Water System Master Plan

Final Report

Prepared for: East Valley Water District

December 2019

Stantec

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2019 Water System Master Plan

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
Acre-ft.	Acre-feet
ADD	Average Day Demand
AF	Acre-Feet
AFY	Acre-Feet per Year
Ave	Avenue
AWWA	American Water Works Association
CDPH	California Department of Public Health
CEO	Chief Operating Officer
CII	Commercial Industrial and Institutional
CIP	Capital Improvement Program
CL&C	Cement Lined & Coated
CML	Cement Mortar Lined
COP	Certificates of Participation
CP	Critical Pipes
DD&W	Double Dipped & Wrapped
DWR	Department of Water Resources
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute, Inc.
ETo	Reference Evapotranspiration

EVWD	East Valley Water District
fps	Feet per Second
Ft.	Feet
GIS	Geographic Information System
GO	General Obligation Bond
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpd/acre	Gallons per Day per Acre
gpm	Gallons per Minute
HGL	Hydraulic Grade Line
HP	Horsepower
hrs.	Hours
ID	Identification
In.	Inch
IRWM	Integrated Regional Water Management
IRWMP	(Greater Los Angeles) Integrated Regional Water Management Plan
IS	Initial Study
MDD	Maximum Day Demand
MG	Million Gallons
MMD	Maximum Monthly Demand
MMP	Maximum Month Production

MSL	Mean Sea Level
MWH	MWH Inc.
NFMWC	North Fork Mutual Water Company
PCE	Passenger Car Equivalent
PHD	Peak Hour Demand
PRS	Pressure Reducing Station
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
RUWMP	Regional Water Urban Water Management Plan
SANBAG	San Bernardino Associated Governments
SBVRUWMP	San Bernardino Valley Regional Urban Water Management Plan
SCADA	Supervisory Control and Data Acquisition
SCAG	Southern California Association of Governments
SCE	Southern California Edison
SGWP	Sustainable Groundwater Planning
SRF	State Revolving Fund
SS	Steady-State
St.	Street
SWP	State Water Project
SWTP	Surface Water Treatment Plant

TCE	Trichloroethylene
TDH	Total Dynamic Head
THM	Trihalomethanes
US	Upstream
USEPA	United States Environmental Protection Agency
UWMP	Urban Water Management Plan
VFD	Variable Frequency Drive
WIFIA	Water Infrastructure Finance and Innovation Act
WSMP	2014 Water System Master Plan
2019 WSMP	2019 Water System Master Plan
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

INTRODUCTION

The primary objective of the East Valley Water District's (EVWD) 2018 Water System Master Plan (2019 WSMP) is to update EVWD's 2014 Water System Master Plan (WSMP) and hydraulic model to provide cost-effective and fiscally responsible water services that meet the water quantity, water quality, system pressure, and reliability requirements of its customers. This 2019 WSMP looks at existing, near-term, and build-out conditions for the EVWD service area. This 2019 WSMP addresses existing system deficiencies and facility requirements to meet increasing demands over the next 20 years. The report also provides details of a proposed Capital Improvement Program (CIP) for the water system, including phasing of projects and capital requirements.

STUDY AREA AND POPULATION

This 2019 WSMP covers the entire service area of EVWD, which consists of the entire City of Highland, portions of the City of San Bernardino, and unincorporated areas of San Bernardino County. Based on the 2017 data from the United States Census Bureau, EVWD currently serves a population of approximately 103,200 within its service area. Based on a review of growth forecasts developed by the Southern California Association of Governments, the population within EVWD's service area is expected to be approximately 141,900 by year 2040. This represents a 37 percent increase in overall population. This population growth results in increased water demands and water supply requirements. In addition, development activity has resumed within EVWD's service area with proposed developments such as the Harmony Development, the Arnott Development, the Highland Hills Development, the Sunland Communities Development, the Centerstone Development, and the Greenspot Village and Marketplace Development being in various stages of planning. The population projections along with the existing and future land use plans are discussed in detail in Section 3. Figure ES-1 shows the existing system water facilities considered for this WSMP.

DEMANDS

New residential and non-residential growth is expected to result in a significant increase in water demands. The model defines near-term and build-out scenarios for analysis of projected demands. The near-term scenario assumes implementation of the will serve list maintained by EVWD in conjunction with projected increases in population growth from 2018-2025. While 2025 was assumed, this scenario is significantly dependent upon timing of projects on the will serve list and population of these developments. Therefore, the near-term scenario is not defined as 2025 as EVWD will need to monitor the pace of growth and development in the service area to assess when projects may be necessary. The build-out scenario considers full development of the service area based on the general plan land use and the projected population in 2040.

Near-Term Planning Scenario

The near-term planning horizon accounts for the specific growth in the system based on the will serve list and developments such as the Casino expansion and the Harmony Development. For this scenario, the demand from the specific developments was assigned to the model based on provided information. For developments that did not have a demand calculated, demand was estimated by using average persons per household data from the US Census, and the 175 gpcd compliance target from the RUWMP. The specific developments from the will serve list accounted for an additional ADD of 5.05 MGD, which was added to the existing demand of 20.29 MGD for a total near-term demand of 25.34 MGD.

Build-out Planning Scenario

Build-out demand for the model was analyzed by looking at both population and land use projections. Population estimates were taken from SANBAG information and US Census data. The 2040 population was estimated to be 122,802, which was used to define the Build-out scenario. It is noted that the recommendations for this scenario should be implemented based on development trends and not based on year.

