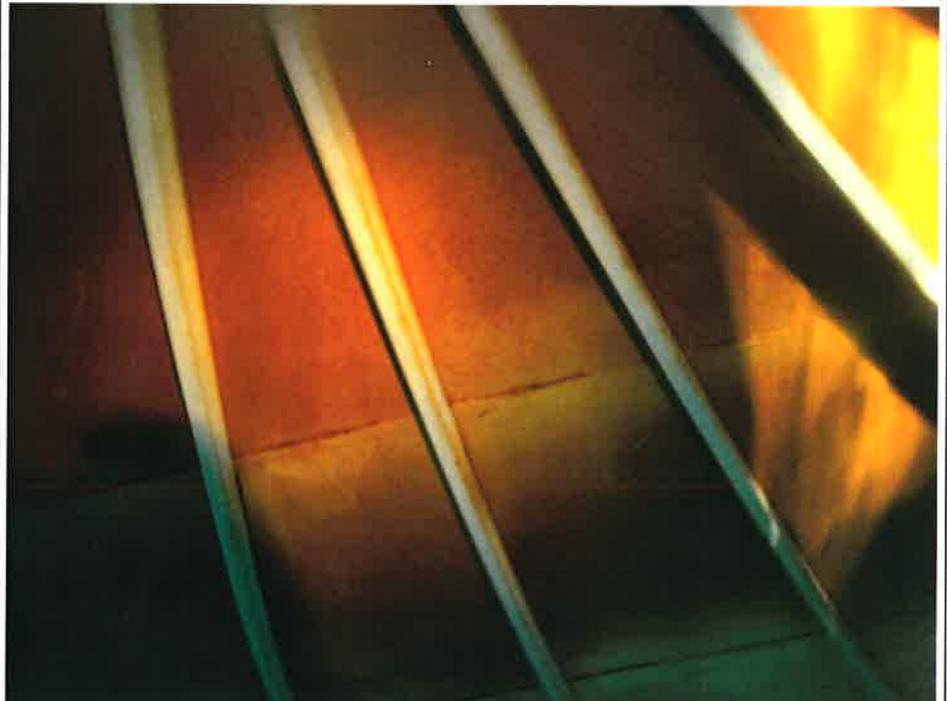


Image #42

Ceiling 6:00

Condition:
Rust Grade¹ 1.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion and moderate delamination observed.



Picard Tank

Image #43

Ceiling 9:00

Condition:
Rust Grade' 1.

Description:
Ceiling appeared to be in poor condition with a heavy amount of corrosion and moderate delamination observed.



Image #44

Overflow 6:30

Condition:
Rust Grade' 7.

Description:
48"x18"x6" Overflow appeared to be in good condition with a minor amount of corrosion.



Picard Tank

Image #45

*Liquid Level Indicator
Float 11:55*

Condition:
Float was suspended
above water line and
did not appear to be in
good working
condition.



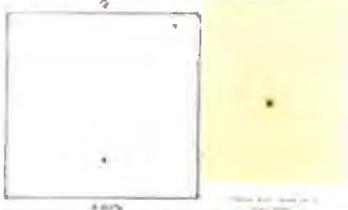
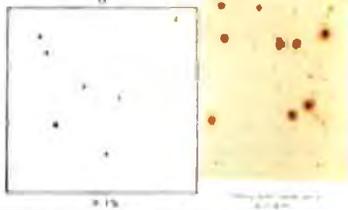
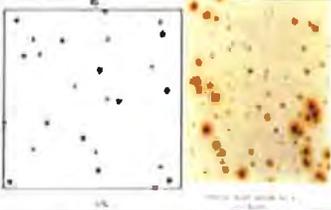
Picard Tank

REFERENCES:

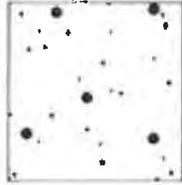
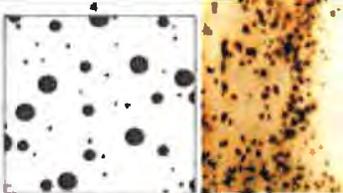
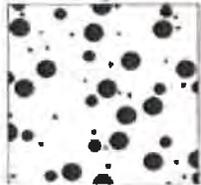
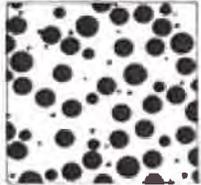
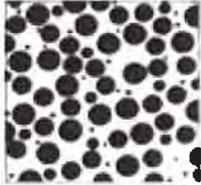
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Picard Tank

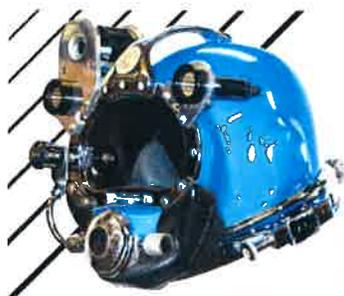
5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



**Raw Water Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on**

January 23, 2015

By



**LiquiVision
Technology
DIVING SERVICES**





LiquiVision
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Klamath Falls, OR 97601
liquivision@divinoservices.com

Toll Free: (800) 229-6959
Phone: (541) 883-6473
Fax: (541) 883-1361

Underwater Inspection of Raw Water Tank

January 23, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Raw Water Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Raw Water Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Raw Water Reservoir
Manager:	Tony Thomasy	Construction:	OG Bolted
Job Number:	A8302315R8T3	Capacity (gal.):	166,266
Date of Inspection:	January 23, 2015	Diameter or L x W:	33'
Report Writer:	Chase Hornaday	Height:	26'
Diver:	Cameron Hagerman	Floor Square FT:	855.3
Tender:	Bobby Barnicoat	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

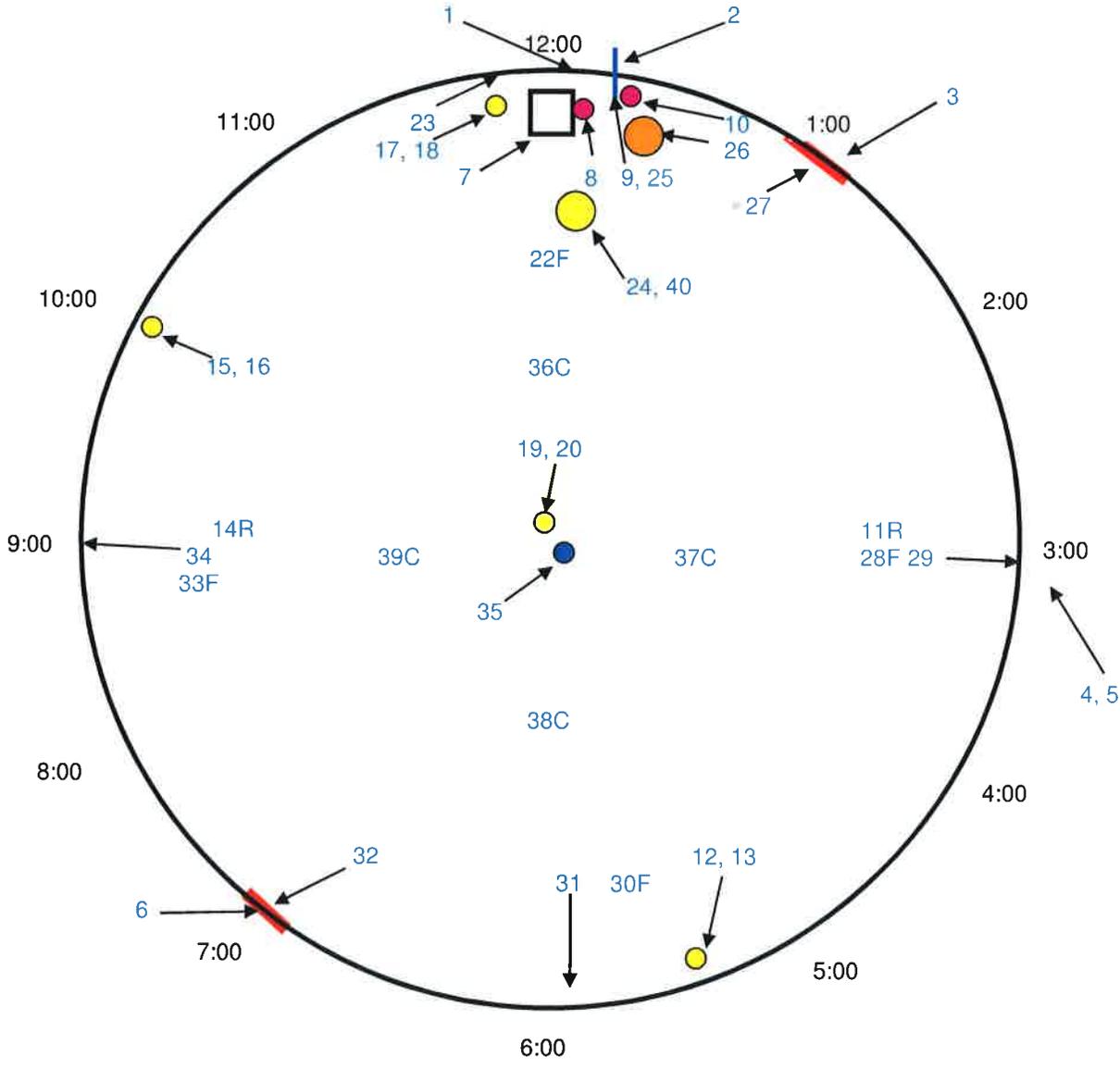
Raw Water Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Raw Water Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Common Inlet/Outlet		Man Entry		Telemetry
	Air Vent		Liquid Level Indicator		

Raw Water Tank

Image #1

Exterior Ladder 12:10

Condition:
Rust Grade' 10.

Description:
Exterior Ladder appeared to be in good condition with no signs of corrosion.



Image #2

Liquid Level Indicator Reader Board 12:10

Condition:
Rust Grade' 9.

Description:
Liquid Level Indicator Reader Board appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #3

Man Way 1:00

Condition:
Rust Grade¹ 9.

Description:
30" Man Way appeared to be in good condition with a minor amount of corrosion.



Image #4

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #5

Exterior Base 3:00

Condition:
Concrete Deform³ GC.

Description:
Exterior Base appeared to be in good condition with no concrete problems.



Image #6

Man Way 7:00

Condition:
Rust Grade¹ 9.

Description:
30" Man Way appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #7

Entry Hatch 12:00

Condition:
Rust Grade¹ 9.

Description:
36"x36" Entry Hatch appeared to be in good condition with a minor amount of corrosion.

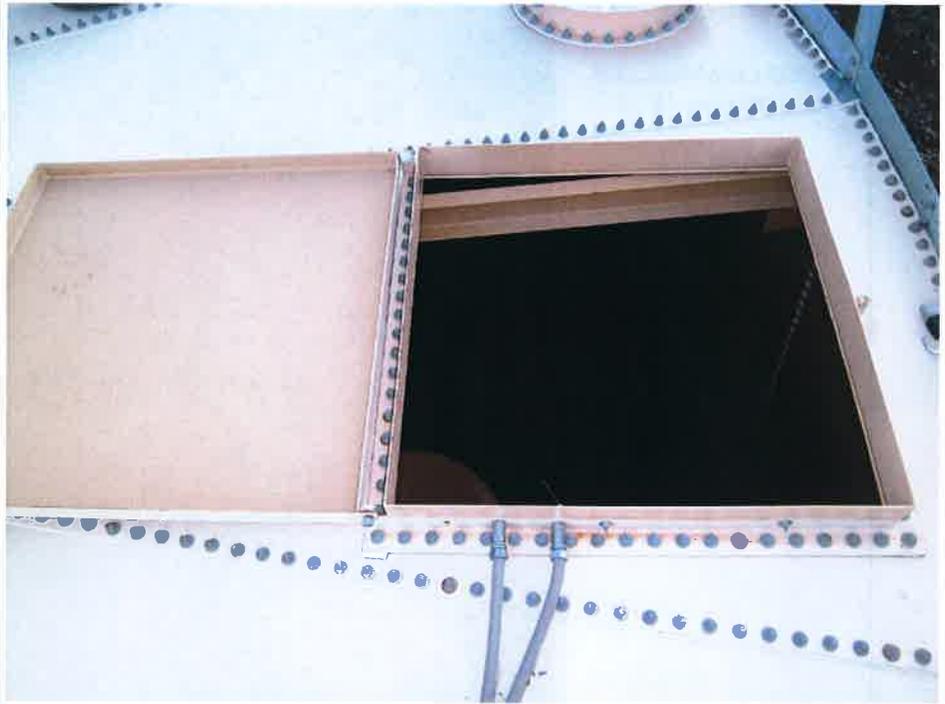


Image #8

Telemetry Penetration 12:00

Condition:
Rust Grade¹ 10.

Description:
1" Telemetry Penetration appeared to be in good condition with no signs of corrosion.



Raw Water Tank

Image #9

*Liquid Level Indicator
Penetration 12:10*

Condition:
Rust Grade¹ 7.

Description:
2" Liquid Level
Indicator Penetration
appeared to be in good
condition with a minor
amount of corrosion.



Image #10

*Telemetry Penetration
12:15*

Condition:
Rust Grade¹ 9.

Description:
3" Telemetry
Penetration appeared to
be in good condition
with a minor amount of
corrosion.



Raw Water Tank

Image #11

Roof 3:00

Condition:
Rust Grade' 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.

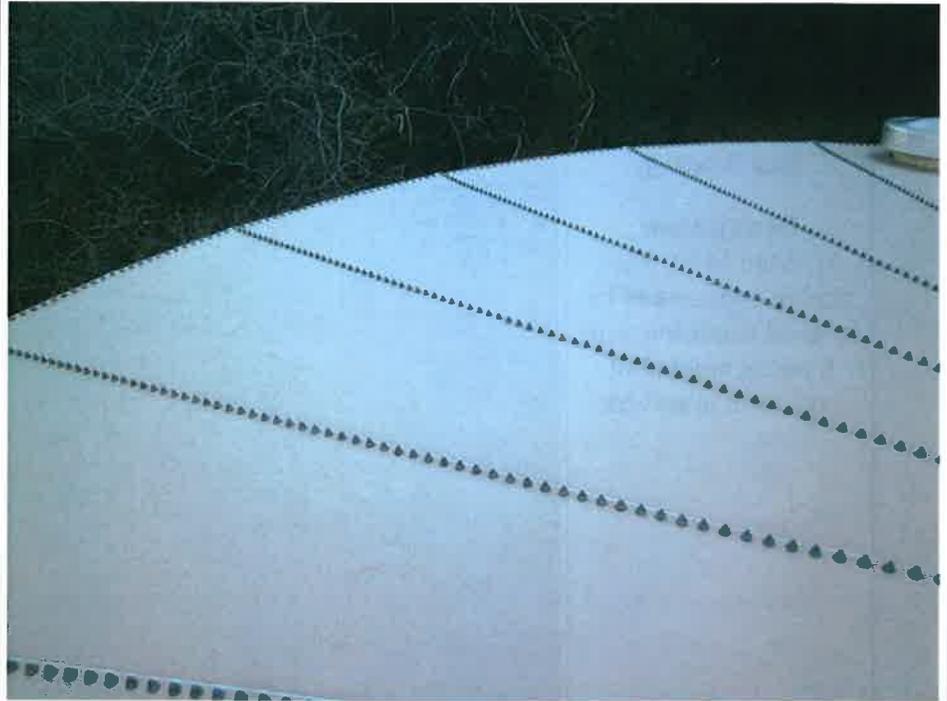


Image #12

Side Vent 5:30

Condition:
Rust Grade' 10.

Description:
18" Side Vent appeared to be in good condition with no signs of corrosion.



Raw Water Tank

Image #13

Vent Screen 5:30

Condition:
Rust Grade! 9.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion observed.

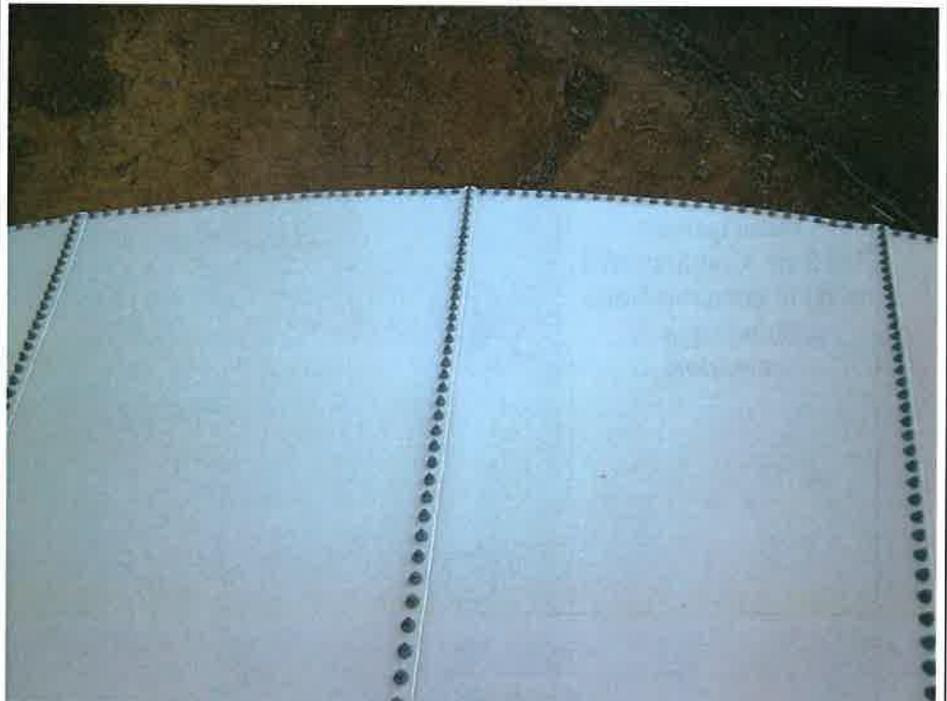


Image #14

Roof 9:00

Condition:
Rust Grade! 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #15

Side Vent 10:00

Condition:
Rust Grade 9.

Description:
18" Side Vent appeared to be in good condition with a minor amount of corrosion.

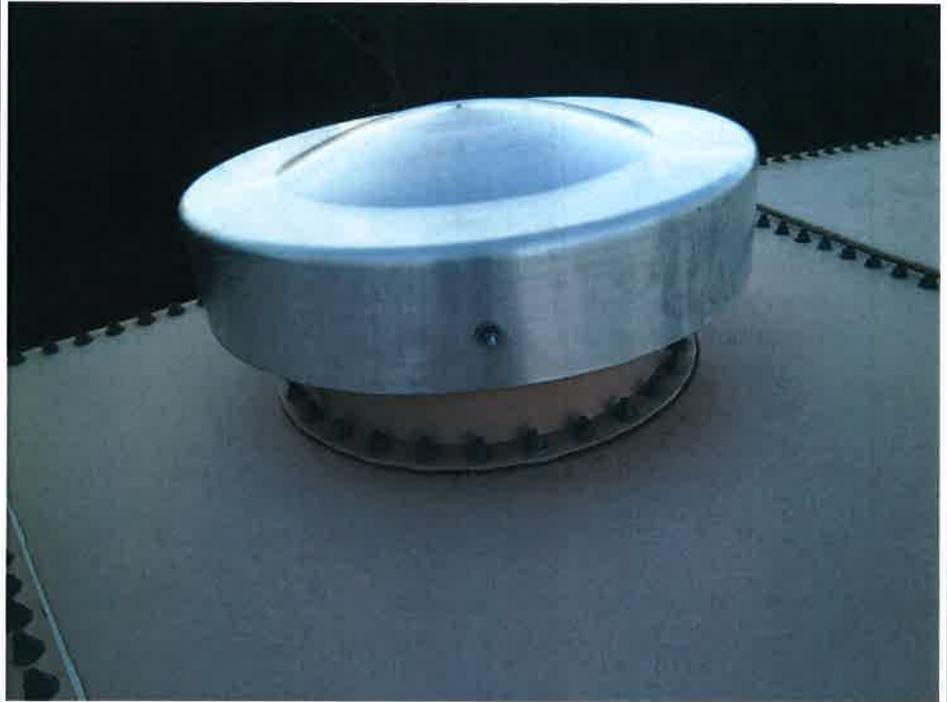
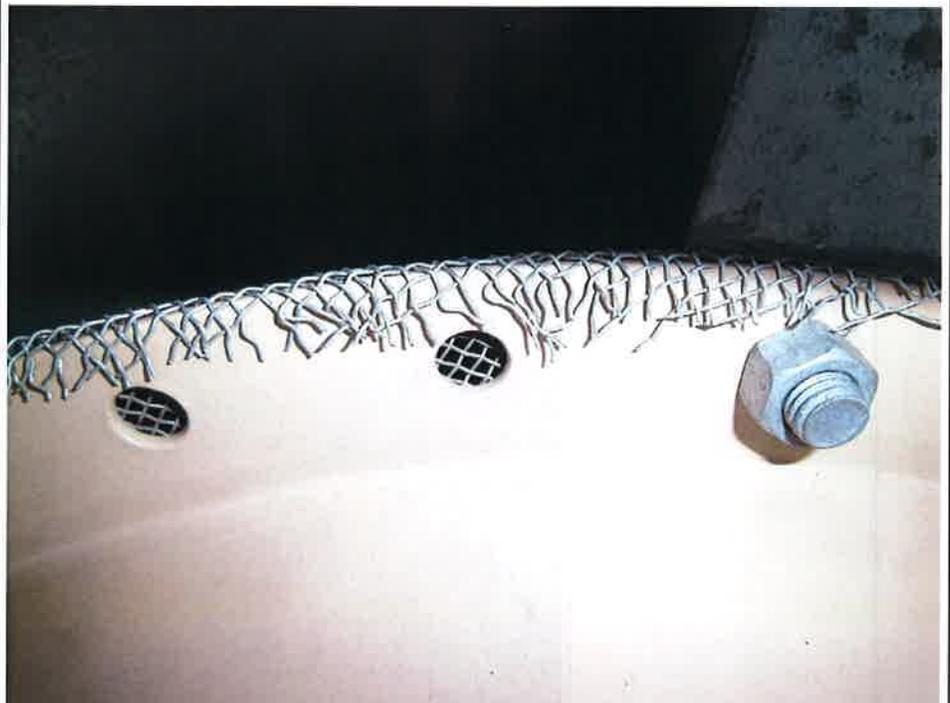


Image #16

Vent Screen 10:00

Condition:
Rust Grade 9.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion observed.



Raw Water Tank

Image #17

Side Vent 11:55

Condition:
Rust Grade¹ 9.

Description:
18" Side Vent appeared to be in good condition with a minor amount of corrosion.



Image #18

Vent Screen 11:55

Condition:
Rust Grade¹ 9.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion observed.



Raw Water Tank

Image #19

Vent Center

Condition:
Rust Grade¹ 9.

Description:
18" Vent appeared to be in good condition with a minor amount of corrosion.



Image #20

Vent Screen Center

Condition:
Rust Grade¹ 9.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion observed.



Raw Water Tank

Image #21

Diver



Image #22

Floor 12:00

Condition:
Rust Grade! 8.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #23

Wall 12:00

Condition:
Rust Grade 7.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Image #24

Overflow 12:00

Condition:
Rust Grade 7.

Description:
Overflow appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #25

*Liquid Level Indicator
Base 12:10*

Condition:
Rust Grade¹ 9.

Description:
Liquid Level Indicator
Base appeared to be in
good condition with a
minor amount of
corrosion.



Image #26

Inlet / Outlet 12:15

Condition:
Rust Grade¹ 8.

Description:
18" Inlet / Outlet
appeared to be in good
condition with a minor
amount of corrosion.



Raw Water Tank

Image #27

Man Way 1:00

Condition:
Rust Grade¹ 10.

Description:
30" Man Way appeared to be in good condition with no signs of corrosion.



Image #28

Floor 3:00

Condition:
Rust Grade¹ 9.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #29

Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Image #30

Floor 6:00

Condition:
Rust Grade¹ 8.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #31

Wall 6:00

Condition:
Rust Grade¹ 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Image #32

Man Way 7:00

Condition:
Rust Grade¹ 10.

Description:
30" Man Way appeared to be in good condition with no signs of corrosion.



Raw Water Tank

Image #33

Floor 9:00

Condition:
Rust Grade¹ 8.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Image #34

Wall 9:00

Condition:
Rust Grade¹ 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #35

Column Center

Condition:
Rust Grade¹ 8.

Description:
6" Column appeared to be in good condition with a minor amount of corrosion.

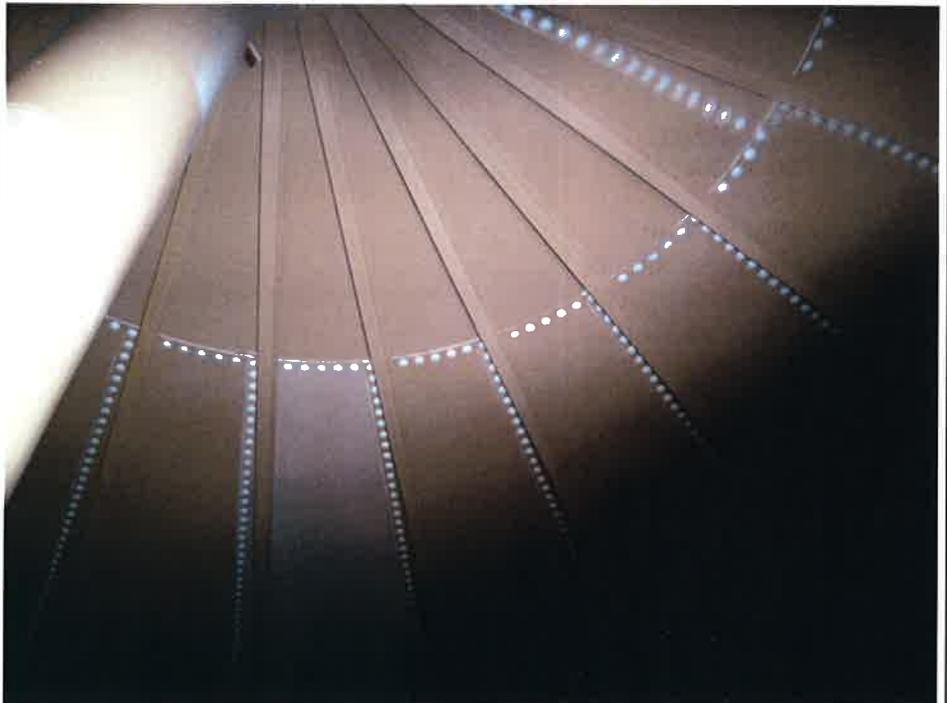


Image #36

Ceiling 12:00

Condition:
Rust Grade¹ 9.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Raw Water Tank

Image #37

Ceiling 3:00

Condition:
Rust Grade¹ 10.

