Sheep Creek Water Company

2024 Water System Master Plan

FINAL

May 2024

Prepared by
Ardurra Group, Inc.

ARDURRA

Water System Master Plan

FINAL

Prepared for:

Sheep Creek Water Company

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May 17, 2024

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Acronyms and Abbreviations

AACE	American Association of Cost Engineers
AC	asbestos cement
ADD	average daily demand
AF	acre-feet
AWWA	American Water Works Association
DOF	California Department of Finance
CFC	California Fire Code
CIP	Capital Improvement Program
DDW	Division of Drinking Water
DEM	Digital Elevation Model
FH	fire hydrant
fps	foot per second
ft	foot
GPCD	gallon per capita per day
gpm	gallon per minute
GPS	Global Positioning System
HDPE	High-density polyethylene
HGL	hydraulic grade line
HWL	high water level
in	inch
LF	linear foot
MDD	maximum day demand
MDD + FF	maximum day demand plus fire flow
MG	million gallon
MGD	million gallon per day
MWA	Mojave Water Agency
PHD	peak hour demand
Plan	Water Master Plan
PPHCP	Phelan/Piñon Hills Community Plan Area
PPHCSD	Phelan Piñon Hills Community Services District
PRS	pressure regulating station
PRV	pressure reducing valve
psi	pound per square inch
PVC	Polyvinyl Chloride
SBCFPD	San Bernardino County Fire Protection District
SCADA	Supervisory Control and Data Acquisition System
SCWC	Sheep Creek Water Company
SS	Steady State
USGS	United States Geological Survey
WDF	Water Demand Factor
2022 Model	2022 SCWC existing hydraulic Model

Executive Summary

The Sheep Creek Water Company (SCWC) is a private water company that owns and operates a community water system (Water System No. CA3610109) supplying water for domestic purposes to portions of the unincorporated community of Phelan/ Piñon Hills in San Bernardino County, CA. The service area is approximately 7,000 acres and currently serves 1,203 active connections.

This Water Master Plan (Plan) has been developed to assess current and future required system capacity, consolidate findings from previous planning documents, and make recommendations for a Capital Improvement Program (CIP) to be implemented over the next 20 years. Key elements of the Plan include an update to water demand projections, recommendations on planning criteria, refinements to the existing hydraulic model, identification of system deficiencies, and development of a prioritized CIP. This Plan is a tool to help SCWC make decisions on implementing water system improvements that provide reliable and efficient water service to its existing and future customers. This Plan has a 20-year planning horizon extending out to 2044. **Section 1** describes the background of SCWC and outlines the goals and objectives of this Master Plan.

Existing Water System

The SCWC's water service area encompasses approximately 73 miles of pipeline throughout the system varying in size from 4-inch to 14-inch. Existing water system is divided into 15 pressure zones defined by 36 active pressure regulating stations, 7 groundwater production wells, a water supply tunnel, and 7 storage tanks that are located throughout the system at various elevations. The system is largely gravity-fed from its higher elevation storage tanks. The existing water system facilities are discussed in detail in **Section 2**.

Water Supply and Demand

The SCWC relies on groundwater supply from seven groundwater wells and a water supply tunnel. The tunnel, constructed in the 1920s, conveys water from an underground water source south of Desert Front Road to Tank 5 and Tank 7 of the distribution system by gravity along the Sheep Creek watercourse north of Wrightwood. It is also a main water supply source for SCWC. Five of the active wells (Wells 2A, 3A, 4A, 5, and 8) and the tunnel are located within the El Mirage Basin (Basin No. 6-043) north of the San Gabriel Mountains. The sixth active well (Well 11) is located within the Alto Subarea of the adjudicated Mojave Basin regulated by the Mojave Water Agency (MWA). The seventh well (Well 13) has been recently constructed and entered into service. Well 13 is located within the Mojave Basin area as well. The SCWC has an annual groundwater right of 3,000 acre-fee (AF) or approximately 2.7 million gallons per day (MGD) in the El Mirage Basin via the Pre-1914 Water Right. Water pumped from Well 11 and Well 13 must be purchased from Mojave Water Agency (MWA). The operational capacity of these water supply facilities combined is estimated at approximately 3.45 MGD.

Historical water billing records of the past ten years (2013 to 2022) were reviewed and utilized to characterize the SCWC's water demand. In general, water usage decreased substantially after 2014, most likely due to implementation of water conservation measures and mandated water conservation restrictions. In 2022, the SCWC had 1,203 active service connections with approximately 0.44 MGD of water usage. A majority of the water usage was by the residential and rural living land use categories. The SCWC water production in the corresponding year was 0.53 MGD. The existing average daily demand (ADD) used in this Plan was estimated to be 0.53 MGD by averaging the billing data of the past five years and including a factor to account for water loss estimated at 17.5%.

The SCWC does not anticipate substantial development or significant growth in its service area in the next 20 years. Future (2044) water demand was projected based on population growth assuming that future water demand increases proportionally to the population growth. Population growth is anticipated to increase by 5.6% within the service area in the next 20 years. The existing and future water supply and water demands are discussed further in **Section 3**.

Planning Criteria Development

This Plan includes a set of recommended planning criteria used for evaluating SCWC's existing and future water system. The system performance and planning criteria include guidelines for storage capacity, pipeline diameter and velocities, system pressures under varying water demand conditions, and required fire flow demands by land use type. The planning criteria are discussed in **Section 4**.

Hydraulic Model Update

The SCWC hydraulic model was developed and calibrated under steady state simulation in 2022 as part of the Consolidation Study with Phelan Piñon Hills Community Services District (PPHCSD). Since then, no major improvements or changes were applied to the system configuration or boundary conditions of the model. As part of this Plan, the SCWC existing hydraulic model (2022 Model) was updated with the latest available information and further refined and adjusted (where needed) to reflect the current conditions. This was performed through a verification process with field data and input from SCWC staff. Updates and refinements to the hydraulic model are discussed in **Section 5**.

Hydraulic Evaluation

The hydraulic evaluation includes model analysis of the distribution system conveyance capacity and desktop analysis of storage capacity under existing demand and future demand scenarios. The model was used to analyze system pressures and pipeline velocities under Peak Hour Demand (PHD), and Maximum Day Demand plus Fire Flow (MDD + FF) conditions. The analyses indicate that the system generally meets the pressure criteria and velocity criteria under PHD conditions except in areas near tank sites and pressure regulating stations. Model results for MDD + FF condition indicated that some fire hydrant locations were unable to meet the designated fire flow criteria mostly due to undersized 4-inch and 6-inch pipes, which represents 60% of the existing pipe network. It should be noted that fire flow requirements in the service area have changed significantly from the past. Older buildings were often constructed with lower fire flow requirements. Although the system may not meet the current fire flow criteria in these areas, fire authorities generally do not require water systems to be upgraded for existing developments to meet the present-day fire flow criteria. However, in planning new development or re-development in these areas, it is crucial to account for and implement system upgrades needed to meet the latest fire flow requirements.

A systemwide storage analysis indicates that SCWC's existing storage facilities can meet the requirements for operational, fire, and emergency storage under existing and future demand scenarios. The details of the hydraulic evaluation are discussed in **Section 6**.

Capital Improvement Program (CIP)

Deficiencies found from the hydraulic analysis and other non-capacity related issues were addressed with recommended CIP projects. These CIP projects include pipeline improvements, wells and tanks rehabilitation, construction of new wells to increase supply capacity, SCADA implementation, and water meter replacements. In Table ES-1, the CIP projects are classified in terms of high priority short-term (5-Year) CIP, medium priority intermediate-term (10-Year) CIP, and low priority long-term (20-Year) CIP, all with estimated capital costs. Estimated capital costs (in 2024 dollars) of the 5-Year CIP, 10-Year CIP, and 20-Year CIP are approximately $15.1 million dollars, $3.7 million dollars, and $4.5 million dollars, respectively. Details of the CIP are discussed in **Section 7**.

Table ES-1. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
Fire Flow Pipeline Improvement Projects	FF-1	Upsize 4" pipes to 8" pipes near Sky Ridge Rd and Rancho Rd	$186,000			
	FF-2	Upsize 4" pipes to 8" pipes near HW 2 and Pipeline Rd	$218,000			
	FF-3	Upsize 4" pipes to 8" pipes near Pipeline Rd and Cygnet Rd	$156,000			
	FF-4	Install new 8" pipelines and a PRV to connect the system at Lebec Rd Northward to Avenal St	$327,000			
	FF-5	Upsize 4" pipes to 8" pipes near Daisy Ln and Harding Dr	$523,000			

Table ES-1. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
	FF-6	Add a 4" pipe to a dead-end with a new PRV to replace by a looped connection near Coyote Rd	$76,000			
	FF-7 [2]	Upsize 6" and 10" pipes to 12" pipes on Riggins Rd between Phelan Rd and Sunny Slope Rd	$2,697,000			
	FF-8	Install a new 8" pipe and a PRV on Snow Line Dr		$276,000		
	FF-9	Upsize 4" and 6" pipes to 8" pipes north of Wild Horse Canyon Rd		$61,000		
	FF-10	Upsize 4" pipe to a12" pipe near Uzzel Rd		$197,000		
	FF-11	Upsize 4" and 6" pipes to 10" pipes near Nielson Rd, Valle Vista, and Phelan Rd		$713,000		
	FF-12	Install and replace by 8" near Johnson Rd between Phelan Rd and Nielson Rd with a new PRV.		$112,000		
	FF-13	Upsize 4" pipes to 8" pipes near Malpaso Rd, near Phelan Rd		$56,000		
	FF-14	Upsize 4" pipes to 8" pipes near Sierra Vista between Yucca Terrace Dr and Lindero St.		$87,000		
	FF-15	Install new 8" pipelines to create a loop near Sahara Rd south to Smoke Tree Rd		$62,000		
	FF-16	Upsize 4" pipes to 8" pipes and install a new pipe and a PRV to connect dead-ends near Sierra Vista Rd		$271,000		
	FF-17	Upsize a 4" pipe to 8" pipe on Sheep Creek Rd		$180,000		
	FF-18	Install a new 8" pipe on Avenal between Montara Rd and Nugget Rd		$43,000		
	FF-19	Install and replace existing 4" and 6" by 8" with a new PRV to loop the system near Smoke Tree Rd and Johnson Rd		$324,000		
	FF-20	Upsize 4" pipes to 8" pipes near Rancho Rd		$115,000		
	FF-21	Install 4" pipe on Johnson Rd and Amador Rd		$25,000		
	FF-22	Upsize 4" and 6" pipes to 10" pipes near Malpaso Rd to Nielson Rd			$574,000	
	FF-23	Upsize 8" pipes to 10" and 12" pipes near Sheep Creek Rd			$542,000	
	FF-24	Upsize 4" and 6" pipes to 10" pipes near Nielson Rd, between Valle Vista and Johnson Rd			$363,000	
	FF-25	Upsize 4" pipes to 8" pipes and install new pipe to connect dead-ends near Yucca Terrace			$122,000	
		Subtotal	**$4,183,000**	**$2,522,000**	**$1,601,000**	**$8,306,000**

Table ES-1. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
Non-Fire Flow Pipeline Improvement Projects	PL-1	Connect Well 13 to Tank 8 by installing 6" pipelines	$573,000			
	PL-2	Install 8" pipe on Lebec Rd between White Fox Trl and Phelan Rd		$107,000		
	PL-3	Replace the rest of all 4" and 6" dead-end pipes			$2,091,000	
		Subtotal	**$573,000**	**$107,000**	**$2,091,000**	**$2,771,000**
Water Supply Projects	W-12	Install new groundwater well (Well 12)	$2,990,000			
	W-15	Install new groundwater well (Well 15)	$2,990,000			
	BP-1	Installation of a new booster pump to transfer water from Well 13 to Tank 8	$185,000			
	W-5	Well 5 Rehabilitation	$195,000			
	W-2	Well 2A Rehabilitation		$195,000		
	W-3	Well 3A Rehabilitation		$195,000		
	W-11	Well 11 Rehabilitation		$195,000		
	TN-1	Tunnel Rehabilitation		$195,000		
	W-4	Well 4A Rehabilitation			$195,000	
	W-8	Well 8 Rehabilitation			$195,000	
	W-13	Well 13 Rehabilitation			$195,000	
		Subtotal	**$6,360,000**	**$780,000**	**$585,000**	**$7,725,000**
Water Storage	T-2	Tank 2 Rehabilitation	$319,000			
	T-3	Tank 3 Rehabilitation	$172,000			
	T-4	Tank 4 Rehabilitation	$319,000			
	T-5	Tank 5 Rehabilitation	$130,000			
	T-6	Tank 6 Rehabilitation	$605,000			
	T-7	Tank 7 Rehabilitation	$691,000			
		Subtotal	**$2,236,000**	**$0**	**$0**	**$2,236,000**
Operation & Monitoring	OM-1 (AMI)	Replace up to 2000 meters with advanced metering infrastructure (AMI)	$972,000	262,000	262,000	
	OM-2 (SCADA)	SCADA Implementation	$808,000			
		Subtotal	**$1,780,000**	**$262,000**	**$262,000**	**$2,304,000**
		Total	**$15,132,000**	**$3,671,000**	**$4,539,000**	**$23,342,000**

[1] Costs are in 2024 U.S. Dollars
[2] Outsourced Project

1. Introduction

Sheep Creek Water Company (SCWC) retained the service of Ardurra to prepare this 2024 Water System Master Plan (Plan). This section provides background, purpose, and scope of work of this Plan.