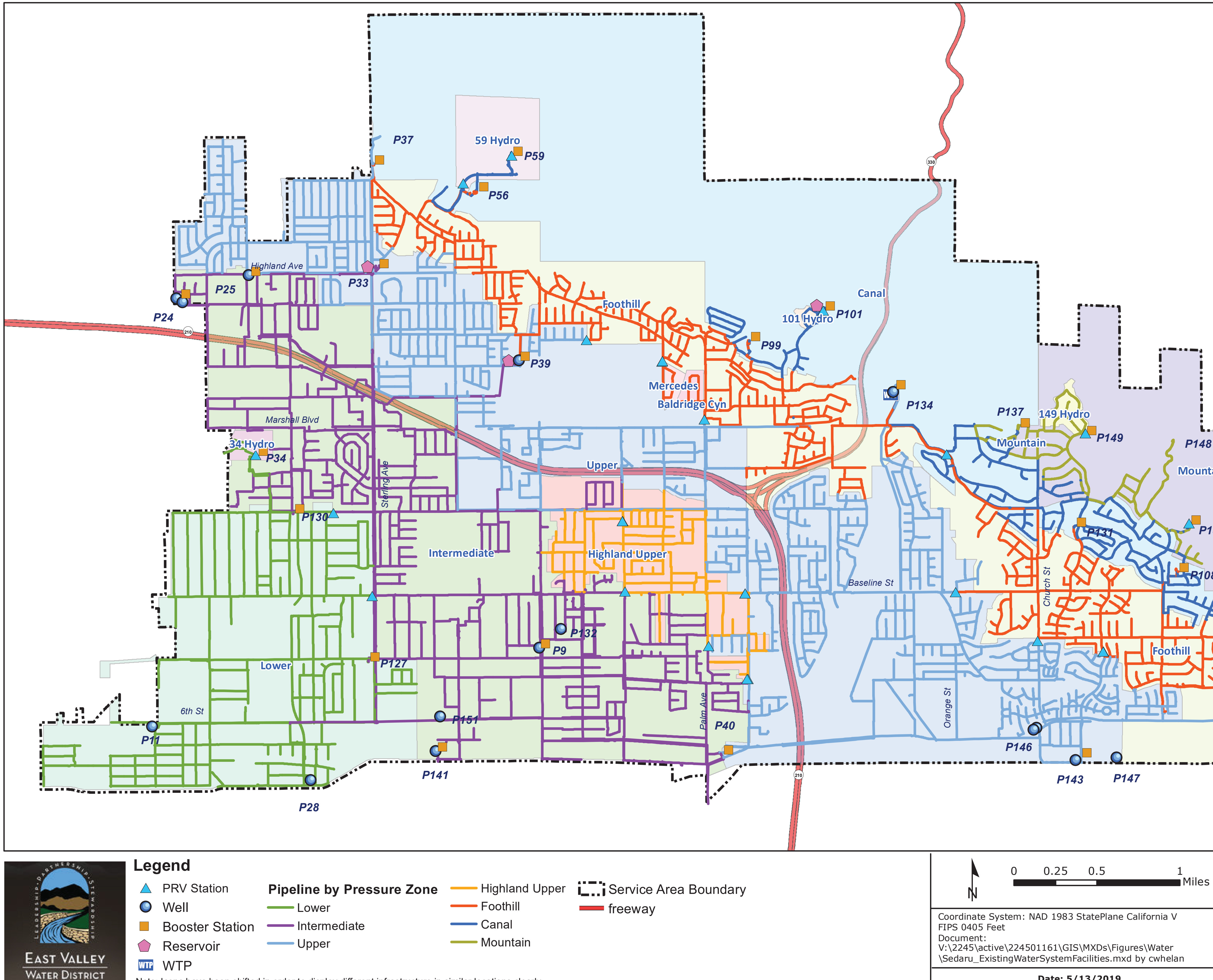
A per capita usage of 175 gpcd was then applied to this population estimate which yielded a total demand of 21.49 MGD. The 175 gpcd value was based on the RUWMP compliance target for EVWD and agrees with the value used in the 2014 WSMP. Based on historical data for EVWD, the current per capita usage averaged 163 gpcd over the last three years, however the 175 gpcd accounts for changes in efficiency that may occur in the future and is reflective of a realistic long-term goal for per capita usage as presented in the SBVRUWMP

Results for the population and land-use base methods for projecting future demand are presented in Table ES-1. This table presents demands in million gallons per day, and presents final demands used for the hydraulic model. Hydraulic model demands account for the demands calculated by both the population and land-use based methodologies, as well as accounting for non-revenue water and specific demands for major developments. Near-term projections for demand exceed the projections for 2025 shown in Table ES-1 as it was assumed major will serve developments would be built prior to the near-term planning year, although the full growth associated with these developments may happen later. For the purposes of comparison, 2025 was used to assess the projections of the near-term scenario, but the near-term demand is dependent upon the progression of development and not connected to a specific year. Build-out growth is consistent with the land use-based methodology.

Table ES-1: Demand Projection Comparisons (MGD)

Demand Source	2018	2020	2025	2040
2015 SBVRUWMP Subtotal	-	22.24	23.37	26.34
Population based demand (using UWMP compliance target for per capita usage)	18.07	18.45	19.33	21.49
Land Use Based	18.58	19.41	21.48	27.69
Model Scenarios	**Existing**		**Near-Term**	**Build-out**
Demand in Model (ADD)	**20.29**	**-**	**25.34**	**27.69**
Demand in Model (MDD)	**36.52**		**45.62**	**49.84**

Note: Total demands for the near-term and build-out scenario were compared to 2025 and 2040, respectively, however the timing of recommendations made for these scenarios are based on development drivers and may be needed earlier or later.



Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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Date: 5/13/2019

Existing Water System Facilities

SEDARU®

Figure ES-1

WATER SUPPLY

EVWD's existing supply sources consist of local groundwater, surface water from the Santa Ana River obtained through the North Fork Water Company and imported water from the State Water Project. There is enough supply to meet existing demands under maximum day demand (MDD) conditions. However, the single largest source analysis indicates there are supply deficits in most zones if any water sources are off-line during MDD conditions. Therefore, the system does not have much redundancy and additional supplies are necessary to support future demands within EVWD's service area.

