Water Master Plan

Valley of the Moon Water District

April 2019 | EKI 80082.00

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577 Airport Blvd, Suite 500 - Burlingame, CA 94010

Water Master Plan

Valley of the Moon Water District

El Verano, CA

FINAL

April 2019

EKI B80082.00

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VALLEY OF THE MOON WATER DISTRICT

WATER MASTER PLAN

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LIST OF ABBREVIATIONS

ACP	asbestos cement pipe
ADD	average day demands
AF	acre feet
AFY	acre feet per year
AMI	advanced metering infrastructure
BPS	Booster Pump Station
CCI	Construction Cost Index
CIP	Capital Improvement Program, Capital Improvement Project, or cast-iron pipe
DIP	ductile iron pipe
District	Valley of the Moon Water District
DSS	Decision Support System
du	dwelling unit
DWR	California Department of Water Resources
ea	each
EKI	EKI Environment & Water
EL	elevation
ENR	Engineering News Record
ES	Executive Summary
ETo	reference evapotranspiration
°F	degrees Fahrenheit
FF	Fire Flow
fps	feet per second
ft	feet
ft/k-ft	feet per thousand feet
FY	fiscal year
gal	gallons
General Plan	2005 Sonoma County General Plan
GIS	geographic information system
GPCD	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HDPE	high-density polyethylene
hp	horsepower
In	inch
JPA	Joint Exercise of Powers Agreement
LAFCO	Sonoma Local Agency Formation Commission
LF	linear feet
MDD	Max Day Demands
MFR	Multi-Family Residence
MG	Million Gallons
MGD	million gallons per day

MMD	maximum month demand
NAD83	North American Vertical Datum 1983
NAVD 88	North American Vertical Datum of 1988
OPC	Opinion of Probable Cost
PHD	Peak Hour Demands
PRV	pressure reducing valve
psi	pounds per square inch
PVC	polyvinyl chloride
PZ	pressure zone
Restructured Agreement	Restructured Agreement for Water Supply
SBx7-7	2020 Senate Bill x7-7
SCADA	Supervisory Control and Data Acquisition
SCWA	Sonoma County Water Agency
SDC	Sonoma Development Center
sf	square feet
SFR	Single Family Residence
SGMA	Sustainable Groundwater Management Act of 2014
SVMWC	Sobre Vista Mutual Water Company
SWRCB	State Water Resources Control Board
Title 22	California Code of Regulations, Title 22
UNK	unknown
UWMP	Urban Water Management Plan
USACE	U.S. Army Corps of Engineers
V	Volume
WMP	Water Master Plan

EXECUTIVE SUMMARY

On behalf of the Valley of the Moon Water District (District), EKI Environment & Water, Inc. (EKI) has prepared this Water Master Plan (WMP or Project). The WMP is intended to provide the District with an overall plan for infrastructure improvements to ensure that the District can continue to reliably and cost-effectively serve its customers through 2050.

Study and Service Areas

The District's service area is located in Sonoma County, approximately 50 miles north of San Francisco, and is adjacent to the City of Sonoma. The District's water service area extends from the Trinity Oaks Subdivision in the north to the Temelec Subdivision in the south. The service area encompasses approximately 11.8 square miles and includes residential and commercial customers. Elevations in the service area range from approximately 60 feet above mean sea level to approximately 1,190 feet above mean sea level.

The District's Sphere of Influence, a boundary determined by the Sonoma Local Agency Formation Commission (LAFCO) indicating the likely eventual limits of the District's service area, was amended in October 2017 to include areas beyond the District's current service area. The District's Sphere of Influence now also to includes the following areas outside of the water service area:

1. Territory served by the Sobre Vista Mutual Water Company (SVMWC); and
2. Territory occupied by the Sonoma Developmental Center (SDC), which currently owns and operates a municipal water supply, treatment, and distribution system on the campus.

District's Existing Water Infrastructure

The District's existing water supply facilities consist of six groundwater wells and ten water turnouts for delivery of water purchased from the Sonoma County Water Agency (SCWA). The District's water distribution system consists of twelve (12) pressure zone with twelve (12) storage tanks, 2 hydropneumatics tanks, 10 booster pump stations (BPSs), and approximately 92 miles of distribution pipelines. Figure ES-1 shows the District's service area and locations of the District's major water system facilities.

Existing and Future Water Demands

This District's water supply is comprised of SCWA water purchases and local groundwater production. Total potable water use in fiscal year (FY) 2017 was 2,415 acre-feet (AF). SCWA purchases represent an average of 80% of District's total water production over the last eight years.

Although population has increased over the past 20 years, per capita water use since 1998 has generally decreased. Specifically, per capita water use dropped to 80 gallons per capita per day (GPCD) in FY 2016 during the peak of the drought. Per capita demands have been below the District-adopted 2020 Senate Bill x7-7 (SBx7-7) Target of 124 GPCD since FY 2009. Water use in the District's service area is predominantly associated with residential use. Residential customers account for approximately 79% of the total water deliveries in FY 2017, with single-family residential (SFR) use accounting for 61% and multi-family residential (MFR) use accounting for 18%. Commercial and institutional accounts represent 7% and 3% of total use, respectively. Irrigation accounts account for the smallest percentage of water deliveries at less than 2% of total. Non-revenue water uses accounts for the remaining 10% of total use.

Future water demand projections were calculated as the sum of the two major components: (1) the volume of water that best represents existing water demands within the District and (2) the anticipated water demands associated with the future development projects. Existing and future projected demands are summarized in Table ES-1 by pressure zone.

Table ES-1. Projected Existing and Future Annual Demands by Pressure Zone

Pressure Zone	Existing Demands (AFY) (a)	Future Demands (AFY)		
		General Plan Growth (b)	Net New Development (c)	Total Future Demands
1	2,109	2,120	283	2,404
1A	247	247	-	247
1B	264	268	-	268
1F	281	284	-	284
2A	2.4	2.4	-	2.4
2B	20	20	-	20
2D	115	115	-	115
2E	0.7	0.7	-	0.7
3D	14	14	-	14
3E	42	42	-	42
4E	0	0	-	0
5E	0.8	0.8	-	0.8
SCWA	5.1	5.3	-	5.3
Total	**3,102**	**3,120**	**283**	**3,403**

Notes:

(a) For the majority of accounts, existing demands equal the total average FY 2013 and FY 2014 billing data by pressure zone plus 11.3% water loss. However, for 292 accounts with an average FY 2013 and FY 2014 demand less than 50% of the FY 2017 demand, the 2017 demand multiplied by a land use specific 2013-2014 to 2017 escalation factor was tallied instead of the FY 2013 and FY 2014 average demand to account for new or develop or uses since 2014.

(b) Equals the total of the existing demands multiplied by the District's Decision Support System (DSS) model's land use-specific 2040 to 2018 escalation factor assuming passive conservation.

(c) See Table 4-10.

Water System Supplies

The District, along with seven other cities and special districts in Sonoma and Marin County, has a water supply agreement with SCWA. The majority (approximately 85% under normal water year conditions) of the District's water supply comes from SCWA purchases and is delivered through the Sonoma Aqueduct. The District's remaining water is supplied by six (6) groundwater wells that are owned and operated by the District.

Supply and Storage Capacity Assessment

EKI recommends firm supply capacity requirements for each pressure zone met through the combination of SCWA turnouts, groundwater wells, and booster pump stations to meet the applicable combination of max day demands, peak hour demands, fire flow requirements, and/or fire storage refilling requirements based on the available storage in each zone.

The supply assessment indicates that Pressure Zones 2E, 3E, 2B, 3D, and 1F have supply capacity deficits under existing and future conditions. To meet the supply criteria for each zone, EKI recommends the following improvements:

- Installation of a new 450 gallons per minute (gpm) BPS to deliver supply from Pressure Zone 1B to Pressure Zone 1F;
- Installation of dedicated 1,000 gpm fire pumps at Donald BPS and Chestnut BPS; and
- Upgrades to the Sobre Vista Lower Pump Station as part of a consolidation of Pressure Zones 2E and 3E.

Treated water storage capacity requirements include a combination of equalization storage, fire storage, and emergency storage. The District currently has 5.132 million gallons (MG) of storage between its 12 tanks. Pressure Zone 1F is projected to have existing and future storage deficits of 0.341 MG and 0.344 MG, respectively. The District has initiated design of a new 0.15 MG tank at the former Saddle Tank site. To cover the remaining Pressure Zone 1F deficit, an additional 0.2 MG tank is required. EKI has identified two potential sites with the appropriate elevations to match the hydraulic grade level of the pressure zone: Alternative #1 - London Ranch Road and Alternative #2 - South of Mound Avenue. Both sites would require extending the transmission mains to the tank sites.

Pressure Zone 2E, which currently cannot receive transfer of storage from Pressure Zones 3E, does not have enough fire flow storage. This deficiency will be resolved with the proposed Pressure Zones 2E and 3E consolidation.

Hydraulic Assessment

EKI constructed a water system hydraulic model to assess the District's existing infrastructure and key planned infrastructure against the design criteria discussed in Section 6.0 and the water demand projections developed in Section 4.0. The hydraulic model, along with the demand projections, was used to evaluate capacity needs for current and future demand conditions and to complete the hydraulic assessment portion of the WMP. EKI took steps to validate and calibrate the model by comparing the model results to system operations data and field-testing results.

As discussed in Section 8.0, the District's water system was evaluated under existing demand conditions and projected future demand conditions. The future scenario includes upcoming capital improvement projects (CIPs) currently in the design or construction phase. These scenarios were evaluated to identify existing and projected future capacity deficiencies.

The District's water distribution system was primarily assessed by ability to supply required pressures under peak demand and fire flow conditions. Pipe velocity and head loss criteria are secondary criteria that indicate which pipes could be upsized to increase downstream pressures and improve water movement within the system.

Model results identified several existing fire flow and peak hour pressure deficiencies that remain in future scenarios with upcoming capital improvement projects. EKI developed improvement projects to address each of these deficiencies.

Recommended Capital Improvement Program

Improvement projects were developed to solve each the supply and storage deficiencies and the identified hydraulic capacity deficiencies, as well as replace infrastructure that has reach the end of its useful life. Figure ES-2 shows an overview of the project locations, Figure ES-3 shows locations of remaining steel main replacement locations, and Table ES-2 summarizes all the identified capacity improvement projects and their estimated planning level opinion of probable costs (OPCs). As shown in Table ES-2, the total OPC for the proposed CIP in March 2019 dollars[1] is between approximately $27.7 million to $35.3 million (depending on whether the pipeline projects will be constructed by the District or a construction contractor) on top of the $10.9 million currently included in the District's 5-year CIP budget. The recommended CIP is discussed in Section 9.0.

[1] Costs based on a March 2019 Engineering News Record (ENR) Construction Cost Index (CCI) of 12,048.19 (San Francisco).

Bolli Tanks 1 & 2
Mountain Well
Chestnut Tank, Hydropneumatic Tank, and BPS
Park Ave. Well
Agua Caliente Well and BPS
Donald Tank, Hydropneumatic Tank, and BPS
SCWA Sonoma Tanks
Donald Well
Verano & Fifth Turnout
Verano & Main Turnout
VeranoTurnout
Glen Ellen
Turnout and BPS
SCWA Eldridge Tanks 1 & 2
Trinity Turnout
Madrone Turnout
Agua Caliente
Turnout
Hannah Turnout
and BPS
Eldridge PRV
Arnold Dr.
Former Saddle Tank
(Out of Service)
Lower Sobre Vista BPS
Hannah Tank
Hannah Lower PRV
Larbre Well
Arnold Dr. BPS
Glen Ellen Tank
Lower Sobre Vista Tank and
Upper Sobre Vista BPS
Altimira Turnout
Boyes Turnout
Verano Well
Upper Sobre Vista Tank and
Sonoma Mountain Lower BPS
Sonoma Mountain Lower Tank
and Upper BPS
Sonoma Mountain Upper Tank
Temelec Tanks 1 & 2

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Abbreviations
BPS = booster pump station
PRV = pressure reducing valve
SCWA = Sonoma County Water Agency

Notes
1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources
1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N
0 3,000 6,000
Feet

Existing Water System Facilities

Valley of the Moon Water District
Sonoma County, CA
April 2019
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Figure ES-1

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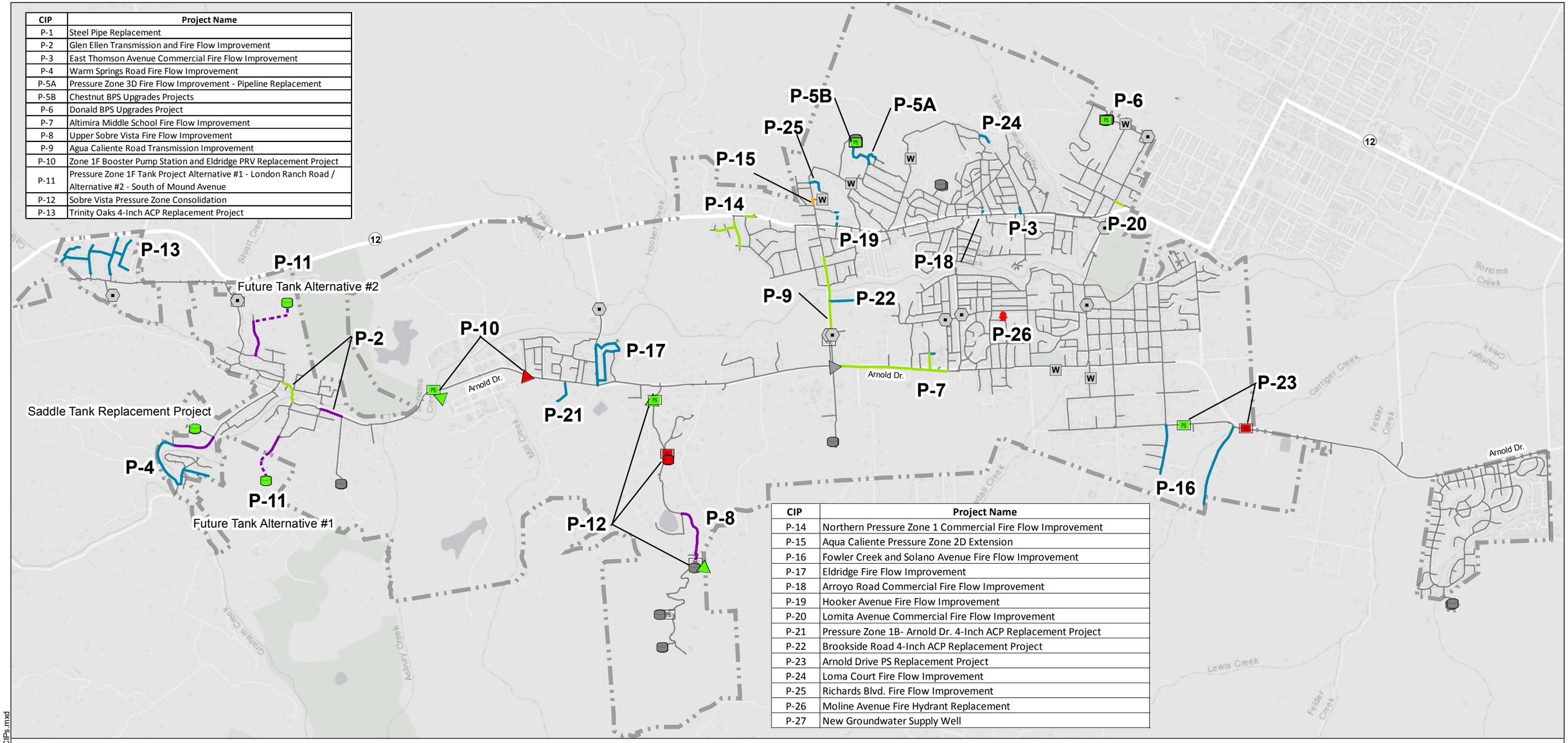
CIP	Project Name
P-1	Steel Pipe Replacement
P-2	Glen Ellen Transmission and Fire Flow Improvement
P-3	East Thomson Avenue Commercial Fire Flow Improvement
P-4	Warm Springs Road Fire Flow Improvement
P-5A	Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement
P-5B	Chestnut BPS Upgrades Projects
P-6	Donald BPS Upgrades Project
P-7	Altimira Middle School Fire Flow Improvement
P-8	Upper Sobre Vista Fire Flow Improvement
P-9	Agua Caliente Road Transmission Improvement
P-10	Zone 1F Booster Pump Station and Eldridge PRV Replacement Project
P-11	Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road / Alternative #2 - South of Mound Avenue
P-12	Sobre Vista Pressure Zone Consolidation
P-13	Trinity Oaks 4-Inch ACP Replacement Project



CIP	Project Name
P-14	Northern Pressure Zone 1 Commercial Fire Flow Improvement
P-15	Aqua Caliente Pressure Zone 2D Extension
P-16	Fowler Creek and Solano Avenue Fire Flow Improvement
P-17	Eldridge Fire Flow Improvement
P-18	Arroyo Road Commercial Fire Flow Improvement
P-19	Hooker Avenue Fire Flow Improvement
P-20	Lomita Avenue Commercial Fire Flow Improvement
P-21	Pressure Zone 1B- Arnold Dr. 4-Inch ACP Replacement Project
P-22	Brookside Road 4-Inch ACP Replacement Project
P-23	Arnold Drive PS Replacement Project
P-24	Loma Court Fire Flow Improvement
P-25	Richards Blvd. Fire Flow Improvement
P-26	Moline Avenue Fire Hydrant Replacement
P-27	New Groundwater Supply Well

Legend

Sphere of Influence

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Recommended CIPS

- Replace existing hydrant with 6-inch hydrant & lateral
- Future PRV
- Future/Upgraded Pump Station
- Future Enclosed Storage Facility
- Abandon Valve
- Abandon Pump Station
- Abandon Enclosed Storage Facility

Replacement Pipe, inches

- 6
- 8
- 10
- 12

New Pipe, inches

- 8
- 10

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.

N

0 3,000 6,000
Feet

Recommended Capacity-Related Water System Improvements

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Figure ES-2

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Path: X:\B80082.00\Maps\Water Master Plan\04\Fig9_1_RecommendedCIPs.mxd

Mountain Well Discharge Pipe
Water Main and Services
Water Main Intertie (Possible CAD Error)
Services
8" Fire Service Main and 2" Customer Service
La Mancha Multi-Family Services
Water Main and Services
Services
Water Main
Services
SDC Intertie (Possible CAD Error)
Water Main
Services
Near Abandoned Check Valve
Services
Service
Water Main
Steel Bridge Crossings
Hydrant Lateral
Water Main

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Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A
- 1B
- SCWA
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Recommended CIPs (Existing Diameter Shown)

- Water Service Conversions
- Steel Main Replacement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Steel mains to be replaced as a part of other CIPs are not shown.
3. Water main materials based on AutoCAD files of the Water System Map provided by the District and updated by EKI based on as-built records.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Remaining Steel Pipe Replacement CIP (P-1)

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Sonoma County, CA
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Figure ES-3

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Table ES-2
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (a)(b)	
						District Staff	External Contractor
Facilities and Maintenance Projects							
CIP-9300	Meter Replacement Program	Existing District CIP with a total remaining 5-year budget of $1,100,000.	--	--	--	--	--
CIP-2957	Equipment Replacement	Existing District CIP with a total remaining 5-year budget of $545,000.	--	--	--	--	--
CIP-2958	Emergency Preparedness Equipment	Existing District CIP with a total remaining 5-year budget of $2,075,000.	--	--	--	--	--
CIP-2978	New Storage in Glen Ellen Zone	Existing District CIP with a $650,000 expenditure and an anticipated $630,571 FEMA reimbursement.	--	--	--	--	--
CIP-6000	Polybutylene Service Replacements (Leak Response)	Existing District CIP with a total remaining 5-year budget of $50,000.	--	--	--	--	--
CIP-6002	Service Replacement Other Than Polybutylene	Existing District CIP with a total remaining 5-year budget of $110,000.	--	--	--	--	--
CIP-6003	Planned Polybutylene Service Replacements	Existing District CIP with a total remaining 5-year budget of $100,000.	--	--	--	--	--
CIP-8100	Valve Replacement Program	Existing District CIP with a total remaining 5-year budget of $170,000.	--	--	--	--	--
CIP-9100	Unanticipated Capital Expenditures	Existing District CIP with a total remaining 5-year budget of $380,000.	--	--	--	--	--
TBD	Building Maintenance & Repair	Existing District CIP with a total remaining 5-year budget of $37,500.	--	--	--	--	--
CIP-5107	County of Sonoma Paving Projects requiring adjustments and or relocation of District facilities	Existing District CIP with a total remaining 5-year budget of $310,000.	--	--	--	--	--
TBD	PRV upgrade GE & Trinity - SS fittings	Existing District CIP with a total remaining 5-year budget of $82,000.	--	--	--	--	--
P-27	SCWA Turnout Flow Meter Installation	Install flow meters at each of the SCWA turnout PRVs and integrate with SCADA system.	2	--	--	--	$312,500
Pipeline Projects							
CIP-2947	Walnut Ave, Oak St. & Penny Ln. Water Main Replacement	Existing District CIP with a total remaining 5-year budget of $275,000.	1	--	--	--	--
CIP-2967	Boyes Blvd. Bridge Pipeline Replacement	Existing District CIP with a total remaining 5-year budget of $375,000.	1	--	--	--	--
TBD	Gibson St., Riddle Rd Easement, Sobre Vista (near Lake Josephine), Brookview & Lomita Water Main Replacements	Existing District CIP with a total remaining 5-year budget of $275,000.	1	--	--	--	--
P-1	Steel Pipe Replacement	Replace all remaining steel water mains and convert steel laterals to customer service connections throughout distribution system as detailed by Figure 9-2.	1	8 6 Service Conversions (c)	800 1,800 24	$730,000	$1,180,000
P-2	Glen Ellen Transmission and Fire Flow Improvement	Replace existing 6-inch and 8-inch steel and ACP water mains with new 10-inch and 12-inch PVC water mains, replace existing service connections, and replace existing fire hydrants.	1	10 12	700 800	$610,000	$1,010,000
P-3	East Thomson Avenue Commercial Fire Flow Improvement	Replace existing 4-inch steel water mains with new 8-inch PVC water mains, and replace one existing fire hydrant along East Thomson Avenue.	1	8	200	$70,000	$130,000
P-4	Warm Springs Road Fire Flow Improvement	Replace existing 6-inch PVC, ACP, and DIP water mains with new 8-inch and 10-inch PVC water mains, replace 47 existing service connections, and replace four existing fire hydrants.	1	8 10	3,400 1,500	$1,550,000	$2,470,000
P-5A	Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement	Replace existing 4-inch ACP, PVC, and DIP water mains with new 8-inch PVC throughout PZ-3D, replace eight existing service connections, and replace one existing fire hydrants.	1	8	1,600	$500,000	$790,000
P-7	Altimira Middle School Fire Flow Improvement	Replace existing 6-inch and 8-inch PVC and ACP water mains with new 12-inch PVC water mains along Arnold Drive, replace existing 6-inch pipe with new 8 and 12-inch pipe adjacent to Altimira Middle School, replace 15 existing service connections, and replace three existing fire hydrants.	1	8 12	160 4,200	$1,760,000	$2,650,000
P-8	Upper Sobre Vista Fire Flow Improvement	Replace existing 6-inch PVC and HDPE water mains with new 8-inch PVC water mains, and replace two existing fire hydrants.	1	10	2,100	$700,000	$1,080,000
P-9	Agua Caliente Road Transmission Improvement	Replace existing 8-inch ACP water mains with new 12-inch PVC water mains, replace 19 existing service connections, and replace two existing fire hydrants. Recommended to be constructed in conjunction with Project P-25 due to proximity.	2	12	2,500	$1,060,000	$1,650,000

Table ES-2 (cont.)
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (b)(c)	
						District Staff	External Contractor
Pipeline Projects							
P-13	Trinity Oaks 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace 49 existing service connections, and replace six existing fire hydrants in the Trinity Oaks area. District to coordinate with Fire Department to determine if additional hydrants are needed. These hydrants would be funded by the Fire Department.	2	8	6,000	$1,780,000	$2,820,000
P-14	Northern Pressure Zone 1 Commercial Fire Flow Improvement	Replace existing 6-inch and 8-inch ACP water mains with new 12-inch PVC water mains, replace 13 existing service connections, and replace three existing fire hydrants.	2	12	1,800	$770,000	$1,210,000
P-15	Aqua Caliente Pressure Zone 2D Extension	Install a parallel 6-inch PVC water main on Aqua Caliente Road and reconnect three services from Pressure Zone 1 to Pressure Zone 2D.	2	6	200	$230,000	$340,000
P-16	Fowler Creek and Solano Avenue Fire Flow Improvement	Replace existing 6-inch ACP water mains with new 8-inch PVC water mains, replace ten existing service connections, and replace five existing fire hydrants.	2	8	4,200	$1,210,000	$1,890,000
P-17	Eldridge Fire Flow Improvement	Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace 49 existing service connections, and replace three existing fire hydrants in the Eldridge area.	2	8	3,900	$1,200,000	$1,950,000
P-18	Arroyo Road Commercial Fire Flow Improvement	Install new 8-inch PVC water main between Highway 12 and Madera Road along Arroyo Road.	3	8	200	$60,000	$100,000
P-19	Hooker Avenue Fire Flow Improvement	Install new 8-inch PVC water main between Highway 12 and Hooker Ave.	3	8	550	$150,000	$240,000
P-20	Lomita Avenue Commercial Fire Flow Improvement	Replace existing 6-inch ACP water main with new 12-PVC water main along Lomita Avenue, replace two service connections, and replace one hydrant.	3	12	300	$140,000	$230,000
P-21	Pressure Zone 1B - Arnold Dr. 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water main with new 8-inch PVC water main in Pressure Zone 1B west of Arnold Drive, and replace three existing service connections.	3	8	800	$50,000	$90,000
P-22	Brookside Road 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water main with 8-inch PVC water main along Brookside Road , and replace eight existing service connections.	3	8	800	$240,000	$370,000
P-24	Loma Court Fire Flow Improvement	Replace existing 6-inch with new 8-inch PVC along Loma Court, replace 11 existing service connections, and replace one existing fire hydrant.	3	8	500	$90,000	$180,000
P-25	Richards Blvd. Fire Flow Improvement	Replace existing 6-inch ACP and DIP water main with 8-inch PVC water main along Richards Blvd, replace four existing service connections, and one existing hydrant.	3	8	300	$100,000	$190,000
P-26	Moline Avenue Fire Hydrant Replacement	Run fire hydrant testing to confirm fire flow availability. If fire flow availability does not meet requirements then replace existing hydrant assembly with 6-inch lateral.	3	--	--	$10,000	$30,000

Table ES-2 (cont.)
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (b)(c)	
						District Staff	External Contractor
Pump Stations, Tanks, and Wells							
CIP-2978	Saddle Tank Replacement Project	Install a new 0.15 MG welded steel tank at the former Saddle Tank site.	1	--	--	--	$640,000
TBD	Bolli Tanks Recoating & Railing Retrofit	Existing District CIP with a total remaining 5-year budget of $600,000.	--	--	--	--	--
TBD	New Well No. 9 Engineering	Existing District CIP with a total remaining 5-year budget of $150,000.	--	--	--	--	--
TBD	New Well No. 11 Engineering (construction to be loan financed)	Existing District CIP with a total remaining 5-year budget of $900,000.	--	--	--	--	--
CIP-2966	Hillside Stabilization at Donald Tank & Booster	Existing District CIP with a total remaining 5-year budget of $200,000.	1	--	--	--	--
P-5B	Chestnut BPS Upgrades Projects	Replace existing Chestnut BPS with two (2) 100-gpm domestic pumps and one (1) 1,000 gpm fire pump at 60 ft total dynamic head (TDH).	1	--	--	--	$2,040,000
P-6	Donald BPS Upgrades Project	Replace existing Donald BPS with two (2) 115-gpm domestic pumps and one (1) 1,000 gpm fire pump at 220 ft TDH.	1	--	--	--	$2,040,000
P-27	New Groundwater Supply Well	Installation of a new well located outside of the Sonoma Valley Subbasin with an assumed capacity of 350 gpm.	1	--	--	--	$1,600,000
P-10	Zone 1F Booster Pump Station and Eldridge PRV Replacement Project	Install new PRV and BPS with a firm capacity of 450 gpm at 275 ft TDH. Abandon existing Eldridge PRV.	2	--	--	--	$1,670,000
P-11	Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road	Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 590 LF of existing 8-inch PVC with a 10-inch PVC water main.	2	8	1,700	--	$1,510,000
	Pressure Zone 1F Tank Project Alternative #2 - South of Mound Avenue	Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 1,100 LF of existing 6-inch PVC with a 10-inch PVC water main.	2	8	2,600	--	$1,880,000
P-12	Sobre Vista Pressure Zone Consolidation	Replace Lower Sobre Vista BPS with a firm capacity of 265 gpm at 270 ft TDH; demolish Lower Sobre Vista Tank and Upper Sobre Vista BPS; connect PZ-2E and 3E; install individual service PRVs in former PZ-2E area.	2	--	--	--	$1,560,000
P-23	Arnold Drive PS Replacement Project	Install new BPS with a firm capacity of 500 gpm along Orange Avenue. Demolish existing Arnold Drive BPS.	3	--	--	--	$1,410,000
					TOTAL WATER DISTRIBUTION SYSTEM IMPROVEMENTS OPC (d)	**$27,672,500**	**$35,262,500**

Notes:

(a) Costs shown are presented in March 2019 dollars based on an ENR CCI of 11,227.88 (20-city average), with totals rounded to the nearest $10,000.

(b) Costs for pipeline projects include construction contingency (25%), design (10%), construction management (5%), permitting (5%), and Project Implementation (5%). Costs for other projects (i.e. BPS installations) include construction contingency (30%), design (15%), construction management (5%), permitting (5%), and Project Implementation (5%).

(c) Service conversions includes groups of steel pipe identified to be replaced with new copper services. Average service length is approximately 100 LF which is substantially larger than a typical service. Thus, the service connection replacement cost factor has been increased by a factor of two.

(d) Total district constructed OPC includes contractor costs for pump station, tanks, wells, and other projects not anticipated to be constructed by the District.

1.0 INTRODUCTION

On behalf of the Valley of the Moon Water District (District), EKI Environment & Water, Inc. (EKI) has prepared this Water Master Plan (WMP or Project). The WMP is intended to provide the District with an overall plan for infrastructure improvements to ensure that the District can continue to reliably and cost-effectively serve its customers through 2050.

1.1 Project Background

The District's prior Water Master Plan was adopted in 2007, and the District has addressed most of the projects identified in that plan. Since the development of the 2007 Water Master Plan, the District's per capita water demands have decreased by 22% and population growth has been low (approximately 0.5% per year). Additionally, the District was impacted by the October 2017 Northern California firestorm, which destroyed Saddle Tank located in Glen Ellen.

Because of these changed conditions, an update to the District's Water Master Plan is needed to evaluate the capacity, resiliency, and reliability of the District's current distribution system and supply sources and to develop a new Capital Improvement Program (CIP).

1.2 Project Scope

The scope of the WMP consists of:

1. A summary and description of the District's water service area and existing water system;
2. An assessment of existing and projected water demands by pressure zone;
3. An evaluation of the District's existing and projected water demands, including allocation of the demands by pressure zone, an assessment of peak demands, and a review of fire flow requirements;
4. An assessment of the District's existing water supply, storage, and pumping capacities and condition;
5. Construction, calibration, and evaluation of a new hydraulic model to assess the existing water system's ability to deliver existing and future water demands and fire flows and identify potential capital improvements to improve system operation;
6. Development, prioritization, cost estimation of recommended capital improvements;
7. A review of the District's current 5-year, $10 million CIP budget, including any recommendations;
8. Development of a 6-year to 25-year CIP budget and funding requirements; and
9. Preparation of the Draft and Final Water Master Plan Report.

EKI submitted two technical memoranda to document preliminary findings for Scope Items 1-4 and Scope Item 5, respectively. The contents of these technical memoranda, with updates based on the District's comments, have been incorporated into this WMP Report.

1.3 Previous Evaluations and Planning Studies

This WMP updates and builds upon the District's previous planning studies including:

- Strategic Water Supply Plan (John Olaf Nelson Water Resources Management, 1999);
- Water Storage Plan (Brelje & Race, 1999);
- 2007 Water Master Plan (Brelje & Race, 2007);
- 2015 Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update (Maddaus, 2015)
- 2015 Urban Water Management Plan (EKI, 2016);
- Saddle Tank Replacement Project Site Assessment (EKI, 2018)

1.4 Report Organization

The WMP is organized into the following sections:

- Section 1.0 - Introduction
- Section 2.0 - Service Area Description
- Section 3.0 - Existing Water System Facilities
- Section 4.0 - Existing and Future Water Demands and Fire Flow Requirements
- Section 5.0 - Water Supply and Storage Capacity Evaluation
- Section 6.0 - Water Distribution System Hydraulic Model Development
- Section 7.0 - Water Distribution System Performance and Sizing Criteria
- Section 8.0 - Water Distribution System Modeling Evaluation
- Section 9.0 - Recommended Capital Improvement Program
- Section 10.0 - References

2.0 SERVICE AREA DESCRIPTION

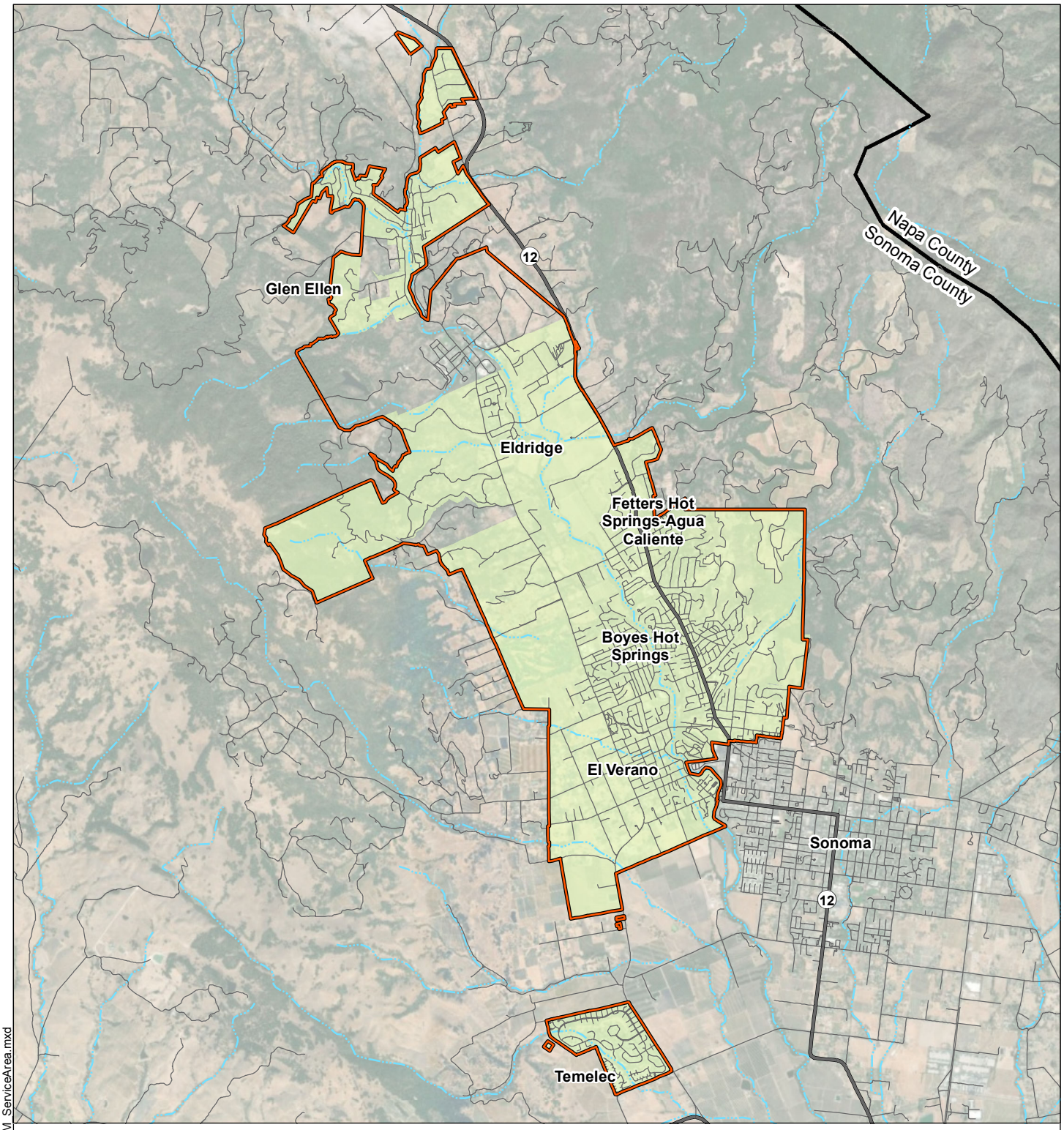
This section describes the physical characteristics of the District's water service area, as well as the current and projected population for the service area.

2.1 Water Service Area and Sphere of Influence

The District's service area is located in Sonoma County, approximately 50 miles north of San Francisco, and is adjacent to the City of Sonoma. As shown in Figure 2-1, the District's water service area extends from the Trinity Oaks Subdivision in the north to the Temelec Subdivision in the south. The service area encompasses approximately 11.8 square miles and includes residential and commercial customers. Elevations in the service area range from approximately 60 feet above mean sea level to approximately 1,190 feet above mean sea level.

The District's Sphere of Influence, a boundary determined by the Sonoma Local Agency Formation Commission (LAFCO) indicating the likely eventual limits of the District's service area, was amended in October 2017 to include areas beyond the District's current service area. As shown in Figure 2-1, the District's Sphere of Influence now also to includes the following areas outside of the water service area:

1. Territory served by the Sobre Vista Mutual Water Company (SVMWC); and
2. Territory occupied by the Sonoma Developmental Center (SDC), which currently owns and operates a municipal water supply, treatment, and distribution system on the campus.



Legend

- VOMWD Service Area
- Sphere of Influence
- County
- Highway
- Road
- Stream

N

0 8,000 16,000

(Scale in Feet)

Sources

1. Aerial photograph provided by ESRI's Arc GIS Online, 26 April 2019.

Notes

1. All locations are approximate.
2. Service area and sphere of influence provided by VOMWD on 25 March 2016.

District Service Area Map

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 2-1

eki environment & water

Path: X:\B80082.00\Maps\Water Master Plan\04\Fig2_1_VOTM_ServiceArea.mxd

2.2 Service Area Climate

The District's service area has a climate that is typical of the Napa and Sonoma County areas, characterized by summers that are dry and warm and winters that are relatively mild with most rainfall occurring during this season. The regional averages for reference evapotranspiration (ETo), rainfall, and temperature are summarized in Table 2-1.

Table 2-1. Climate Characteristics

Month	Reference Evapotranspiration, ETo (a) (inches)	Average Rainfall (b) (inches)	Average Temperature (b)	
			Min (°F)	Max (°F)
January	1.0	6.14	37.2	57.2
February	1.6	5.27	39.9	63.2
March	3.0	4.05	40.8	66.4
April	4.5	1.77	42.3	71.2
May	5.6	0.82	46.0	77.2
June	6.6	0.23	49.7	84.1
July	7.1	0.03	51.2	88.6
August	6.3	0.08	50.8	88.2
September	4.7	0.33	49.3	86.3
October	3.3	1.67	45.5	78.6
November	1.5	3.85	40.6	65.9
December	1.0	5.18	37.1	57.5
Annual	**46.1**	**29.4**	**44.2**	**73.7**

Notes:

(a) Reference evapotranspiration data for Valley of the Moon from Appendix A of the California Code of Regulations, Title 23, Division 2, Chapter 2.7, Model Water Efficient Landscape Ordinance, 15 July 2015.

(b) Precipitation and temperature data for the Sonoma Climate Station (048351) from the Western Regional Climate Center for the period 1 January 1893 through 31 May 2016.

2.3 Number of Service Connections

Table 2-2 and Figure 2-2 summarize the number of customer service connections in each water use category between FY 2010 and FY 2017. Customers in the District's service area are classified by the following categories:

- Single-Family Residential (SFR);
- Multi-Family Residential (MFR);
- Commercial;
- Institutional; and
- Irrigation (MFR and Commercial).

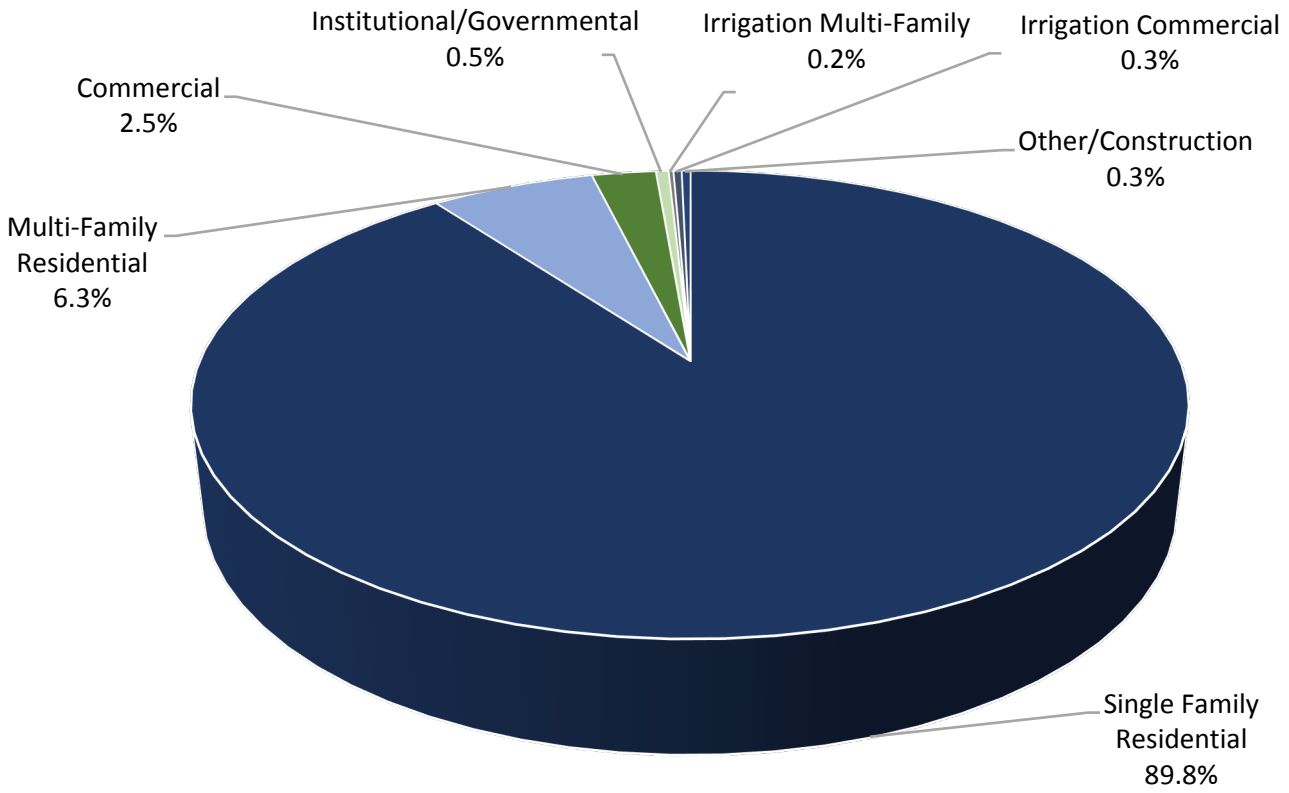
Table 2-2
Number of Current and Historical Potable Water Services by Customer Category

Water Use Sector	Number of Potable Water Service Connection (a)							
	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Single Family Residential	6,163	6,184	6,204	6,206	6,218	6,225	6,226	6,239
Multi-Family Residential	433	435	438	439	440	440	439	440
Commercial	162	166	167	170	173	170	166	172
Institutional/Governmental	32	32	34	34	34	34	33	34
Irrigation Multi-Family	12	13	13	12	12	11	12	13
Irrigation Commercial	18	20	20	20	20	20	20	22
Other/Construction	11	21	23	24	26	27	21	24
Total Number of Services	**6,831**	**6,871**	**6,899**	**6,905**	**6,923**	**6,927**	**6,917**	**6,944**

Notes:

(a) Number of service connections processed from water billing data provided by the District on 1 August 2018 based on the number of unique billing data accounts in each land use classification.

Figure 2-2
Current (FY 2017) Potable Water Services by Customer Category



The SFR category comprises approximately 90% of all customer service connections in the District. The number of SFR service connections has grown by 76 (1.2%) since FY 2010. The number of Commercial and Institutional and Irrigation connections has remained stable over the past eight years.

2.4 Service Area Demographics

The demographics of the District's customers include a wide range of income, household size, and water demands. Typically, the more affluent households are located along the foothills and are characterized by larger lots and homes with higher water demands for irrigation. On the other end of the spectrum, there are two disadvantaged communities located within the District which tend to have smaller lots and lower water use.

Due to the District's setting in the heart of a tourist destination, Sonoma Valley, another factor impacting water use in recent years has been the increase in the number of second homes and vacation rentals. These accounts tend to have higher water use because the sites do not have fulltime owners looking for leaks and managing irrigation water use in accordance with weather patterns.

2.5 Current and Projected Population

The current 2018 population was estimated using a persons-per-connection method consistent with methodology used in the District's 2015 Urban Water Management Plan (UWMP). A population estimate was obtained by compiling population estimates from the 2010 Census for each Census Block contained in the District's service area. This aggregate population estimate (23,636) was compared to the total number of service connections in 2010 (6,841) to determine the number of persons per connection (3.455). This persons-per-connection factor for 2010 (the most recent census year) was then multiplied by the number of service connections in FY 2017 (6,994) to estimate the service area population. Using this methodology, the District's existing service area population was estimated to be 24,164.

The 2015 UWMP relied on population and employment projections based on the 2005 Sonoma County General Plan. The 2005 Sonoma County General Plan is the most recent planning document available for unincorporated areas of Sonoma County, which the District serves, and to date has been tracking closely to actual population and number of new connections per year. The existing and projected service area population from the District's 2015 UWMP is summarized in Table 2-3.

Table 2-3. Population Projections

	2018 (Existing)	2020	2025	2030	2035	2040
Population Estimates (a)	24,164	24,873	25,229	25,586	25,943	26,300

Notes:

(a) The 2018 population is calculated based upon a persons-per-connection method. Projected populations are based on Sonoma County Draft General Plan 2005 estimates, as summarized in Section 2.4 and 4.1 and included in the Maddaus Demand Analysis (Maddaus, 2015).

These population estimates do not include the anticipated future development discussed below.

2.6 Anticipated Future Development

After adoption of the 2015 UWMP, the District identified additional planned developments within its service area that were not incorporated into the 2015 UWMP population or water demand projections. The District anticipates providing connections and service to the following major developments in the future:

- An 80-unit multi-family development on Verano Avenue across from Maxwell Farms Regional Park anticipated to be completed by 2025; and
- The Springs Specific Plan, bounded by Agua Caliente Road at the north and Verano Avenue at the south and bisected by the Highway 12 commercial corroder, which includes up to an additional 124 single-family dwellings units, 561 multi-family or live-work dwelling units, 167,000 square feet of commercial space, 120 hotel rooms, 82,000 square feet of office space, and 27,000 square feet of recreational area anticipated to be completed over the next 50 years.

Water demand projections associated with these developments are discussed further in Section 4.2.3.

Two additional developments are anticipated within the District's sphere of influence:

- Approximately 200 single-family dwelling units on vacant land at the intersection of Arnold Drive and Agua Caliente Road; and
- Between 200 and 500 dwelling units as part of redevelopment of the Sonoma Development Center.

However, the timelines for these future developments are uncertain, and thus they are not accounted for in this master planning effort.

3.0 EXISTING WATER SYSTEM FACILITIES

The District's water supply is provided by the Sonoma County Water Agency (SCWA) and groundwater wells owned and operated by the District. The District owns, operates, and maintains the potable water distribution system that serves drinking water to its residential, commercial, and institutional customers. This section summarizes the District's water supply facilities and distribution system, including water storage, pumping facilities, and pipe network. A map of the District's existing water system is shown on Figure 3-1 and a hydraulic profile schematic of the District's water system is shown on Figure 3-2.

3.1 Water Supply Facilities

The District, along with seven other cities and special districts in Sonoma and Marin County, has a water supply agreement with SCWA for the purchase of Russian River water. The majority (approximately 85% under normal water year conditions) of the District's water supply comes from SCWA Russian River water purchases. The District's remaining water is supplied by six (6) groundwater wells that are owned and operated by the District. The District's imported water and groundwater supply facilities are described in detail below.

3.1.1 SCWA Supply and Transmission System

The District's water supply contract with SCWA, known as *Restructured Agreement for Water Supply* (Restructured Agreement), was executed in 2006 and entitles the District to 8.5 million gallons per day (MGD) during any month and an annual maximum of 3,200 AFY. Provided the supply is available, the Restructured Agreement permits the District to take delivery of water more than its entitlement during a given month, provided specific conditions specified in the Restructured Agreement are met.

The SCWA's storage and transmission system is shown on Figure 3-3. As described below, the system includes lakes, streams, rivers, aqueducts, tanks and other facilities.

The SCWA storage and transmission system is supplied water from the natural flow of the Russian River. The Russian River water is stored in Lake Sonoma, behind Warm Springs Dam, and in Lake Mendocino, behind Coyote Dam. These dams are federal projects under the jurisdiction of the U.S. Army Corps of Engineers (USACE). The SCWA is the local sponsor and partners with the USACE for the water supply portion of the reservoir projects. The SCWA owns and operates the water supply pools at both Lake Sonoma and Lake Mendocino. The design water supply pool capacities of Lake Sonoma and Lake Mendocino are 245,000 AFY and 122,500 AFY, respectively.

Bolli Tanks 1 & 2
Mountain Well
Chestnut Tank, Hydropneumatic Tank, and BPS
Park Ave. Well
Agua Caliente Well and BPS
Donald Tank, Hydropneumatic Tank, and BPS
SCWA Sonoma Tanks
Donald Well
Verano & Fifth Turnout
Verano & Main Turnout
VeranoTurnout
Glen Ellen
Turnout and BPS
SCWA Eldridge Tanks 1 & 2
Trinity Turnout
Madrone Turnout
Agua Caliente
Turnout
Hannah Turnout
and BPS
Eldridge PRV
Arnold Dr.
Former Saddle Tank
(Out of Service)
Lower Sobre Vista BPS
Hannah Tank
Hannah Lower PRV
Larbre Well
Arnold Dr. BPS
Glen Ellen Tank
Lower Sobre Vista Tank and
Upper Sobre Vista BPS
Altimira Turnout
Boyes Turnout
Verano Well
Upper Sobre Vista Tank and
Sonoma Mountain Lower BPS
Sonoma Mountain Lower Tank
and Upper BPS
Sonoma Mountain Upper Tank
Temelec Tanks 1 & 2

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Abbreviations
BPS = booster pump station
PRV = pressure reducing valve
SCWA = Sonoma County Water Agency

Notes
1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources
1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N
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Feet

Existing Water System Facilities

Valley of the Moon Water District
Sonoma County, CA
April 2019
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Figure 3-1

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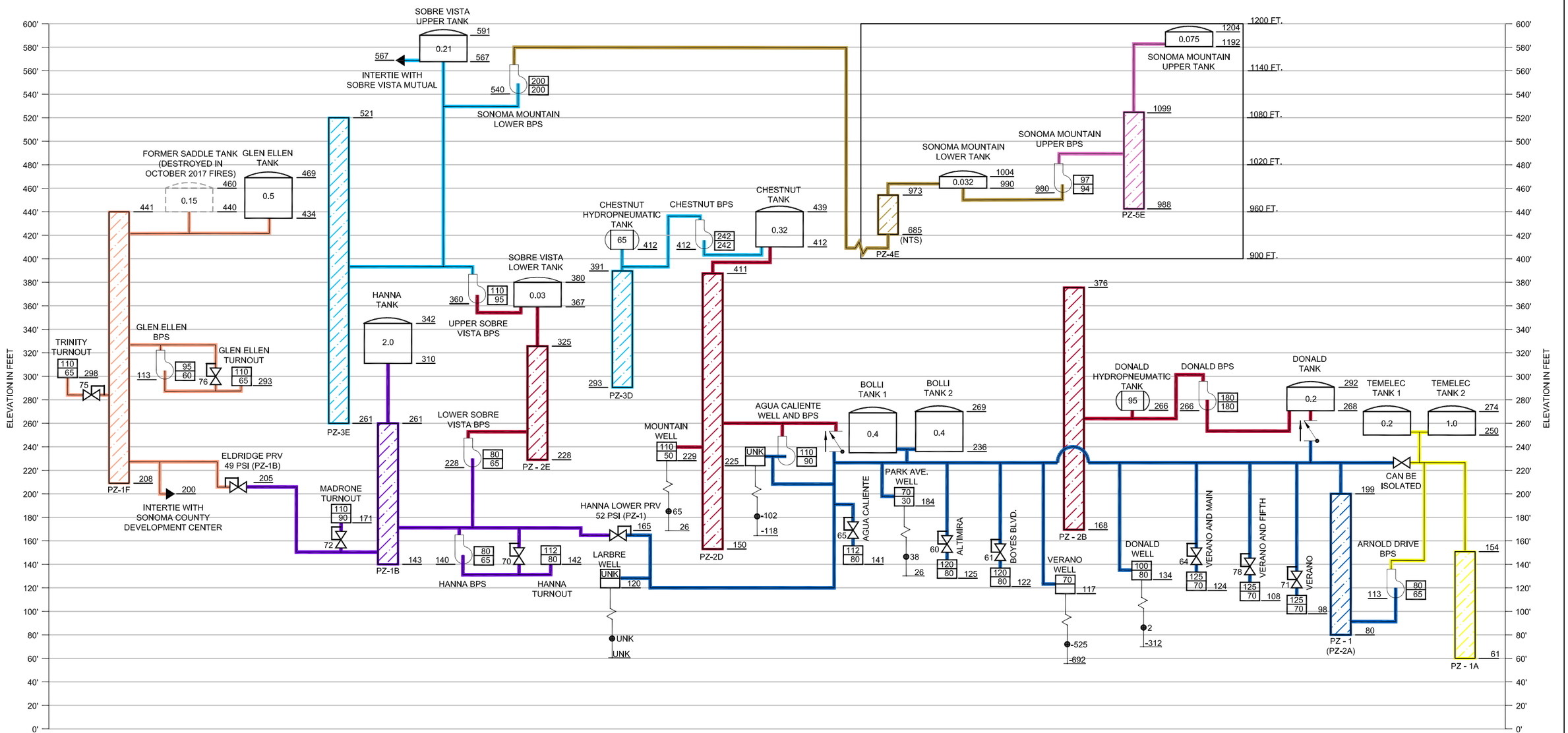

Legend:

- Tank with Volume (MG), Base and High Water Level Elevation
- SCWA Turnout with Max and Min Aqueduct Pressure (psi)
- Pressure Reducing/Sustaining Valve with Elevation and Pressure Settings (psi)
- Open Valve
- Check Valve
- Hydropneumatic Tank with Pressure Setting (psi) and Base Elevation
- Pump Station with Max and Min Discharge Pressure (psi) and Base Elevation
- Supply Well with Well Head, Pump, and Bottom Elevations and Max and Min Discharge Pressures (psi)
- Pressure Zone with Highest and Lowest Elevation Served

Abbreviations:

BPS	= Booster Pump Station
EL.	= Elevation
MG	= Million Gallons
PRV	= Pressure Reducing Valve
psi	= Pounds Per Square Inch
PZ	= Pressure Zone
SCWA	= Sonoma County Water Agency
UNK	= Unknown
V	= Volume

Notes:

1. All elevations are approximate.
2. Elevations are based on NAD88 vertical datum.
3. PRV/PSV settings have been updated based on hydraulic modeling recommendations and may vary +/- 5 psi.