1.1. Background and Purpose

The SCWC is a private shareholder-owned water company that was established in 1914 to serve portions of the unincorporated community of Phelan/ Piñon Hills in San Bernardino County, California. The water system has a Water System ID of CA3610109, is operated under the Domestic Water Supply Permit No. 78-007, and is regulated by the California State Water Resources Control Board, Division of Drinking Water (DDW). There are a total of 8,000 shares in SCWC that are held by 1,445 shareholders. The service area is approximately 7,000 acres characterized by rural natural environment with a total population estimated at 3,360.

SCWC relies on groundwater as its sole source of water supply. In August of 2018, the SCWC was issued a Compliance Order for source capacity violations (Order No. 05-13-18R-002) by DDW. This was followed by an amendment Compliance Order (Order No. 05-13-18R-002A1) to establish directives to be met by the SCWC. In response, SCWC prepared system-wide evaluation reports including the Safe Drinking Water State Revolving Fund Applicant Engineering Report prepared by California Water Rural Association in 2019 (2019 PER), the Final Feasibility Report Addressing Water Source Capacity Issues prepared by Infrastructure Engineering Corporation (IEC), now Ardurra, in 2019 (2019 Feasibility Study), and the Asset Management Plan prepared by IEC in 2020 (2020 AMP).

This Plan evaluates the system capacity under existing (2024) and future (2044) conditions and consolidates findings from previous planning documents to make capital improvement recommendations for a 20-year planning horizon. This Plan is intended to aid the planning and phasing of the SCWC's water system improvement projects to provide reliable service to existing customers and be better prepared for anticipated growth within the service area.

1.2. Scope of Work

This Plan encompasses the following tasks:

- Evaluate the current and future state of water supply and demand,
- Update and refine the existing hydraulic network model with latest operational and field data,
- Develop planning criteria for system evaluation,
- Perform hydraulic analysis using the model to identify system deficiencies under different demand conditions,
- Make recommendations on capital improvements and operational changes needed to meet established planning criteria under current and future conditions and enhance system reliability and redundancy, and
- Estimate costs for, and prioritize, the recommended capital improvement projects.

1.3. Data Sources

This Plan was developed using various data and information, including but not limited to the following:

- 2006 Water Master Plan by Albert A. Webb Associates, Inc., dated December 2006 (2006 WMP)
- 2019 Feasibility Study Report Addressing Water Source Capacity Issues by IEC, dated January 2019 (2019 Feasibility Study)
- 2019 Safe Drinking Water State Revolving Fund Applicant Engineering Report by California Water Rural Association, Dated July 2019 (2019 PER)
- 2020 Asset Management Plan by IEC, dated December 2020 (2020 AMP)

- 2022 SCWC Water Consolidation Project by Ardurra, dated March 2022 (2022 Consolidation Project)
- 2020 Water System Master Plan for Phelan Piñon Hills Community Services District by Ardurra, dated October 2021 (2020 PPHCSD WMP)
- Water Demands and System Operational Data provided by SCWC:
  - Historic water consumption data for the period 2013-2022
  - Latest well production records for the period 2019-2022
  - Latest operational records and settings
  - Latest pump curves
- Local bid estimates

Ardurra also consulted with SCWC staff to get clarifications on specific aspects of system operations and hydraulics as well as gather knowledge on the current condition of the existing water system facilities and inputs for system improvement recommendations.

2. Existing Water System

This section provides general information on the SCWC's service area and land use characterization. Additionally, it discusses the existing potable water system facilities including groundwater wells and tunnel, pumping capacity, storage tanks, pressure regulating stations, pipelines, and the existing system operations.

2.1. Service Area and Land Use

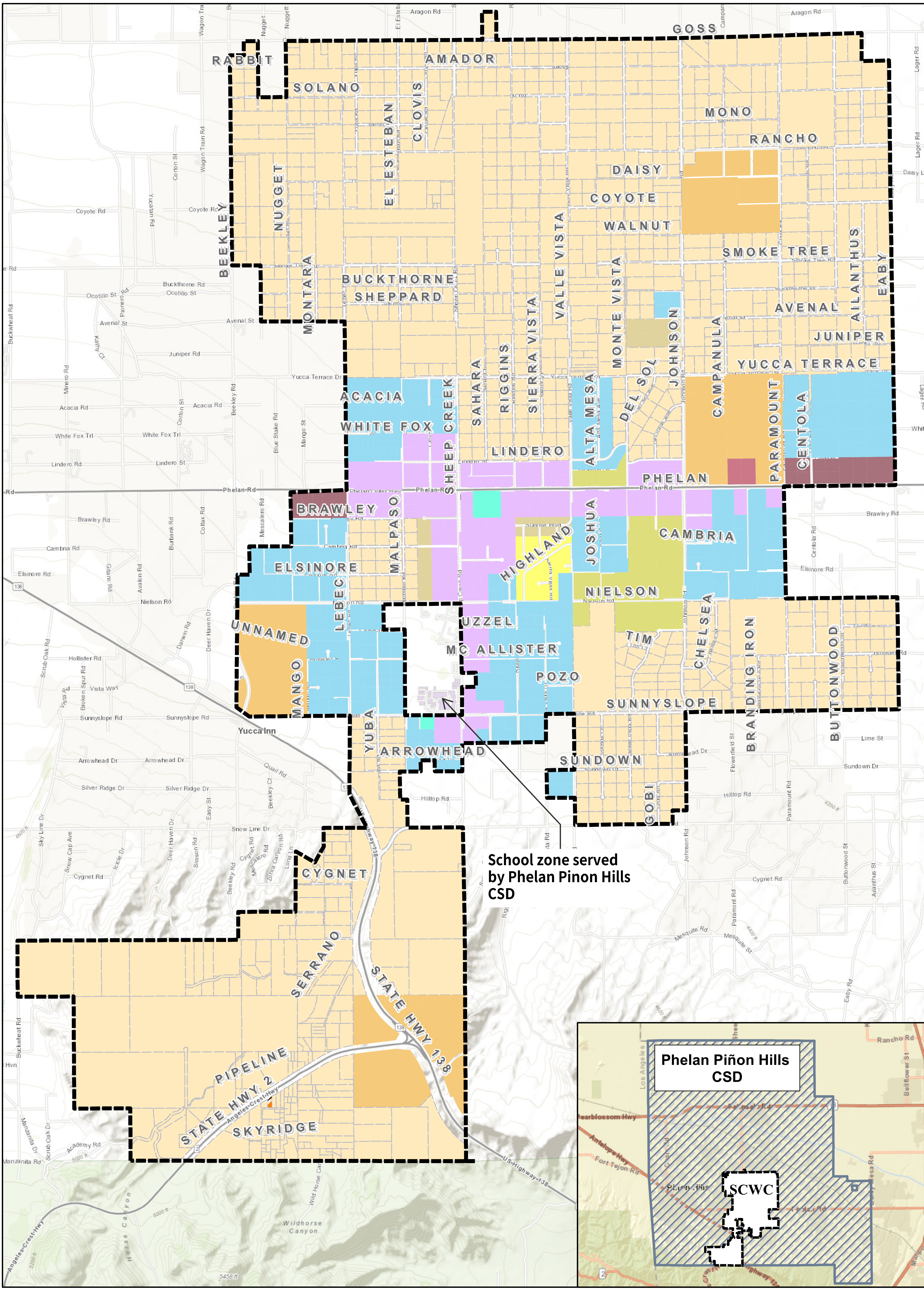
The SCWC service area is located within the Phelan/Piñon Hills Community Plan Area (PPHCP), one of the unincorporated communities in the San Bernardino County (County). PPHCP is located in the foothill desert areas north of Mount San Antonio adjacent to the southwest corner of the North Desert County Region [1]. The PPHCP encompasses of approximately 80,300 acres. SCWC provides water services to approximately 8% of the total PPHCP area, and the remaining area is served by the Phelan Piñon Hills Community Services District (PPHCSD) [2]. Figure 2-1 shows the SCWC service area. The topography of SCWC's service area generally slopes downward from southwest to northeast, with service elevations approximately ranging between 3,690 feet (ft) and 4,944 ft. The primary sources of supply are situated in the southwest corner of the service area with the highest elevations. This allows water to be distributed through the system by gravity.

The SCWC service area encompasses approximately 7,000 acres of land with Rural Living and Single Residential making up over 80% of the area. Table 2-1 summarizes the SCWC's existing land use information categorized according to the County Land Use Designations. Currently, the SCWC service area is approximately 50% developed.

Table 2-1. Existing Land Use Summary

Code	Zoning Designation	Area (acres)	% of Total Land
PH/CG	Phelan/Pinon Hills/General Commercial	381	5.4%
PH/CN	Phelan/Pinon Hills/Neighborhood Commercial	1	0.0%
PH/CO	Phelan/Pinon Hills/Office Commercial	11	0.2%
PH/CS	Phelan/Pinon Hills/Service Commercial	134	1.9%
PH/IN	Phelan/Pinon Hills/Institutional	14	0.2%
PH/RL	Phelan/Pinon Hills/Rural Living	4,904	70.1%
PH/RL-5	Phelan/Pinon Hills/Rural Living-5 Acre Minimum	0	0.0%
PH/RM	Phelan/Pinon Hills/Multiple Residential	50	0.7%
PH/RS-1	Phelan/Pinon Hills/Single Residential -1 Acre Minimum	900	12.9%
PH/RS-14M	Phelan/Pinon Hills/Single Residential - 14,000 square feet Minimum	40	0.6%
PH/SD-COM	Phelan/Pinon Hills/Special Development-Commercial	61	0.9%
PH/SD-RES	Phelan/Pinon Hills/Special Development-Residential	505	7.2%
	Total	**7,000**	**100.0%**

[1] Source: San Bernardino County Countywide Plan Land Use Element, last updated in October 2020 (https://countywideplan.com/policy-plan/land-use/)
[2] Source: https://countywideplan.com/wp-content/uploads/sites/68/2020/07/Phelan-_PinionHillsCommunityProfile_20190522.pdf?x23421



Legend

- SCWC Service Area

Existing Land Use

- General Commercial
- Institutional
- Multiple Residential
- Neighborhood Commercial
- Office Commercial
- Rural Living
- Service Commercial
- Single Residential - 14,000 Sqft Min
- Single Residential -1 Acre Min
- Special Development-Commercial
- Special Development-Residential

N

0 0.1 0.2 0.4 0.6 0.8 1 Miles

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Figure 2.1

SCWC Service Area & Land Use

2.2. Existing Water System Facilities

The SCWC's water distribution system comprises of approximately 73 miles of transmission and distribution pipelines, 7 groundwater wells, 7 water storage reservoirs sites, 36 pressure regulating stations, and 2 emergency interconnections with PPHCSD, as shown in Figure 2-2 and Figure 2-3. The existing water system is divided into 15 pressure zones.

2.2.1. Groundwater Wells and Water Supply Tunnel

SCWC's sole source of supply is groundwater pumped from six local active wells and from a water supply tunnel (Tunnel). A seventh well (Well 13) has been constructed and entered into service recently. Five of the active supply wells (Wells 2A, 3A, 4A, 5, and 8) were installed in the period between 1993 and 2011 and are located south of Desert Front Road east of Highway 2 within the El Mirage Groundwater Basin (Figure 2-2). The sixth well, Well No. 11, was constructed in Fall of 2018. Well 11 is located southwest of the intersection of Monte Vista Rd and Walnut Rd in the northern part of the distribution system within the adjudicated Mojave Groundwater Basin. Well 13 is located on Mescalero Rd midway between Phelan Rd and Nielson Rd within the Mojave Groundwater Basin with an operational capacity of 0.58 MGD (400 gpm). The well pumps were equipped with variable frequency drives (VFD) to allow adjusting of pump speeds to meet varying system demands.

The Tunnel was initially constructed in 1920s north of Wrightwood along the Sheep Creek watercourse. It is a 14-inch concrete pipe over approximately 3,800 feet in length. Groundwater seeps into the tunnel headwall and is conveyed northward to Tank 7 by gravity [4].