Description:
Ceiling appeared to be in good condition with no signs of corrosion.

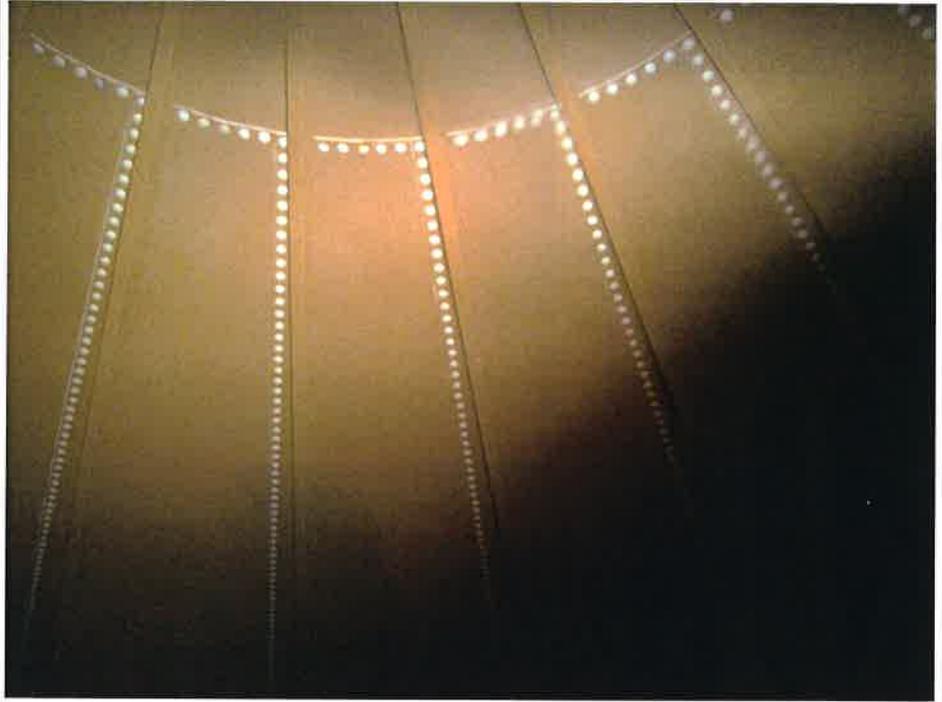
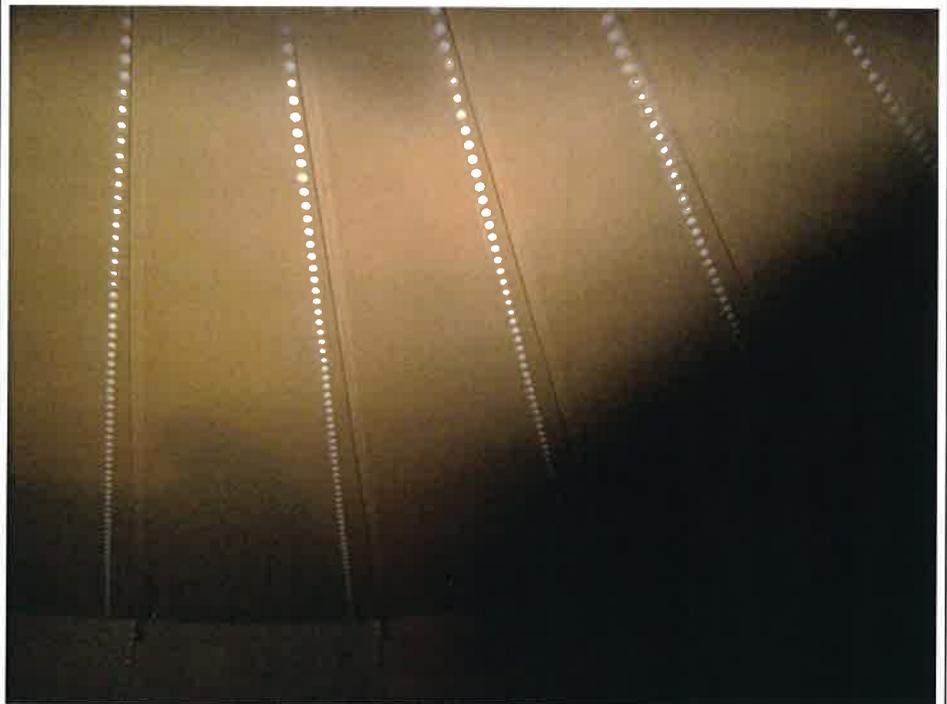


Image #38

Ceiling 6:00

Condition:
Rust Grade¹ 10.

Description:
Ceiling appeared to be in good condition with no signs of corrosion.



Raw Water Tank

Image #39

Ceiling 9:00

Condition:
Rust Grade' 10.

Description:
Ceiling appeared to be in good condition with no signs of corrosion.

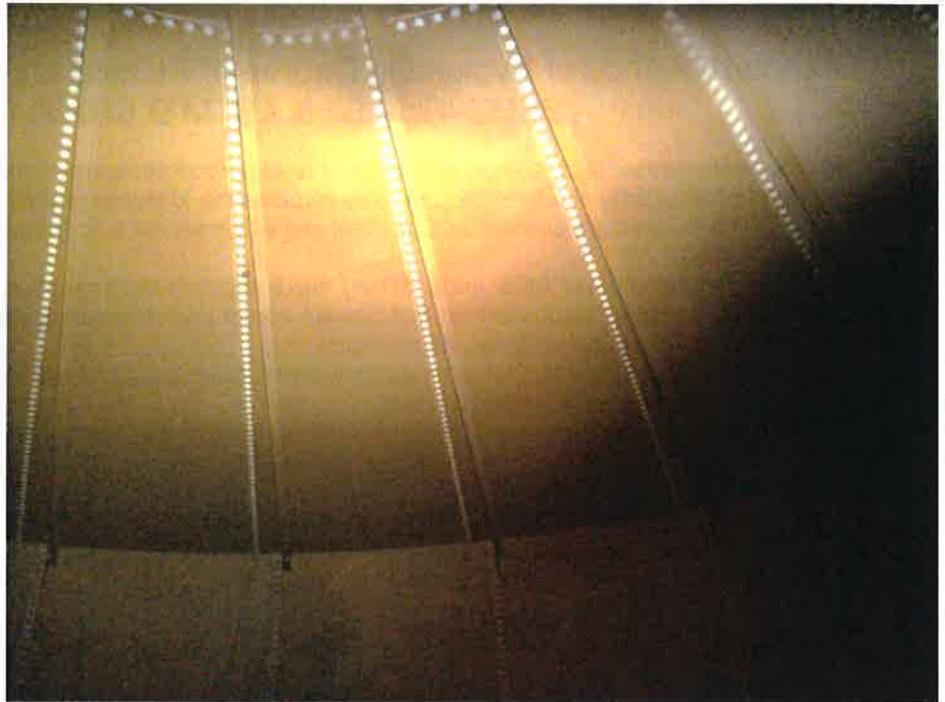
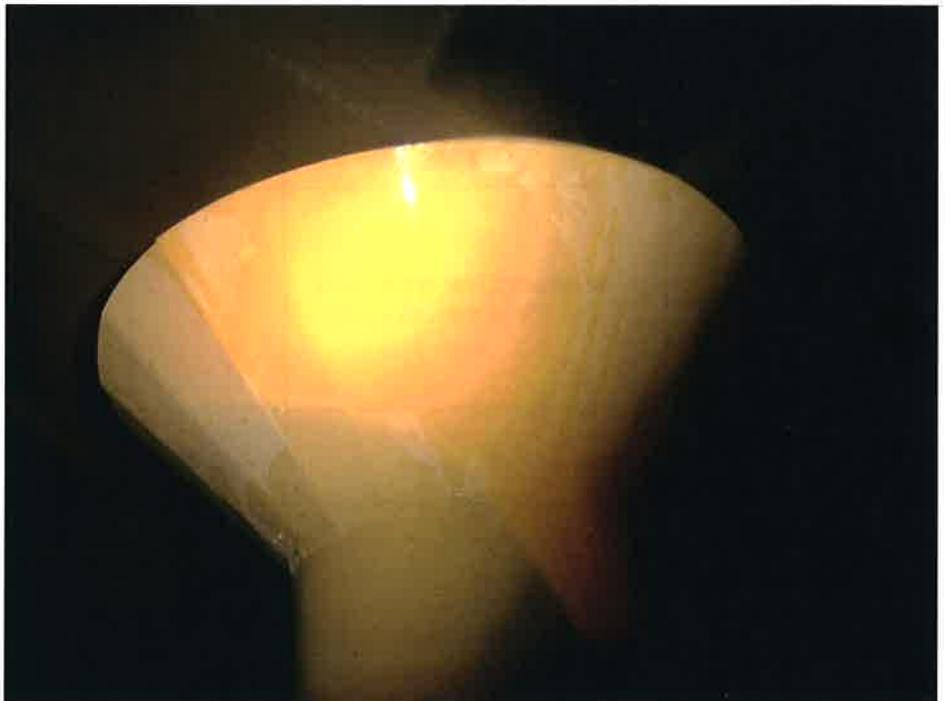


Image #40

Overflow Bell 12:00

Condition:
Rust Grade' 10.

Description:
30" Overflow Bell appeared to be in good condition with no signs of corrosion.



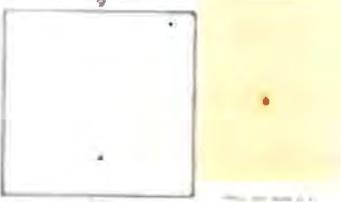
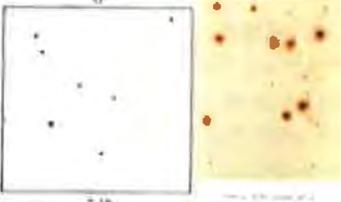
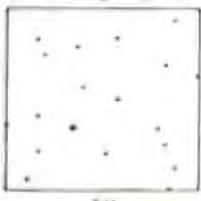
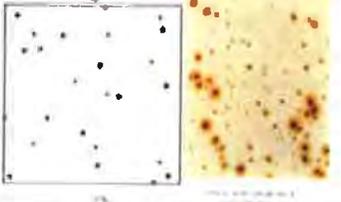
Raw Water Tank

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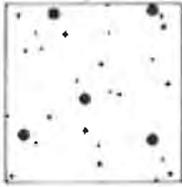
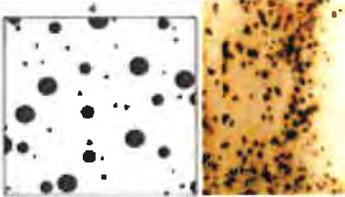
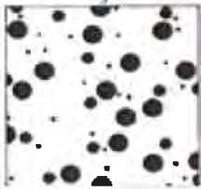
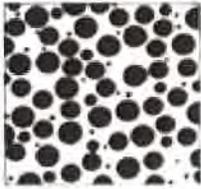
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

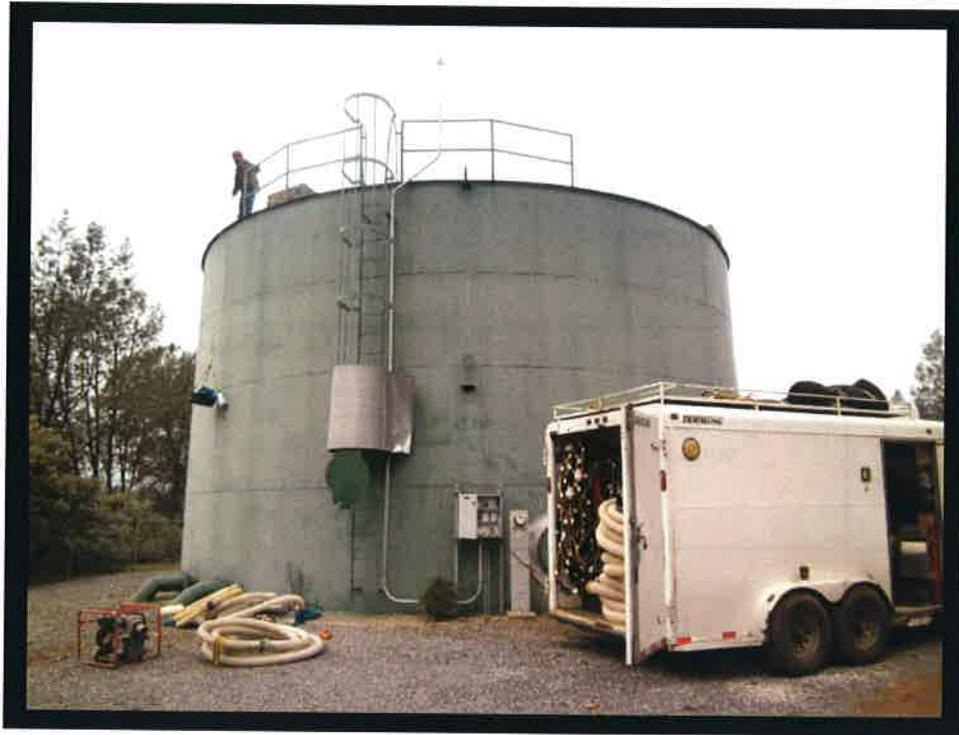
The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Raw Water Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



Rouge Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on

January 22, 2015

By



LiquiVision
Technology
DIVING SERVICES





Underwater Inspection of Rouge Tank

January 22, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Rouge Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Rouge Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Rouge Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R2T3	Capacity (gal.):	186,548
Date of Inspection:	January 22, 2015	Diameter or L x W:	38'
Report Writer:	Chase Hornaday	Height:	22'
Diver:	Cameron Hagerman	Floor Square FT:	1,134.1
Tender:	Bobby Barnicoat	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

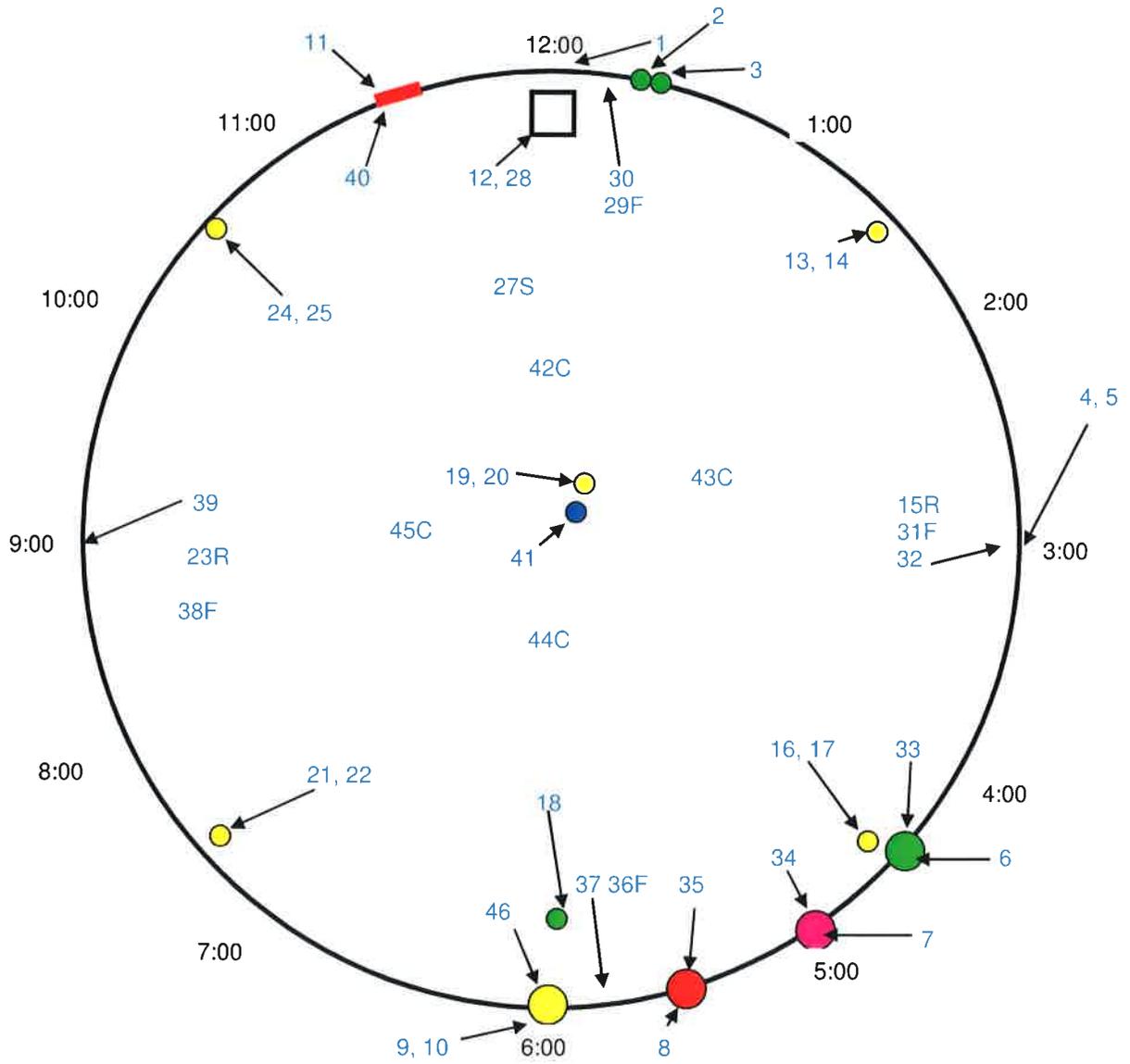
Rouge Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Rouge Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Inlet		Man Entry		Drain/Scour
	Outlet		Capped off Penetration		Air Vent

Rouge Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade' 9.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Capped Off Penetration 12:05

Condition:
Rust Grade' 9.

Description:
8" Capped Off Penetration appeared to be in good condition with a minor amount of corrosion and delamination observed.



Rouge Tank

Image #3

Capped Off Penetration
12:10

Condition:
Rust Grade¹ 9.

Description:
8" Capped Off
Penetration appeared to
be in good condition
with a minor amount of
corrosion.

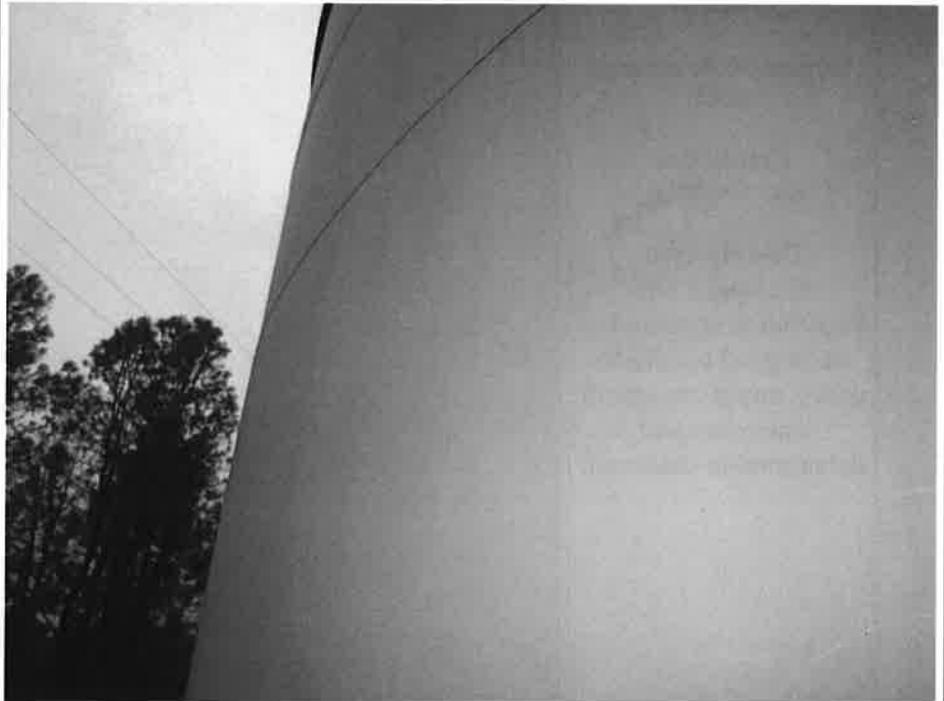


Image #4

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Rouge Tank

Image #5

Exterior Base 3:00

Condition:
Concrete Deform³ CK.

Description:
Exterior Base appeared to be in fair condition with a moderate amount of cracking.



Image #6

Inlet 4:30

Condition:
Rust Grade¹ 9.

Description:
10" Inlet appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #7

Outlet 5:00

Condition:
Rust Grade' 9.

Description:
10" Outlet appeared to be in good condition with a minor amount of corrosion.



Image #8

Drain 5:30

Condition:
Rust Grade' 6

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #9

Overflow 6:00

Condition:
Rust Grade' 9.

Description:
8" Overflow appeared to be in good condition with a minor amount of corrosion.



Image #10

Overflow Screen 6:00

Condition:
Rust Grade' 9.

Description:
Medium Mesh
Overflow Screen
appeared to be in good
condition with a minor
amount of corrosion.



Rouge Tank

Image #11

Man Way 11:30

Condition:
Rust Grade' 7.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.

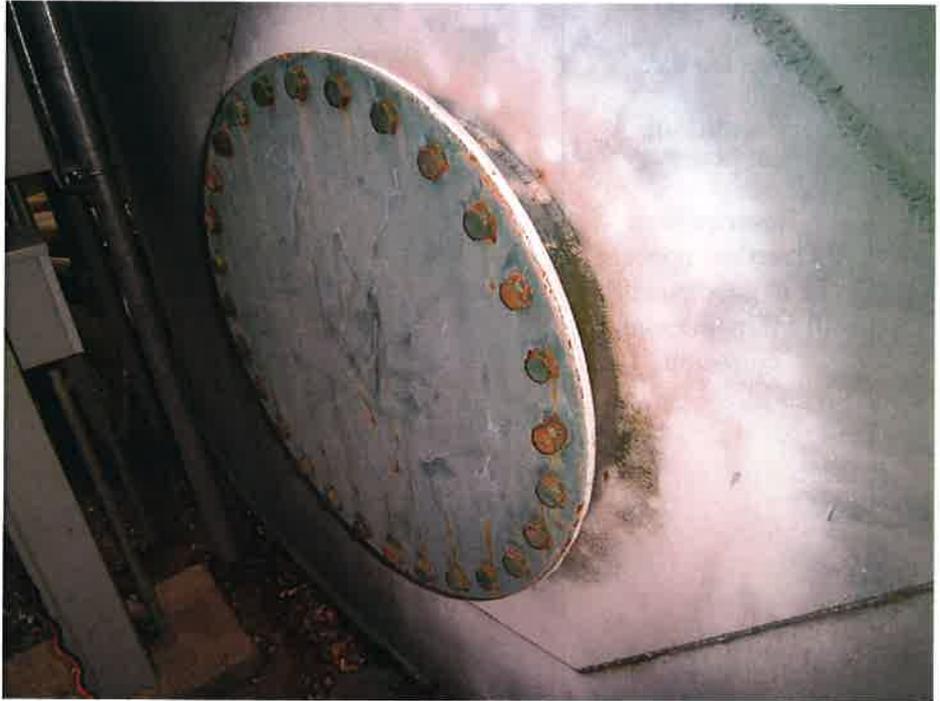
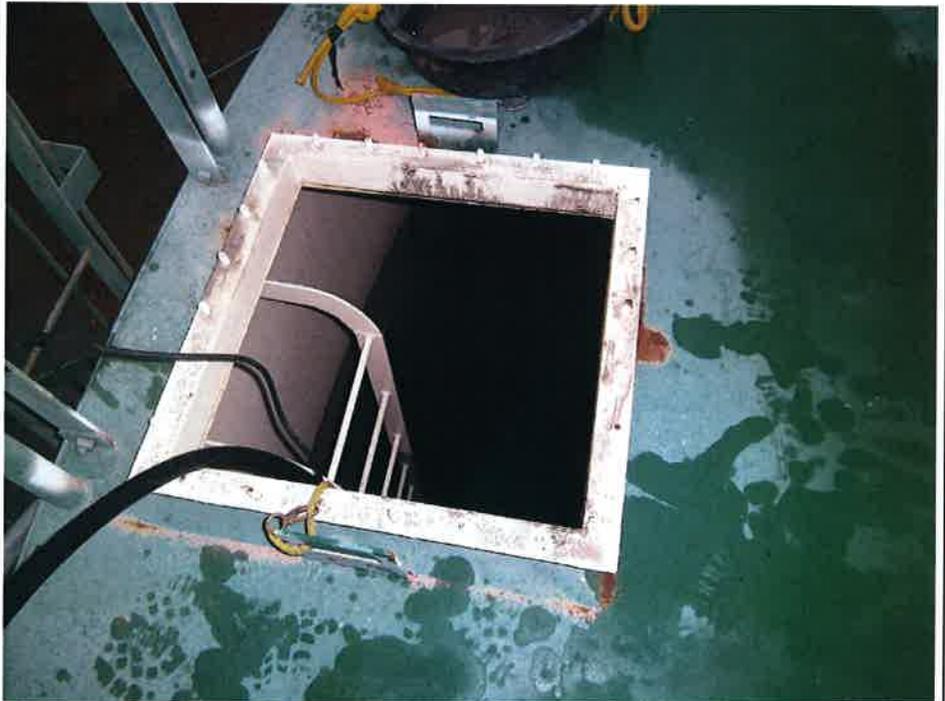


Image #12

Entry Hatch 12:00

Condition:
Rust Grade' 8.

Description:
24"x24" Entry Hatch appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #13

Side Vent 1:30

Condition:
Rust Grade¹ 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #14

Vent Screen 1:30

Condition:
Rust Grade¹ 7.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Rouge Tank

Image #15

Roof 3:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.



Image #16

Side Vent 4:30

Condition:
Rust Grade¹ 8.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #17

Vent Screen 4:30

Condition:
Rust Grade¹ 2.

Description:
Fine Mesh Vent Screen appeared to be in fair condition with a moderate amount of corrosion.



Image #18

Capped Off Penetration 6:00

Condition:
Rust Grade¹ 9.

Description:
8" Capped Off Penetration appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #19

Vent Center

Condition:
Rust Grade¹ 8.

Description:
36" Vent appeared to be in good condition with a minor amount of corrosion.



Image #20

Vent Screen Center

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #21

Side Vent 7:30

Condition:
Rust Grade' 8.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Image #22

Vent Screen 7:30

Condition:
Rust Grade' 5.

Description:
Fine Mesh Vent Screen appeared to be in fair condition with a minor amount of corrosion.



Rouge Tank

Image #23

Roof 9:00

Condition:
Rust Grade! 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion with minor chalking observed.