Sources:

1. 2007 Water Master Plan, Brielje & Race.
2. Water System Map, January 2015.
3. Valley of the Moon Water System Schematic.

Existing Water System Hydraulic Profile

Valley of the Moon Water District

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April 2019
EKI B80082.00
Figure 3-2

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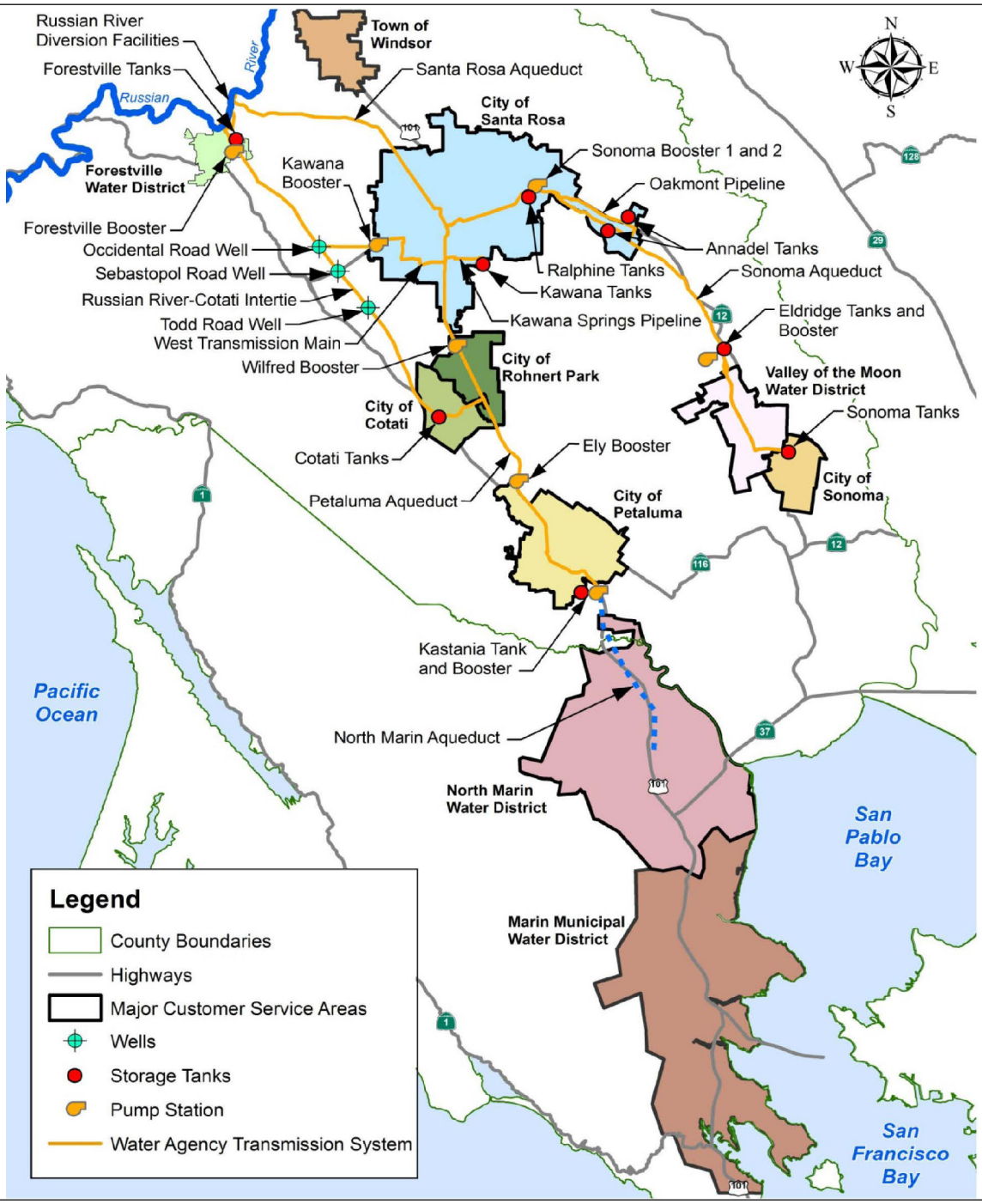

Notes

1. All locations are approximate.
2. Not to scale.

Sources

1. Sonoma County Water Agency 2010 Urban Water Management Plan

SCWA Service Area and Water Transmission System Facilities

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 3-3

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Path: X:\B80082.00\Maps\Water Master Plan\04\Fig3_3_VOTM_SCWA.mxd

The SCWA uses approximately 14 miles of the natural channel of Dry Creek and approximately eight miles of the Russian River to convey water from Lake Sonoma to its diversion facilities. Water is diverted and extracted from the stretch of river located just upstream of Wohler Bridge and downstream of Mirabel via six Ranney Collectors. The diverted river water percolates through sand and gravel and only needs the addition of chlorine to meet the California Drinking Water Program drinking water quality standards. A system of aqueducts, booster pumps, and tanks then distribute the water to the various Water Contractors and other transmission system users. The transmission system was designed to meet peak day demands of its customers.

The SCWA also owns and operates three groundwater supply wells located in the Santa Rosa Plain Subbasin of the Santa Rosa Valley Groundwater Basin. These groundwater wells are located along the Russian River-Cotati Intertie Pipeline and are used to supplement the SCWA water supply.

The District's SCWA supply is conveyed from the Sonoma Aqueduct, which is owned and operated by the SCWA and serves both the District and the City of Sonoma. Storage in this portion of the Sonoma Aqueduct is provided by the Annadel Tanks located upstream of the District near Oakmont, the Eldridge Tanks located between the northern and southern portions of the District south of Glen Ellen, and the Sonoma Tanks located downstream of the District and serve the City of Sonoma. Pressure for the aqueduct in this region is provided by Sonoma Booster Pump Station No. 1 and Sonoma Booster Pump Station No. 2, located on the east side of Spring Lake. The Eldridge Booster Pump Station located at the Eldridge Tank is typically off-line.

The District is supplied through 10 turnouts that are spread along the aqueduct from just north of Trinity Road and Highway 12 south to Verano Avenue and Fifth Street West near the City of Sonoma (see Figure 3-1). Two turnouts are located upstream of the SCWA Eldridge Tanks (Glen Ellen and Trinity Oaks turnouts), and the remaining eight turnouts are located downstream of the Eldridge Tanks. The SCWA meters water to the District at each turnout. Pressure available at each turnout depends on the hydraulic conditions along the aqueduct and the fill cycles of the SCWA Eldridge and Sonoma Tanks. Pressures are typically substantially lower at the turnouts when the tanks are filling. Detailed information regarding each turnout is listed in Table 3-1.

Downstream of each SCWA turnout, the District owns and operates pressure reducing valve (PRV) stations. These stations are described in Section 3.2.2.

Table 3-1
SCWA Turnout Information

SCWA Turnout	Pressure Zone Served	Meter Size (in)	Turnout Elevation (ft)	SCWA Aqueduct Pressure (psi) at Turnout (a)		Associated District PRV Station (b)
				Low	High	
Verano	1	6	98	70	125	PRV-1
Verano and Main	1	10	124	70	125	PRV-2
Verano and Fifth	1	6	108	70	125	PRV-3
Boyes Boulevard	1	6	122	80	120	PRV-4
Altimira	1	6	125	80	120	PRV-5
Agua Caliente	1	6	141	80	112	PRV-6
Hanna	1B	10	142	80	112	PRV-7
Madrone	1B	6	171	90	110	PRV-9
Glen Ellen	1F	6 & 4	293	65	110	PRV-11
Trinity Oaks	1F	6	298	65	110	PRV-12

Notes:

(a) Pressure in aqueduct at each turnout location vary based on the SCWA tank filling cycles. Pressure ranges are approximate.

(b) The District operates PRV stations directly downstream of each turnout location to reduce pressures as necessary from the aqueduct pressures. Refer to Table 3-5 for PRV station information.

3.1.2 Groundwater Supply

The District supplements its purchased SCWA water with the use of local groundwater. The District owns and/or operates a total of six active municipal production wells[2]. Portions of the District are located within the Sonoma Valley Subbasin, which is identified by the California Department of Water Resources (DWR) as 2-002.02 and is a subbasin of the Napa-Sonoma Valley Groundwater Basin (DWR 2-002). As shown in Figure 3-4, two of the District's existing wells (Verano and Larbre) are located within Sonoma Valley Subbasin; the other wells are outside of the DWR-defined groundwater basins.

3.1.2.1. *Groundwater Management*

The Sonoma Valley Subbasin is not adjudicated and has not been identified by DWR as a critically-overdrafted groundwater basin. The Basin is listed as a high priority and is subject to mandatory management under the Sustainable Groundwater Management Act of 2014 (SGMA) requirements. The Sonoma Valley Groundwater Sustainability Agency (GSA) was formed in June 2017 through a Joint Exercise of Powers Agreement (JPA) between the District and the City of Sonoma, North Bay Water District, Sonoma Resource Conservation District, SCWA, and County of Sonoma. The GSA is currently developing a Groundwater Sustainability Plan (GSP), which is required under SGMA to be submitted to the California Department of Water Resources (DWR) in January 2022.

3.1.2.2. *Groundwater Wells and Treatment*

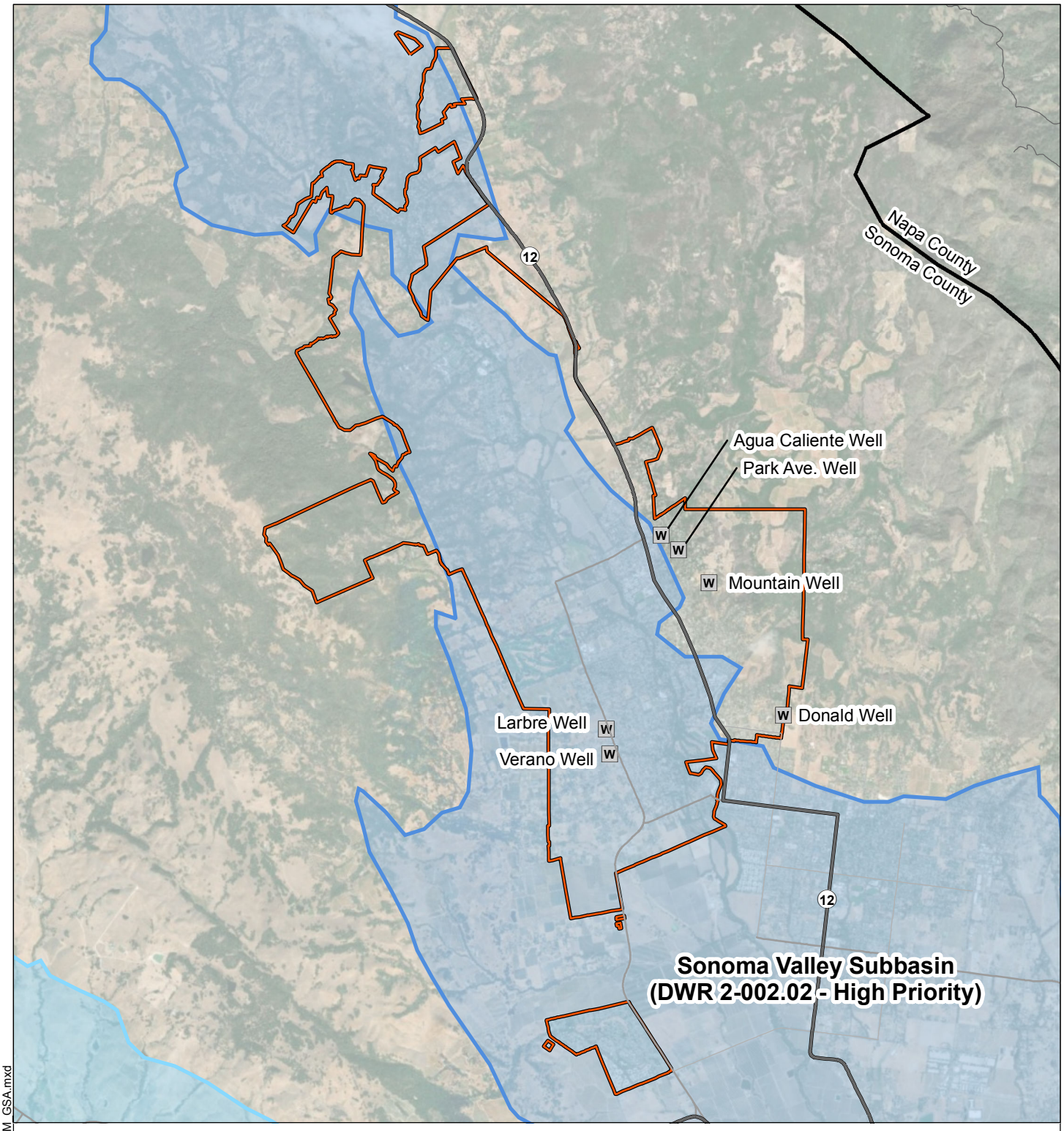
The District's active groundwater wells are summarized in Table 3-2. The capacities of the District's wells range from 90 gallons per minute (gpm) to 300 gpm. The District cycles through its wells; each well typically pumps for nine months and then remains offline for a three-month recovery period.

The District recently replaced one of its municipal supply wells, known as "Well 5" or the "Verano Well" with new Well 5A, installed in the deep aquifer. An existing green sand filtration treatment system to remove iron and manganese was rehabilitated and connected to the new Well 5A as part of the Project. Well 5A began operations in Fall 2018. The other active wells are all installed in the shallow aquifer and do not require treatment other than chlorination.

The SCWA Restructured Agreement established a goal for each of water contractors including the District to supply and maintain approximately 40% of its maximum month demand through local sources to mitigate against drought, emergencies, and temporary Transmission System outages. The District's existing total groundwater capacity is approximately 840 gpm or approximately 30% of the existing maximum month demand and 28% of the projected future maximum month demand of 4,290 gpm (see Section 4.3). The District will need to increase its local supply by approximately 350 gpm to meet the 40% maximum month demand supply goal.

The District is exploring options to add additional wells including the Pedroncelli Well and a replacement for the Larbre Well, both near the existing Larbre Well site. The District will likely need to further expand its groundwater supply (or secure a local surface water source) to meet the 40% maximum month demand supply goal.

[2] The District also owns a seventh well, Trinity Oaks Well, which is inactive. The District does not intend to reactivate this well.



Legend

- Sonoma Valley Subbasin
- Other Groundwater Basins
- Sphere of Influence
- County
- Highway
- Road
- W Production Well

N

0 8,000 16,000

(Scale in Feet)

Sources

1. Aerial photograph provided by ESRI's Arc GIS Online, 26 April 2019.

Notes

1. All locations are approximate.
2. Service area and sphere of influence provided by VOMWD on 25 March 2016.

Summary of Local and Regional Groundwater Management

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 3-4

eki environment & water

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Table 3-2
Groundwater Well Information

Well Name	Pressure Zone Served	Ground Surface Elevation (ft)	Pump Elevation	Bottom of Casing Elevation (ft)	Design Flow Rate (gpm)	Motor Horsepower	Design Head (feet)	Backup Power	Treatment
Donald	1	134	2	-312	110	15	288	No	Chlorination - Chlorine Tablets
Mountain Ave.	2D	229	65	26	110	15	290	Yes	
Park Ave.	1	184	38	26	90	7.5	370	No	
Agua Caliente	1	225	-102	-118	120	25	370	Yes	
Verano	1	117	-525	-692	300	50	400	No	Iron/Manganese/Arsenic Treatment - Green Sand Filtration Chlorination - Sodium Hypochlorite
Larbre	1	120	--	--	110	15	200	No	Grit Removal Chlorination - Chlorine Tablets

Abbreviations:
gpm - gallons per minute
ft - feet

3.1.3 Emergency Interties

The District has emergency interties with the Sonoma Development Center (SDC) and Sobre Vista Mutual Water Company (SVMWC). In the event of an emergency, either the District can supply SVMWC or SDC with potable water under the terms of their agreements. The District can also receive water from SDC should the SCWA Aqueduct be impaired.

The District's operations staff are currently training with SDC operating staff to learn how to operate the SDC's surface water treatment facility. The District could add this water source to its supply portfolio in the future, which would help contribute to the 40% local supply goal discussed in Section 3.1.2. A booster pump station would be required to deliver water from the SDC to the District's distribution system on a permanent basis.

3.2 Water Distribution System Pressure Zones and Facilities

The District's existing water distribution system facilities including its pipe network, PRV stations, water storage facilities, booster pump stations, and other features. The District' distribution system consists of several pressure zones These pressure zones and the District's distribution system facilities are discussed in the following sections.

3.2.1 Pressure Zones

The District's water distribution system has eleven pressure zones as shown on Figure 3-1. The District's service area also includes several customers that are supplied water directly from the SCWA aqueduct. The majority of the District's customers that are located on the valley floor are served from the SCWA aqueduct pressure (Pressure Zones 1, 1A, 1B, 1F) while customers in the higher elevations of the Sonoma Valley are served by separate pressure zones. Pressures Zones 1 and 1A typically operate as a single pressure zone, but the District can isolate Pressure Zone 1A by pumping from Zone 1 via Arnold Drive Pump Station if there is insufficient aqueduct pressure. Under certain conditions, booster pump stations are needed to supply flow to Pressure Zones 1B and 1F, as discussed in Section 3.2.4. Minimum and maximum service point elevations are shown on Figure 3-2 and summarized in Table 3-3.

The number of services in each zone is listed in Table 3-3 and Table 3-4. Approximately 68% of service connections are in Pressure Zone 1 and 94% of connections in total are in the lower aqueduct zones (Pressure Zones 1, 1A, 1B, and 1F). All of the District's commercial, institutional, and landscape accounts are located in the lower aqueduct zones (Pressure Zones 1, 1A, 1B, and 1F).

3.2.2 Pressure Reducing Valve Stations

The District maintains 12 PRV Stations in its system. Ten of the PRV stations are installed directly downstream of each SCWA turnout to control the pressures delivered from the aqueduct to the District's distribution system. In addition, the district operates the Eldridge PRV to separate Pressure Zones 1F and 1B and the Hanna Lower PRV to separate Pressure Zone 1B and Pressure Zone 1. These valves typically remain close but are set to open in case of an emergency to deliver flow from Pressure Zones 1F to 1B through the Eldridge PRV and from Pressure Zone 1B and 1 through the Hanna PRV. Information on the District's PRV Information is provided in Table 3-5.

3.2.3 Water Storage Facilities

As shown in Table 3-6, the District has approximately 5.3 million gallons (MG) of total storage in 12 ground-level storage tanks. The District's tanks are used to help meet system demands during peak hours, provide emergency storage, and provide fire flow storage.

During the October 2017 Sonoma County wildfires, the District's Saddle Tank was destroyed. Saddle Tank was a 0.15-MG redwood tank serving Glen Ellen (Pressure Zone 1F). The District is developing construction documents to replace the tank with a tank of similar size at the existing Saddle Tank site.

Table 3-3
Pressure Zone Information

Pressure Zone	Service Point Elevation (ft) (a)		Number of Service Connections (FY2017)
	Min	Max	
1	80	199	4,733
1A (b)	61	154	807
1B	142	243	421
1F	208	441	543
2A (b)	134	212	2
2B	168	376	27
2D	150	411	332
2E	228	325	2
3D	293	391	26
3E	261	521	34
4E	685	973	0
5E	988	1,099	3

Notes:

(a) Elevations are approximate and based on NAD88. Service points include service connections or hydrants.

(b) Pressure Zones 1A and 2A typically operate as part of Pressure Zone 1 but can be isolated, if necessary.

Table 3-4
Current and Historical Potable Water Services by Pressure Zone and Customer Classification

Sector	Number of Potable Water Service Connections by Pressure Zone											
	1	1A	1B	1F	2A	2B	2D	2E	3D	3E	5E	SCWA (a)
Single Family Residential	4,171	793	393	472	2	27	320	2	25	27	3	4
Multi-Family Residential	367	2	16	35	--	--	12	--		7	--	--
Commercial	125	8	5	25	--	--	--	--	--	--	--	--
Institutional	26	--	3	4	--	--	--	--	--	--	--	1
Irr. Multi-Family Residential	9	4	1	3	--	--	--	--	--	--	--	--
Irr. Commercial	16	--	1	1	--	--	--	--	--	--	--	--
Other/Construction	19	--	2	3	--	--	--	--	--	--	--	--
Total Number of Services	**4,733**	**807**	**421**	**543**	**2**	**27**	**332**	**2**	**25**	**34**	**3**	**5**

Notes:
(a) SCWA serves these customers directly off of the aqueduct.

Table 3-5
PRV Station Information

PRV ID	Description	Type	Pressure Zone Served	Size (in) (a)	PRV Setting (b) (psi)	Elevation (ft)
PRV-1	Verano Turnout PRV	SCWA Turnout Pressure Reducing	1	8	65	98
PRV-2	Verano and Main Turnout PRV		1	10	72	124
PRV-3	Verano and Fifth Turnout PRV		1	6	90	108
PRV-4	Boyes Boulevard Turnout PRV		1	6	60	121
PRV-5	Altimira Turnout PRV		1	8	60	125
PRV-6	Agua Caliente Turnout PRV		1	6	57	141
PRV-7	Hanna Turnout PRV		1B	10	70	142
PRV-9	Madrone Turnout PRV		1B	10	72	171
PRV-11	Glen Ellen Turnout PRV		1F	6 & 4	74	293
PRV-12	Trinity Oaks Turnout PRV		1F	6	75	298
PRV-10	Eldridge PRV	Reducing	1F to 1B	6	50 PSI (PZ1B)	213
PRV-13	Hanna Lower PRV	Reducing	1B to 1	12	60 PSI (PZ1)	165

Notes:

(a) Verified by Valley of the Moon Water District operations staff on 9 November 2018.

(b) PRV settings shown are the original settings provided by the District on 20 September 2018. EKI has proposed new settings as discussed in Section 6.

Abbreviations:

gpm - gallons per minute
in - inch
PRV - pressure reducing valve
SCWA - Sonoma County Water Agency

Table 3-6
Water Storage Facility Information

Tank Number	Tank Name	Pressure Zones Served (a)	Date Constructed	Material	Capacity (MG)	Height (ft)	Diameter (ft)	Tank Floor Elevation (ft)
T-1	Temelec 1	1A & 1	1985	Welded Steel	1.0	24.0	84	250
T-2	Temelec 2	1A & 1	1966	Welded Steel	0.2	24.0	38	250
T-3	Donald	2B & 1*	1963	Welded Steel	0.2	24.1	40	268
T-4	Glen Ellen	1F, 1B*, & 1*	2006	Welded Steel	0.5	35.0	52	434
T-6	Bolli 1	1	2001	Welded Steel	0.4	33.0	46	236
T-7	Bolli 2	1	2001	Welded Steel	0.4	33.0	46	236
T-8	Chestnut	2D, 3D, and 1*	1992	Welded Steel	0.32	27.0	48	412
T-9	Hanna	1B & 1*	1977	Welded Steel	2.0	32.0	104	310
T-10	Sobre Vista - Lower	2E	Pre-1909	Concrete - HDPE Lined	0.03	13.0	20	367
T-11	Sobre Vista - Upper	3E	2002	Bolted Steel	0.2075	24.0	38	567
T-14	Sonoma Mountain - Lower	4E	2006	Bolted Steel	0.032	16.0	18.5	990
T-15	Sonoma Mountain - Upper	5E	2002	Bolted Steel	0.022	8.0	21.6	1192

Notes:
(a) An asterisk (*) indicates the lower pressure zones can be served indirectly through from this tank through pressure reducing valves.

3.2.4 Booster Pump Stations and Hydropneumatic Tanks

As shown in Table 3-7, the District has 10 booster pump stations (BPSs) to serve upper pressure zones and fill upper storage tanks. The Hanna and Glen Ellen BPSs operate to boost pressure from the SCWA aqueduct during certain operating conditions to supply Pressure Zones 1B and 1F, respectively. Six BPS have backup power. Hanna Pump Station is the only BPS with variable frequency drive pumps; all other pumps are constant speed.

Hydropneumatic tanks are installed at the Donald and Chestnut BPS to supply Pressure Zones 2B and 3D, respectively, during lower demand periods to limit cycling the BPSs on and off. Characteristics of these hydropneumatic tanks are described in Table 3-7.

3.2.5 Water Mains and Other Distribution System Features

The District's water distribution network consists of approximately 92 miles of pipe ranging from 3/4 inches to 14 inches in diameter. Pipe materials are primarily asbestos cement pipe (ACP) and polyvinyl chloride (PVC) pipe, but there are also sections of cast-iron pipe (CIP), ductile iron pipe (DIP), steel pipe, and high-density polyethylene (HDPE) pipe. Table 3-8 summarizes the District's distribution pipelines by diameter and material. The District's standard material for new pipe installations is PVC pipe. Distribution system pipe sizes are shown on Figure 3-5 and materials are shown on Figure 3-6.

The Districts distribution system also contains valves, blow offs, air release valves, hydrants, service connections, meters, and other appurtenances necessary to reliably operate the system.

3.2.6 SCADA System

The District has a supervisory control and data acquisition (SCADA) system monitoring all wells, pump stations, storage tanks, hydropneumatic tanks. The system allows the District to remotely control operational setpoints and monitors for discharge flows, suction and discharge pressures, tank levels, pump runtimes, and chlorine residual. Alarms are set for minimum and maximum levels and pressures. The District also monitors levels in and flows from the SCWA Eldridge Tank and flows in the Aqueduct upstream and downstream of the District. Between 2016 and 2017, the District upgraded the SCADA System and added tank hatch alarms and video cameras.

Table 3-7
Booster Pump Station Information

Booster Pump Station	Pump No.	Pressure Zone (Tank) Served	Head (ft)(a)	Design Flow (gpm)(a)	Horsepower (hp)(a)	Firm Capacity (gpm)	Elevation (ft)	Backup Power	Hydropneumatic Tank Volume (gallons)	Hydropneumatic Pressure Setting (psi)
Arnold Dr.	PS-1	1 to 1A	160	500, 500	20, 20	500	114	No	--	--
Donald (c)	PS-2	1 to 2B	210	100, 100, 350	2, 7.5, 25	450	268	Yes	2,000	95
Chestnut	PS-4	2D to 3D	155	100, 100	5, 5	100	413	Yes	3,000	65
Agua Caliente	PS-5	1 to 2D	205	350, 350	25, 25	350	225	Yes	--	--
Sobre Vista Lower	PS-6	1 to 2E	160	130, 130	7.5 , 7.5	130	229	Yes (b)	--	--
Sobre Vista Upper	PS-7	2E to 3E	105	100, 100	10, 10	100	351	Yes	--	--
Glen Ellen	PS-9	SCWA to 1F	175	450, 450	25, 25	450	290	Yes (b)	--	--
Hanna	PS-10	SCWA to 1B	160	800, 800	20, 20	800	143	No	--	--
Sonoma Mntn. Lower	PS-11	3E to 4E	475	26, 26	5, 5	26	535	No	--	--
Sonoma Mntn. Upper	PS-12	4E to 5E	220	17, 17	5, 5	17	980	No	--	--

Notes:

(a) Source: Water Master Plan, April 2007. Updated based on validation of pump curves using SCADA data.

(b) At these locations generators have been installed as of November 2018, but are not yet active pending recieiving Bay Area Air Quality Management District permit.

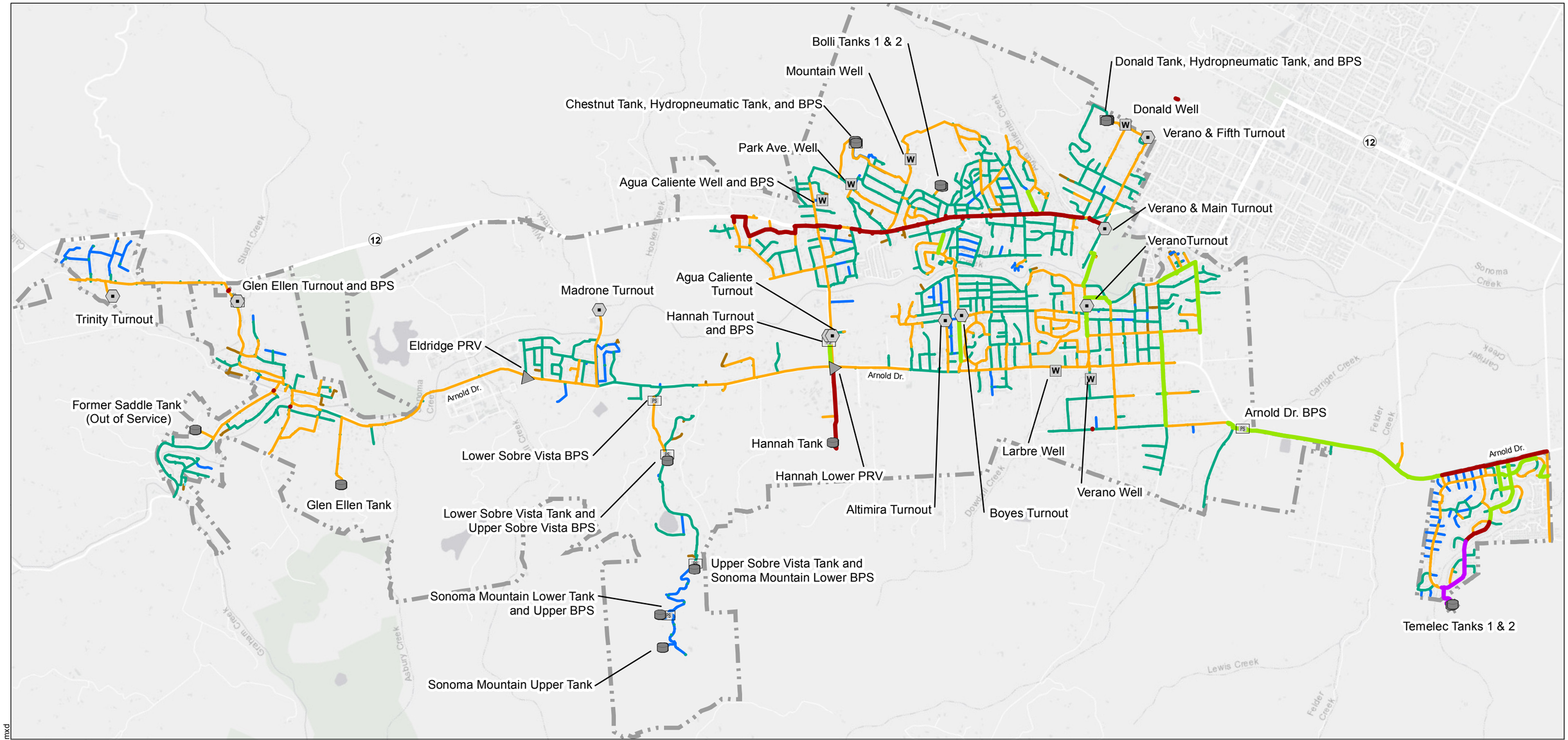
(c) Updated flow and firm capacity of Donald pump station fire pump based on fire flow testing data collected on 18 December 2018.

Table 3-8
Pipeline Lengths by Diameter and Material

Pipeline Diameter (inches)	Length (ft)						Length (miles)	Percent of Water System
	ACP	CIP	DIP	HDPE	PVC	Steel		
≤2	89	--	--	759	1,691	6,738	1.76	1.9%
3	--	--	--	--	--	249	0.05	0.1%
4	30,069	81	615	6,610	3,880	2,520	8.29	9.0%
6	160,838	--	10,549	3,586	53,899	274	43.40	47.1%
8	91,005	--	4,291	--	58,357	1,107	29.31	31.8%
10	19,621	--	742	--	6,019	--	5.00	5.4%
12	7,497	--	1,457	73	11,305	--	3.85	4.2%
14	2,684	--	--	--	--	--	0.51	0.6%
Total	311,804	81	17,654	11,028	135,151	10,889	92.16	100%

Notes:

(a) Pipeline lengths, diameters, and material includes all active potable water transmission and distribution pipelines present in the AutoCAD files of the Water System Map provided by the District and updated by EKI based on as-built records.



Legend

Sphere of Influence

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well

Existing Pipe Diameter, Inches

- ≤ 2
- 3
- 4
- 6
- 8
- 10
- 12
- 14

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Existing Water Main Diameters

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 3-5

eki environment & water

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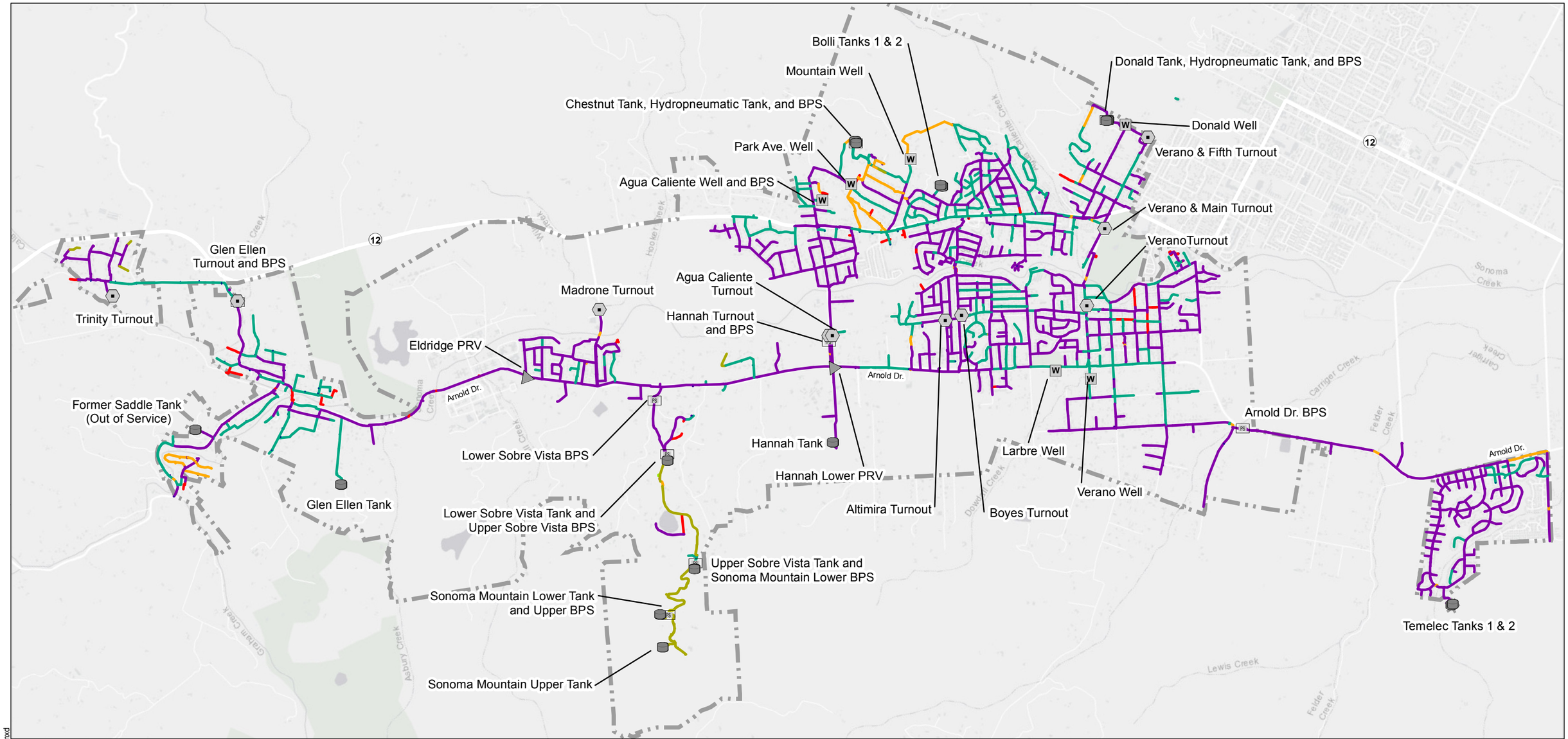

Legend

- Sphere of Influence

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Existing Pipe Materials

- Ductile Iron
- Cast Iron
- PVC
- Asbestos-Cement Pipe
- Steel
- HDPE

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Existing Water Main Materials

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 3-6

eki environment & water

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4.0 EXISTING AND FUTURE WATER DEMANDS AND FIRE FLOW REQUIREMENTS

The following sections summarize the District's historical and current water demands, water demand projections, water peaking factors, and fire flow requirements.

4.1 Current and Historical Water Production and Consumption

Table 4-1, Figure 4-1, and Figure 4-2 provide historical context by summarizing the District's potable water use, service area population, and per capita potable water demand for the fiscal years[3] (FY) 1998 through 2017. Historical water use is based on total annual SCWA water purchases and local groundwater production. Total potable water use in FY 2017 was 2,415 acre-feet (AF). Table 4-2 and Figure 4-3 provide potable water production by supply source between FY 2010 and FY 2017. SCWA purchases represent an average of 80% of District's total water production over the last eight years.

Potable water use has generally decreased over the past 20 years, although significant variations have occurred from year to year and are believed to be associated with changing hydrologic and economic conditions. The District experienced a decrease in both total and per capita demand in FY 2009 and FY 2010. This decreased demand likely reflects the impacts of the economic recession. The subsequent increase in water use from FY 2011 to FY 2013 is thought to reflect improved economic conditions. Between FY 2014 and FY 2016, total and per capita water use declined as the recent drought intensified. The District experienced particularly significant decreases in demand in FY 2015 and 2016, with total potable water demand decreasing by approximately 29% from 2013 demands. This decrease in demand is likely attributable to the severe drought conditions that persisted into 2016 and that resulted in mandatory state-wide restrictions in urban water use imposed by the State Water Resources Control Board (SWRCB). Total and per capita water use increased slightly in FY 2017, signaling the beginning of the drought rebound.

Although population has increased over the past 20 years, per capita water use since 1998 has generally decreased as shown in Figure 4-2. Specifically, per capita water use dropped to 80 gallons per capita per day (GPCD) in FY 2016 during the peak of the drought. Per capita demands have been below the District-adopted 2020 Senate Bill x7-7 (SBx7-7) Target of 124 GPCD since FY 2009.

The District-wide current and historical potable water use over FY 2010 through 2017 is presented in Table 4-3, Figure 4-4, and Figure 4-5 by individual customer sectors. Table 4-4, Figure 4-6, and Figure 4-7 presents current and historical water use by individual pressure zones. Table 4-5 presents demands by pressure zone and customer categories. Water demand within the District's service area is measured using water meters that are installed at each customer account. Records of current and historical water use at each account are maintained by the District and are based on billing data.

[3] The District's fiscal years span from 1 July of the prior calendar year to 30 June of the fiscal year. As such, "FY 2015" represents 1 July 2014 to 30 June 2015, and so forth.

Table 4-1
Current and Historical Potable Water Use and Population

Fiscal Year	Potable Water Use (AF) (a)	Service Area Population (b)	Per Capita Potable Water Use (GPCD) (c)
1998	3,146	21,179	133
1999	3,518	21,432	147
2000	3,545	21,658	146
2001	3,526	21,853	144
2002	3,445	22,006	140
2003	3,394	22,237	136
2004	3,576	22,422	142
2005	3,298	22,913	129
2006	3,424	23,127	132
2007	3,484	23,239	134
2008	3,339	23,549	127
2009	3,039	23,515	115
2010	2,584	23,636	98
2011	2,733	23,717	103
2012	2,886	23,793	108
2013	3,042	23,801	114
2014	3,029	23,847	113
2015	2,528	23,874	95
2016	2,151	23,878	80
2017	2,415	23,927	90
2018	2,719	23,954	101

Notes:

(a) Detailed historical and current water demand data from 2010 through 2017 are documented in Table 4-3 and Table 4-5.

(b) Historical population from 1998 to 2007 is based on population estimates included in the 2015 UWMP. Population data from 2007 to 2018 are estimated following the 2015 UWMP

(c) Per capita potable water use is calculated by dividing the total annual potable water demand by service area population and the number of days in a year.

Figure 4-1
Current and Historical Potable Water Use and Population

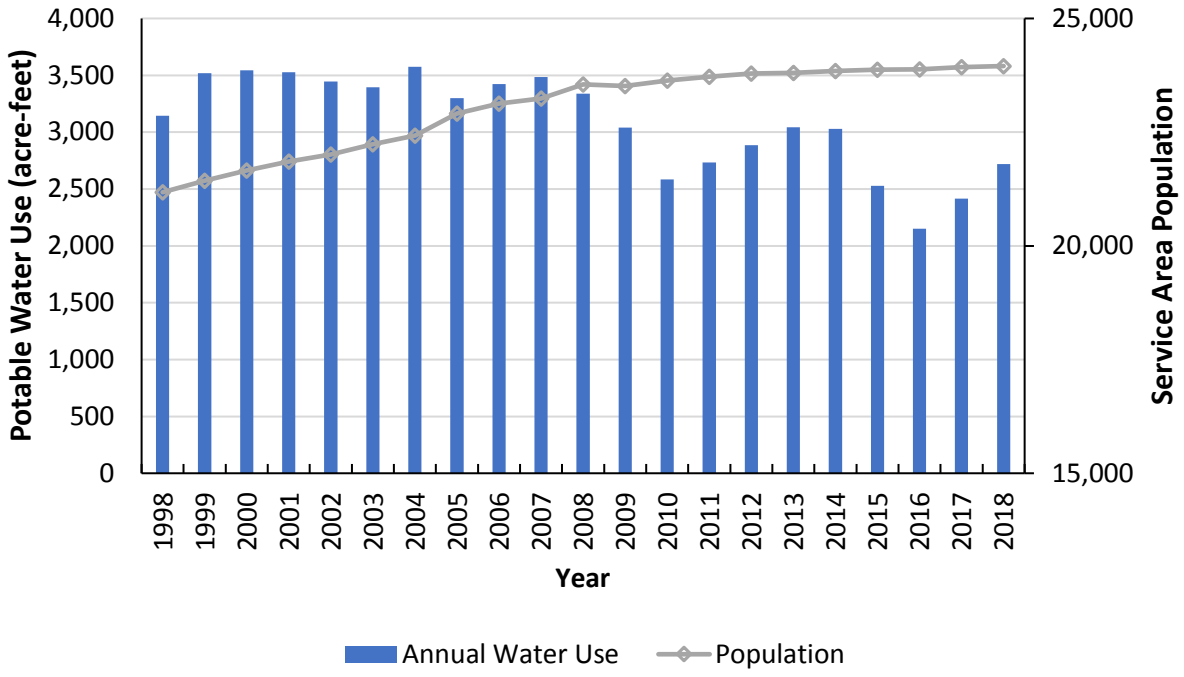


Figure 4-2
Current and Historical Per Capita Potable Water Use

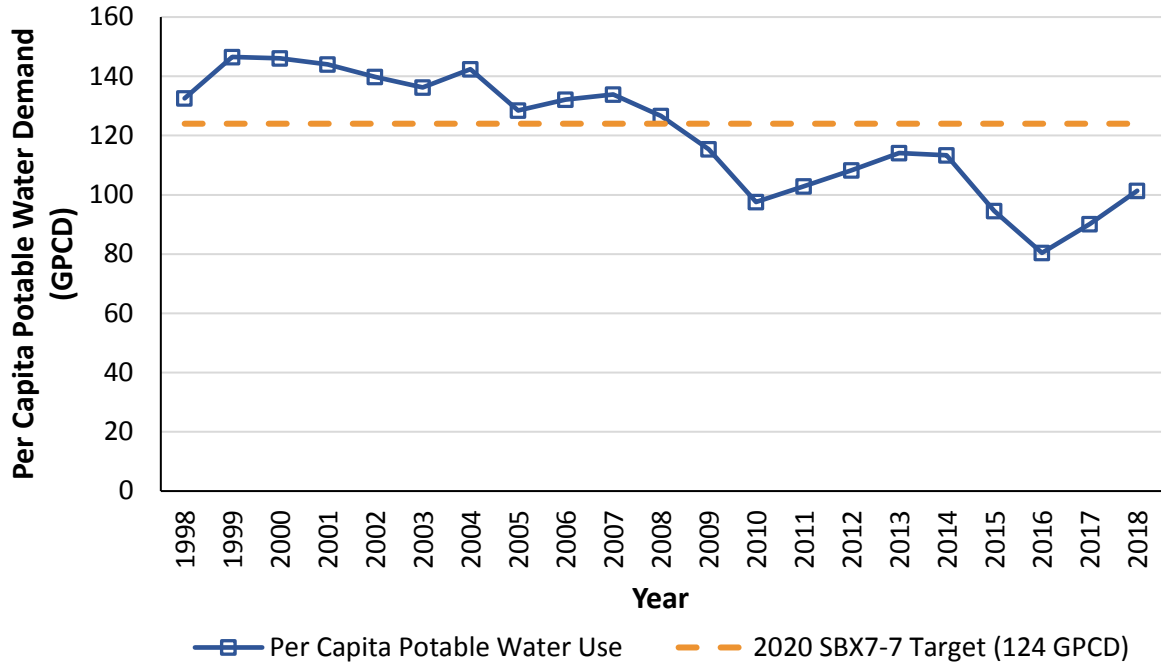


Table 4-2
Current and Historical Potable Water Production by Source

Potable Water Source	Annual Production (AF) (a)							
	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
Imported Water								
SCWA	2,183	2,437	2,589	2,534	1,947	1,691	1,819	2,075
Local Supply								
Donald	75	71	82	81	119	137	140	164
Mountain Ave.	57	71	65	75	84	28	82	63
Park Ave.	101	53	58	66	94	50	129	102
Agua Caliente	99	87	92	123	135	121	111	166
Verano	38	0	0	0	0	0	0	0
Larbre	180	167	156	150	149	123	134	149
Production Wells Total	*550*	*449*	*453*	*495*	*581*	*459*	*596*	*644*
Total Water Production	**2,733**	**2,886**	**3,042**	**3,029**	**2,528**	**2,151**	**2,415**	**2,719**
Percent Imported	*80%*	*84%*	*85%*	*84%*	*77%*	*79%*	*75%*	*76%*
Percent Local Supply	*20%*	*16%*	*15%*	*16%*	*23%*	*21%*	*25%*	*24%*

Notes:
(a) Production data provided by the District in October 2018.

Figure 4-3
Current and Historical Potable Water Production by Source

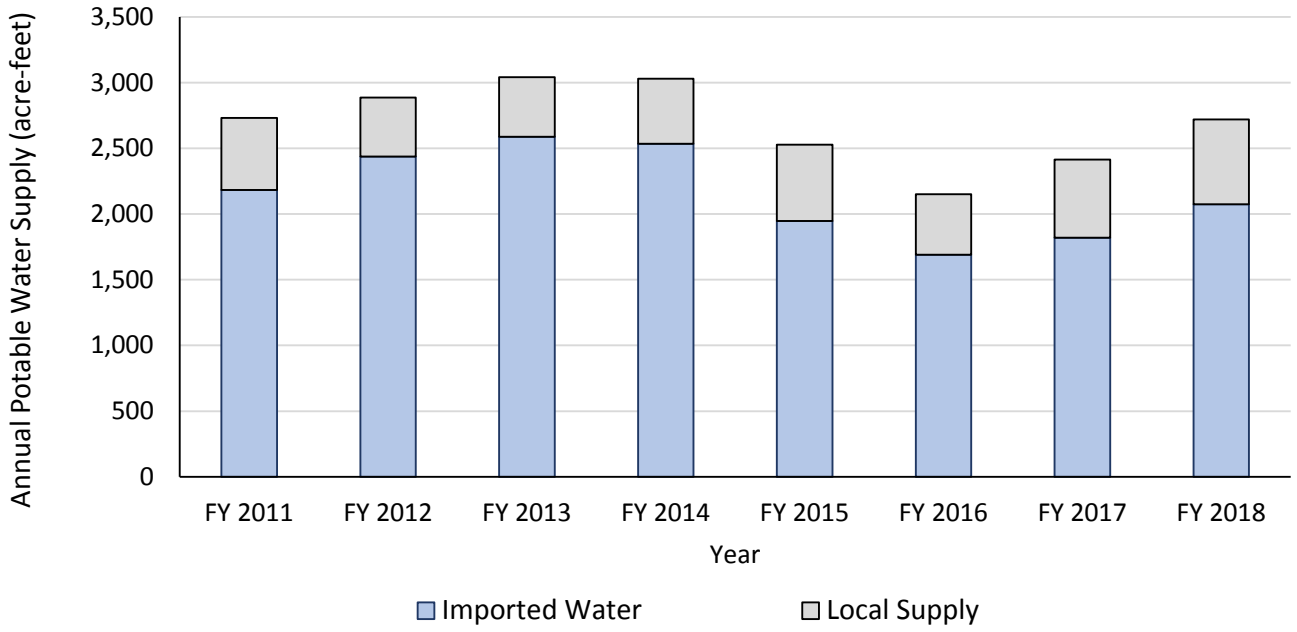


Table 4-3
Current and Historical Potable Water Use by Customer Category

Water Use Sector	Potable Water Demand (AF) (a)							
	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Single Family Residential	1,669	1,641	1,691	1,853	1,829	1,546	1,350	1,401
Multi-Family Residential	476	469	505	531	516	457	411	438
Commercial	178	179	180	185	182	176	167	169
Institutional/Governmental	76	80	107	102	100	80	74	73
Irrigation Multi-Family	24	29	30	34	44	32	17	24
Irrigation Commercial	16	14	13	13	14	10	7	8
Other/Construction	1	0	0	1	0	0	0	0
Total Water Consumption	**2,440**	**2,413**	**2,526**	**2,718**	**2,685**	**2,301**	**2,026**	**2,115**
Non-revenue Water (b)	6%	12%	12%	11%	11%	9%	6%	12%
	144	320	360	324	343	226	125	300
Total Water Demand (c)	**2,584**	**2,733**	**2,886**	**3,042**	**3,029**	**2,528**	**2,151**	**2,415**

Notes:

(a) Water use data was processed from water billing data provided by the District on 1 August 2018.
(b) Non-revenue water includes water used for fire hydrant flushing and testing, for water main flushing, as well as distribution system water losses. This value is calculated as the difference between metered water consumption and total water production.
(c) Total water demand is the sum of metered water consumption and non-revenue water.
(d) Totals may not add exactly due to rounding.

Figure 4-4
Annual Water Use by Customer Category: FY 2010 - FY 2017

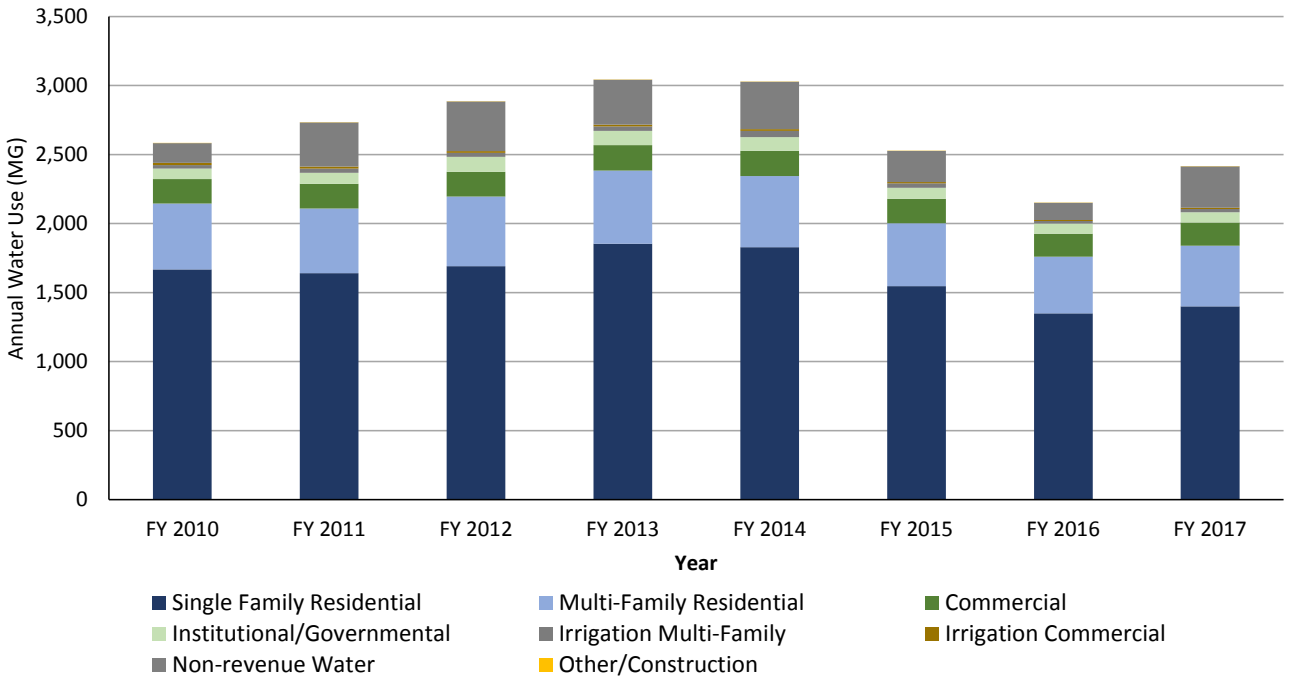


Figure 4-5
Percentage of Total Water Use by Customer Category: FY 2010 - FY 2017

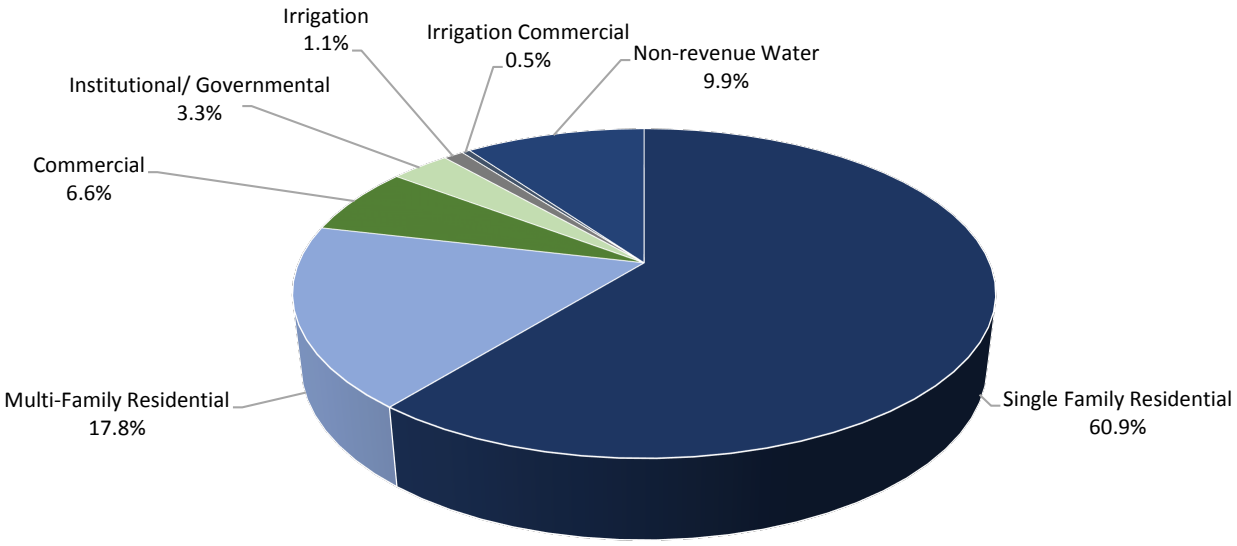


Table 4-4
Current and Historical Potable Water Use by Pressure Zone

Pressure Zone	Potable Water Demand (AF) (a)							
	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
1	1,678	1,656	1,710	1,856	1,822	1,580	1,391	1,453
1A	184	189	203	214	213	176	164	172
1B	208	200	213	229	230	190	165	171
1F	209	210	219	242	239	202	183	194
2A	1.7	2.1	2.5	2.2	2.1	1.8	1.4	1.2
2B	17	17	17	18	17	16	13	14
2D	93	89	91	97	104	85	70	71
2E	1.2	0.9	1.4	0.6	0.5	0.6	0.4	0.4
3D	10	10	11	12	13	12	9.0	8.7
3E	33	31	37	38	37	33	28	24
5E	0.9	1.7	0.3	0.4	0.3	0.3	0.3	0.5
SCWA (b)	3.1	2.8	4.8	3.9	5.3	4.7	10.8	3.9
Other / Construction	1.8	4.1	16.8	5.5	2.7	0.4	0.3	2.1
Total Water Consumption	**2,440**	**2,413**	**2,526**	**2,718**	**2,685**	**2,301**	**2,036**	**2,115**
Non-revenue Water (c)	6%	12%	12%	11%	11%	9%	5%	12%
	144	320	360	324	343	226	115	300
Total Water Demand (d)	**2,584**	**2,733**	**2,886**	**3,042**	**3,029**	**2,528**	**2,151**	**2,415**

Notes:

(a) Water use data was processed from water billing data provided by the District on 1 August 2018.
(b) SCWA serves these customers directly off of the aqueduct.
(c) Non-revenue water includes water used for fire hydrant flushing and testing, for water main flushing, as well as distribution system water losses. This value is calculated as the difference between metered water consumption and total water production.
(d) Total water demand is the sum of metered water consumption and non-revenue water.
(e) Totals may not add exactly due to rounding.