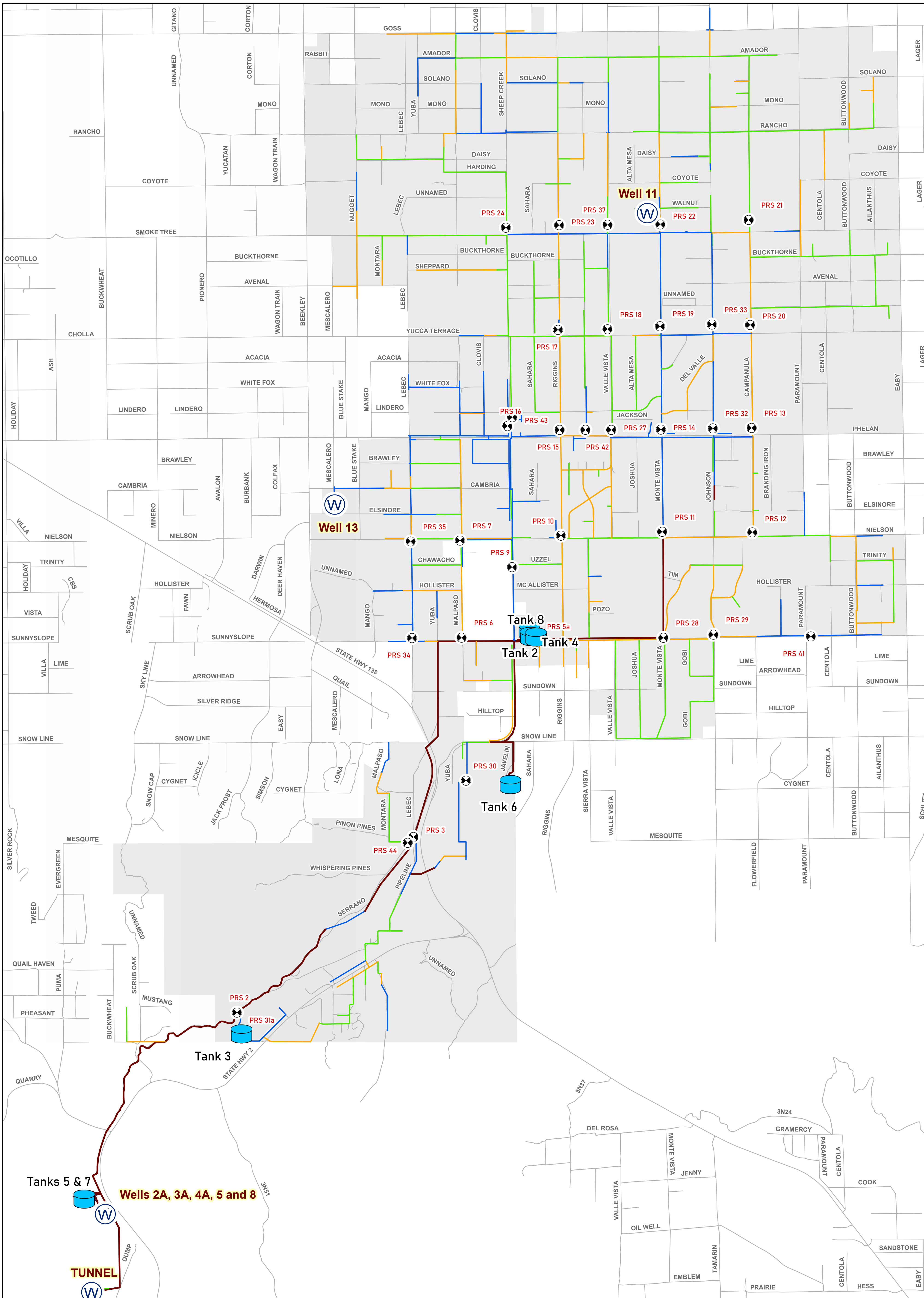
The SCWC has annual water rights of 3,000 acre-feet (AF) or approximately 2.7 MGD in the El Mirage Basin via the Pre-1914 Water Right and has pumping rights in the Mojave Basin[3]. Water pumped from Well 11 and from Well 13 has to be purchased from Mojave Water Agency (MWA). Based on these arrangements, SCWC uses groundwater pumped from the El Mirage Basin as the primary source, and Wells 11 and 13 serve as backup sources of supply. Groundwater is chlorinated at each of the well sites when the pumps are in operation, while chlorination is maintained continuously to the tunnel flow at the Tunnel site [4]. Table 2-2 summarizes the existing water supply sources.

Table 2-2. Existing Water Supply Sources

#	Source	Groundwater Basin	Pumped to [1]	Well Depth (ft)	Pump Depth (ft)	Head Elevation (ft)	Operational Capacity (MGD)
1	Tunnel	El Mirage	Tank 7	242	NA	5500	0.19
2	Well 2A	El Mirage	Tank 7	725	505	4849	0.48
3	Well 3A	El Mirage	Tank 7	500	460	4854	0.45
4	Well 4A	El Mirage	Tank 7	500	460	4860	0.44
5	Well 5	El Mirage	Tank 7	495	420	4870	0.43
6	Well 8	El Mirage	Tank 7	480	460	4860	0.52
7	Well 11	Mojave	Directly to the system	1500	1100	2500	0.36
8	Well 13	Mojave	Directly to the system	1900	1200	1860	0.58
						Total	**3.45**

[1]Tank 5 feeds from Tank 7, but can also feed from water pumped directly from the wells or received by gravity from the Tunnel through a bypass line.

[3] Source: 2019 Feasibility Study
[4] Source: 2019 PER



Legend

- PRS
- Groundwater Well
- Tank
- Roadway
- SCWC Service Area

Existing Pipeline Diameter

- < = 4"
- 6"
- 8"
- = > 10"

N

0 0.1 0.2 0.4 0.6 0.8 1 Miles

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Figure 2-2

Existing Water System Facilities

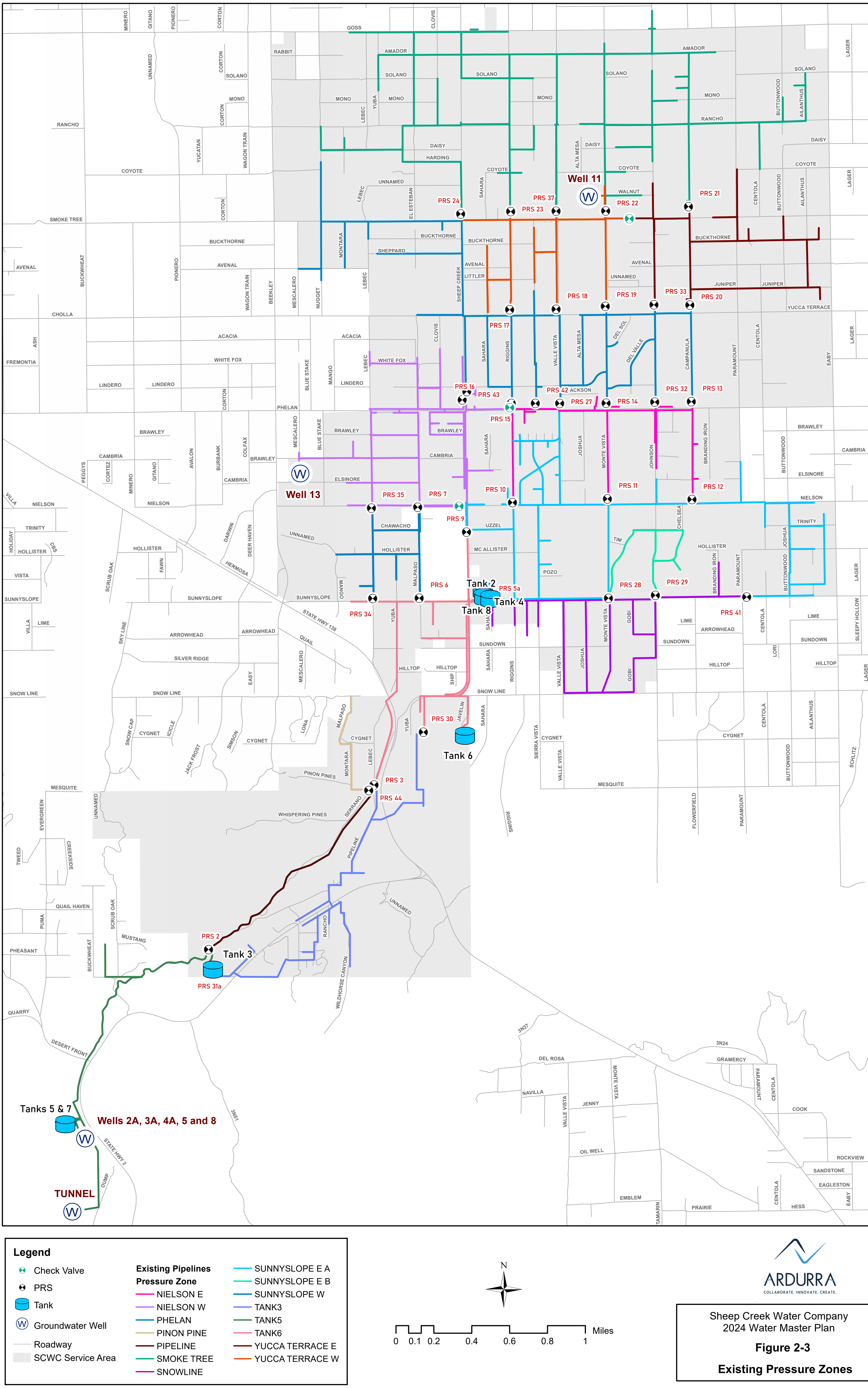

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Figure 2-3

Existing Pressure Zones

2.2.2. Pipelines

The water system consists of approximately 73 miles of pipeline ranging from 4 inches to 14 inches in diameter (Table 2-3). Primary pipe materials include steel, asbestos cement (AC), and polyvinyl chloride (PVC), as shown in Table 2-4. The specific date of installation of most pipelines is not available. Most of the new pipelines and replacement pipelines are PVC C900 material and some are high-density polyethylene (HDPE) material.

Table 2-3. Pipelines by Size

Pipe Diameter (inch)	Length (ft)	Percent of Total Length
4	133,481	34.5%
6	107,962	27.9%
8	103,865	26.9%
10	28,288	7.3%
12	11,307	2.9%
14	1,620	0.4%
Total	**386,524**	**100.0%**

Table 2-4. Pipelines by Material

Material	Length (ft)	Percent of Total Length
Asbestos Cement	20,173	5.2%
PVC	264,551	68.4%
Concrete Pipe	1,557	0.4%
Ductile Iron	149	0.0%
Galvanized Pipe	977	0.3%
HDPE	406	0.1%
Steel	98,712	25.5%
Total	**386,524**	**100.0%**

2.2.3. Storage Tanks

The SCWC owns and operates 7 storage tanks with capacities ranging from 0.14 million gallons (MG) to 3.0 MG. The storage tanks are located at different sites and elevations throughout the system that allows the entire distribution to be gravity fed (Table 2-5 and Figure 2-2). There are currently five bolted steel tanks and two welded steel tanks. The total storage capacity of the 7 tanks is 6.12 MG. Table 2-5 provides an inventory of existing storage tanks.

Table 2-5. Existing Storage Tanks

Tank	Diameter (ft)	Height (ft)	Volume (MG)	High Water Level (ft above tank floor)	Type	Year Installed
Tank 2	55	24	0.43	23	Bolted Steel	1979
Tank 3	47	16	0.21	15	Bolted Steel	1983
Tank 4	55	24	0.43	23	Bolted Steel	1984
Tank 5	39	16	0.14	15	Bolted Steel	1985
Tank 6	80	24	0.91	23.2	Bolted Steel	1989
Tank 7	103	16	1.0	15.1	Welded Steel	1993
Tank 8	150	24	3.0	23	Welded Steel	2009
		Total	**6.12**			

2.2.4. Pressure Zones

The system is divided into 15 primary pressure zones (i.e., hydraulic regions), as shown in Figure 2-3, to maintain adequate pressures throughout the distribution system and accommodate the service area's varying topography. Table 2-6 summarizes the general characteristics of each pressure zone. The hydraulic grade line (HGL) of each pressure zone is determined either by high water level (HWL) elevation of storage tank(s), or by the discharge pressure setting of the pressure regulating facilities serving the zone.

Table 2-6. Pressure Zone Summary

Pressure Zones Name	HGL (ft)	Elevation Range Served (ft)	Storage Tanks	Groundwater Well	Pressure Regulating Stations (PRS)
Smoke Tree	4018	3717 - 5114	----	----	PRS 24, PRS 23, PRS 37, PRS 22, and PRS 21
Yucca Terrace W	4137	3871 - 4024	----	Well 11	PRS 17, PRS 18, and PRS 19
Yucca Terrace E	4081	3936 - 4080	----	----	PRS 20 and PRS 33
Phelan	4200	3921 - 4093	----	----	PRS 13, PRS 14, PRS 15, PRS 27, PRS 32, PRS 42, and PRS 43
Nielson W	4332	4005 - 4226	----	----	PRS 7, PRS 8, and PRS 35
Nielson E	4290	4005 - 4170	----	----	PRS 10, PRS 11, and PRS 12
Sunnyslope W	4428	4225 - 4319	----	----	PRS 6 and PRS 34
Sunnyslope E A	4330	4318 - 4031	Tank 2, Tank 4, Tank 8	----	PRS 41
Sunnyslope E B	4375	4125 - 4238	----	----	PRS 28 and PRS 29
Snowline	4474	4145 - 4408	----	----	PRV 5a
Tank 6	4626	4318 - 4599	Tank 6	----	PRS 3 and PRS 30
Tank 3	4991	4548 - 4952	Tank 3	----	PRS 31
Pinon Pine	4806	4548 - 4689	----	----	PRS 44
Pipeline	4906	4585 - 4863	----	----	PRS 2
Tank 5	5239	4863 - 5260	Tank 5, Tank 7	Well 2A, Well 3A, Well 4A, Well 5, Well 8	-----

2.2.5. Pressure Regulating Stations

The system has 36 pressure regulating stations (PRSs). Most of these PRSs are pressure reducing stations, and the remainder are combination pressure reducing/sustaining stations. Most pressure reducing stations have two pressure reducing valves (PRVs) with one main valve and one smaller supplemental or by-pass valve for low flows. Table 2-7 lists the details of the pressure reducing stations.

The SCWC operates 3 combination pressure reducing/sustaining stations which are located in the southwestern part of the system to maintain a constant downstream pressure and sustain a minimum upstream pressure, regardless of distribution demand. Table 2-8 lists the combination pressure reducing/sustaining stations.