This WSMP considers two new potential future supply sources for EVWD's system. These consist of:

- Groundwater Wells – EVWD could drill five new 2.8 MGD wells in the Intermediate, Upper or Foothill Zones. These wells could be phased for immediate or near-term use and would provide increased supply reliability especially during extended drought.

- Eastside Water Treatment Plant – EVWD could build a new 3.0 MGD water treatment plant to serve the Harmony Development and other developments on the east side of EVWD's service area. Water for this treatment plant would come from EVWD's rights to Santa Ana River Water and from purchased SWP water. A new water treatment plant may provide opportunities for improved water management in the region.

EVWD could further consider expansion of P134 from its current 8 MGD capacity. However, it has been communicated that additional space is limited at the P134 site and additional land acquisition may be needed in order to expand.

HYDRAULIC MODEL DEVELOPMENT

EVWD has an existing hydraulic model of the water system that was developed in 2014 as part of the 2014 WSMP using Innovyze's InfoWater software, which is based on ESRI's ArcGIS platform. The existing system model was updated by identifying new or abandoned elements as compared to the latest ArcGIS geodatabase provided by EVWD. Pipes, along with their connection junctions, identified as new, with a major alignment change, or hydraulically significant were included as part of the model update.

The updated hydraulic model contains pipelines as discussed above and facilities (booster pumps, storage tanks, wells, and pressure reducing valves) currently in the ArcGIS geodatabase provided by EVWD. The model was also updated to reflect the current system SCADA operation logic and settings for all facilities (booster pumps, storage tanks, wells, and pressure reducing valves) as provided by EVWD.

CALIBRATION

Model calibration is the process of comparing model results with field results and adjusting model parameters where appropriate until the model results match corresponding field measurement data, within an acceptable difference. Typical adjustments include adjustments to system connectivity, operational controls, facility configurations, diurnal patterns, elevations, roughness coefficients for pipelines, etc. Several indicators are utilized to determine if the model accurately simulates field conditions: water levels in storage tanks, the run times for pumps, and static and residual pressures from the fire flow tests. This also acts as the "debugging" phase for the hydraulic model where any modeling discrepancies or data input errors are discovered and corrected.

The hydraulic model is calibrated for two scenarios:

- Steady-State Calibration: Simulating fire hydrant flow tests to match field results (April 12th and 17th, 2018)
- 24-hour EPS Calibration: Modifying the model until it mimics the field operations on the day of calibration (April 19, 2018)

it can be concluded that the results from the hydraulic model are satisfactory for the purposes of long-term planning, where 48 out of 50 (96 percent) measurements are within the calibration criteria. While this model can be used for long-term planning, it is important to understand the inherent errors in the model are due to the input data used to develop the model. While the inherent errors may not result in the output to exceed the calibration criteria, it is important to understand where discrepancies are most likely going to come from within the EVWD model.

PLANNING AND DESIGN CRITERIA

Design criteria are established for the evaluation of EVWD's water system. Peaking factors for EVWD's system are determined based on a review of daily production data for the years 2015 to 2017. The criteria are developed using the typical planning criteria used in the systems of similar water utilities, local codes, engineering judgment, and commonly accepted industry standards. The "industry standards" are typical ranges of values that are acceptable for the criteria in question and, therefore, are used more as a check to confirm that the values being developed are reasonable. The design criteria and analytical methodologies used to conduct this evaluation are presented in Table ES-2.

Table ES-2: Water System Evaluation Criteria

Evaluation Criteria	Value	Units[(1)]	Evaluation Demand Conditions[(2)]
Peaking Factors			
MDD/ADD	1.8	-	-
PHD/ADD	2.75	-	-
System Pressure			
Maximum Pressure	125	psi	ADD
Minimum Pressure, normal conditions	40	psi	PHD
Minimum Pressure, with fire flow	20	psi	MDD
Minimum Pressure, transmission mains with no water services	5	psi	PHD
Maximum Pipeline Velocity			
Existing Pipelines (excluding fire hydrant runs)	6	fps	MDD
New Distributions Pipelines (≤ 12-inch in diameter)	4[(4)]	fps	MDD

Evaluation Criteria	Value	Units[1]	Evaluation Demand Conditions[2]
New Transmission Mains (>12-inch in diameter)	6[4]	fps	MDD
Pump Station suction pipelines	4	fps	MDD
Distribution System			
Pipeline Life Expectancy	75	years	n/a
Minimum Diameter for New Pipelines	8	inches	n/a
Storage Volume			
Operational	25% of MDD	MG	MDD
Fire Fighting	Highest fire flow requirement per zone	MG	MDD
Emergency	100% of MDD	MG	MDD
Fire Flow Requirements [3]			
Single Family Residential	1,500 gpm	2 hours	MDD
Multi-Family Residential	2,500 gpm	2 hours	MDD
Commercial	3,000 gpm	3 hours	MDD
Public	3,000 gpm	3 hours	MDD
Industrial	4,000 gpm	4 hours	MDD
Agricultural	1,500 gpm	2 hours	MDD
Supply Capacity			
Entire System	Provide MDD with largest single source out of service		MDD
By Pressure Zone	Provide MDD with firm transfer/booster capacity between zones		MDD
Tank Replenishment	Provide sufficient supply and transmission capacity to refill reservoirs to operating HGL in 24 hours. (i.e. replenish water used during MDD within 24 hours)		MDD
System Reliability			
Pipe Breaks	Maintain service with a single transmission pipeline out of service		MDD
No Wells	Maintain service for 7 days with all groundwater wells out of service		MDD
No Purchased Water	Maintain service for 7 days with no imported water from Valley District (i.e. without SWP supplies to Plant 134)		MDD

Evaluation Criteria	Value	Units(1)	Evaluation Demand Conditions(2)
Single Largest Source Out of Service per Pressure Zone	Maintain service for 7 days with a single source out of service in each pressure zone		MDD

(1) psi = pounds per square inch, fps = feet per second, gpm = gallons per minute, MG = million gallons

(2) PHD = peak hour demand, MDD = maximum day demand, ADD = average day demand

(3) Based on 2014 WSMP and generally accepted planning standards

(4) Maximum pipeline velocities up to 15 fps are acceptable for new pipelines under fire flow scenarios.