Figure 4-6
Annual Water Use by Pressure Zone: FY 2010 - FY 2017

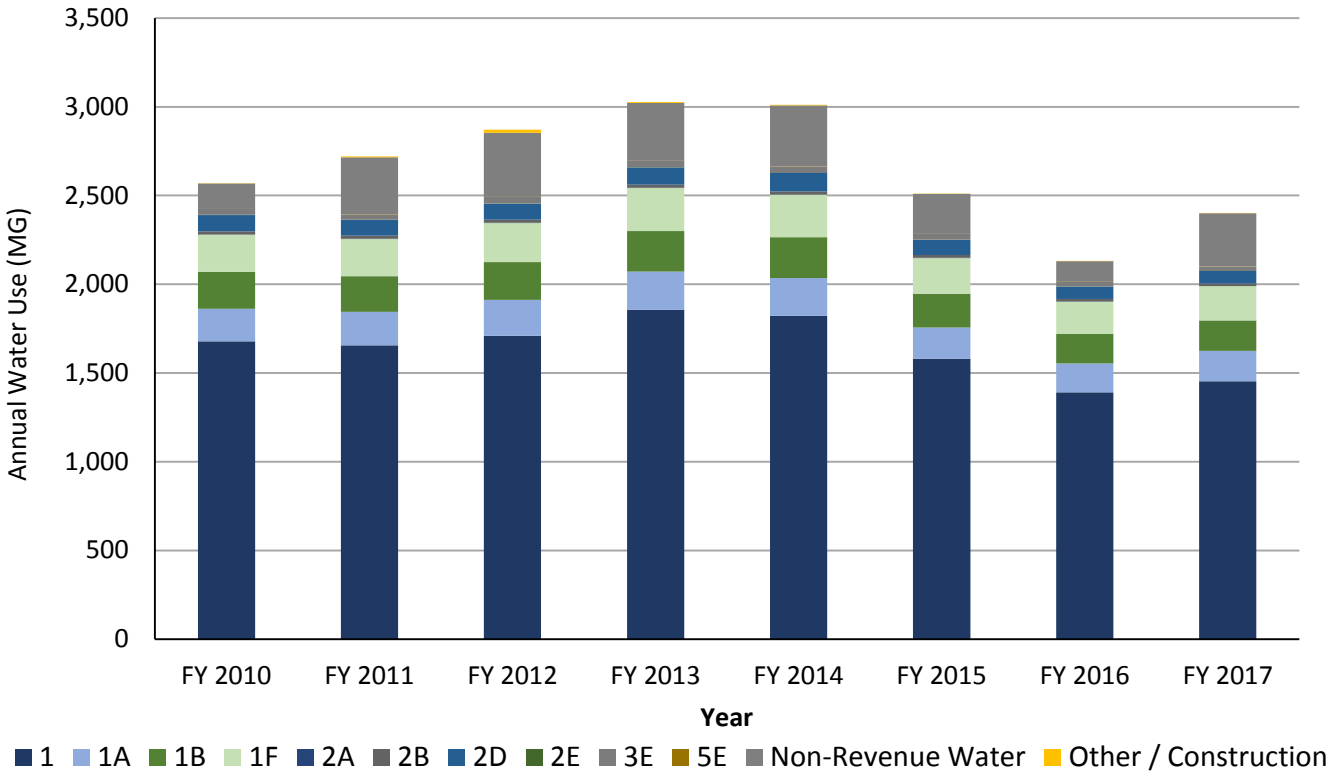


Figure 4-7
Percentage of Total Water Use by Pressure Zone: FY 2010 - FY 2017

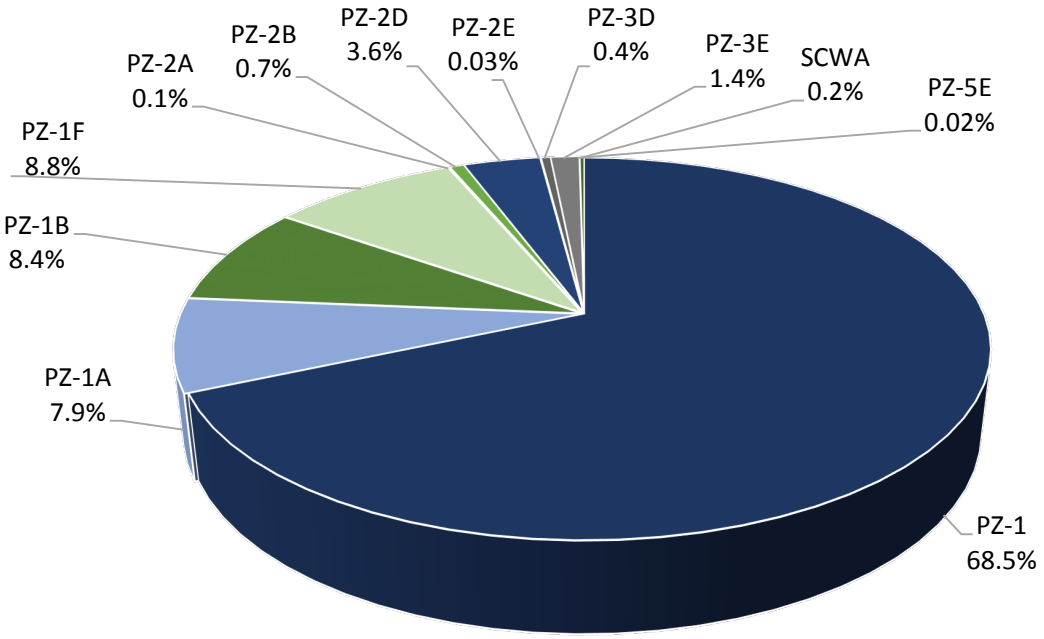


Table 4-5
Current and Historical Potable Water Use by Pressure Zone and Customer Category

Sector	Potable Water Demand (AF) (a)							
	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Pressure Zone 1								
Single Family Residential	1,113	1,089	1,115	1,229	1,198	1,026	879	921
Multi-Family Residential	370	367	373	398	388	346	322	336
Commercial	127	124	125	131	130	125	125	124
Institutional	37	43	64	61	59	49	46	46
Irr. Multi-Family Residential	18	23	23	27	37	28	13	20
Irr. Commercial	12	9.2	8.5	9.5	10.1	6.5	4.6	5.5
Other/Construction	0.6	0.2	0.3	0.3	0.3	0.3	0.2	0.1
Subtotal Pressure Zone 1	*1,678*	*1,656*	*1,710*	*1,856*	*1,822*	*1,580*	*1,391*	*1,453*
Pressure Zone 1A								
Single Family Residential	132	132	140	147	147	124	117	121
Multi-Family Residential	43	47	54	59	56	46	42	44
Commercial	2.6	3.0	2.3	1.9	2.9	2.3	1.5	2.5
Irr. Multi-Family Residential	6.2	6.4	6.0	6.1	6.3	3.1	3.2	4.0
Subtotal Pressure Zone 1A	*184*	*189*	*203*	*214*	*213*	*176*	*164*	*172*
Pressure Zone 1B								
Single Family Residential	130	126	130	147	145	118	105	110
Multi-Family Residential	32	29	33	35	36	31	28	29
Commercial	9.0	9.3	9.4	9.1	10.2	12.4	8.4	7.5
Institutional	35	34	39	37	37	27	23	23
Irr. Multi-Family Residential	0.2	0.2	0.5	0.4	0.6	0.7	0.4	0.4
Irr. Commercial	1.0	1.6	1.0	0.8	0.9	0.9	0.8	0.8
Other/Construction	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.03
Subtotal Pressure Zone 1B	*208*	*200*	*213*	*229*	*230*	*190*	*165*	*171*
Pressure Zone 1F								
Single Family Residential	151	152	156	177	178	145	132	139
Multi-Family Residential	16	15	17	20	20	17	16	17
Commercial	38	38	40	41	36	36	31	33
Institutional	1.9	1.3	2.1	1.6	1.6	1.5	1.5	1.3
Irr. Multi-Family Residential	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.2
Irr. Commercial	2.7	3.6	3.3	2.8	3.1	2.5	2.1	2.2
Other/Construction	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.2
Subtotal Pressure Zone 1F	*209*	*210*	*219*	*242*	*239*	*202*	*183*	*194*
Pressure Zone 2A								
Single Family Residential	1.7	2.1	2.5	2.2	2.1	1.8	1.4	1.2
Subtotal Pressure Zone 2A	*1.7*	*2.1*	*2.5*	*2.2*	*2.1*	*1.8*	*1.4*	*1.2*
Pressure Zone 2B								
Single Family Residential	17	17	17	18	17	16	13	14
Subtotal Pressure Zone 2B	*17*	*17*	*17*	*18*	*17*	*16*	*13*	*14*
Pressure Zone 2D								
Single Family Residential	89	85	87	94	100	81	68	68
Multi-Family Residential	3.9	3.1	3.7	3.4	3.7	3.9	2.5	2.5
Subtotal Pressure Zone 2D	93	89	91	97	104	85	70	71
Pressure Zone 2E								
Single Family Residential	1.2	0.9	1.4	0.6	0.5	0.6	0.4	0.4
Subtotal Pressure Zone 2E	*1.2*	*0.9*	*1.4*	*0.6*	*0.5*	*0.6*	*0.4*	*0.4*
Pressure Zone 3D								
Single Family Residential	9.2	8.8	10	10	11	10	7.8	7.8
Multi-Family Residential	1.0	1.1	1.1	1.3	1.3	1.7	1.2	0.8
Subtotal Pressure Zone 3D	*10*	*10*	*11*	*12*	*13*	*12*	*9.0*	*8.7*

Table 4-5 (Cont.)
Current and Historical Potable Water Use by Pressure Zone and Customer Category

Sector	Potable Water Demand (AF) (a)							
	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
Pressure Zone 3E								
Single Family Residential	24	25	29	27	26	22	19	16
Multi-Family Residential	9	6	8	10	11	11	9	8
Subtotal Pressure Zone 3E	*33*	*31*	*37*	*38*	*37*	*33*	*28*	*24*
Pressure Zone 5E								
Single Family Residential	0.9	1.7	0.3	0.4	0.3	0.3	0.3	0.5
Subtotal Pressure Zone 5E	*0.9*	*1.7*	*0.3*	*0.4*	*0.3*	*0.3*	*0.3*	*0.5*
SCWA(c)								
SCWA - Single Family Residential (c)	0.9	0.7	2.5	1.5	3.1	1.8	7.7	1.0
SCWA - Institutional (c)	2.2	2.1	2.3	2.4	2.1	2.9	3.1	3.0
Subtotal SCWA (c)	*3.1*	*2.8*	*4.8*	*3.9*	*5.3*	*4.7*	*11*	*3.9*
Other Uses								
Blow Off - Irr. Commercial	0	--	--	--	--	--	--	--
Hydrant Meter - Multi-Family Residential	--	--	14	4	--	--	--	--
Hydrant Meter - Commercial	2	4	2	2	3	0	0	2
Subtotal of Other Uses	*1.8*	*4.1*	*17*	*5.5*	*2.7*	*0.4*	*0.3*	*2.1*
Total Water Demand (d)	**2,440**	**2,413**	**2,526**	**2,718**	**2,685**	**2,301**	**2,036**	**2,115**

Abbreviations:
MG = Millions of Gallons

Notes:
(a) Water use data was processed from water billing data provided by the District on 1 August 2018.
(b) Non-revenue water includes water used for fire hydrant flushing and testing, for water main flushing, as well as distribution system water losses. This value is calculated as the difference between metered water consumption and total water production.
(c) SCWA serves these customers directly off of the aqueduct.
(d) Total water demand is the sum of metered water consumption and non-revenue water.
(e) Totals may not add exactly due to rounding.
(f) Pressure Zone 4E is a pressure break between Pressure Zone 3E and 5E and does not have any service connections.

Water use in the District's service area is predominantly associated with residential use. Residential customers account for approximately 79% of the total water deliveries in FY 2017, with single-family residential (SFR) use accounting for 61% and multi-family residential (MFR) use accounting for 18%. Commercial and institutional accounts represent 7% and 3% of total use, respectively. Irrigation accounts account for the smallest percentage of water deliveries at less than 2% of total.

4.2 Water Demand Projections

The District's recently prepared water demand projections as part of the 2015 UWMP planning effort that was based on the Maddaus Demand Analysis and the Decision Support System (DSS) Model (Maddaus 2015). As discussed in Section 2.5, the land use and population assumptions that underpin the water use projections are based on the 2005 Sonoma County General Plan (General Plan). The population and job forecasts provided in the General Plan were relied upon for the demand projections conducted in the Maddaus Demand Analysis. However, as noted in Section 2.6, new development has been identified subsequent to the Maddaus Demand Analysis. Additionally, the Maddaus Demand Analysis only estimated future District-wide demands. For master planning purposes, it is necessary to develop spatial distributions of future demand estimates to apply to the water system hydraulic model and evaluate distribution system performance.

The following subsections discuss the District's current projected water demands and their associated spatial distribution.

4.2.1 Existing Water Demand

For purposes of developing water use projections, the Maddaus Demand Analysis used a planning estimate for the year 2015 and not the actual 2015 billing data. The 2015 planning estimate is then used as a "take-off" point from which future demand projections are based. A planning estimate was utilized because actual FY 2015 water demand was significantly suppressed due to water conservation that occurred in response to the historic drought of 2012 through 2015. The 2015 planning estimate utilized by the Maddaus Demand Analysis was based on the average water use over the eight-year period from 2006 to 2013. This increase reflects a potential rebound from the drought-suppressed water demands in 2015. As discussed in Section 4.1, water demands have not dully rebounded to pre-drought levels as of FY 2017.

The District provided monthly billing data between FY 2010 and FY 2017 (i.e., from July 2009 through June 2017). As such EKI was not able to determine the spatial distribution of the 2006 to 2013 take-off point. Based on a review of the billing data, EKI determined that average water use by account between FY 2013 and FY 2014 is very similar to 2006 to 2013 average water use. Therefore, EKI is using the average FY 2013 and FY 2014 water billing data, which can be associated spatially, as the basis for the take-off point. A comparison of the 2006 to 2013 and FY 2013 to FY 2014 average per account water use by customer category is provided below in Table 4-6.

Table 4-6. Maddaus and Substitute Demand Factor Comparison

Customer Categories	Maddaus Demand Factors (2006-2013) (gpd/account)	Average FY 2013 - FY 2014 Demand Factors (gpd/account)	Percent Difference
Single Family	264.5	264.7	-0.071%
Multi-family	1,071	1,063	0.77%
Commercial	1,064	958	10.0%
Irrigation	1,458	1,460	-0.12%
Institutional	2,643	2,657	-0.52%

EKI also updated the existing demands to capture the customer accounts that were added as of the end of FY 2017. For each account, if the average FY 2013 and FY 2014 consumption was less than 50% FY 2017 consumption (292 accounts), EKI took the FY 2017 consumption multiplied by a customer-category-specific FY2013-FY2014 to FY 2017 consumption scaling factor shown in Table 4-7.

Table 4-7. 2017 to 2013-2014 Demand Scaling Factors

Customer Categories	Average FY 2013 - FY 2014 Consumption (gpd/account)	FY 2017 Consumption (gpd/account)	FY 17 to FY 13-14 Scaling Factor
Single Family	265	200	1.32
Multi-family	1,063	890	1.20
Commercial	958	879	1.09
Irr. Multi-Family Residential	1,731	985	1.76
Irr. Commercial	1,008	583	1.73
Institutional	2,657	1,928	1.38

To account for water loss, EKI applied the average percentage of non-revenue water demands between FY 2010 and FY 2017 (11%) uniformly to all accounts.

4.2.2 General Plan Growth Projections

As discussed above, the population and job forecasts provided in the General Plan were relied upon for the Maddaus Demand Analysis. Projected customer water demands for years 2020 through 2040 are presented in Table 4-8. These projected demands are broken down by sector, including water loss. These water use projections include assumptions about future water savings due to passive conservation and water use by lower income households.

Table 4-8. Projected Water Demands for General Plan Growth

Use Type	Projected Water Use (AFY) (a)				
	2020	2025	2030	2035	2040
Single Family	1,878	1,881	1,871	1,870	1,874
Multi-Family	533	529	522	519	518
Commercial	202	203	205	206	207
Irrigation	54	54	56	56	57
Institutional/Governmental	103	104	106	107	109
Losses	352	354	352	351	352
TOTAL	**3,121**	**3,125**	**3,111**	**3,110**	**3,117**

Notes:

(a) Demand projections include passive conservation assumptions, including water conservation that would incur because of compliance with existing plumbing codes (i.e., Federal Energy Policy Act of 1992, CALGreen Building Code, AB 715, SB 407). Totals may not add exactly due to rounding.

Following the rebound in potable water demand, the District is estimating that future total water demand will plateau and remain relatively stable, despite additional population and economic growth. Specifically, between 2020 and 2040, potable water demand is projected to decrease by 5 AFY, or less than 1%. This projection reflects an anticipated sustained decrease in per capita water use as a result of continued investment in water efficiency improvements by the District and its customers.

To spatially estimate these projected 2040 demands, EKI scaled the existing demands (see Section 4.2.1) by the difference between the Maddaus 2018 and 2040 projected demands for each customer class. These scaling factors, which are inclusive both of anticipated General Plan growth and passive conservation, are shown in Table 4-9. This methodology assumes that the General Plan growth and conservation will be generally uniform across the District within each customer category.

Table 4-9. General Plan Growth Projected Water Demand Scaling Factor

Customer Categories	2018 Projected Demands (AFY) (a)	2040 Projected Demands (AFY) (a)	Projected 2018 to 2040 Scaling Factors
Single Family	1,863	1,874	100.6%
Multi-Family	530	518	97.8%
Commercial	201	207	103.2%
Irrigation MFR	34	37	106.9%
Irrigation Commercial	19	20	108.0%
Institutional	101	109	106.9%

Notes:

(a) Projected demands based on General Plan Growth and passive conservation assumptions from the Maddaus Demand Analysis.

4.2.3 Other Anticipated Development Projections

As discussed in Section 2.6, the District anticipates additional development beyond General Plan growth. Specifically, an 80-unit multi-family residential development on Verano Avenue across from Maxwell Farms Regional Park is anticipated to be complete by 2025 and the mixed-use Springs Specific Plan is

planned to be completed over the next 50 years.[4] EKI has estimated demands for these planned developments to add to the water demand projections associated with the General Plan growth.

For each of these developments, Table 4-10 summarizes the conservative assumptions for increases in new development, assumed water demand factors, and projected increase in water demands for each land use type. The water demand factors were generally based on the Maddaus Demand Analysis projected 2040 per account demands for each land use, with the following modifications:

- To estimate a per unit (instead of a per account) multi-family residential factor, EKI calculated the average FY 2013 and FY 2014 per unit multifamily demand for multi-family accounts with 2-unit and 3-unit meter codes (L and K), multiplied by the multi-family passive savings. This method excludes accounts with four or more connections, because the exactly number of units per account could not be determined.
- To estimate a per hotel room water demand factor, EKI calculated the average FY 2013 and FY 2014 per room demand for the Sonoma Creek Inn (16 rooms) and the Fairmont Sonoma Mission Inn & Spa (226 rooms), multiplied by the commercial passive savings.
- EKI accounted for passive water conservation based on the Maddaus demand analysis in all demand factors.

The Springs Specific Plan is anticipated to fully completed beyond the District's planning horizon (2050), but EKI has included all of the estimated water demands associated with the Development in the future demands for conservatism.

[4] The District is also tracking progress on other planned developments discussed in Section 2.6, but has not incorporated these into the water demand projections, because of they are in the infancy of the planning process.

Table 4-10
Projected Water Demands for Anticipated New Development

Land Use Designation	Pressure Zone	Net Increase in New Development (a)		Water Demand Factor Including Losses (b)		Net Increase in Water Demands (AF)
Verano Ave Multi-Family Residential Development						
Multi-Family Residential	1	80	du	0.22	AFY/du (c)	17
					Subtotal	*17*
Springs Specific Plan						
Single-Family Residential	1	124	du	0.31	AFY/du (d)	38
Multi-Family Residential	1	423	du	0.22	AFY/du (c)	92
Work-Live/MF in Mixed Use	1	138	du	0.22	AFY/du (c)	30
Commercial	1	167,029	sf	1.25	AFY/4,000 sf (e)	52
Commercial - Hotel	1	120	Rooms	0.080	AFY/Room (f)	10
Office	1	82,226	sf	1.25	AFY/4,000 sf (g)	26
Recreation	1	26,648	sf	3.29	AFY/5,000 sf (h)	18
					Subtotal	*266*
					TOTAL NET INCREASE IN WATER DEMANDS	**283**

Notes:

(a) Net increases in new development were provided by the District based on current conservative estimates.

(b) Factor of 1.11 applied to each demand factor to account for water loss.

(c) Multi-family residential water demand factor is based on average FY 2013 and 2014 per-dwelling-unit demand for all 2 and 3 unit multi-family accounts and incorporates the DSS model passive savings for multi-family residential accounts.

(d) Single-family residential water demand factor is based on the DSS Model 2040 single-family per account demand, including passive savings.

(e) Commercial water demand factor is based on the DSS Model 2040 commercial per account demand, including passive savings, assuming 4,000 sf of commercial space per account consistent with the November 2018 Springs Specific Plan Projected Water Demands (De Novo, 2018).

(f) Commercial-Hotel water demand factor is based on the FY 2013 to 2014 average per hotel room demand for the Sonoma Creek Inn (16 rooms) and the Fairmont Sonoma Mission Inn & Spa (226 rooms), accounting for DSS Model commercial passive savings.

(g) Commercial water demand factor is based on the DSS Model 2040 commercial per account demand, including passive savings, assuming 4,000 sf of commercial space per account consistent with the November 2018 Springs Specific Plan Projected Water Demands (De Novo, 2018).

(e) Recreation water demand factor is based on the DSS Model 2040 institutional per account demand, including passive savings, assuming 5,000 sf of recreational space per account consistent with the November 2018 Springs Specific Plan Projected Water Demands (De Novo, 2018).

Abbreviations:

DSS - Decision Support System
du - dwelling unit
sf - square feet

4.2.4 Total Projected Demands

Existing and future projected demands are summarized in Table 4-11 by pressure zone. These demands serve as the basis for the existing and future capacity evaluations and are allocated at the parcel level in the hydraulic model to evaluate system performance.

Table 4-11. Projected Existing and Future Annual Demands by Pressure Zone

Pressure Zone	Existing Demands (AFY) (a)	Future Demands (AFY)		
		General Plan Growth (b)	Net New Development (c)	Total Future Demands
1	2,109	2,120	283	2,404
1A	247	247	-	247
1B	264	268	-	268
1F	281	284	-	284
2A	2.4	2.4	-	2.4
2B	20	20	-	20
2D	115	115	-	115
2E	0.7	0.7	-	0.7
3D	14	14	-	14
3E	42	42	-	42
4E	0	0	-	0
5E	0.8	0.8	-	0.8
SCWA	5.1	5.3	-	5.3
Total	**3,102**	**3,120**	**283**	**3,403**

Notes:

(d) For the majority of accounts, existing demands equal the total average FY 2013 and FY 2014 billing data by pressure zone plus 11.3% water loss. However, for 292 accounts with an average FY 2013 and FY 2014 demand less than 50% of the FY 2017 demand, the 2017 demand multiplied by a land use specific 2013-2014 to 2017 escalation factor was tallied instead of the FY 2013 and FY 2014 average demand to account for new or develop or uses since 2014.

(e) Equals the total of the existing demands multiplied by the District's Decision Support System (DSS) model's land use-specific 2040 to 2018 escalation factor assuming passive conservation.

(f) See Table 4-10.

4.3 Peak Demands

EKI reviewed the District's historical water consumption and production data and available SCADA flow and tank level data to identify the peaking factors for each pressure zone relative to average day demand (ADD) that best estimate maximum month demand (MMD), maximum day demands (MDD), and peak hour demands (PHD). To determine the MMD peaking factor, EKI evaluated the District's monthly consumption data by pressure zone. Monthly consumption between July 2009 and June 2017 is shown on Figure 4-8. Monthly consumption for each zone exhibits seasonal trends with peak flows occurring during the summer months, when irrigation demands are high, and lower flows in winter months, when there are minimal irrigation demands. Figure 4-8 shows that maximum month consumption declined significantly from previous years in the summer of 2015, after the SWRCB to

imposed mandatory restrictions. Peak flows began to rebound in summer of 2016, as the restrictions were lifted. The average FY 2013 and FY 2014 monthly consumption was used to develop the MMD peaking factor to reflect a potential rebound from drought conditions.

EKI reviewed data collected from the District's SCADA system and SCWA's advanced metering infrastructure (AMI) to estimate the MDD and PHD peaking factors for each pressure zone. The District provided flow data from each of its wells and pump stations and elevation data from each of its storage tanks in 10-minute increments between October 2016 and August 2018. SCWA provided daily flow data from each of the District's turnouts. Using these data, EKI calculated daily demands for each zone by summing the flows into and out of each zone and the change in storage in each tank within the zone. Because SCWA only provided daily flow data, hourly demands could only be calculated for the upper pressure zones. A list of the sources of inflows, storage, and outflows for each zone are listed in Table 4-12.

An analysis of the daily demand data indicated that certain pressure zones were not isolated as originally anticipated. Calculated daily demands for Pressure Zone 1F were approximately double the historical consumption until November 2017, indicating that water was regularly flowing from Pressure Zone 1F to Pressure Zone 1B through the Eldridge PRV. After November 2017, demands are consistent with anticipated consumption in Pressure Zone 1F, likely because the PRV settings were changed after the October 2017 fires. Calculated daily demands in Pressure Zone 1B were nearly ten times the historical Pressure Zone 1B consumption, indicating that a significant amount of water is conveyed from Pressure Zone 1B to Pressure Zone 1 through the Hanna Lower PRV. Calculated daily demands also significantly exceeded historical consumption in Pressure Zone 2D for certain periods. EKI used data after November 2017 to determine separate ADD peaking factors for Pressure Zone 1F and the other aqueduct pressure zones.

Based on the consumption data and calculated daily and hourly demands by zone, EKI developed pressure-zone-specific peaking factors. These peaking factors and key assumptions are listed in Table 4-13. Table 4-14 lists the projected existing and future peak demands by pressure zone based on these peaking factors and the average day demands.

The application of these peaking factors to assess system capacity and performance is described in Section 5.0.

Figure 4-8
Monthly Consumption Data by Pressure Zone

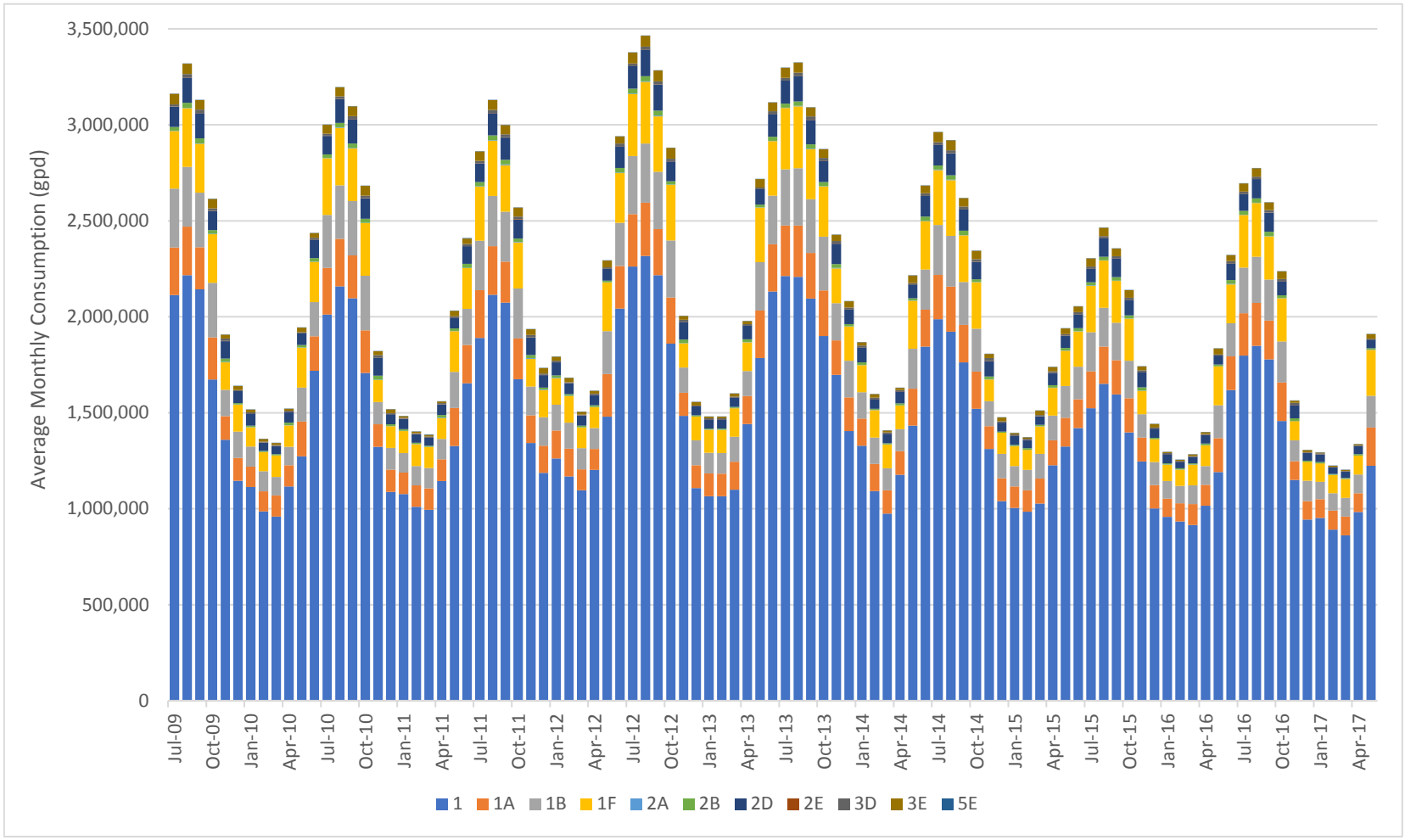


Table 4-12
Sources of Inflow and Outflow and Storage by Pressure Zone

Pressure Zone	Sources of Flow In	Storage Tanks	Sources of Flow Out	Notes
1	SCWA Turnouts[a]: Verano, Verano & Main, Verano & 5th, Boyes Blvd, Atlimira, & Agua Caliente Wells: Donald, Park Ave. Aqua Caliente, Verano, & Larbre *PRV: Hanna Lower (only intended to open in emergency; not metered)[b]	Storage Tanks: Bolli 1 & 2, Temelec 1 & 2, Donald	Booster Pump Stations: Agua Caliente & Donald	Daily demands calculated together for Pressure Zones 1, 1A, 2A, 1B, 2D, 3D, and 1F (only through October 2017) (see Note b, c, d) because the pressure zones were not isolated.
1A				
2A				
1B	SCWA Turnouts[a]: Madrone & Hanna *PRV: Eldridge (only intended to open in emergency; not metered)[c]	Storage Tanks: Hanna	*PRV: Hanna Lower (only intended to open in emergency; not metered)[b]	
2D	Wells: Mountain Ave. Booster Pump Stations: Agua Caliente	Storage Tanks: Chestnut	Booster Pump Stations: Chestnut Isolation Valves between Pressure Zones 2D and 1 (typically closed)[d]	
3D[e]	Booster Pump Stations: Chestnut	Hydropneumatic: Chestnut[f]	None	
1F	SCWA Turnouts[a]: Glen Ellen (6" & 4") & Trinity Oaks	Storage Tanks: Glen Ellen & Saddle[g]	*PRV: Eldridge (only intended to open in emergency; not metered)[c]	Daily demands calculated as part of Pressure Zones 1, 1A, 2A, 1B, 2D, and 3D until November 2017 (see Note c).
2B	Booster Pump Stations: Donald	Hydropnuematic: Donald[e]	None	
2E	Booster Pump Stations: Sobre Vista Lower	Storage Tanks: Sobre Vista Lower	Booster Pump Stations: Sobre Vista Upper	Daily and hourly demands could not be calculated because flow and tank level data not sensitive enough for the low demands.
3E	Booster Pump Stations: Sobre Vista Upper	Storage Tanks: Sobre Vista Upper	Booster Pump Stations: Sonoma Mountain Lower	
4E	Booster Pump Stations: Sonoma Mountain Lower	Storage Tanks: Sonoma Mountain Lower	Booster Pump Stations: Sonoma Mountain Upper	Daily and hourly demands could not be calculated because flow and tank level data not sensitive enough for the low demands.
5E	Booster Pump Stations: Sonoma Mountain Upper	Storage Tanks: Sonoma Mountain Upper	None	

Notes:

(a) Only daily flow data available for SCWA turnouts. Therefore hourly demands could not be calculated for Pressure Zones 1, 1A, 2A, 1B, or 1F.

(b) A comparison of historical consumption data vs. calculated daily demand data for Pressure Zone 1B indicated that a significant amount of flow is being conveyed through the Hanna Lower PRV from Zone 1B to Zone 1 on a regular basis.

(c) A comparison of consumption data vs. calculated daily demand data for Pressure Zones 1F indicated that a significant amount of flow was being conveyed through the Eldridge PRV from Zone 1F to Zone 1B on a regular basis until October 2017. After October 2017, Pressure Zones 1F and 1B appear to be isolated (closed PRV), except for short periods of flow from 1F to 1B when the Hanna Turnout was not active.

(d) A comparison of historical consumption data vs. calculated daily demands for Pressure Zones 2D and 3D indicated that a significant amount of flow is being conveyed from Pressure Zone 2D to

(e) The District does not meter flow from the Chestnut Pump Station, so demands could not be calculated separately for Pressure Zone 3D.

(f) Storage in Chestnut and Donald Hydropnuematic Tanks not included in demand calculations.

(g) Saddle Tank was destroyed in the October 2017 Fire.

Table 4-13
Summary of Peaking Factors by Pressure Zone

Pressure Zone	Peaking Factors				
	[1] MMD to ADD (a)	[2] MDD to MMD (b)	[3] PHD to MDD (c)	[4] MDD to ADD (d)	[5] PHD to ADD (e)
1	1.38	1.14	2.0	1.6	3.2
1A	1.42			1.7	3.3
1B	1.48			1.7	3.4
2A	1.53			1.8	3.5
2D	1.51			1.8	3.5
3D	1.58	1.74	3.3	2.8	9.1
1F	1.51	1.26	2.0	2.7	3.9
2B	1.58	1.74	3.3	2.8	9.1
2E	1.46	1.97	2.2	2.9	6.4
3E	1.66			3.3	7.3
5E	1.46			2.9	6.5

Notes:

(a) Calculated based on average FY 2013 and FY 2014 consumption data.

(b) Calculated based on daily demand calculations for FY2017 for Pressure Zones 2B and 3E and between November 2017 to August 2018 for Pressure Zones 1, 1A, 1B, 2A, 2D, and 3D and 1F (i.e., when zone 1F was isolated). Peaking daily demands exclude demands between 8 October 2017 and 16 October 2017 related to the October 2017 fires. Peaking Factor for Pressure Zone 3D assumed to equal the Pressure

(c) Peak hour demands factors calculated for Pressure Zones 2B and 3E are based on the peak hour demands on the maximum demand day (6/18/2018 for Pressure Zone 2B and 7/21/2017 for Pressure Zone 3E). Calculated Pressure Zone 3E peaking factor assumed for Pressure Zones 2E and 5E. PHD to MDD peaking factor of 2.0 assumed for all other pressure zones; for comparison, a peaking factor of 1.67 was calculated for non-isolated Pressure Zones 2D and 3E. Peaking Factor for Pressure Zone 3D assumed to equal the Pressure Zone 2B peaking factor because of similar land use.

(d) Equals Column [1] x Column [2], rounded up to the nearest tenth.

(e) Equals Column [1] x Column [2] x Column [3], rounded up to the nearest tenth.

Table 4-14
Projected Existing and Future Peak Demands by Pressure Zone

Pressure Zone (a)	Existing Demands								Future Demands							
	Average Day Demand		Maximum Month Deman		Maximum Day Demand		Peak Hour Demand		Average Day Demand		Maximum Month Deman		Maximum Day Demand		Peak Hour Demand	
	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm	1,000 gpd	gpm
1	1,883	1,308	2,597	1,804	3,013	2,092	6,025	4,184	2,146	1,490	2,960	2,055	3,433	2,384	6,867	4,768
1A	220	153	314	218	374	260	727	505	220	153	314	218	375	260	727	505
1B	236	164	349	242	401	279	803	557	240	166	354	246	407	283	815	566
1F	251	174	383	266	678	471	979	680	253	176	387	269	684	475	988	686
2A	2.1	1.5	3.2	2.2	3.9	2.7	7.5	5.2	2.2	1.5	3.2	2.3	3.9	2.7	7.5	5.2
2B	18	13	29	20	51	35	165	115	18	13	29	20	51	36	166	115
2D	102	71	154	107	184	128	358	249	103	71	155	108	185	128	360	250
2E	0.6	0.4	1.0	0.7	1.8	1.2	3.9	2.7	0.6	0.43	1.0	0.7	1.8	1.2	4.0	2.8
3D	13	8.8	18.5	12.8	35	25	115	80	13	8.8	18.5	12.9	36	25	116	80
3E	38	26	62	43	124	86	274	190	37	26	62	43	123	86	273	190
5E	0.7	0.5	1.1	0.8	2.1	1.5	4.8	3.3	4.7	3.3	6.9	4.8	13.7	9.5	30.6	21.2
Totals	**2,764**	**1,919.7**	**3,912**	**2,716.5**	**4,868**	**3,381**	**9,462**	**6,571**	**3,038**	**2,110**	**4,290**	**2,979**	**5,314**	**3,690**	**10,353**	**7,190**

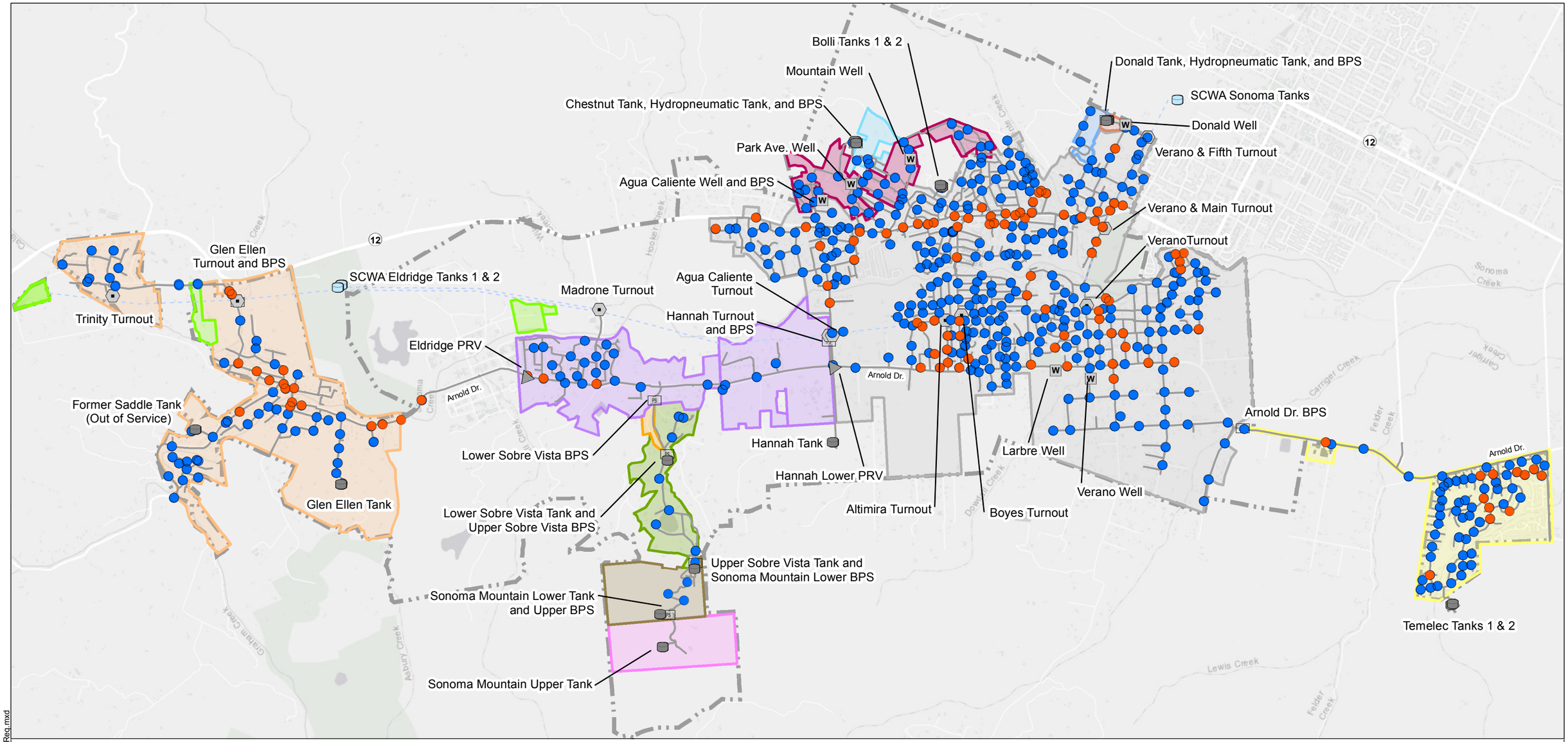
Notes:
(a) SCWA Zone demands not included because these are supplied directly from the SCWA aqueduct and are not needed for distribution system master planning purposes.

4.4 Fire Flow Requirements

Fire protection for the District is provided by Sonoma Valley Fire and Rescue Authority and by the Glen Ellen Fire Department. The Sonoma Valley and Glen Ellen Fire Departments have indicated that a fire flow of 2,500 gpm should be provided in commercial and institutional areas. In residential areas, a fire flow of 1,000 gpm is required.[5] These fire flows must be available for a minimum of two hours in conjunction with maximum day demand conditions while maintaining a minimum residual pressure of 20 pounds per square inch (psi) at all system nodes. The distribution of the required fire flows within the District are shown on Figure 4-9.

As discussed in the following sections, these flows and durations are used to establish supply capacity criteria, pipe sizing, and storage and supply capacity requirements.

[5] In the 2007 Master Plan, a residential fire flow of 500 gpm was required and a fire flow of 1,000 gpm was desired. In light of the October 2017 Sonoma fires, this requirement has been updated to require a residential fire flow of 1,000 gpm.



Path: X:\B80082.00\Maps\Water Master Plan\04\Fig4_9_VOTM_FireFlowReq.mxd

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Required Fire Flow Availability, gpm

- 1000
- 2500

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Required Fire Flow Availability Map

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 4-9

eki environment & water

5.0 WATER SUPPLY AND STORAGE CAPACITY EVALUATION

This section develops recommended supply and storage criteria and evaluates the District's water system storage and supply capacity to meet these criteria under existing and future demand scenarios described in Section 4.0.

5.1 Storage and Supply Capacity Criteria

EKI recommends the following water supply and storage criteria, which update criteria established in prior master planning efforts.

5.1.1 Water Supply and Pumping Capacity Requirements

As discussed in Section 4.3, peaking factors were developed to capture varying water use conditions. Higher water demand periods occur during summer months as compared to winter months when irrigation demands are higher. Over the course of the day, usage peaks in the early morning when people are preparing for their day and at night when people return home and begin irrigating their landscapes.

To meet varying demand conditions, EKI recommends a firm supply capacity through the combination of SWCA turnouts, groundwater wells, and booster pump stations in each pressure zone equal to the following:

- For pressure zones with storage to provide operational and fire storage by gravity (all but Pressure Zones 1 & 2A, 2B, and 3D): the sum of (1) maximum day demands of the pressure zones and the upper pressure zones that they supply and (2) the required supply to refill fire storage for the largest single fire flow in the zone (i.e., either residential = 120,000 gallon or commercial = 300,000 gallons) in 12 hours.
- For pressure zones that are only supplied pumped flows (Pressure Zones 2B and 3D): peak hour demands plus one residential fire; and
- For Pressure Zone 1 & 2A that is supplied peak flows by gravity from the aqueduct: the sum of peak hour demands for Pressure Zone 1 & 2A and maximum day demands for the upper pressure zones supplied by Pressure Zone 1.

Firm capacity is defined as follows:

- For SCWA turnouts: The largest turnout in the pressure zone is assumed out of service. For turnouts fed by gravity, capacity is assumed to equal the maximum flow capacity for Cla-Val model 90-01 PRVs.[6] For the Hanna and Glen Ellen Turnouts, which require boosting from their associated pump stations under certain operational conditions, the capacity is equal to the firm capacity of the pump station (i.e., with the largest pump out of service).
- Groundwater wells: The largest well in the pressure zone is assumed out of service.

[6] Actual flow capacity of PRV will vary based on system conditions.

- Booster pump stations: The largest single domestic pump is assumed out of service. For Donald Pump Station, the 300 gallons per minute (gpm) fire pump is assumed in service to supply fire flows to Pressure Zone 2B.

These criteria are recommended to ensure there is sufficient supply capacity distributed throughout the system to meet peak demand conditions. EKI also recommends the District establish criteria to provide backup power for all pumping facilities (wells and booster pump stations).

5.1.2 Water Storage Capacity Requirements

Treated water storage capacity includes equalization storage, fire storage, and emergency storage. The following sections explains the recommended requirement for each storage component in detail. Existing storage capacity is evaluated by pressure zone to meet the following criteria.

5.1.2.1. Operational Storage

As discussed in Section 5.1.1, the recommended water supply criteria require firm water supply capacity to provide MDD in zones with operational storage. This storage is used to meet peak demand conditions. This storage volume is then refilled during low demand periods when water supply is greater than water demand.

The storage volume used to meet these high demand periods is called operational or equalization storage. Recommended equalization storage is equal to 25% of MDD.

As discussed in Section 5.1.1, operational storage is not required for Zone 1 & 2A because the aqueduct directly supplies peak demands by gravity.

5.1.2.2. Emergency Storage

Emergency storage is required to supply demands during various emergencies, such as natural disasters, pipeline failures, treatment failures, power outages or pump station failure. No standard requirements exist for determining the appropriate amount of emergency storage, and each utility establishes these requirements based on their judgement. Currently, the District has an emergency storage requirement of 100% of ADD. EKI finds this requirement to be appropriately conservative given that peak season irrigation would be curtailed in case of an emergency. Emergency storage may be located in an upstream pressure zone as long as there is a reliable means to transfer the volume to that pressure zone during an emergency.

Groundwater wells equipped with backup power could be used to reduce the emergency storage requirement, but EKI has conservatively not accounted for this supply. EKI has also not accounted for any storage in the SCWA system.

5.1.2.3. Fire Storage

As discussed in Section 4.4, fire flow and duration requirements were established for long-term planning purposes by the District and local fire departments. For the larger pressure zones with both residential and commercial land uses (Pressure Zones 1 & 2A, 1A, 1B, and 1F), EKI recommends fire storage to supply a concurrent commercial fire (2,500 gpm for 2 hours) and residential fire (1,000 gpm for 2 hours). This results in a fire storage requirement of 0.42 MG. This concurrent fire storage requirement is

recommended to address vulnerabilities identified by the October 2017 Sonoma Fires, during which Glen Ellen Tank was drained to only 3 feet and Saddle Tank was ultimately destroyed.

For the smaller pressure zones with only residential land uses, EKI recommends fire storage to supply a single residential fire (1,000 gpm for 2 hours), resulting in a fire storage requirement of 0.12 MG.

Fire storage may be located in an upstream pressure zone as long as there is a reliable means to transfer the volume to that pressure zone during an emergency.

5.2 Supply and Pumping Evaluation

The District's existing firm supply capacity for each pressure zone was evaluated against the recommended criteria discussed in Section 5.1.1 under existing and projected future demand conditions. The results of this evaluation are presented in Table 5-1.

Table 5-1 indicates that Pressure Zones 2E, 3E, 2B, 3D, and 1F have supply capacity deficits under existing and future conditions. Pressure Zones 2B and 3D, which only are delivered pumped flows, do not have enough pumping capacity to meet the fire flow requirements. EKI recommends that dedicated fire pumps be added to each pump station that can meet the 1,000 gpm residential fire flow requirement.

Supply deficits (437 gpm and 442 gpm) are shown for Pressure Zone 1F for existing and future demand conditions. However, EKI conservatively did not include capacity for Trinity turnout in the zone supply capacity, which can supply peak demands by gravity in portions of the pressure zone. EKI recommends installation of a new 450 gpm BPS to deliver supply from Pressure Zone 1B to Pressure Zone 1F to meet the supply criteria. This new BPS also improve system resiliency and addresses fire flow concerns along Arnold Drive (see Section 8.0). Based on discussions with the District, we recommend installing the new Eldridge BPS and relocating the existing Eldridge PRV north of SDC. This location would allow for surface water supplies from SDC to be pumped to Pressure Zone 1F if these facilities are annexed by the District in the future.

As proposed by the District, EKI recommends that Pressure Zones 2E, which only has two service connections, and 3E be consolidated. Consolidation would consist of abandoning Sobre Vista Lower Tank, which is over 85-years-old and presents maintenance challenges, and Sobre Vista Upper Pump Station; connecting the two zones; installing individual service PRVs on the Pressure Zone 2E services; and upgrading Sobre Vista Lower Pump Station to be able to pump up to Sobre Vista Upper Tank. EKI recommends that as part of the Lower Sobre Vista BPS upgrades, the capacity be expanded to 265 gpm to meet the supply capacity requirements.

EKI also evaluated whether Arnold Drive BPS could be abandoned. During normal operating conditions, operating Arnold Drive BPS is not necessary; there is enough pressure in the system to fill the Temelec Tanks. However, as the District experienced in late 2018, if a portion of the SCWA Aqueduct is shutdown between Eldridge Tanks and Sonoma Tanks, Arnold Drive BPS is needed to move water south through the system and provide enough pressure to fill Temelec Tanks. Due to the existing poor condition and hazardous location along Arnold Drive, EKI recommends replacing Arnold Drive BPS and relocating the new BPS to Orange Avenue, between Solano Avenue and Arnold Drive.

Table 5-1
Water Supply Capacity Requirements by Pressure Zone

Pressure Zone(s)	Existing Firm Supply Capacity (gpm)				Required Supply Criteria (d)	Existing Requirements		Future Requirements	
	SCWA Turnouts (a)	Wells (b)	Booster Pump Stations (c)	Total		Required Firm Supply Capacity (gpm)	Firm Supply Capacity Surplus (Deficit) (gpm)	Required Firm Supply Capacity (gpm)	Firm Supply Capacity Surplus (Deficit) (gpm)
1 & 2A	11,600	540	-	12,140	1 & 2A PHD + 1A, 2B, 2D, 3D MDD	4,637	7,503	5,223	6,917
1A	-	-	500	500	1A MDD + Tank Fill	427	73	427	73
2B	-	-	450	450	2B PHD + FF	1,115	-665	1,115	-665
2D	-	-	350	350	2D & 3D MDD	319	31	320	30
3D	-	-	100	100	3D PHD + FF	1,080	-980	1,080	-980
1F	450	-	-	450	1F MDD + Tank Fill	887	-437	892	-442
1B	800	-	-	800	1B, 2E, 3E, 5E MDD + Tank Fill	784	16	796	4
2E	-	-	130	130	2E, 3E, 5E MDD + Tank Fill	255	-125	263	-133
3E	-	-	100	100	3E, 5E MDD + Tank Fill	254	-154	262	-162
5E	-	-	17	17	5E MDD	1.5	16	9.5	8

Notes:

(a) Firm turnout capacity defined as the maximum rated flow capacity of each turnout with one turnout in each pressure zone offline. For gravity fed turnouts maximum capacity is equal to PRV flow capacity. For pumped turnouts, Hannah and Glen Ellen, capacity is equal to the firm capacity of the associated booster pump station.

(b) Firm well capacity defined as the total well capacity with the largest well offline.

(c) Firm pumping capacity defined as the total capacity of all pumps minus the capacity of one domestic pump.

(d) Required supply criteria for each pressure zone is further described in Section 5.1.1.

In addition to the supply criteria discussed in Section 5.1.1, the SCWA Restructured Agreement established a goal for each of water contractors including the District to supply and maintain approximately 40% of its maximum month demand. As discussed in Section 3.1.2.2, the District will likely need to expand its local supply beyond the District's current plans to meet this goal. EKI recommends that the District install a new groundwater supply well, preferably located outside of the GSA.

These recommended supply improvements are discussed in more detail in Section 9.0.

5.3 Storage Evaluation

The District's required storage capacity is composed of equalization, fire, and emergency storage described in Section 5.1.2. The District currently has 5.132 MG of storage between its 12 tanks. Table 5-2 provides a summary of existing and future storage requirements and capacity by pressure zone.