Table 2-7. Pressure Reducing Stations

PRS	Location	Main Valve Size (in)	By-Pass Valve Size (in)	Elevation (ft)	Setting (psi)	From Zone	To Zone
24	Sheep Creek Rd & Smoke Tree Rd	6	2	3945.7	60.0	Phelan	Smoke Tree
23	Riggins Rd & Smoke Tree Rd	6	2	3933.5	60.0	Yucca Terrace W	Smoke Tree
37	Valle Vista Rd & Smoke Tree Rd	6	2	3921.2	60.0	Yucca Terrace W	Smoke Tree
22	Monte Vista Rd & Smoke Tree Rd	6	2	3899.0	60.0	Yucca Terrace W	Smoke Tree
21	Campanula Rd & Smoke Tree Rd	6	2	3862.0	60.0	Yucca Terrace E	Smoke Tree
17	Riggins Rd & Yucca Terrace Dr	6	2	4012.8	70.0	Phelan	Yucca Terrace W
18	Valle Vista Rd & Yucca Terrace Dr	6	2	3990.1	60.0	Phelan	Yucca Terrace W
19	Monte Vista Rd & Yucca Terrace Dr	6	2	3973.1	60.0	Phelan	Yucca Terrace W
33	Johnson Rd & Yucca Terrace Dr	6	2	3942.8	60.0	Phelan	Yucca Terrace E
20	Campanula Rd & Yucca Terrace Dr	6	2	3918.9	60.0	Phelan	Yucca Terrace E
16	Sheep Creek Rd & Phelan Rd	6	2	4105.5	60.0	Nielson W	Phelan (sub-zone)
15	Riggins Rd & Phelan Rd	6	2	4091.0	55.0	Nielson E	Phelan
42	Sierra Vista Rd & Phelan Rd	6	2	4078.2	65.0	Nielson E	Phelan
27	Valle Vista Rd & Phelan Rd	4	-----	4061.5	60.0	Nielson E	Phelan
14	Monte Vista Rd & Phelan Rd	6	2	4039.1	55.0	Nielson E	Phelan
32	Johnson Rd & Phelan Rd	6	2	4012.6	55.0	Nielson E	Phelan
13	Campanula Rd & Phelan Rd	6	2	4004.9	55.0	Nielson E	Phelan
35	Lebec Rd & Nielson Rd	6	2	4224.1	55.0	Sunnyslope W	Nielson W
7	Malpaso Rd & Nielson Rd	4	-----	4226.4	60.0	Sunnyslope W	Nielson W
8	Sheep Creek Rd & Uzzel Rd	6	-----	4229.6	45.0	Tank 6	Nielson W
10	Riggins Rd & Nielson Rd	6	2	4176.0	55.0	Sunnyslope E A	Nielson E
11	Monte Vista Rd & Nielson Rd	6	2	4134.4	55.0	Sunnyslope E A	Nielson E
12	Campanula Rd & Nielson Rd	6	2	4087.1	55.0	Sunnyslope E A	Nielson E
34	Lebec Rd & Mirage Rd/Sunnyslope Rd	6	-----	4336.2	55.0	Tank 6	Sunnyslope W
6	Malpaso Rd & Mirage Rd/Sunnyslope Rd	Inactive	Inactive	Inactive	Inactive	Tank 7	Sunnyslope W
28	Monte Vista Rd & Sunnyslope Rd	6	-----	4237.3	60.0	Snowline	Sunnyslope E B
29	Johnson Rd & Sunnyslope Rd	6	-----	4206.2	60.0	Snowline	Sunnyslope E B
41	Paramount Rd & Sunnyslope Rd	6	2	4161.7	76.0	Snowline	Sunnyslope E B
44	Pipeline Rd & Serrand Rd / Next to Reg 3	4	1.5	4541.0	120.0	Pipeline	Tank 6
40	Scrub Oak Dr & Manzanita Dr	2	-----	4956.4	60.0	Tank 5	Tank 5 (sub-zone)

Table 2-7. Pressure Reducing Stations

PRS	Location	Main Valve Size (in)	By-Pass Valve Size (in)	Elevation (ft)	Setting (psi)	From Zone	To Zone
31a	Near Tank 3	6	2	4958.8	30.0	Tank 5	Tank 3
45	Smoke Tree Rd 660' W/ Johnson Rd	6	-----	3887.8	70.0	Yucca Terrace E	Yucca Terrace W
43	Sheep Creek Rd & Lindero Rd	4	-----	4091.7	55.0	Nielson W	Phelan

Table 2-8. Combination Pressure Reducing/Pressure Sustaining Valves

Combination Valve	Location	Main Valve Size (in)	By-Pass Valve Size (in)	Elevation (ft)	Upstream Setting (psi)	Downstream Setting (psi)	From Zone	To Zone
2	Pipeline Rd & Manzanita Rd	6	6	4871	125	20	Tank 5	Pipeline
3	Serrano Rd & Pipeline Rd	6	6	4541.0	120	38	Pipeline	Tank 6
30	E/ HWY 138 & S/ Sheep Creek Rd	6	------	4535.6	130	45	Tank 3	Tank 6

2.2.6. System Interconnections

The SCWC has two existing interconnections with PPHCSD that have been historically used for emergency purposes only. One of these connections was recently installed in November 2021 with a pressure reducing valve near Snow Line Dr and Valle Vista Rd. The other interconnection is located near Tank 6 that permits water flows both directions.

2.3. General Operations

The SCWC currently does not have Supervisor Control and Data Acquisition System (SCADA) to control the PRSs, well pumps, or storage tanks remotely and store and collect operational and hydraulic data of these facilities. The system is monitored and operated manually via on-site visits a few times a day by SCWC staff based on system demands and rehabilitation and maintenance activities. Typically, two wells are operated along with the tunnel to supply the system during summer months, and one well is operated along with the tunnel to supply the system during winter months. SCWC staff stated that Well 4 and Well 8 do not typically operate at the same time due to well interference issues. Wells are operated alternately to allow rehabilitation and maintenance activities. Certain isolation valves in the system are opened or closed based on summer operations or winter operations. The SCWC anticipates implementing SCADA in the near future for continuous monitoring and remote control of the wells, storage tanks, and PRSs.

3. Water Demand and Production

This section outlines the SCWC's historical water production and demands, anticipated increase in water supply, as well the projected future demands for the service area through the next 20 years. Future water demand was developed using a population-based projection method. Historical water demands and productions are presented in calendar year.

3.1. Historical Water Demand

The SCWC's billing water usage from 2013 to 2022 is summarized in Table 3-1. A substantial decrease in the annual consumption rate is noted post 2014 (Table 3-1 and Figure 3-1), which can be mainly attributed to the implementation of water conservation measures. Average water usage per service connection was estimated for the period from 2018 to 2022 using the number of active service connections of 1,203. (Table 3-1).

Table 3-1. Historical Water Usage from 2013 to 2022

Year	Total Consumption (acre-feet)	Average Demand (MGD)	Average Demand per Connection (gpd)
2013	805	0.72	----
2014	814	0.73	----
2015	678	0.61	----
2016	679	0.61	----
2017	558	0.50	----
2018	532	0.47	395
2019	469	0.42	348
2020	494	0.44	367
2021	536	0.48	398
2022	496	0.44	368

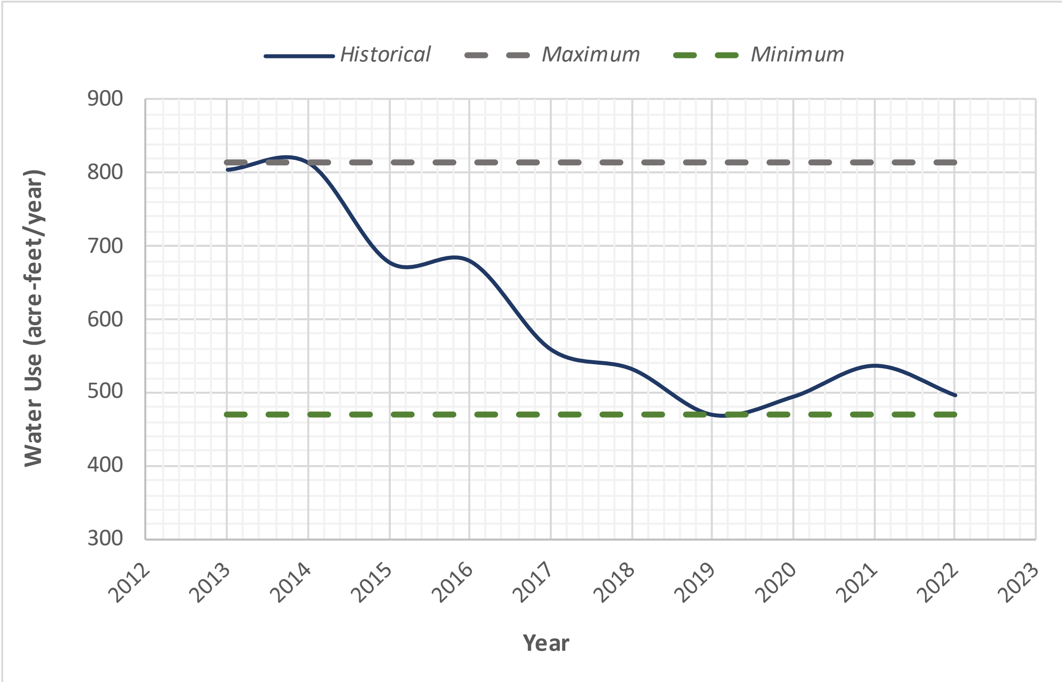


Figure 3-1. Annual Water Consumption from 2013 to 2022

3.2. Water Demand Factors

Water demand factors (WDFs) were developed to characterize the water usage by land use type within the SCWC service area and can be used to estimate water demands for any future developments based on development area and land use type.

The 2022 billing records were utilized and spatially referenced to parcels with land use designations to determine the WDFs. The area and water usage of the same land use type were aggregated, and total water usage was divided by the total area for each land use type to calculate WDFs in units of acre-feet per year per acre (AFY/acre) and gallons per day per acre (gpd/acre). The WDFs were then scaled to the production rate to account for water loss by multiplying the WDF by a factor of 1.175. More discussion on water loss is provided in Section 3.4. Table 3-2 lists estimated WDFs.

Table 3-2. Water Demand Factors by Land Use

Zone Designation	Total Area (acre)	WDF (AFY/acre)	WDF (gpd/acre)
General Commercial	162	0.42	378
Neighborhood Commercial	1	0.20	176
Service Commercial	87	0.15	137
Institutional	10	2.40	2,139
Rural Living	1,926	0.17	150
Multiple Residential	26	0.89	792
Single Residential -1 Acre Minimum	370	0.20	181
Single Residential - 14,000 square feet Minimum	34	0.80	713
Special Development-Residential	21	0.09	78

3.3. Water Production

From 2019 to 2022 the SCWC produced an average of 586 AFY, or 0.52 MGD (363 gpm) of groundwater from the six groundwater wells and the tunnel. Table 3-3 summarizes the historical water production annually.

Table 3-3. Historical Annual Water Production

Year	Total Production (acre-feet)	Average Daily Production (MGD)
2019	542	0.48
2020	585	0.52
2021	627	0.56
2022	590	0.53
Average	**586**	**0.52**

Monthly average water production compared to monthly average water use are plotted on Figure 3-2. The overall trend shows typical seasonal variation with highest water production and water usage occurring during the summer.

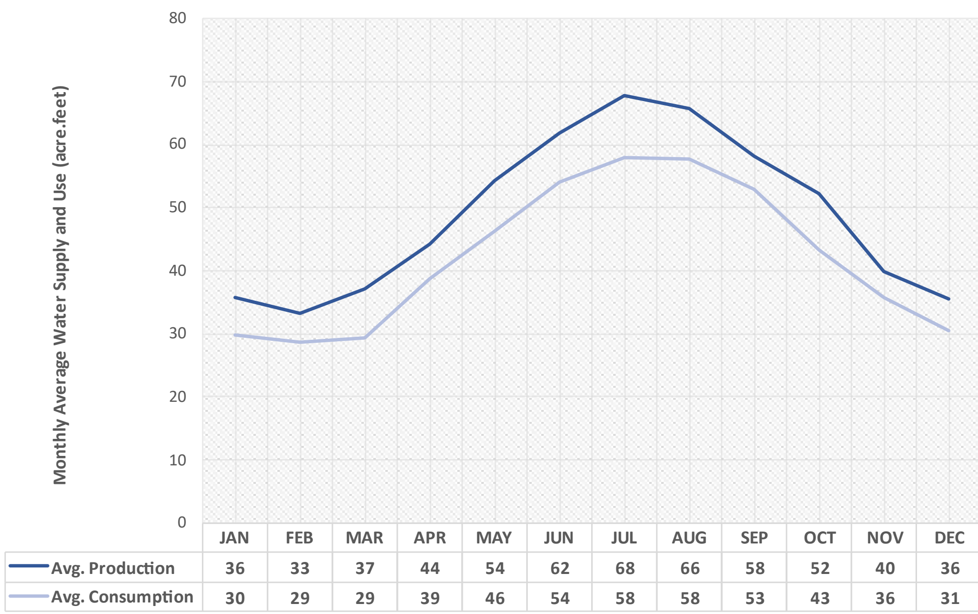


Figure 3-2. Historical Average Monthly Water Production versus Average Monthly Water Usage

3.4. Water Loss

Water loss is defined as the difference between water production and billed water usage. Water loss can be due to various factors such as accounting and metering inaccuracies, system leaks, unbilled authorized consumption such as hydrant flushing and fire-fighting, unmetered or unauthorized water use. Table 3-4 shows that historical water loss between 2019 and 2022 varying between 15.6% to 19% with an average of 17.5%. The scope of this planning study does not include efforts to evaluate and determine the specific causes for the apparent water loss. As such, a water loss factor based on the historical data is applied to the water demand estimates to account for water losses.

Table 3-4. Water Loss from 2019 to 2022

Year	Production (acre-feet)	Billed Water (acre-feet)	Water Loss (acre-feet)	Percent to Production (%)
2019	542	469	73	15.6
2020	585	494	91	18.4
2021	627	536	91	16.9
2022	590	496	94	19.0
Average	**586**	**499**	**87**	**17.5**

3.5. Future Demand Projections

There are different approaches for water demand forecasting depending on system characterization, scope, and data availability. This Plan utilized population projections to forecast future water demands. An average per capita water use expressed in gallons per capita per day (gpcd) was determined by dividing the 2022 average demand by the current population within the SCWC service area as shown in Table 3-5. Based on the 2020 PPHCSD UWMP, population within its service area was anticipated to grow by a total of 5.6% in the next 20 years. Since the SCWC service area is bounded by the PPHCSD, population growth within the SCWC service area was assumed to be the same as PPHCSD. Future water demand was assumed to increase proportionally to the population growth. The population growth rate used on the 2020 PPHCSD UWMP is similar with the population growth rate projected in the California Department of Finance (DOF) regional growth forecast report released in 2023, which states that the population of San Bernardino County will increase from 2,189,276 in 2023 to 2,302,986 in 2043; this represents a 5.2% increase countywide.