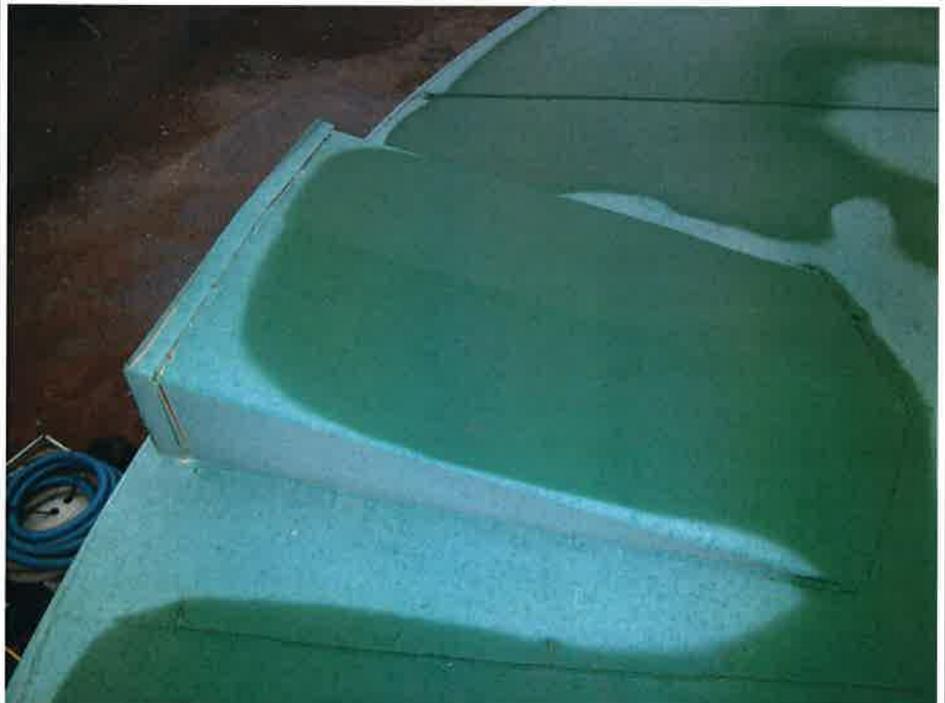


Image #24

Side Vent 11:30

Condition:
Rust Grade! 9.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #25

Vent Screen 11:30

Condition:
Rust Grade' 5.

Description:
Fine Mesh Vent Screen
appeared to be in fair
condition with a minor
amount of corrosion.



Image #26

Diver



Rouge Tank

Image #27

Sediment

Description:
1/32" of sediment was removed from reservoir floor.



Image #28

Interior Ladder 12:00

Condition:
Rust Grade 9.

Description:
Interior Ladder appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #29

Floor 12:00

Condition:
Rust Grade¹ 9.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Image #30

Wall 12:00

Condition:
Rust Grade¹ 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #31

Floor 3:00

Condition:
Rust Grade¹ 9.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.

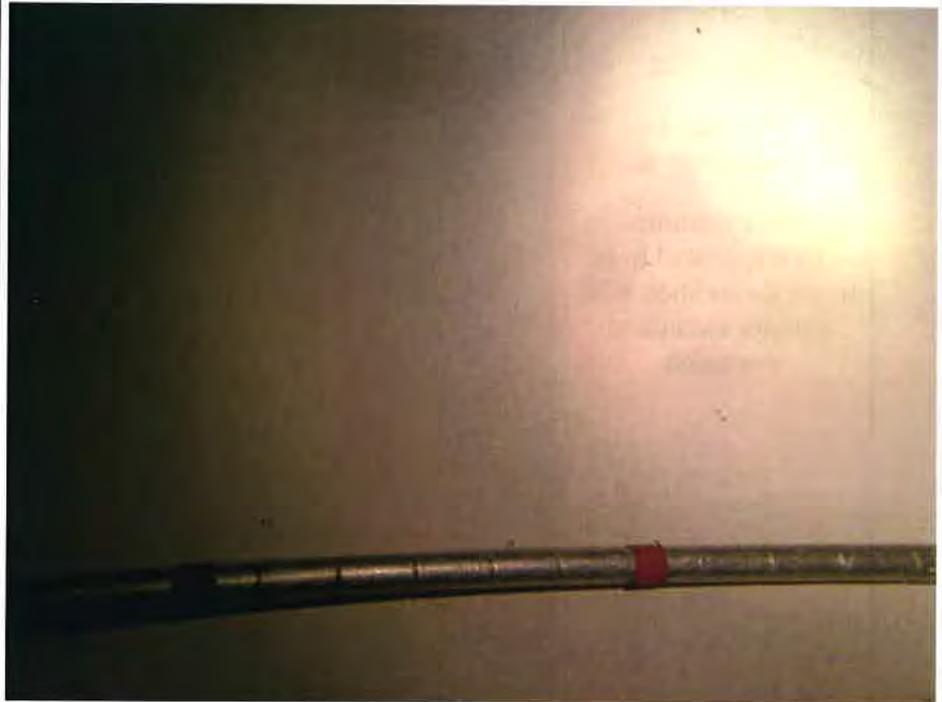


Image #32

Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #33

Inlet 4:30

Condition:
Rust Grade' 8.

Description:
10" Inlet appeared to be in good condition with a minor amount of corrosion.

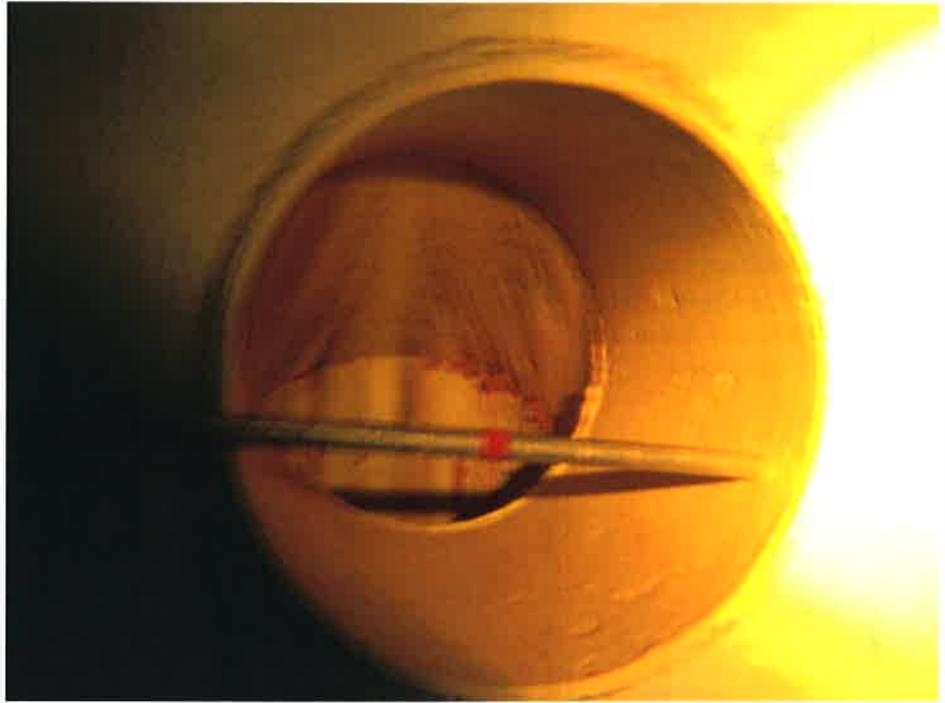


Image #34

Outlet 5:00

Condition:
Rust Grade' 9.

Description:
10" Outlet appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #35

Drain 5:30

Condition:
Rust Grade¹ 7.

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.

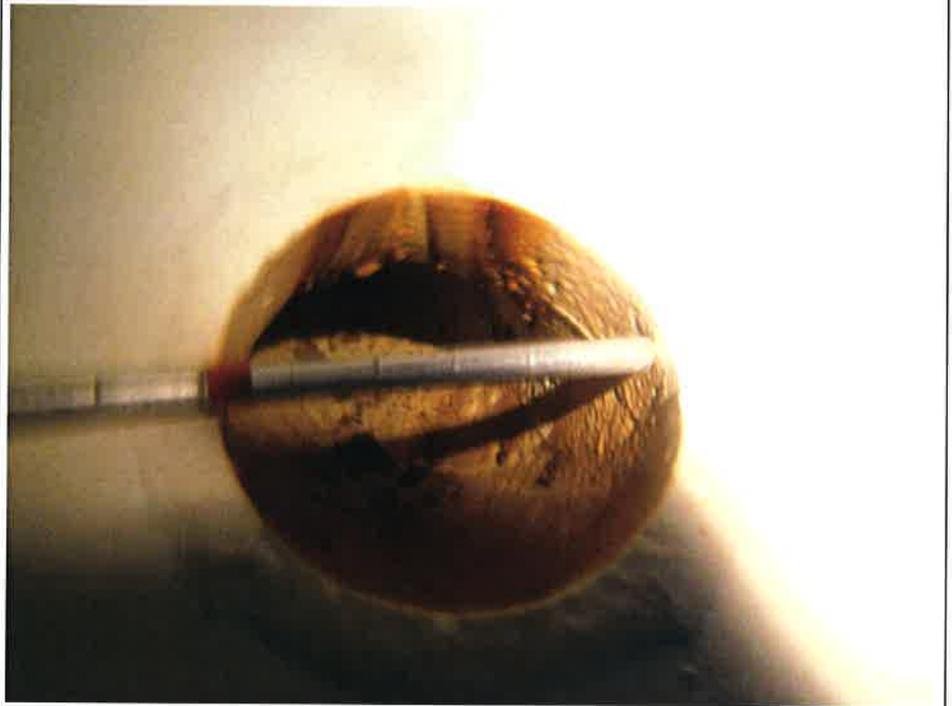


Image #36

Floor 6:00

Condition:
Rust Grade¹ 9.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #37

Wall 6:00

Condition:
Rust Grade' 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Image #38

Floor 9:00

Condition:
Rust Grade' 9.

Description:
Floor appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #39

Wall 9:00

Condition:
Rust Grade' 9.

Description:
Wall appeared to be in good condition with a minor amount of corrosion.



Image #40

Man Way 11:30

Condition:
Rust Grade' 8.

Description:
24" Man Way appeared to be in fair condition with a minor amount of corrosion.



Rouge Tank

Image #41

Column Center

Condition:
Rust Grade' 7.

Description:
6'' Column appeared to be in good condition with a minor amount of corrosion.

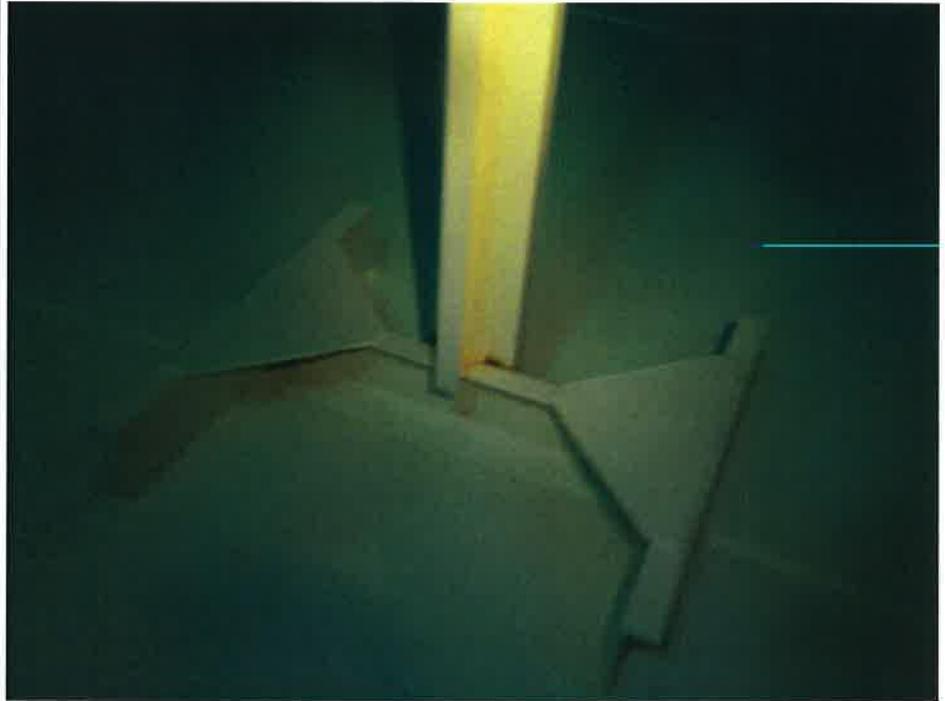


Image #42

Ceiling 12:00

Condition:
Rust Grade' 9.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #43

Ceiling 3:00

Condition:
Rust Grade' 9.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.

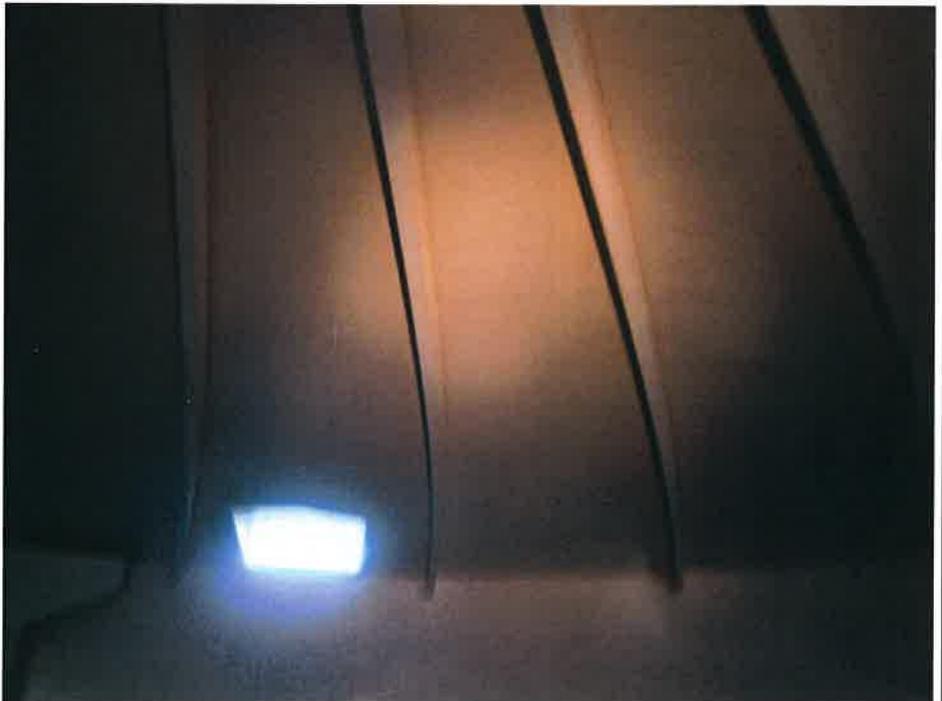


Image #44

Ceiling 6:00

Condition:
Rust Grade' 9.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Rouge Tank

Image #45

Ceiling 9:00

Condition:
Rust Grade' 9.

Description:
Ceiling appeared to be in good condition with a minor amount of corrosion.



Image #46

Overflow Bell 6:00

Condition:
Rust Grade' 9.

Description:
48"x6"x18" Overflow Bell appeared to be in good condition with a minor amount of corrosion.



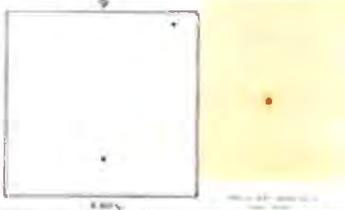
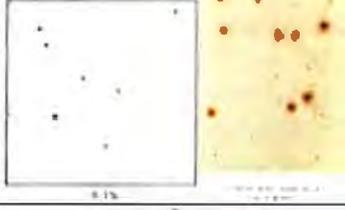
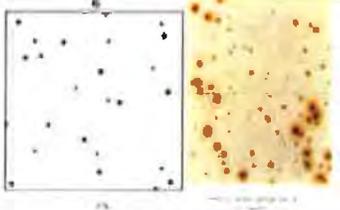
Rouge Tank

REFERENCES:

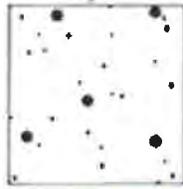
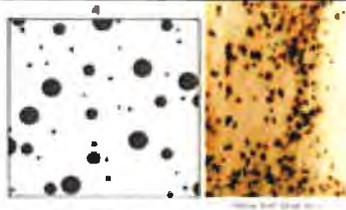
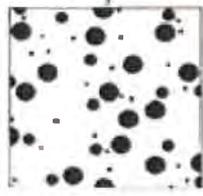
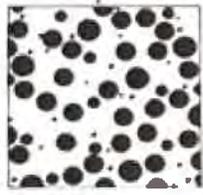
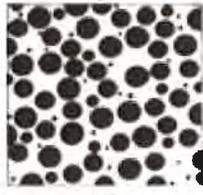
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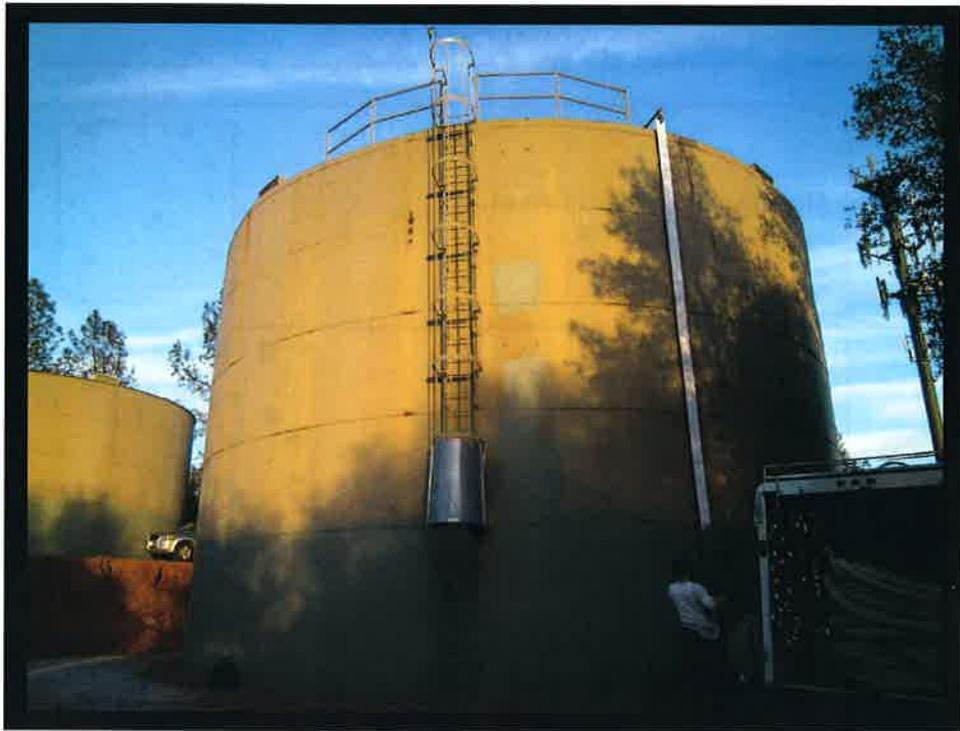
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Rouge Tank

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Shasta Way A Tank

City of Shasta Lake

Report of Findings

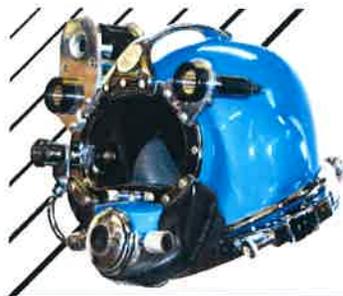
From the

Diving Operations

Conducted on

January 21, 2015

By



LiquiVision
Technology
DIVING SERVICES





Underwater Inspection of Shasta Way A Tank

January 21, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

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Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Shasta Way A Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

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NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Shasta Way A Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Shasta Way A Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R3T3	Capacity (gal.):	469,777
Date of Inspection:	January 21, 2015	Diameter or L x W:	32'
Report Writer:	Chase Hornaday	Height:	50'
Diver:	Bobby Barnicoat	Floor Square FT:	804.2
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

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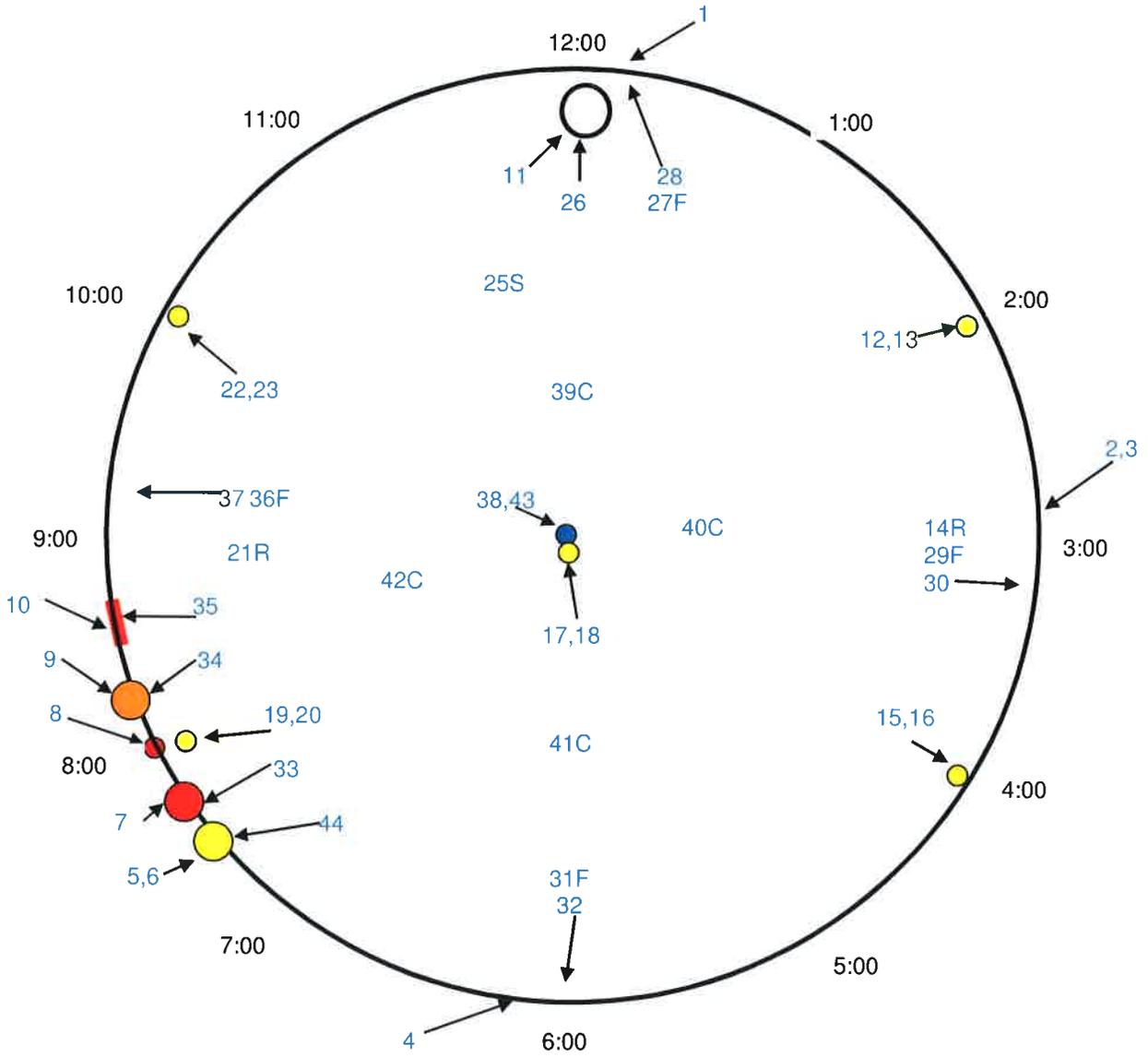
Shasta Way A Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Recommend Blast and recoat and a structural evaluation by an engineer	
Total Estimated Hours	

Shasta Way A Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Drain/Scour		Man Entry		Water Tap
	Common Inlet/Outlet		Air Vent		

Shasta Way A Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade' 9.

Description:
Exterior Ladder
appeared to be in good
condition with minor
signs of corrosion.

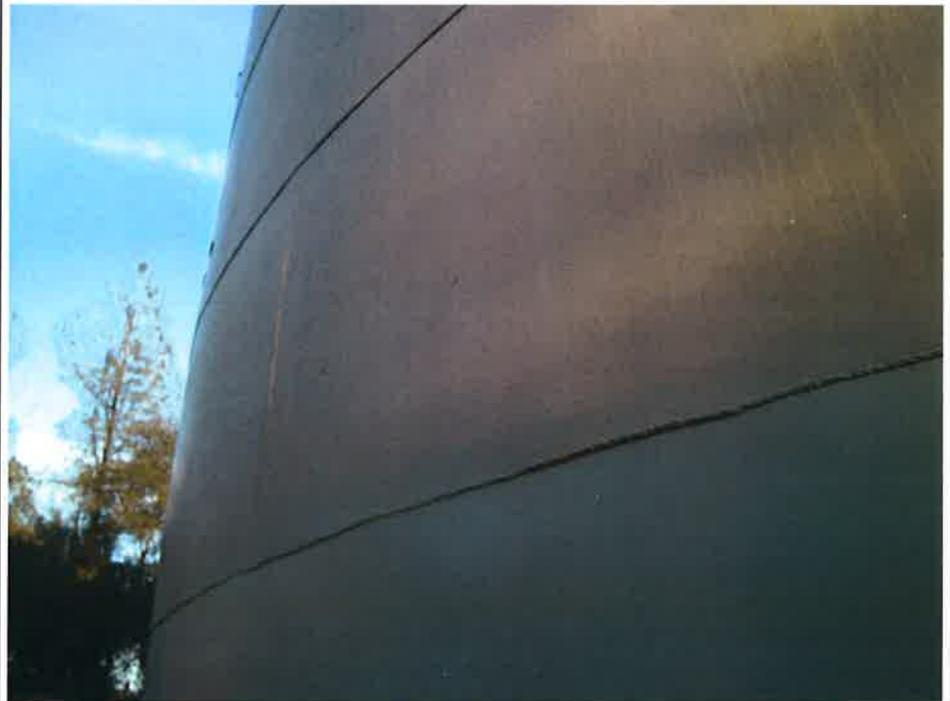


Image #2

Exterior Wall 3:00

Condition:
Rust Grade' 9.

Description:
Exterior Wall
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way A Tank

Image #3

Exterior Base 3:00

Condition:
Concrete Deform³ UE.

Description:
Unable to evaluate the condition of the Exterior Base due to earthen covering.