Pressure Zone 1F is projected to have existing and future storage deficits of 0.341 MG and 0.344 MG, respectively. As discussed in Section 3.2.3, the District has initiated design of a new 0.15 million tank at the existing site. The former Saddle Tank site and adjacent properties were determined to not be suitable for construction of a tank significantly larger than the former Saddle Tank (0.15 MG). Thus, to cover the Pressure Zone 1F deficit an additional 0.2 MG tank is required. EKI has identified two potential sites with the appropriate elevations to match the hydraulic grade level of the pressure zone: Alternative #1 - London Ranch Road and Alternative #2 - South of Mound Avenue. Both sites would require extending the transmission mains to the tank sites. These alternatives are described in more detail in Section 9.0.

Pressure Zone 2E, which currently cannot receive transfer of storage from Pressure Zones 3E, does not have enough fire flow storage. This deficiency will be resolved with the proposed Pressure Zones 2E and 3E consolidation, described in Section 5.2. As part of this project, EKI recommends installing a PRV between Pressure Zones 2E and 1B, so that storage in Sobre Vista Upper Tank can be transferred to the lower zones, if needed.

These recommended storage improvements are discussed in more detail in Section 9.0.

Table 5-2
Water Storage Capacity Requirements by Pressure Zone

Pressure Zone(s)	Existing Storage Capacity (a)		Existing Requirements						Future Requirements					
	(1,000 gal)	Notes	Operational Storage (1,000 gal) (b)	Fire Storage (1,000 gal) (c)	Emergency Storage (1,000 gal) (d)	Total Required Storage (1,000 gal)	Available Surplus from Upstream Zone (1,000 gal)	Storage Capacity Surplus (Deficit) (1,000 gal)	Operational Storage (1,000 gal) (b)	Fire Storage (1,000 gal) (c)	Emergency Storage (1,000 gal) (d)	Total Required Storage (1,000 gal)	Available Surplus from Upstream Zone (1,000 gal)	Storage Capacity Surplus (Deficit) (1,000 gal)
1F	500	Can deliver storage to 1B by gravity	169	420	251	841	-	(341)	171	420	253	844	-	(344)
2D & 3D	320	Can deliver storage to 1 by gravity	55	120	115	290	-	30	55	120	115	291	-	29
2B	200	Can deliver storage to 1 and 2A by gravity	13	120	18	151	-	49	13	120	18	151	-	49
1A	1,200	Typically operates as single zone with 1 and 2A; can deliver storage to 1 and 2A by gravity	94	420	220	734	-	466	94	420	220	734	-	466
4E & 5E	54	-	0.54	0 (e)	0.74	1.27	-	53	3.41	0 (e)	4.71	8.12	-	46
3E	207.5	-	31	120	38	188	-	19	31	120	37	188	-	19
2E	30	-	0.45	120	0.62	121	-	(91)	0.45	120	0.62	121	-	(91)
1B	2,000	Can receive storage from 1F and transfer to 1 by gravity	100	420	236	756	-	1,244	102	420	240	761	-	1,239
1 & 2A	800	Can receive storage from 1A, 1B, 1F (through 1B), 2B, and 2D by gravity	0 (f)	420	1,885	2,305	1,789	284	0 (f)	420	2,148	2,568	1,783	15
TOTAL	5,312													

Notes:

(a) Refer to Table 3-6
(b) Operational storage equal to 25% of max day demands.
(c) Fire storage volume for Pressure Zones 1 & 2A, 1A, 1B, and 1F equal to volume require to supply a concurrent commercial fire (2,500 gpm for 2 hours) and residential fire (1,000 gpm 2 hours). Fire storage volume for other pressure zones equal to volume required to supply a single residential fire (1,000 gpm 2 hours).
(d) Emergency storage volume equal to 100% of ADD.
(e) Fire storage volume requirement for the Sonoma Mountain Homestead area provided by a private irrigation system.
(f) Operational storage for Pressure Zones 1 and 2A is not required because Aqueduct provides peak demands by gravity. While this is also normally true for Pressure Zones 1A and 1B, operational storage is required because pumping is still required under certain operational conditions.

5.4 Summary of Recommended Supply and Storage Facility Improvements

EKI recommends the following improvements to address projected supply and storage deficits:

- Addition of dedicated fire pumps at Donald Pump Station and Chestnut Pump Station with enough capacity to meet the fire flow requirements.
- Installation of a new 450-gpm pump station to supply flow from Pressure Zone 1B to Pressure Zone 1F.
- Consolidation of Pressure Zones 2E and 3E by abandoning Sobre Vista Lower Tank and Sobre Vista Upper Pump Station, replacing the Sobre Vista Lower Pump Station pumps with higher head, 265-gpm pumps.
- Construction of a new 0.2 MG storage tank in Pressure Zone 1F in addition to replacement of the former 0.15 MG Saddle Tank.

In addition to these capacity-related improvements, EKI has evaluated the following proposed improvements to simplify operations and improve system resiliency and redundancy:

- Expand local groundwater supply by at least approximately 350 gpm with a new well to meet the SCWA 40% maximum month demand local supply goal.
- Installation of a new PRV between Pressure Zones 3E/2E and 1B to be able to transfer surplus storage to lower zones.
- Replacement and relocation of the Eldridge PRV in conjunction with the new Zone 1F pump station north of SDC.
- Replacement of Arnold Drive Pump Station based on the existing pump station condition and access restrictions.
- Addition of backup generators to remaining critical wells and pump stations currently without backup power.
- Installation of flow meters at each of the SCWA turnout PRVs and SCADA integration.

Table 5-3 and Table 5-4 show that with the improvements discussed above, the District will address its projected supply and storage deficits. These recommended improvements are further investigated based on hydraulic modeling analysis in Section 8.0 and are integrated into the recommended CIP as discussed in Section 9.0.

Table 5-3
Water Supply Capacity Requirements by Pressure Zone with Recommended Improvements

Pressure Zone(s)	Proposed Firm Supply Capacity (gpm)				Required Supply Criteria (d)	Future Requirements	
	SCWA Turnouts (a)	Wells (b)	Booster Pump Stations (c)	Total		Required Firm Supply Capacity (gpm)	Firm Supply Capacity Surplus (Deficit) (gpm)
1 & 2A	11,600	540	-	12,140	1 & 2A PHD + 1A, 2B, 2D, 3D MDD	5,223	6,917
1A	-	-	500	500	1A MDD + Tank Fill	427	73
2B	-	-	1115 (e)	1,115	2B PHD + FF	1,115	0
2D	-	-	350	350	2D & 3D MDD	320	30
3D	-	-	1100 (f)	1,100	3D PHD + FF	1,080	20
1F	450	-	450 (g)	900	1F MDD + Tank Fill	892	8
1B	800	-	-	800	1B, 2E/3E, 5E MDD + Tank Fill	796	4
2E/3E	-	-	265 (h)	265	2E/3E, 5E MDD + Tank Fill	263	2
5E	-	-	17	17	5E MDD	9.5	8

Notes:

(a) Firm turnout capacity defined as the maximum rated flow capacity of each turnout with one turnout in each pressure zone offline. For gravity fed turnouts maximum capacity is equal to PRV flow capacity. For pumped turnouts, Hannah and Glen Ellen, capacity is equal to the firm capacity of the associated booster pump station.
(b) Firm well capacity defined as the total well capacity with the largest well offline.
(c) Firm pumping capacity defined as the total capacity of all pumps minus the capacity of one domestic pump.
(d) Required supply criteria for each pressure zone is further described in Section 5.1.1.
(e) Proposed Donald BPS upgrades include two 115-gpm domestic pumps and one 1,000-gpm fire pump.
(f) Proposed Chesnut BPS upgrades include two 100-gpm domestic pumps and one 1,000-gpm fire pump.
(g) Capacity accounts for proposed 450-gpm Eldridge BPS.

Table 5-4
Water Storage Capacity Requirements by Pressure Zone with Recommended Improvements

Pressure Zone(s)	Proposed Storage Capacity (a) (b)		Future Requirements					
	(1,000 gal)	Notes	Operational Storage (1,000 gal)	Fire Storage (1,000 gal)	Emergency Storage (1,000 gal)	Total Required Storage (1,000 gal)	Available Surplus from Upstream Zone (1,000 gal)	Storage Capacity Surplus (Deficit) (1,000 gal)
1F	850	Addition of 0.35 MG tank; can deliver storage to 1B by gravity	171	420	253	844	-	**6**
2D & 3D	320	Can deliver storage to 1 by gravity	55	120	115	291	-	**29**
2B	200	Can deliver storage to 1 and 2A by gravity	13	120	18	151	-	**49**
1A	1,200	Typically operates as single zone with 1 and 2A; can deliver storage to 1 and 2A by gravity	94	420	220	734	-	**466**
4E & 5E	54	PRVs added to deliver storage to 3E by gravity	3.41	0 (c)	4.71	8.12	-	**46**
2E & 3E	207.5	Zones 2E and 3E consolidated and SV Lower Tank abandoned; PRV added to deliver storage to 1B by gravity	31	120	38	189	46	**64**
1B	2,000	Can receive storage from 1F and 2E-5E and deliver to 1 by gravity	102	420	240	761	70	**1,308**
1 & 2A	800	Can receive storage from 1A, 1B, 1F (through 1B), 2E-5E (through 1B), 2B, and 2D by gravity.	0 (d)	420	2,148	2,568	1,853	**85**
TOTAL	5,662							

Notes:

(a) Proposed storage capacity includes a new 0.4 MG storage tank in Pressure Zone 1F, consolidation of Pressure Zones 2E and 3E and abandonment of Sobre Vista Lower Tank, and installation of new PRVs between 5E and 4E, 4E and 3E/2E, and 3E/2E and 1B.

(b) = denotes improvements

(c) Fire storage volume requirement for the Sonoma Mountain Homestead area provided by a private irrigation system.

(d) Operational storage for Pressure Zones 1 and 2A is not required because Aqueduct provides peak demands by gravity. While this is also normally true for Pressure Zones 1A and 1B, operational storage is required because pumping is still required under certain operational conditions.

6.0 WATER DISTRIBUTION SYSTEM HYDRAULIC MODEL DEVELOPMENT

This section describes the development, validation, and calibration of the District's water system hydraulic model. A hydraulic model transforms information about the physical water facilities and distribution system into a mathematical model to analyze the water system under various demand and operational conditions. The hydraulic model generates information on pressures, flows, velocities, and head losses that can be used to assess system performance and identify deficiencies. The hydraulic model can also be used to verify the adequacy of recommended or proposed system improvements.

To develop the hydraulic model, EKI completed the following tasks:

- Updated the AutoCAD map of the District's distribution system;
- Created a hydraulic model of the District's distribution system based on the updated AutoCAD map;
- Spatially allocated existing and future demands using the District's billing data and distributed these demands to nodes in the model;
- Validated the hydraulic model to check the accuracy of the model's representation of real system operations; and
- Calibrated the hydraulic model using flow and pressures observed in the field during hydrant flow testing on 17 and 18 December 2018 and 28 January 2019.

EKI worked closely with District staff to obtain and review data required to develop the model. Development of the hydraulic model is discussed in more detail, below.

6.1 Model Construction

EKI constructed the model in Innovyze's InfoWater software package using the District's existing AutoCAD map of the distribution system, available as-built records, SCADA data, and water billing records to populate the network of nodes (i.e., tanks, pumps, valves, hydrants, reservoirs, and pipe junctions) and pipes that comprise the model. The steps completed to populate information for each of these elements are discussed below.

6.1.1 Pipelines and Junctions

EKI updated the District's existing AutoCAD map to incorporate recent pipeline replacement projects and to edit the pipe AutoCAD layering to match the pipe material and size text labels. AutoCAD blocks for hydrant elements were converted to line segments with an assumed length of 10 feet. Next, EKI reprojected the AutoCAD map from a local coordinate system to North American Vertical Datum 1983 (NAD83) California State Plane 2.

EKI exported AutoCAD pipe layers into a geographic information system (GIS) geodatabase with attribute fields for pipe size and material to import into the InfoWater software. After importing the geodatabase, EKI used the InfoWater Append Nodes tool to create and assign beginning and end nodes to each pipe segment and used software tools to check pipe and node connectivity.

For each pipe segment, a roughness factor (i.e., Hazen-Williams coefficient of friction or "C-factor") needs to be assigned to represent the frictional losses along the pipe section. The District did not have any information regarding the roughness factors associated with its water mains. EKI assigned preliminary C-factors based on typical values for various materials and diameters. These preliminary C-factors were evaluated during model calibration (see Section 6.2).

6.1.2 Water System Facilities

After adding the pipes and junctions to the model, EKI added the following information for each system facility to the model based on information inventoried in Section 3.0:

- Tanks
    - Diameter
    - Height
    - Normal low water level
    - Base elevation
- Booster Pump Stations (BPSs)
    - Pump curves
    - Elevation
- Wells (modeled as a reservoir and pump combination)
    - Normal groundwater levels
- Pressure Regulating Valves (PRVs)
    - Pressure settings
    - Elevation

Pump curves were derived from pump flow, suction pressure, and discharge pressure data, tank normal low water levels were derived from SCADA data, and PRV settings were provided by the District. As discussed in Section 6.3, PRV settings originally provided by the District were refined by EKI to balance flows from the SCWA turnouts and limit flow through the Hannah Lower PRV between Pressure Zones 1B and 1.

6.1.3 Sonoma County Water Agency Aqueduct and Turnouts

EKI modeled the portion of the SCWA Aqueduct that supplies flows to the District. Modeled SCWA elements include:

- Aqueduct pipelines between Trinity Oaks Turnout and Sonoma Tank;
- Eldridge Tanks;
- Sonoma Tank; and
- Each of the District's SCWA turnouts and meters.

A single reservoir was modeled directly upstream of Trinity Oaks Turnout to represent the pressure in the aqueduct as it reaches the District. EKI added the tank characteristics for each SCWA tank and head loss curves for the SCWA meters. The reservoir and tank levels can be adjusted to represent varying SCWA operating conditions, and tank filling cycles, which act to lower SCWA aqueduct pressures upstream of the tanks, can also be simulated. Additionally, this methodology allows for more accurate fire flow simulations by capturing upstream and downstream pressure effects on the SCWA aqueduct which may reduce the available flow through each turnout.

6.1.4 System Elevations

EKI populated elevation data for each of the model junctions and facilities based on LiDAR bare ground elevation maps provided by Sonoma County. Elevations in these maps were extracted and assigned to each node in the hydraulic model. Elevations are based on North American Vertical Datum of 1988 (NAVD 88). Tank and pump station elevations were spot checked against available as-built records.

6.1.5 Water Demand Allocations

Based on the water demand analysis performed in Section 4.0, EKI developed parcel-by-parcel existing and future water demand projections. These water demands were allocated to the appropriate nodes in the model using modeling software tools to create existing and future demand scenarios. Model demands were assigned under separate water billing classifications as shown in Table 6-1. Separate model demand fields allow for operational flexibility and could allow for the application of billing-class-specific diurnal patterns or peaking factors, if needed.

Table 6-1. Model Demand Assignments

Model Demand Field	Billing Classification
1	Single Family Residential
2	Commercial
3	Institutional
4	Multi-Family Residential
5	Commercial Irrigation
6	Multi-Family Irrigation
7	Fire Line Demands

The pressure-zone-specific MDD and PHD peaking factors were applied to the allocated to create the MDD and PHD demand scenarios for both existing and future conditions.

6.1.6 Fire Flow Allocations

EKI assigned the fire flow requirements to each hydrant node in the model based on the adjacent land use to perform fire flow modeling analyses. As discussed in Section 4.4, a required fire flow of 1,000 gpm was assigned to hydrants in residential areas and a required fire flow of 2,500 gpm was assigned to hydrants in commercial and institutional areas.

6.2 Model Validation and Calibration

After model construction, EKI validated and calibrated the model to verify correct model construction, controls, and correct assignment of model variables. EKI conducted model validation runs of the existing

system scenario to check the accuracy of the model's representation of real system operations. EKI verified the results of these validation runs against SCADA outputs provided by the District and made minor modifications to system facilities and pipe connectivity to confirm modeled system pressures were generally consistent with actual system pressures.

After initial model validation, calibration field testing and model runs were performed to confirm the finer accuracy of model settings and evaluate appropriate C-factors for various pipe sizes and locations. EKI developed a calibration test plan that is included in Appendix A. The test procedures, calibration criteria, and results are discussed in the following sections.

6.2.1 Calibration Testing Procedures

Hydrant flow testing consisted of flowing hydrants and measuring the flow and residual pressures upstream of the flowing hydrant prior to and during the flow testing. These flow and pressure data are recorded and compared against the model results for calibration purposes.

Two types of hydrant tests were conducted:

1. Hydrant flow tests; and
2. C-factor tests.

During hydrant flow tests, all valves are left open to mimic normal operating conditions. This test measures the system's ability to produce required fire flows at a given location and can illuminate macro-level issues in the model's settings such as pump controls, pipe diameter, demand conditions, or pipe connectivity issues. Additionally, this test can illuminate other real-world operating issues such as partially closed valves.

For C-factor tests, certain valves are closed to isolate and measure flow and pressure along a single line. This test allows for determination of frictional losses along the isolated pipeline. Based on these measurements, the modeled C-factors can be compared to and calibrated to observed data. Test locations along a single dead-end line only require a single test to capture both hydrant flow and C-factor test information.

6.2.2 Field Testing

EKI selected 13 test locations, as listed in Table 6-2. These locations were selected to ensure that data was collected for a wide range of pipeline sizes, ages, and materials and pressure zones. Additionally, these tests were located sufficiently distant from tanks and pumps to avoid unintended influences and to ensure sufficient pressure drop in the tested pipeline to allow for more accurate calibration.

The District's operations staff performed testing on 17 and 18 December 2018 and select retesting on 28 January 2019. At locations along dead-end lines, a single test was performed. At all other locations, both hydrant tests and C-factor tests were performed. Appendix A shows for each location the flow hydrant, test hydrants (where residual pressures were measured), which valves were closed to perform the C-factor tests, and test results.

Table 6-2
Fire Hydrant Testing Locations

Test Number	Diameter	Material	Pressure Zone	Flow Hydrant Location	Isolation Required (For C-Factor Test)	SCWA Turnout Monitored
1	6	ACP	3E	1225 Sobre Vista Road		
2	6	DIP	1F	4120 Lakeside Road	X	Glen Ellen
3	8	ACP	1F	14600 Arnold Dr.		Glen Ellen
4	8	PVC	1B	143 Loma Vista Dr.		Hannah
5	6	PVC/DIP	2B	640 Michael Dr.		
6	6	DIP	3D	17201 Cragmont Dr.		
7A	6	ACP	2D	17398 Hillside Ave.		
7B	6	DIP	2D	17387 Buena Vista Ave.		
8	14	ACP	1A	21115 Via Colombard	X	
9	12	PVC	1	16501 Meadow Oaks Dr.	X	Agua Caliente
10	6	ACP	1	1299 Fowler Creek Road		
11	10	PVC	1	1171 Solano Ave.	X	Verano
12	6	ACP	1	18500 Happy Ln.	X	

During testing, the District also monitored pressures upstream and downstream SCWA turnout PRVs that could supply flow to hydrants. This data was used in conjunction with SCADA data provided by the District so that the modeled tank set points and pump flow rates matched actual operating conditions for each test scenario.

6.2.3 Calibration Criterion

Various criteria exist to calibrate hydraulic models based on the quality and quantity of available data and intended model use. For purposes of long-range master planning, EKI uses a calibration criterion ±10% (i.e., the modeled and observed system pressures must agree to within ±10%). This criterion creates a tighter ±2 pounds psi range for the lowest pressures measured (approximately 20 psi) and a wider range of ±8 psi for the highest pressure measured while hydrants were flowing (approximately 80 psi).

6.2.4 Calibration Results

For the first set of fire hydrant testing data collected on 17 and 18 December 2018, with minor modifications to pump controls and slight adjustments to turnout PRV settings, modeled results met the ±10% calibration criteria for static pressures at all but three residual hydrants. All static pressure results were within 14%.

With adjustments to the preliminary C-factor assignments, EKI was able to successfully calibrate 6 of the C-factor tests to within the ±10% calibration criteria. Other tests could not be calibrated either because a pressure of zero was observed (Test 5 along Michael Drive), residual hydrants could be tested along a single sections of main (Test 6 at the end of Cragmont Drive), test results indicated an unusually high C-factor (i.e., smooth pipe), or because pressure readings were deemed to be unreliable because they could not be reconciled with model results. Four locations were flagged for re-testing.

During re-testing on 28 January 2019, field staff measured pressures at a single location with multiple gauges used for calibration testing and documented that readings varied by up to 11 psi between gauges. Therefore, EKI has conservatively assumed that the calibration analyses, which indicated that higher C-factors might be appropriate, do not have sufficient precision to support increasing pipe C-factors above typical values. Thus, EKI has used calibration data to establish general C-factor assignments by pipe material and reduce C-factors where appropriate. Final modeled C-factor are summarized in Table 6-3.

Complete results for each hydrant test are included in Appendix B.

6.3 PRV Setting Adjustments

During the model calibration runs, EKI observed that with the existing PRV settings provided by the District certain SCWA turnouts were not delivering flows and a significant amount of water was being delivered between Pressure Zones 1B and 1 through the Hanna Lower PRV. EKI adjusted the PRV settings in the model to better balance flows from the SCWA turnouts and limit flow between Pressure Zones 1B and 1 during normal operations. Recommended PRV setting adjustments are shown in Table 6-4.

Table 6-3
Final Model C-factors

Pipeline Material		C-Factor (a)	
	Pressure Zone	Diameter ≤ 8-inches	Diameter > 8-inches
Asbestos Cement	Pressure Zone 1	140	150
	All Other Pressure Zones	150	150
Cast Iron	All Pressure Zones	90	100
Ductile Iron		130	140
High Density Polyethylene		140	150
Polyvinyl Chloride		140	150
Steel		110	120
Unknown		120	130
Fire Hydrant Lateral and Assembly (b)	All Pressure Zones	60	--

Notes:

(a) PZ-2D has conservative pipe specific C-factors ranging between 80 and 140 for portions of Steel, PVC, and Ductile Iron pipe to better represent calibration testing data.

(b) It is assumed that hydrant laterals are 10-feet long extending from the water main.

Table 6-4
Recommended PRV Setting Adjustments

PRV ID	Description	Type	Pressure Zone Served	Size (in) (a)	Elevation (ft)	Original PRV Setting (psi)	Recommended PRV Setting (psi) (b)
PRV-1	Verano Turnout PRV	SCWA Turnout Pressure Reducing	1	8	98	65	71
PRV-2	Verano and Main Turnout PRV		1	10	124	72	64
PRV-3	Verano and Fifth Turnout PRV		1	6	108	90	78
PRV-4	Boyes Boulevard Turnout PRV		1	6	121	60	61
PRV-5	Altimira Turnout PRV		1	8	125	60	60
PRV-6	Agua Caliente Turnout PRV		1	6	141	57	65
PRV-7	Hanna Turnout PRV		1B	10	142	70	70
PRV-9	Madrone Turnout PRV		1B	10	171	72	72
PRV-11	Glen Ellen Turnout PRV		1F	6 & 4	293	74	76
PRV-12	Trinity Oaks Turnout PRV		1F	6	298	75	75
PRV-10	Eldridge PSV/PRV	Reducing	1F to 1B	6	213	50 PSI (PZ1B)	49
PRV-13	Hanna Lower PRV	Reducing	1B to 1	12	165	60 PSI (PZ1)	52

Notes:
(a) Verified by Valley of the Moon Water District operations staff on 9 November 2018.
(b) Recommended PRV settings based on modeling analysis as further discussed in Section 6.3.

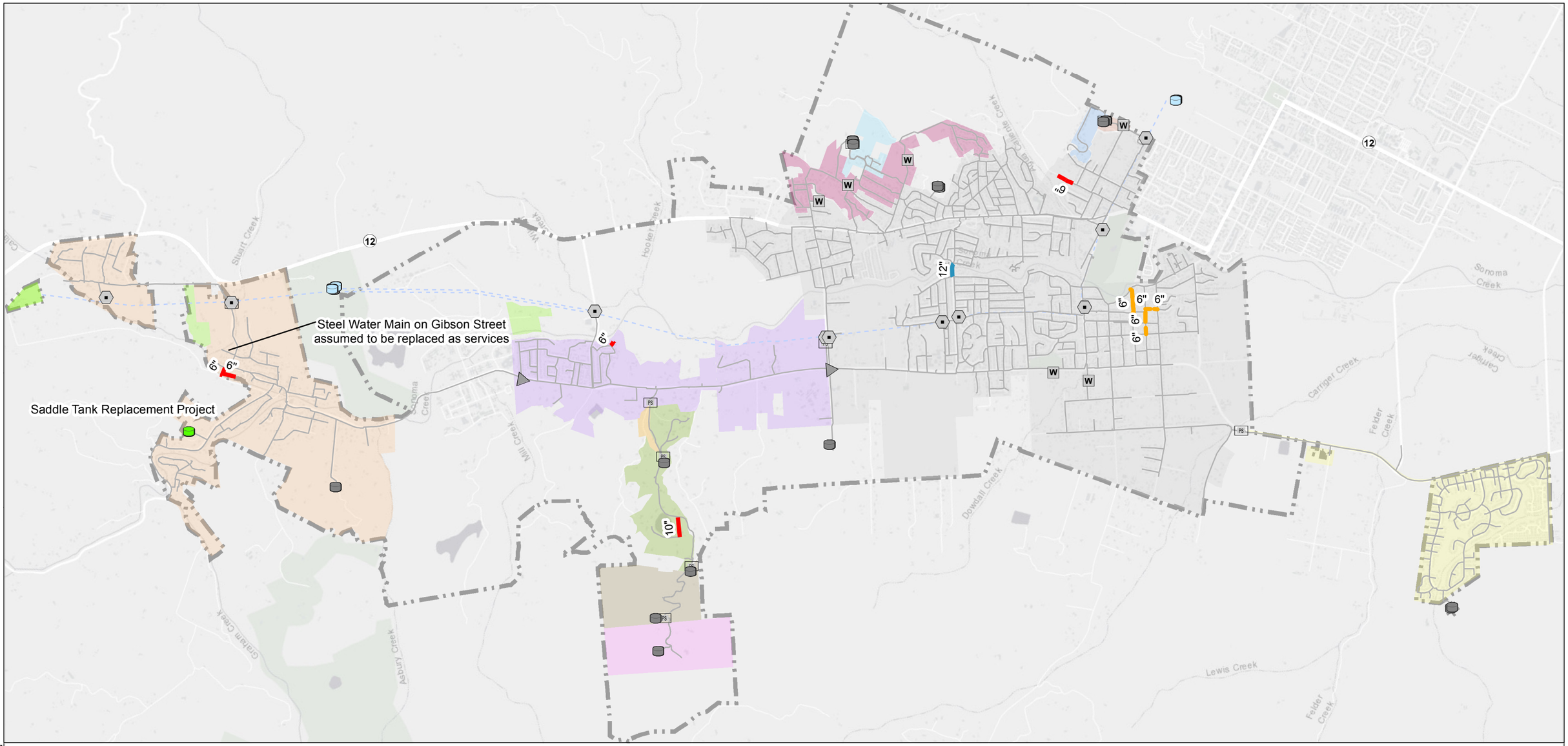
Abbreviations:
gpm - gallons per minute
PRV - pressure reducing valve
PSV - pressure sustaining valve
SCWA - Sonoma County Water Agency

6.4 Modeling Scenarios

As discussed in Section 8.0, the District's water system was evaluated under existing demand conditions and projected future demand conditions. The future scenario includes upcoming capital improvement projects (CIPs) currently in the design or construction phase, including:

- Completion of the Walnut Ave, Oak St. & Penny Ln. Water Main Replacement Project (currently in construction);
- Completion of the Gibson St., Riddle Rd Easement, Sobre Vista (near Lake Josephine), Brookview & Lomita Steel Water Main Replacements (currently in design);
- Completion of the Boyes Blvd. Bridge Pipeline Replacement Project (currently in design); and
- Construction of a new approximately 0.15 MG storage tank to replace Saddle Tank (currently in design).

These scenarios were evaluated under the modeling simulations described in Section 8.0 to identify existing and projected future capacity deficiencies.



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

1, 1A, 1B, SCWA, 1F, 2A, 2B, 2D, 2E, 3D, 3E, 4E, 5E

Pipeline Projects Included

- Gibson St., Riddle Rd Easement, Sobre Vista (near Lake Josephine), Brookview & Lomita Steel Water Main Replacements Project (currently in design)
- Completion of the Walnut Ave, Oak St. & Penny Ln. Water Main Replacement Project (currently in construction)
- Boyes Bridge Pipeline Replacement Project (currently in design)

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

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Projects In Developement Included in Future Modeling Scenario

Valley of the Moon Water District
Sonoma County, CA
April 2019
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Figure 6-1

eki environment & water

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7.0 WATER DISTRIBUTION SYSTEM PERFORMANCE AND SIZING CRITERIA

This section develops recommended water distribution system performance and sizing criteria for water distribution pipelines to be used when evaluating the District's water system under existing and future modeling scenarios described in Section 8.0. These criteria are summarized in Table 7-1.

7.1 Distribution System Pressures

The distribution system's ability to maintain adequate system pressures is the primary indicator of acceptable system performance. Under normal operating conditions, the distribution system is required to maintain a minimum pressure of 35 psi at all service connections based on District standards. A maximum pressure of 80 psi is required at all service connections where there are not individual service PRVs installed. It is understood that the District has agreements with residents at the certain far reaches of the distribution system where the system frequently operates below 35 psi. In these locations, some residents have installed and maintain small booster pumps on their service connections to increase pressure as-needed. Further, while 35 psi is acceptable for most uses, fire sprinkler systems may need upwards of 50 psi to function optimally. When new services include fire sprinkler systems, the District reviews the plans and documents whether booster pumps have been deemed necessary.

As discussed in Section 4.4, the system must be able to maintain a minimum of 20 psi throughout the system under fire flow conditions to comply with California Code of Regulations, Title 22 (Title 22) requirements.

7.2 Water Transmission and Distribution Pipeline Sizing Criteria

The following pipeline velocity and head loss criteria are used for sizing new transmission and distribution pipelines. However, when evaluating the existing system, velocity and head loss criteria are secondary to the system pressure criteria (Section 7.1).

For example, if system pressures are satisfied under PHD and MDD plus fire flow (FF) conditions, an existing pipe that exceeds maximum velocity or head loss criteria are not necessarily indicative of a problem that requires system improvements. Any identified exceedances have been reviewed on a case-by-case basis to determine if they are influencing any deficient system pressures or if improving these pipes to meet velocity or head loss criteria would benefit the water movement within the system. In certain cases, upsizing deficient upstream piping near supply sources where flow and headloss are greatest can effectively address multiple downstream pressure deficiencies.

7.2.1 Velocity Criteria

The following velocity criteria, in conjunction with head loss criteria described below, are recommended for sizing of new water mains:

- PHD conditions: Maximum velocity of 6 feet per second (fps) for all mains
- MDD plus fire flow conditions: Maximum velocity of 10 fps for all mains

As discussed above, for existing infrastructure these criteria are secondary to pressure criteria and are evaluated to identify potential bottlenecks in the system that could be upsized to address pressure deficiencies.

7.2.2 Headloss Criterion

In addition to velocity criteria, the following head loss criterion must also be met for sizing of new water mains:

- PHD conditions: Maximum head loss of 7 feet per 1,000 feet of pipe (ft/k-ft)

For existing pipelines this criterion is used to identify bottlenecks in the system that if upsized could relieve downstream pressure to meet pressure criteria and improve connectivity of major supply sources and storage facilities to outlying areas.

Table 7-1
Summary of Recommended Potable Water System Performance and Operational Criteria

Component	Criteria
Fire Flow Requirements	
Single Family Residential	1,000 gpm for 2 hours.
General Commercial and Office	2,500 gpm for 2 hours.
Distribution System Pressure Requirements	
Maximum Pressure	80 psi at customer service connections without PRVs on service laterals
Minimum Pressure - Normal Operating Conditions (a)(b)	35 psi at customer service connections excluding fire flow
Minimum Pressure - Max Day Plus Fire Flow Conditions	20 psi (Title 22 requirement for minimum allowable pressure)
Recommended Pipeline Sizing Criteria	
Maximum Velocity (Secondary)	6 ft/s, all system mains, peak hour demand 10 ft/s, all system mains, maximum day plus fire flow
Maximum Head Loss (Secondary)	7 ft per 1,000 ft, peak hour demand
Hazen Williams "C" Factor	New piping = 140 Existing system piping = 80 - 150 per model calibration Standard 10-foot hydrant lateral and assembly = 60 per model calibration
New Distribution Main Diameter	General: 8-inch diameter or larger Cul-de-sacs and dead end runs: 6-inch diameter acceptable within cul- de-sacs and dead end runs of less than 500 feet where future extensions will not occur and no fire hydrants are located. Commercial: 10-inch diameter or larger.

Notes:

(a) Title 22 CCR Section 64602 requires that water distribution systems maintain a minimum of 40 psi in each expansion of the distribution system that expands the existing system service connections by more than 20 percent. No developments of this magnitude are currently planned.

(b) The District maintains individual agreements with customers where the minimum pressure cannot be maintained due to elevation. Customers may need to provide booster pumps to increase pressure for fire suppression systems.

8.0 WATER DISTRIBUTION SYSTEM MODELING EVALUATION

The following sections describe the modeling approach and results.

8.1 Modeling Approach

To evaluate distribution system performance against performance criteria, EKI conducted steady-state model simulations of (1) PHD and (2) MDD+FF for both the Existing and Future Scenarios.

PHD Simulations

The followings operating conditions were assumed under the PHD model runs to represent normal "worst-case" operating conditions:

- All groundwater wells were out of service;
- Donald and Chestnut BPSs operating at firm domestic capacity (i.e., with the largest pump out of service) with all fire pumps offline;
- All other BPSs offline;
- All PRVs set at the recommended PRV settings listed in Table 6-4;
- All tanks (including Eldridge and Sonoma SCWA Tanks) filled to their normal low levels;
- Eldridge Tank and Sonoma Tank filling at 2,700 gpm and 500 gpm, respectively, which represent the average fill rates according to an analysis of available SCADA data; and
- The hydraulic grade level in the SCWA Aqueduct as it enters the District set at approximately the average level.

Results from these simulations provided information on junction pressures and pipeline head loss and velocity under PHD conditions.

MDD + FF Simulations

The MDD + FF scenarios were run under the same operational conditions as the PHD simulations with the following exceptions:

- Fire pumps are available as-needed; and
- BPSs controls were set such that pumps switched on (up to firm capacity) when upstream pressures dropped below normal levels, representing the District's ability to manually turn pumps on if needed during an emergency.

EKI also ran the MDD+FF simulations with all groundwater wells in service. Results for these analyses provided in Appendix C.

The fire flow simulations determine the fire flow availability at each hydrant while maintaining a minimum of 20 psi everywhere in the system. These results were compared to required fire flows to determine which hydrants are not meeting the required criteria. To address observed fire flow deficiencies, additional fire flow analyses were conducted under MDD+FF conditions on a case by case

basis by manually applying fire demands on individual hydrant nodes to assess pipeline head loss and velocity under fire flow conditions.

8.2 Existing Scenario Evaluation

Existing scenario model simulations were evaluated to identify existing system deficiencies, as are discussed in the following sections.

8.2.1 PHD Results

Model results indicate that the existing system cannot meet minimum pressure criteria of 35 psi system-wide under PHD conditions. Modeled system pressures at service connections ranged from approximately 27 psi to 135 psi, as shown on Figure 8-1. The lowest pressures were observed at high elevation service connections near the Chestnut Tank, the Sobre Vista Upper Tank, Glen Ellen Tank, and prior to the Agua Caliente Well and pump station along East Aqua Caliente Road.

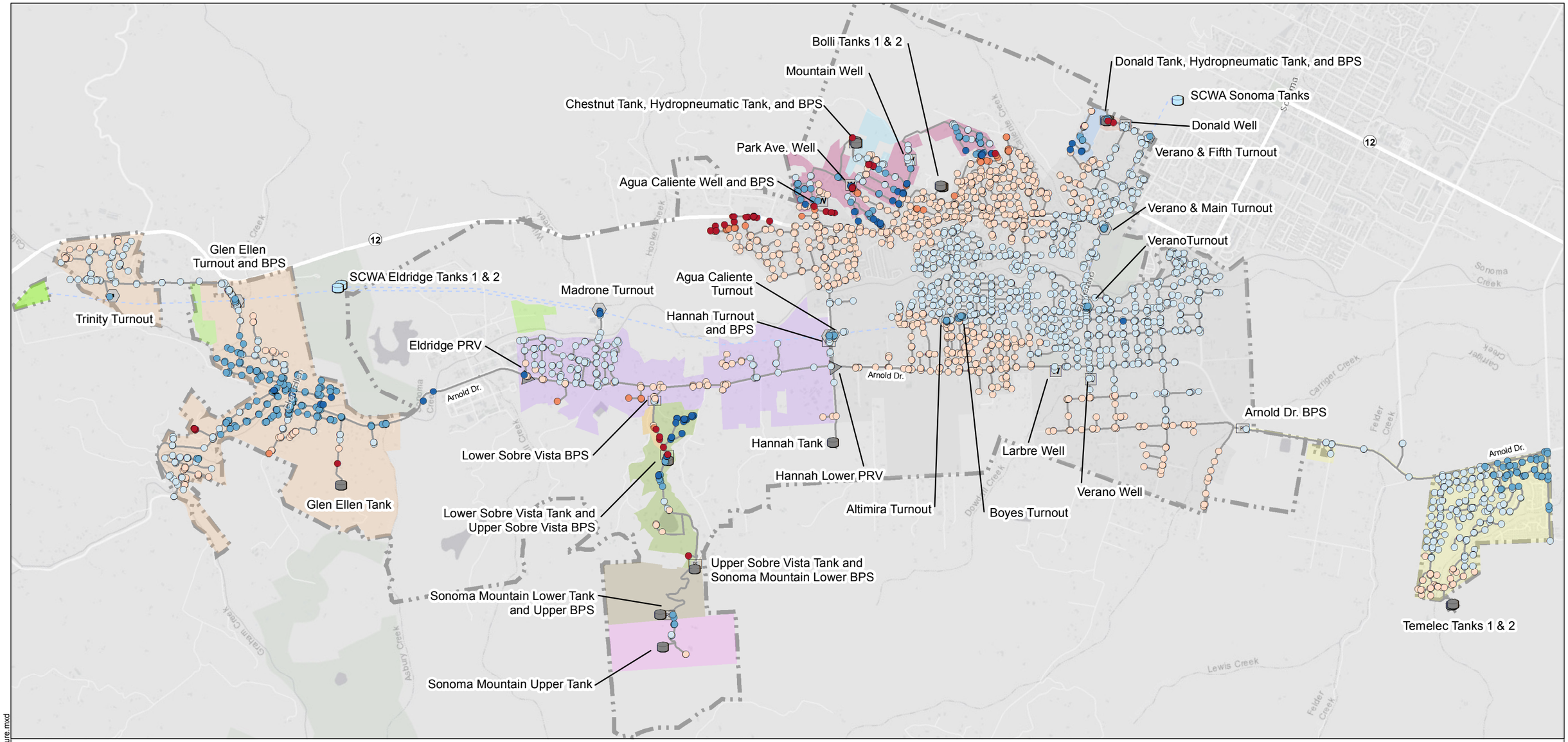
Analysis of pipeline head losses and velocities indicate that the system is generally able to meet the required criteria. The highest headloss of 13.2 ft/k-ft is experienced on the 8-inch main leading from Agua Caliente Turnout towards Highway 12, which exceeds the criteria of 7 ft/k-ft. Although headloss is a secondary criterion, this section of pipeline is recommended for replacement to improve transmission capacity from Aqua Caliente Turnout and help address both deficient PHD pressures and fire flows.

8.2.2 MDD Plus Fire Flow Results

Modeled fire flow availability is shown on Figure 8-2. Several hydrants cannot meet fire flow requirements, including:

- Multiple hydrants in the Trinity Oaks residential area in Pressure Zone 1F.
- Multiple hydrants in the residential areas along Warm Springs Road in Pressure Zone 1F.
- Multiple hydrants in the Glen Ellen commercial area along Arnold Drive in Pressure Zone 1F.
- Four hydrants in Eldridge residential neighborhoods in Pressure Zone 1B.
- Multiple hydrants with significant deficiencies throughout Sobre Vista and Sonoma Mountain in Pressure Zones 2E, 3E, 4E, and 5E.
- Multiple hydrants in commercial areas proximate to Highway 12 Pressure Zone 1.
- Three hydrants around the Altimira Middle School in Pressure Zone 1.
- Four hydrants in residential areas proximate to Arnold Drive in southern Pressure Zone 1.
- Two hydrants in residential neighborhoods of Pressure Zone 2D.
- Three hydrants in residential neighborhoods of Pressure Zone 3D.
- All hydrants in Pressure Zone 2B.

As shown in Appendix C, Figure C-1, the identified fire flow deficiencies are largely the same with groundwater wells in service, indicating the wells have minimal influence on the fire flow availability.



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Junction Pressure, psi

- Less than 35 (Not Meeting Criteria)
- 35 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Greater than 100

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

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Feet

Existing Water System Performance Evaluation
Peak Hour Demand - System Pressures

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 8-1

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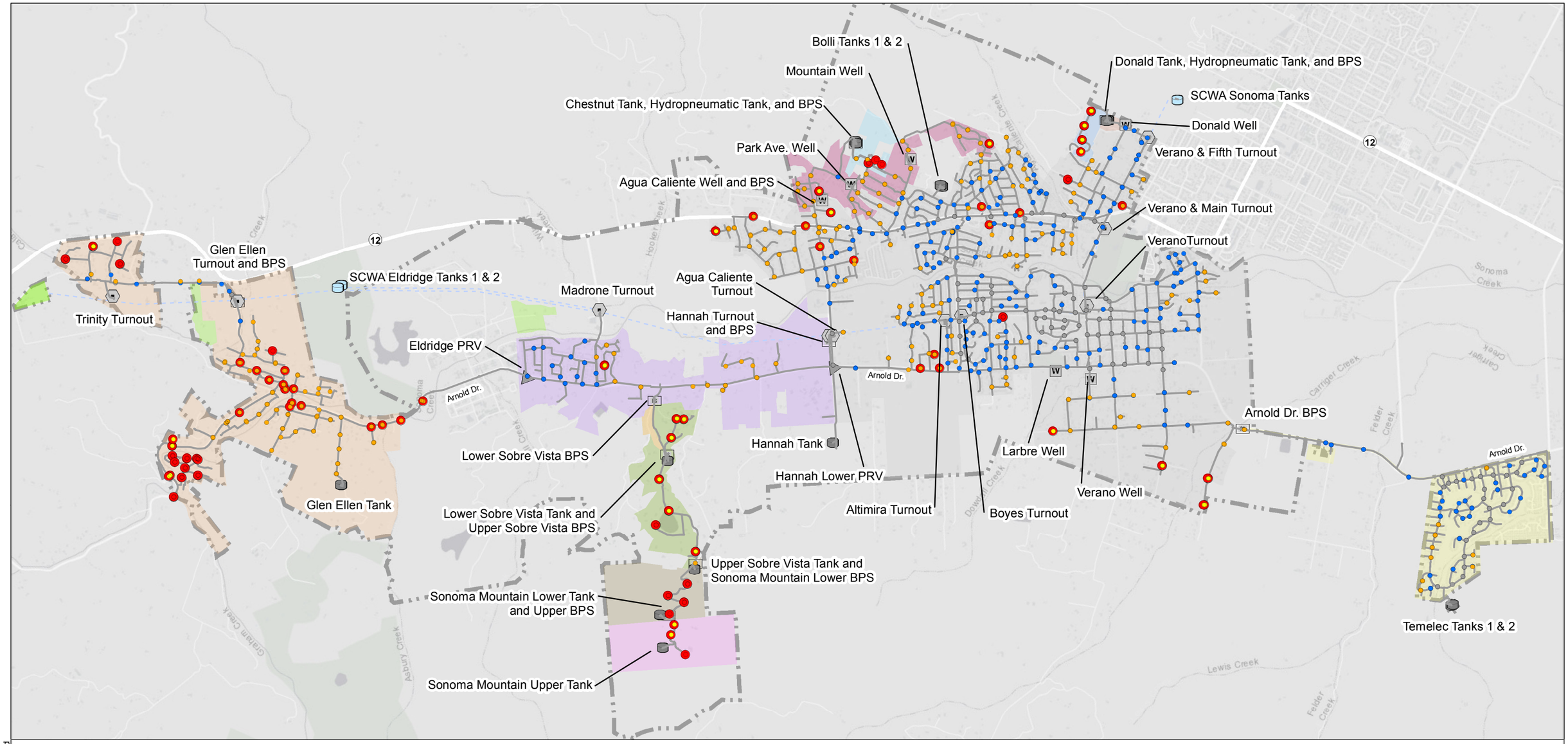

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Existing Water System Performance Evaluation
Max Day Demands - Available Fire Flow

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 8-2

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8.3 Future Scenario Evaluation

Modeled results for the Future scenario were evaluated to anticipate system deficiencies under future demand conditions. As discussed in Section 2.3, the Future scenario includes CIPs currently in planning or design phases, such as the Saddle Tank replacement and steel water line replacement project.

8.3.1 PHD Results

Model results for the Future scenario are similar to the Existing scenario, indicating that the planned development including the Springs Specific Plan does not significantly impact system pressures. Modeled system pressures at service connections under PHD ranged from approximately 25 psi to 135 psi, as shown on Figure 8-3. The lowest pressures experienced are located at similar locations as discussed in Section 4.2.1, and low-pressure areas have expanded slightly.

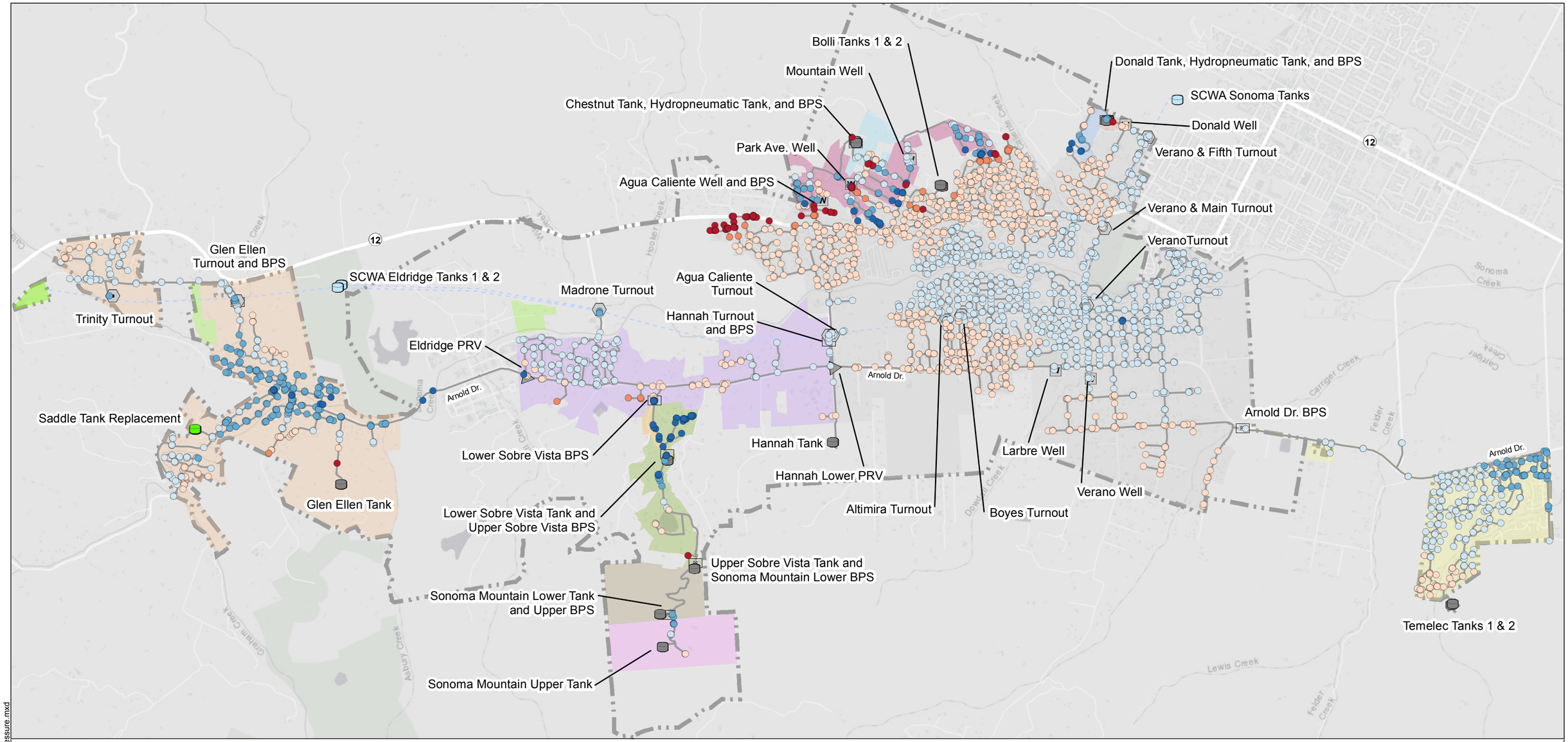
8.3.2 MDD Plus Fire Flow Results

Modeled fire flow availability is shown on Figure 8-4. Fire flow deficiencies in the Future scenario are generally similar to the Existing scenario. The installation of the Saddle Tank helped address many fire flow deficiencies in the Glen Ellen area, though several deficient hydrants remain.

8.4 Recommended Distribution System Capacity Improvements

Projects were developed to solve each hydraulic capacity deficiency identified in the hydraulic modeling evaluation. EKI first modeled the proposed the facility improvement projects discussed in Section 5.4. For the remaining deficiencies, EKI identified pipeline projects to improve system pressures. In general, supply source and storage tank transmission pipelines that exhibited higher velocities and head losses in modeling results were targeted first, because upsizing these pipelines can significantly assist downstream pressure issues. Remaining fire flow deficiencies were addressed by upsizing distribution mains, adding new pipe connections, or by replacing the hydrant with a larger lateral. Lastly, transmission mains were identified for upsizing which could assist pressure deficiencies.

These hydraulic capacity projects are discussed in Section 9.0. EKI modeled the proposed improvements under future demand conditions to confirm that the identified deficiencies had been addressed. These results are presented in Appendix D.



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility

Junction Pressure, psi

- Less than 35 (Not Meeting Criteria)
- 35 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Greater than 100

Abbreviations
BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes
1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources
1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N
0 3,000 6,000
Feet

Future Water System Performance Evaluation
Peak Hour Demand - System Pressures

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00
Figure 8-3

eki environment & water

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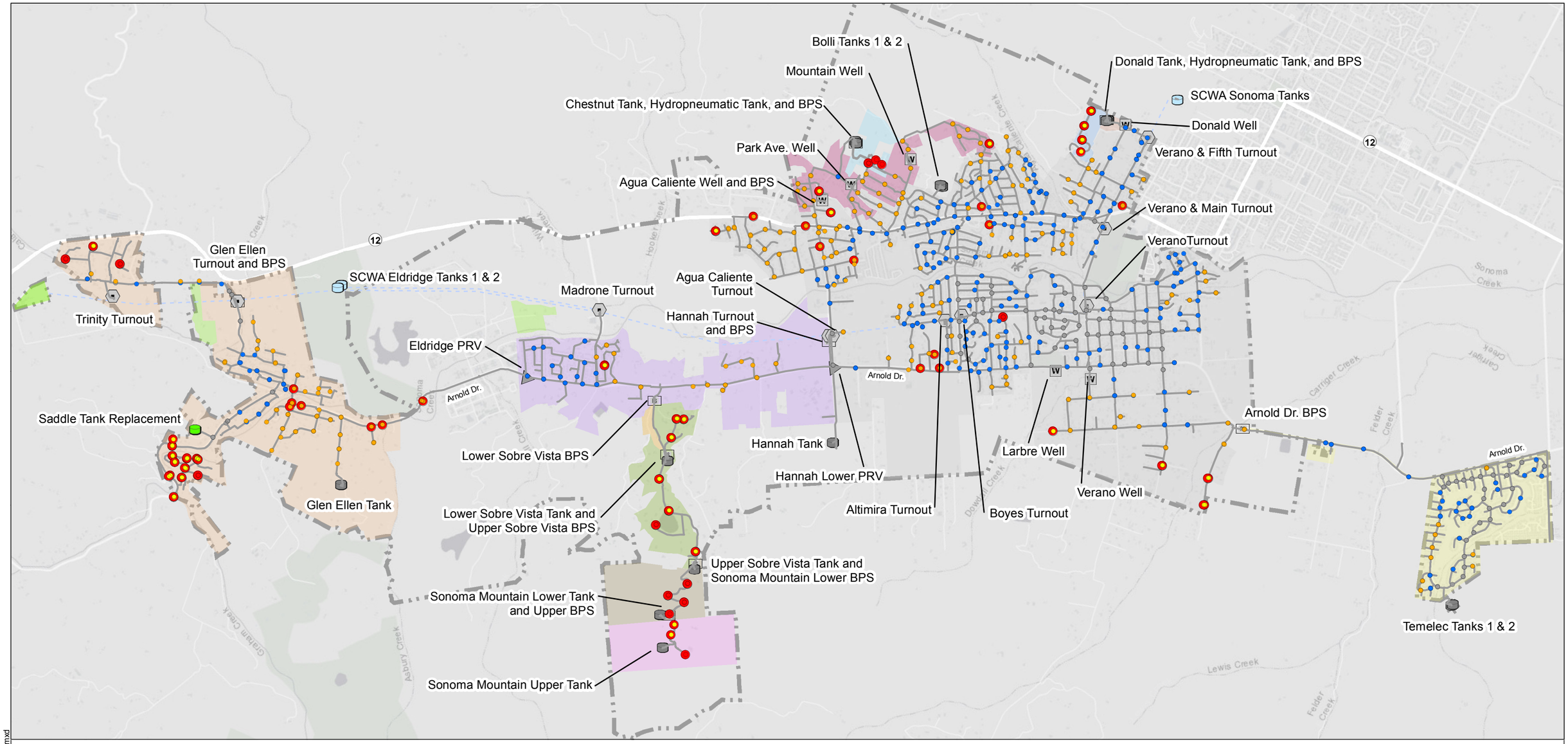

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Future Water System Performance Evaluation
Max Day Demands - Available Fire Flow

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 8-4

eki environment & water

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9.0 RECOMMENDED CAPITAL IMPROVEMENT PROGRAM

This section summarizes the recommended CIP that includes the (1) supply and storage facility improvements recommended in Section 5.4, the hydraulic capacity improvement projects to address deficiencies identified in Sections 8.2 and 8.3, (3) additional pipeline condition projects to replace pipelines that have reached the end of their useful lives, and (4) improvements identified previously by the District that are included in the District's existing CIP budget. EKI has developed opinions of probable cost (OPC) and recommended priorities for each project.