For reference, an estimate of the future water demand at build-out was also developed. SCWC staff anticipates that service connections at build-out will reach 2,000. Based on the average water usage per connection of 368 gpd/connection in 2022 and the average water loss percentage to production of 17.5%, the total average annual system demand at build-out is anticipated to be on the order of 865,000 gpd.

Table 3-5. Population and Water Demand Forecast

Parameter	Value	Unit
Existing (2024) Population	3,360	capita
Existing 2022 Average Annual Demand	530,000	gpd
Existing Average Annual Demand per Capita	158	gpcd
Projected 2044 Population [1]	3,550	capita
2044 Estimated Average Annual Demand	560,000	gpd

[1] Based on a 20-year growth rate of 5.6%

4. Planning Criteria

This section discusses the planning criteria used for the evaluation of the existing water distribution system and recommendation of capital improvement projects. The criteria developed for this Plan followed industry standards, local and state codes, and typical planning criteria used by neighboring agencies.

4.1. Peaking Factors

As part of the master planning process, the performance of the distribution system is evaluated under a range of operating conditions and demand scenarios. This process involves estimating representative peaking factors for the maximum day demand (MDD) and peak hour demand (PHD), with each factor relating to the average daily demand (ADD).

Peaking factor for MMD represents the seasonal demand variation in a calendar year. Monthly water production records for the period between 2019 and 2022 were used for computing peaking factors for MMD each year which is a ratio of MMD to ADD. The average peaking factor of MMD for the indicated period is 1.5.

The MDD and PHD represents the highest daily demand and the highest hourly demand recorded in one year, respectively. However, in the absence of daily and hourly water production data, peaking factors for MDD and PHD are recommended to be 2.0 and 3.0, respectively, based on values used by nearby water agencies and the American Water Work Association (AWWA) M32 as shown in Table 4-1.

Table 4-1. Recommended Peaking Factors

Peaking Factor	West Valley Water District [5]	City of San Bernardino [6]	Phelan Piñon Hills CSD [7]	City of Victorville [8]	City of Hesperia [9]	AWWA Manuals - M32 [10]	Recommendation for SCWC
Maximum Day Demand (MDD)	1.7	1.54	2	2	1.74	1.5 to 3	2.0
Peak Hour Demand (PHD)	2.9	1.8	3	3	2.9	2 to 8	3.0

4.2. System Pressures

It is important to maintain an acceptable service pressure range while delivering water to consumers. There are typically three design pressures established for water systems: maximum pressure, minimum pressure during PHD, and minimum pressure during MDD plus fire flow.

Table 4-2 presents a comparison of pressure criteria of the recommended values for the SCWC to the nearby agencies. These criteria are established to ensure that the distribution system will provide adequate, but not excessively high, water pressures and that the system can accommodate peak demands without causing premature facility deterioration or resulting in inefficient

[5] Source: 2020 West Valley Water Facilities Master Plan by AKEL Engineering Group, INC.
[6] Source: 2015 Water Facilities Master Plan Report for the City of San Bernardino Water Department by Kennedy/Jenks Consultants
[7] Source: 2020 PPHCSD Water Master Plan by Ardurra
[8] Source: Standard Specifications for Public Improvements, City of Victorville (Revised November 2021)
[9] Source: 2008 Water Master Plan for the City of Hesperia by Carollo Engineers
[10] Source: American Water Works Association Manual of Water Supply Practices: M32: Computer Modeling of Water Distribution Systems, 4th Edition

energy usage. The minimum pressure for the MDD plus fire flow demand condition is generally dictated by local fire agency requirements and commonly set at 20 psi at/near the fire hydrant where the fire demand is located.

Table 4-2. Recommended Pressure Criteria

Scenarios	West Valley Water District [5]	City of San Bernardino [6]	Phelan Piñon Hills CSD [7]	City of Victorville [8]	City of Hesperia [9]	AWWA Manuals - M32 [10]	Recommendation for SCWC
Maximum Static Pressure (psi)	130	120	150	120	150	90 to 130	150
Minimum Static Pressure under PHD Condition (psi)	40	40	40	60	40	35 to 50	40
Minimum Residual Pressure under MDD + FF (psi)	20	20	20	20	20	20	20

4.3. Pipelines

Pipelines in a water system should be designed to accommodate various flow conditions while limiting head loss and minimizing risks of detrimental pressure surges. In municipal water systems, the diameter of a pipeline is usually based on PHD or MDD + FF whichever is greater. Fire hydrant laterals are excluded from these criteria. Higher velocities are acceptable during fire flows since these are generally very short-duration events.

New pipelines are recommended to be a minimum of 8-inch diameter and should be either sized or looped to provide adequate fire flows. The roughness coefficient, or Hazen-Williams Roughness Coefficient (C factor), of the pipes vary depending on the material and age of the pipelines. For planning purposes, and since nearly three quarters of the existing pipes are comprised of relatively smooth PVC, a C factor of 130 is recommended to account for both friction losses and losses due to minor obstructions (e.g. valves and fittings). The recommended criteria for pipeline velocities and head loss for the SCWC compared to nearby agencies are listed in Table 4-3.

Table 4-3. Recommended Pipeline Criteria

Scenarios	West Valley Water District [5]	City of San Bernardino [6]	Phelan Piñon Hills CSD [7]	City of Victorville [8]	City of Hesperia [9]	AWWA Manuals - M32 [10]	Recommendation for SCWC
Maximum Allowable Velocity for ADD (fps)	---	---	---	5	5	4-6	5
Maximum Allowable Velocity for PHD (fps)	5	10 for existing pipes, and 5.5 for new pipes	7	---	7	10	7
Maximum Allowable Velocity for MDD with Fire Flow (fps)	10	15	15	7.5	15	10	15
Minimum Pipeline Diameter on New Construction (inch)	---	---	8	8	8	6, and 8 for branching pipes or dead ends	8

4.4. Fire Flow Criteria

Fire flow requirements and duration varies by land use, structure square footage, and the availability of automatic sprinkler systems per California Water Code (CFC). The SCWC's fire flow requirements follow the San Bernardino County Fire Protection District (SBCFPD). For planning purposes and to evaluate system capacity, fire flow requirements were established per land use type. Table 4-4 presents the fire flow requirements used for the system evaluation portion of this Plan. Actual fire flow requirements dictated by the SBCFPD may vary depending on land use type, building structural type, building area, and other fire protection equipment requirements (e.g. building sprinkler) at the time of construction.

Table 4-4. Recommended Fire Flow Requirements

Land Use Category	Abbreviation	Fire Flow Requirement (gpm)	Duration
General Commercial	CG	3,000	3
Neighborhood Commercial	CN	3,000	3
Office Commercial	CO	3,000	3
Service Commercial	CS	3,000	3
Community Industrial	IC	3,000	3
Institutional	IN	3,000	3
Rural Living	RL	500	2
Multiple Residential	RM	500	2
Single Residential	RS	500	2

4.5. Storage Criteria

The total storage required for a storage tank comprises three components: 1) operational storage, 2) fire protection storage, and 3) emergency storage. Since the SCWC water system is a gravity flow system allowing the storage tanks to serve the lower zones via PRSs, storage capacity was evaluated on a systemwide basis.

4.5.1. Operational Storage

Operational storage aims to meet daily demand variations in excess of water production rate. In other words, an increase in demand during peak hours can be sustained by the operational storage rather than by increasing production from supply sources. The AWWA recommends 25% to 30% of MDD to be designated for operational storage, but larger storage volumes are not uncommon as shown in Table 4-5. The operational storage was recommended to be 50% of MDD for SCWC.

4.5.2. Fire Protection Storage

Fire protection storage aims to meet the maximum fire flow requirement for the required flow duration in the service area, which is 3,000 gpm for 3 hours as listed in Table 4-4.

4.5.3. Emergency Storage

Emergency storage aims to provide a backup supply in the emergency events such as power outage or a major facility failure. The frequency and magnitude of service interruption is unforeseeable; therefore, the recommended emergency storage is 100% of the MDD. Table 4-5 presents a comparison of storage design criteria between the SCWC and the nearby agencies.

Table 4-5. Recommended Storage Criteria

Scenarios	West Valley Water District [5]	City of San Bernardino [6]	Phelan Piñon Hills CSD [7]	City of Victorville [8]	City of Hesperia [9]	AWWA Manuals - M32 [10]	Recommendation for SCWC
Operational Storage	100% MDD	25% of MDD	25% of MDD	50% of MDD	30% of MDD	function of diurnal pattern (25% of MDD is typical)	50% of MDD
Fire Storage	Largest Fire Flow x Duration	Largest Fire Flow x Duration	Largest Fire Flow x Duration	Largest Fire Flow x Duration	Largest Fire Flow x Duration	Largest Fire Flow x Duration	Largest Fire Flow x Duration
Emergency Storage	----	30% of MDD	100% of MDD	50% of MDD	100% of MDD or 7 days of ADD, whichever is largest	A percentage of ADD or MDD based on risk of failures	100% of MDD

5. Hydraulic Model Update

This section outlines updates and refinements to the SCWC's existing hydraulic model to reflect current system conditions, which was then used to evaluate system performance under existing and future conditions.

5.1. Existing Model

The SCWC hydraulic model was created in 2022 (2022 Model) in support of the AR6214-A SCWC Water Consolidation Project prepared by Ardurra in March 2022 (2022 Consolidation Project). The model was developed using InfoWater software, which is a GIS integrated hydraulic modeling and management software developed by Innovyze, now part of Autodesk. The placement and characterization of various network elements were imported from the GIS database. Elevation data was based on the United States Geological Survey (USGS) Digital Elevation Model (DEM). System boundary conditions and control settings were defined such that it reflects the typical existing system operations. Customer meter locations were surveyed via Global Positioning System (GPS) and then linked to the nearest system node for demand allocation. The model was calibrated in a steady state (SS) condition utilizing field pressure readings and fire flow tests as part of the 2022 Consolidation Project.

5.2. Model Updates and Refinement

The 2022 Model was converted to InfoWater Pro 2024 as part of this Plan. The converted InfoWater Pro model was further updated and refined as needed by reviewing updated system data. In addition, the level of confidence in model output results were increased through adjustments made per discussions with SCWC staff during the course of the project.

No major changes were identified in water demands since the 2022 Consolidation Project. The pipeline network was revised in the current model to fix misplaced connections or add missing or recently installed pipelines based on SCWC staff input.

In addition, control set points and boundary conditions defined in the 2022 model were updated to reflect the most recent settings. A breakdown of the system control set points input into the model, including PRS settings, isolation valves, and check valves, is included in Appendix A. Model input for system pumps, such as pump curves and pumping efficiency, were updated based on recent well drawdown records (see Appendix B).

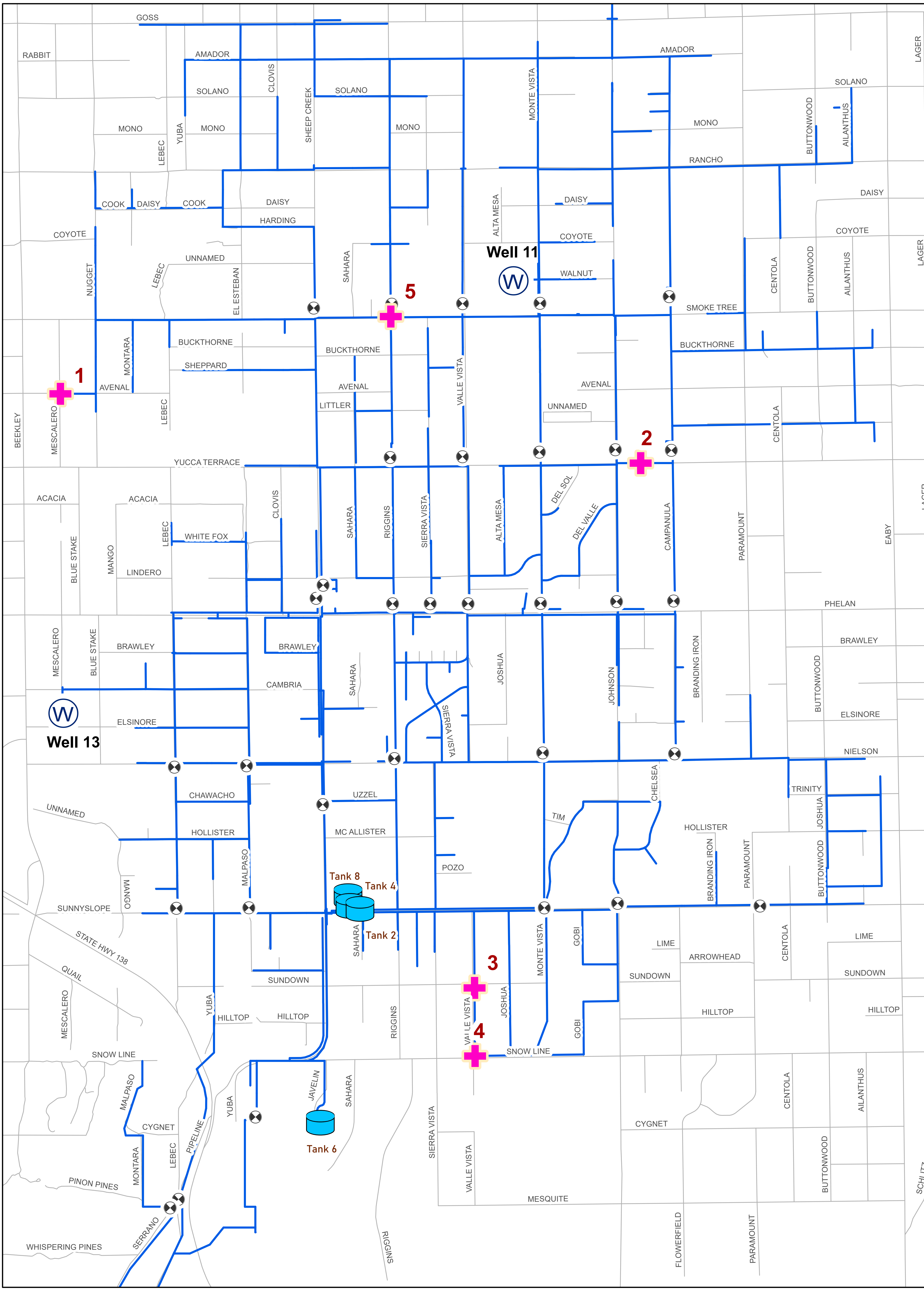
5.3. Model Validation

A validation of the updated model performance was conducted by comparing model predictions to field data measured at five locations in the system. This process followed the general guidelines for master planning models as defined by AWWA M32. This standard defines a model as being representative of the water system when the hydraulic grade line (HGL) predicted by the model is within 5 to 10 ft (2.2 to 4.3 psi) of that recorded in the field.