SYSTEM EVALUATION

The adequacy of EVWD's system under existing, near-term, and build-out demand conditions is evaluated using a calibrated hydraulic model of EVWD's water system. A well calibrated model serves as an excellent planning tool and results in the development of defensible recommendations. The hydraulic model, built using EVWD's robust GIS database, contains all the pipes within the potable water system and is an accurate representation of the water distribution system. This model is used to identify pressure, fire flow, supply, and storage deficiencies in the water system. Recommendations are made to address these deficiencies. The development and the calibration of the hydraulic model are discussed in Section 4 of this report. The details of the hydraulic analyses are discussed in Section 6 of this report.

The distribution system analysis consists of evaluations that are conducted for each planning horizon (Existing, near-term, and build-out). Improvements identified for each planning horizon are incorporated in the model for subsequent planning horizons. Hence, each improvement listed in this section is only included in one category and is summarized at the end of each planning horizon evaluation. This approach provides a limited amount of phasing, where further phasing and prioritization is discussed in Section 8.

The EVWD hydraulic model is used to evaluate the system pressures for the following scenarios:

- Meet PHD while maintaining a minimum pressure of 40 psi at all demand junctions associated with customer services
- Meet ADD while not exceeding a maximum pressure of 125 psi
- Meet MDD plus fire flow while maintaining a minimum pressure of 20 psi at all demand junctions

GIS MANAGEMENT EVALUATION

EVWD's water GIS network was audited with the intention of helping EVWD improve the process of ensuring the GIS data are model-ready to more easily update and integrate GIS data in the hydraulic model.

In general, GIS layers representing a water system are comprehensive and not needed in entirety to develop a hydraulic model. However, there are model details that are essential for modeling, but are unnecessary when building GIS layers. Based on the audit, these critical details are identified to enable EVWD to achieve more seamless GIS integration in the future.

After reviewing the overall schema and data, a sample area was selected to import into the modeling software, identify issues with those data sets, and present EVWD with recommendations to implement into the overall GIS workflow.

Spatial integrity amongst related GIS layers can be validated and maintained using advanced topology and geometric tools. Most connectivity checks discussed earlier in this document can be resolved by defining and applying GIS topology rules and data review checks for the network. In addition to maintaining network connectivity, it is important to identify and resolve missing or incorrect attributes in the GIS layers, prior to importing in the model. While these issues can be resolved in the model, this breaks the intended link between GIS and model data.

Based on the GIS audit and findings during the review of the selected sample area, Section 7.5 outlines the conclusions and recommendations for EVWD to consider incorporating in their overall GIS workflow.

RECOMMENDED IMPROVEMENTS

The water distribution system and water facilities are evaluated using the updated hydraulic model and the criteria discussed in Section 5. This evaluation has been conducted for both existing water demand conditions and the projected future demands for near-term and build-out. Based on these evaluations, the recommendations are divided into three categories; existing, near-term, and build-out system.

Key observations and insights about the distribution system can be learned through the process of updating the model, calibrating it, and performing the evaluation against EVWD design criteria. This section provides a discussion of those findings by topic.

Model Calibration: It was observed that the PRVs in the system can significantly impact hydraulics and therefore tank levels in the distribution system. It is recommended that EVWD add the most frequently used PRVs to the SCADA system. Real-time flow, pressure, and valve status of these PRVs would be valuable data for system operators.

Pump Operation: The calibration and evaluation efforts revealed some operational rigidity for plants having both wells, a forebay, and booster pumps. In most cases, small forebays do not provide sufficient operational flexibility. For example, there are times when booster station pumps turn off in order to allow the forebay water level to recover. Adding variable frequency drives (VFD) to one or more booster pumps would allow better synchronization between well and booster pumps.

Existing System Pressure Analysis: This analysis indicates there are no areas that experience low pressures (below 40 psi) during PHD. Areas in the model having pressure below 40 psi were either near tanks or had low pressure due to elevation and not accumulated head loss. In general, the system is well looped and has ample pipe capacity. Some areas see high pressures, above 125 psi; however, these high pressures are due to being in the lowest elevation range for the pressure zone.

Fire Flow Improvements: The fire flow evaluation identified some minor adjustments that could be made to one existing PRV to support better flow and pressure during a fire. PRS_302 was adjusted to 80 psi to satisfy fire flow requirements. The higher PRV pressure setting provides more flow to downstream hydrants. Also, a new PRV is proposed on the 12-inch main at 3588 E Highland Avenue, north of the intersection with Palm Avenue. The proposed PRV, at a 50-psi setting, will allow flow from Foothill to Upper Zone.

Fire Flow Evaluation: The fire flow evaluation found areas that do not meet the land use-based fire flow criteria. Solutions were developed to address the ten areas that would benefit most from improvement and are presented in **Appendix D**.