Image #4

Exterior Wall 6:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall appeared to be in fair condition with a minor amount of corrosion and some minor structural bowing.



Shasta Way A Tank

Image #5

Overflow 7:30

Condition:
Rust Grade¹ 9.

Description:
8" Outlet appeared to be in good condition with a minor amount of corrosion.



Image #6

Overflow Screen 7:30

Condition:
Rust Grade¹ 9.

Description:
Medium Mesh
Overflow Screen
appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #7

Drain 7:35

Condition:
Rust Grade' 7.

Description:
6" Drain appeared to be in good condition with a minor amount of corrosion.



Image #8

Water Tap 8:00

Condition:
Rust Grade' 9.

Description:
2" Water Tap appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #9

Inlet / Outlet 8:10

Condition:
Rust Grade' 9.

Description:
10" Inlet / Outlet
appeared to be in good
condition with a minor
amount of corrosion.

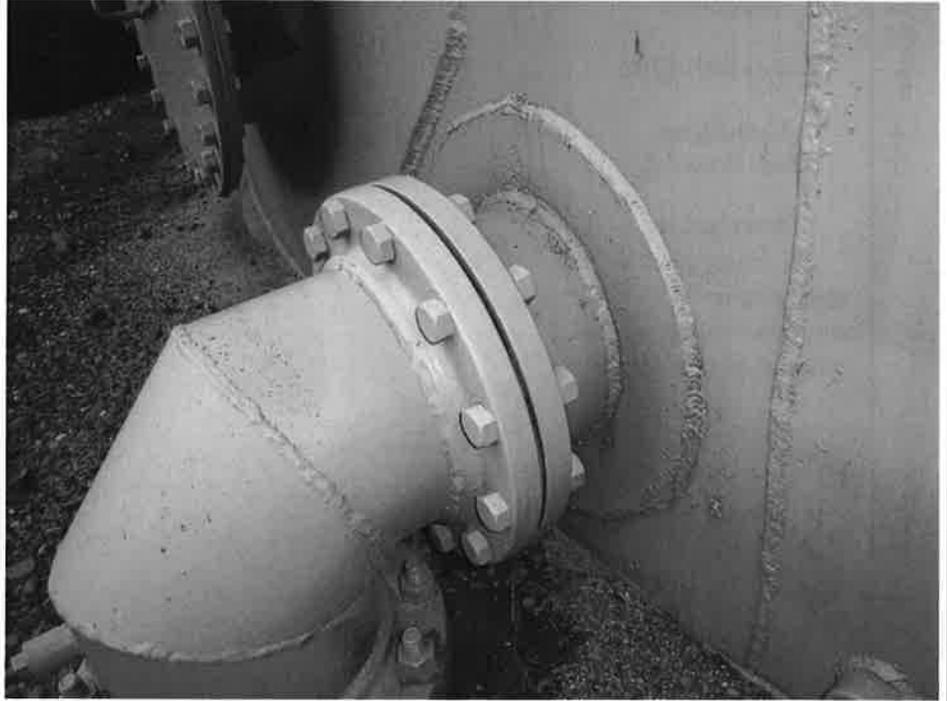
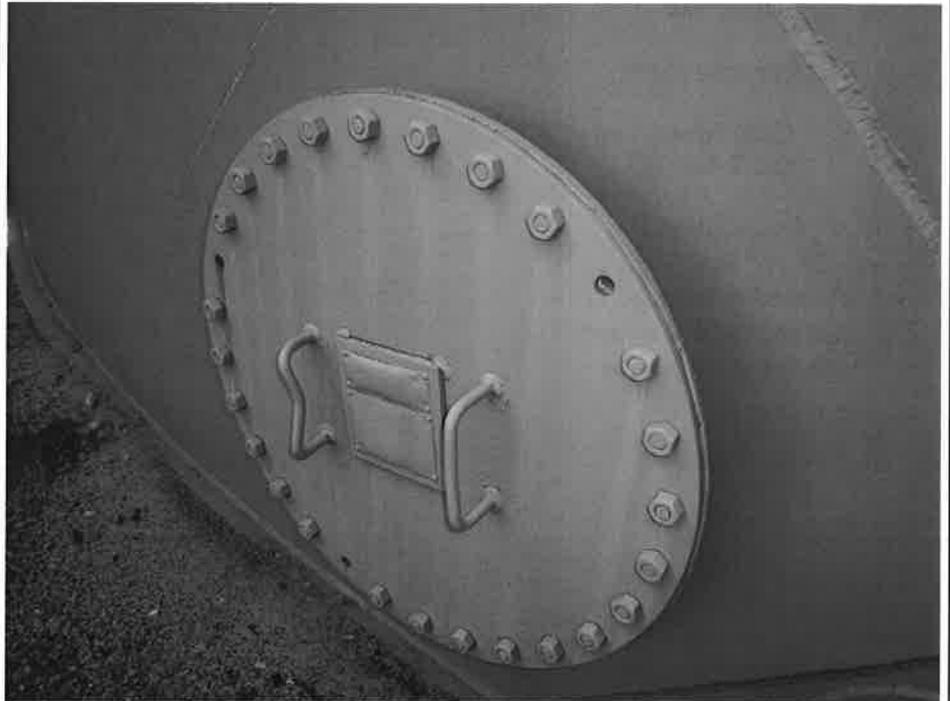


Image #10

Man Way 8:30

Condition:
Rust Grade' 9.

Description:
30" Man Way appeared
to be in good condition
with a minor amount of
corrosion and missing
to bolts.



Shasta Way A Tank

Image #11

Entry Hatch 12:00

Condition:
Rust Grade¹ 8.

Description:
20" Entry Hatch
appeared to be in UE
condition with a minor
amount of corrosion.



Image #12

Side Vent 2:00

Condition:
Rust Grade¹ 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way A Tank

Image #13

Vent Screen 2:00

Condition:
Rust Grade! 8.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion and some heavy staining.



Image #14

Roof 3:00

Condition:
Rust Grade! 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #15

Side Vent 4:00

Condition:
Rust Grade¹ 9.

Description:
26"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #16

Vent Screen 4:00

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way A Tank

Image #17

Vent Center

Condition:
Rust Grade¹ 9.

Description:
18" Vent appeared to be in good condition with a minor amount of corrosion.

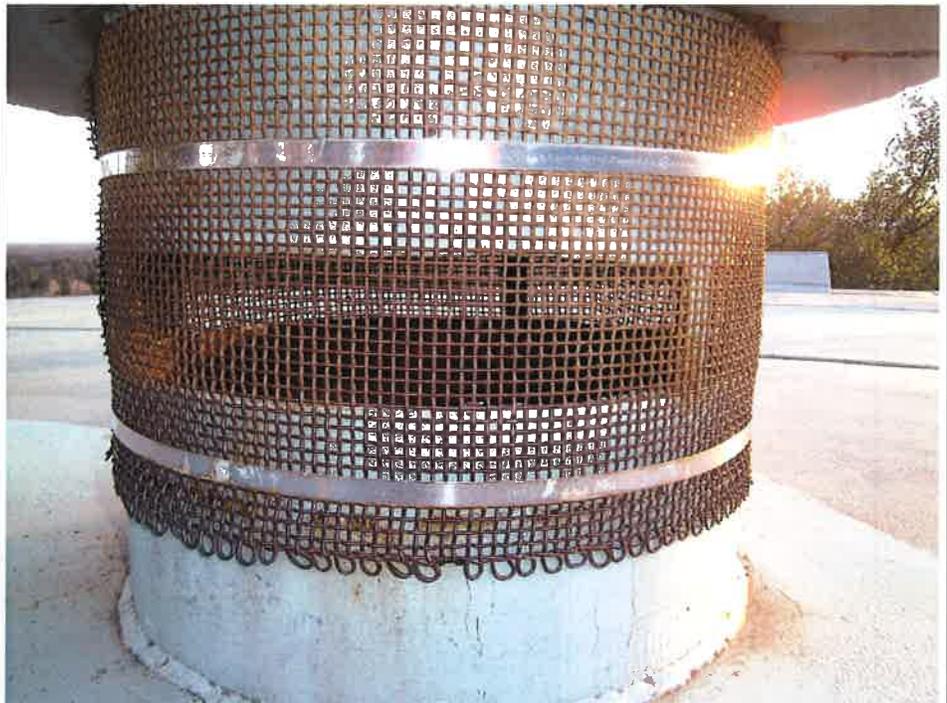


Image #18

Vent Screen Center

Condition:
Rust Grade¹ 7.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #19

Side Vent 8:00

Condition:
Rust Grade' 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #20

Vent Screen 8:00

Condition:
Rust Grade' 9.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way A Tank

Image #21

Roof 9:00

Condition:
Rust Grade 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Image #22

Side Vent 10:00

Condition:
Rust Grade 9.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #23

Vent Screen 10:00

Condition:
Rust Grade' 8.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #24

Diver



Shasta Way A Tank

Image #25

Sediment

Description:
Light skiff of sediment
was removed from
reservoir floor.

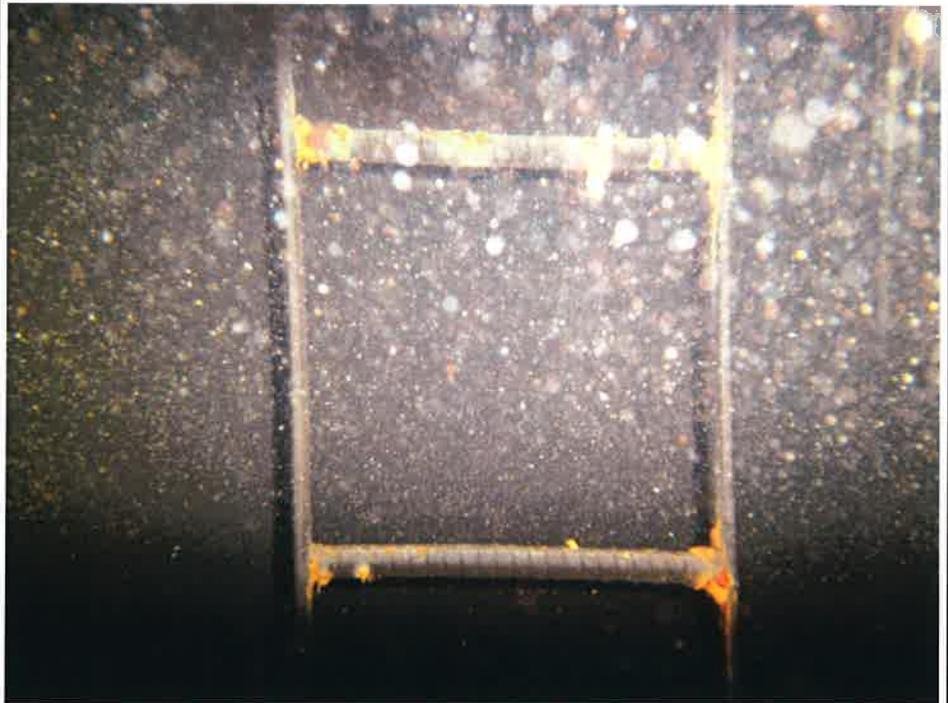


Image #26

Interior Ladder 12:00

Condition:
Rust Grade' 6.

Description:
Interior Ladder
appeared to be in fair
condition with a
moderate amount of
corrosion.



Shasta Way A Tank

Image #27

Floor 12:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating.

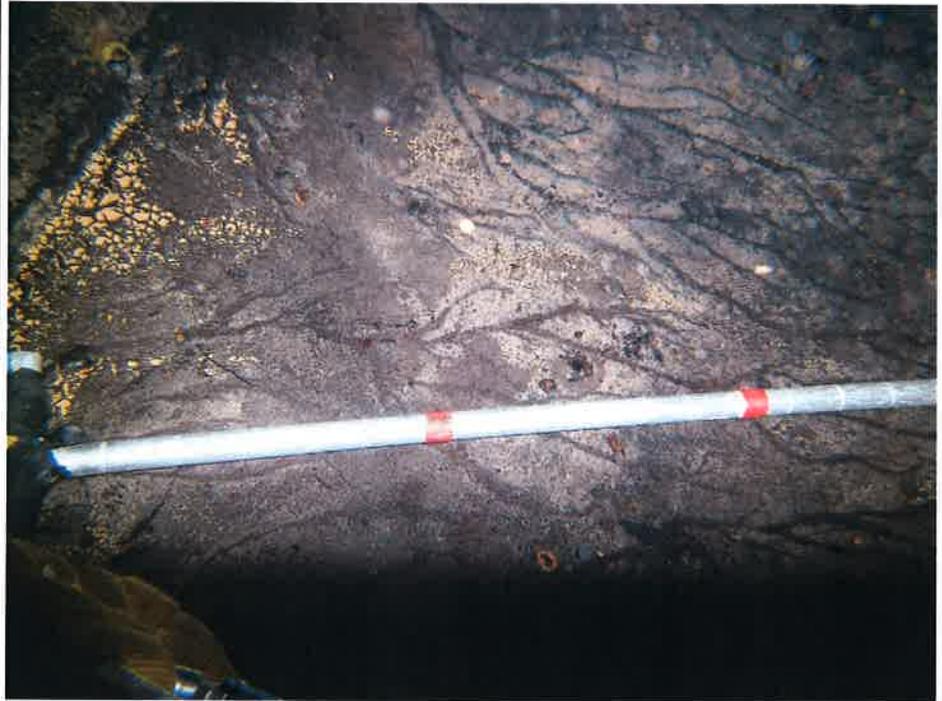
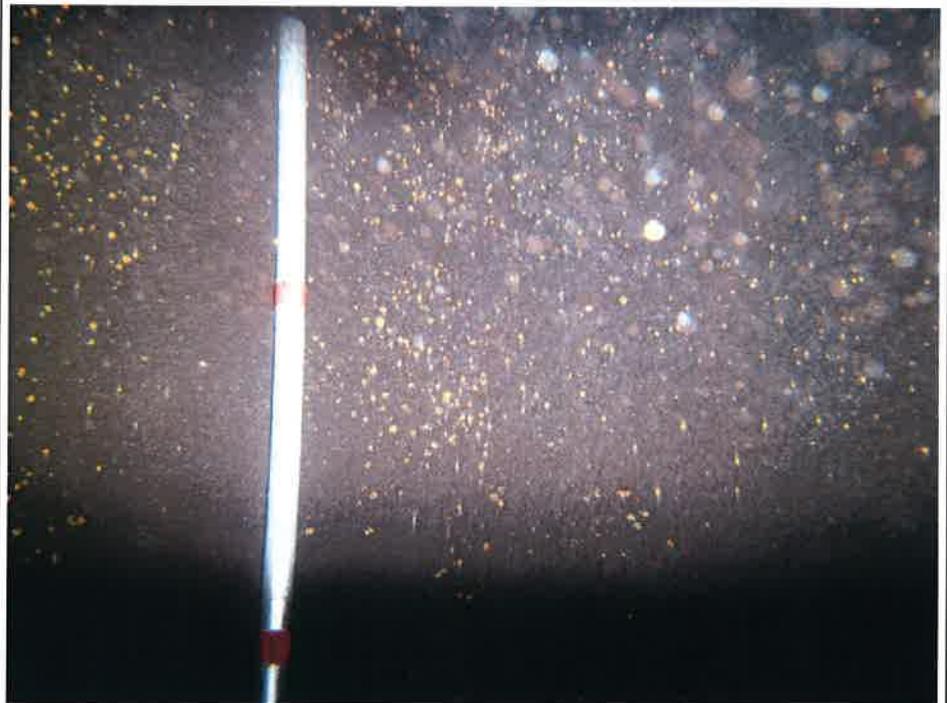


Image #28

Wall 12:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating.



Shasta Way A Tank

Image #29

Floor 3:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating.

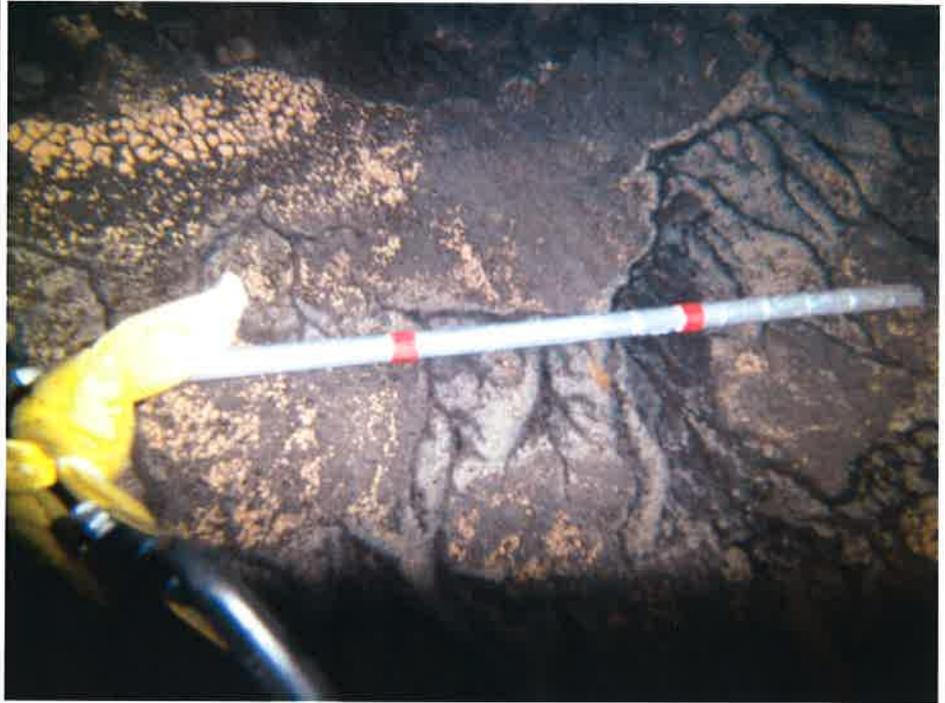
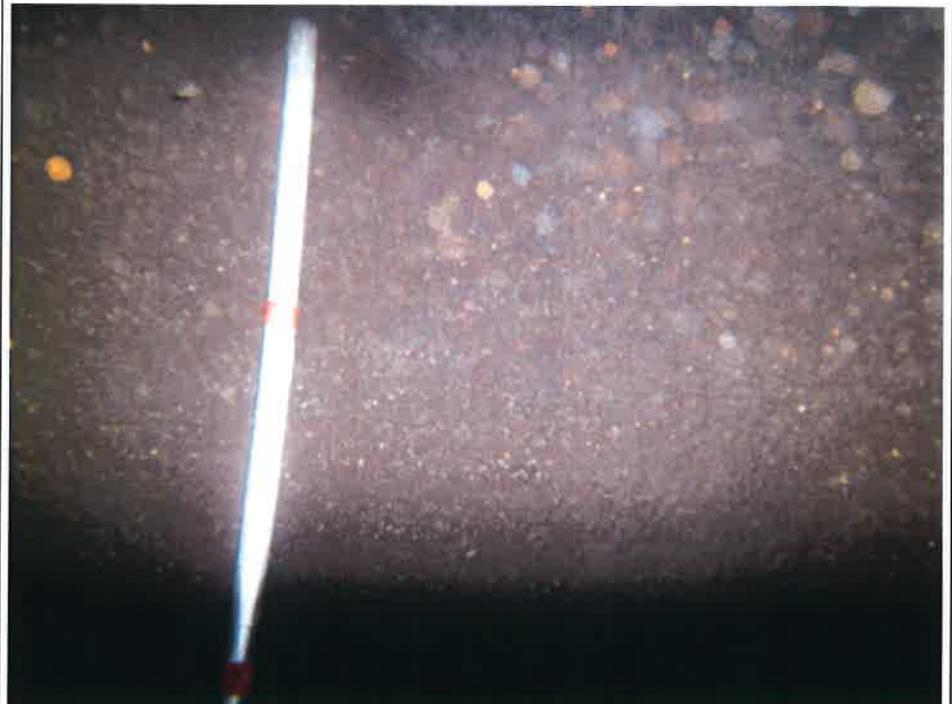


Image #30

Wall 3:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating.



Shasta Way A Tank

Image #31

Floor 6:00

Condition:
Rust Grade' UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating.

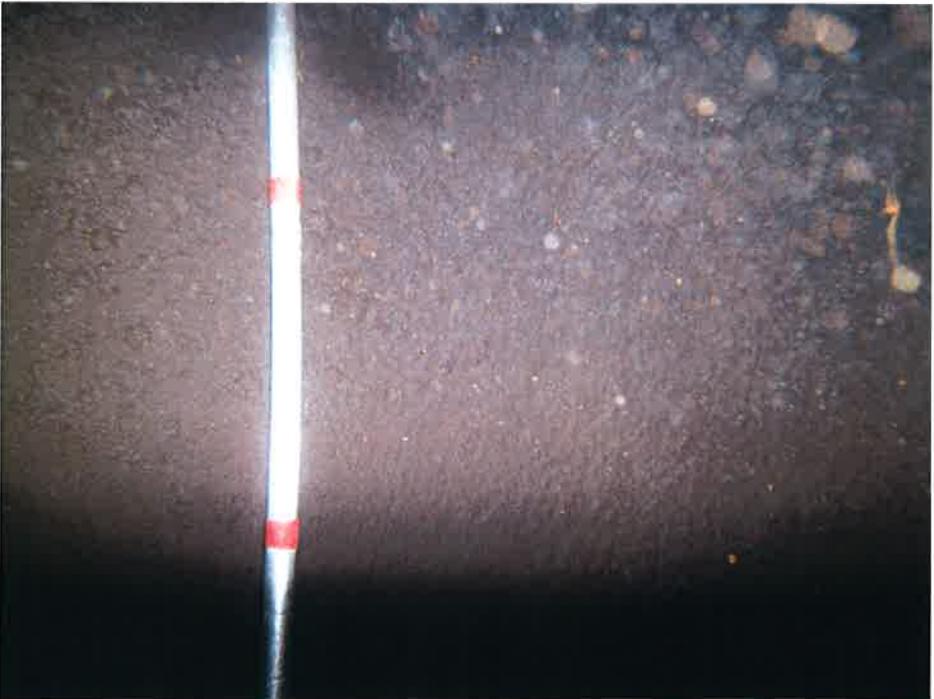


Image #32

Wall 6:00

Condition:
Rust Grade' UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating.



Shasta Way A Tank

Image #33

Drain 7:30

Condition:
Rust Grade' Z.

Description:
6" Drain appeared to be in fair condition with a minor amount of corrosion.



Image #34

Inlet / Outlet 8:10

Condition:
Rust Grade' Z.

Description:
10" Inlet / Outlet appeared to be in fair condition with a minor amount of corrosion.



Shasta Way A Tank

Image #35

Man Way 8:30

Condition:
Rust Grade' Z.

Description:
30" Man Way appeared to be in fair condition with a minor amount of corrosion.

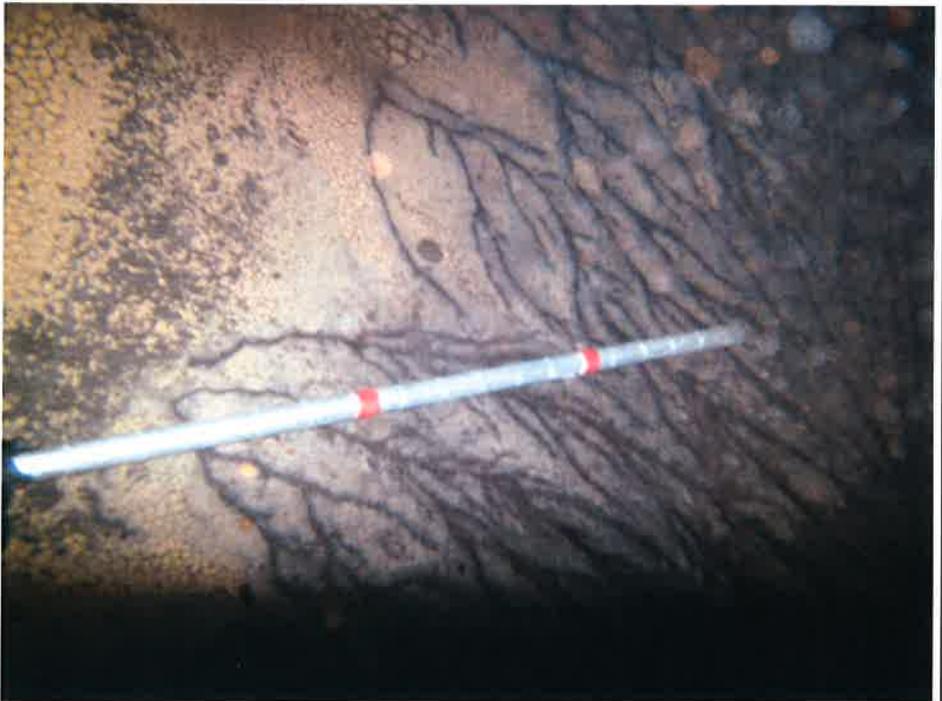


Image #36

Floor 9:00

Condition:
Rust Grade' UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating.



Shasta Way A Tank

Image #37

Wall 9:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating.