The test locations, shown in Figure 5-1, were selected to record system pressures based on preliminary model results and engineering judgment, and discussion with the SCWC staff. Some field tests were re-done due to large discrepancies found between model results and field observation.

Table 5-1 documents a comparison between the final field measurements and modeled system static pressures. Field tests were either recorded for an extended period (~ 3 days) or as an instantaneous measurement. Field measurements were compared to the range of model predicted pressures under ADD and MDD conditions since actual demands during the recording period were not available. The model predicted pressure at Test Location #3 exceeded the field pressure by more than 5 psi. However, the model predicted pressure at Test Location #4 was within 1 psi of measured value. These two test locations are on the same pipeline approximately 1,300 linear feet (LF) apart within the same pressure zone. Based on this information, it was concluded that the discrepancy at Test #3 was most likely attributable to instrumental reading error and/or incorrect elevation input.

Overall, model results were found to be within reasonable tolerance (+/- 5 psi) with field values and the updated model was considered suitable for master planning to evaluate the system, identify system deficiencies, and help propose capital improvement projects to accommodate current needs and future growth.



Legend

- Test Location
- Tank
- PRS
- Existing Pipeline
- Groundwater Well

N

0 0.125 0.25 0.5 0.75 1 Miles

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Sheep Creek Water Company
2024 Water Master Plan

Figure 5-1

System Pressure Test Locations

Table 5-1. Steady State Model Validation Results

Test Location #	Location	Field Observation (psi)			Model Results (psi)			Pressure Difference (psi)	Percent Difference (%)
		Low Pressure	High Pressure	Field Average	Low pressure (MDD)	High Pressure (ADD)	Model Average		
1	Avenal & Mescalero Rd	66	70	68	71.0	74.9	73.0	5.0	7.3
2	Yucca Terrace 300' east of Johnson Rd	110	120	115	111.2	116.2	113.7	-1.3	-1.2
3 [1]	Sundown Dr & Valle Vista			51	58.3	59.0	58.7	7.7	15.0
4 [1]	Snow Line & Valle Vista			28	28.7	29.8	29.3	1.3	4.5
5 [1]	Smoke Tree & Riggins			90	90.6	93.9	92.3	1.3	1.4

[1] Instantaneous pressure measurement test location

6. System Evaluation

This section presents findings from the system evaluation based on hydraulic model results and desktop analyses.

6.1. Hydraulic Evaluation

The updated model was used for evaluating the system under PHD and MDD + FF conditions. Existing (2024) and future (2044) system deficiencies were identified based on the recommended planning criteria. All scenarios were analyzed under steady state simulation.

6.1.1. Peak Hour Demands (PHD)

The system was evaluated for existing and future demand scenarios under PHD condition to identify low pressure areas. The minimum static pressure under PHD condition is recommended to be 40 psi, as listed in Table 4-2. Model results show that the pressures for existing system are above 40 psi in most areas under PHD condition. Areas with pressures less than the recommended minimum static pressures are on transmission lines, near storage reservoirs sites, and areas just downstream of a PRS as shown in Figure 6-1. One exception is the demand node at the intersection of Snow Line Dr with Valle Vista due to high terrain elevation at this particular location; this condition was confirmed with the SCWC staff. No service locations were found to experience unacceptably high or low pressures during the PHD condition.

Model predicted that flow velocities were meeting the recommended maximum pipeline velocity of 7 fps under PHD flow conditions as shown in Figure 6-1.

Model results for future demand scenarios under PHD conditions were found to be very similar to the results for the existing demand scenario given the forecasted nominal increase in future water demands.

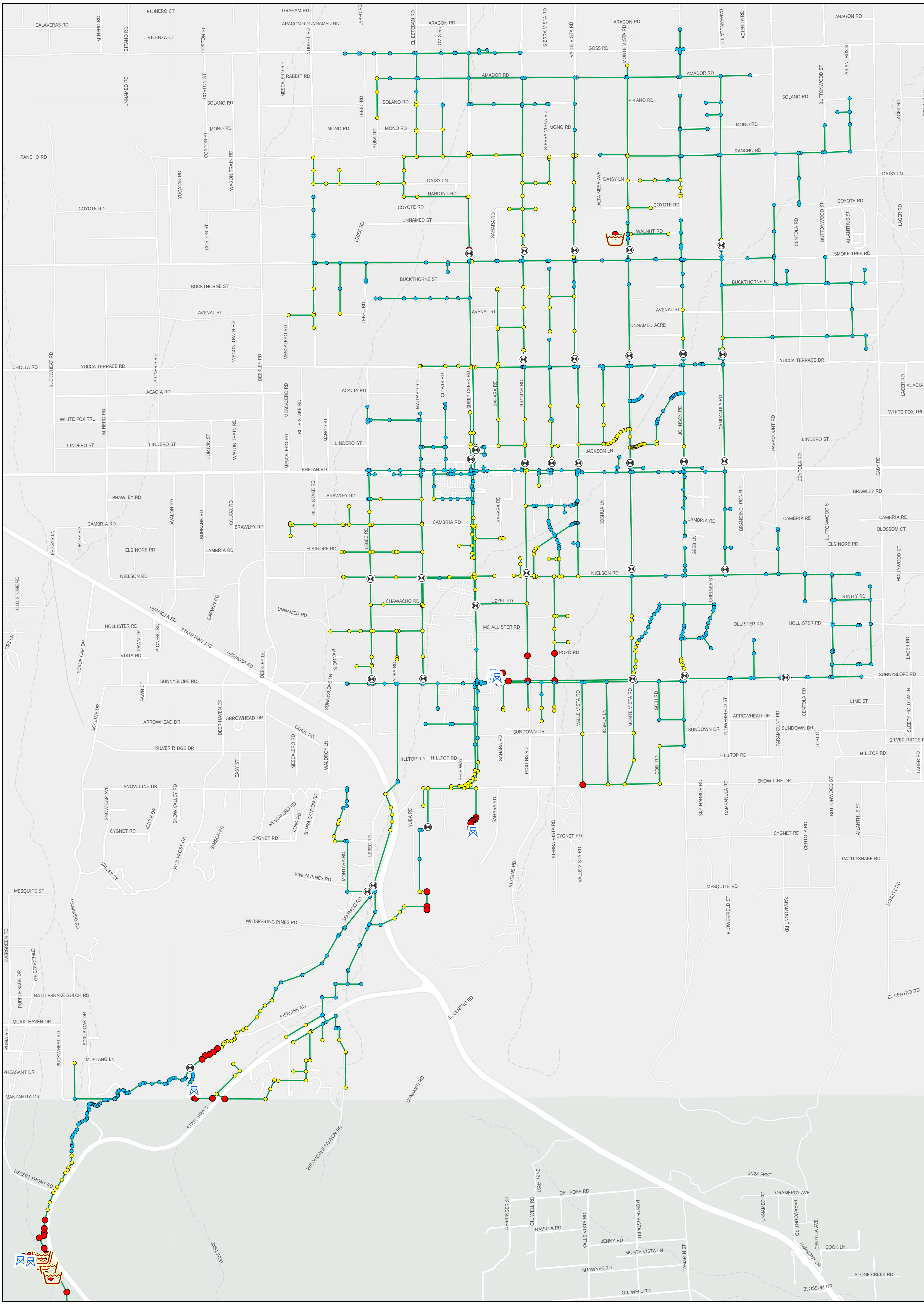
6.1.2. Maximum Day Plus Fire Flow (MDD + FF)

Model hydrant nodes were assigned with the required fire flows based on the fire flow criteria summarized in **Section 4**. The system was analyzed under MDD + FF condition to determine the residual pressures at the model hydrant nodes with required fire flows. The model was also used to estimate the available fire flows at the model hydrant nodes while meeting the fire flow criteria. As discussed above, the recommended minimum residual pressure under MDD + FF condition is 20 psi, and the recommended maximum pipe velocity under MDD + FF condition is 15 fps.

A global fire flow analysis was performed to identify locations that cannot meet the recommended fire flow criteria. Figure 6-2 shows the model predicted residual pressures at hydrant nodes, and highlights locations that are not able to provide the assigned fire flow under MDD condition. Deficiencies in these areas can be mainly attributed to the undersized 4-inch and 6-inch pipelines in the system that accounts for nearly 62% of the existing network (Table 2-3). In addition, some of the 8-inch pipes within commercial areas cannot provide the fire flow requirement of 3,000 gpm. Figure 6-3 shows the available flows at hydrants meeting the system pressure and pipe velocity criteria under MDD +FF.

It should be noted that fire flow requirements in the service area have changed significantly from the past. Older buildings were often constructed with lower fire flow requirements and met fire flow requirements at the time of construction. Although the system may not meet the current fire flow criteria at these areas, fire authorities generally do not require water systems to be upgraded for existing developments to meet the present-day fire flow criteria.

For future development and redevelopment in the areas where fire flows do not meet the criteria, it is anticipated that the developers would be required to upgrade the system to provide the necessary fire flow as required by SBCFPD. Model results presented herein should be used as a planning guide so that SCWC can field verify hydrants that cannot meet the fire flow requirements, especially those predicted to have an available fire flow less than 500 gpm, before pipe improvements are implemented.



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PRS

Existing Tank

Exiting Well

Pipe

Velocity (ft/s)

Less than 7.0

Greater than 7.0

Junction

Pressure (psi)

Less than 40

40 ~ 80

80 ~ 150

Greater than 150

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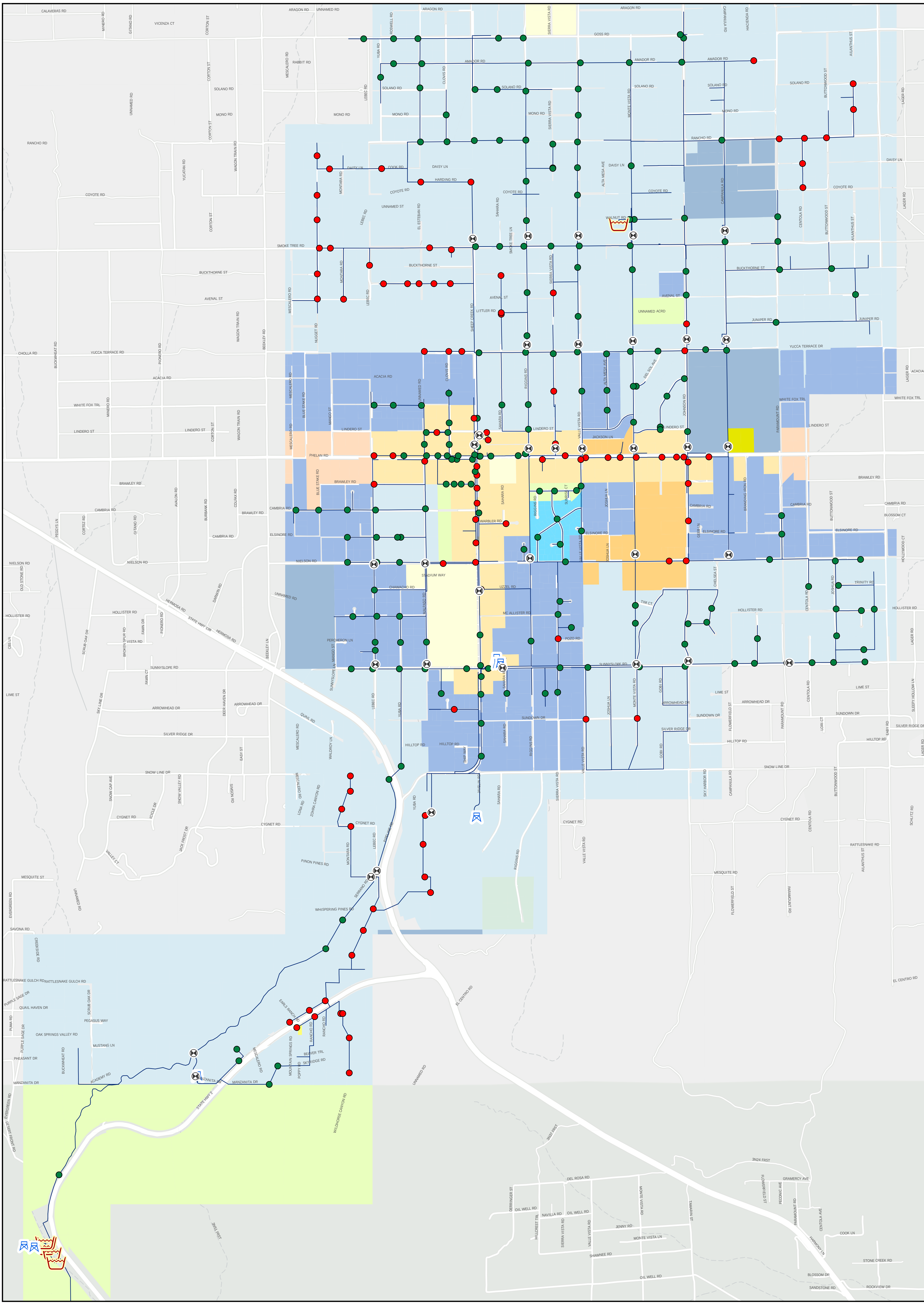