Existing System Storage Evaluation: The distribution system has an existing storage deficit of 5.5 MG on a zone-by-zone basis. The storage evaluation provides proposed storage volumes by pressure zone. However, when siting reservoirs, adjacent zones at higher hydraulic grades should be considered to provide multi-zone benefits, provided adequate transmission piping exists to deliver the recommended operational, fire protection, and emergency storage to the area needing the storage. For instance, the Lower Zone needs 3.5 MG based on the evaluation. The 3.5 MG could be provided from the Intermediate Zone or by future wells with a standby power source in the Lower Zone.

Existing System Supply Analysis: One of the significant findings of the supply analysis is that groundwater supply has decreased significantly since the 2014 WSMP. Per conversations with EVWD, the decrease in capacity is from offline wells due to water quality issues, as well as decreasing groundwater levels at some wells. EVWD has a limited amount of excess supply during MDD conditions. Therefore, a critical recommendation is to investigate maximizing current sources including new well locations. Some wells may be candidates for larger pumps and motors if significant capacity has been lost due to lowered groundwater levels, if the existing well casing and screen can accommodate a larger pump, and screen depths are sufficient to allow deeper pump settings.

Existing System Reliability Analysis: The three critical pipe segment outages tested in the reliability analysis can all be mitigated by a quick operational response. In most cases, opening nearby zone boundary valves or turning on additional pumps will maintain acceptable pressures until the pipe can be repaired.

The Recommended System Improvement project cost estimates in this section are planning level cost estimates. The appropriate use of this estimate is for planning and may not be an actual representation of design to construction activities and costs. This estimate was developed as an Association for the Advancement of Cost Engineering (AACE) – International Class 5 cost estimate which has an expected accuracy range of -20 to -50 percent on the low end, and +30 to +100 percent on the high end. This range depends on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Accuracy could exceed this range in unusual circumstances. The estimate was prepared using a combination of parametric estimating factors and local experience in delivering projects similar to those that constitute this Recommended Projects.

The cost of the water system improvements is estimated by project for each planning horizon using the cost estimating assumptions and the project phasing discussed previously. The Recommended System Improvements are presented in Table ES-3. Table ES-4Table 8-6 calculates a total project cost by taking the construction costs presented in Table ES-3 and adding a contingency allowance of 20% of the construction cost, and an allowance for engineering, legal, and administration costs of 30% of construction cost. Figure ES-2 presents the total project costs by planning horizon while Figure ES-3 presents the costs by asset type. Improvements recommended for the existing system are shown on Table ES-4, and for the near-term on Table ES-5. No map was created for the build-out system improvements as the location of the recommendation for this phase were not sited to a specific location.

Table ES-3: Recommended Project Construction Costs

Recommended System Improvements Name	Size	Quantity	Unit	Description	Unit Cost	Construction Cost
Existing System Improvements						
	Proposed Improvements					
Transmission Improvements						
T-1	16-inch	2,100	LF	Along Highland Ave, from Plant 134 to Orchard Road.	Completed	Completed
Storage Improvements						
Lower Zone	3.5	-	MG	Additional storage in Lower Zone.	$ 1,250,000	$ 4,375,000
Foothill Zone	1.5	-	MG	Additional storage in Foothill Zone.	$ 1,250,000	$ 1,875,000
Mountain Zone	0.5	-	MG	Additional storage in Mountain Zone.	$ 1,250,000	$ 625,000
Supply Improvements						
New Well 01	2.88 MGD	1	each	Additional well for either Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
Near-Term Improvements						
Recommended System Improvements Name	**Size**	**Quantity**	**Unit**	**Description**	**Unit Cost**	**Project Cost**
Transmission Improvements						
T-2	21-inch	50	LF	Reconfiguration of pipe at Greenspot Rd and Santa Paula Street	$ 408.00	$ 20,000
Harmony Transmission Pipe	24-inch	5,500	LF	Dependent on growth to the east of the system (Harmony Development).	$ 408.00	$ 3,672,000
Storage Improvements						
Foothill Zone	2.75	-	MG	Storage needed Foothill Zone.	$ 1,250,000	$ 3,437,500
S-1	4.5		MG	S-1 is for growth to the east of the system.	$ 1,250,000	$ 5,625,000
Canal 3	2		MG	Storage needed in Canal 3 Zone.	$ 1,250,000	$ 2,500,000
Supply Improvements						
New Well 02	2.88 MGD	1	each	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well 03	2.88 MGD	1	each	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well or SWTP	3.00 MGD	1	MGD or gpd	New supply to support growth in eastern system.	$ 1,212,500 or $ 3.00	$ 3,492,000 or $ 9,000,000
Pumping Improvements						
PMP-1	3.7 MGD	1	Each	Proposed booster station for future growth in eastern part of system. Pumping to 250 ft.	None	$ 2,500,000
Build-out System Improvements						
Recommended System Improvements Name	**Size**	**Quantity**	**Unit**	**Description**	**Unit Cost**	**Project Cost**
Transmission Improvements						
-	-	-	-	-		
Storage Improvements						
Lower Zone	0.75	-	MG	Total storage needed in Lower Zone.	$ 1,250,000	$ 937,500
Foothill Zone	0.5	-	MG	Total storage needed Foothill Zone.	$ 1,250,000	$ 625,000
Canal 1	0.25		MG	Total storage needed in Canal 1 Zone.	$ 1,250,000	$ 312,500
Canal 2	0.75		MG	Total storage needed in Canal 2 Zone.	$ 1,250,000	$ 937,500
Canal 3	0.75		MG	Total storage needed in Canal 3 Zone.	$ 1,250,000	$ 937,500
Mountain Zone	0.25	-	MG	Total storage needed in Mountain Zone.	$ 1,250,000	$ 312,500
Supply Improvements						
New Well 04	2.88 MGD	1	MGD	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well 05	2.88 MGD	1	MGD	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000