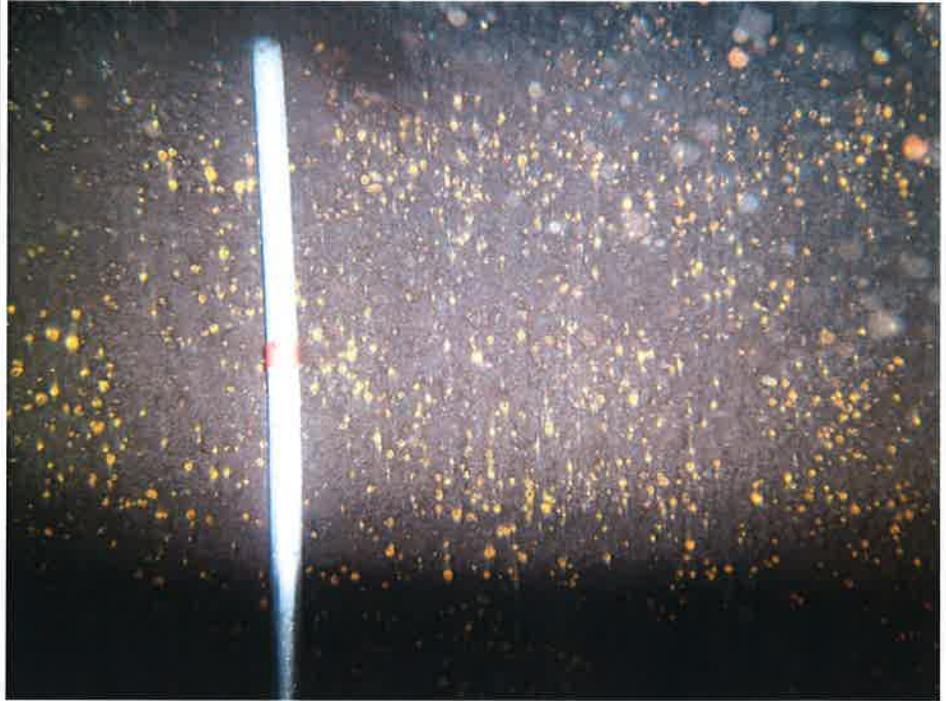
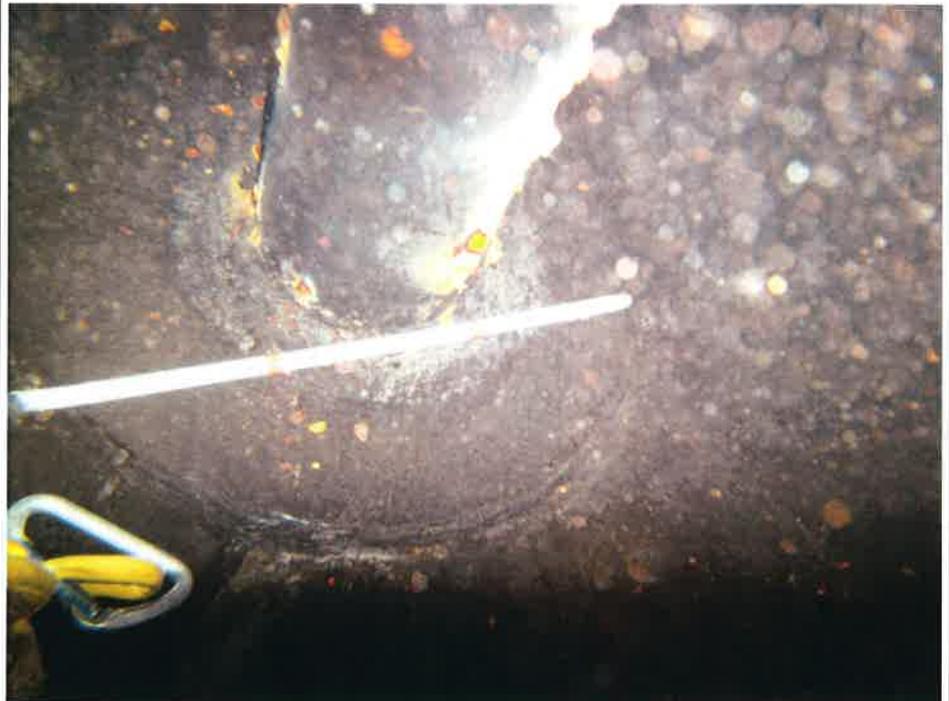


Image #38

Column Center

Condition:
Rust Grade¹ Z.

Description:
8" Column appeared to be in good condition with a minor amount of corrosion.



Shasta Way A Tank

Image #39

Ceiling 12:00

Condition:
Rust Grade' 7.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.

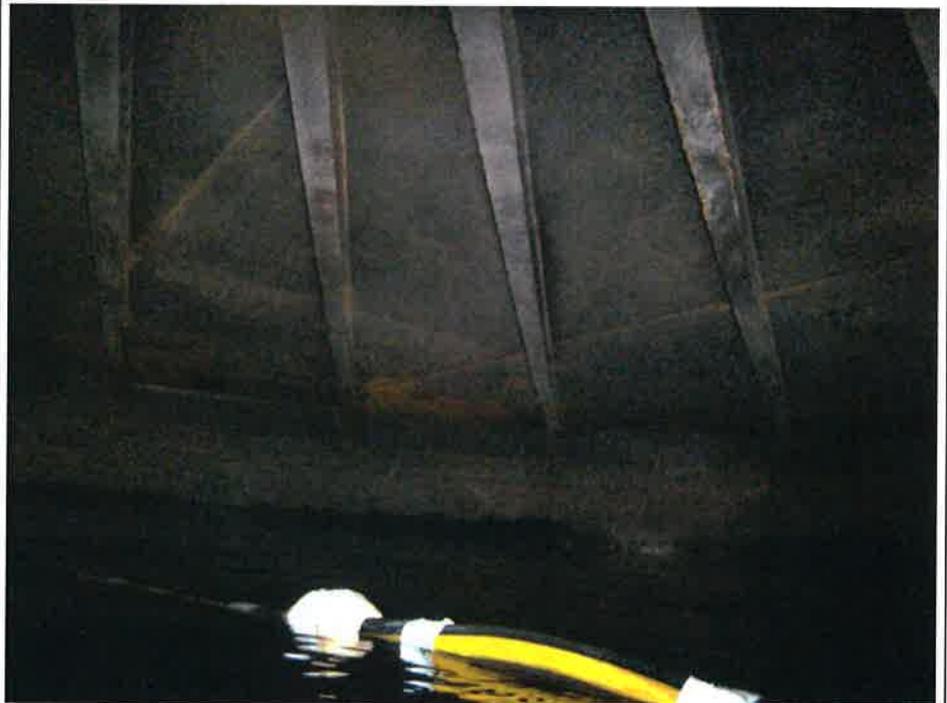


Image #40

Ceiling 3:00

Condition:
Rust Grade' 7.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Shasta Way A Tank

Image #41

Ceiling 6:00

Condition:
Rust Grade' Z.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Image #42

Ceiling 9:00

Condition:
Rust Grade' Z.

Description:
Ceiling appeared to be in fair condition with a minor amount of corrosion.



Shasta Way A Tank

Image #43

Column Center

Condition:
Rust Grade' 0.

Description:
8" Column appeared to be in poor condition with a heavy amount of corrosion towards the top above the water line.



Image #44

Overflow 8:30

Condition:
Rust Grade' 2.

Description:
8" Overflow appeared to be in fair condition with a minor amount of corrosion.



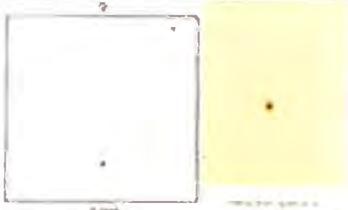
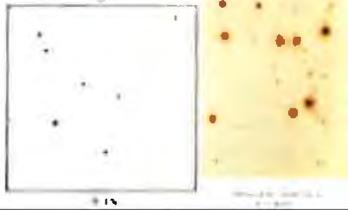
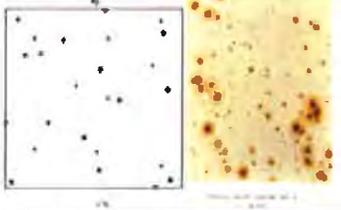
Shasta Way A Tank

REFERENCES:

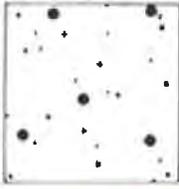
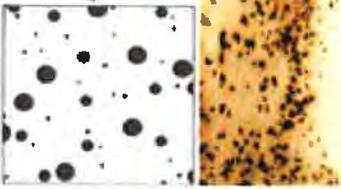
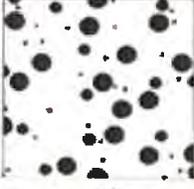
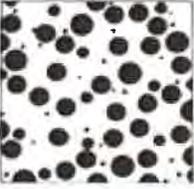
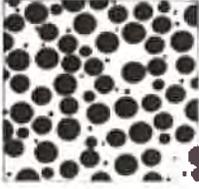
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Shasta Way A Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



Shasta Way B Tank

City of Shasta Lake

Report of Findings

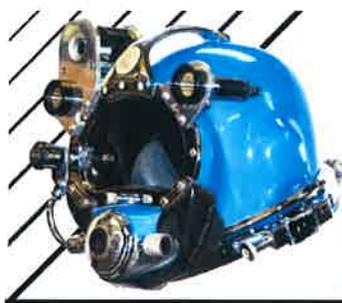
From the

Diving Operations

Conducted on

January 21, 2015

By



**LiquiVision
Technology
DIVING SERVICES**



LiquiVision
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Phone: (541) 883-6473
Fax: (541) 883-1361
liquivision@divinoservices.com

Underwater Inspection Of Shasta Way B Tank

January 21, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Shasta Way B Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Shasta Way B Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Shasta Way B Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R4T3	Capacity (gal.):	186,548
Date of Inspection:	January 21, 2015	Diameter or L x W:	38'
Report Writer:	Chase Hornaday	Height:	22'
Diver:	Bobby Barnicoat	Floor Square FT:	1134.1
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

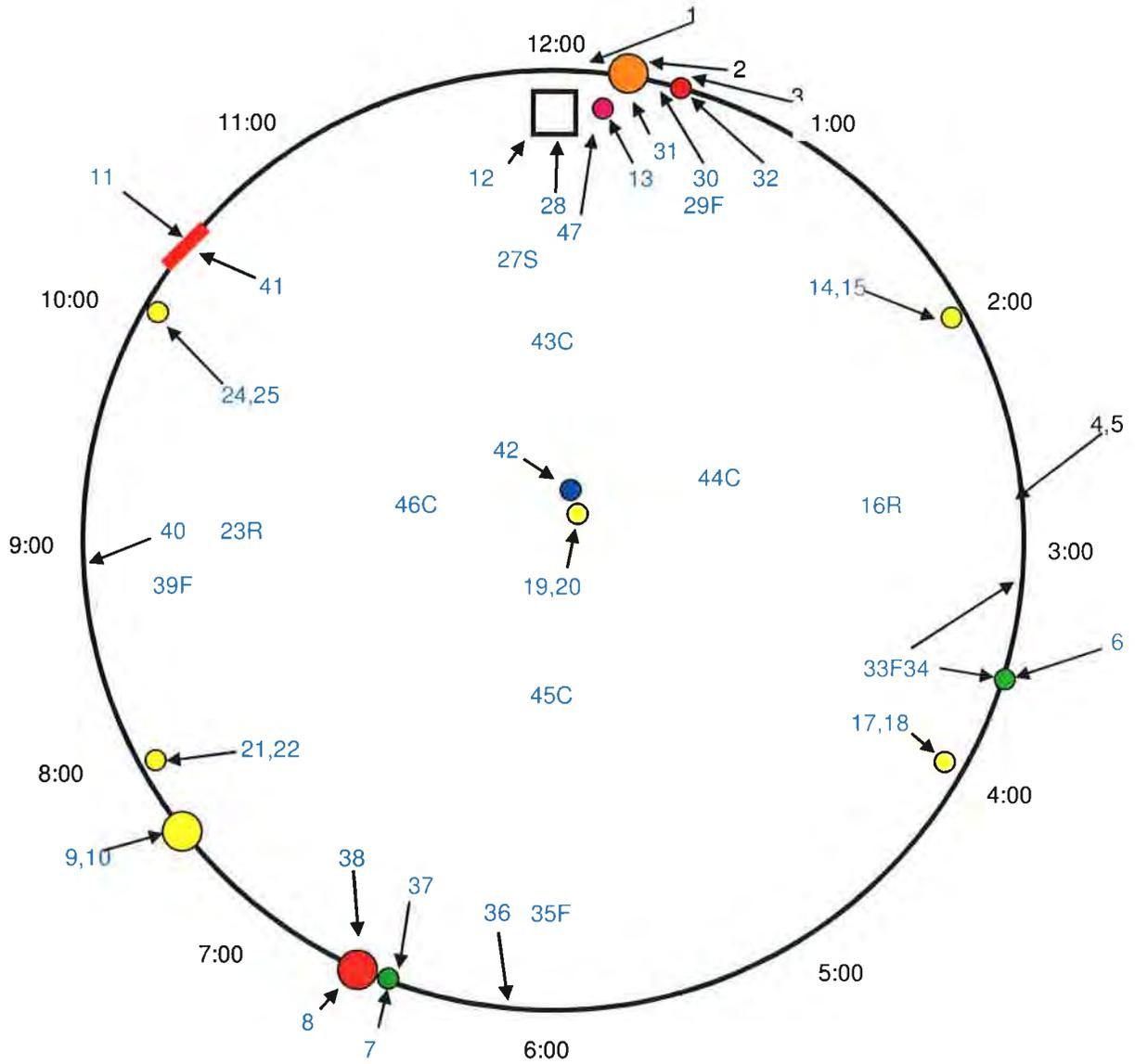
Shasta Way B Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	Please contact our sales office for an estimate.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Shasta Way B Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Drain/Scour		Man Entry		Water Tap
	Common Inlet/Outlet		Capped off penetration		Air Vent
	Liquid Level Indicator				

Shasta Way B Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade' 10.

Description:
Exterior Ladder
appeared to be in good
condition with no signs
of corrosion.



Image #2

Inlet / Outlet 12:05

Condition:
Rust Grade' 10.

Description:
10" Inlet / Outlet
appeared to be in good
condition with no signs
of corrosion.



Shasta Way B Tank

Image #3

Water Tap 12:10

Condition:
Rust Grade! 9.

Description:
1" Water Tap appeared to be in good condition with a minor amount of corrosion.



Image #4

Exterior Wall 3:00

Condition:
Rust Grade! 9.

Description:
Exterior Wall appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #5

Exterior Base 3:00

Condition:
Concrete Deform³ **CK.**

Description:
Exterior Base
appeared to be in poor
condition with a heavy
amount of cracking.



Image #6

*Capped Off Penetration
3:30*

Condition:
Rust Grade¹ **2.**

Description:
2" Capped Off
Penetration appeared to
be in good condition
with a minor amount of
corrosion.



Shasta Way B Tank

Image #7

Capped Off Penetration
6:30

Condition:
Rust Grade' 10.

Description:
6" Capped Off
Penetration appeared to
be in good condition
with no signs of
corrosion.



Image #8

Drain 6:30

Condition:
Rust Grade' 7.

Description:
4" Drain appeared to
be in good condition
with a minor amount of
corrosion.



Shasta Way B Tank

Image #9

Overflow 7:30

Condition:
Rust Grade! 10.

Description:
8" Overflow appeared to be in good condition with no signs of corrosion.

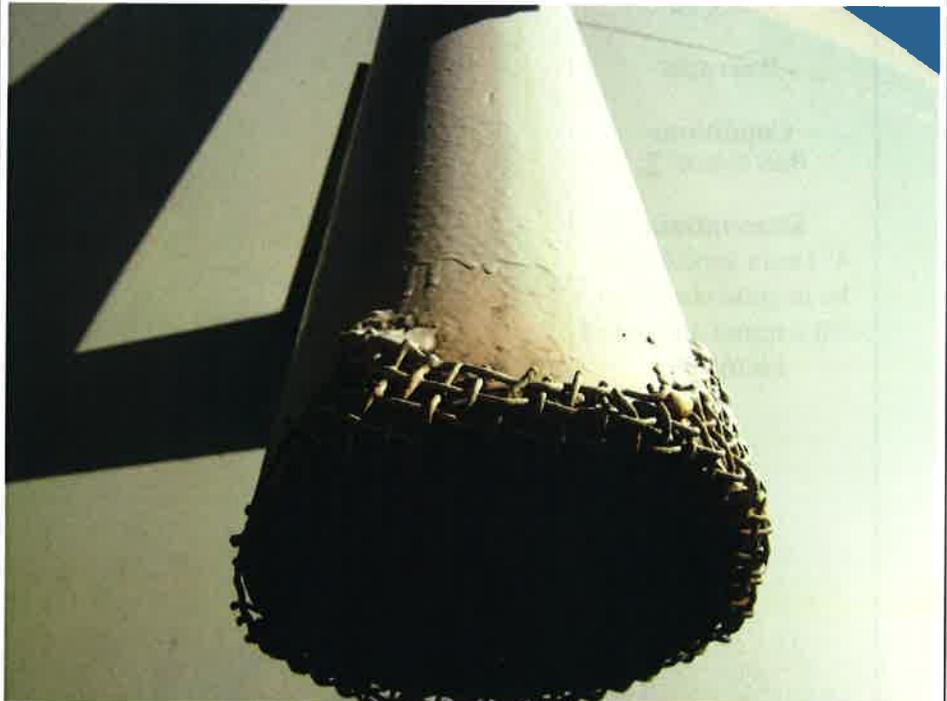


Image #10

Overflow Screen 7:30

Condition:
Rust Grade! 7.

Description:
Medium Mesh Overflow Screen appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #11

Man Way 10:30

Condition:
Rust Grade' 10.

Description:
24" Man Way appeared to be in good condition with no signs of corrosion.

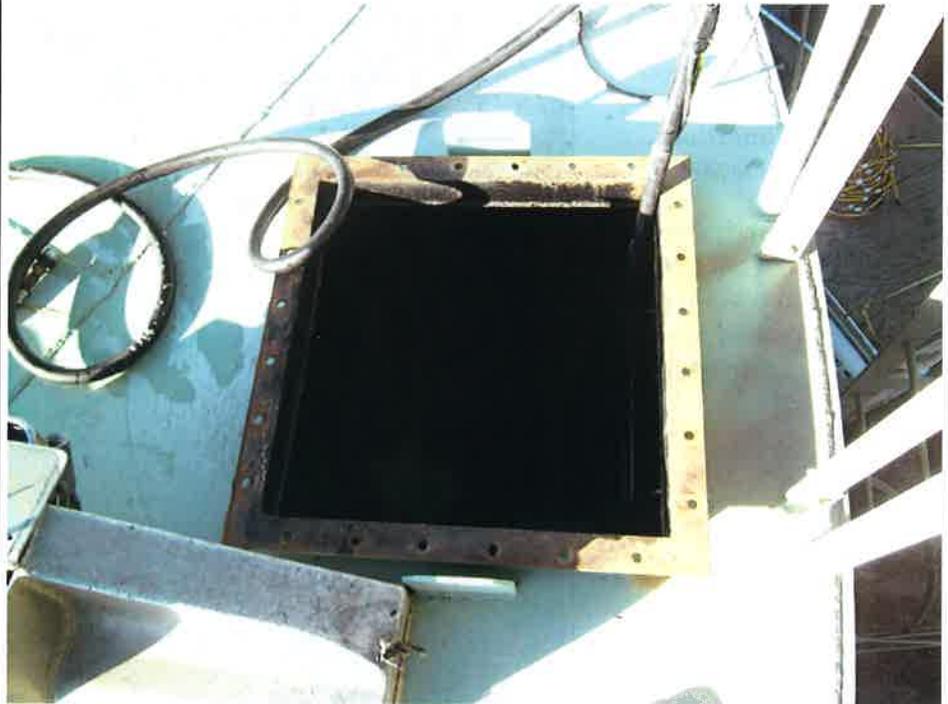


Image #12

Entry Hatch 12:00

Condition:
Rust Grade' 8.

Description:
24"x24" Entry Hatch appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #13

Liquid Level Indicator Penetration 12:05

Condition:
Rust Grade' 9.

Description:
1" Liquid Level Indicator Penetration appeared to be in good condition with a minor amount of corrosion.

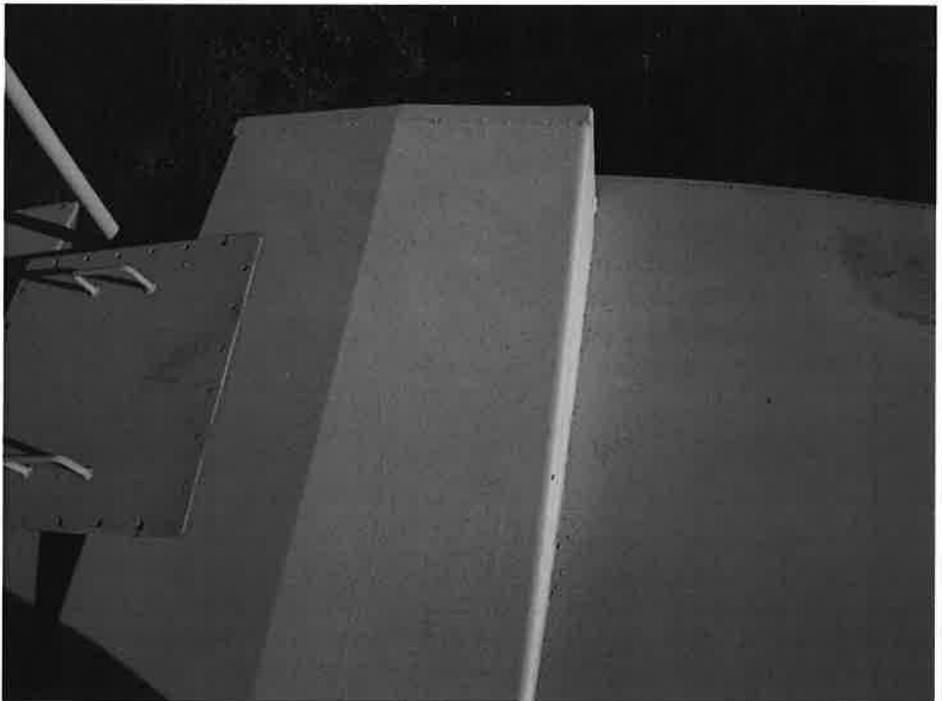


Image #14

Side Vent 2:00

Condition:
Rust Grade' 9.

Description:
24"x6" Vent appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #15

Vent Screen 2:00

Condition:
Rust Grade' 9.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #16

Roof 3:00

Condition:
Rust Grade' 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #17

Side Vent 4:00

Condition:
Rust Grade¹ 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.



Image #18

Vent Screen 4:00

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way B Tank

Image #19

Vent Center

Condition:
Rust Grade¹ 9.

Description:
36" Vent appeared to be in good condition with a minor amount of corrosion.



Image #20

Vent Screen Center

Condition:
Rust Grade¹ 8.

Description:
Medium Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #21

Side Vent 8:00

Condition:
Rust Grade¹ 9.

Description:
24"x6" Side Vent
appeared to be in good
condition with a minor
amount of corrosion.

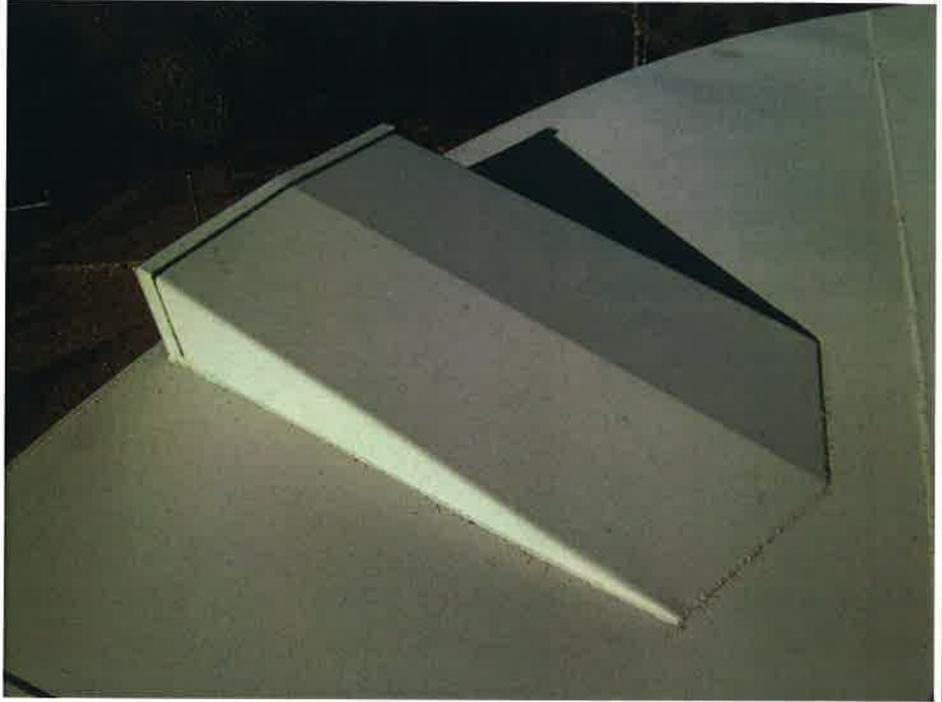


Image #22

Vent Screen 8:00

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen
appeared to be in fair
condition with a minor
amount of corrosion.



Shasta Way B Tank

Image #23

Roof 9:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion.



Image #24

Side Vent 10:00

Condition:
Rust Grade¹ 9.

Description:
24"x6" Side Vent appeared to be in good condition with a minor amount of corrosion.



Shasta Way B Tank

Image #25

Vent Screen 10:00

Condition:
Rust Grade¹ 9.

Description:
Fine Mesh Vent Screen appeared to be in good condition with a minor amount of corrosion.



Image #26

Diver



Shasta Way B Tank

Image #27

Sediment

Description:
Light Skiff of
sediment was removed
from reservoir floor.



Image #28

Interior Ladder 12:00

Condition:
Rust Grade' 9.

Description:
Interior Ladder
appeared to be in good
condition with a minor
amount of corrosion.



Shasta Way B Tank

Image #29

Floor 12:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating with moderate corrosion spots.



Image #30

Wall 12:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating with some minor cracking.



Shasta Way B Tank

Image #31

Inlet / Outlet 12:05

Condition:
Rust Grade' 8.

Description:
10'' Inlet / Outlet
appeared to be in good
condition with a minor
amount of corrosion.



Image #32

Water Tap 12:10

Condition:
Rust Grade' 0.

Description:
2'' Water Tap appeared
to be in poor condition
with a heavy amount of
corrosion.



Shasta Way B Tank

Image #33

Floor 3:00

Condition:
Rust Grade¹ UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating with moderate corrosion spots.

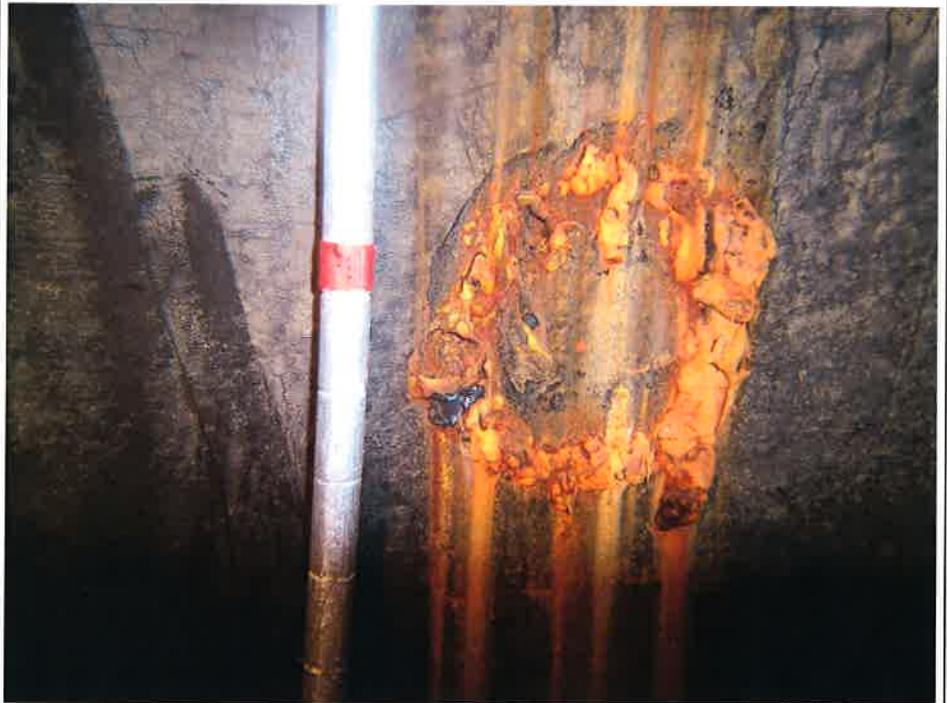


Image #34

Wall/Capped Off
Penetration 3:30

Condition:
Rust Grade¹ 0₂

Description:
3'' Capped Off
Penetration appeared to be in poor condition with a heavy amount of corrosion.