9.1 CIP Costs

Cost for capacity improvement projects have been estimated for both construction completed by District staff based on recent costs provided by the District and by construction contractors based on recent bid results and EKI's experience with similar projects.

These costs are conceptual level estimates, considered to have an estimated accuracy range of -30% to +50%, suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed to design and construction. An OPC for construction of each project has been developed using unit cost factors discussed below and are presented in March 2019 dollars based on an Engineering News Record (ENR) Construction Cost Index (CCI) of 12,048.19 (San Francisco).

The total CIP OPC also includes allowances equal to 50-60% of the construction OPC for project construction contingency, design, construction management, permitting, regulatory compliance, CEQA, and project implementation:

- Project Construction Contingency: 25% for pipeline replacements and 30% for all other projects
- Design: 10% for pipeline replacements and 15% for all other projects
- Construction Management: 5%
- Permitting, Regulatory Compliance, CEQA: 5%
- Project Implementation: 5%

9.1.1 Pipeline Project Costs

Unit costs for water pipeline projects are presented in Table 9-1. These costs vary by diameter both for installations by District staff and construction contractors. These cost factors assume open-trench construction and installation of C900 PVC pipe for all projects. The unit construction costs presented below generally include pipeline materials, trenching, placing and joining pipe, placing imported pipe bedding and backfill material, and partial asphalt pavement replacement, if required. These costs are representative of pipeline construction under normal conditions and would be higher for difficult cases.

Table 9-1. Unit Construction Cost for Pipeline Projects

Pipe Diameter (inches)	Estimated Cost ($/linear foot)	
	Constructed by District Staff	Constructed by Contractor
6	150	215
8	180	260
10	215	310
12	260	370

In addition to the unit construction cost for length of pipe installed, Table 9-2 presents additional unit costs that have been included to better estimate total project costs.

Table 9-2. Miscellaneous Costs for Pipeline Projects

Item	Estimated Cost ($/ea)	
	Constructed by District Staff	Constructed by Contractor
Hydrant Replacements	5,000	18,000
Service Replacements	1,500	4,000
Main Connections	2,000	7,500

EKI assumes that additional fire hydrants, if requested by the Fire Department, would be funded by the Fire Department.

9.1.2 Treated Water Storage Tank Costs

Treated water storage tank costs are based on unit-volume cost factors which include the installation of above-grade steel storage tank, site piping, earthwork, paving, instrumentation, and all related sitework. Note that these costs are representative of construction conducted under normal excavation and foundation conditions and would be significantly higher for special or difficult foundation requirements.

9.1.3 Booster Pump Station Costs

The BPS OPCs conservatively assume full replacement the BPSs at the flow rates specified. This assumption has been made to capture the potential need for major BPS upgrades due to increased electrical loading or for condition-based replacements. Costs include installation of the booster pumps, pump station building, site piping, earthwork, paving, on-site backup/standby power generator, SCADA, and related sitework.

9.1.4 Groundwater Supply Well Costs

The new groundwater supply well OPC assumes the project will consistent of pilot hole drilling, e-logging, water quality/soil sampling, pilot hole reaming, well construction, well development, and installation of the necessary housing, pump, motor, electrical equipment, backup generator, SCADA equipment, discharge piping, and disinfection equipment. The construction OPC for a new 350 gpm well

is estimated to be approximately $1,000,000 based on the costs for the recent installation of Well 5A. The OPC assumes that no additional wellhead treatment will be required.

9.1.5 Miscellaneous Costs

In addition to the costs presented above, other cost factors are presented in Table 9-3.

Table 9-3. Miscellaneous Costs

Item	Estimated Cost ($/ea)	
	District Staff	Contractor
PRV Installation	75,000	100,000
PRV Abandonment	--	10,000
Tank Demolition	--	50,000
BPS Removal	--	50,000
Flow Meter	16,000	32,000

PRV Station cost assumes a pre-assembled packaged PRV station that includes a 6-inch PRV and a 2-inch low-flow bypass PRV, a precast utility vault, and required connection piping, valves, and fittings.

9.2 Recommended Priorities

EKI has developed recommended priorities for each of the proposed improvements. Generally, EKI developed three levels of prioritization, described below:

- **Priority 1** – Critical projects that should be initiated as soon as possible and completed over the next 5 years, including:
    - Replacement of all remaining steel water mains;
    - Projects to address significant fire flow deficiencies in sensitive areas (e.g., areas adjacent to urban-wildland boundary or a school);
    - Pipeline replacements that would benefit from being implemented in conjunction with steel main replacements or Priority 1 fire flow projects;
    - Saddle Tank Replacement Project and Donald Tank Hillside Stabilization (currently in design);
    - New groundwater supply well to meet the 40% local supply goal in the SCWA Restructured Agreement.
- **Priority 2** – Near-term projects that should be implemented in the next five to ten years, including:
    - Remaining projects that address significant fire flow deficiencies (i.e., greater than 40% deficient);
    - Projects that address remaining storage and a supply deficiencies; and
    - Projects that address minimum pressure deficiencies during normal operations.

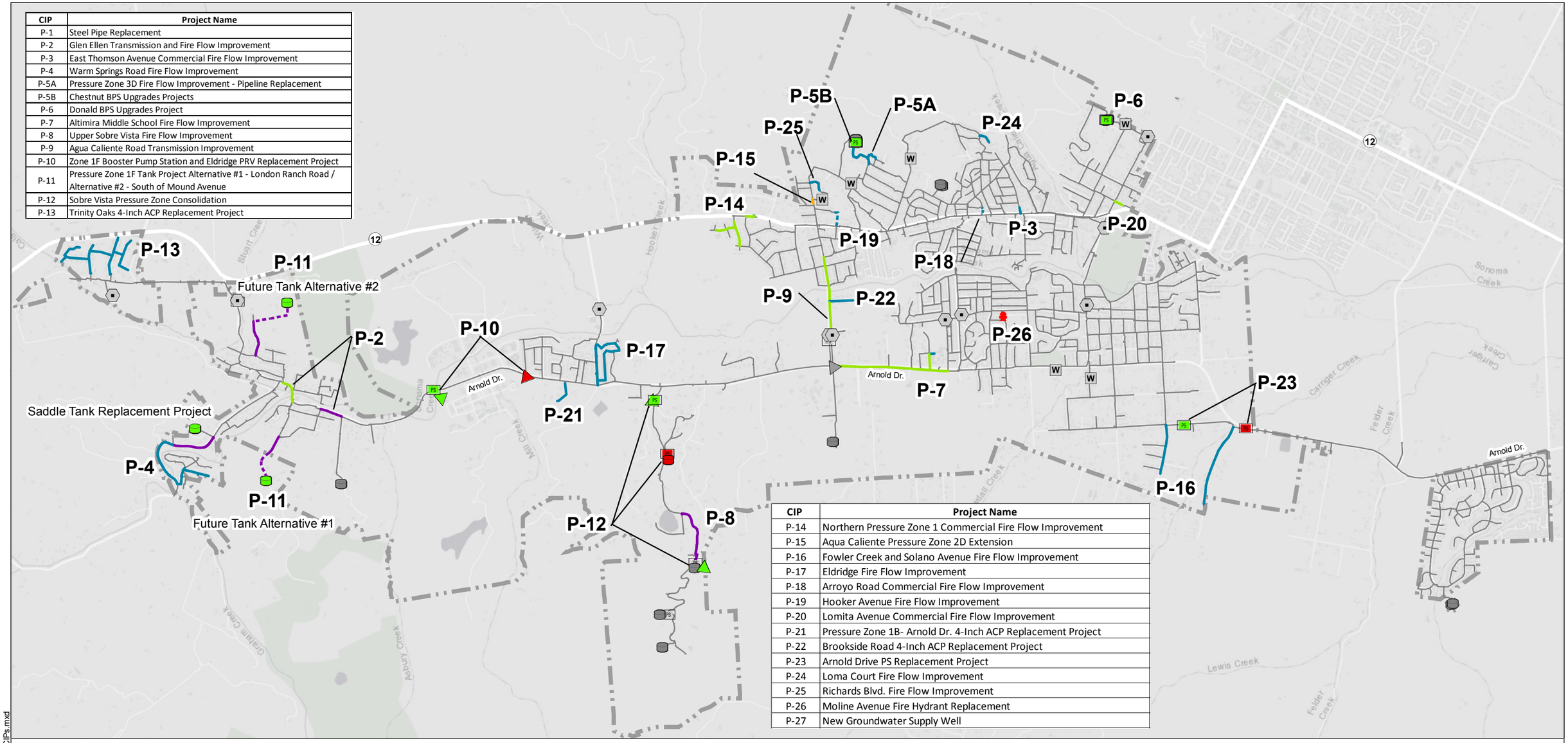
- **Priority 3** – Long-term projects that should be implemented after priority two projects, including:
    - Projects that address the remaining fire flow deficiencies;
    - Replacement of aging 4-inch ACP; and
    - Other identified operational improvement.

9.3 Capital Improvement Projects

Figure 9-1 shows an overview of the recommended improvements P-2 through P-26 and Figure 9-2 shows the remaining steel water main locations to be replaced as part of Project P-1. A summary of the recommended improvements, as well the CIPs included in the District's existing 5-year CIP budget, are presented in Table 9-4. As shown in Table 9-4, the total OPC for the proposed CIP in March 2019 dollars is between approximately $27.7 million to $35.3 million (depending on whether the pipeline projects will be constructed by the District or a construction contractor) on top of the $10.9 million currently included in the District's 5-year CIP budget. It should be noted that the recommended CIP only identifies improvements at a master plan level and does not constitute a design of such improvements. Subsequent detailed design is required to determine the exact sizes and locations of these proposed improvements.

Project summary sheets are provided for each project in Appendix E. Each summary sheet includes a location map, a description of and justification for the proposed improvements, recommended priority, and estimated planning level OPC.

CIP	Project Name
P-1	Steel Pipe Replacement
P-2	Glen Ellen Transmission and Fire Flow Improvement
P-3	East Thomson Avenue Commercial Fire Flow Improvement
P-4	Warm Springs Road Fire Flow Improvement
P-5A	Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement
P-5B	Chestnut BPS Upgrades Projects
P-6	Donald BPS Upgrades Project
P-7	Altimira Middle School Fire Flow Improvement
P-8	Upper Sobre Vista Fire Flow Improvement
P-9	Agua Caliente Road Transmission Improvement
P-10	Zone 1F Booster Pump Station and Eldridge PRV Replacement Project
P-11	Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road / Alternative #2 - South of Mound Avenue
P-12	Sobre Vista Pressure Zone Consolidation
P-13	Trinity Oaks 4-Inch ACP Replacement Project



CIP	Project Name
P-14	Northern Pressure Zone 1 Commercial Fire Flow Improvement
P-15	Aqua Caliente Pressure Zone 2D Extension
P-16	Fowler Creek and Solano Avenue Fire Flow Improvement
P-17	Eldridge Fire Flow Improvement
P-18	Arroyo Road Commercial Fire Flow Improvement
P-19	Hooker Avenue Fire Flow Improvement
P-20	Lomita Avenue Commercial Fire Flow Improvement
P-21	Pressure Zone 1B- Arnold Dr. 4-Inch ACP Replacement Project
P-22	Brookside Road 4-Inch ACP Replacement Project
P-23	Arnold Drive PS Replacement Project
P-24	Loma Court Fire Flow Improvement
P-25	Richards Blvd. Fire Flow Improvement
P-26	Moline Avenue Fire Hydrant Replacement
P-27	New Groundwater Supply Well

Legend

Sphere of Influence

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Recommended CIPS

- Replace existing hydrant with 6-inch hydrant & lateral
- Future PRV
- Future/Upgraded Pump Station
- Future Enclosed Storage Facility
- Abandon Valve
- Abandon Pump Station
- Abandon Enclosed Storage Facility

Replacement Pipe, inches

- 6
- 8
- 10
- 12

New Pipe, inches

- 8
- 10

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.

N

0 3,000 6,000
Feet

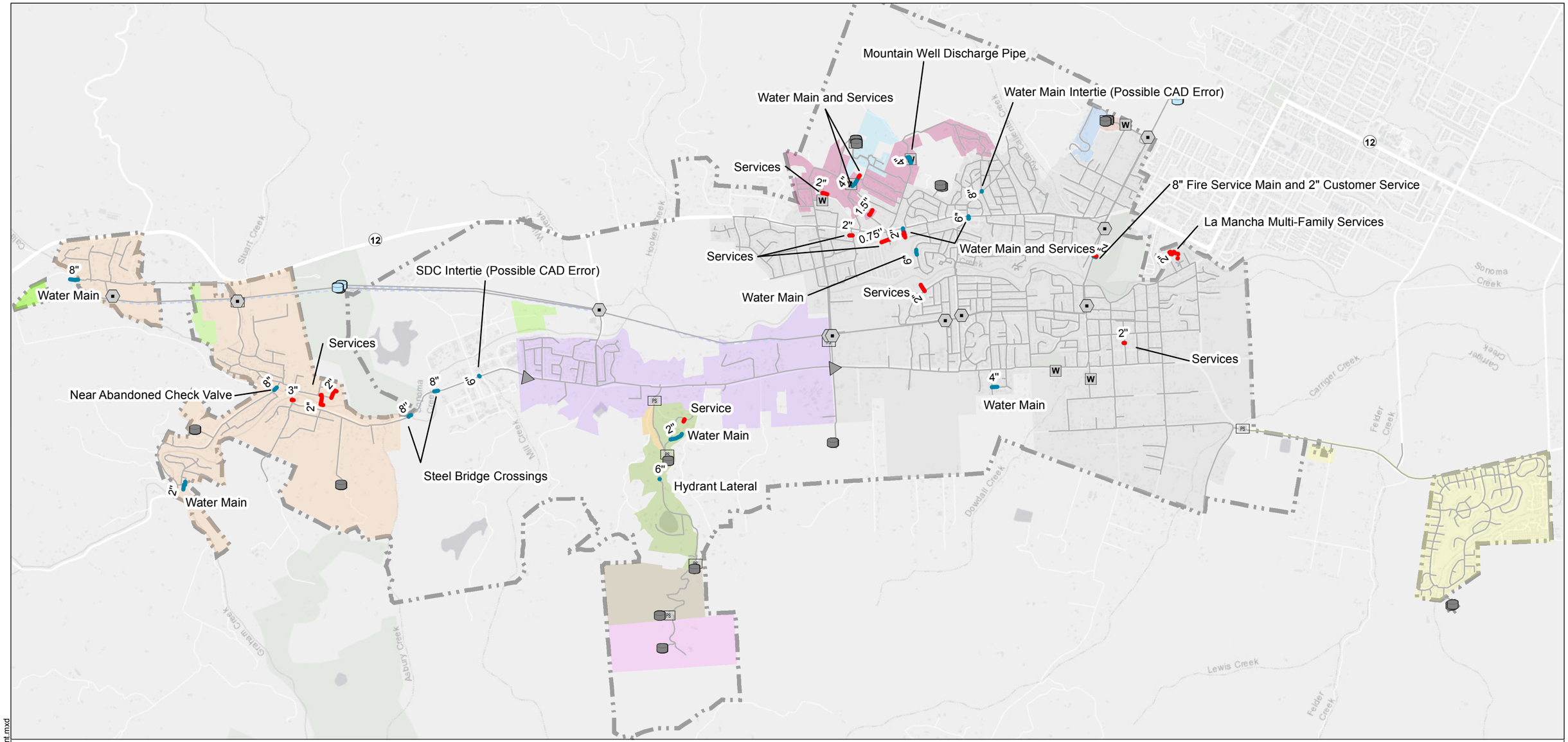
Recommended Capacity-Related Water System Improvements

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 9-1

eki environment & water

Path: X:\B80082.00\Maps\Water Master Plan\04\Fig9_1_RecommendedCIPs.mxd



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV/PSV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A
- 1B
- SCWA
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Recommended CIPs (Existing Diameter Shown)

- Water Service Conversions
- Steel Main Replacement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Steel mains to be replaced as a part of other CIPs are not shown.
3. Water main materials based on AutoCAD files of the Water System Map provided by the District and updated by EKI based on as-built records.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Remaining Steel Pipe Replacement CIP (P-1)

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure 9-2

eki environment & water

Path: X:\B80082.00\Maps\Water Master Plan\04\Fig9_2_SteelReplacement.mxd

Table 9-4
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (a)(b)	
						District Staff	External Contractor
Facilities and Maintenance Projects							
CIP-9300	Meter Replacement Program	Existing District CIP with a total remaining 5-year budget of $1,100,000.	--	--	--	--	--
CIP-2957	Equipment Replacement	Existing District CIP with a total remaining 5-year budget of $545,000.	--	--	--	--	--
CIP-2958	Emergency Preparedness Equipment	Existing District CIP with a total remaining 5-year budget of $2,075,000.	--	--	--	--	--
CIP-2978	New Storage in Glen Ellen Zone	Existing District CIP with a $650,000 expenditure and an anticipated $630,571 FEMA reimbursement.	--	--	--	--	--
CIP-6000	Polybutylene Service Replacements (Leak Response)	Existing District CIP with a total remaining 5-year budget of $50,000.	--	--	--	--	--
CIP-6002	Service Replacement Other Than Polybutylene	Existing District CIP with a total remaining 5-year budget of $110,000.	--	--	--	--	--
CIP-6003	Planned Polybutylene Service Replacements	Existing District CIP with a total remaining 5-year budget of $100,000.	--	--	--	--	--
CIP-8100	Valve Replacement Program	Existing District CIP with a total remaining 5-year budget of $170,000.	--	--	--	--	--
CIP-9100	Unanticipated Capital Expenditures	Existing District CIP with a total remaining 5-year budget of $380,000.	--	--	--	--	--
TBD	Building Maintenance & Repair	Existing District CIP with a total remaining 5-year budget of $37,500.	--	--	--	--	--
CIP-5107	County of Sonoma Paving Projects requiring adjustments and or relocation of District facilities	Existing District CIP with a total remaining 5-year budget of $310,000.	--	--	--	--	--
TBD	PRV upgrade GE & Trinity - SS fittings	Existing District CIP with a total remaining 5-year budget of $82,000.	--	--	--	--	--
P-27	SCWA Turnout Flow Meter Installation	Install flow meters at each of the SCWA turnout PRVs and integrate with SCADA system.	2	--	--	--	$312,500
Pipeline Projects							
CIP-2947	Walnut Ave, Oak St. & Penny Ln. Water Main Replacement	Existing District CIP with a total remaining 5-year budget of $275,000.	1	--	--	--	--
CIP-2967	Boyes Blvd. Bridge Pipeline Replacement	Existing District CIP with a total remaining 5-year budget of $375,000.	1	--	--	--	--
TBD	Gibson St., Riddle Rd Easement, Sobre Vista (near Lake Josephine), Brookview & Lomita Water Main Replacements	Existing District CIP with a total remaining 5-year budget of $275,000.	1	--	--	--	--
P-1	Steel Pipe Replacement	Replace all remaining steel water mains and convert steel laterals to customer service connections throughout distribution system as detailed by Figure 9-2.	1	8 6 Service Conversions (c)	800 1,800 24	$730,000	$1,180,000
P-2	Glen Ellen Transmission and Fire Flow Improvement	Replace existing 6-inch and 8-inch steel and ACP water mains with new 10-inch and 12-inch PVC water mains, replace existing service connections, and replace existing fire hydrants.	1	10 12	700 800	$610,000	$1,010,000
P-3	East Thomson Avenue Commercial Fire Flow Improvement	Replace existing 4-inch steel water mains with new 8-inch PVC water mains, and replace one existing fire hydrant along East Thomson Avenue.	1	8	200	$70,000	$130,000
P-4	Warm Springs Road Fire Flow Improvement	Replace existing 6-inch PVC, ACP, and DIP water mains with new 8-inch and 10-inch PVC water mains, replace 47 existing service connections, and replace four existing fire hydrants.	1	8 10	3,400 1,500	$1,550,000	$2,470,000
P-5A	Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement	Replace existing 4-inch ACP, PVC, and DIP water mains with new 8-inch PVC throughout PZ-3D, replace eight existing service connections, and replace one existing fire hydrants.	1	8	1,600	$500,000	$790,000
P-7	Altimira Middle School Fire Flow Improvement	Replace existing 6-inch and 8-inch PVC and ACP water mains with new 12-inch PVC water mains along Arnold Drive, replace existing 6-inch pipe with new 8 and 12-inch pipe adjacent to Altimira Middle School, replace 15 existing service connections, and replace three existing fire hydrants.	1	8 12	160 4,200	$1,760,000	$2,650,000
P-8	Upper Sobre Vista Fire Flow Improvement	Replace existing 6-inch PVC and HDPE water mains with new 8-inch PVC water mains, and replace two existing fire hydrants.	1	10	2,100	$700,000	$1,080,000
P-9	Agua Caliente Road Transmission Improvement	Replace existing 8-inch ACP water mains with new 12-inch PVC water mains, replace 19 existing service connections, and replace two existing fire hydrants. Recommended to be constructed in conjunction with Project P-25 due to proximity.	2	12	2,500	$1,060,000	$1,650,000

Table 9-4 (cont.)
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (b)(c)	
						District Staff	External Contractor
Pipeline Projects							
P-13	Trinity Oaks 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace 49 existing service connections, and replace six existing fire hydrants in the Trinity Oaks area. District to coordinate with Fire Department to determine if additional hydrants are needed. These hydrants would be funded by the Fire Department.	2	8	6,000	$1,780,000	$2,820,000
P-14	Northern Pressure Zone 1 Commercial Fire Flow Improvement	Replace existing 6-inch and 8-inch ACP water mains with new 12-inch PVC water mains, replace 13 existing service connections, and replace three existing fire hydrants.	2	12	1,800	$770,000	$1,210,000
P-15	Aqua Caliente Pressure Zone 2D Extension	Install a parallel 6-inch PVC water main on Aqua Caliente Road and reconnect three services from Pressure Zone 1 to Pressure Zone 2D.	2	6	200	$230,000	$340,000
P-16	Fowler Creek and Solano Avenue Fire Flow Improvement	Replace existing 6-inch ACP water mains with new 8-inch PVC water mains, replace ten existing service connections, and replace five existing fire hydrants.	2	8	4,200	$1,210,000	$1,890,000
P-17	Eldridge Fire Flow Improvement	Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace 49 existing service connections, and replace three existing fire hydrants in the Eldridge area.	2	8	3,900	$1,200,000	$1,950,000
P-18	Arroyo Road Commercial Fire Flow Improvement	Install new 8-inch PVC water main between Highway 12 and Madera Road along Arroyo Road.	3	8	200	$60,000	$100,000
P-19	Hooker Avenue Fire Flow Improvement	Install new 8-inch PVC water main between Highway 12 and Hooker Ave.	3	8	550	$150,000	$240,000
P-20	Lomita Avenue Commercial Fire Flow Improvement	Replace existing 6-inch ACP water main with new 12-PVC water main along Lomita Avenue, replace two service connections, and replace one hydrant.	3	12	300	$140,000	$230,000
P-21	Pressure Zone 1B - Arnold Dr. 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water main with new 8-inch PVC water main in Pressure Zone 1B west of Arnold Drive, and replace three existing service connections.	3	8	800	$50,000	$90,000
P-22	Brookside Road 4-Inch ACP Replacement Project	Replace existing 4-inch ACP water main with 8-inch PVC water main along Brookside Road , and replace eight existing service connections.	3	8	800	$240,000	$370,000
P-24	Loma Court Fire Flow Improvement	Replace existing 6-inch with new 8-inch PVC along Loma Court, replace 11 existing service connections, and replace one existing fire hydrant.	3	8	500	$90,000	$180,000
P-25	Richards Blvd. Fire Flow Improvement	Replace existing 6-inch ACP and DIP water main with 8-inch PVC water main along Richards Blvd, replace four existing service connections, and one existing hydrant.	3	8	300	$100,000	$190,000
P-26	Moline Avenue Fire Hydrant Replacement	Run fire hydrant testing to confirm fire flow availability. If fire flow availability does not meet requirements then replace existing hydrant assembly with 6-inch lateral.	3	--	--	$10,000	$30,000

Table 9-4 (cont.)
Summary of Recommended Water System Capital Improvement Projects

Project #	Project	Improvement Description	Priority	Recommended Pipe Diameter (in)	Pipe Length (Linear Feet)	Total Project OPC (b)(c)	
						District Staff	External Contractor
Pump Stations, Tanks, and Wells							
CIP-2978	Saddle Tank Replacement Project	Install a new 0.15 MG welded steel tank at the former Saddle Tank site.	1	--	--	--	$640,000
TBD	Bolli Tanks Recoating & Railing Retrofit	Existing District CIP with a total remaining 5-year budget of $600,000.	--	--	--	--	--
TBD	New Well No. 9 Engineering	Existing District CIP with a total remaining 5-year budget of $150,000.	--	--	--	--	--
TBD	New Well No. 11 Engineering (construction to be loan financed)	Existing District CIP with a total remaining 5-year budget of $900,000.	--	--	--	--	--
CIP-2966	Hillside Stabilization at Donald Tank & Booster	Existing District CIP with a total remaining 5-year budget of $200,000.	1	--	--	--	--
P-5B	Chestnut BPS Upgrades Projects	Replace existing Chestnut BPS with two (2) 100-gpm domestic pumps and one (1) 1,000 gpm fire pump at 60 ft total dynamic head (TDH).	1	--	--	--	$2,040,000
P-6	Donald BPS Upgrades Project	Replace existing Donald BPS with two (2) 115-gpm domestic pumps and one (1) 1,000 gpm fire pump at 220 ft TDH.	1	--	--	--	$2,040,000
P-27	New Groundwater Supply Well	Installation of a new well located outside of the Sonoma Valley Subbasin with an assumed capacity of 350 gpm.	1	--	--	--	$1,600,000
P-10	Zone 1F Booster Pump Station and Eldridge PRV Replacement Project	Install new PRV and BPS with a firm capacity of 450 gpm at 275 ft TDH. Abandon existing Eldridge PRV.	2	--	--	--	$1,670,000
P-11	Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road	Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 590 LF of existing 8-inch PVC with a 10-inch PVC water main.	2	8	1,700	--	$1,510,000
	Pressure Zone 1F Tank Project Alternative #2 - South of Mound Avenue	Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 1,100 LF of existing 6-inch PVC with a 10-inch PVC water main.	2	8	2,600	--	$1,880,000
P-12	Sobre Vista Pressure Zone Consolidation	Replace Lower Sobre Vista BPS with a firm capacity of 265 gpm at 270 ft TDH; demolish Lower Sobre Vista Tank and Upper Sobre Vista BPS; connect PZ-2E and 3E; install individual service PRVs in former PZ-2E area.	2	--	--	--	$1,560,000
P-23	Arnold Drive PS Replacement Project	Install new BPS with a firm capacity of 500 gpm along Orange Avenue. Demolish existing Arnold Drive BPS.	3	--	--	--	$1,410,000
					TOTAL WATER DISTRIBUTION SYSTEM IMPROVEMENTS OPC (d)	**$27,672,500**	**$35,262,500**

Notes:

(a) Costs shown are presented in March 2019 dollars based on an ENR CCI of 11,227.88 (20-city average), with totals rounded to the nearest $10,000.

(b) Costs for pipeline projects include construction contingency (25%), design (10%), construction management (5%), permitting (5%), and Project Implementation (5%). Costs for other projects (i.e. BPS installations) include construction contingency (30%), design (15%), construction management (5%), permitting (5%), and Project Implementation (5%).

(c) Service conversions includes groups of steel pipe identified to be replaced with new copper services. Average service length is approximately 100 LF which is substantially larger than a typical service. Thus, the service connection replacement cost factor has been increased by a factor of two.

(d) Total district constructed OPC includes contractor costs for pump station, tanks, wells, and other projects not anticipated to be constructed by the District.

10.0 REFERENCES

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Appendix A

Calibration Fire Hydrant Testing Plan and Field Notes

eki environment & water

VALLEY OF THE MOON WATER DISTRICT

WATER MASTER PLAN
FIRE HYDRANT TESTING PLAN

DECEMBER 2018

LEGEND

- Flowing Hydrant
  - Measure hydrant static pressure prior to testing with gauge.
  - Measure hydrant flow and pressure with pitot tube.

- Residual Hydrant
  - Measure hydrant static pressure before testing and residual pressure while testing with gauge.

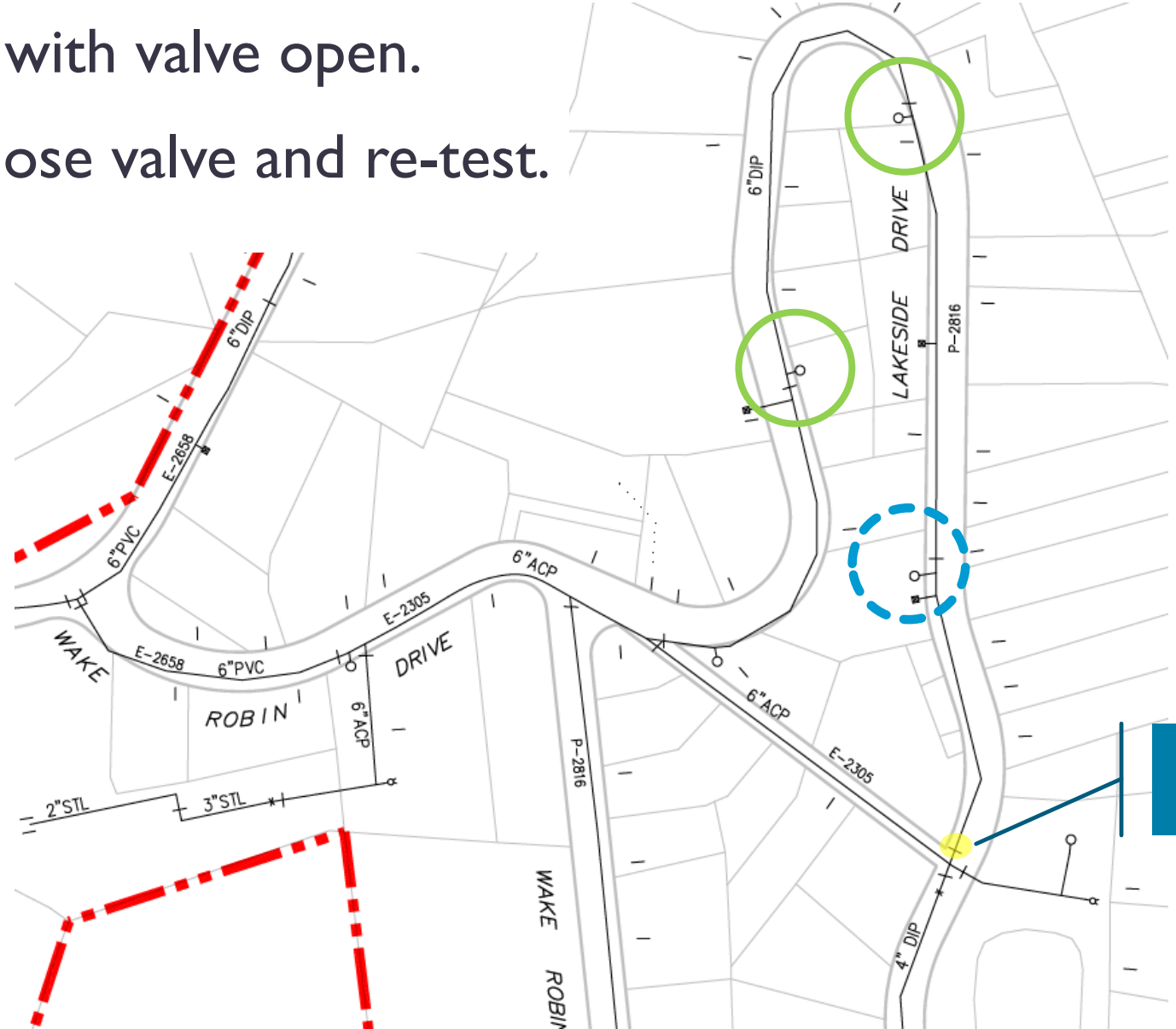
SUMMARY OF TEST LOCATIONS

Test Number	Diameter	Material	Pressure Zone	Flow Hydrant Location	Map Book Grid Number	Isolation Required (Two Test Rounds)	Turnout to Monitor	SCADA Data to Review
1	6	ACP	PZ3E	1225 Sobre Vista Road	M25			Upper Sobre Vista PS Upper Sobre Vista Tank
2	6	DIP	PZ1F	4120 Lakeside Road	K18	X	Glen Ellen	Glen Ellen Tank Glen Ellen PS
3	8	ACP	PZ1F	14600 Arnold Dr.	L21		Glen Ellen	Glen Ellen Tank Glen Ellen PS
4	8	PVC	PZ1B	143 Loma Vista Dr.	N25		Hannah	Hannah Tank Hannah PS
5	6	PVC/DIP	PZ2B	640 Michael Dr.	R29/ Q29			Donald PS
6	6	DIP	PZ3D	17201 Cragmont Dr.	Q26			Chestnut PS
7A	6	ACP	PZ2D	17398 Hillside Ave.	P26/P27			Chestnut Tank Mountain Well Agua Caliente PS
7B	6	DIP	PZ2D	17387 Buena Vista Ave.	P26/P27			Chestnut Tank Mountain Well Agua Caliente PS
8	14	ACP	PZ1A	21115 Via Colombard	N37/O37	X		Temelec Tank
9	12	PVC	PZ1	16501 Meadow Oaks Dr.	O25/P25	X	Agua Caliente	Agua Caliente PS Bolli Tanks
10	6	ACP	PZ1	1299 Fowler Creek Road	N33/O33			Temelec Tank
11	10	PVC	PZ1	1171 Solano Ave.	O32	X	Verano	Temelec Tank
12	6	ACP	PZ1	18500 Happy Ln.	P28/P29	X	Altimira & Boyes	Bolli Tank

TEST 1 – 1225 SOBRE VISTA ROAD – 6” ACP

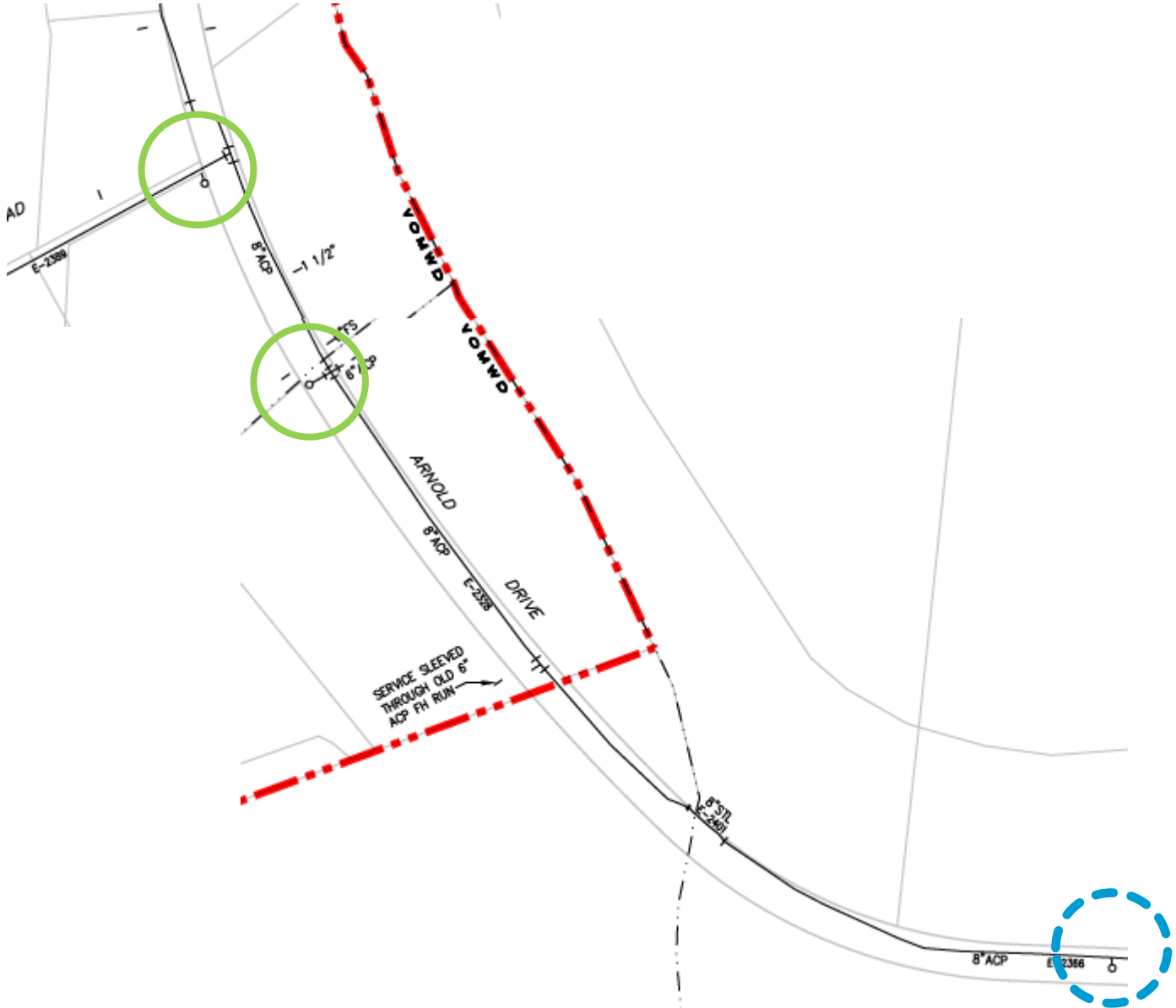
TEST 2 – 4120 LAKESIDE ROAD – 6” DIP

- First – test with valve open.
- Second – close valve and re-test.

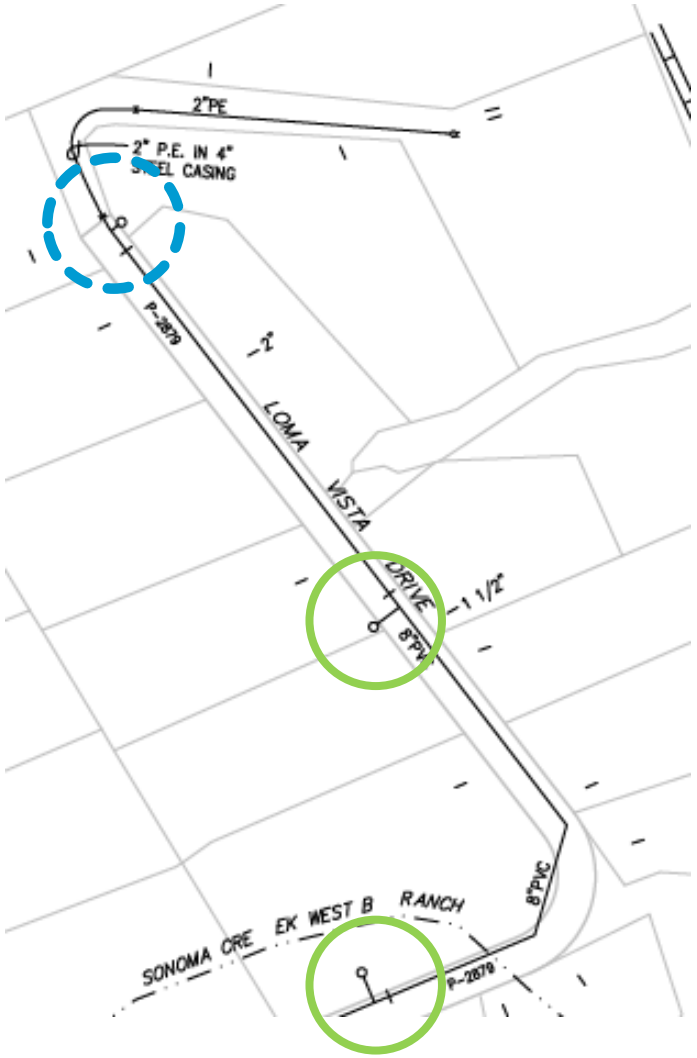


Close Valve on Branch During C-Factor Test

TEST 3 – 14600 ARNOLD DRIVE – 8” ACP



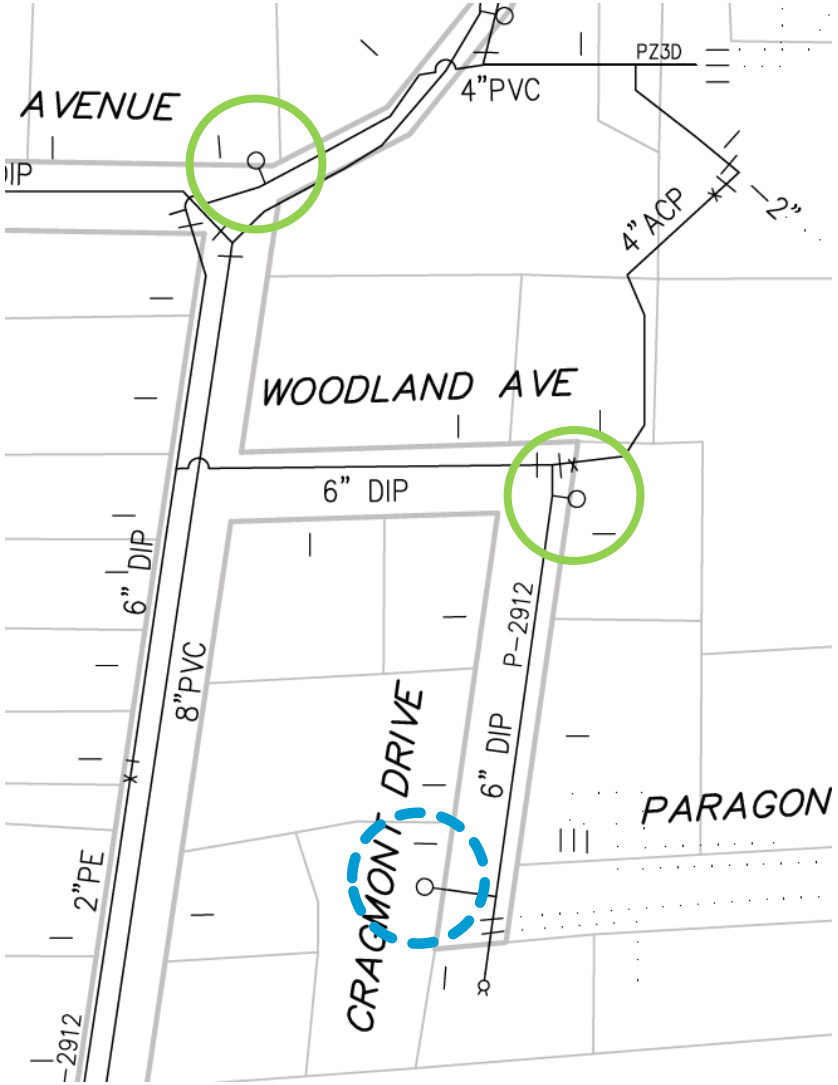
TEST 4 – 143 LOMA VISTA DRIVE – 8” PVC



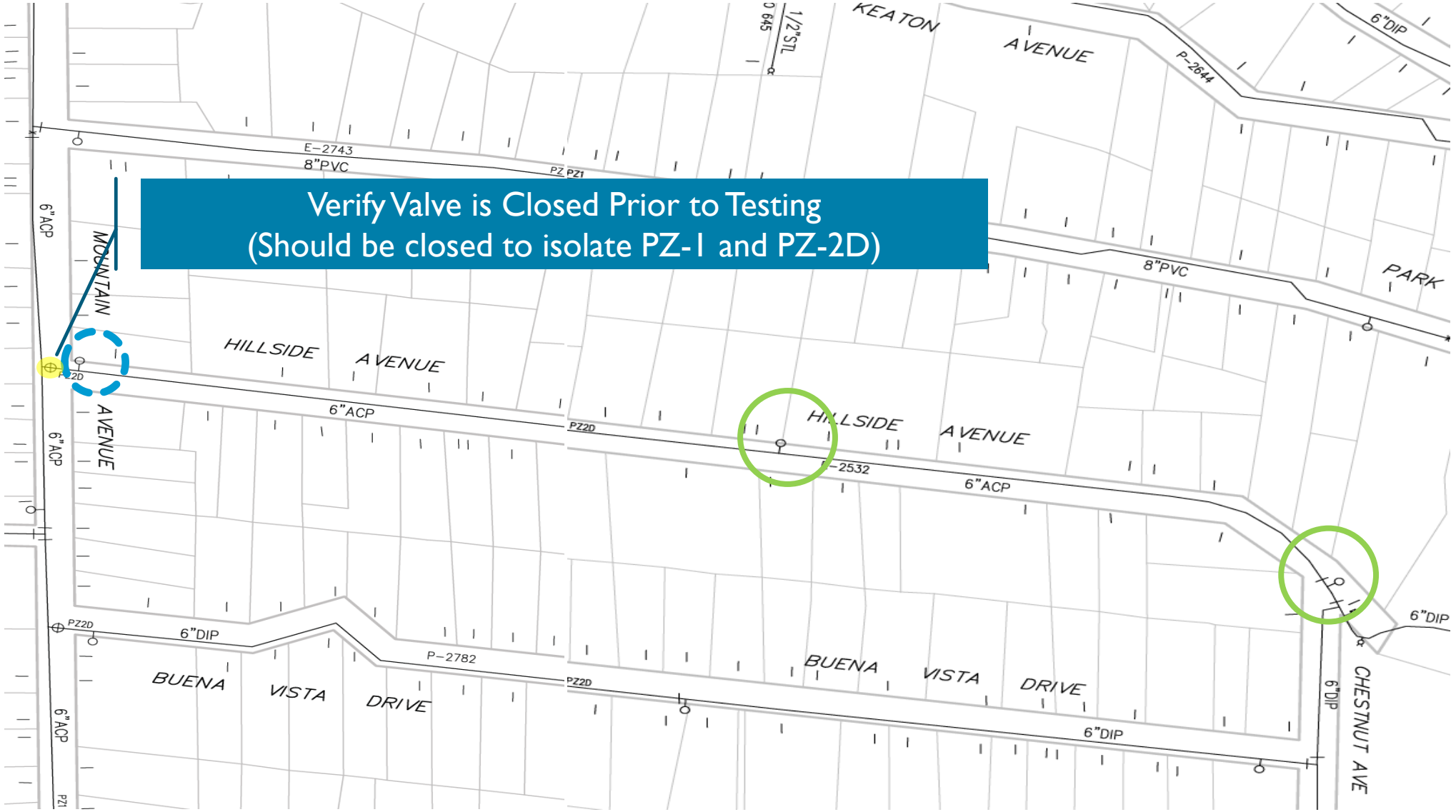
TEST 5 – 640 MICHAEL DRIVE – 6” PVC AND DIP

- Three residual hydrants to be measured.

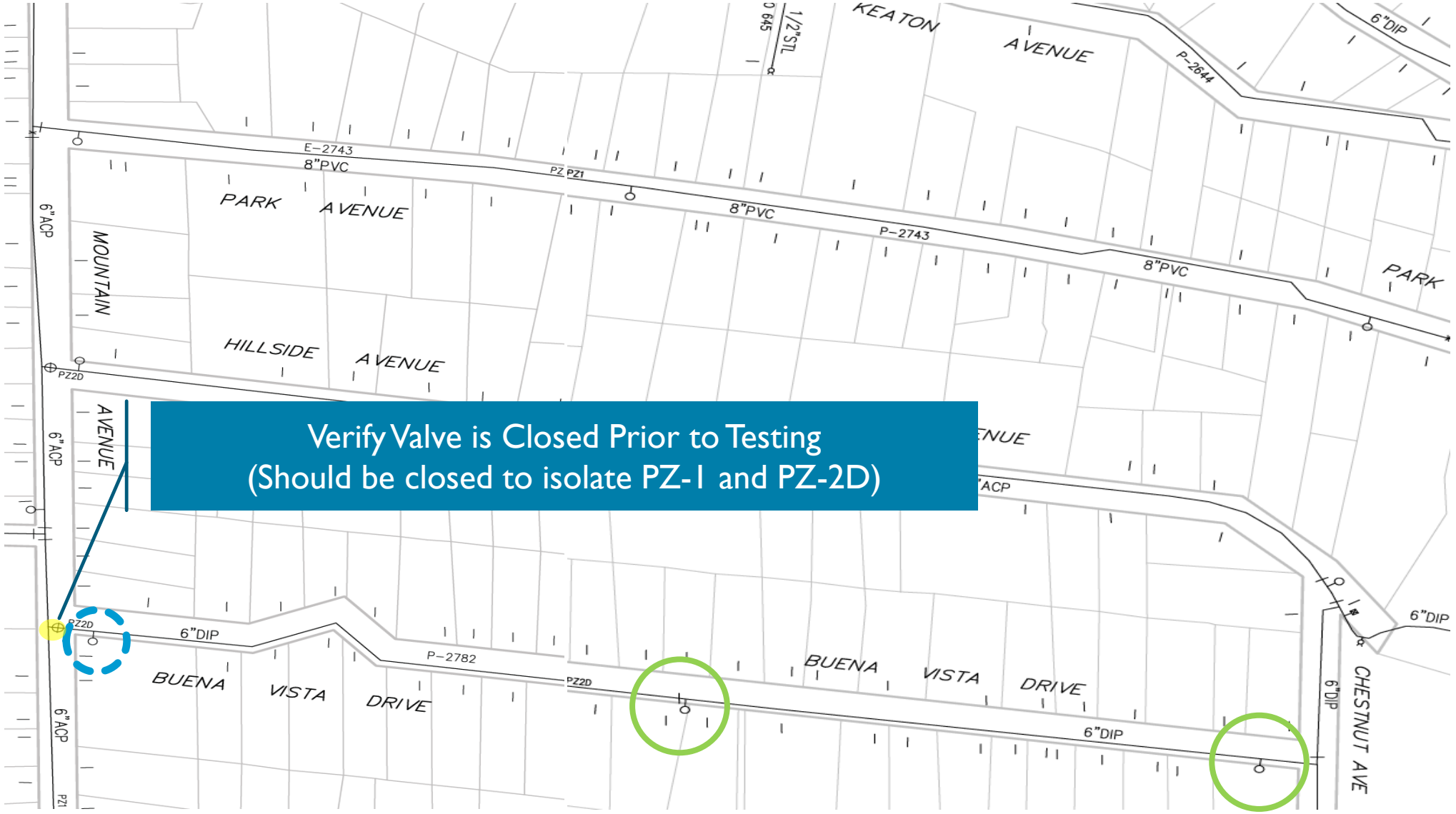
TEST 6 – 17201 CRAGMONT DRIVE – 6” DIP



TEST 7A – 17398 HILLSIDE AVE – 6” ACP



TEST 7B – 17387 BUENA VISTA AVE – 6” DIP



TEST 8 – 21115 VIA COLOMBARD – 14” ACP

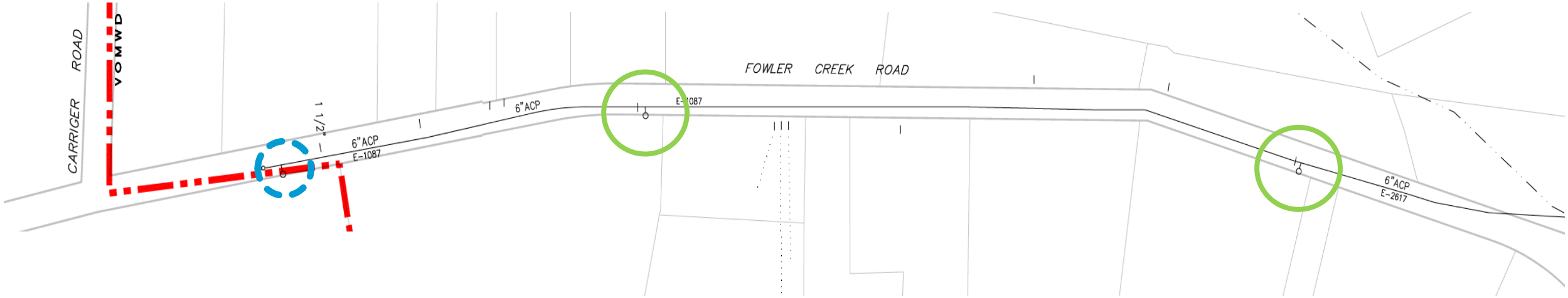
Close Valve on Run
During C-Factor Test

Close Valve on Run
During C-Factor Test

TEST 9 – 16501 MEADOW OAKS DRIVE – 12” PVC

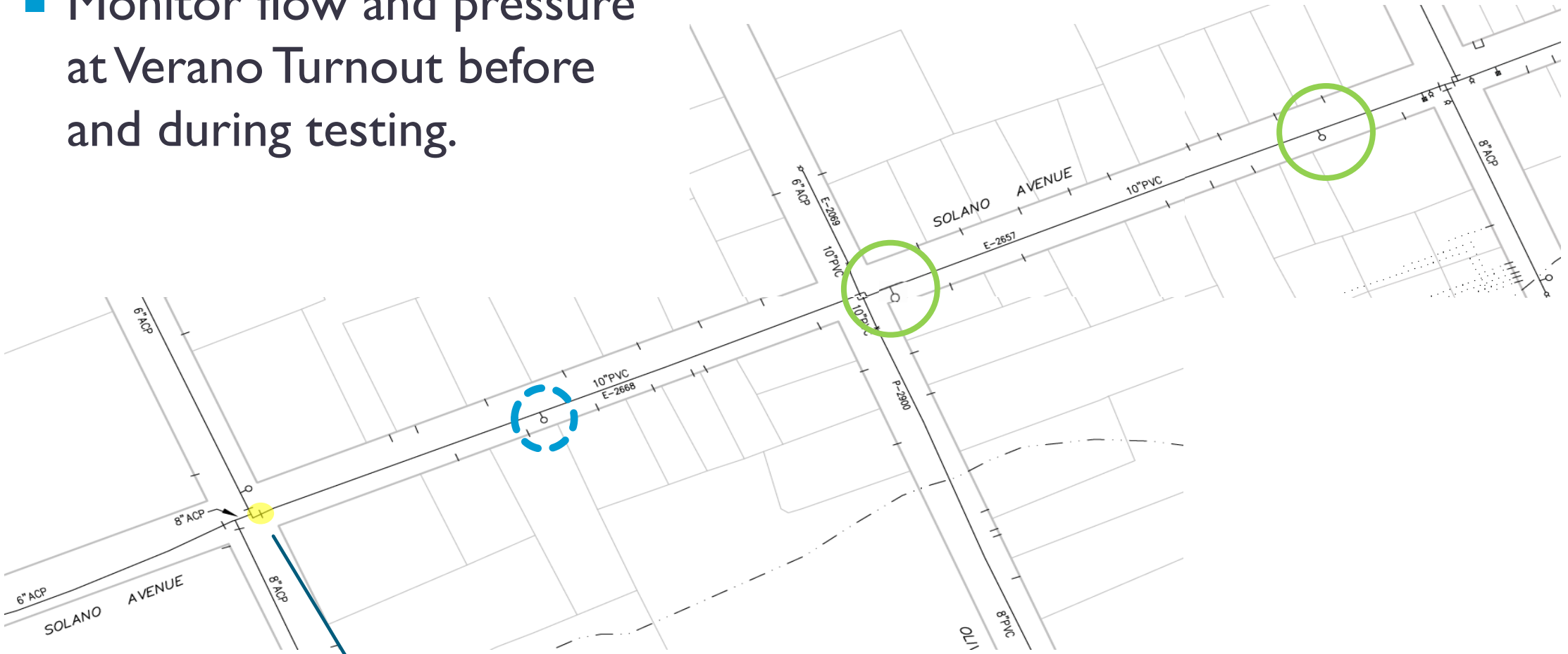
Close Valve on Branch
During C-Factor Test

TEST 10 – 1299 FOWLER CREEK ROAD – 6” ACP

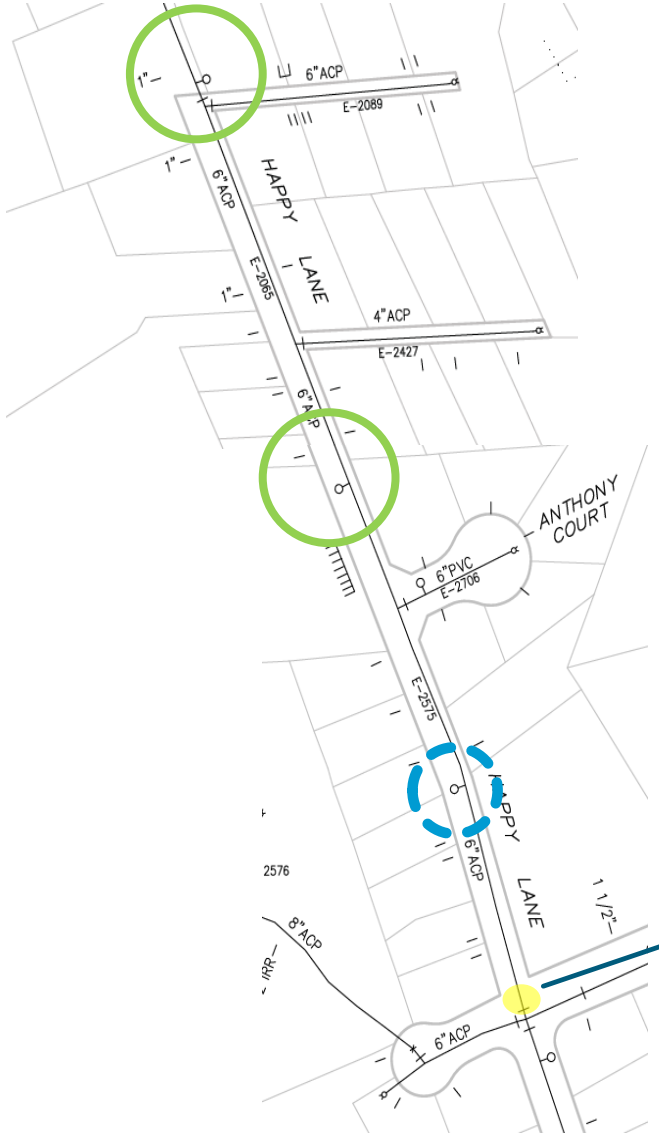


TEST 11 – 1171 SOLANO AVE – 10” PVC

- Monitor flow and pressure at Verano Turnout before and during testing.