Table ES-4: Recommended Improvement Project Costs

Recommended System Improvements Name	Construction Cost	Contingency (20% of construction cost	Engineering, Legal & Administration (30% of construction cost)	Total Project Cost
	2018 US Dollars ($)			
Existing System Improvements				
Storage Improvements				
Lower Zone	4,375,000	875,000	1,312,500	6,563,000
Foothill Zone	1,875,000	375,000	562,500	2,813,000
Mountain Zone	625,000	125,000	187,500	938,000
Supply Improvements				
New Well 01	3,492,000	698,400	1,047,600	5,238,000
Near-Term Improvements				
Transmission Improvements				
T-2	20,000	4,000	6,000	30,000
Harmony Transmission Pipe	3,672,000	734,400	1,101,600	5,508,000
Storage Improvements				
Foothill Zone	3,437,500	687,500	1,031,250	5,156,000
S-1	5,625,000	1,125,000	1,687,500	8,438,000
Canal 3	2,500,000	500,000	750,000	3,750,000
Supply Improvements				
New Well 02	3,492,000	698,400	1,047,600	5,238,000
New Well 03	3,492,000	698,400	1,047,600	5,238,000
New Well	3,492,000	698,500	1,047,750	5,238,000
or	or			or
SWTP (assumed for total cost below)	9,000,000	1,800,000	2,700,000	13,500,000
Pumping Improvements				
PMP-1	2,500,000	500,000	750,000	3,750,000
Build-out System Improvements				
Storage Improvements				
Lower Zone	937,500	187,500	281,250	1,406,000
Foothill Zone	625,000	125,000	187,500	938,000
Canal 1	312,500	62,500	93,750	469,000
Canal 2	937,500	187,500	281,250	1,406,000
Canal 3	937,500	187,500	281,250	1,406,000
Mountain Zone	312,500	62,500	93,750	469,000
Supply Improvements				
New Well 04	3,492,000	698,400	1,047,600	5,238,000
New Well 05	3,492,000	698,400	1,047,600	5,238,000
TOTAL	**55,152,000**	**11,030,400**	**16,545,600**	**82,730,000**

Figure ES-2: Project Costs by Planning Horizon

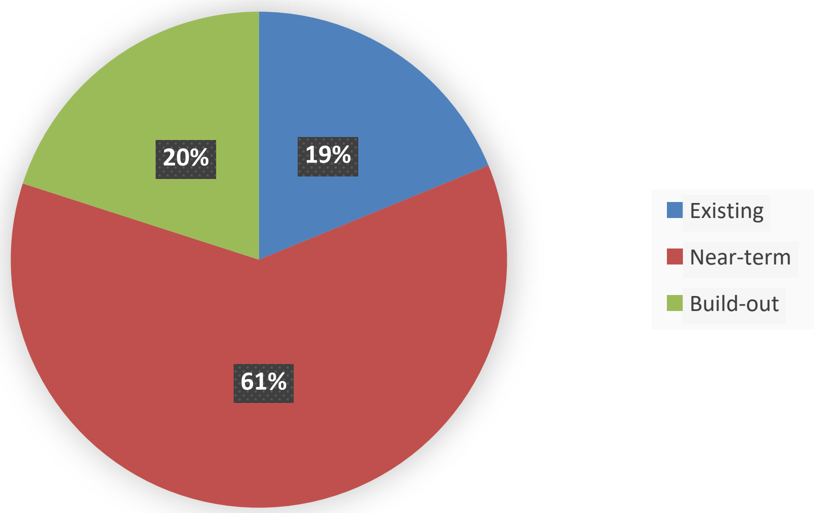
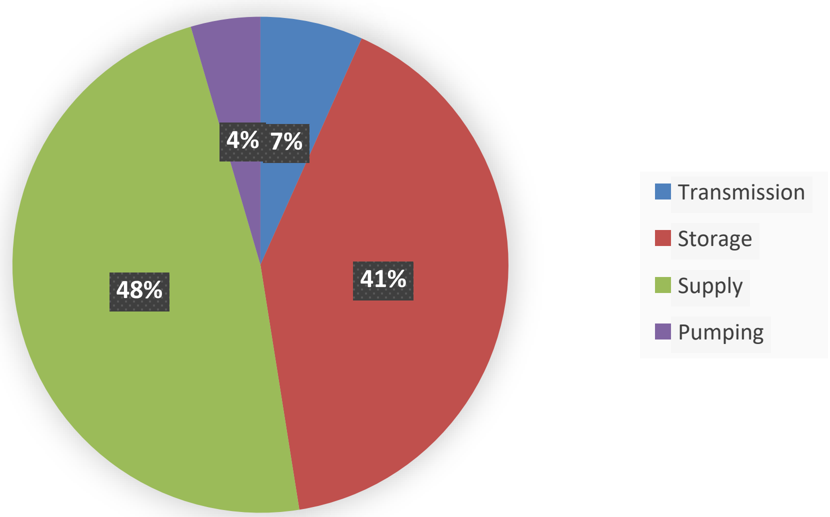


Figure ES-3: Project Cost by Asset Type



SUMMARY OF GENERAL RECOMMENDATIONS

A summary of general recommendations made throughout the 2019 WSMP is summarized in Section 8. These general recommendations are not costed as part of the overall system recommendations.