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- PRS
- Water Line
- Existing Tank
- Exiting Well

Junction

Residual Pressure (psi)

- Less than 20.0
- Greater than 20.0

Land Use Designation

- General Commercial
- Institutional
- Multiple Residential
- Neighborhood Commercial
- Office Commercial
- Rural Living
- Rural Living-5 Acre Minimum
- Service Commercial
- Single Residential - 14,000 square feet Minimum
- Single Residential -1 Acre Minimum
- Special Development-Commercial
- Special Development-Residential
- Resource Conservation

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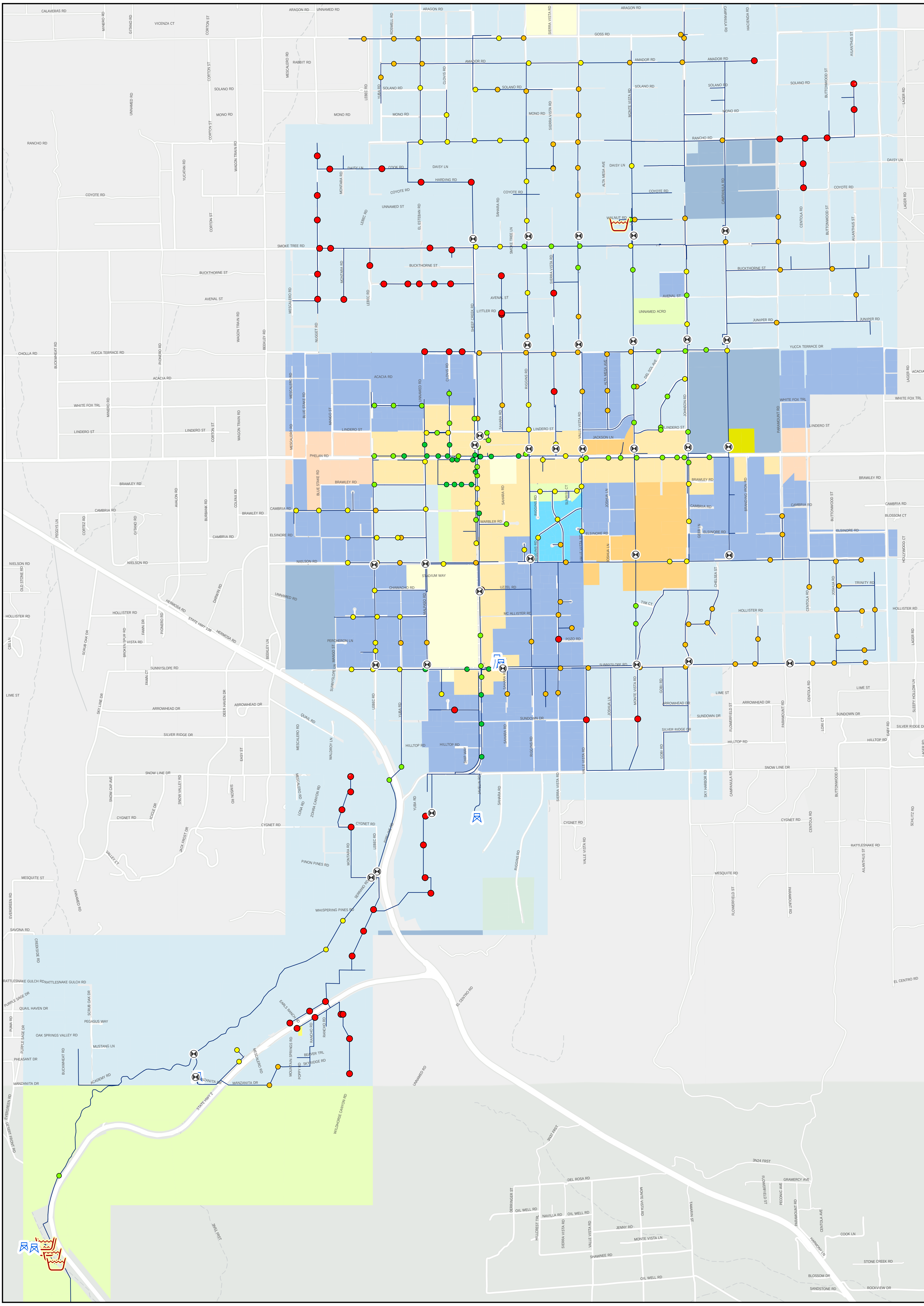

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- PRS
- Water Line
- Exiting Well
- Existing Tank

Junction

Hydrant Available Flow (gpm)

- Less than 500
- 500 ~ 1,000
- 1,000 ~ 2,000
- 2,000 ~ 3,000
- Greater than 3000

Land Use Designation

- General Commercial
- Institutional
- Multiple Residential
- Neighborhood Commercial
- Office Commercial
- Rural Living
- Rural Living-5 Acre Minimum
- Service Commercial
- Single Residential - 14,000 square feet Minimum
- Single Residential -1 Acre Minimum
- Special Development-Commercial
- Special Development-Residential
- Resource Conservation

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6.2. Storage Capacity Evaluation

A desktop system-wide storage analysis was performed to evaluate storage capacities of the distribution system for existing and projected 2044 demand conditions. The system-wide approach utilized herein is adequate given the current system configuration in which tanks in the upper zones can feed the lower zones from southwest to northeast by gravity via PRS's, as shown in Figure 2-3. Meanwhile, in-zone water demands of the upper zones are considered minimal. For example, in-zone existing ADD of Zone Tank 5 (served by Tank 5 and Tank 7), Zone Tank 3 (served by Tank 3), and Zone Tank 6 (served by Tank 6) are 0.03 mgd, 0.041 mgd, and 0.02 mgd, respectively. Land use types in these zones are mainly residential uses with lower fire flow requirements.

The total storage capacity of the system is 6.12 MG as listed in Table 2-5. Table 6-1 presents a summary of the storage capacity evaluation for existing and 2044 demand conditions. The storage requirements for existing and 2044 demand conditions were determined to be 2.13 MG and 2.22 MG, respectively. System storage capacity of 6.12 MG surpasses the existing and 2044 storage requirements by 4.0 MG and 3.9 MG, respectively.

Table 6-1. System Wide Storage Analysis for Existing and Future Water Demand

Demand Conditions		
Existing ADD	0.53	MGD
Existing MDD (Existing ADD x 2)	1.06	MGD
Future ADD	0.56	MGD
Future MDD (Future ADD x 2)	1.12	MGD
Existing Storage Requirements		
Existing Operational Storage (0.5 x MDD)	0.53	MG
Existing Emergency Storage (1.0 x MDD)	1.06	MG
Existing Fire Storage (3000 gpm x 3 hours)	0.54	MG
Total	**2.13**	**MG**
Future Storage Requirements		
Future Operational Storage (0.5 x MDD)	0.56	MG
Future Emergency Storage (1.0 x MDD)	1.12	MG
Future Fire Storage (3000 gpm x 3 hours)	0.54	MG
Total	**2.22**	**MG**
Surplus/(Deficit) Compared to Existing Total Storage Volume		
Existing	**4.0**	**MG**
Future	**3.9**	**MG**

7. Capital Improvement Recommendation

This section presents the capital Improvement projects recommended based on findings from the hydraulic evaluation, desktop analysis, improvement recommendations from previous planning documents, and discussions with the SCWC staff. In addition, this section presents planning level opinions of estimated costs and prioritization of the proposed improvement projects.

7.1. Unit Costs

Unit costs used to develop the capital cost estimates were based on local bid results, unit costs used in the 2022 Consolidation Project, and other insights and updates provided by the SCWC staff. The unit costs utilized herein are considered to be in 2024 U.S. dollars.

The opinions of cost estimates in this study are provided for planning purposes and represent "Class 4 for Studies or Feasibility Report" level costs as established by the American Association of Cost Engineers (AACE), with an accuracy of +50% to -30%. A project contingency of 30% of the estimated unit cost has been included to account for unforeseen events and unknown field conditions. An additional 15% of the unit cost was added for soft costs: engineering, design, project management, and legal and administrative costs. These estimates do not include costs for other project elements that may be incurred including, but not limited to, inspection, construction management, environmental compliance, and right of way acquisition. Due to fluctuations in market prices and labor costs, as well as cost escalation due actual project implementation timelines, these costs may not reflect actual costs or contractor bids. More refined estimates should be obtained during detailed design of proposed improvements to confirm budget amounts.

SCWC has the in-house capability to replace existing pipelines and install new pipelines depending on project size and locations. Larger pipeline projects and more specialized projects, such as tank rehabilitation, would be outsourced via a public bidding process. As such, Table 7-1 lists two sets of unit costs for pipeline projects, one for in-house pipeline projects, and one for pipeline projects that are likely to be outsourced. Table 7-2 summarizes unit costs for other non-pipeline capital improvement projects.

Table 7-1. Pipeline Unit Replacement/Installing Costs

Pipelines (In-house Projects)	
Diameter	***Capital Unit Cost ($/LF)*** [1]
4	55
6	65
8	90
10	140
12	160
Pipelines (Outsourced Projects)	
8	300
10	380
12	450

[1] Costs are in 2024 U.S. dollars

Table 7-2. Improvement Projects Unit Cost (non-pipeline projects)

Type	Capital Unit Cost ($/each) [1]
Fire Hydrant Installation	7,500
Pressure Reducing Station	35,000
Tank Rehabilitation [2]	370,000
Existing Well Rehabilitation	195,000
Booster Pump	185,000
Construction of New well	2,990,000
AMI Meter	750

[1] Costs are in 2024 U.S. dollars

[2] An average cost based on 2022 Consolidation Project. Tank rehabilitation costs vary based on tank size and condition.

7.2. Capital Improvement Program

The proposed Capital Improvement Program (CIP) includes pipeline improvements developed to meet fire flow demands, replace aged pipes, and reduce dead-end pipes. In addition, the proposed CIP projects include well rehabilitations, construction of new wells, tank rehabilitations, implementation of SCADA, and replacement of existing meters with Advanced Metering Infrastructure (AMI). These proposed improvements aim to increase water supply, enhance system redundancy and reliability, enhance system operation and asset management, and reduce water loss. Figure 7-1 presents the proposed CIP projects recommended by this Plan. The following sections provide more information about each category.

7.2.1. Pipeline Improvements

Based on the model results, few hydrant nodes were unable to meet the fire flow criteria designated for this Master Plan, most likely due to undersized pipes (4- and 6-inch pipes). These pipes are recommended to be upsized with 8-inch or larger pipes to meet the fire flow demands. Some of the 8-inch pipes within commercial areas may require to be upsized to 10-inch or 12-inch in order to accommodate the current fire flow requirements.

Twenty-eight (28) pipeline improvement projects were identified with most of them aimed at improving fire flow capacity within the SCWC potable water system as shown on Figure 7-1. Detail maps of individual pipeline projects are included in Appendix C. A detailed list of pipeline replacement/installation projects with model ID's is included in Appendix D.

The pipeline improvement projects are comprised of installing new pipes (a total of ~ 21,100 LF), upsizing existing pipes (replacement of a total of ~ 46,500LF), installation of six new PRS's, repair of an existing PRV, and installation of a new fire hydrant. Some of the proposed pipeline improvement projects also eliminate dead-end pipes in the system by looping.

In order to optimize Well 13 and operate it during off-peak hours, SCWC is planning to construct approximately 9,000 LF of 6-inch pipeline and a booster station to transfer water from Well 13 to Tank 8 (PL-1).

In addition, SCWC is planning to eliminate the rest of 4- and 6-inch dead-end pipes either by upsizing to 8-inch pipes or by looping to mitigate issues of stagnant water and sediment accumulation. Pipes in this category total approximately 23,700 LF. The timing of the improvements for these dead-end pipes will be on a case-by-case basis, but for planning purposes, the cost for this CIP project (PL-3) is estimated in Table 7-3 assuming that all 4- and 6-inch dead pipes will be replaced by 8-inch pipes.

7.2.2. Water Supply Improvements

Rehabilitation of existing wells will help improve well pump performance and help sustain steady and efficient production. The SCWC has an on-going program to rehabilitate existing wells and implement required maintenance. Between 2019 and 2023, the SCWC rehabilitated Well 3A, Well 4A, and Well 8, and the production capacity of these wells increased significantly. Per the 2019 Feasibility Study the total source capacity of the six wells and the supply tunnel was estimated to be 1.05 MGD, whereas the current total source capacity of these facilities now amounts to 2.88 MGD. The recently added Well 13 increases the source capacity further by 0.58 MGD. The SCWC will continue providing regular maintenance to the existing wells and rehabilitate them in a 10-year cycle. In addition, the SCWC plans to rehabilitate the water supply tunnel in the near future to extend its useful life as a reliable source of water and maintain safe accessibility. Section 7-3 provides details on the costs and prioritization of proposed rehabilitation projects at existing wells based on historical information provided by SCWC.