TEST 12 – 18500 HAPPY LANE – 6” ACP



Close Valve on Branch During C-Factor Test

Fire Hydrant Flow Data

eki environment & water

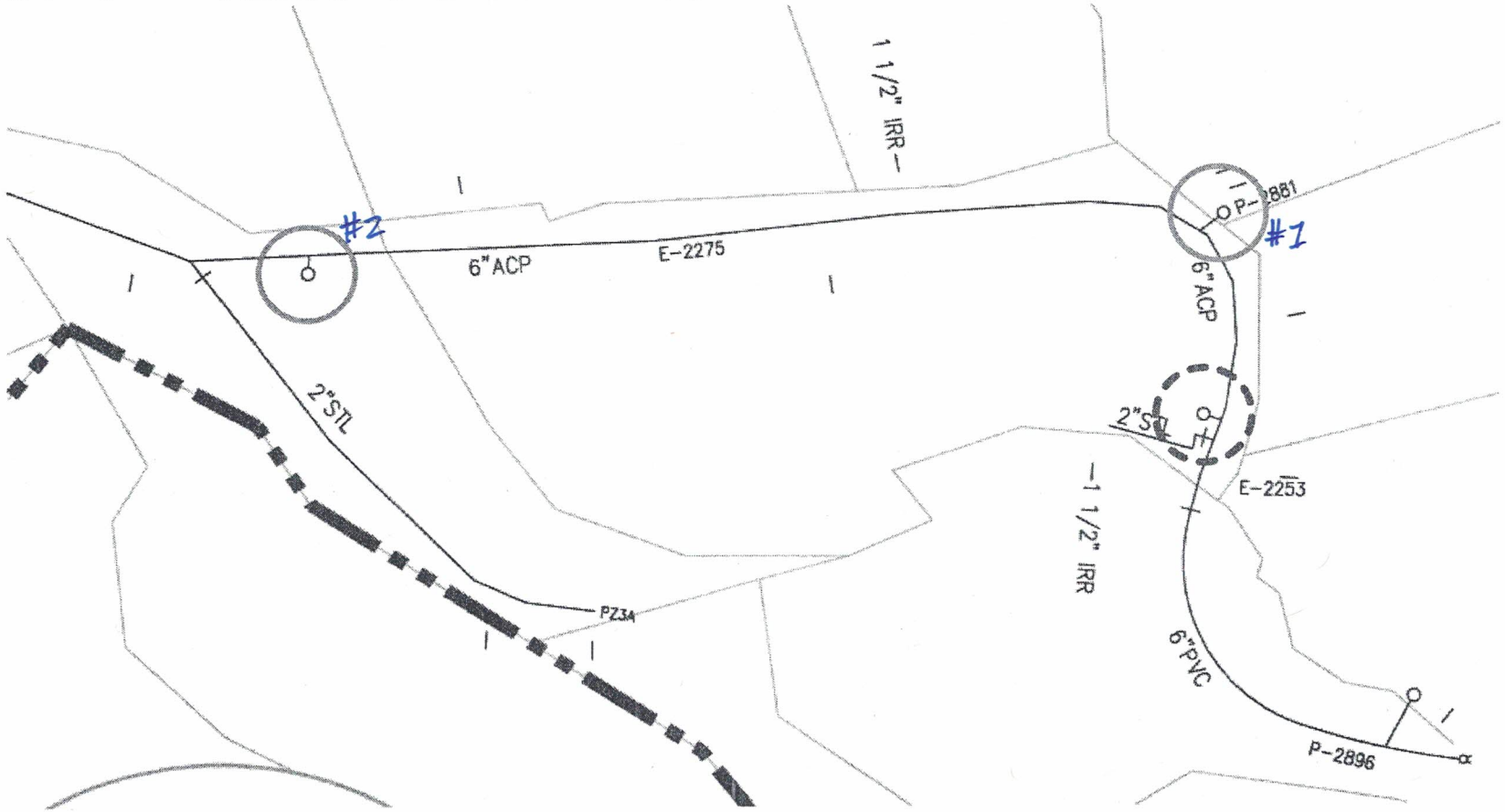
Test Location:	1225 Sobre Vista Dr.
Test Date:	12-17-18

Test Time:	1 51 PM
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	135	23 800gpm	135
Residual #1	2 1/2	133	29	133
Residual #2	2 1/2	123	30	123
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 1 – 1225 SOBRE VISTA ROAD – 6" ACP



Fire Hydrant Flow Data

eki environment & water

Test Location:	4220 Lakeside Rd.
Test Date:	12-17-18

Test Time:	2 58 pm / 3 12 pm C-factor
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	85/85	13 / 11 C-factor (5906pm / 5506pm)	82/85
Residual #1	2 1/2	84/84	24/23	84/82
Residual #2	2 1/2	78/76	15/18	78/73
Residual #3				

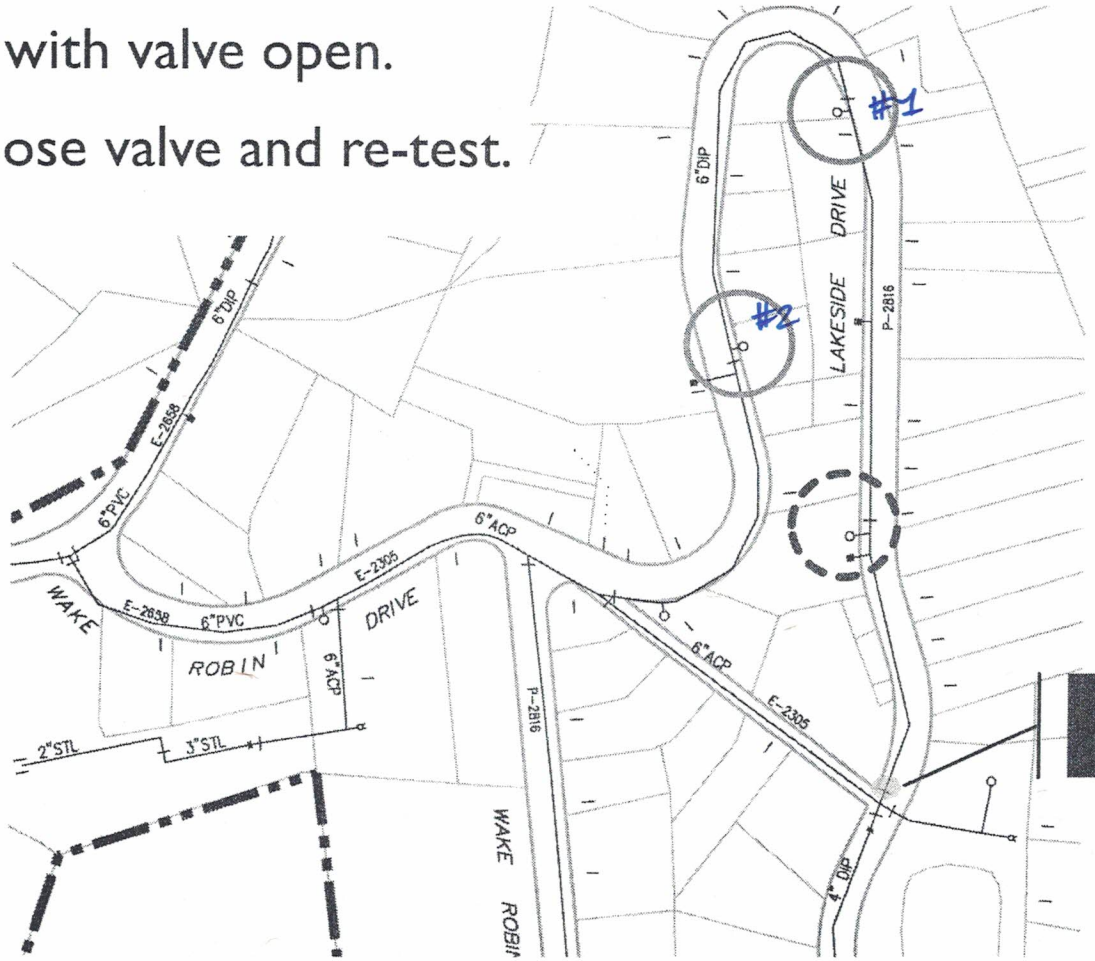
Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

2:58 G/E Turnout : Static : SCWA = 112 VOMWD = 79 flowing = SCWA = 100 VOMWD = 74

3:12 G/E Turnout : Static : SCWA 119 VOMWD 80 flowing = SCWA = 100 VOMWD = 74

TEST 2 – 4120 LAKESIDE ROAD – 6" DIP

- First – test with valve open.
- Second – close valve and re-test.



Close Valve on Branch During C-Factor Test

Fire Hydrant Flow Data

eki environment & water

Test Location:	14600 Arnold Dr.
Test Date:	12-17-18

Test Time:	~~2~~ 3 pm 2:25 pm
Testers:	N. Crews

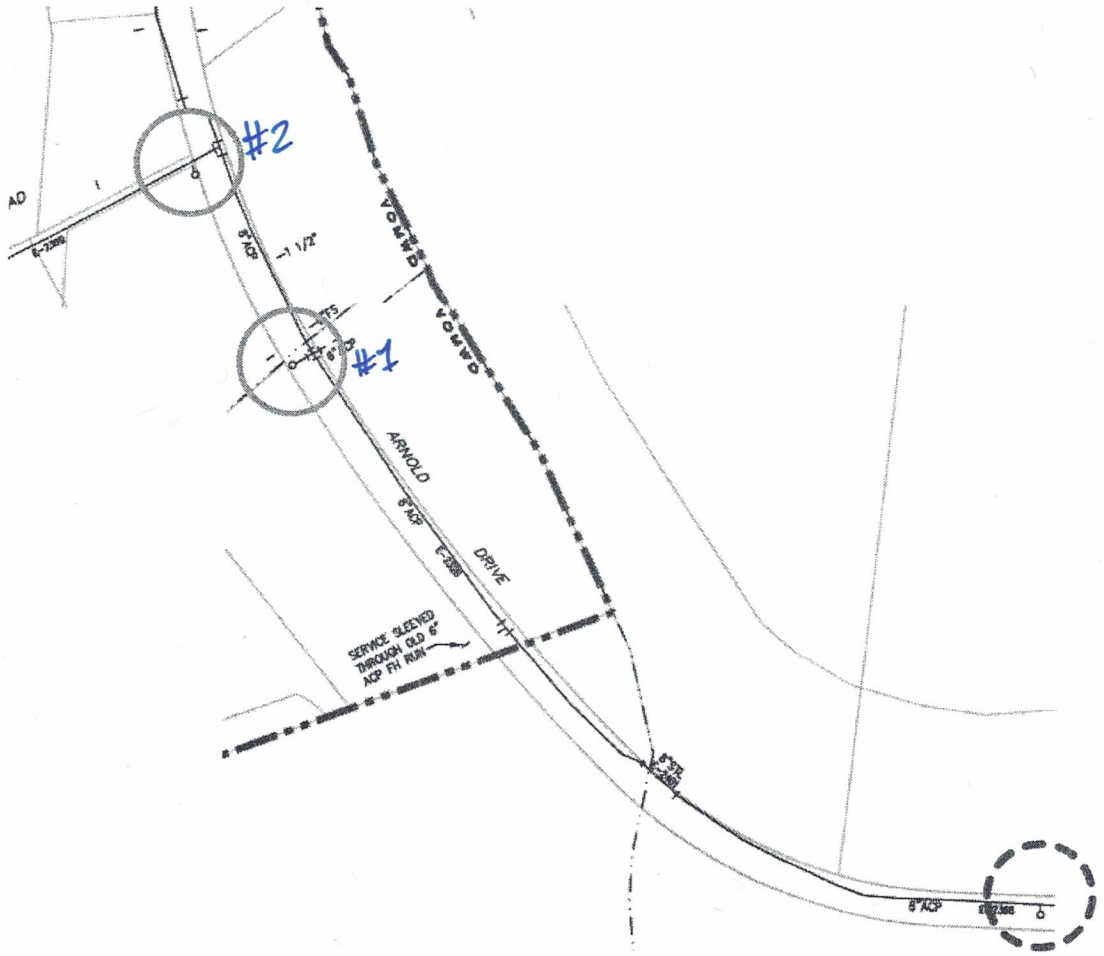
Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	115	48 1160 gpm	113
Residual #1	2 1/2	108	80	107
Residual #2	2 1/2	99	78	98
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

GB Turnout = Static: SCWA = 116 VOMWD = 79

flowing: SCWA = 100 VOMWD = 74

TEST 3 – 14600 ARNOLD DRIVE – 8" ACP



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Fire Hydrant Flow Data

eki environment & water

Test Location:	143 Loma Vista Dr.
Test Date:	12-17-18

Test Time:	1 25 pm
Testers:	N. Crews

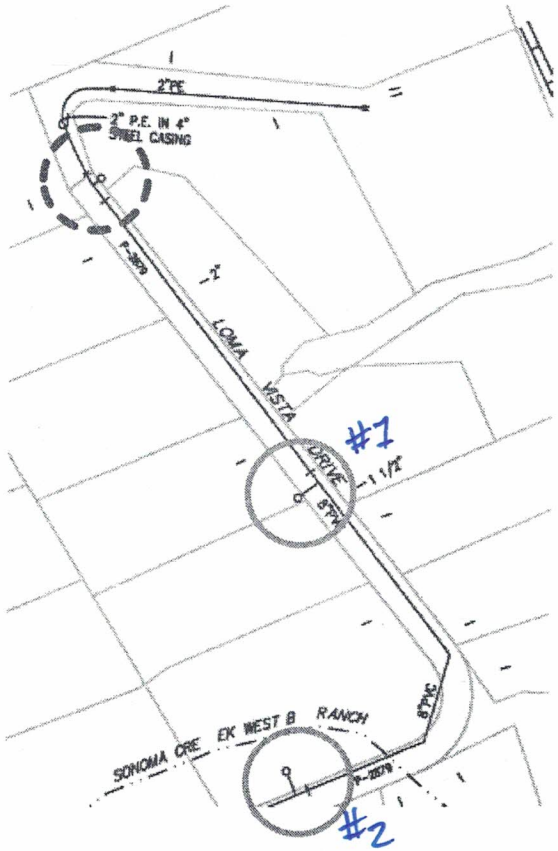
Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	71	45 1130gpm	71
Residual #1	2 1/2	74	58	72
Residual #2	2 1/2	76	60	76
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

Hanna Turnout = Static: SCWA = 125 VOMWD = 90

flowing: SCWA = 110 VOMWD = 70

TEST 4 – 143 LOMA VISTA DRIVE – 8" PVC



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Fire Hydrant Flow Data

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Test Location:	640 Michael Dr.
Test Date:	12-18-18

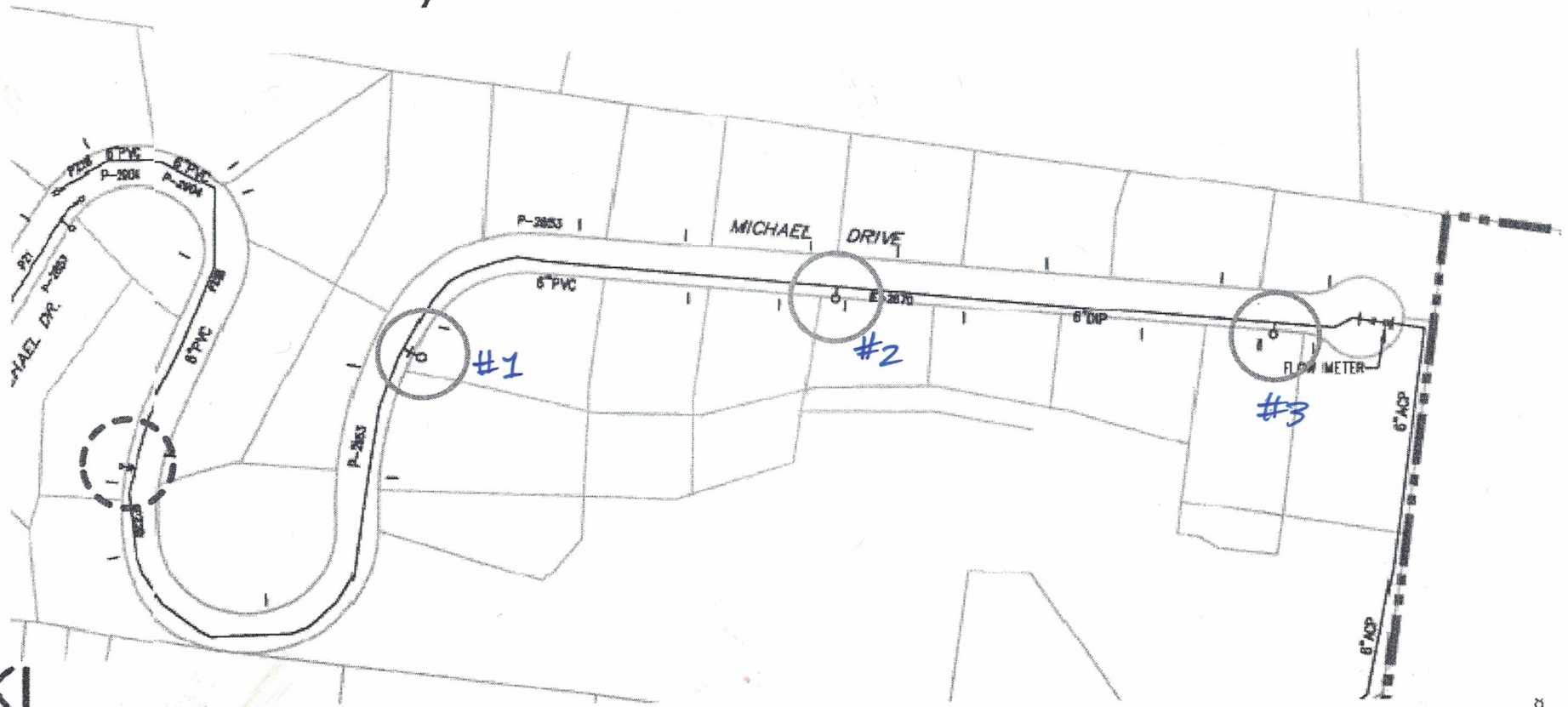
Test Time:	10 27 AM
Testers:	NC

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	102	23 800 Gpm	107
Residual #1	2 1/2	86	16	92
Residual #2	2 1/2	50	0	65
Residual #3	2 1/2	40	0	43

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 5 – 640 MICHAEL DRIVE – 6" PVC AND DIP

- Three residual hydrants to be measured.



eki

Fire Hydrant Flow Data

eki environment & water

Test Location:	17201 Cragmont Dr.
Test Date:	12-18-18

Test Time:	9 13 AM
Testers:	N. Crews

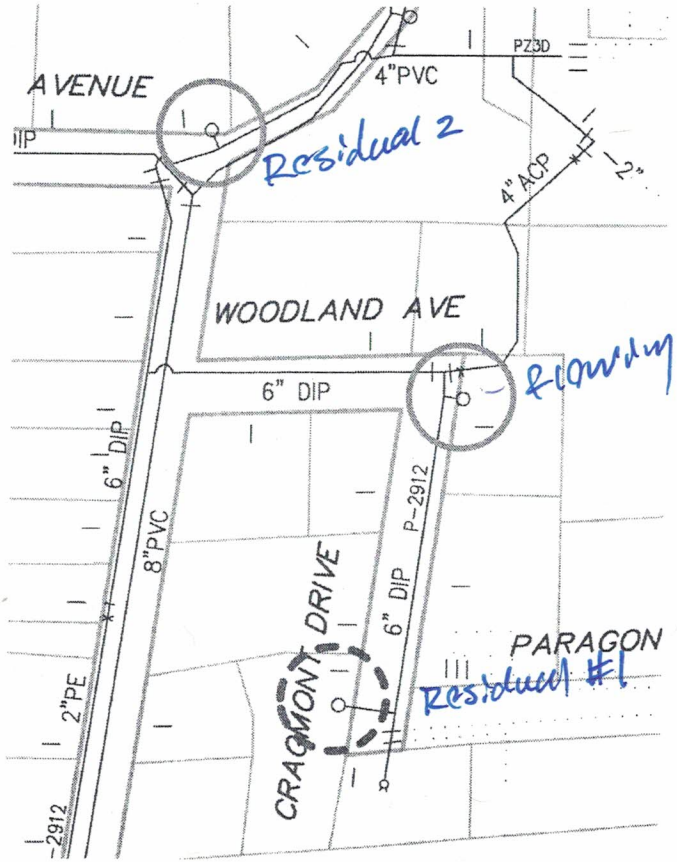
Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	72	7 450 Gpm	73
Residual #1	2 1/2	80	15	80
Residual #2	2 1/2	~~85~~ 85	25	83
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

Had to flow Hydrant @ Woodland & Cragmont not the one @ the end of cragmont.

TEST 6 – ~~17201~~ CRAGMONT DRIVE – 6" DIP

17258



eki

Fire Hydrant Flow Data

eki environment & water

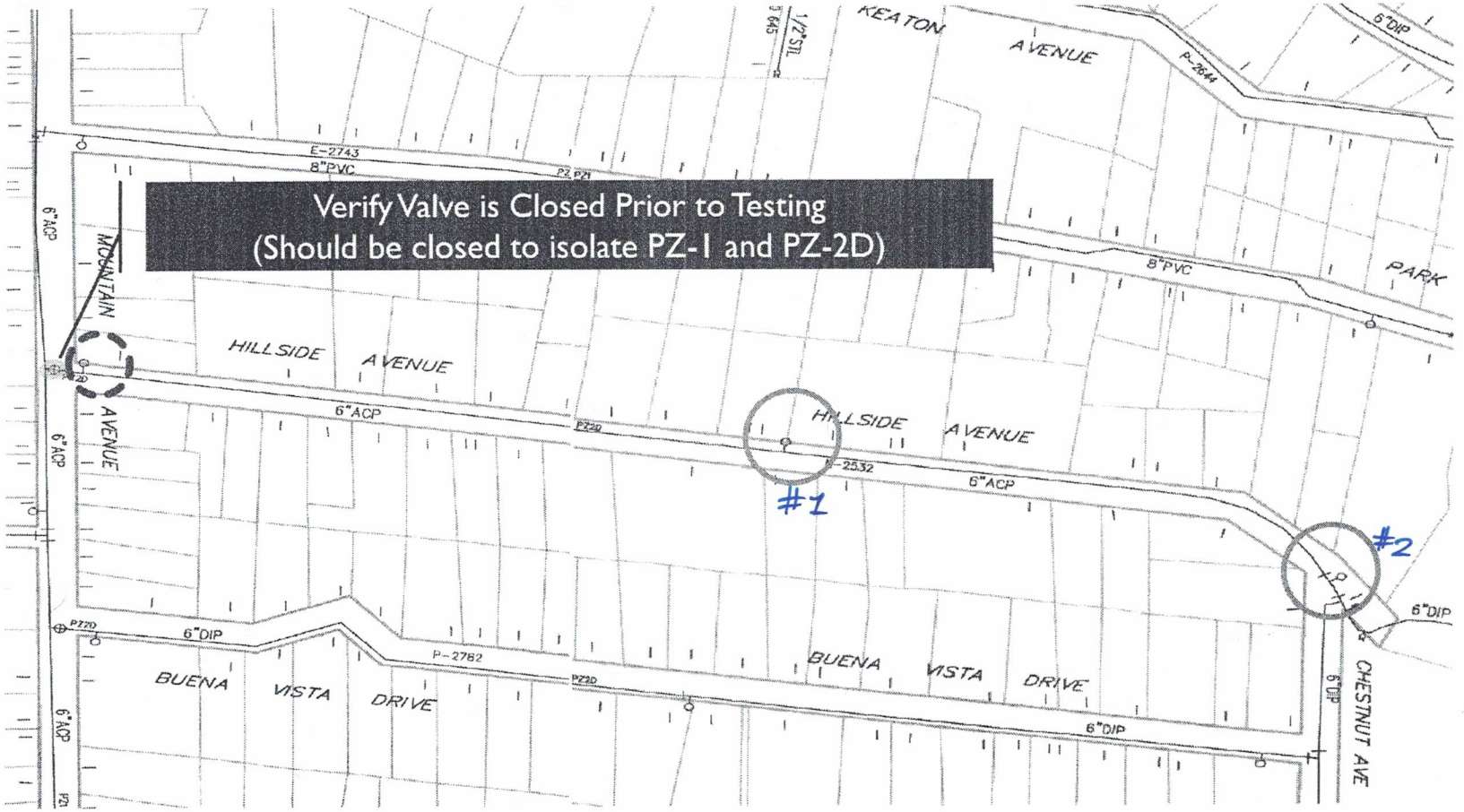
Test Location:	17398 Hillside Ave
Test Date:	12-18-18

Test Time:	8 16 AM
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	128	46 1140Gpm	129
Residual #1	2 1/2	102	54	102
Residual #2	2 1/2	84	50	85
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 7A – 17398 HILLSIDE AVE – 6" ACP



Fire Hydrant Flow Data

eki environment & water

Test Location:	17387 Buena Vista Ave.
Test Date:	12-18-18

Test Time:	8 32 Am
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	120	49 1180 Gpm	121
Residual #1	2 1/2	77	40	77
Residual #2	2 1/2	56	35	56
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 7B – 17387 BUENA VISTA AVE – 6" DIP

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Fire Hydrant Flow Data

eki environment & water

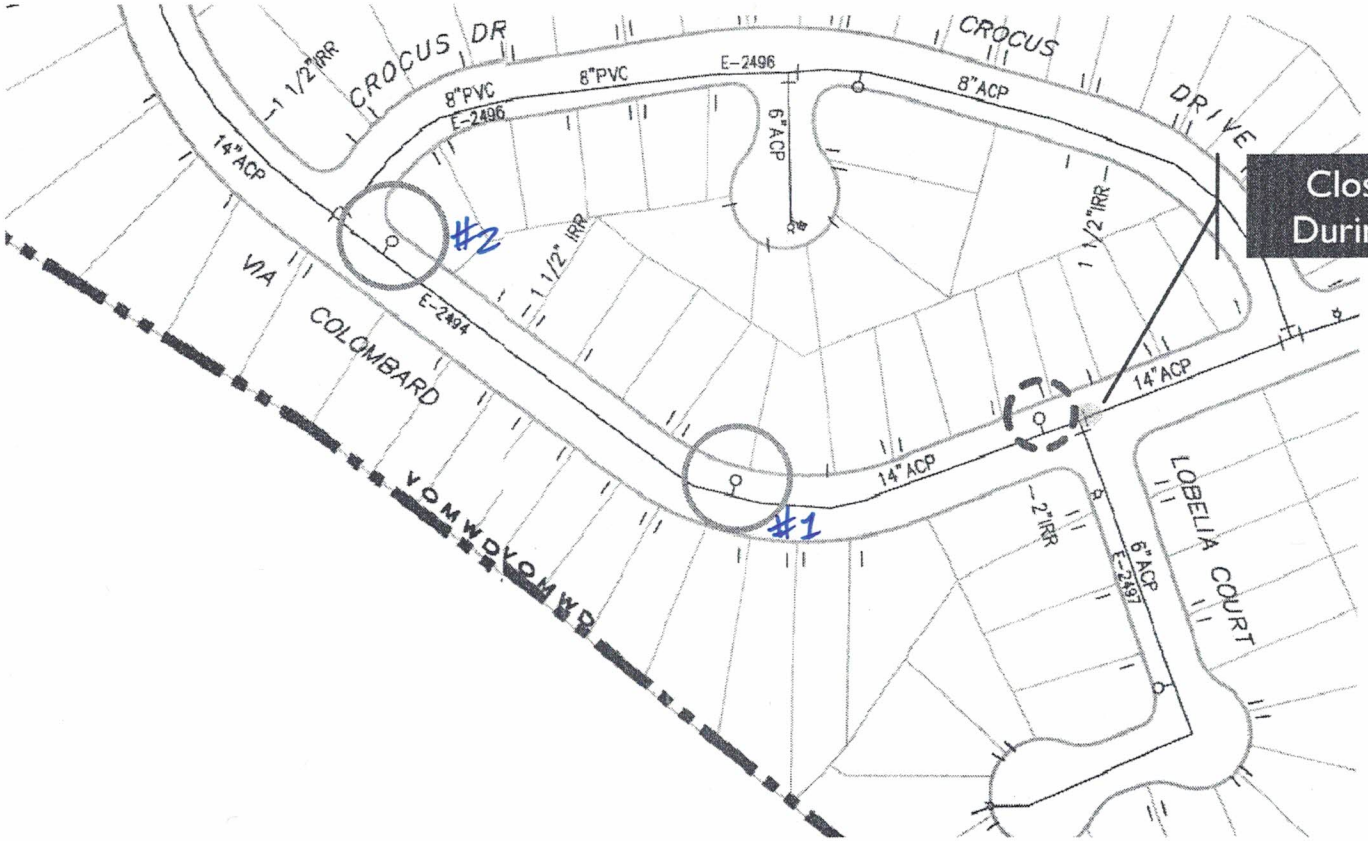
Test Location:	2115 Via Colombard
Test Date:	12-17-18

Test Time:	11 35 Am
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	62	53 1220 Gpm	63
Residual #1	2 1/2	61	48	60
Residual #2	2 1/2	56	~~56~~ 52	56
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 8 – 21115 VIA COLOMBARD – 14" ACP



Close Valve on Run During C-Factor Test

eki

Fire Hydrant Flow Data

eki environment & water

Test Location:	16501 Meadow Oaks Dr.
Test Date:	12-17-18

Test Time:	C-factor 4 03 pm 12-17-18 / 7 41 Am 12-18-18
Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	51 / 51	C-factor 30 / 36 (920 GPM / 1020 GPM)	52 / 51
Residual #1	2 1/2	48 / 48	42 / 42	48 / 48
Residual #2	2 1/2	50 / 50	45 / 45	50 / 51
Residual #3	2 1/2	55 / 55	48 / 50	54 / 55

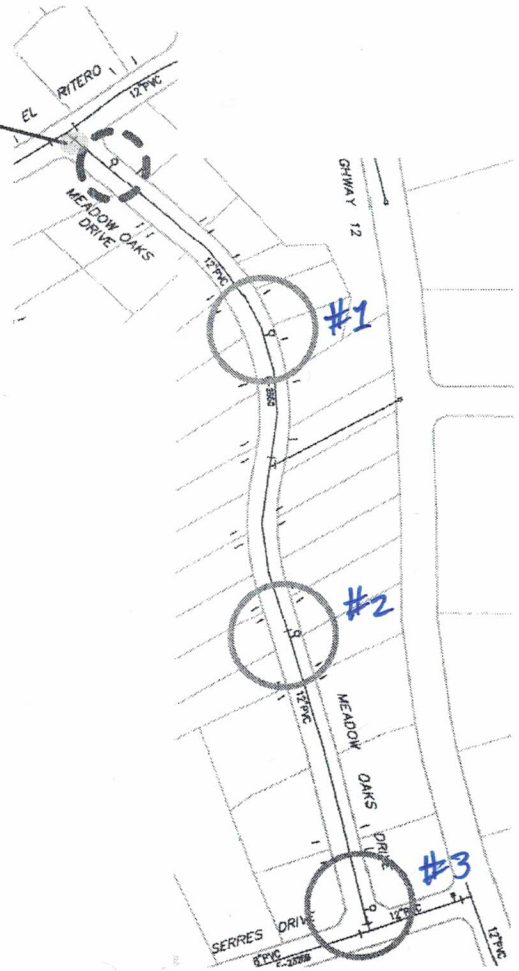
Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

C-factor test 4:03 pm 12-17-18
AC Turnout: Static: SCWA = 106 VOMWD = 59
flowing SCWA = 90 VOMWD = 57

AC Turnout: 7:41 am 12-18-18 : Static: SCWA = 110
VOMWD = 60 flowing: SCWA = 90 to 140 VOMWD = 58

TEST 9 – 16501 MEADOW OAKS DRIVE – 12" PVC

Close Valve on Branch
During C-Factor Test



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Fire Hydrant Flow Data

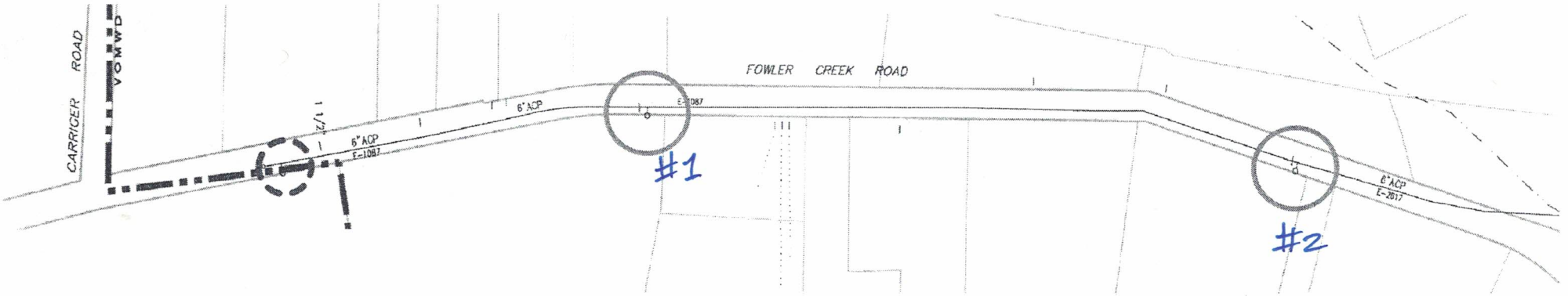
eki environment & water

Test Location:	1299 Fowler Creek Rd	Test Time:	11 56 AM
Test Date:	12-17-18	Testers:	N. Crews

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	55	17 700 Gpm	51
Residual #1	2 1/2	59	36	~~55~~ 59
Residual #2	2 1/2	64	54	64
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

TEST 10 – 1299 FOWLER CREEK ROAD – 6" ACP



eki

Fire Hydrant Flow Data

eki environment & water

Test Location:	1171 Solano Ave.
Test Date:	12-18-18

Test Time:	11 31 Am	/	11 40 Am c-factor
Testers:	N. Crews		

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	71 / 71	55 / 52 c-factor 1250gpm 1220gpm	72 / 71
Residual #1	2 1/2	68 / 68	61 / 60	68 / 69
Residual #2	2 1/2	76 / 77	63 / 67	77 / 77
Residual #3				

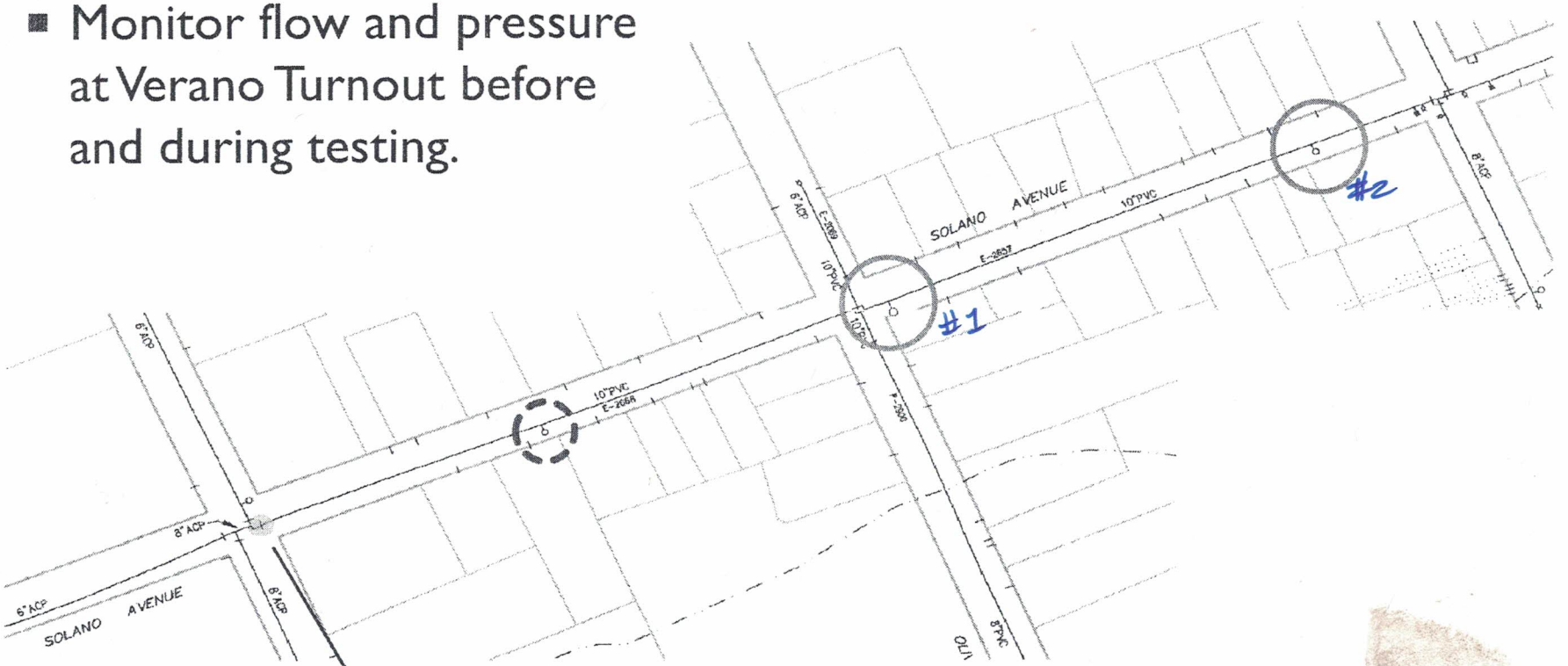
Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

Verano Turnout (11:31) static: SCWA = 125
VOMWD = 75 flowing = SCWA = 111 VOMWD = 69

Verano Turnout (11:40 c-factor) static: SCWA = 125 VOMWD = 75 flowing: SCWA = 105 VOMWD = 65

TEST 11 – 1171 SOLANO AVE – 10" PVC

- Monitor flow and pressure at Verano Turnout before and during testing.



Close Valve on Branch During C-Factor Test

Fire Hydrant Flow Data

eki environment & water

Test Location:	18500 Happy Ln.
Test Date:	12-18-18

Test Time:	10 57 AM / 11 00 AM
Testers:	N. Crews

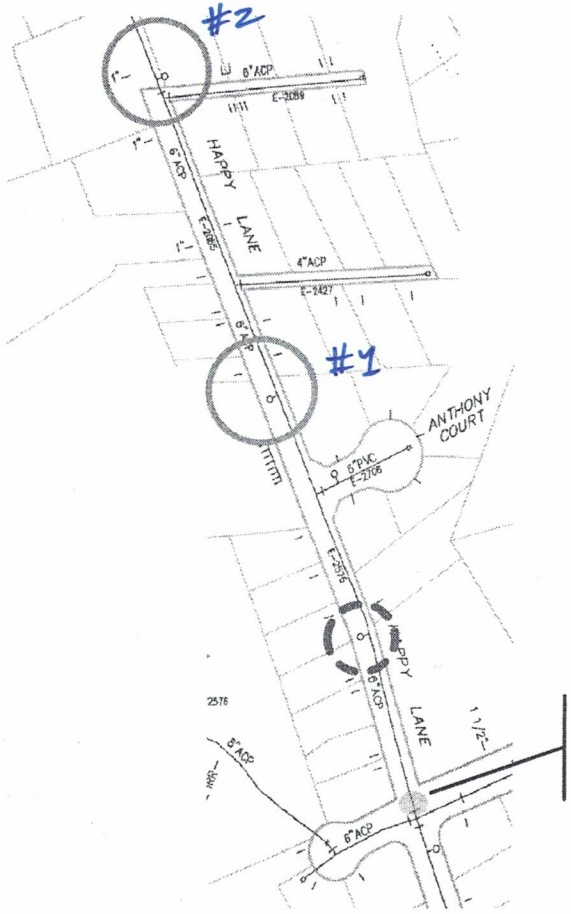
C-factor

Hydrant Flow Testing	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant	2 1/2	78 / 76	47 / 29 (C-factor) 1160gpm 910gpm	77 / 79
Residual #1	2 1/2	71 / 72	60 / 42	73 / 70
Residual #2	2 1/2	75 / 75	63 / 53	73 / 75
Residual #3				

Pipe Loss Test	Hydrant Outlet Diameter (in)	Static Pressure Prior to Testing (psi)	Testing Pressure (psi)	Static Pressure After Testing (psi)
Flow Hydrant				
Residual #1				
Residual #2				
Residual #3				

Did not monitor Altamira Turnout.

TEST 12 – 18500 HAPPY LANE – 6" ACP



Close Valve on Branch During C-Factor Test

eki

SUMMARY OF TEST LOCATIONS

Test Number	Diameter	Material	Pressure Zone	Flow Hydrant Location	Map Book Grid Number	Isolation Required (Two Test Rounds)	Turnout to Monitor	SCADA Data to Review
1	6	ACP	PZ3E	1225 Sobre Vista Road ✓	M25	12-17 13:33 to 13:58		Upper Sobre Vista PS Upper Sobre Vista Tank
2	6	DIP	PZ1F	4120 Lakeside Road ✓	K18	12-17 14:54 to 15:17	~~Glen Ellen~~	Glen Ellen Tank Glen Ellen PS
3	8	ACP	PZ1F	14600 Arnold Dr. ✓	L21	12-17 14:20 to 14:33	Glen Ellen	Glen Ellen Tank Glen Ellen PS
4	8	PVC	PZ1B	143 Loma Vista Dr. ✓	N25	12-17 13:17 to 13:32	Hannah	Hannah Tank Hannah PS
5	6	PVC/DIP	PZ2B	640 Michael Dr.	R29/ Q29	12-18 10:00 to 10:43		Donald PS
6	6	DIP	PZ3D	17201 Cragmont Dr.	Q26	12-18 8:52 to 9:27		Chestnut PS
7A	6	ACP	PZ2D	17398 Hillside Ave.	P26/P27	12-18 8:05 to 9:05		Chestnut Tank Mountain Well Agua Caliente PS
7B	6	DIP	PZ2D	17387 Buena Vista Ave.	P26/P27	11		Chestnut Tank Mountain Well Agua Caliente PS
8	14	ACP	PZ1A	21115 Via Colombard ✓	N37/O37	12-17-18 X 11:10 to 12:10		Temelec Tank + Arnold Booster
9	12	PVC	PZ1	16501 Meadow Oaks Dr.	O25/P25	12-17 15:56 to 16:16 12-18 7:30 to 7:55	~~Agua Caliente~~	Agua Caliente PS Bolli Tanks
10	6	ACP	PZ1	1299 Fowler Creek Road ✓	N33/O33	12-17 11:10 to 12:10 (Same as #8)		Temelec Tank + Arnold Booster
11	10	PVC	PZ1	1171 Solano Ave.	O32	12-18 11:28 to 11:46	Verano	Temelec Tank + Arnold Booster
12	6	ACP	PZ1	18500 Happy Ln.	P28/P29	12-18 10:50 to 11:10	Altimira & Boyes	Bolli Tank

eki

Appendix B

Hydraulic Model Calibration Results

Table B-1
Fire Hydrant Flow Testing and Model Results

Hydrant Test Results										
Date	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)			Calculations	
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C	Observed Flow at Hydrant Tested (Applied to Model) (gpm)	Calculated Flow at 20 psi (gpm)
12/17/18 14:58	2	4120 Lakeside Road	85	84	78	--	24	15	--	605	627
12/18/18 7:41	9	16501 Meadow Oaks Dr.	51	48	50	55	44	48	50	1,062	3036
12/18/18 11:31	11	1171 Solano Ave.	71	68	76	--	61	63	--	1,245	3521
12/18/18 10:57	12	18500 Happy Ln.	78	71	75	--	60	63	--	1,151	2635

Hydraulic Model Results (a)									
Date	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)		
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C
12/17/18 14:58	2	4120 Lakeside Road	78	82	68	--	27	15	--
12/18/18 7:41	9	16501 Meadow Oaks Dr.	50	50	53	53	44	48	48
12/18/18 11:31	11	1171 Solano Ave.	64	67	72	--	60	65	--
12/18/18 10:57	12	18500 Happy Ln.	73	74	73	--	60	64	--

Percent Difference between Model Results and Observations (a)									
Date	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)		
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C
12/17/18 14:58	2	4120 Lakeside Road	-10%	-2%	-14%	--	11%	0%	--
12/18/18 7:41	9	16501 Meadow Oaks Dr.	-2%	4%	6%	10%	0%	0%	-4%
12/18/18 11:31	11	1171 Solano Ave.	20%	28%	31%	--	-2%	3%	--
12/18/18 10:57	12	18500 Happy Ln.	-6%	3%	-3%	--	0%	2%	--

Abbreviations:
gpm - gallons per minute
psi - pounds per square inch

Notes:

(b) Shading indicates model and observations exceed 10% difference. See Appendix C for further discussion.

Table B-2
C-Factor Testing and Modeled Results

Hydrant Test Results											
Date and Time	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)			Calculations	
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C	Observed Flow at Hydrant Tested (Applied to Model) (gpm)	Calculated Flow at 20 psi (gpm)
12/17/18 13:51	1	1225 Sobre Vista Road	135	133	123	-	29	30	-	805	817
12/17/18 15:12	2	4120 Lakeside Road	85	84	78	-	23	18	-	557	519
12/17/18 14:25	3	14600 Arnold Dr.	115	108	99	-	80	78	-	1,163	1,404
12/17/18 13:25	4	143 Loma Vista Dr.	71	74	76	-	58	60	-	1,126	1,620
12/18/18 10:27	5	640 Michael Dr.	102	86	50	40	16	0	0	805	821
12/18/18 9:13	6	17201 Cragmont Dr.	72	80	85	-	15	25	-	444	394
12/18/18 8:16	7A	17398 Hillside Ave.	128	102	84	-	54	50	-	1,138	1,321
12/18/18 8:32	7B	17387 Buena Vista Ave.	120	77	56	-	40	35	-	1,175	1,414
12/17/18 11:35	8	21115 Via Colombard	62	61	56	-	48	52	-	1,222	2,808
12/17/18 16:03	9	16501 Meadow Oaks Dr.	51	48	50	55	42	45	48	919	1,135
12/17/18 11:56	10	1299 Fowler Creek Road	55	59	64	-	36	54	-	692	662
12/18/18 11:40	11	1171 Solano Ave.	71	68	77	-	60	67	-	1,210	2,063
12/18/18 11:00	12	18500 Happy Ln.	76	72	75	-	42	53	-	904	994

Hydraulic Model Results									
Date and Time	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)		
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C
12/17/18 13:51	1	1225 Sobre Vista Road	131	130	123	-	23	27	-
12/17/18 15:12	2	4120 Lakeside Road	78	82	69	-	26	18	-
12/17/18 14:25	3	14600 Arnold Dr.	107	101	96	-	80	78	-
12/17/18 13:25	4	143 Loma Vista Dr.	65	67	72	-	49	58	-
12/18/18 10:27	5	640 Michael Dr.	107	80	52	38	5	(b)	(b)
12/18/18 9:13	6	17201 Cragmont Dr.	68	78	78	-	16	19	-
12/18/18 8:16	7A	17398 Hillside Ave.	122	100	79	-	53	53	-
12/18/18 8:32	7B	17387 Buena Vista Ave.	114	72	56	-	26	35	-
12/17/18 11:35	8	21115 Via Colombard	64	59	56	-	59	56	-
12/17/18 16:03	9	16501 Meadow Oaks Dr.	51	51	55	55	45	49	49
12/17/18 11:56	10	1299 Fowler Creek Road	49	54	65	-	26	52	-
12/18/18 11:40	11	1171 Solano Ave.	66	69	74	-	57	63	-
12/18/18 11:00	12	18500 Happy Ln.	73	74	73	-	43	54	-

Table B-2 (cont.)
C-Factor Testing and Modeled Results

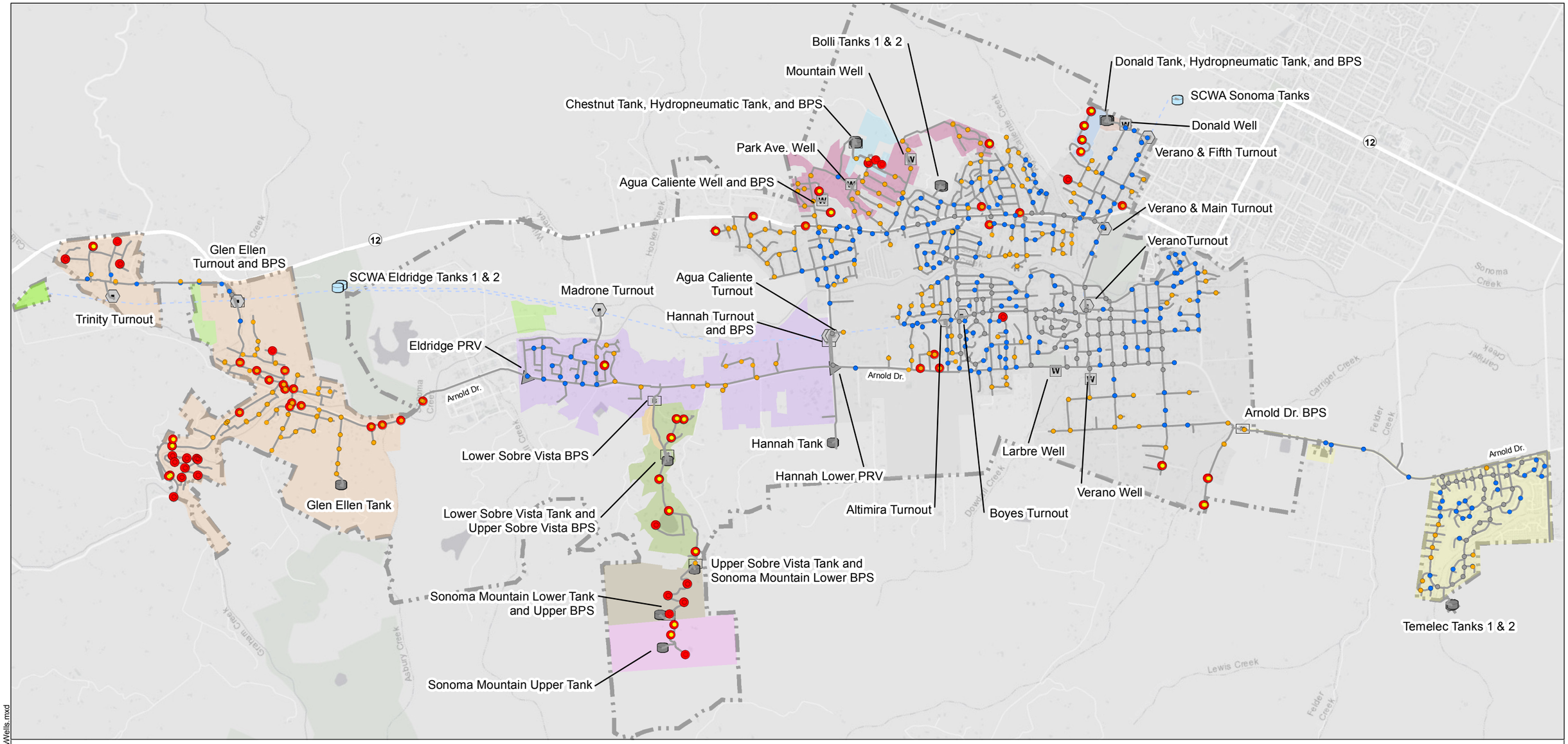
Percent Difference between Model Results and Observations									
Date	Test Number	Flow Hydrant Test Location	Static Pressure (psi)				Test Pressure (psi)		
			Flow Hydrant	Residual A	Residual B	Residual C	Residual A	Residual B	Residual C
12/17/18 13:51	1	1225 Sobre Vista Road	-3%	-3%	0%	-	-27%	-13%	-
12/17/18 15:12	2	4120 Lakeside Road	-9%	-2%	-14%	-	10%	-2%	-
12/17/18 14:25	3	14600 Arnold Dr.	-8%	-7%	-3%	-	-0.4%	0.4%	-
12/17/18 13:25	4	143 Loma Vista Dr.	-10%	-10%	-5%	-	-20%	-3%	-
12/18/18 10:27	5	640 Michael Dr.	5%	-7%	4%	-5%	-195%	0% (b)	0% (b)
12/18/18 9:13	6	17201 Cragmont Dr.	-6%	-3%	-8%	-	8%	-32%	-
12/18/18 8:16	7A	17398 Hillside Ave.	-5%	-2%	-7%	-	-2%	6%	-
12/18/18 8:32	7B	17387 Buena Vista Ave.	-5%	-6%	0%	-	-56%	-1%	-
12/17/18 11:35	8	21115 Via Colombard	3%	-4%	-1%	-	18%	7%	-
12/17/18 16:03	9	16501 Meadow Oaks Dr.	1%	7%	9%	0%	7%	8%	2%
12/17/18 11:56	10	1299 Fowler Creek Road	-13%	-9%	1%	-	-39%	-3%	-
12/18/18 11:40	11	1171 Solano Ave.	-7%	2%	-4%	-	-6%	-6%	-
12/18/18 11:00	12	18500 Happy Ln.	-4%	2%	-3%	-	2%	2%	-

Abbreviations:
psi - pounds per square inch
gpm - gallons per minute

Notes:
(a) Shading indicates model and observations exceed 10% difference.
(b) Model reports theoretical negative pressures which are equivalent to a zero psi pressure gauge reading.