Shasta Way B Tank

Image #35

Floor 6:00

Condition:
Rust Grade' UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating with moderate corrosion spots.

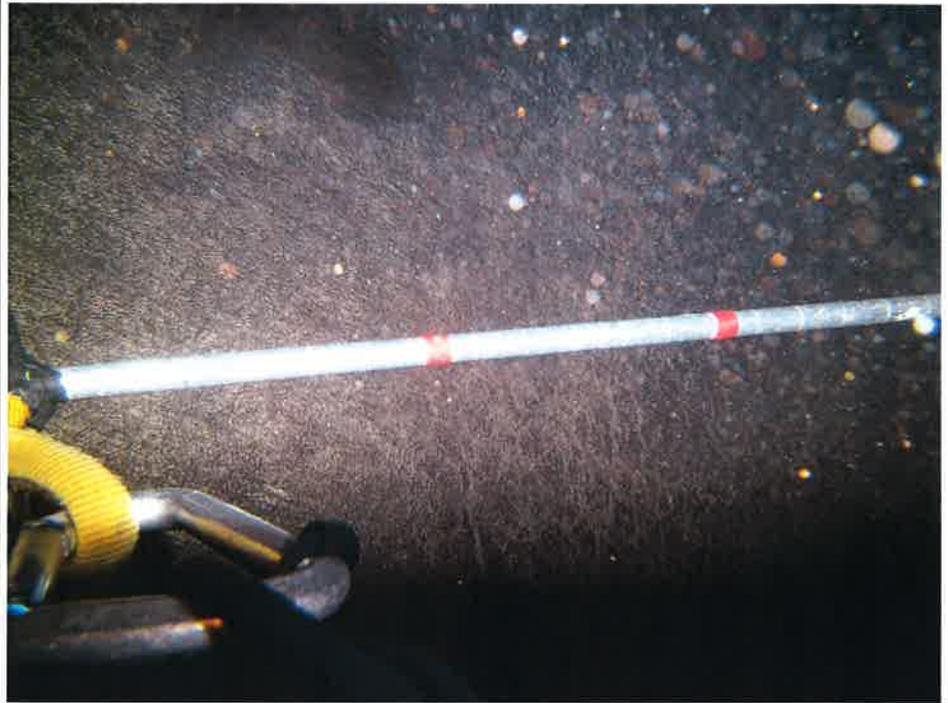


Image #36

Wall 6:00

Condition:
Rust Grade' UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating with moderate corrosion spots.



Shasta Way B Tank

Image #37

Capped Off Penetration
6:30

Condition:
Rust Grade¹ 8.

Description:
6" Capped Off
Penetration appeared to
be in good condition
with a minor amount of
corrosion.

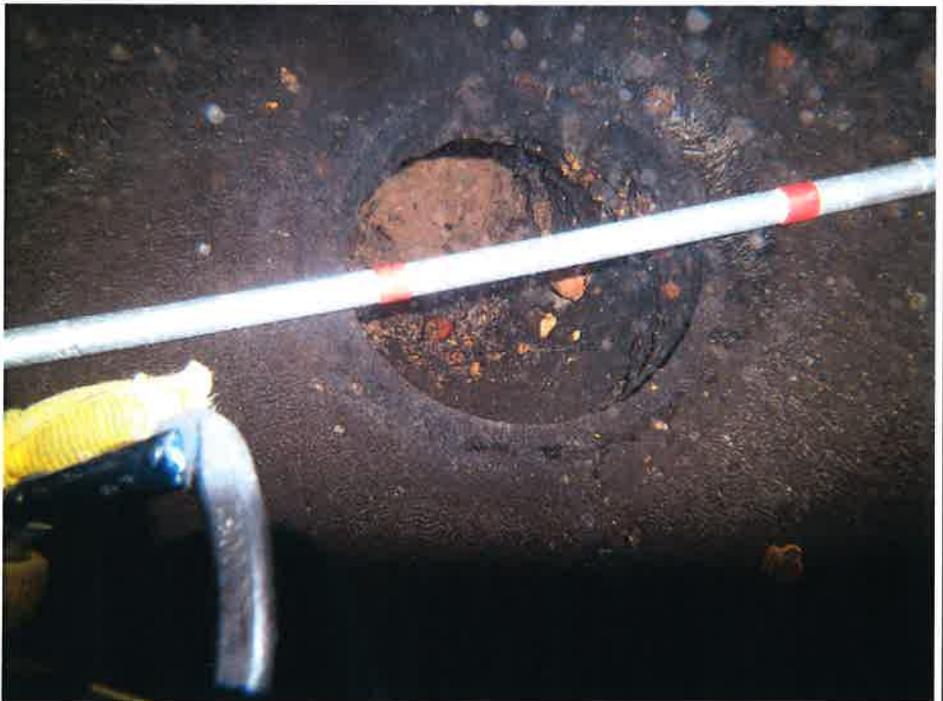


Image #38

Drain 6:30

Condition:
Rust Grade¹ 7.

Description:
6" Drain appeared to
be in good condition
with a minor amount of
corrosion.



Shasta Way B Tank

Image #39

Floor 9:00

Condition:
Rust Grade! UE.

Description:
Unable to evaluate the condition of the Floor due to cold tar coating with moderate corrosion spots.

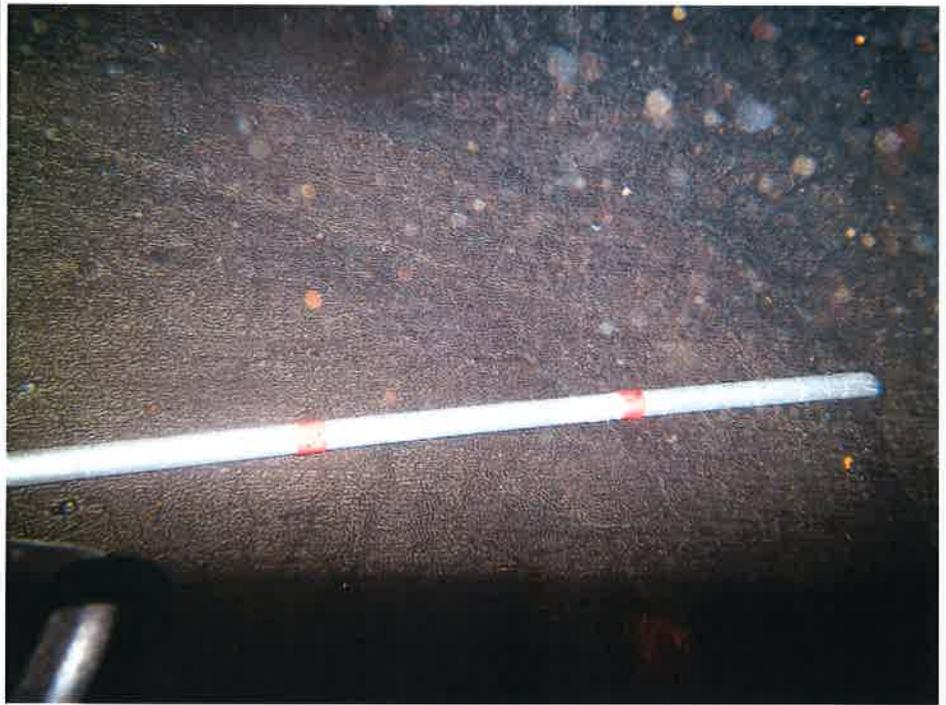


Image #40

Wall 9:00

Condition:
Rust Grade! UE.

Description:
Unable to evaluate the condition of the Wall due to cold tar coating.



Shasta Way B Tank

Image #41

Man Way 10:30

Condition:
Rust Grade' 4.

Description:
24" Man Way appeared to be in poor condition with a moderate amount of corrosion.

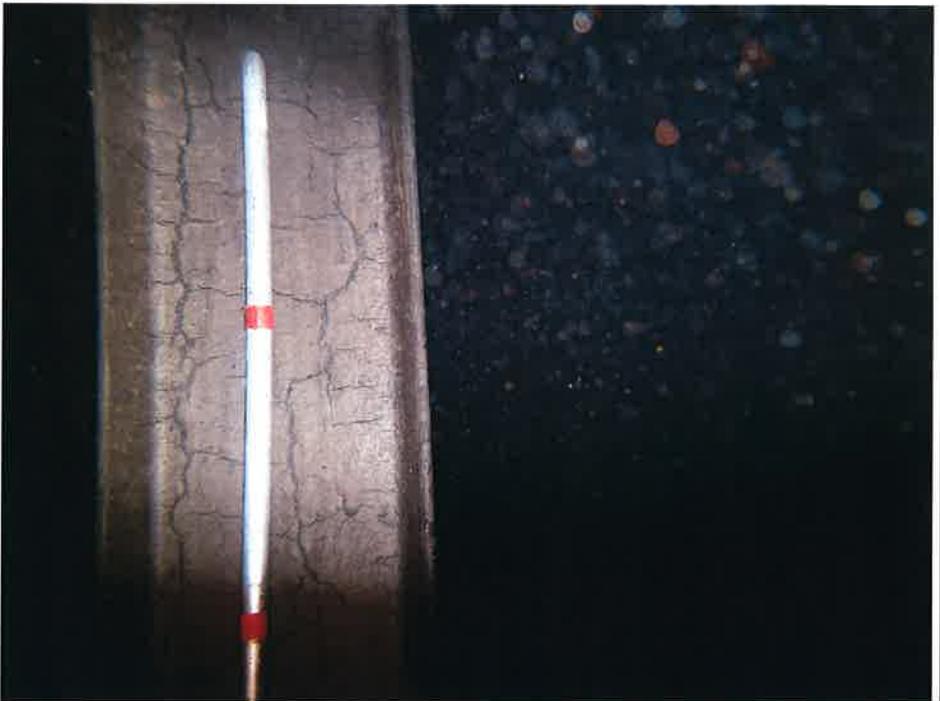


Image #42

Column Center

Condition:
Rust Grade' 7.

Description:
Column appeared to be in fair condition with a minor amount of corrosion.



Shasta Way B Tank

Image #43

Ceiling 12:00

Condition:
Rust Grade¹ 3.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.

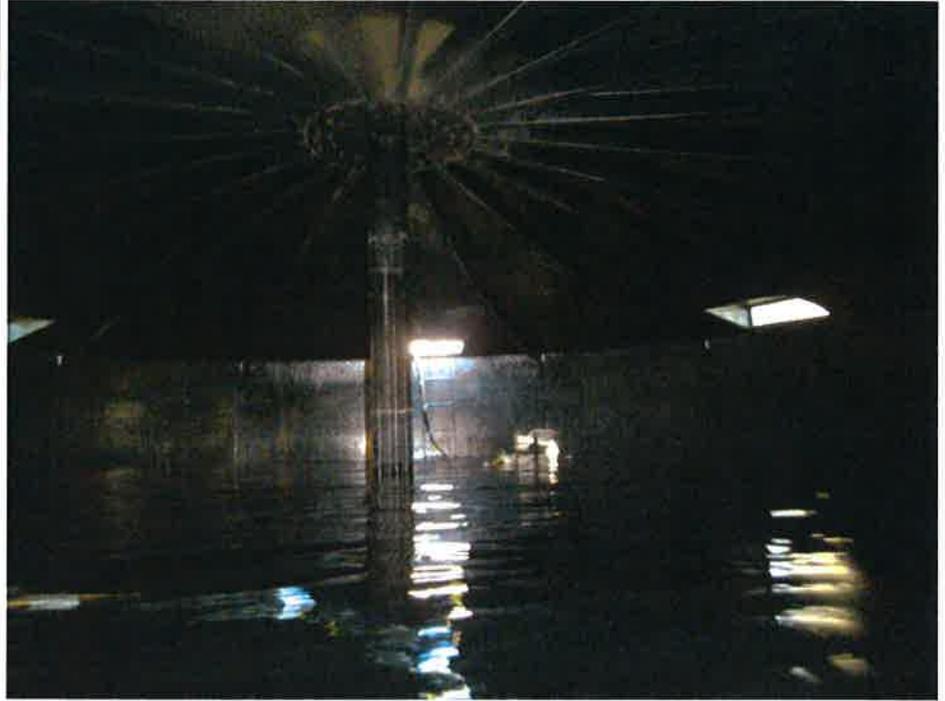


Image #44

Ceiling 3:00

Condition:
Rust Grade¹ 3.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Shasta Way B Tank

Image #45

Ceiling 6:00

Condition:
Rust Grade¹ 3.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Image #46

Ceiling 9:00

Condition:
Rust Grade¹ 3.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.

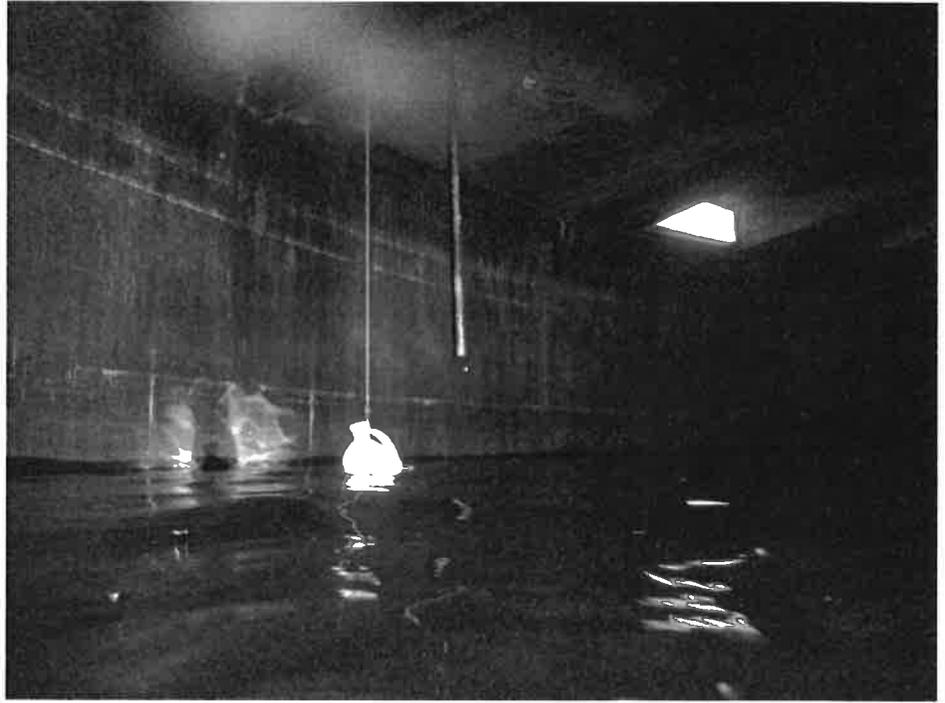


Shasta Way B Tank

Image #47

*Liquid Level Indicator
Float 12:05*

Condition:
Appeared to be
suspended functioning
properly.



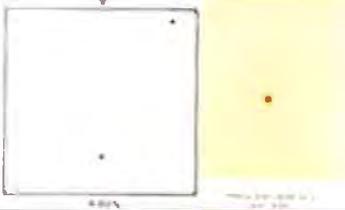
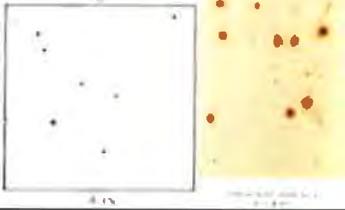
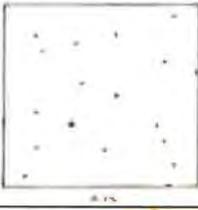
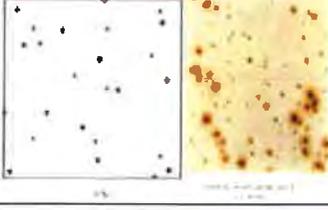
Shasta Way B Tank

REFERENCES:

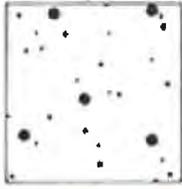
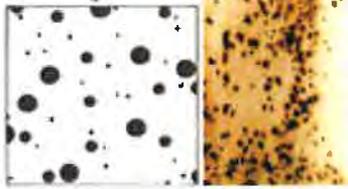
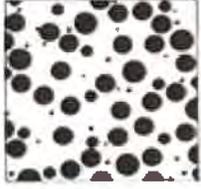
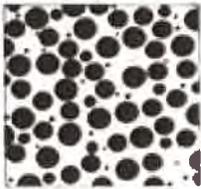
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces
– SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Shasta Way B Tank

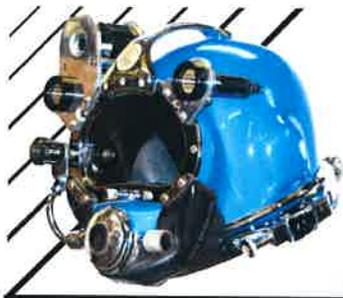
5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary



Toyon 5 Tank
City of Shasta Lake
Report of Findings
From the
Diving Operations
Conducted on

January 23, 2015

By



LiquiVision
Technology
DIVING SERVICES





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Western Operations
835 Market Street
Klamath Falls, OR 97601

Toll Free: (800) 229-8959
Phone: (541) 883-5473
Fax: (541) 883-1361

liuvision@divinoservices.com

Underwater Inspection of Toyon 5 Tank

January 23, 2015

Tony Thomasy
City of Shasta Lake
P.O. Box 777
Shasta Lake, CA 96019

Following is the report of findings during the underwater work conducted on your storage tank.

It will focus on issues of concern or areas that need attention. In order to see a complete and detailed inspection, please view each video.

Color images of all plumbing fixtures, components and areas of concern were taken via underwater digital camera. The images should give you a clear view of the conditions described. The video may give you another view and a clearer understanding of any area that you may wish to look at more closely.

METHODOLOGY:

Disinfection of All Equipment With 200ppm+ Chlorine Solution Immediately Prior to Entering System: This process prevents contamination of the water supply. All LVT equipment was properly disinfected prior to entering the potable water system.

Full-Time Voice Communication between surface and Diver: The system allowed for constant communication between the diver, and all surface personnel. In addition, customers were able to communicate with the diver at any time. For purposes of a more efficient inspection, cleaning, and repair program, that enabled the diver to immediately discuss any observations he made inside the storage tank.

Full-Time Live High Resolution Color Video: Allowed for constant viewing of the diver's work and observations. This also enabled the district personnel to view what the diver in the storage tank was witnessing.

Toyon 5 Tank

TERMINOLOGY:

When describing the features or areas of interest inside the storage tank, an image number is placed next to the description that corresponds with the inspection findings. The diagram is shown in a view looking from the top down. The entry hatch is referred to as the 12:00 o'clock position.

Following the diagram are pictures of the pertinent areas of the storage tank and the locations where the pictures were taken. Each picture is described and numbered.

The standards used to evaluate the condition of the storage tank include: Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85
NACE Standard RP0196-96 & RP0388-2001 or Condition of Concrete In-service – ACI 201.1R-92.

Toyon 5 Tank

OVERVIEW OF STORAGE TANK INSPECTED:

Customer Name:	City of Shasta Lake	Tank Name:	Toyon 5 Reservoir
Manager:	Tony Thomasy	Construction:	OG Welded
Job Number:	CA8302315R7T3	Capacity (gal.):	465,079
Date of Inspection:	January 23, 2015	Diameter or L x W:	60'
Report Writer:	Chase Hornaday	Height:	22'
Diver:	Bobby Barnicoat	Floor Square FT:	2,827.4
Tender:	Cameron Hagerman	Date Built:	Unknown

N/A –not applicable **Excellent** (Ex.) –like new condition, no repairs needed. **Good** – Cosmetic only problems, repairs if wanted. **Fair**-Minor problems, repairs needed, not immediate. **Poor** –Major problems, structural or like, immediate repairs needed.

1. Rust Grades

Grades	% of Surface Rusted	Description
10	0% - 0.01%	No rusting or less than 0.01% of surface rusted
9	0.01% - 0.03%	Minute rusting, less than 0.03% of surface rusted
8	0.03% - 0.1%	Few isolated rust spots, less than 0.1% of surface rusted
7	0.1%- 0.3%	Less than 0.3% of surface rusted
6	0.3% - 1%	Extensive rust spots, but less than 1% of surface rusted
5	1% - 3%	Rusting to the extent of 3% of surface rusted
4	3% - 10%	Rusting to the extent of 10% of surface rusted
3	10% - 16%	Approximately one sixth of the surface rusted (16%)
2	16% - 33%	Approximately one third of the surface rusted (33%)
1	33% - 50%	Approximately one half of the surface rusted (50%)
0	50% - 100%	Approximately 100% of the surface rusted

2. Concrete Deformities

Unable to Evaluate	Good Condition	Cracks	Blistering	Chalking	De-Lamination	Pitting	Popouts	Scaling	Spalling	Warping
UE	GC	CK	BL	CH	DL	PT	PO	SC	SP	WA

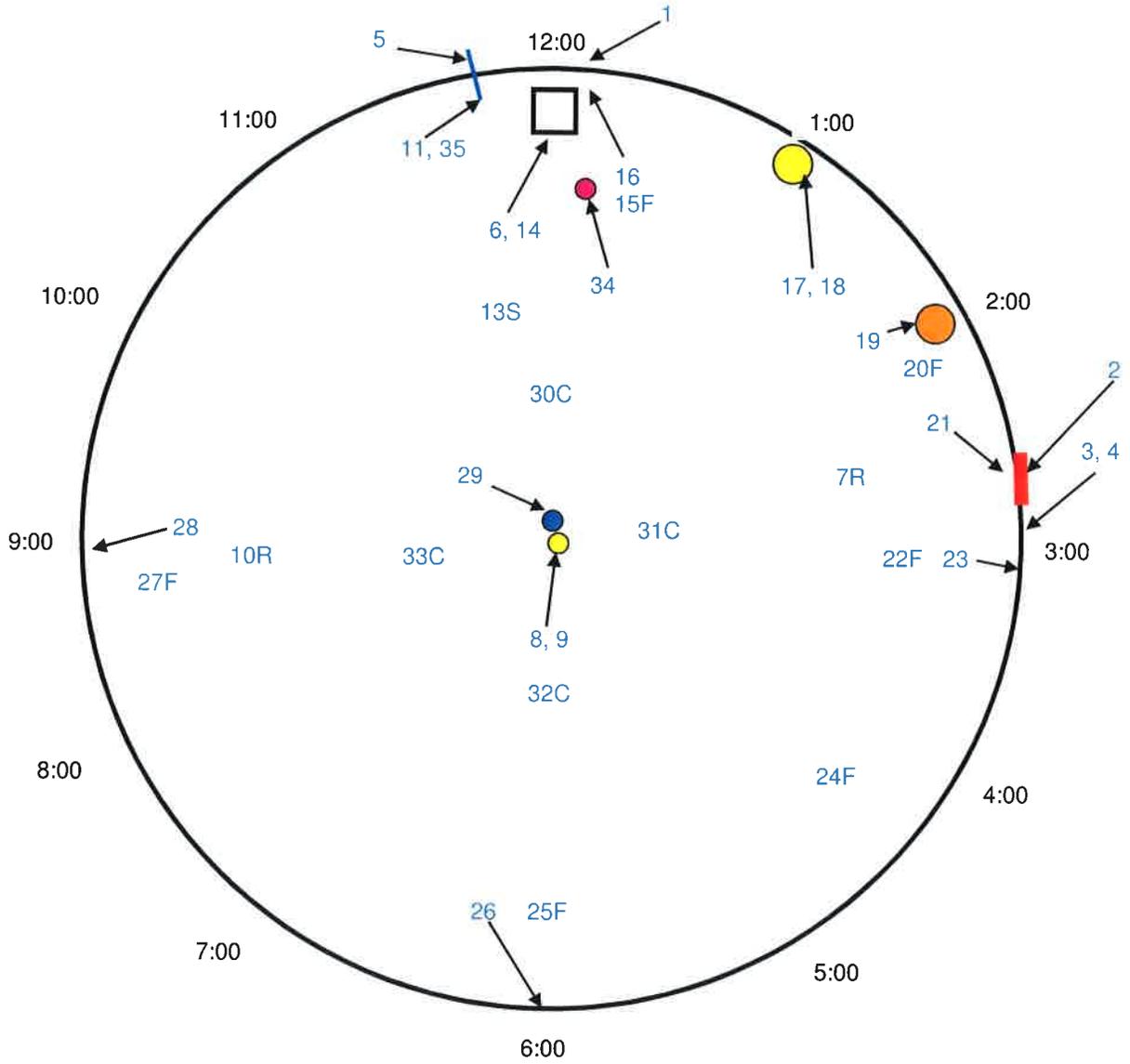
Toyon 5 Tank

RECOMMENDATIONS:

Recommendation	Estimated Time - Hrs.
Repair and/or install fine mesh screens on exterior vents to limit the risk of bugs and other matter from entering the storage tank.	2.0
Install weather stripping on entry hatch to limit the risk of bugs and other matter from entering the storage tank.	1.0
Replace liquid level indicator float with a more durable stainless steel type float. Consider replacing the liquid level indicator reader board with a more legible one. If the liquid level indicator is not needed then you may want to consider removing it instead.	Please contact our sales office for an estimate.
Remove the existing interior coating and apply a new NSF approved epoxy type coating. The existing interior coating was in such disrepair that it would not be cost effective to attempt to patch all of the problem areas.	LiquiVision Technology does not perform this service.
Perform a regular cleaning, inspection and repair cycle every 2-3 years in order to ensure superior water quality and proper maintenance of coating condition and appurtenances is performed.	Please contact our sales office for an estimate.
Total Estimated Hours	

Toyon 5 Tank

Tank Diagram



Drawing Not To Scale

	Entry Hatch		Overflow		Support Column
	Common Inlet/Outlet		Man Entry		Telemetry
	Liquid Level Indicator		Air Vent		

Toyon 5 Tank

Image #1

Exterior Ladder 12:00

Condition:
Rust Grade' 8.