FINANCING OBJECTIVES

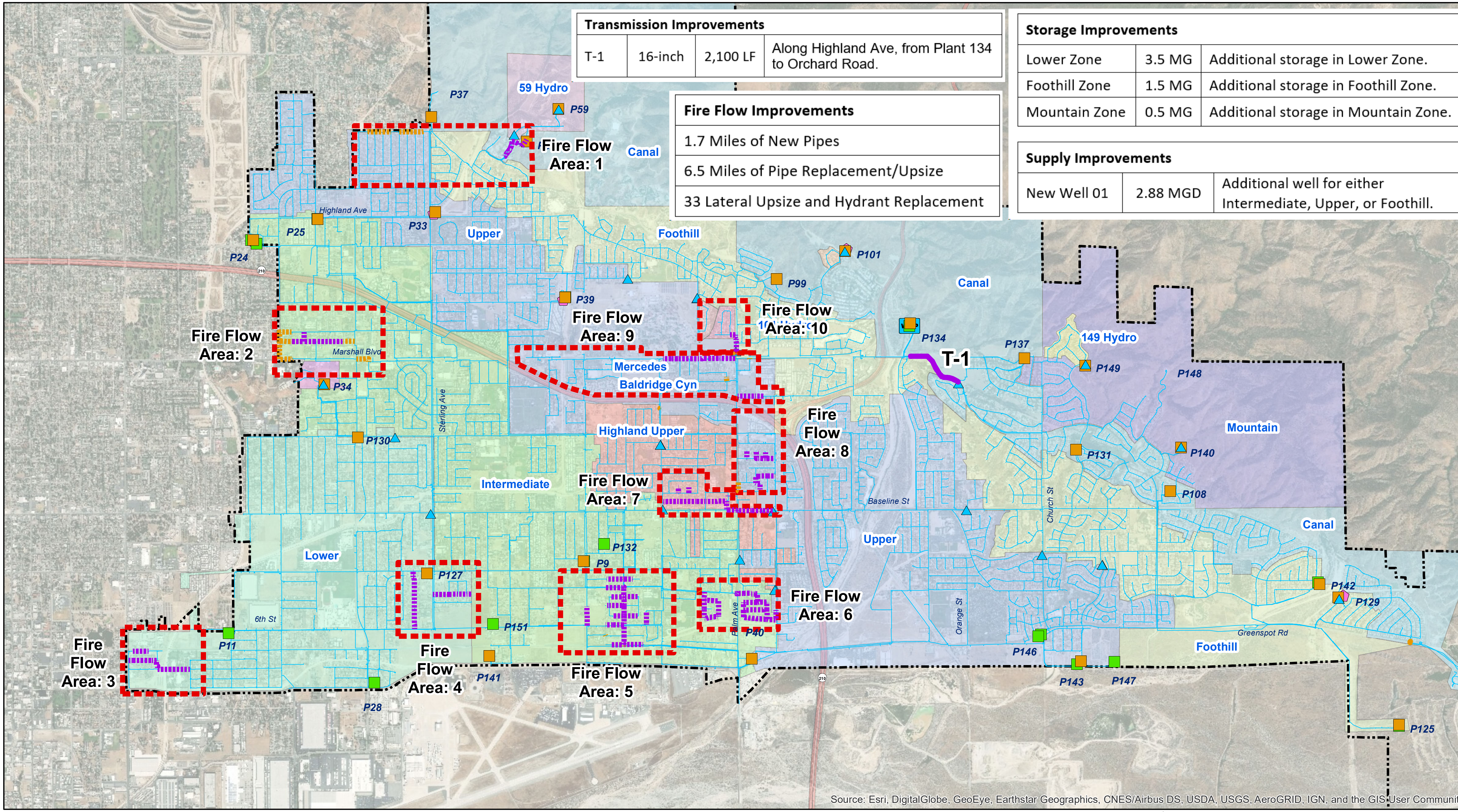
There are several possible funding sources available for the successful implementation of recommended projects, including pay-as- you-go, Drinking Water State Revolving Fund Loan Program, general obligation bonds, revenue bonds, Certificates of Participation, commercial paper (short term notes), developer impact or connection fees, and other state grants and loans. These methods are described in Section 9.

Transmission Improvements			
T-1	16-inch	2,100 LF	Along Highland Ave, from Plant 134 to Orchard Road.

Fire Flow Improvements
1.7 Miles of New Pipes
6.5 Miles of Pipe Replacement/Upsize
33 Lateral Upsize and Hydrant Replacement

Storage Improvements		
Lower Zone	3.5 MG	Additional storage in Lower Zone.
Foothill Zone	1.5 MG	Additional storage in Foothill Zone.
Mountain Zone	0.5 MG	Additional storage in Mountain Zone.

Supply Improvements		
New Well 01	2.88 MGD	Additional well for either Intermediate, Upper, or Foothill.



Legend

Capital Projects
- New Pipe
- Pipe Upsize

FF Improvements (Pipes)
- New Pipe
- Pipe Upsize

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas
- Service Area Boundary
- freeway