Appendix C

Water System Performance (MDD + FF) with All Groundwater Wells in Service



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Existing Water System Performance Evaluation
Max Day Demands - Available Fire Flow
With All Wells In Service

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure C-1

eki environment & water

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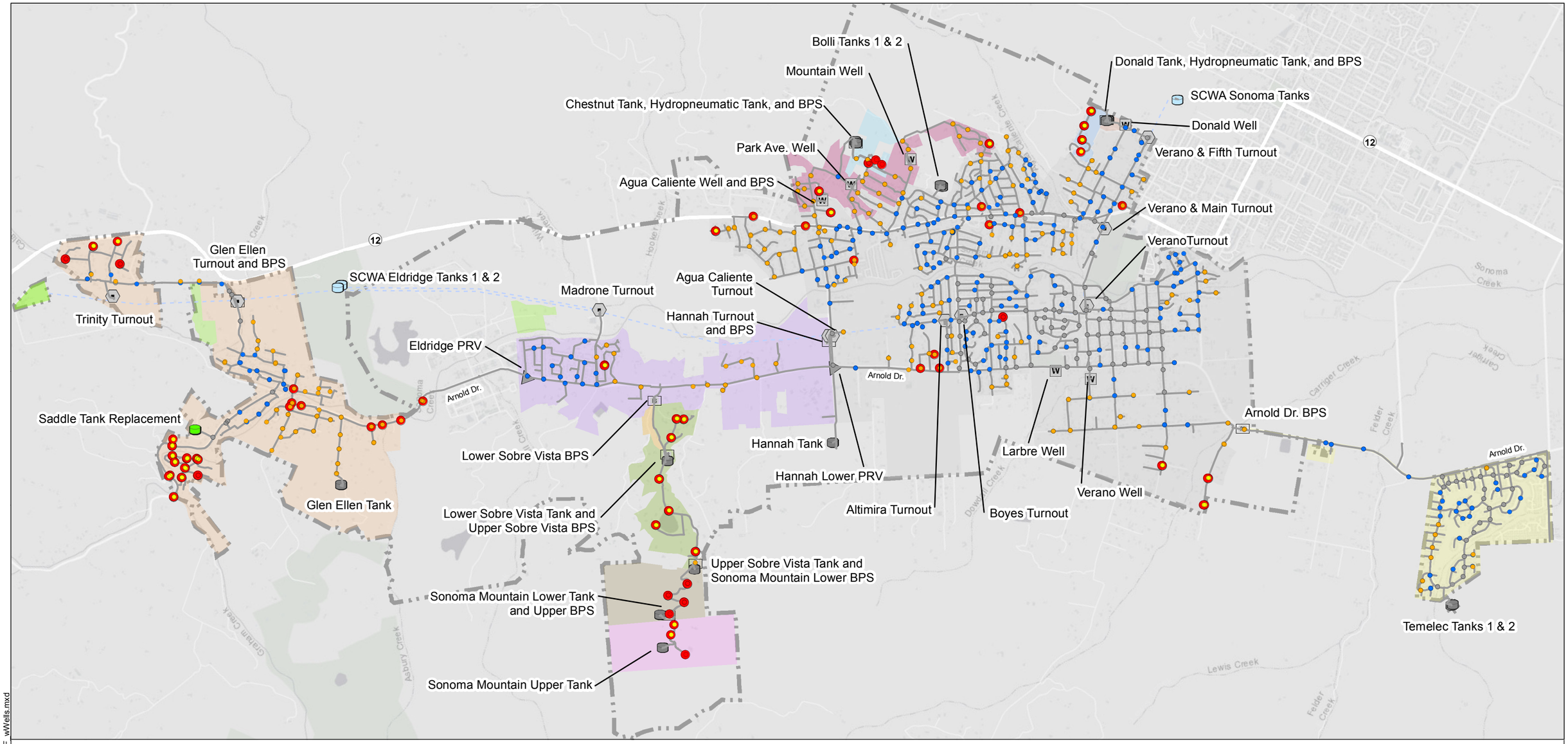

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 2E
- 3D
- 3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
psi = pounds per square inch
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Future Water System Performance Evaluation
Max Day Demands - Available Fire Flow
With All Wells in Service

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure C-2

eki environment & water

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Appendix D

Water System Performance with Recommended Capacity Improvements

WATER SYSTEM PERFORMANCE WITH RECOMMENDED CAPACITY IMPROVEMENTS

EKI modeled the proposed improvements under future demand conditions to confirm that the identified deficiencies had been addressed. EKI modeled the improvements with each alternative Pressure Zone 1F tank location. However, both tank locations offered similar system performance and neither had an obvious operational advantage. However, the Alternative #1 location would likely require a shorter length of new transmission main, and it could be installed adjacent to London Ranch Road, providing easy access. PHD and MDD plus FF results with the proposed improvements are discussed below.

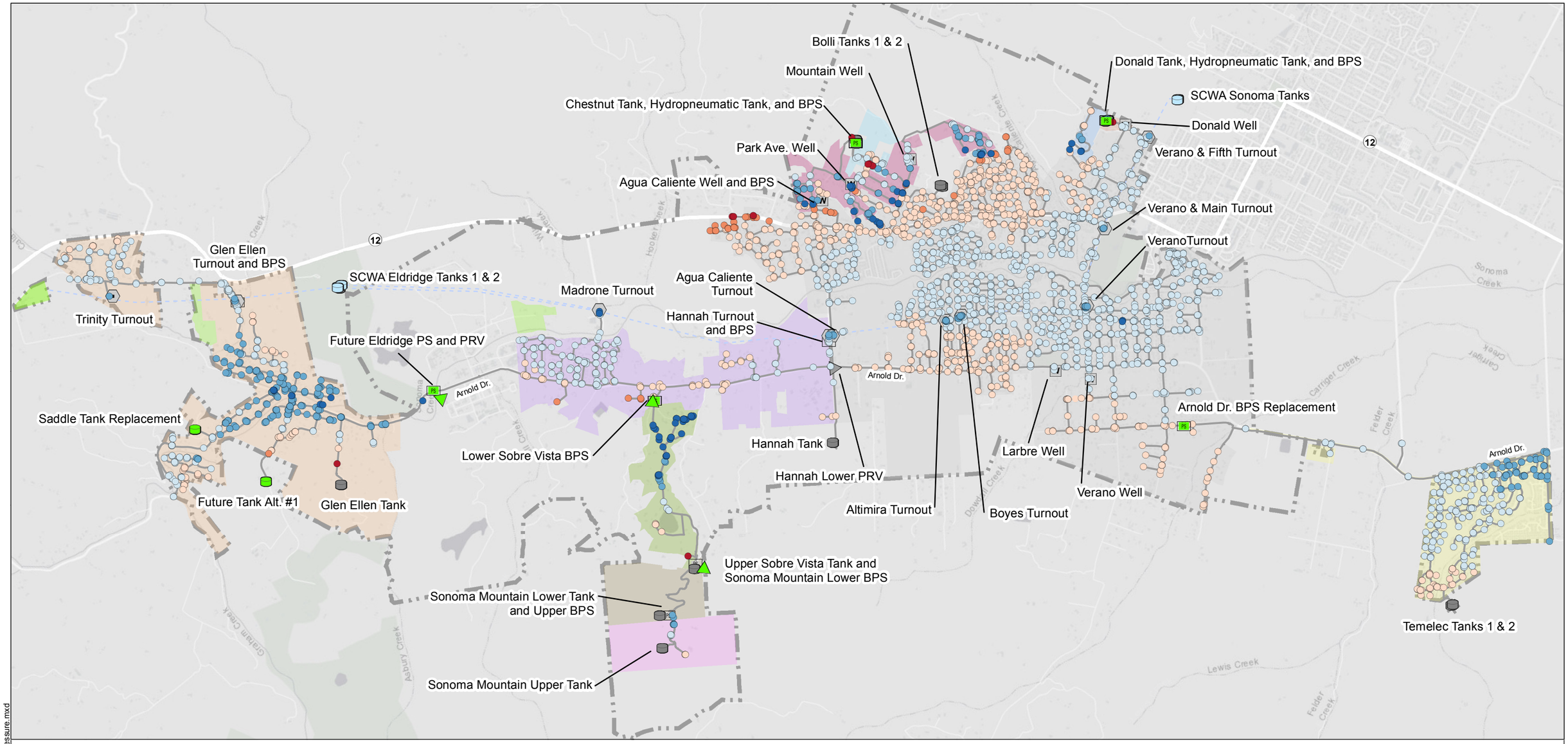
PHD Results

PHD modeling results with the recommended improvements and either the Alternative #1 and #2 Tank locations are presented in

Figure D and Figure , respectively. Generally, the deficient low-pressure pockets seen in the Existing and Future scenarios have been addressed. Only two nodes in the northern portion of Pressure Zone 1 are barely not meeting pressure criteria at 33 and 34 psi. Two nodes directly below Glen Ellen Tank and Upper Sobre Vista Tank also are slightly below the pressure criteria at 31 psi and 28 psi, respectively. Pressures at each of these locations are limited by elevation (i.e., static pressures) and pipeline upsizing will not increase pressures above 35 psi.

MDD Plus Fire Flow Results

MDD+FF modeling results with the recommended improvements and either the Alternative #1 and #2 Tank locations are presented in Figure and Figure, respectively. For both alternatives, all fire flow deficiencies have been corrected, except for those on the Sonoma Mountain in Pressure Zone 4E and 5E. Projects to address fire deficiencies in Pressure Zone 4E and 5E have not been identified in the list of recommended projects. These zones only serve one customer, and it would require a significant cost to replace approximately 1,750 linear feet of recently-installed 4-inch HDPE pipe and install fire pumps to supply required flows.



Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 3D
- 2E/3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility
- Future Pump Station
- Future PRV

Junction Pressure, psi

- Less than 35 (Not Meeting Criteria)
- 35 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Greater than 100

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Water System Performance with Capacity Improvements (Tank Alt. #1) - Peak Hour Demands - System Pressures

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure D-1

eki environment & water

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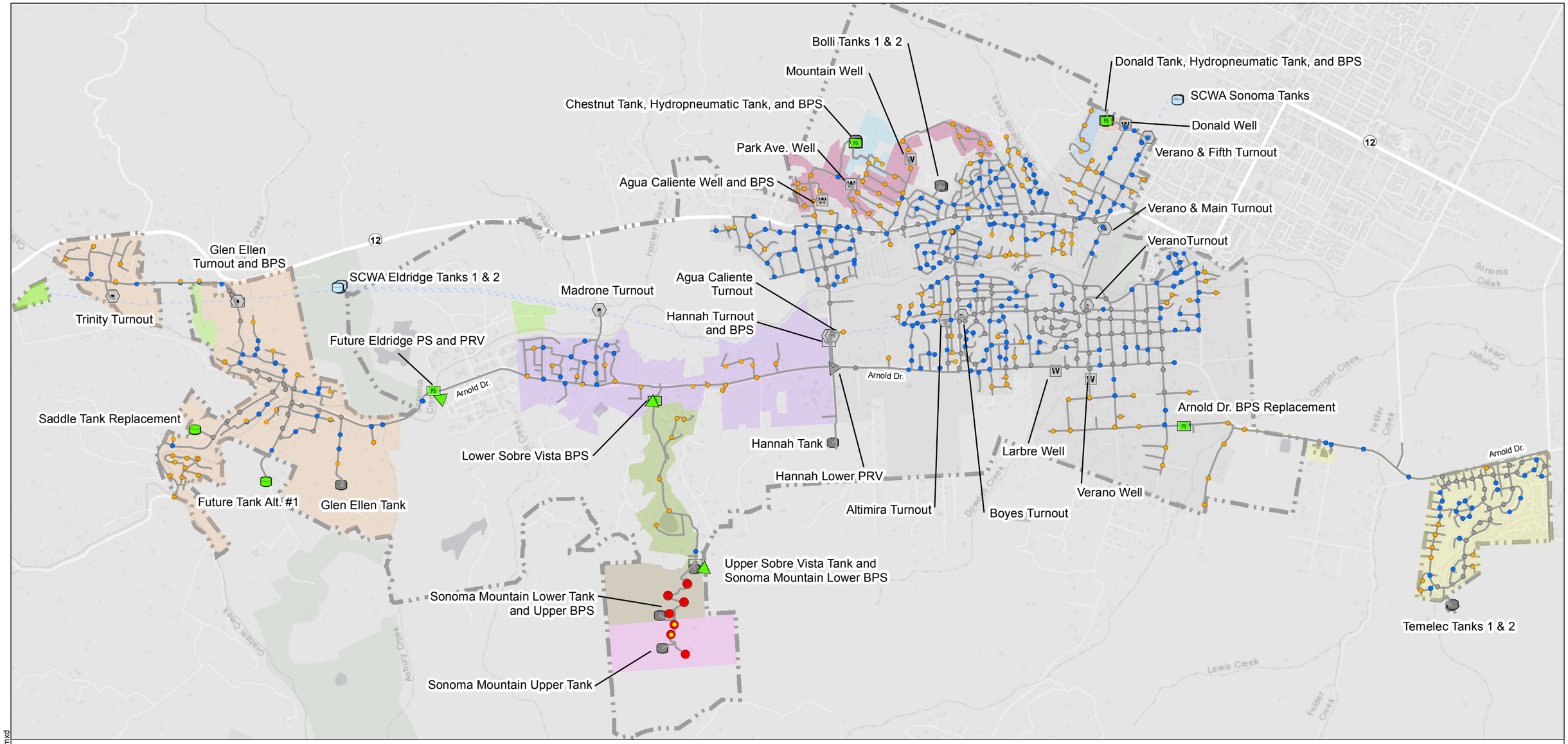

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 3D
- 2E/3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility
- Future Pump Station
- Future PRV

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Water System Performance with Capacity Improvements (Tank Alt. #1) - Max Day Demands - Available Fire Flow

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure D-2

eki environment & water

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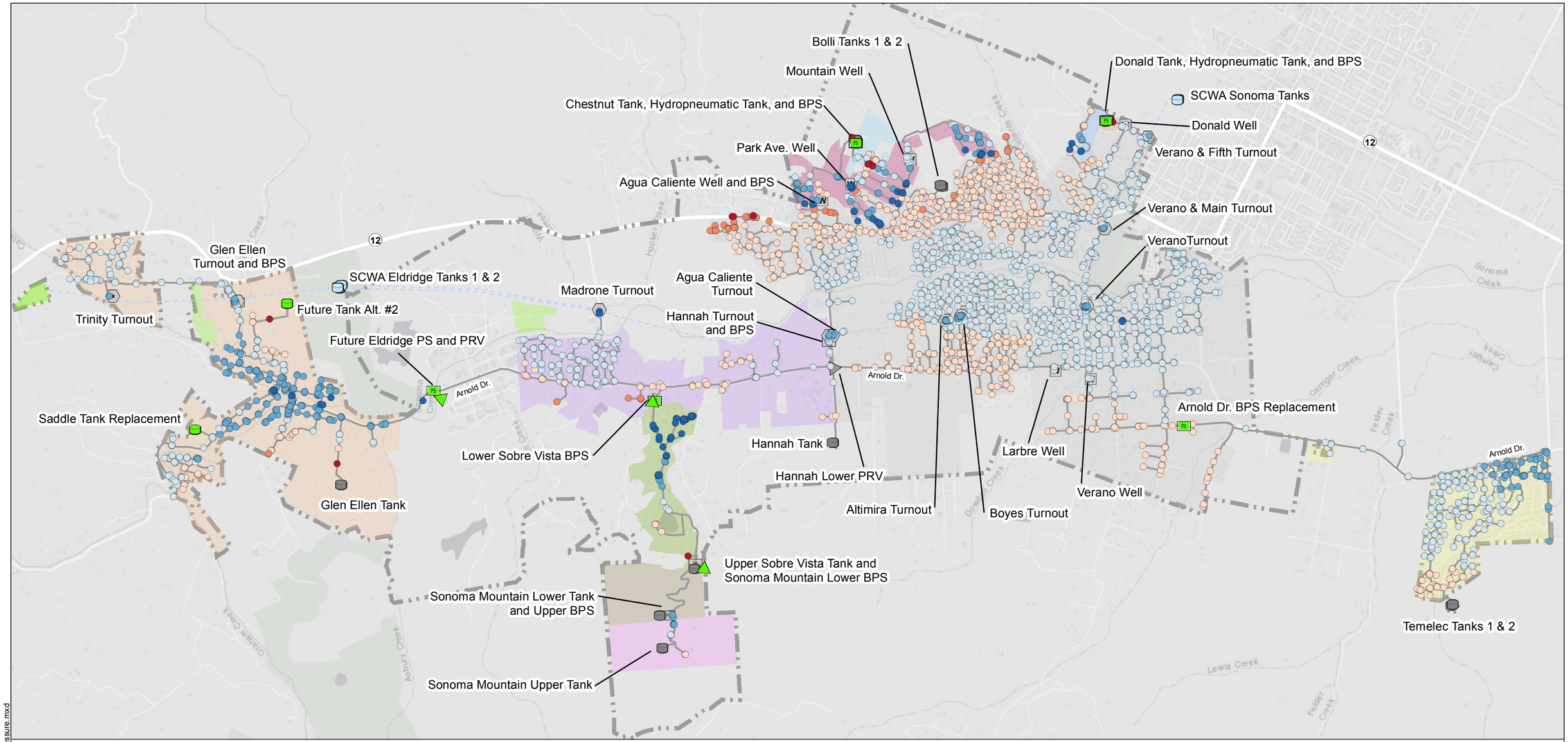

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 3D
- 2E/3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility
- Future Pump Station
- Future PRV

Junction Pressure, psi

- Less than 35 (Not Meeting Criteria)
- 35 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Greater than 100

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Water System Performance with Capacity Improvements (Tank Alt. #2) - Peak Hour Demands - System Pressures

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure D-3

eki environment & water

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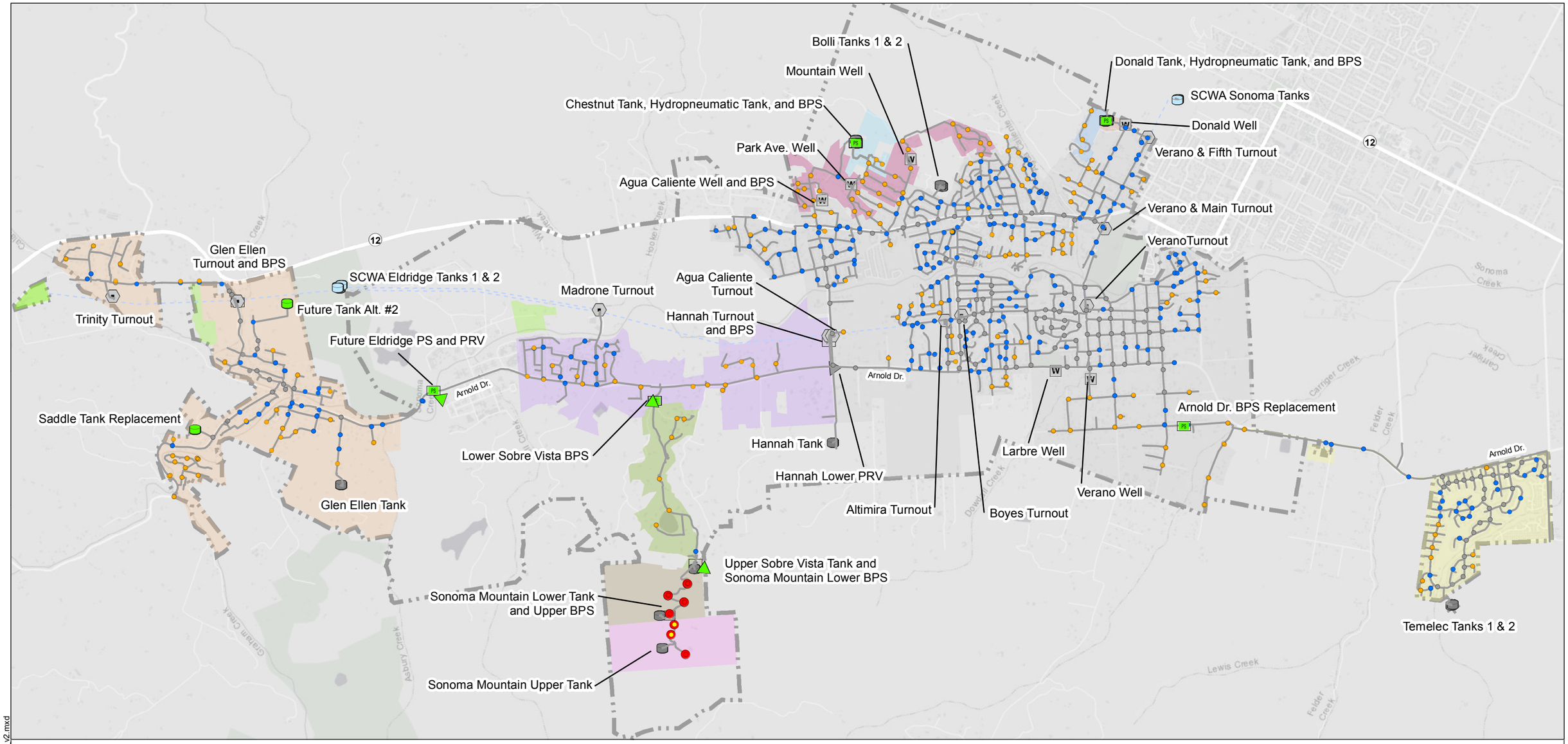

Legend

- Sphere of Influence
- SCWA Enclose Storage Facility
- SCWA Aqueduct

Existing District Infrastructure

- PRV
- Pump Station
- Enclosed Storage Facility
- Turnout and PRV
- Production Well
- Pipe

Pressure Zones

- 1
- 1A (See Note 2)
- 1B
- SCWA (See Note 3)
- 1F
- 2A
- 2B
- 2D
- 3D
- 2E/3E
- 4E
- 5E

Future District Infrastructure

- Future Enclosed Storage Facility
- Future Pump Station
- Future PRV

Available Fire Flow, Gallons per Minute

- Less than 500
- 500 - 1000
- 1000 - 2500
- 2500 - 4000
- Greater than 4000

Hydrant Residual Pressure Not Meeting Criteria

- Residual Pressure Below Requirement

Abbreviations

BPS = booster pump station
PRV = pressure reducing valve
PSI = pounds per square inch
PSV = pressure sustaining valve
SCWA = Sonoma County Water Agency

Notes

1. All locations are approximate.
2. Pressure Zone 1A can be isolated with boosted pressure from Arnold Dr. PS.
3. Pressure Zone 1C served directly by SCWA aqueduct.

Sources

1. Aerial basemap provided by ESRI's ArcGIS Online, 26 April 2019.
2. Pressure zone information adapted from Water System Map, January 2015.

N

0 3,000 6,000
Feet

Water System Performance with Capacity Improvements (Tank Alt. #2) - Max Day Demands - Fire Flow Coverage

Valley of the Moon Water District
Sonoma County, CA
April 2019
B80082.00

Figure D-4

eki environment & water

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Appendix E

CIP Project Detail Sheets

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-1

Project ID: P-1 **Project Priority Level:** 1

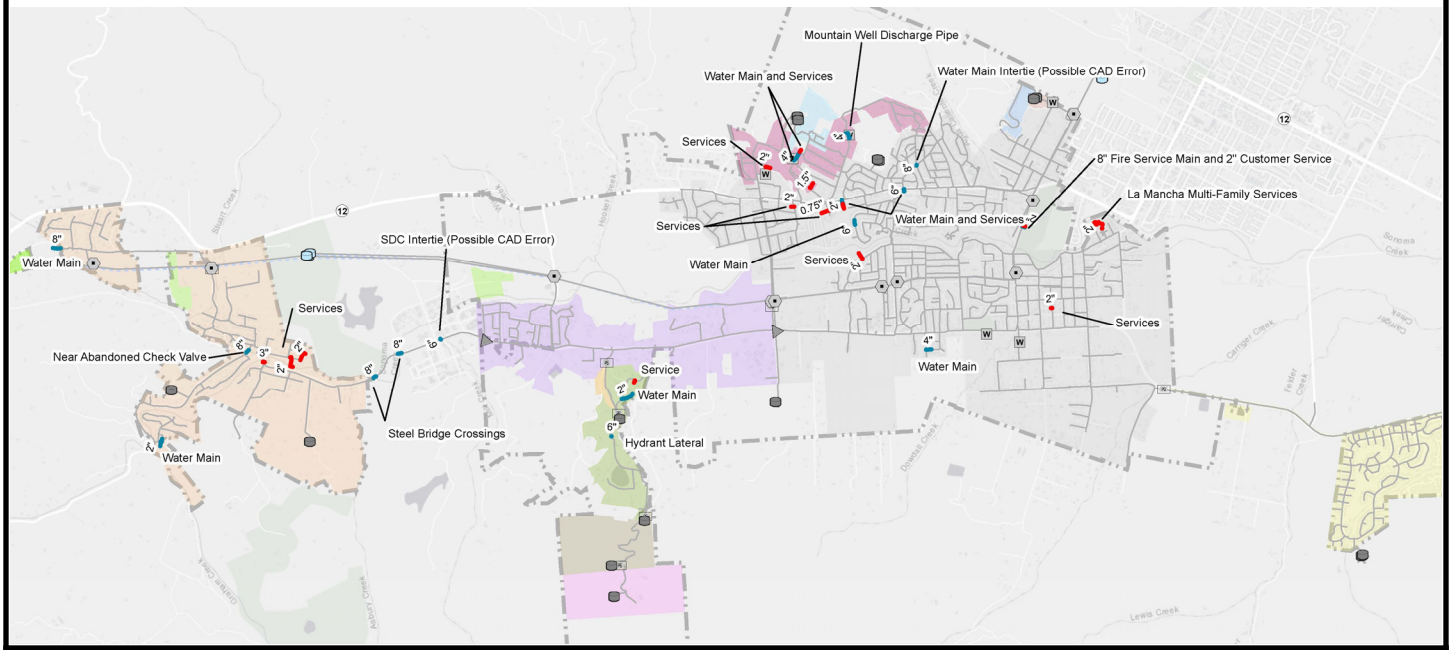
Description: Steel Pipe Replacement

Location: Various locations (see Figure 9-2)

Improvement Details: Replace all remaining steel water mains and convert steel laterals to customer service connections throughout distribution system as shown in Figure 9-2.

Justification: Replace all remaining aging steel water mains in the distribution system, which are susceptible to failure.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Steel Pipe Replacement							
Replacement Pipeline	8	800	LF	$180	$144,000	$260	$208,000
Replacement Pipeline	6	1,800	LF	$150	$270,000	$215	$387,000
Service Connection Replacement (a)	--	24	EA	$3,000	$72,000	$8,000	$192,000
Main Tie-ins	--	0	EA	$2,000	$0	$7,500	$0
Construction Contingency (25%)					$121,500		$196,800
Construction OPC					$607,500		$983,800
Engineering, Administration, and Permitting Costs (25%)					$121,500		$196,800
Total OPC					**$730,000**		**$1,180,000**

(a) Average length of steel pipe to be replace as a new copper services is approximately 100 LF which is substantially larger than a typical service. Thus, the service connection replacement cost factor has been increased by a factor of two.

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-2

Project ID: P-2 **Project Priority Level:** 1

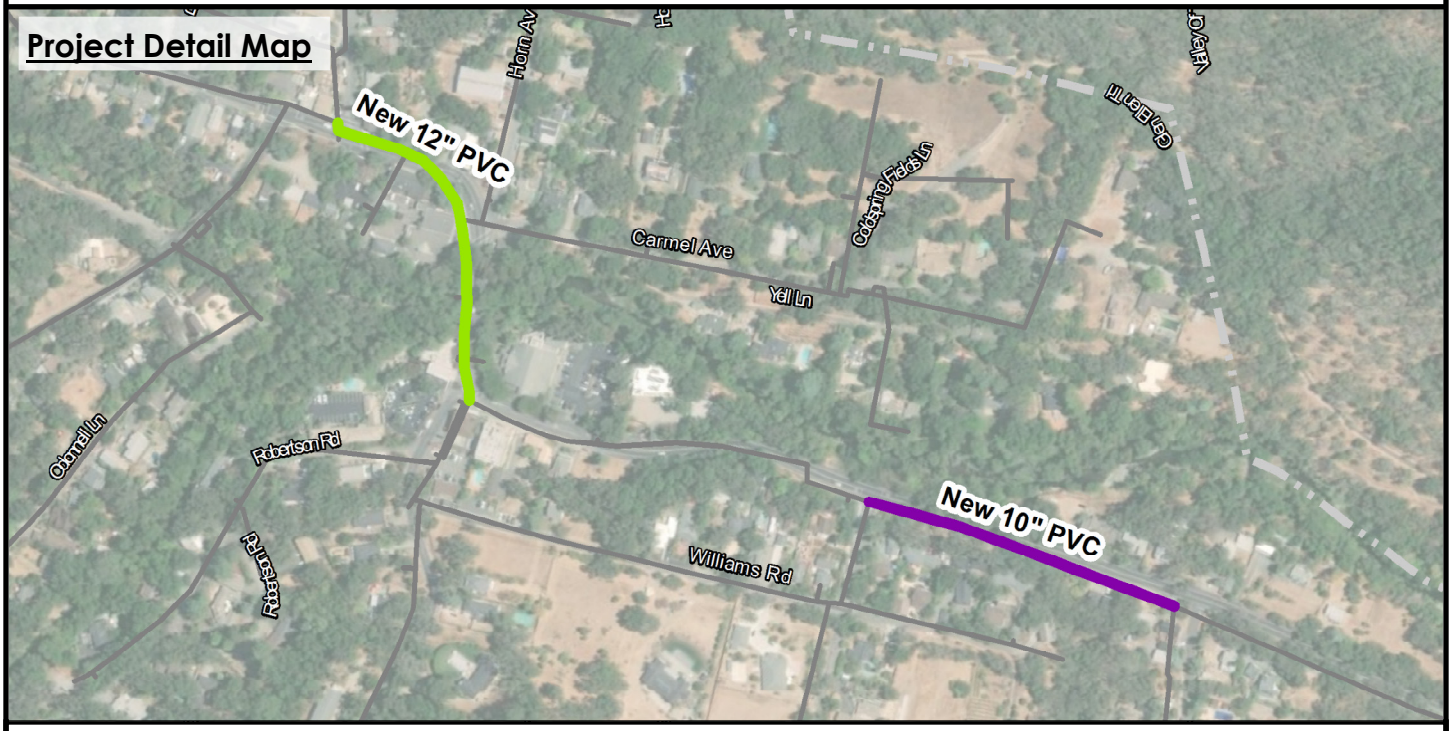
Description: Glen Ellen Transmission and Fire Flow Improvement

Location: Arnold Dr between Warm Springs Rd and London Ranch Rd and between Chauvet Rd and Hill Rd

Improvement Details: Replace existing 6-inch and 8-inch steel and ACP water mains with new 10-inch and 12-inch PVC water mains, replace existing service connections, and replace existing fire hydrants.

Justification: Replaces steel water mains, assists with addressing fire flow deficiency in PZ-1F, and increases transmission capability. Verify steel main to be replaced; if steel main is not present then project may be moved to Priority 2.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by Contractor	
			Unit Cost	Total Cost	Cost Factor	Total Cost
Glen Ellen Transmission and Fire Flow Improvement						
Replacement Pipeline	12	800 LF	$260	$208,000	$370	$296,000
Replacement Pipeline	10	700 LF	$215	$150,500	$310	$217,000
Hydrant Replacement	--	2 EA	$5,000	$10,000	$18,000	$36,000
Service Connection Replacement	--	18 EA	$1,500	$27,000	$4,000	$72,000
Main Tie-ins	--	7 EA	$2,000	$14,000	$7,500	$52,500
Construction Contingency (25%)				$102,400		$168,400
Construction OPC				$511,900		$841,900
Engineering, Administration, and Permitting Costs (25%)				$102,400		$168,400
Total OPC				**$610,000**		**$1,010,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-3

Project ID: P-3 **Project Priority Level:** 1

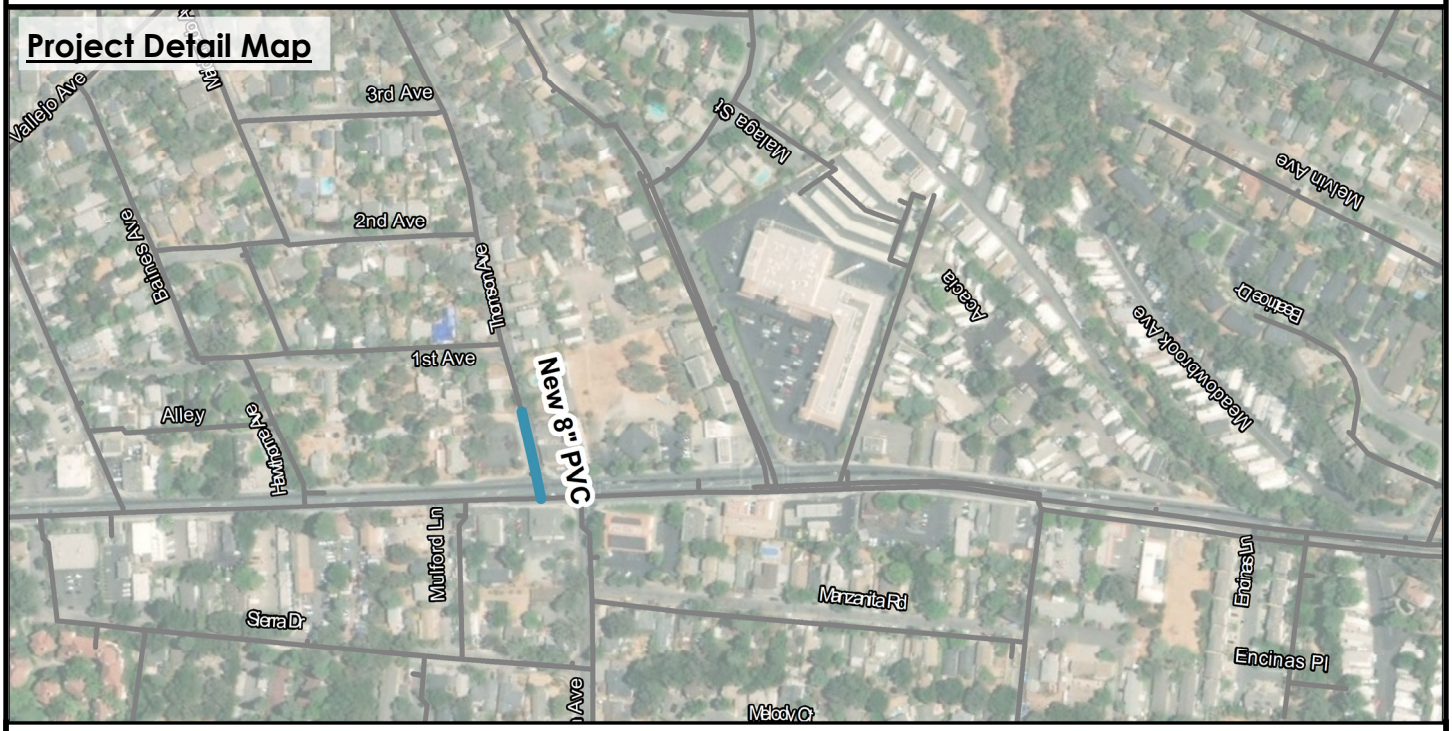
Description: East Thomson Avenue Commercial Fire Flow Improvement

Location: East Thomson Ave and Highway 12.

Improvement Details: Replace existing 4-inch steel water mains with new 8-inch PVC water mains and replace one existing fire hydrant along East Thomson Avenue.

Justification: Replaces steel water mains and addresses commercial fire flow deficiencies. Verify steel main to be replaced; if steel main is not present then project may be moved to Priority 2.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
East Thomson Avenue Commercial Fire Flow Improvement							
Replacement Pipeline	8	200	LF	$180	$36,000	$260	$52,000
Hydrant Replacement	--	1	EA	$5,000	$5,000	$18,000	$18,000
Service Connection Replacement	--	1	EA	$1,500	$1,500	$4,000	$4,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
Construction Contingency (25%)					$11,600		$22,300
Construction OPC					$58,100		$111,300
Engineering, Administration, and Permitting Costs (25%)					$11,600		$22,300
Total OPC					**$70,000**		**$130,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-4

Project ID: P-4 **Project Priority Level:** 1

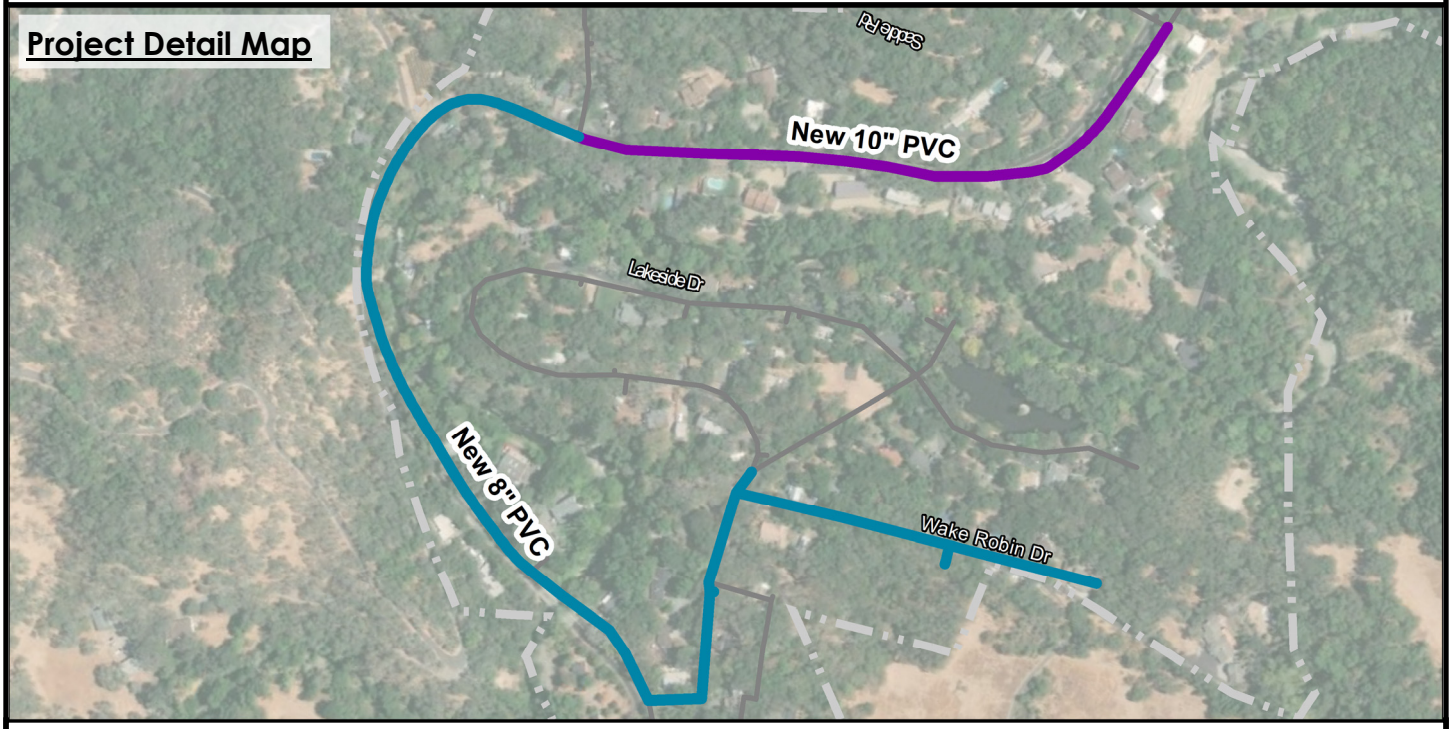
Description: Warm Springs Road Fire Flow Improvement

Location: Warm Springs Rd, Lakeside Rd, and Wake Robin Dr.

Improvement Details: Replace existing 6-inch PVC, ACP, and DIP water mains with new 8-inch and 10-inch PVC water mains, replace 47 existing service connections, and replace four existing fire hydrants.

Justification: Addresses significant fire flow deficiencies in residential areas near the wildland-urban interface.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Warm Springs Road Fire Flow Improvement							
Replacement Pipeline	8	3,400	LF	$180	$612,000	$260	$884,000
Replacement Pipeline	10	1,500	LF	$215	$322,500	$310	$465,000
Hydrant Replacement	--	4	EA	$5,000	$20,000	$18,000	$72,000
Service Connection Replacement	--	47	EA	$1,500	$70,500	$4,000	$188,000
Main Tie-ins	--	5	EA	$2,000	$10,000	$7,500	$37,500
Construction Contingency (25%)					$258,800		$411,600
Construction OPC					$1,293,800		$2,058,100
Engineering, Administration, and Permitting Costs (25%)					$258,800		$411,600
Total OPC					**$1,550,000**		**$2,470,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-5A

Project ID: P-5A **Project Priority Level:** 1

Description: Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement

Location: Throughout Pressure Zone 3D.

Improvement Details: Replace existing 4-inch ACP, PVC, and DIP water mains with new 8-inch PVC throughout PZ-3D, replace eight existing service connections, and replace one existing fire hydrants.

Justification: Addresses significant fire flow deficiencies in residential areas near the wildland-urban interface.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Pressure Zone 3D Fire Flow Improvement - Pipeline Replacement							
Replacement Pipeline	8	1,600	LF	$180	$288,000	$260	$416,000
Hydrant Replacement	--	1	EA	$5,000	$5,000	$18,000	$18,000
Service Connection Replacement	--	8	EA	$1,500	$12,000	$4,000	$32,000
Main Tie-ins	--	4	EA	$2,000	$8,000	$7,500	$30,000
				Construction Contingency (30%)	$93,900		$148,800
				Construction OPC	$406,900		$644,800
				Engineering, Administration, and Permitting Costs (30%)	$93,900		$148,800
				Total OPC	**$500,000**		**$790,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-5B

Project ID: P-5B **Project Priority Level:** 1

Description: Chestnut BPS Upgrades Projects

Location: Pressure Zone 3D BPS

Improvement Details: Replace existing Chestnut BPS with two (2) 100-gpm domestic pumps and one (1) 1,000 gpm fire pump at 60 ft total dynamic head (TDH).

Justification: Addresses supply deficiency and significant fire flow deficiencies in residential areas near the wildland-urban interface and replaces aging pump station facility.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by	
			Unit Cost	Total Cost	Cost Factor	Total Cost
Chestnut BPS Upgrades Projects						
BPS Improvement - Fire Pump Installation	--	1 LS	--	--	$1,272,000	$1,272,000
Construction Contingency (30%)				--		$381,600
Construction OPC				--		$1,653,600
Engineering, Administration, and Permitting Costs (30%)				--		$381,600
Total OPC				--		**$2,040,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-6

Project ID: P-6 **Project Priority Level:** 1

Description: Donald BPS Upgrades Project

Location: Pressure Zone 2B BPS

Improvement Details: Replace existing Donald BPS with two (2) 115-gpm domestic pumps and one (1) 1,000 gpm fire pump at 220 ft TDH.

Justification: Addresses supply deficiency and significant fire flow deficiencies in residential areas near the wildland-urban interface and replaces aging pump station facility.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by Contractor	
			Unit Cost	Total Cost	Cost Factor	Total Cost
Donald BPS Upgrades Project						
BPS Improvement - Fire Pump Replacement	--	1 LS	--	--	$1,272,000	$1,272,000
Construction Contingency (30%)				--		$381,600
Construction OPC				--		$1,653,600
Engineering, Administration, and Permitting Costs (30%)				--		$381,600
Total OPC				--		**$2,040,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-7

Project ID: P-7 **Project Priority Level:** 1

Description: Altimira Middle School Fire Flow Improvement

Location: Arnold Dr between Agua Caliente Rd and Boyes Blvd.

Improvement Details: Replace existing 6-inch and 8-inch PVC and ACP water mains with new 12-inch PVC water mains along Arnold Drive, replace existing 6-inch pipe with new 8 and 12-inch pipe adjacent to Altimira Middle School, replace 15 existing service connections, and replace three existing fire hydrants.

Justification: Addresses significant fire flow deficiency near Altimira Middle School and increases PZ-1 transmission capability.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Altimira Middle School Fire Flow Improvement							
Replacement Pipeline	8	160	LF	$180	$28,800	$260	$41,600
Replacement Pipeline	12	4,200	LF	$260	$1,092,000	$370	$1,554,000
Hydrant Replacement	--	3	EA	$5,000	$15,000	$18,000	$54,000
Service Connection Replacement	--	15	EA	$1,500	$22,500	$4,000	$60,000
Main Tie-ins	--	8	EA	$2,000	$16,000	$7,500	$60,000
Construction Contingency (25%)					$293,600		$442,400
Construction OPC					$1,467,900		$2,212,000
Engineering, Administration, and Permitting Costs (25%)					$293,600		$442,400
Total OPC					**$1,760,000**		**$2,650,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-8

Project ID: P-8 **Project Priority Level:** 1

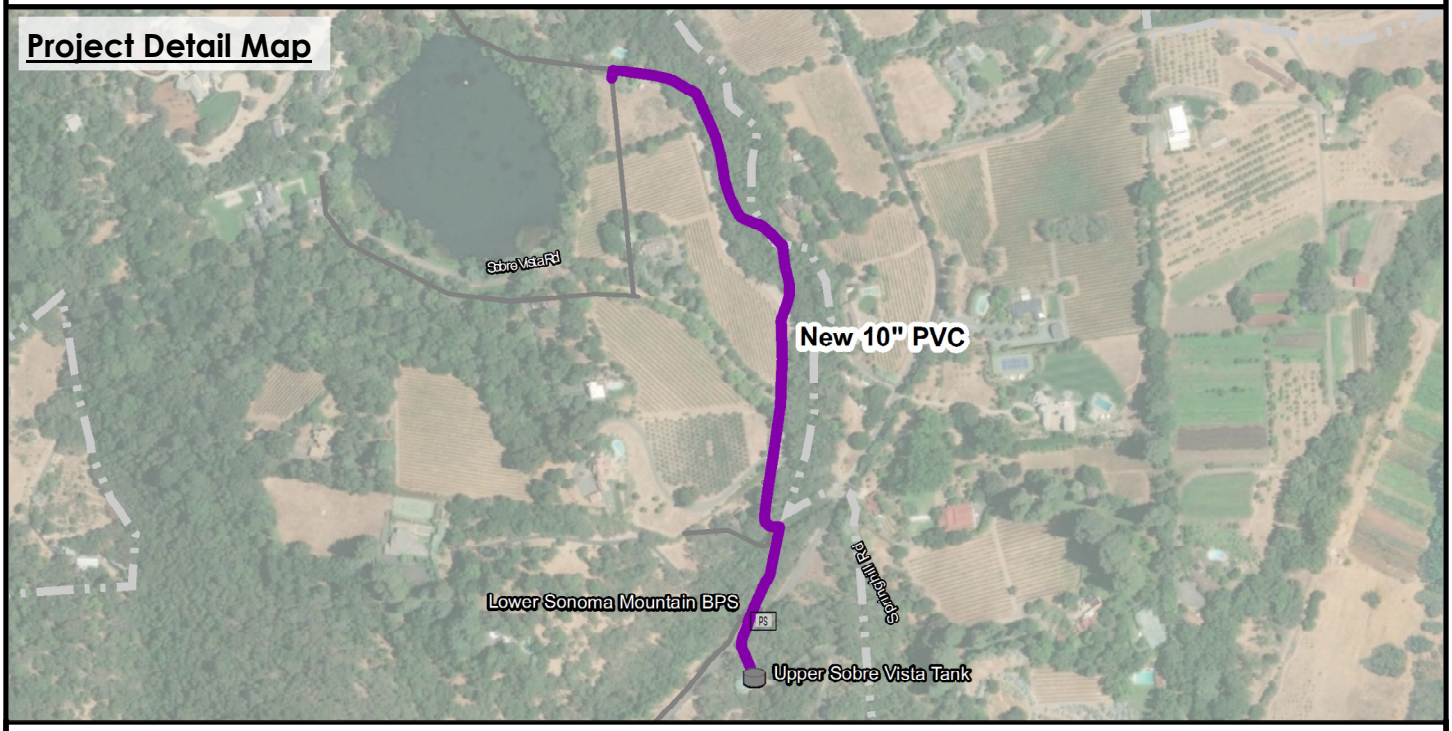
Description: Upper Sobre Vista Fire Flow Improvement

Location: Sobre Vista Rd.

Improvement Details: Replace existing 6-inch PVC and HDPE water mains with new 8-inch PVC water mains and replace two existing fire hydrants.

Justification: Addresses fire flow deficiencies in residential areas near the wildland-urban interface.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Upper Sobre Vista Fire Flow Improvement							
Replacement Pipeline	10	2,100	LF	$215	$451,500	$310	$651,000
Hydrant Replacement	--	2	EA	$5,000	$10,000	$18,000	$36,000
Main Tie-ins	--	4	EA	$2,000	$8,000	$7,500	$30,000
Construction Contingency (25%)					$117,400		$179,300
Construction OPC					$586,900		$896,300
Engineering, Administration, and Permitting Costs (25%)					$117,400		$179,300
Total OPC					**$700,000**		**$1,080,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-9

Project ID: P-9 **Project Priority Level:** 2

Description: Agua Caliente Road Transmission Improvement

Location: Agua Caliente Rd.

Improvement Details: Replace existing 8-inch ACP water mains with new 12-inch PVC water mains, replace 19 existing service connections, and replace two existing fire hydrants. Recommended to be constructed in conjunction with Project P-25 due to proximity.

Justification: Assists with multiple fire flow deficiencies and address minimum system pressure deficiencies in PZ-1.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Agua Caliente Road Transmission Improvement							
Replacement Pipeline	12	2,500	LF	$260	$650,000	$370	$925,000
Hydrant Replacement	--	2	EA	$5,000	$10,000	$18,000	$36,000
Service Connection Replacement	--	19	EA	$1,500	$28,500	$4,000	$76,000
Main Tie-ins	--	8	EA	$2,000	$16,000	$7,500	$60,000
				Construction Contingency (25%)	$176,100		$274,300
				Construction OPC	$880,600		$1,371,300
				Engineering, Administration, and Permitting Costs (25%)	$176,100		$274,300
				Total OPC	**$1,060,000**		**$1,650,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-10

Project ID: P-10 **Project Priority Level:** 2

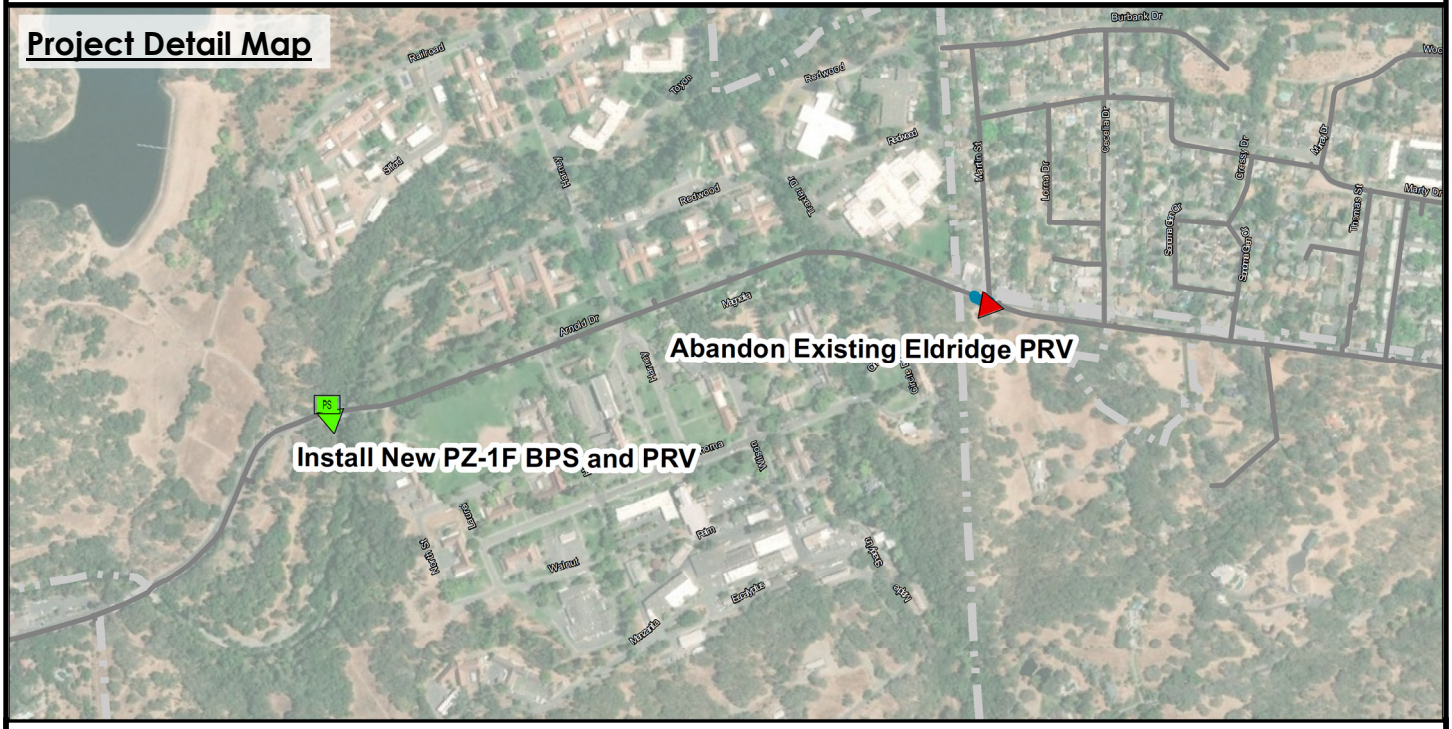
Description: Zone 1F Booster Pump Station and Eldridge PRV Replacement Project

Location: Near 14500 Arnold Dr.

Improvement Details: Install new PRV and BPS with a firm capacity of 450 gpm at 275 ft TDH. Abandon existing Eldridge PRV.