Description:
Exterior Ladder appeared to be in good condition with a minor amount of corrosion.



Image #2

Man Way 2:45

Condition:
Rust Grade' 7.

Description:
24" Man Way appeared to be in good condition with a minor amount of corrosion.



Toyon 5 Tank

Image #3

Exterior Wall 3:00

Condition:
Rust Grade¹ 9.

Description:
Exterior Wall appeared to be in good condition with a minor amount of corrosion.

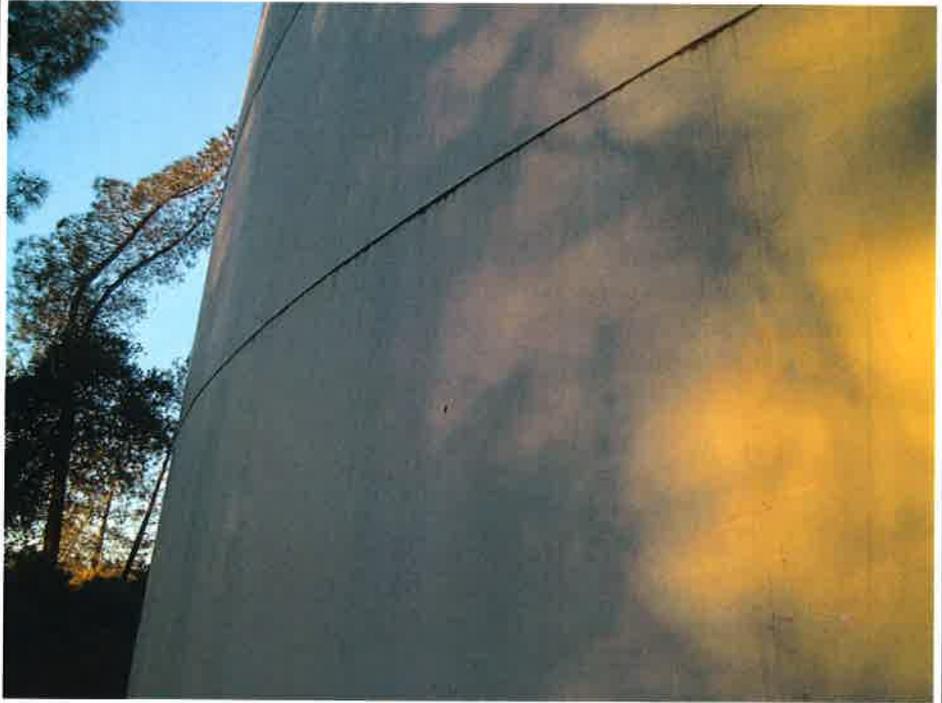


Image #4

Exterior Base 3:00

Condition:
Concrete Deform³ CK.

Description:
Exterior Base appeared to be in fair condition with a moderate amount of cracking.



Toyon 5 Tank

Image #5

*Liquid Level Indicator
Reader Board 11:45*

Condition:
Rust Grade¹ 7.

Description:
Liquid Level Indicator
Reader Board appeared
to be in good condition
with a minor amount of
corrosion.

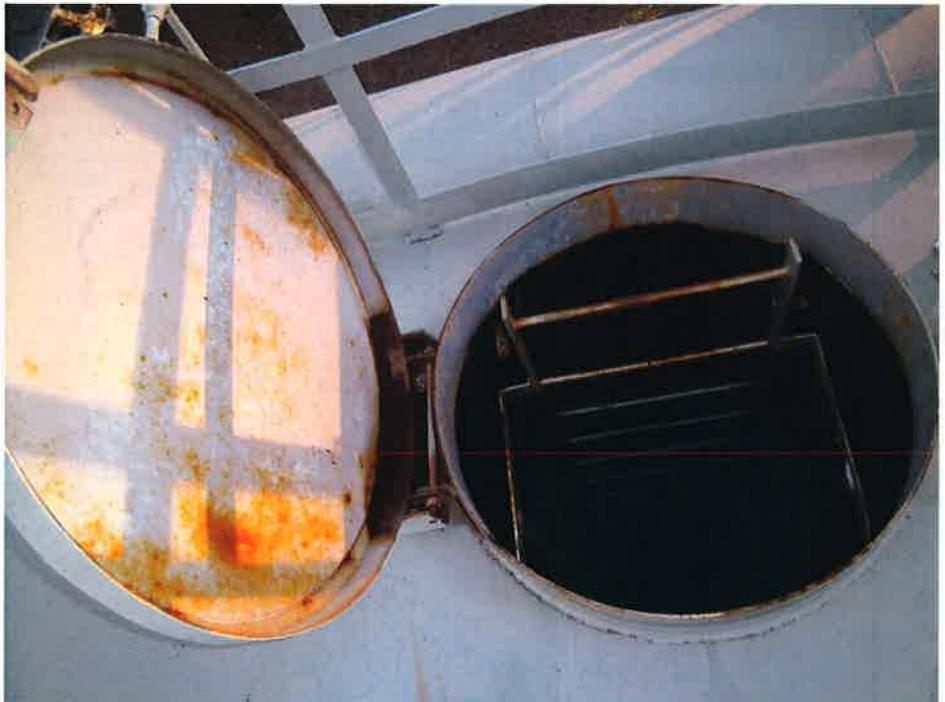


Image #6

Entry Hatch 12:00

Condition:
Rust Grade¹ 6.

Description:
24" Entry Hatch
appeared to be in good
condition with a
moderate amount of
corrosion.



Toyon 5 Tank

Image #7

Roof 3:00

Condition:
Rust Grade¹ 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.

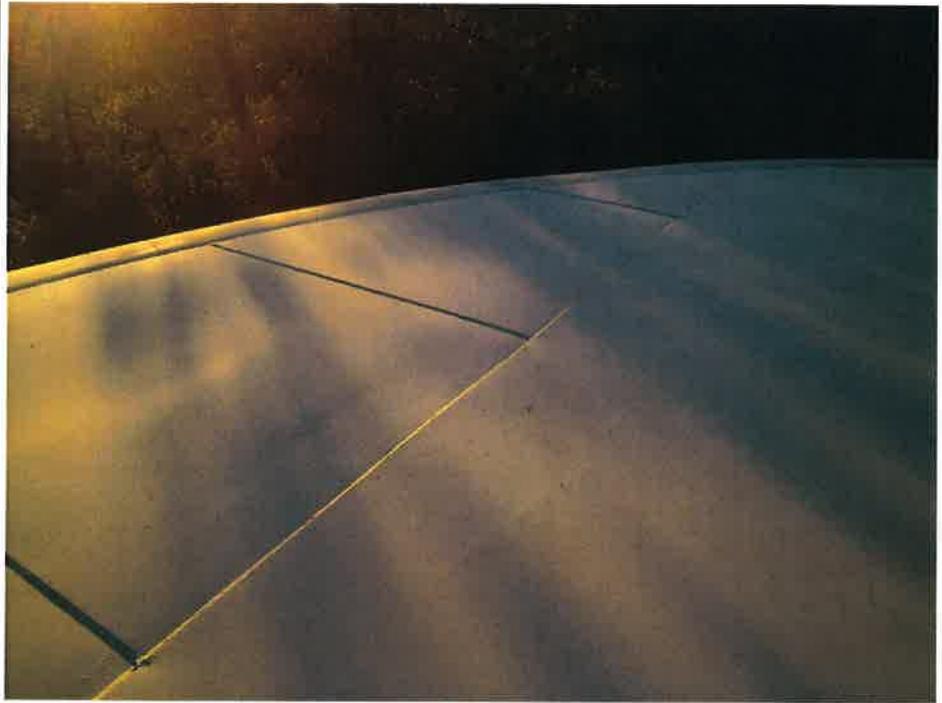


Image #8

Vent Center

Condition:
Rust Grade¹ 74

Description:
30" Vent appeared to be in good condition with a minor amount of corrosion. Most corrosion observed was on underside of lid.



Toyon 5 Tank

Image #9

Vent Screen Center

Condition:
Rust Grade' 3.

Description:
Large and Fine Mesh Vent Screens appeared to be in fair condition with tears observed in Fine Mesh Screen and moderate corrosion observed on the Large Mesh Screen.



Image #10

Roof 9:00

Condition:
Rust Grade' 9.

Description:
Roof appeared to be in good condition with a minor amount of corrosion and chalking observed.



Toyon 5 Tank

Image #11

*Liquid Level Indicator
Penetration 11:45*

Condition:
Rust Grade 7.

Description:
1" Liquid Level
Indicator Penetration
appeared to be in good
condition with a minor
amount of corrosion.

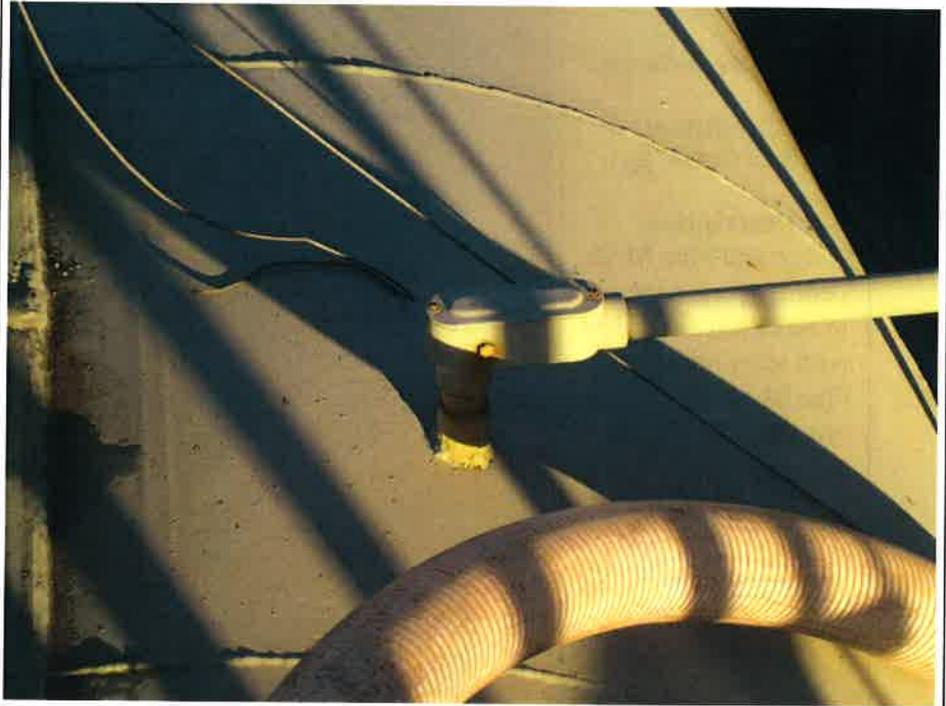


Image #12

Diver



Toyon 5 Tank

Image #13

Sediment

Description:
1/32" of sediment was removed from reservoir floor.

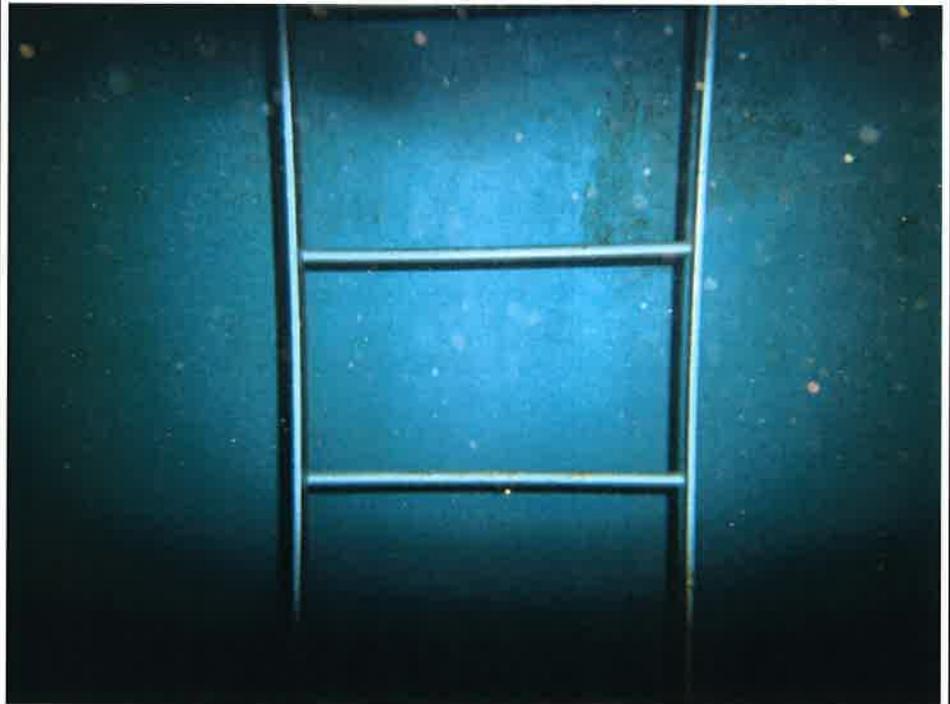


Image #14

Interior Ladder 12:00

Condition:
Rust Grade¹ 6.

Description:
Interior Ladder appeared to be in fair condition with a moderate amount of corrosion.



Toyon 5 Tank

Image #15

Floor 12:00

Condition:
Rust Grade' 3.

Description:
Floor appeared to be in poor condition with a heavy amount of corrosion and moderate blistering observed.

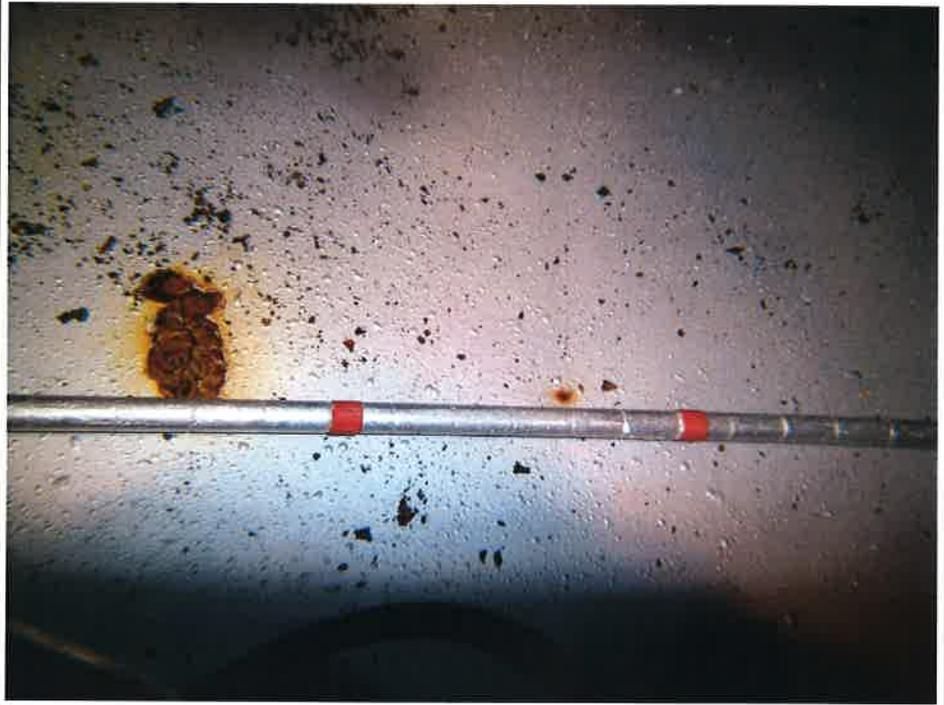


Image #16

Wall 12:00

Condition:
Rust Grade' 7.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and minor blistering observed.



Toyon 5 Tank

Image #17

Overflow 1:00

Condition:
Rust Grade' 6.

Description:
12" Overflow appeared to be in fair condition with a moderate amount of corrosion.



Image #18

Overflow Bell 1:00

Condition:
Rust Grade' 7.

Description:
16" Overflow Bell appeared to be in good condition with a minor amount of corrosion.



Toyon 5 Tank

Image #19

Inlet / Outlet 2:00

Condition:
Rust Grade¹ 8.

Description:
10" Inlet / Outlet appeared to be in fair condition with a minor amount of corrosion and blistering observed.



Image #20

Floor 2:00

Condition:
Rust Grade¹ 2.

Description:
Floor appeared to be in poor condition with a heavy amount of corrosion and moderate blistering observed.
Heavy surface corrosion on floor was observed near Inlet/Outlet from rust scale.



Toyon 5 Tank

Image #21

Man Way 2:45

Condition:
Rust Grade¹ 7.

Description:
24" Man Way appeared to be in fair condition with a minor amount of corrosion and moderate blistering observed.

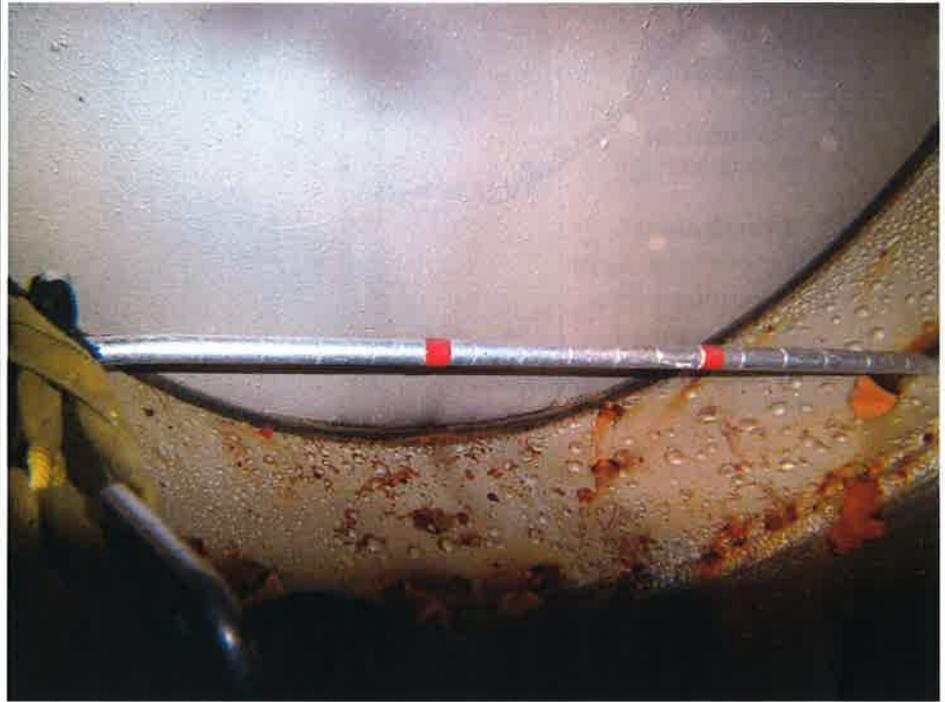


Image #22

Floor 3:00

Condition:
Rust Grade¹ 3.

Description:
Floor appeared to be in poor condition with a heavy amount of corrosion and moderate blistering observed.



Toyon 5 Tank

Image #23

Wall 3:00

Condition:
Rust Grade' 7.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and blistering observed.

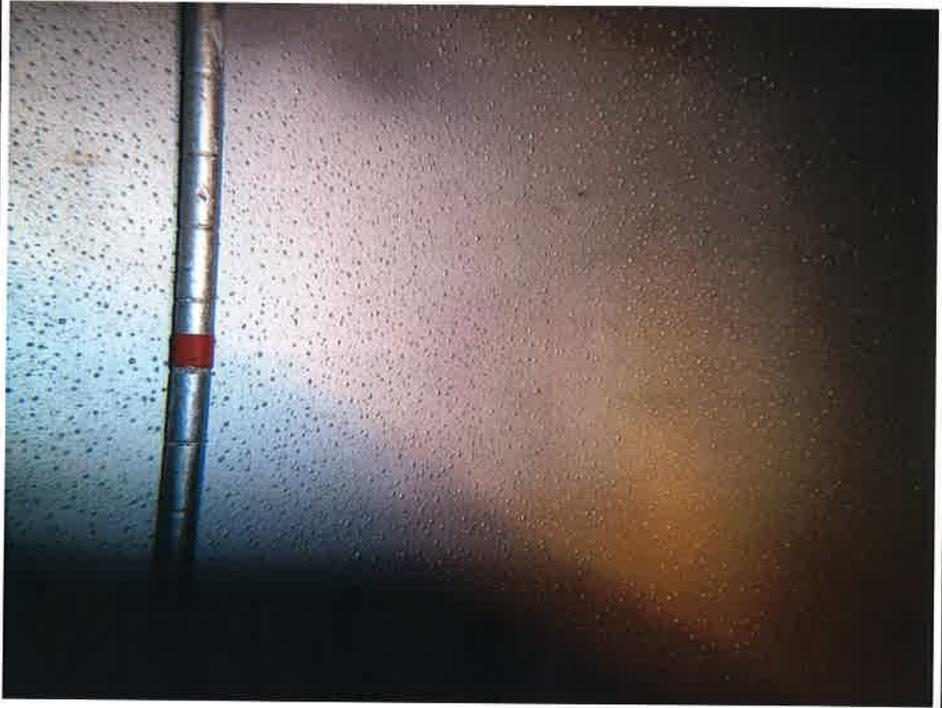


Image #24

Floor 4:30

Condition:
Rust Grade' 4.

Description:
Floor appeared to be in poor condition with a moderate amount of corrosion and blistering observed.



Toyon 5 Tank

Image #25

Floor 6:00

Condition:
Rust Grade 4.

Description:
Floor appeared to be in poor condition with a moderate amount of corrosion and heavy blistering observed.

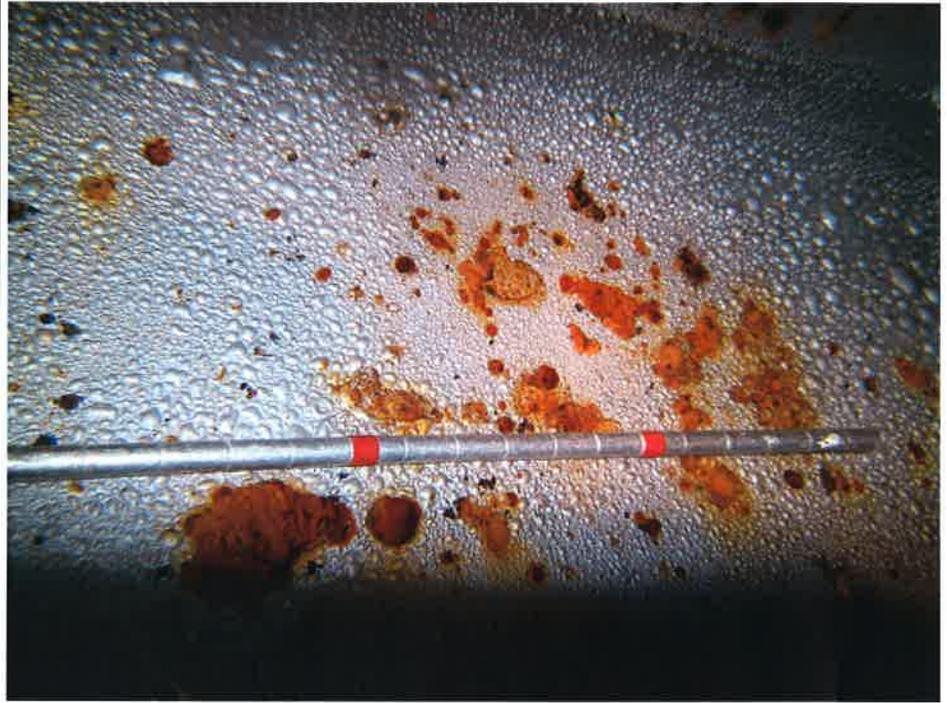


Image #26

Wall 6:00

Condition:
Rust Grade 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and blistering observed.



Toyon 5 Tank

Image #27

Floor 9:00

Condition:
Rust Grade' 4.

Description:
Floor appeared to be in poor condition with a moderate amount of corrosion and heavy blistering observed.

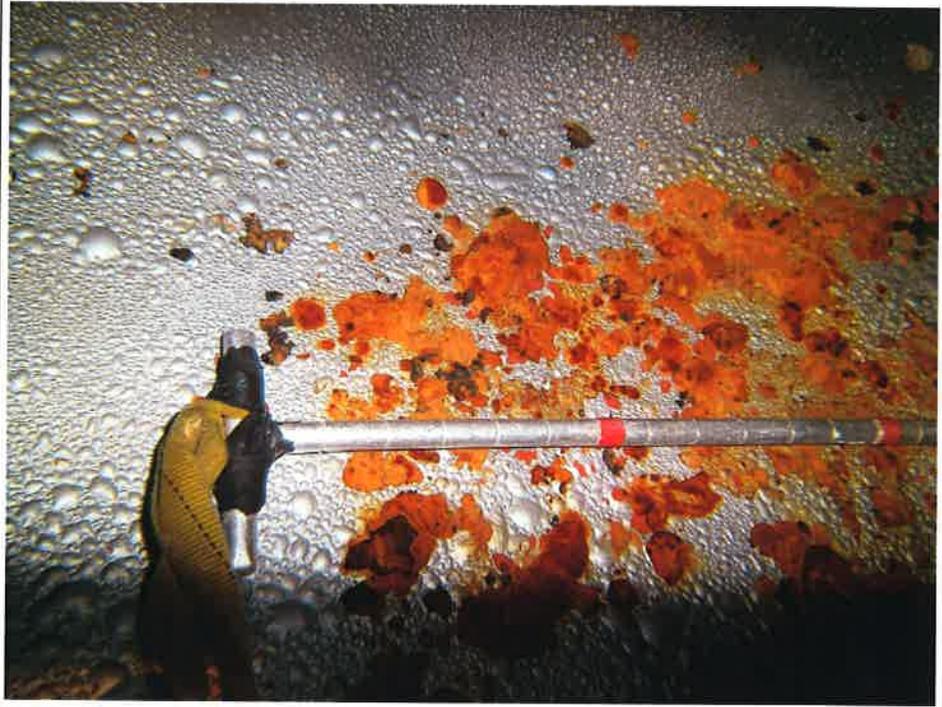
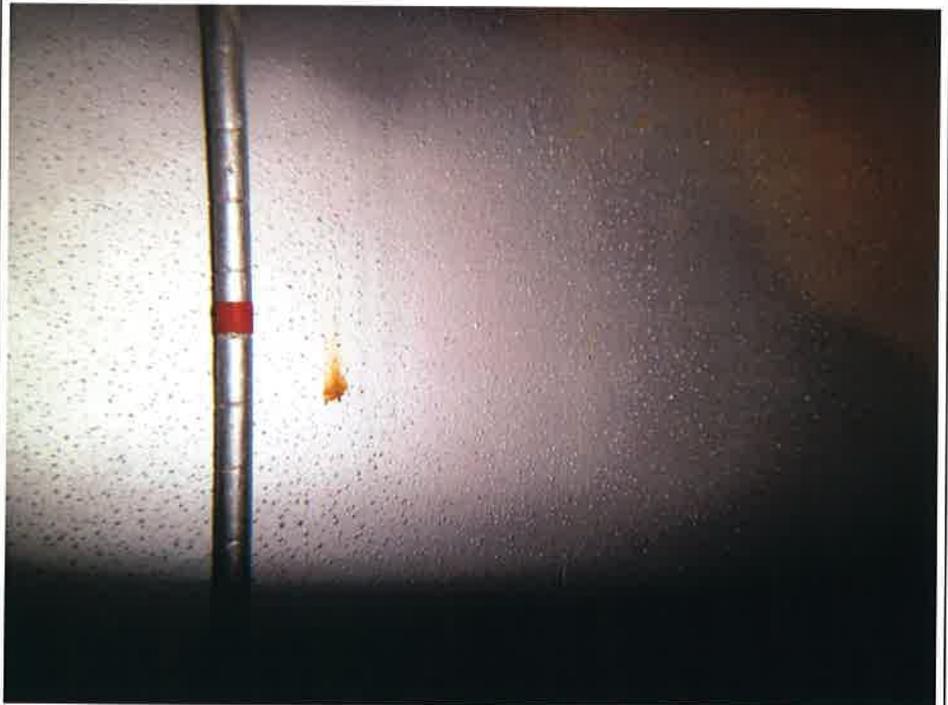


Image #28

Wall 9:00

Condition:
Rust Grade' 8.