Since well production can be affected due to age, condition, and groundwater level declines, additional wells were recommended in the 2019 Feasibility Study and the 2022 Consolidation Project. In line with these recommendations, SCWC proceeded with the construction of Well 13, which has been completed and put into service recently. In addition, the SCWC is planning to construct two additional wells (Well 12 and Well 15) in the Mojave Basin. Well 12 and 15 are planned to be installed as near-term projects with an anticipated design capacity of 300 gpm, or 0.43 MGD each. In the past, SCWC has endeavored to keep groundwater production from the El Mirage Basin under a rate of 1.0 MGD to prevent overdrafting. SCWC can utilize wells (Well 11 and Well 13) in the Mojave Basin with a total operational capacity of 0.96 MGD to offset groundwater supply from the El Mirage Basin when needed. Production capacity will increase further from the Mojave Basin when Well 12 and Well 15 come online. Figure 7-1 shows the locations of the new wells.

7.2.3. Storage Improvements

Based on tanks inspections conducted in 2018 (as reported in the 2020 AMP) and discussion with the SCWC Staff, all storage tanks except Tank 8, require some measure of repair/rehabilitation. Tank rehabilitation will extend their useful life and bring the storage tanks up to local and State standards. Recommended tank repairs and improvements are likely to involve re-coating the interior and exterior of tank walls, installing tank mixtures, replacing liquid level indicators, and other structural enhancements to meet seismic requirements, as well the addition of safety features for SCWC personnel.

For CIP budgeting purpose, one to two storage tanks were assumed to be rehabilitated every year. Concept-level costs and prioritization of the tank rehabilitations are included in Table 7-3 with tanks needing the most work being given highest priority based on SCWC staff input.

7.2.4. Operation and Monitoring Improvements

Accurate metering at all service connections is important to record usage, help detect leaks, monitor demands, and help understand water losses in the system. The service meters in the SCWC system are manually read. From 2019 to 2022, the average water loss per year was estimated to be 17.5%. To better control and prevent water loss in the system, the SCWC is planning to upgrade its service meters to Advanced Metering Infrastructure (AMI). The proposed meter replacement program will include meter replacement for 2000 connections accounting for existing and future growth.

The existing system requires SCWC staff to operate and control its PRSs, well pumps and storage tanks on site and collect data such as pump flows, tank levels, and PRS outlet pressures manually. The SCWC is planning to install a SCADA system for remote monitoring and process control, electronic data acquisition and storage, and timely notification of problems and alarms at its facilities. This effort is included as a single project in the CIP list in Table 7-3.

7.3. CIP Costs Summary and Prioritization

A summary of the recommended improvements is presented in Table 7-3 and includes proposed project priorities as high, medium, and low based on system needs and discussions with SCWC staff. High priority CIP projects are those suggested to be completed in the next 1 to 5 years, medium priority in the next 6 to 10 years, and low priority projects can be conducted in the next 11 to 20 years. The prioritization of the proposed fire flow improvement projects was based on considerations of the pipe size, pipe material, the severity of fire flow deficiency, as well as the area impacted by the improvement project.

Estimated project costs based on the unit costs and other cost assumptions described in Section 7.1 above are also summarized in Table 7-3. Cost estimates provided herein are for planning purposes. Since prices of material and labor fluctuate over time, costs should be re-estimated during the preliminary and final design of a project to confirm budget amounts.

SCWC is considering the following approaches to fund the proposed improvement projects:

- Apply for grants. SCWC is concurrently working with a grant funding consultant to research and determine grant funding programs that SCWC can apply for system improvements.

- Increase annual system upgrade budget to $25,000 plus inflation every year and get shareholders' approval on additional budget that is needed for system improvements and/or upgrades.
- SCWC will drill additional wells as needed to accommodate demands from new customers and use revenues from new service connections towards the repayment of a new well.

Financial planning to support CIP implementation is beyond the scope of this Master Plan. It is recommended that SCWC conduct a separate rate study to evaluate the proposed CIP, grant funding opportunities and options for rate adjustments needed to achieve financial viability alongside the CIP project execution.

Table 7-3. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
Fire Flow Pipeline Improvement Projects	FF-1	Upsize 4" pipes to 8" pipes near Sky Ridge Rd and Rancho Rd	$186,000			
	FF-2	Upsize 4" pipes to 8" pipes near HW 2 and Pipeline Rd	$218,000			
	FF-3	Upsize 4" pipes to 8" pipes near Pipeline Rd and Cygnet Rd	$156,000			
	FF-4	Install new 8" pipelines and a PRV to connect the system at Lebec Rd Northward to Avenal St	$327,000			
	FF-5	Upsize 4" pipes to 8" pipes near Daisy Ln and Harding Dr	$523,000			
	FF-6	Add a 4" pipe to a dead-end with a new PRV to replace by a looped connection near Coyote Rd	$76,000			
	FF-7 [2]	Upsize 6" and 10" pipes to 12" pipes on Riggins Rd between Phelan Rd and Sunny Slope Rd	$2,697,000			
	FF-8	Install a new 8" pipe and a PRV on Snow Line Dr		$276,000		
	FF-9	Upsize 4" and 6" pipes to 8" pipes north of Wild Horse Canyon Rd		$61,000		
	FF-10	Upsize 4" pipe to a12" pipe near Uzzel Rd		$197,000		
	FF-11	Upsize 4" and 6" pipes to 10" pipes near Nielson Rd, Valle Vista, and Phelan Rd		$713,000		
	FF-12	Install and replace by 8" near Johnson Rd between Phelan Rd and Nielson Rd with a new PRV.		$112,000		
	FF-13	Upsize 4" pipes to 8" pipes near Malpaso Rd, near Phelan Rd		$56,000		
	FF-14	Upsize 4" pipes to 8" pipes near Sierra Vista between Yucca Terrace Dr and Lindero St.		$87,000		
	FF-15	Install new 8" pipelines to create a loop near Sahara Rd south to Smoke Tree Rd		$62,000		
	FF-16	Upsize 4" pipes to 8" pipes and install a new pipe and a PRV to connect dead-ends near Sierra Vista Rd		$271,000		
	FF-17	Upsize a 4" pipe to 8" pipe on Sheep Creek Rd		$180,000		

Table 7-3. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
	FF-18	Install a new 8" pipe on Avenal between Montara Rd and Nugget Rd		$43,000		
	FF-19	Install and replace existing 4" and 6" by 8" with a new PRV to loop the system near Smoke Tree Rd and Johnson Rd		$324,000		
	FF-20	Upsize 4" pipes to 8" pipes near Rancho Rd		$115,000		
	FF-21	Install 4" pipe on Johnson Rd and Amador Rd		$25,000		
	FF-22	Upsize 4" and 6" pipes to 10" pipes near Malpaso Rd to Nielson Rd			$574,000	
	FF-23	Upsize 8" pipes to 10" and 12" pipes near Sheep Creek Rd			$542,000	
	FF-24	Upsize 4" and 6" pipes to 10" pipes near Nielson Rd, between Valle Vista and Johnson Rd			$363,000	
	FF-25	Upsize 4" pipes to 8" pipes and install new pipe to connect dead-ends near Yucca Terrace			$122,000	
		Subtotal	**$4,183,000**	**$2,522,000**	**$1,601,000**	**$8,306,000**
Non-Fire Flow Pipeline Improvement Projects	PL-1	Connect Well 13 to Tank 8 by installing 6" pipelines	$573,000			
	PL-2	Install 8" pipe on Lebec Rd between White Fox Trl and Phelan Rd		$107,000		
	PL-3	Replace the rest of all 4" and 6" dead-end pipes			$2,091,000	
		Subtotal	**$573,000**	**$107,000**	**$2,091,000**	**$2,771,000**
Water Supply Projects	W-12	Install new groundwater well (Well 12)	$2,990,000			
	W-15	Install new groundwater well (Well 15)	$2,990,000			
	BP-1	Installation of a new booster pump to transfer water from Well 13 to Tank 8	$185,000			
	W-5	Well 5 Rehabilitation	$195,000			
	W-2	Well 2A Rehabilitation		$195,000		
	W-3	Well 3A Rehabilitation		$195,000		
	W-11	Well 11 Rehabilitation		$195,000		
	TN-1	Tunnel Rehabilitation		$195,000		
	W-4	Well 4A Rehabilitation			$195,000	
	W-8	Well 8 Rehabilitation			$195,000	
	W-13	Well 13 Rehabilitation			$195,000	
		Subtotal	**$6,360,000**	**$780,000**	**$585,000**	**$7,725,000**

Table 7-3. Capital Improvement Cost Estimates Summary

Improvement Category	Project ID	Proposed Improvement	CIP Priority and Project Cost Summary [1]			Total
			High	Medium	Low	
Water Storage	T-2	Tank 2 Rehabilitation	$319,000			
	T-3	Tank 3 Rehabilitation	$172,000			
	T-4	Tank 4 Rehabilitation	$319,000			
	T-5	Tank 5 Rehabilitation	$130,000			
	T-6	Tank 6 Rehabilitation	$605,000			
	T-7	Tank 7 Rehabilitation	$691,000			
		Subtotal	**$2,236,000**	**$0**	**$0**	**$2,236,000**
Operation & Monitoring	OM-1 (AMI)	Replace up to 2000 meters with advanced metering infrastructure (AMI)	$972,000	262,000	262,000	
	OM-2 (SCADA)	SCADA Implementation	$808,000			
		Subtotal	**$1,780,000**	**$262,000**	**$262,000**	**$2,304,000**
		Total	**$15,132,000**	**$3,671,000**	**$4,539,000**	**$23,342,000**

[1] Costs are in 2024 U.S. Dollars
[2] Outsourced Project

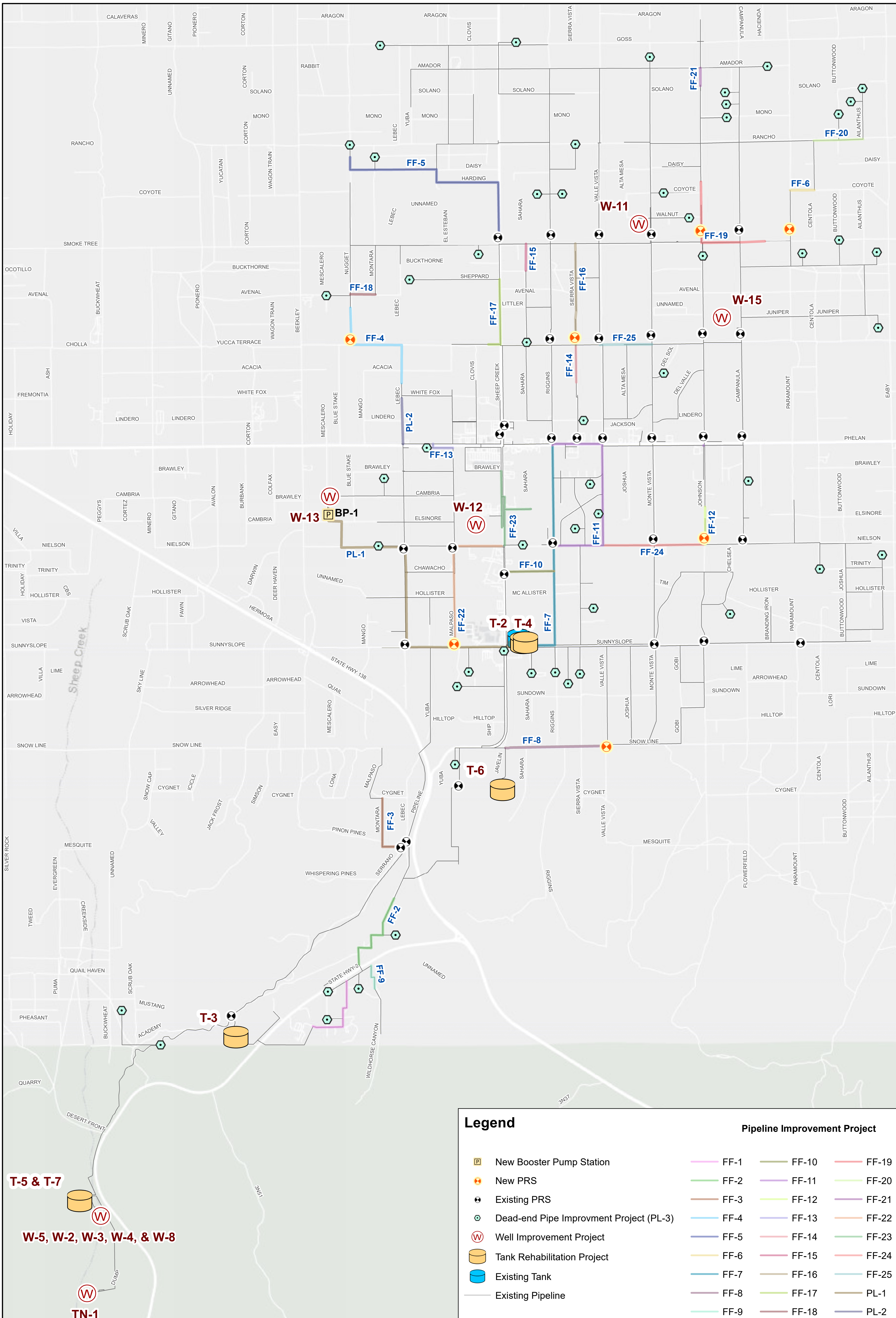

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Figure 7-1

Proposed Capital Improvement Projects