Justification: Addresses supply deficiency and fire flow deficiencies in PZ-1F and improves system redundancy.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by Contractor	
			Unit Cost	Total Cost	Cost Factor	Total Cost
Zone 1F Booster Pump Station and Eldridge PRV Replacement Project						
BPS Improvement - Fire Pump Replacement	--	1 LS	--	--	$988,000	$988,000
PRV Installation	--	1 EA	--	--	$100,000	$100,000
Main Tie-ins	--	2 EA	--	--	$7,500	$15,000
Abandonment of Existing PRV		1 EA	--	--	$10,000	$10,000
Construction Contingency (25%)				--		$278,300
Construction OPC				--		$1,391,300
Engineering, Administration, and Permitting Costs (25%)				--		$278,300
Total OPC				--		**$1,670,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-11 (ALTERNATIVE 1)

Project ID: **P-11 (Alternative 1)** **Project Priority Level:** 2

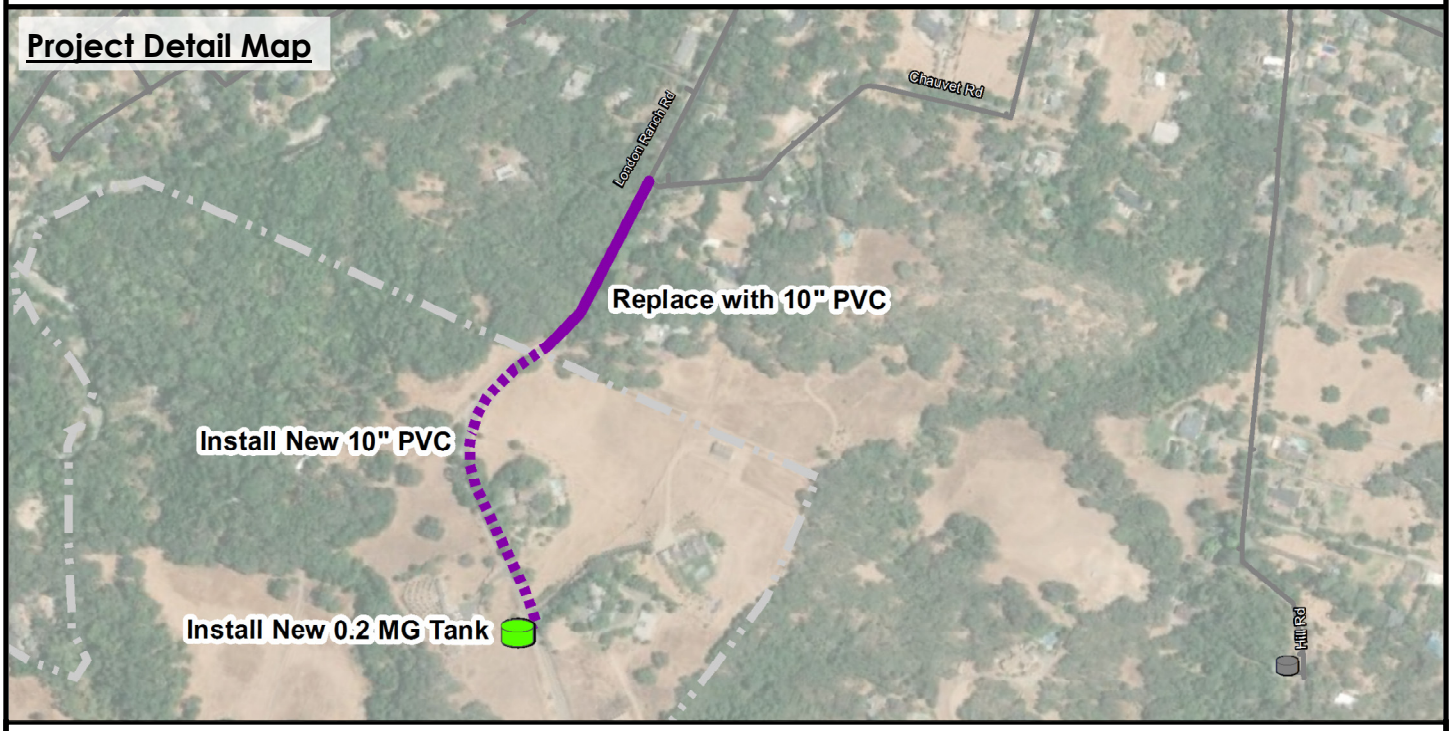
Description: Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road

Location: London Ranch Rd.

Improvement Details: Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 590 LF of existing 8-inch PVC with a 10-inch PVC water main.

Justification: Addresses storage deficiency in PZ-1F.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Pressure Zone 1F Tank Project Alternative #1 - London Ranch Road							
Replacement and New Pipeline Installation	8	1,700	LF	--	--	$260	$442,000
Tank Installation - 0.2 MG	--	1	LS	--	--	$492,000	$492,000
Main Tie-ins	--	1	EA	--	--	$7,500	$7,500
Construction Contingency (30%)					--		$282,500
Construction OPC					--		$1,224,000
Engineering, Administration, and Permitting Costs (30%)					--		$282,500
Total OPC					--		**$1,510,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-11 (ALTERNATIVE 2)

Project ID: **P-11 (Alternative 2)** **Project Priority Level:** 2

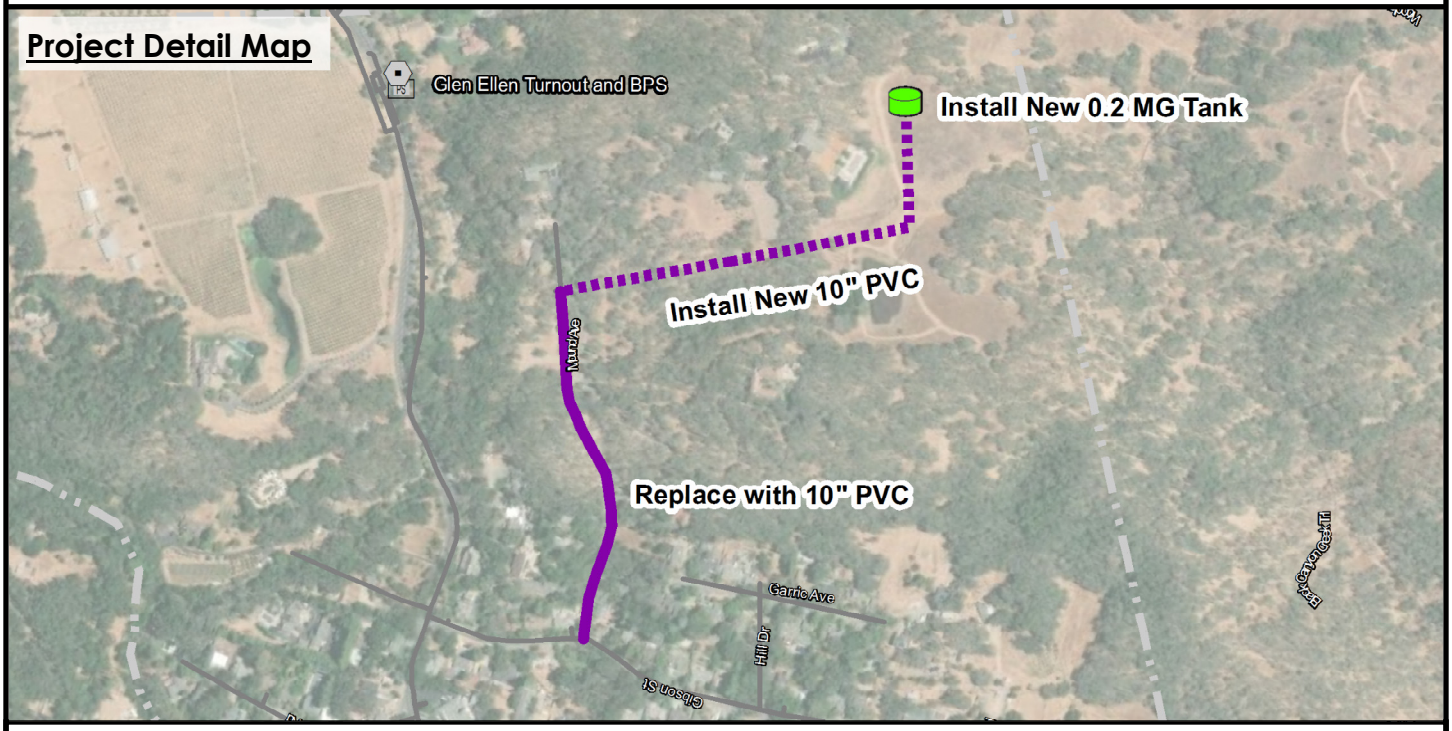
Description: Pressure Zone 1F Tank Project Alternative #2 - South of Mound Avenue

Location: South of Mound Ave.

Improvement Details: Install a new 0.2 MG welded steel tank and a new 10-inch PVC transmission main; replace 1,100 LF of existing 6-inch PVC with a 10-inch PVC water main.

Justification: Addresses storage deficiency in PZ-1F.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Pressure Zone 1F Tank Project Alternative #2 - South of Mound Avenue							
Replacement and New Pipeline Installation	8	2,600	LF	--	--	$260	$676,000
Tank Installation - 0.2 MG	--	1	LS	--	--	$492,000	$492,000
Main Tie-ins	--	1	EA	--	--	$7,500	$7,500
Construction Contingency (30%)					--		$352,700
Construction OPC					--		$1,528,200
Engineering, Administration, and Permitting Costs (30%)					--		$352,700
Total OPC					--		**$1,880,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-12

Project ID: P-12 **Project Priority Level:** 2

Description: Sobre Vista Pressure Zone Consolidation

Location: Lower Sobre Vista BPS and Tank

Improvement Details: Replace Lower Sobre Vista BPS with a firm capacity of 265 gpm at 270 ft TDH; demolish Lower Sobre Vista Tank and Upper Sobre Vista BPS; connect PZ-2E and 3E; install individual service PRVs in former PZ-2E area; install new PRV station between Pressure Zones 2E/3E and 1B.

Justification: Addresses supply and storage deficiencies in PZ-2E and PZ-3E, decommissions aging Lower Sobre Vista Tank, and improves system operations and redundancy.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Sobre Vista Pressure Zone Consolidation							
Replacement BPS - 265 gpm	--	1	LS	--	--	$814,600	$814,600
Tank Removal	--	1	LS	--	--	$50,000	$50,000
PRV Installation	--	1	EA	--	--	$100,000	$100,000
Main Tie-ins	--	4	EA	--	--	$2,000	$8,000
Construction Contingency (30%)					--		$291,800
Construction OPC					--		$1,264,400
Engineering, Administration, and Permitting Costs (30%)					--		$291,800
Total OPC					--		**$1,560,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-13

Project ID: P-13 **Project Priority Level:** 2

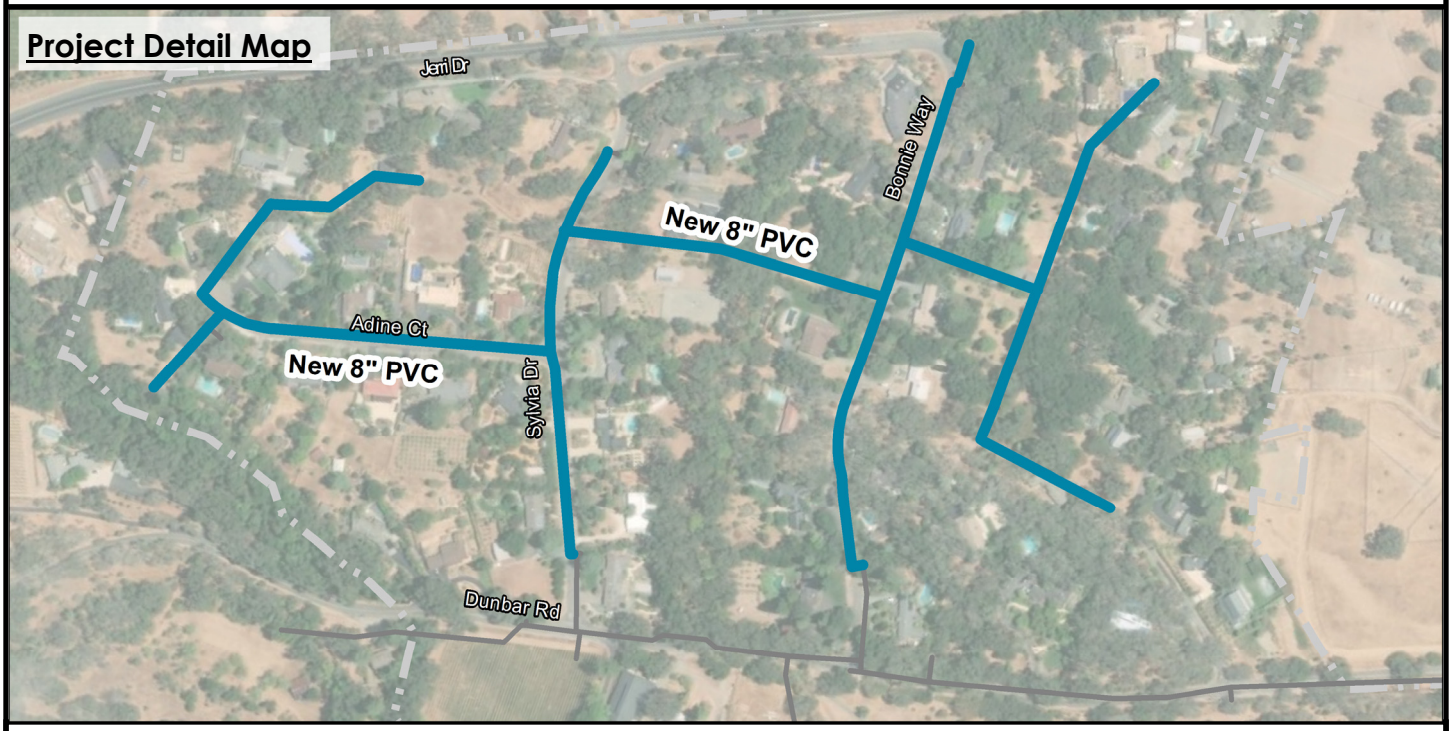
Description: Trinity Oaks 4-Inch ACP Replacement Project

Location: Bonnie Way, Sylvia Dr, Adine Ct.

Improvement Details: Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace existing service connections, and replace existing fire hydrants in the Trinity Oaks area. District to coordinate with Fire Department to determine if additional hydrants are needed. These hydrants would be funded by the Fire Department.

Justification: Addresses fire flow deficiencies in the area and replaces aging 4-inch ACP.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Trinity Oaks 4-Inch ACP Replacement Project							
Replacement Pipeline	8	6,000	LF	$180	$1,080,000	$260	$1,560,000
Hydrant Replacement	--	6	EA	$5,000	$30,000	$18,000	$108,000
Service Connection Replacement	--	49	EA	$1,500	$73,500	$4,000	$196,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
				Construction Contingency (25%)	$296,900		$469,800
					Construction OPC $1,484,400		$2,348,800
				Engineering, Administration, and Permitting Costs (25%)	$296,900		$469,800
					Total OPC $1,780,000		**$2,820,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-14

Project ID: P-14 **Project Priority Level:** 2

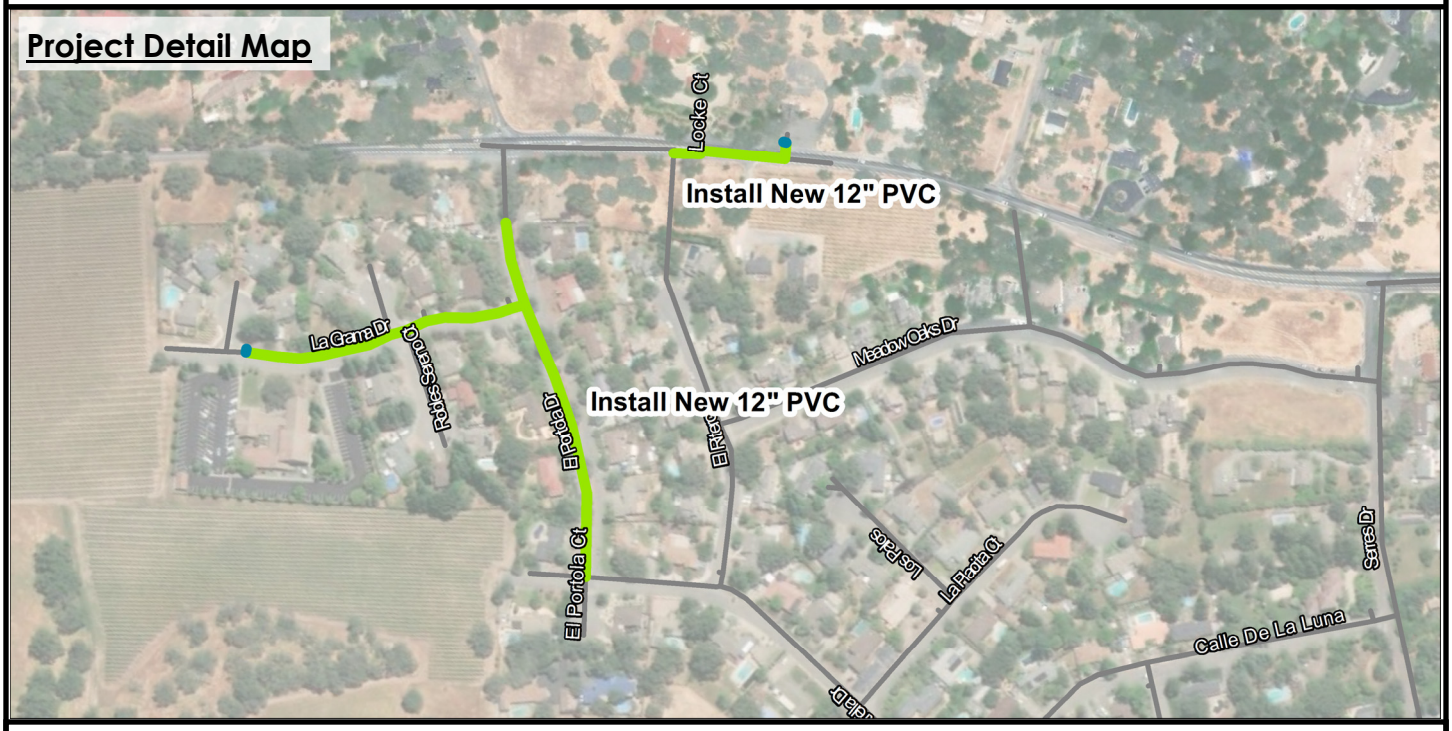
Description: Northern Pressure Zone 1 Commercial Fire Flow Improvement

Location: La Grama Dr, El Portola Dr, and Highway 12.

Improvement Details: Replace existing 6-inch and 8-inch ACP water mains with new 12-inch PVC water mains, replace 13 existing service connections, and replace three existing fire hydrants.

Justification: Addresses significant commercial fire flow deficiencies.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Northern Pressure Zone 1 Commercial Fire Flow Improvement							
Replacement Pipeline	12	1,800	LF	$260	$468,000	$370	$666,000
Hydrant Replacement	--	3	EA	$5,000	$15,000	$18,000	$54,000
Service Connection Replacement	--	13	EA	$1,500	$19,500	$4,000	$52,000
Main Tie-ins	--	5	EA	$2,000	$10,000	$7,500	$37,500
Construction Contingency (25%)					$128,100		$202,400
Construction OPC					$640,600		$1,011,900
Engineering, Administration, and Permitting Costs (25%)					$128,100		$202,400
Total OPC					**$770,000**		**$1,210,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-15

Project ID: P-15 **Project Priority Level:** 2

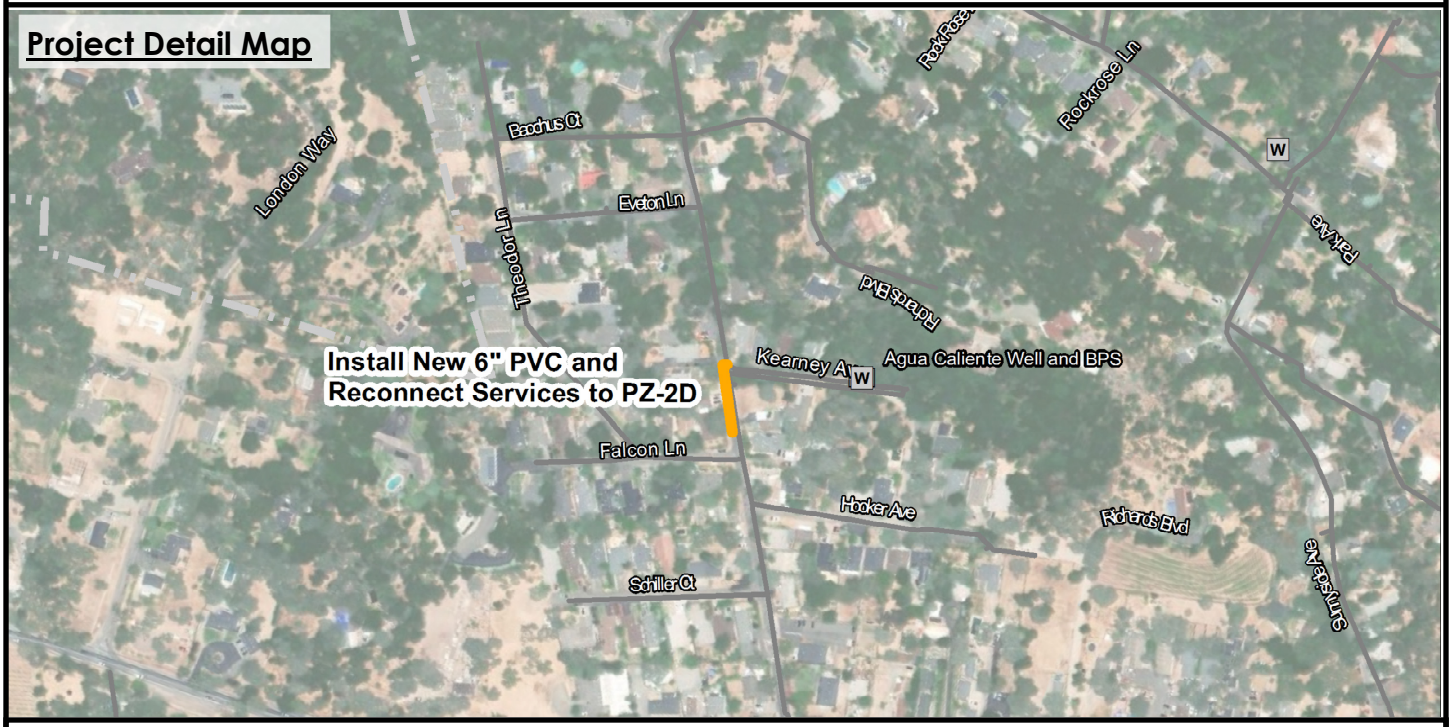
Description: Aqua Caliente Pressure Zone 2D Extension

Location: East Agua Caliente Rd.

Improvement Details: Install a parallel 6-inch PVC water main on Aqua Caliente Road and reconnect three services from Pressure Zone 1 to Pressure Zone 2D.

Justification: Address minimum system pressure deficiencies at the border between PZ-1 and PZ-2D.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Aqua Caliente Pressure Zone 2D Extension							
Replacement Pipeline	6	200	LF	$150	$30,000	$215	$43,000
Service Connection Replacement	--	3	EA	$1,500	$4,500	$4,000	$12,000
Main Tie-ins	--	1	EA	$2,000	$2,000	$7,500	$7,500
Construction Contingency (25%)					$9,100		$15,600
Construction OPC					$45,600		$78,100
Engineering, Administration, and Permitting Costs (25%)					$9,100		$15,600
Total OPC					**$50,000**		**$90,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-16

Project ID: P-16 **Project Priority Level:** 2

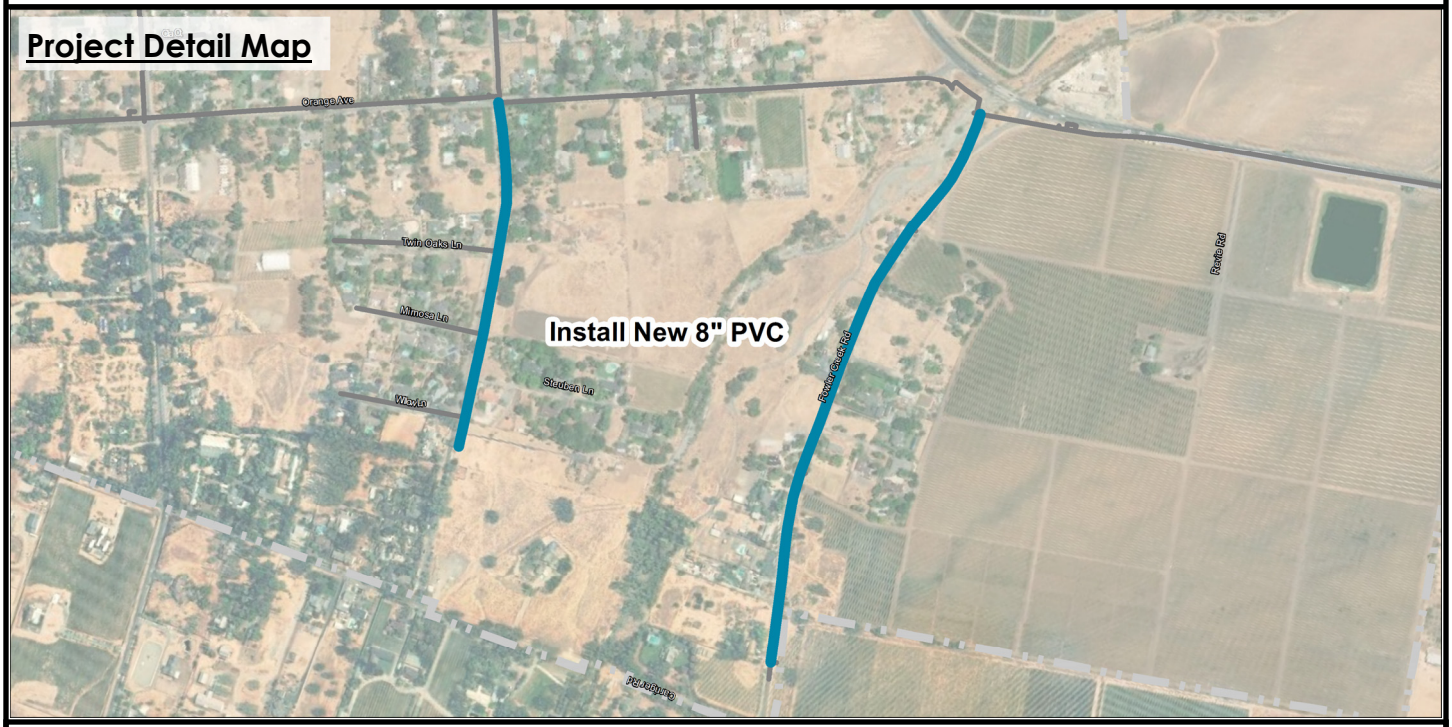
Description: Fowler Creek and Solano Avenue Fire Flow Improvement

Location: Fowler Creek Rd and Solano Ave.

Improvement Details: Replace existing 6-inch ACP water mains with new 8-inch PVC water mains, replace ten existing service connections, and replace five existing fire hydrants.

Justification: Addresses significant fire flow deficiencies on dead-end residential streets.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Fowler Creek and Solano Avenue Fire Flow Improvement							
Replacement Pipeline	8	4,200	LF	$180	$756,000	$260	$1,092,000
Hydrant Replacement	--	5	EA	$5,000	$25,000	$18,000	$90,000
Service Connection Replacement	--	10	EA	$1,500	$15,000	$4,000	$40,000
Main Tie-ins	--	5	EA	$2,000	$10,000	$7,500	$37,500
Construction Contingency (25%)					$201,500		$314,900
Construction OPC					$1,007,500		$1,574,400
Engineering, Administration, and Permitting Costs (25%)					$201,500		$314,900
Total OPC					**$1,210,000**		**$1,890,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-17

Project ID: P-17 **Project Priority Level:** 2

Description: Eldridge Fire Flow Improvement

Location: Madrone Rd, Glenwood Dr, Maplewood Dr, and Oakwood Dr.

Improvement Details: Replace existing 4-inch ACP water mains with new 8-inch PVC water mains, replace 49 existing service connections, and replace three existing fire hydrants in the Eldridge area.

Justification: Addresses fire flow deficiencies in the residential area and replaces aging 4-inch ACP.

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Eldridge Fire Flow Improvement							
Replacement Pipeline	8	3,900	LF	$180	$702,000	$260	$1,014,000
Hydrant Replacement	--	3	EA	$5,000	$15,000	$18,000	$54,000
Service Connection Replacement	--	49	EA	$1,500	$73,500	$4,000	$196,000
Main Tie-ins	--	5	EA	$2,000	$10,000	$7,500	$37,500
				Construction Contingency (25%)	$200,100		$325,400
				Construction OPC	$1,000,600		$1,626,900
				Engineering, Administration, and Permitting Costs (25%)	$200,100		$325,400
				Total OPC	**$1,200,000**		**$1,950,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-18

Project ID: P-18 **Project Priority Level:** 3

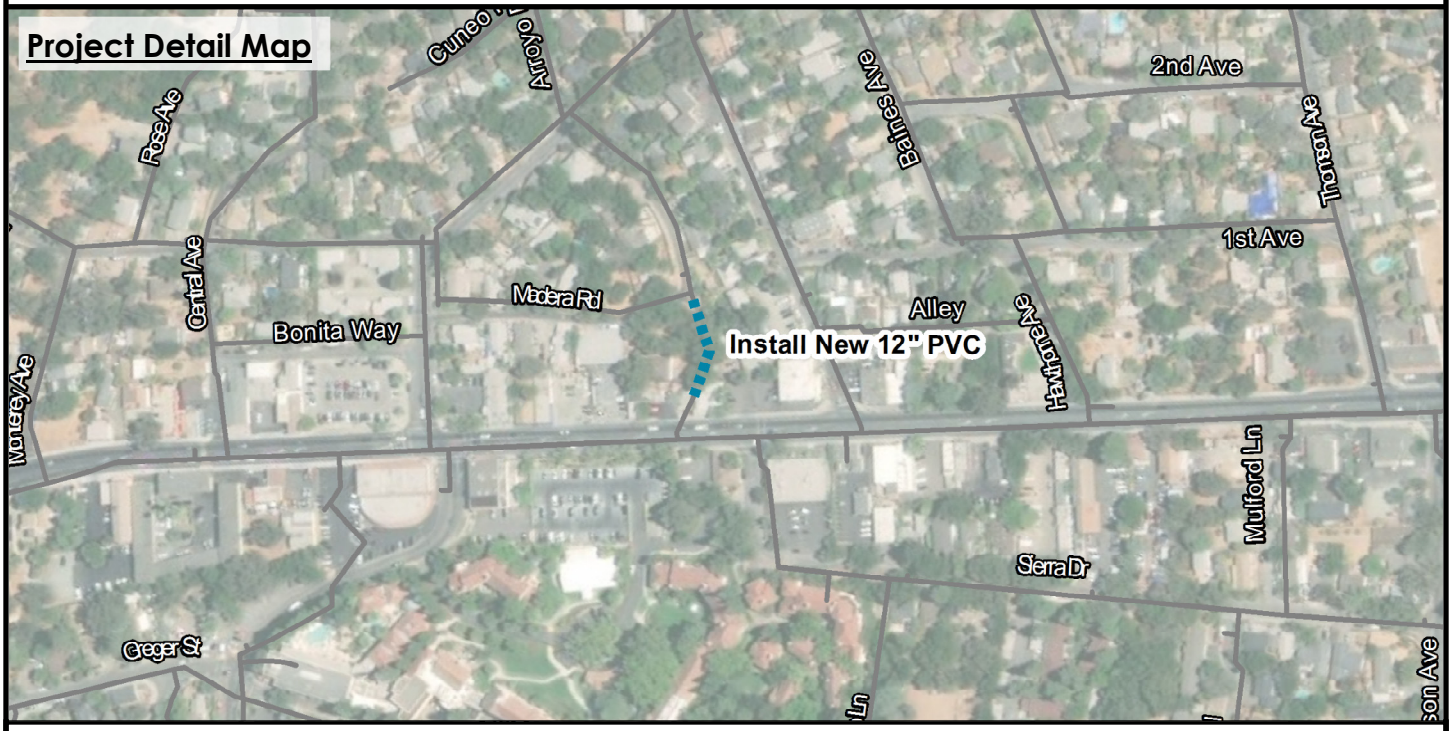
Description: Arroyo Road Commercial Fire Flow Improvement

Location: Arroyo Rd.

Improvement Details: Install new 8-inch PVC water main between Highway 12 and Madera Road along Arroyo Road.

Justification: Addresses commercial fire flow deficiencies.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Arroyo Road Commercial Fire Flow Improvement							
New Pipeline Installation	8	200	LF	$180	$36,000	$260	$52,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
Construction Contingency (25%)					$10,000		$16,800
Construction OPC					$50,000		$83,800
Engineering, Administration, and Permitting Costs (25%)					$10,000		$16,800
Total OPC					**$60,000**		**$100,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-19

Project ID: P-19 **Project Priority Level:** 3

Description: Hooker Avenue Fire Flow Improvement

Location: Between Highway 12 and Hooker Ave.

Improvement Details: Install new 8-inch PVC water main between Highway 12 and Hooker Ave.

Justification: Addresses residential fire flow deficiencies.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Hooker Avenue Fire Flow Improvement							
New Pipeline Installation	8	550	LF	$180	$99,000	$260	$143,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
Construction Contingency (25%)					$25,800		$39,500
Construction OPC					$128,800		$197,500
Engineering, Administration, and Permitting Costs (25%)					$25,800		$39,500
Total OPC					**$150,000**		**$240,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-20

Project ID: P-20 **Project Priority Level:** 3

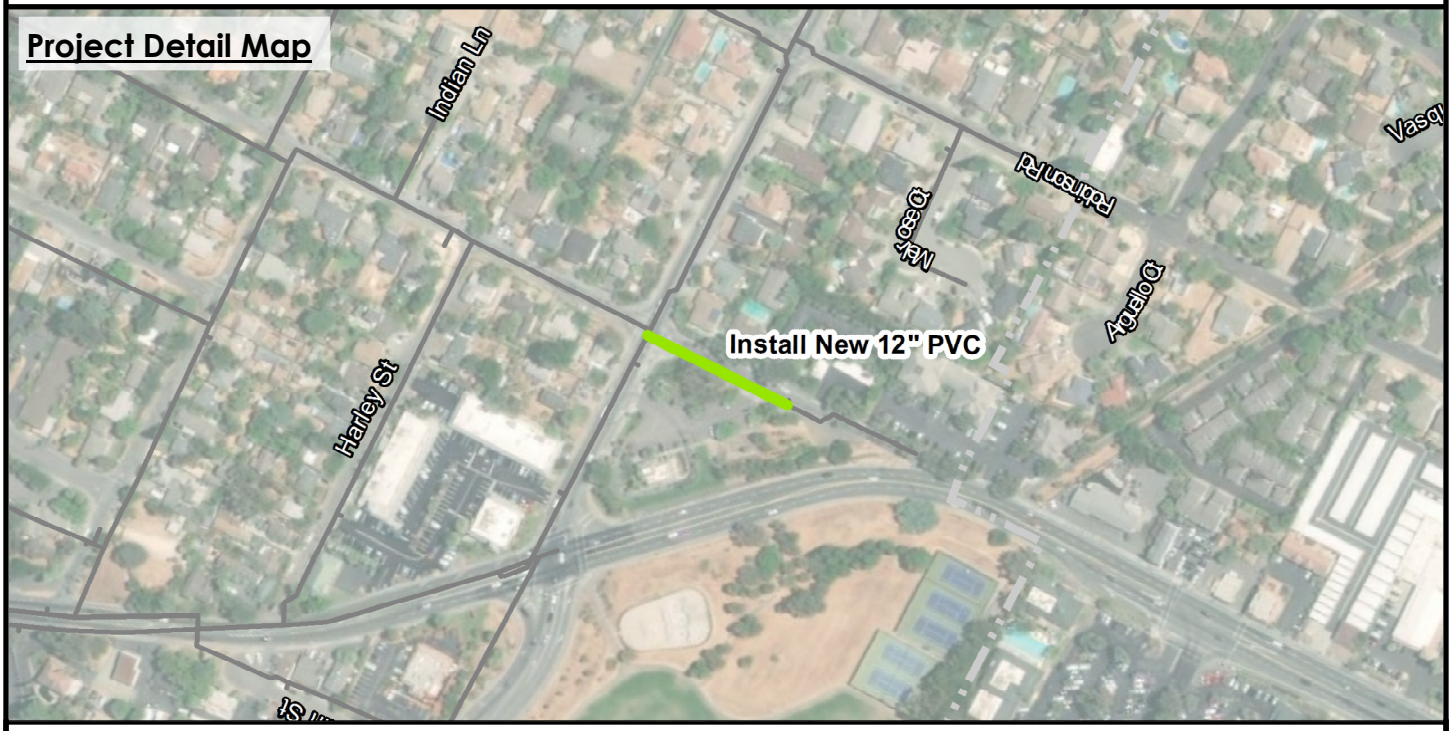
Description: Lomita Avenue Commercial Fire Flow Improvement

Location: Lomita Ave.

Improvement Details: Replace existing 6-inch ACP water main with new 12-PVC water main, replace two service connections, and replace one hydrant.

Justification: Addresses commercial fire flow deficiencies.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Lomita Avenue Commercial Fire Flow Improvement							
Replacement Pipeline	12	300	LF	$260	$78,000	$370	$111,000
Hydrant Replacement	--	1	EA	$5,000	$5,000	$18,000	$18,000
Service Connection Replacement	--	2	EA	$1,500	$3,000	$4,000	$8,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
Construction Contingency (25%)					$22,500		$38,000
Construction OPC					$112,500		$190,000
Engineering, Administration, and Permitting Costs (25%)					$22,500		$38,000
Total OPC					**$140,000**		**$230,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-21

Project ID: P-21 **Project Priority Level:** 3

Description: Pressure Zone 1B - Arnold Drive 4-Inch ACP Replacement Project

Location: Private road near 15263 Arnold Dr.

Improvement Details: Replace existing 4-inch ACP water main with new 8-inch PVC water main in Pressure Zone 1B west of Arnold Drive and replace three existing service connections.

Justification: Replaces aging 4-inch ACP.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Pressure Zone 1B- Arnold Dr. 4-Inch ACP Replacement Project							
Replacement Pipeline	8	800	LF	$180	$144,000	$260	$208,000
Service Connection Replacement	--	3	EA	$1,500	$4,500	$4,000	$12,000
Main Tie-ins	--	1	EA	$2,000	$2,000	$7,500	$7,500
				Construction Contingency (25%)	$37,600		$56,900
				Construction OPC	$188,100		$284,400
				Engineering, Administration, and Permitting Costs (25%)	$37,600		$56,900
				Total OPC	**$230,000**		**$340,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-22

Project ID: P-22 **Project Priority Level:** 3

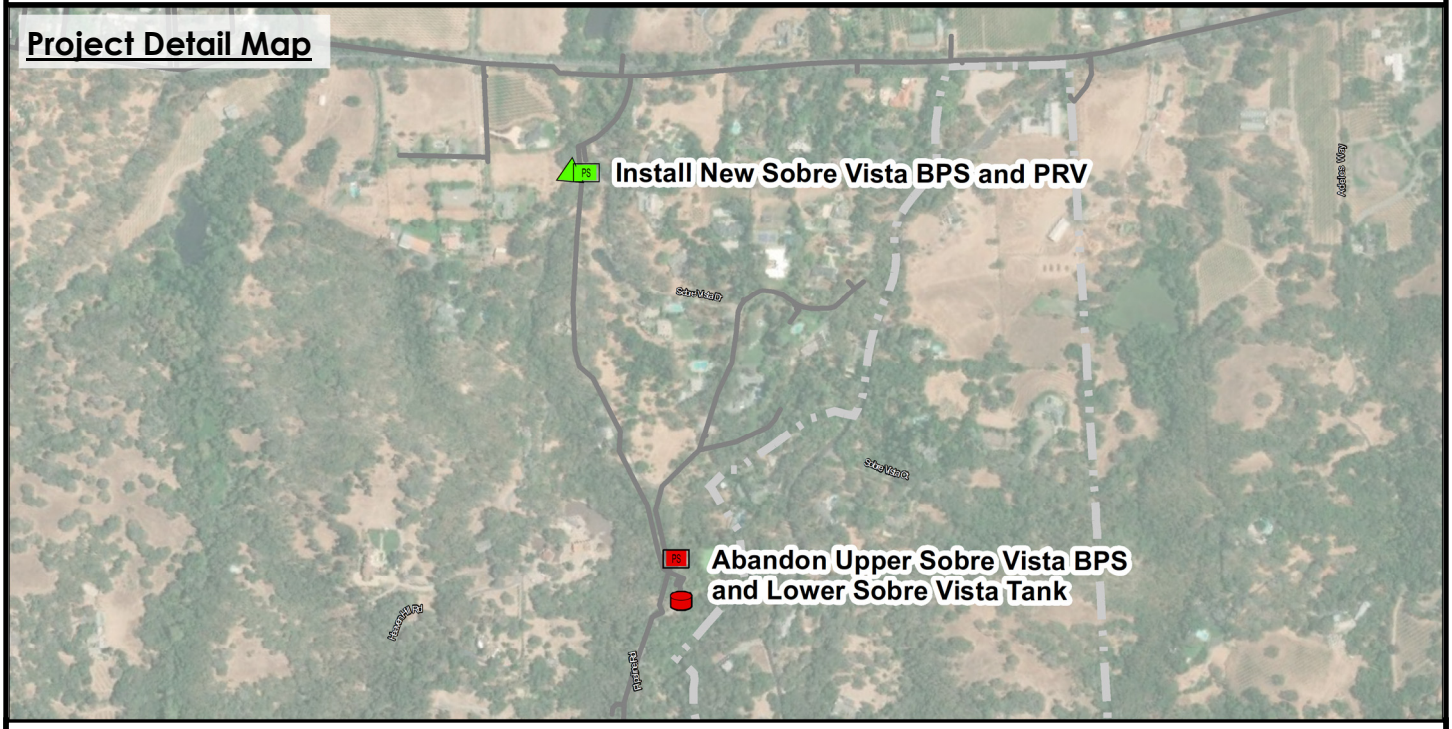
Description: Brookside Road 4-Inch ACP Replacement Project

Location: Brookside Rd.

Improvement Details: Replace existing 4-inch ACP water main with 8-inch PVC water main along Brookside Road , and replace eight existing service connections.

Justification: Replaces aging 4-inch ACP.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Brookside Road 4-Inch ACP Replacement Project							
Replacement Pipeline	8	800	LF	$180	$144,000	$260	$208,000
Service Connection Replacement	--	8	EA	$1,500	$12,000	$4,000	$32,000
Main Tie-ins	--	1	EA	$2,000	$2,000	$7,500	$7,500
Construction Contingency (25%)					$39,500		$61,900
Construction OPC					$197,500		$309,400
Engineering, Administration, and Permitting Costs (25%)					$39,500		$61,900
Total OPC					**$240,000**		**$370,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-23

Project ID: P-23 **Project Priority Level:** 3

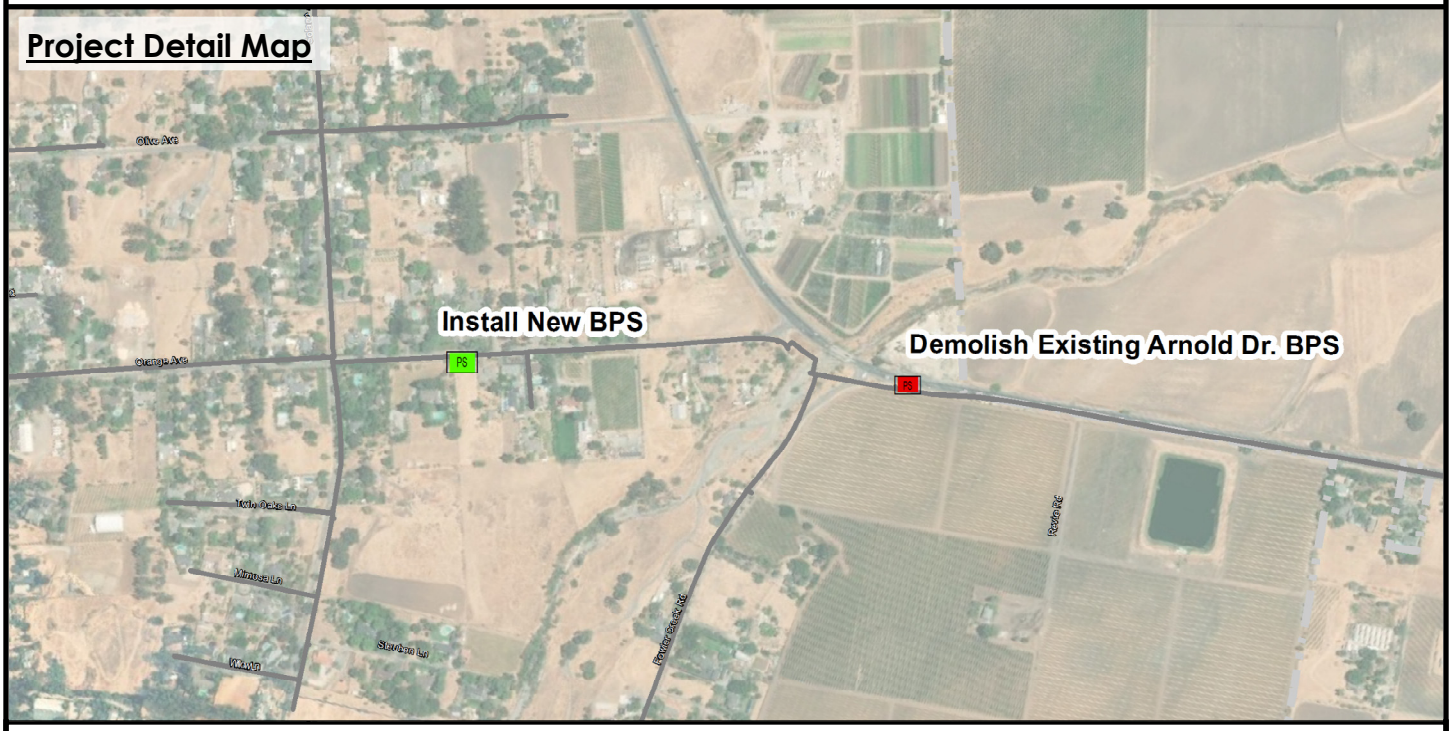
Description: Arnold Drive PS Replacement Project

Location: Near 19328 Orange Ave.

Improvement Details: Install new BPS with a firm capacity of 500 gpm along Orange Avenue. Demolish existing Arnold Drive BPS.

Justification: Replaces aging infrastructure and improves operations and maintenance for a facility needed for operational flexibility.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by Contractor	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Arnold Drive PS Replacement Project							
Replacement BPS - 500 gpm	--	1	LS	--	--	$1,026,700	$814,600
Decommission PS	--	1	EA	--	--	$50,000	$50,000
Main Tie-ins	--	2	EA	--	--	$7,500	$15,000
Construction Contingency (30%)					--		$263,900
Construction OPC					--		$1,143,500
Engineering, Administration, and Permitting Costs (30%)					--		$263,900
Total OPC					--		**$1,410,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-24

Project ID: P-24 **Project Priority Level:** 3

Description: Loma Court Fire Flow Improvement

Location: Loma Ct.

Improvement Details: Replace existing 6-inch with new 8-inch PVC along Loma Court, replace 11 existing service connections, and replace one existing fire hydrant.

Justification: Addresses minor fire flow deficiency.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Loma Court Fire Flow Improvement							
Replacement Pipeline	8	200	LF	$180	$36,000	$260	$52,000
Hydrant Replacement	--	1	EA	$5,000	$5,000	$18,000	$18,000
Service Connection Replacement	--	11	EA	$1,500	$16,500	$4,000	$44,000
Main Tie-ins	--	1	EA	$2,000	$2,000	$7,500	$7,500
				Construction Contingency (25%)	$14,900		$30,400
					Construction OPC	$74,400	$151,900
				Engineering, Administration, and Permitting Costs (25%)		$14,900	$30,400
					Total OPC	**$90,000**	**$180,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-25

Project ID: P-25 **Project Priority Level:** 3

Description: Richards Blvd Fire Flow Improvement

Location: Richards Blvd.

Improvement Details: Replace existing 6-inch ACP and DIP water main with 8-inch PVC water main along Richards Blvd, replace four existing service connections, and one existing hydrant.

Justification: Addresses minor fire flow deficiency.

Project Detail Map

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity		Construction by District		Construction by	
				Unit Cost	Total Cost	Cost Factor	Total Cost
Richards Blvd. Fire Flow Improvement							
Replacement Pipeline	8	300	LF	$180	$54,000	$260	$78,000
Hydrant Replacement	--	1	EA	$5,000	$5,000	$18,000	$18,000
Service Connection Replacement	--	4	EA	$1,500	$6,000	$4,000	$16,000
Main Tie-ins	--	2	EA	$2,000	$4,000	$7,500	$15,000
Construction Contingency (25%)					$17,300		$31,800
Construction OPC					$86,300		$158,800
Engineering, Administration, and Permitting Costs (25%)					$17,300		$31,800
Total OPC					**$100,000**		**$190,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-26

Project ID: P-26 **Project Priority Level:** 3

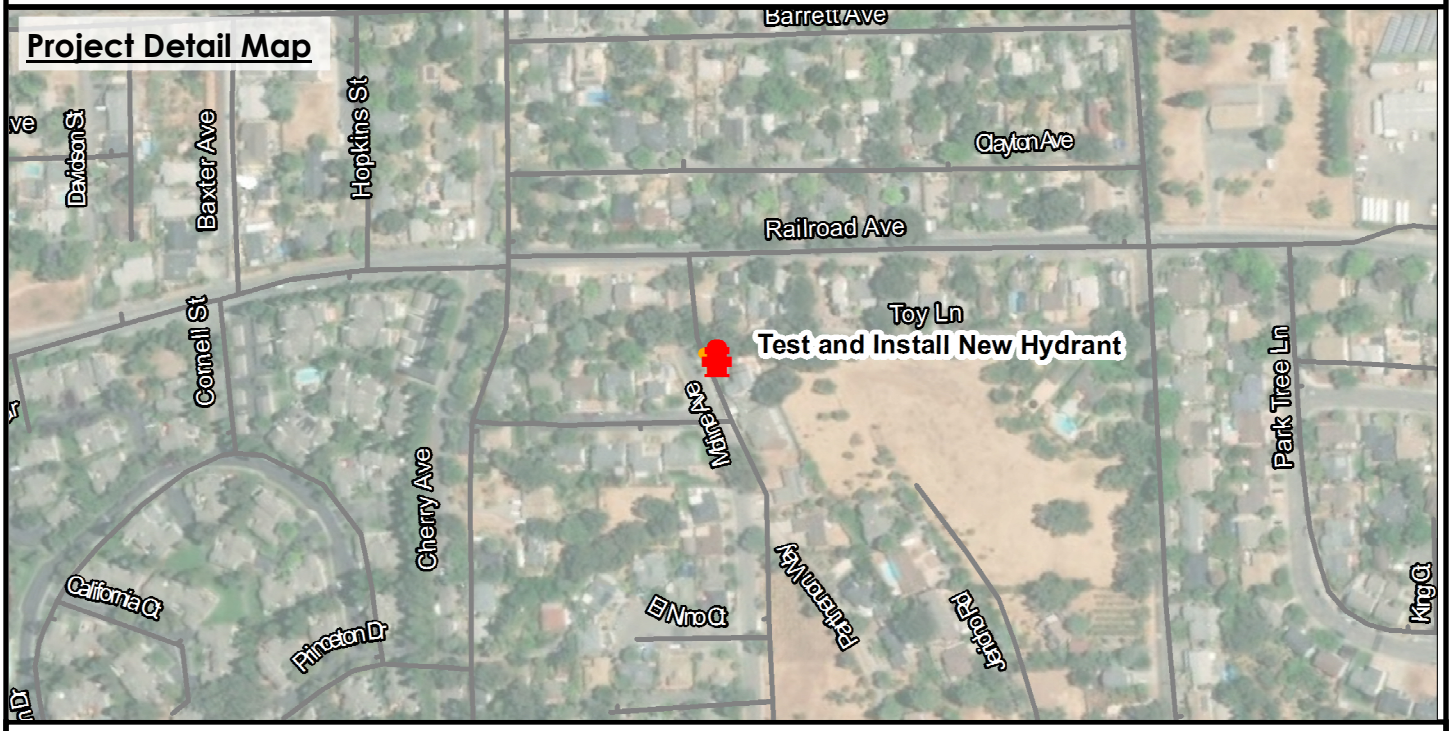
Description: Moline Avenue Fire Hydrant Replacement

Location: Moline Ave.

Improvement Details: Run fire hydrant testing to confirm fire flow availability. If fire flow availability does not meet requirements then replace existing hydrant assembly with 6-inch lateral.

Justification: Addresses fire flow deficiency (hydrant lateral size and material should be verified). If steel water main is found then project may be moved to Priority 1.

Project Detail Map



Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by	
			Unit Cost	Total Cost	Cost Factor	Total Cost
Moline Avenue Fire Hydrant Replacement						
Hydrant Replacement	--	1 EA	$5,000	$5,000	$18,000	$18,000
Construction Contingency (25%)				$1,300		$4,500
Construction OPC				$6,300		$22,500
Engineering, Administration, and Permitting Costs (25%)				$1,300		$4,500
Total OPC				**$10,000**		**$30,000**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-27

Project ID: P-27 **Project Priority Level:** 3

Description: SCWA Turnout Flow Meter Installation

Location: Various (Each SCWA Turnout PRV Station)

Improvement Details: Install flow meters at each of Turnout PRV Stations and integrate with SCADA system.

Justification: Provides District ability to verify SCWA billing and perform zonal demand analyses.

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by Contractor	
			Unit Cost	Total Cost	Cost Factor	Total Cost
SCWA Turnout Flow Meter Installation						
Flow Meter	--	10 EA	—	—	$20,000	$200,000
Construction Contingency (25%)				—		$50,000
Construction OPC				—		$250,000
Engineering, Administration, and Permitting Costs (25%)				—		$62,500
Total OPC				—		**$312,500**

Valley of the Moon Water District
Water Master Plan
CAPITAL IMPROVEMENT PROJECT P-28

Project ID: **P-28** **Project Priority Level:** 1

Description: Install New Groundwater Supply Well

Location: To be determined. Preferred location is outside of the Sonoma Valley Subbasin.

Improvement Details: Installation of a new well with an assumed capacity of 350 gpm. Project will include identification of preferred well location.

Justification: Increase local supplies to meet the local supply goal of 40% of maximum month demands established in the SCWA Restructured Agreement.

Total Opinion of Probable Cost

Improvement Type	Recommended Diameter	Quantity	Construction by District		Construction by	
			Unit Cost	Total Cost	Cost Factor	Total Cost
New Groundwater Supply Well						
Groundwater Well Installation - 350 gpm	--	1 LS	--	--	$1,000,000	$1,000,000
Construction Contingency (30%)				--		$300,000
Construction OPC				--		$1,300,000
Engineering, Administration, and Permitting Costs (30%)				--		$300,000
Total OPC				--		**$1,600,000**