Description:
Wall appeared to be in fair condition with a minor amount of corrosion and blistering observed.



Toyon 5 Tank

Image #29

Column Center

Condition:
Rust Grade¹ 8.

Description:
12" Column appeared to be in fair condition with a minor amount of corrosion and moderate blistering observed.

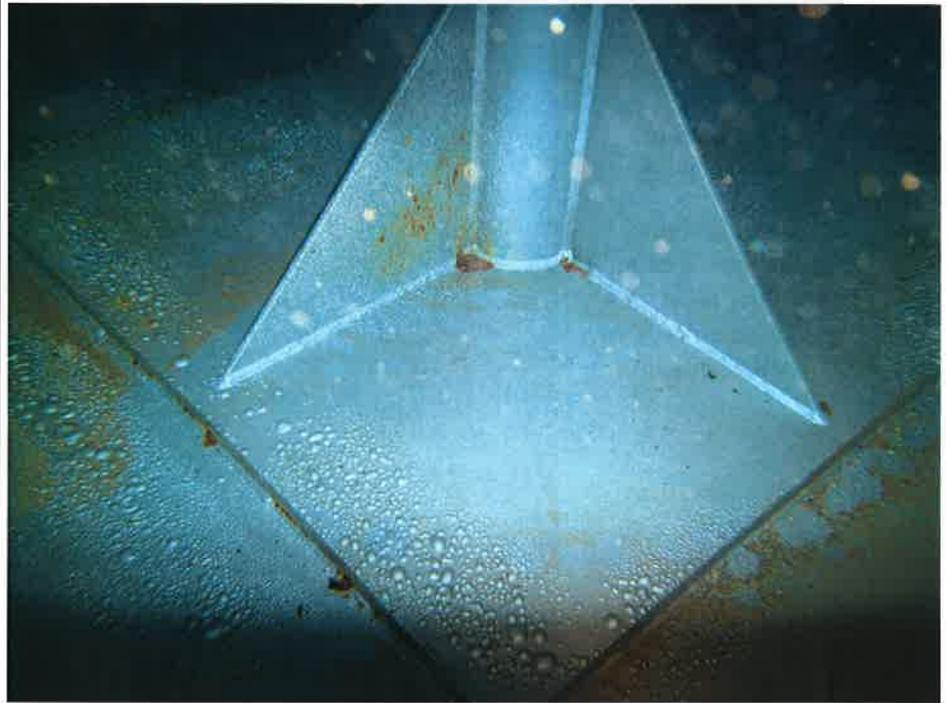


Image #30

Ceiling 12:00

Condition:
Rust Grade¹ 4.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Toyon 5 Tank

Image #31

Ceiling 3:00

Condition:
Rust Grade' 4.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Image #32

Ceiling 6:00

Condition:
Rust Grade' 4.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Toyon 5 Tank

Image #33

Ceiling 9:00

Condition:
Rust Grade¹ 4.

Description:
Ceiling appeared to be in fair condition with a moderate amount of corrosion.



Image #34

Telemetry Stillwell 12:00

Condition:
Rust Grade¹ 8.

Description:
8" Telemetry Stillwell appeared to be in fair condition with a minor amount of corrosion and blistering observed. Sensor appeared to be properly suspended.

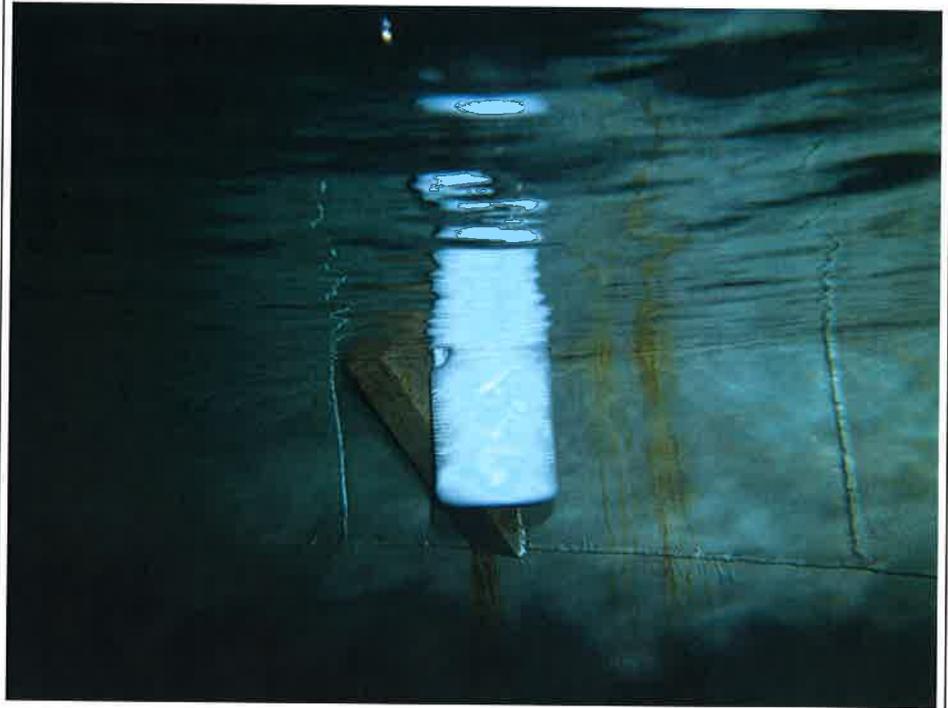


Toyon 5 Tank

Image #35

*Liquid Level Indicator
Float 11:45*

Condition:
Float appeared to be in
good working
condition.



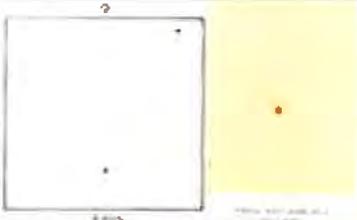
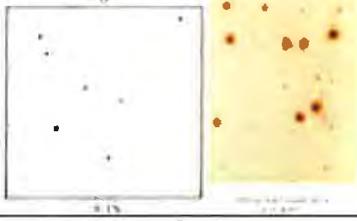
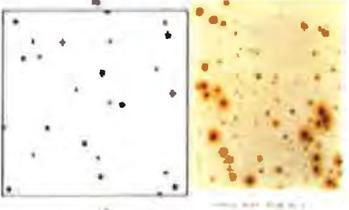
Toyon 5 Tank

REFERENCES:

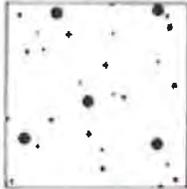
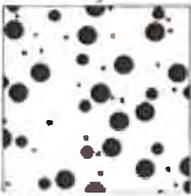
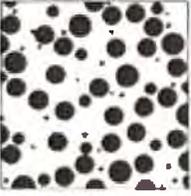
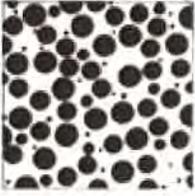
Standard Method of Evaluating Degree of Rusting on Painted Steel Surfaces – SSPC-Vis 2-82 & ASTM D 610-85 (1989)

The graphical representations show examples of area percentages, which may be helpful in rust grading. The use of photographic reference standards requires the following precautions:

1. Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.
2. Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.
3. Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.
4. It must be realized that failure may vary over a given area and discretion must therefore be used in applying these reference standards.
5. In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as white, than on a similar color, such as iron oxide finish.
6. The photographic reference standards are not required for use of the rust-grade scale since the scale is based upon the percent of the area rusted and any method of assessing area rusted may be used to determine the rust grade.

Rust Grades	Description	Graphical Representation
10	No rusting or less than 0.01% of surface rusted	Unnecessary
9	Minute rusting, less than 0.03% of surface rusted	
8	Few isolated rust spots, less than 0.1% of surface rusted	
7	Less than 0.3% of surface rusted	
6	Extensive rust spots, but less than 1% of surface rusted	

Toyon 5 Tank

5	Rusting to the extent of 3% of surface rusted	
4	Rusting to the extent of 10% of surface rusted	
3	Approximately one sixth of the surface rusted (16%)	
2	Approximately one third of the surface rusted (33%)	
1	Approximately one half of the surface rusted (50%)	
0	Approximately 100% of the surface rusted	Unnecessary

Appendix I
RAW WATER FACILITIES EVALUATION
TECHNICAL MEMORANDUM



City of Shasta Lake
2016-2026 Water Master Plan

Technical Memorandum
Raw Water Facilities Evaluation



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Technical Memorandum 1

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Technical Memorandum 1

RAW WATER FACILITIES

1.1 Background

The City of Shasta Lake's (City's) previous Water Master Plan was developed in 1998 by Pace Civil, Inc. and was subsequently updated in 2003 by Pace. The objectives of the 1998 and 2003 Water Master Plans were to review the current water distribution system and to identify improvements required over a 20 year planning period, with a special emphasis on prioritizing improvements needed within the next 10 years. The Master Plans considered supply, storage, and distribution system needs to meet existing and projected water demands. In September 2015, the City approved a professional service agreement with Carollo Engineers, Inc. (Carollo), to update the 2003 Master Plan, and prepare a Capital Improvement Plan for the 2016 to 2026 timeframe.

The City's sole source of water is surface water diverted from Shasta Lake. The diversion point is located at the face of the dam. Currently there are two intakes that draw water from elevations of 750-feet and 950-feet above sea level. Raw water is pumped to the City's Fisherman's Point Water Treatment Plant (WTP) via a Raw Water Pumping Station (RWPS) operated by the United States Bureau of Reclamation (USBR). The RWPS is located at the base of Shasta Dam. USBR controls, via contract, and is responsible for the maintenance of the following water supply facilities: 950-foot and 750-foot discharge tube connections inside Shasta Dam, manifold piping and transmission main (located both inside the Dam and attached to the Dam face), raw water pump station (RWPS) and associated controls facility at the base of the Dam, and transmission pipeline from the RWPS to the edge of the City's Fisherman's Point Water Treatment Plant (WTP).

1.2 Raw Water Facility Descriptions

This sections provides a brief description of three raw water facilities and concerns in regards to each facility.

1.2.1 Raw Water Pump Station

The RWPS was constructed in 1948 and currently has five pumping units and one spare fixture that can accommodate a sixth pumping unit. The RWPS units are summarized in

Table 1 shows a summary of the RWPS which is equipped with a hydropneumatic tank at the pump station site. Raw water is pumped from two intakes at 750 feet and 950 feet on Shasta Dam through a single 16-inch raw water transmission main up the hill to the City's Raw Water Tank. The RWPS pumping capacity is be affected by low water levels in Shasta Lake during drought conditions. See Appendix A for RWPS site layout.

Table 1 Raw Water Pump Station Summary

No.	Year Installed	Power (HP)	Pump Capacity (gpm)	Design Head (ft)	Speed Type	Pump Elevation (ft)
1	n/a	125	750	275	Constant	764
2	n/a	125	850	275	Constant	764
3	n/a	200	1,600	275	Constant	764
4	n/a	350	3,300	275	Constant	764
5	2007	400	2,500	470	Variable	764

There are several issues/noteworthy items related to the RWPS, including the following:

- Pump 1 was recently out of service, and was rebuilt with the wrong impeller size. The City resolved this issue and Pump 1 is back in service with the proper impeller size.
- Pump 2 was recently out of service and has been rebuilt. It is back in service.
- If Pump 5 were to go out of service, the RWPS will not have enough capacity during specific hydraulic conditions to provide enough raw water supply to meet the City's needs.
- Pump 5 is a 400 HP Variable Frequency Drive (VFD) that is unable to run during low demand conditions.
- The USBR recently obtained the money to add a new pump (Pump 6) which will mirror Pump 5.
- Based on an analysis of existing and projected demands, there is a need to increase the firm capacity of the pump station to provide the City with reliable pumping capacity.

1.2.2 Raw Water Transmission Main and Storage Tank

The City is supplied with raw water through a single 16-inch diameter transmission main. The transmission main conveys water from the RWPS to the raw water storage tank located at the WTP. As mentioned earlier, the raw water transmission main has failed multiple times. In the past, failures that involve significant leaks in the main have taken USBR up to several weeks to repair. A complete failure of this main would result in a complete loss of water supply to the WTP and to the City. USBR has discussed constructing a new raw water transmission main, but has not provided the City a schedule for completion.

The City currently has one 0.17 million gallon (MG) Raw Water Storage Tank at the WTP. Should the transmission main fail the City only has about 20 minutes of raw water storage to supply to the WTP. The raw water transmission main, is the single most critical facility in the City's water supply system.

1.3 Capacity Analysis

The capacity of the RWPS depends on the available suction head and the pump station, which is dependent on the level of Shasta Lake. The firm capacity of the pump station is significantly lower during drought conditions when the lake has been drawn down. The available firm capacity of the RWPS for various lake levels was determined as part of the 2016 - 2026 Water Master Plan. The capacity analysis was performed for Pumps 1-4 as well as with the new 400 HP Pump 5, and with the future Pump 6 (which has not yet been installed).

Table 2 summarizes the results of the capacity evaluation of the RWPS. As shown on Table 2, the existing firm capacity of the RWPS (with Pumps 1-5 only) ranges from 3.02 million gallons per day (mgd) to 8.35 mgd, depending on the level in Shasta Lake. Under existing MDD conditions, the RWPS does not have sufficient firm capacity at the low lake level condition (Lake Level = 830') to deliver the required supply. At low lake levels the RWPS is deficient by 2.1 mgd.

Table 2 Raw Water Pump Station Capacity Evaluation

Planning Year	MDD (mgd)	Existing Firm Capacity ⁽²⁾ (mgd)			Capacity Surplus/(Deficit) (mgd)		
		High Lake Level (1,069')	Int. Lake Level (993')	Low Lake Level (830')	High Lake Level (1,069')	Int. Lake Level (993')	Low Lake Level (830')
Existing	5.12	8.35	7.49	3.02	3.23	2.37	(2.10)
2036	6.32	8.35	7.49	3.02	2.03	1.17	(3.30)
Build-Out	15.86	8.35	7.49	3.02	(7.51)	(8.37)	(12.84)

Notes:

- (1) Source: 1999 Water Master Plan, assuming "Stage 1" improvements have been constructed.
- (2) Assumes that Pumps 1-5 have been installed. The firm capacity of the RWPS will increase once Pump 6 is installed.

1.4 Recommendations

The City's ability to supply water is dependent on the three raw water facilities. Failure of the RWPS or the transmission main will result in a loss of supply to the City. Currently the City has 6.0 MG of treated water storage in the distribution system. This storage is equivalent to 2.6 days of average day demand (ADD). However, a failure of the raw water pumping and transmission system, and the time required to make repairs, creates a significant risk to the City should the failure occur during MDD conditions, or in the event of a fire. Projects were recommended in the 2016 - 2026 Water Master Plan recommended projects to mitigate risks by increasing capacity and redundancy of the raw water system.

The RWPS capacity relies on water level of Shasta Lake. For conservative planning purposes recommended RWPS projects are designed to meet MDD at low tank level conditions. Figure 1 shows a comparison of the existing and projected MDD through year 2036, to the firm capacity of the RWPS. As shown on Figure 1, the installation of Pump 6 at the RWPS (with an estimated capacity of 2,500 gallons per minute [gpm] at 500-feet of head) would increase the City's capacity to 6.6 mgd. The addition of Pump 6 would mitigate the current pumping deficiency, and would meet the City's projected MDD through year 2036. Additional pump replacements would be required to replace the aging Pumps 1 through 4, which are 35 to 68 years old, and have reached the end of their useful lives.

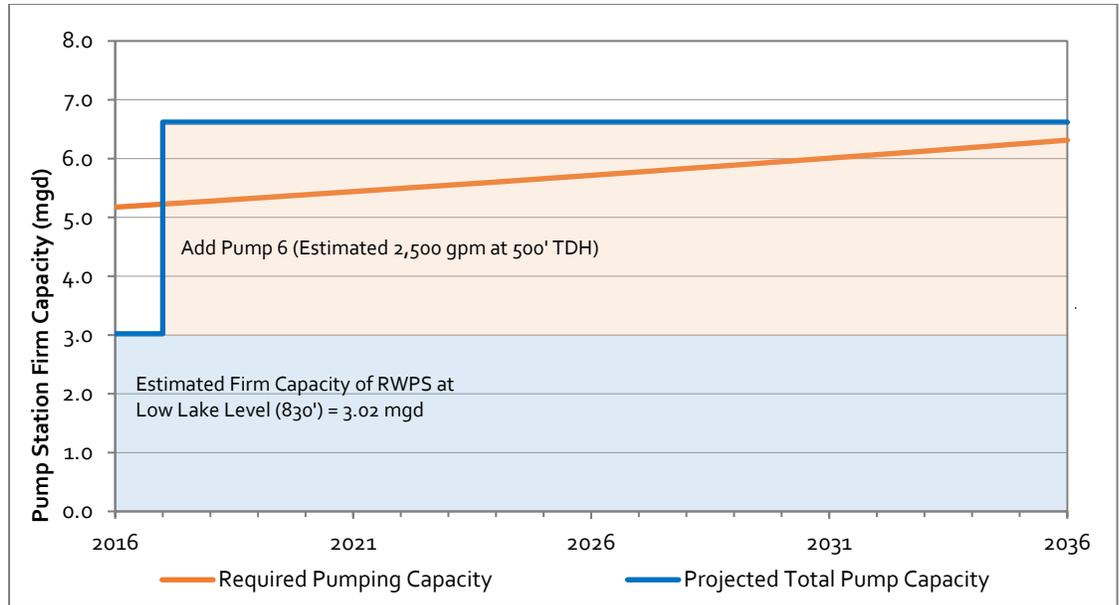


Figure 1 Raw Water Pump Station Capacity Evaluation at Low Lake Level

The existing raw water storage provides 0.07 days of ADD raw water in the event of a transmission main failure. The 2016 - 2026 Master Plan recommended the construction of the proposed Centimudi Tank which would add an additional 2.45 MG to the treated water storage system, and would allow the City to demolish the existing treated water storage tanks at the WTP. The 2016 - 2026 Master Plan recommended replacing the treated water tanks at the WTP with a new 1.6 MG raw water storage tank that would provide 0.68 days of ADD. Once the proposed 1.6 MG Raw Water Tank is constructed, the existing Raw Water Tank would be used as a standby tank for when the new Raw Water Tank is drained for maintenance. This is a high priority improvement. The proposed raw water tank was sized to maximize storage at the WTP site.

Failure in the existing raw water transmission main would result in a loss in raw water supply to the City for an extended period of time. To mitigate the risk of the City having a loss of raw water supply it is recommended that a parallel 20-inch diameter raw water transmission main be constructed. Building a redundant transmission main allows USBR to take one main out of service and perform inspections or make repairs should they be needed, without limiting the raw water supply to the City. The recommended raw water projects and their estimated capital costs are summarized in Table 3.

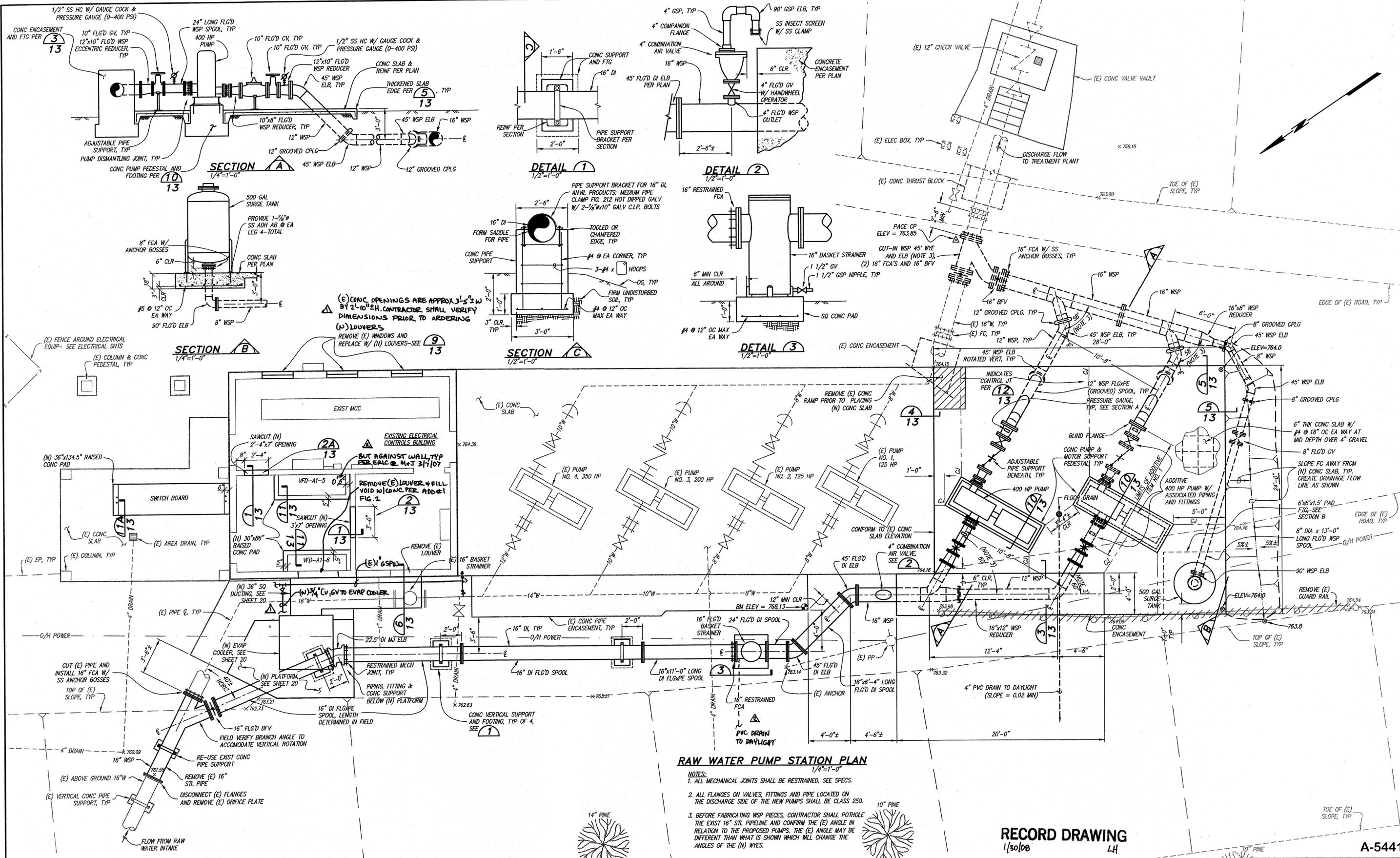
Table 3 Recommended Raw Water Projects

Recommended Project	Capacity/Size	Justification	Estimated Capital Cost
RWPS - Pump 6	2,500 gpm at 500-foot of head	Needed to meet existing and 2036 MDD and pumps 1-4 have reached the end of their useful lives.	\$216,000
Raw Water Storage Tank	1.6 MG	Existing raw water storage tank is undersized and it provides additional buffer for the WTP to continue to operate in the event of a failure of the RWPS or the raw water transmission main	\$1,989,000
20-inch Transmission Main	1,700 feet of 20-inch parallel pipeline	Increase reliability of existing raw water transmission main and existing raw water transmission main is prone to failure.	\$676,000
Total	NA	NA	\$2,881,000

Currently, the City's raw water supply system creates significant risk to the City's ability to ensure adequate supply for its users and fire protection. The projects summarized above were determined to be high priority and should be implemented as soon as funds are available.

Appendix A

RAW WATER PUMP STATION SITE LAYOUT



RAW WATER PUMP STATION PLAN
1/4"=1'-0"

- NOTES:
1. ALL MECHANICAL JOINTS SHALL BE RESTRAINED, SEE SPECS.
 2. ALL FLANGES ON VALVES, FITTINGS AND PIPE LOCATED ON THE DISCHARGE SIDE OF THE NEW PUMPS SHALL BE CLASS 250.
 3. BEFORE FABRICATING WSP PIECES, CONTRACTOR SHALL POTHOLE THE EXIST 16" STL PIPELINE AND CONFIRM THE (E) ANGLE IN RELATION TO THE PROPOSED PUMPS. THE (E) ANGLE MAY BE DIFFERENT THAN WHAT IS SHOWN WHICH WILL CHANGE THE ANGLES OF THE (N) WYES.

RECORD DRAWING
1/30/08 LH

A-5441

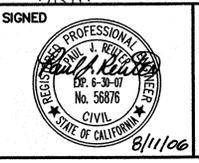
REVISIONS

NO	DATE	DESCRIPTION
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2	03-06	RECORD DRAWINGS

BAR IS ONE INCH ON ORIGINAL DRAWING
0" = 1'
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

PACE CIVIL, INC.
REDDING, CALIFORNIA

DES. SW/P/R CKD SLS JOB NO.
DRN SW DATE 08/11/08 110.78



CITY OF SHASTA LAKE
PHASE 2 - WATER IMPROVEMENTS PROJECT
SCHEDULE B
**RAW WATER PUMP STATION
MECHANICAL & STRUCTURAL**

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This study was partially funded by a CDBG
Planning and Technical Assistance Grant
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