East Valley Water District

0 0.25 0.5 1 Miles

N

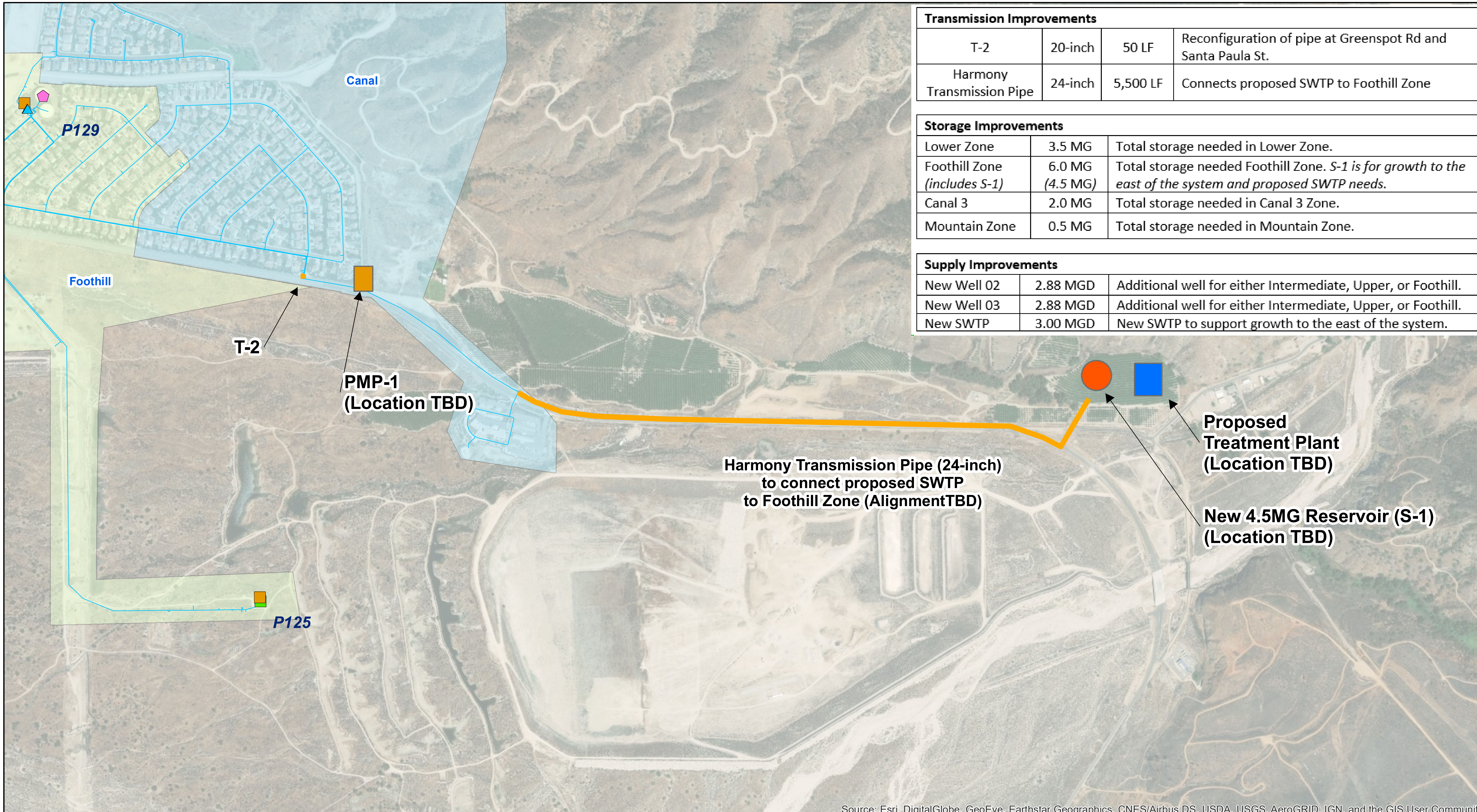
Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Nov 26, 2018

Existing System Recommendations

SEDARU

Figure ES-4



Transmission Improvements			
T-2	20-inch	50 LF	Reconfiguration of pipe at Greenspot Rd and Santa Paula St.
Harmony Transmission Pipe	24-inch	5,500 LF	Connects proposed SWTP to Foothill Zone

Storage Improvements		
Lower Zone	3.5 MG	Total storage needed in Lower Zone.
Foothill Zone *(includes S-1)*	6.0 MG *(4.5 MG)*	Total storage needed Foothill Zone. *S-1 is for growth to the east of the system and proposed SWTP needs.*
Canal 3	2.0 MG	Total storage needed in Canal 3 Zone.
Mountain Zone	0.5 MG	Total storage needed in Mountain Zone.

Supply Improvements		
New Well 02	2.88 MGD	Additional well for either Intermediate, Upper, or Foothill.
New Well 03	2.88 MGD	Additional well for either Intermediate, Upper, or Foothill.
New SWTP	3.00 MGD	New SWTP to support growth to the east of the system.

EAST VALLEY WATER DISTRICT

Legend

- Proposed CIP Pipes
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe

N

0 0.05 0.1 0.2 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Dec 20, 2018

Near-Term System Recommendations

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Figure ES-5

1.0 INTRODUCTION

East Valley Water District (EVWD) retained Stantec Consulting Services, Inc. (Stantec) to prepare this 2019 Water System Master Plan (2019 WSMP) on January 11, 2018. Stantec has partnered with Sedaru in order to deliver the updated model for the 2019 WSMP. This plan updates EVWD's 2014 Water System Master Plan (2014 WSMP). A brief narrative of the project background, scope of work, and a description of the report sections is presented below.

1.1 PROJECT BACKGROUND

EVWD provides both water and sewer service to customers within its service area that lies at the foothills of the San Bernardino Mountains, east of the City of San Bernardino and north of the City of Redlands. EVWD's last WSMP was completed in 2014. Since completion of the 2014 WSMP, there have been significant changes to water demand within EVWD's service area. These changes are due to factors such as the economic downturn following the housing market collapse in 2008, the prolonged drought in southern California, and changes to anticipated development. These resulted in projected water demand estimated in the 2014 WSMP being higher than what was recorded.

Updated information on the proposed Harmony Development, Highland Hills Development, and Greenspot Village and Marketplace Development have also affected projected demand and planning for the water system. Finally, changes to the overarching goals of EVWD, such as maximizing water rights, increasing the amount of stored water, and increasing operational flexibility of the system have also driven a need for changes to the WSMP.

This 2019 WSMP update provides a guideline for the orderly planning and expansion of EVWD's water system, as well as the future operation of the system. This 2019 WSMP evaluates EVWD's water system under existing and future (near-term and build-out) conditions and considers different sources of water resources in the future.

This 2019 WSMP covers the entire service area of EVWD, which includes the City of Highland, portions of the City of San Bernardino, the San Manuel Band of Mission Indians, and portions of unincorporated San Bernardino County. With over 23,464 water meters, EVWD currently serves a population of approximately 100,000. The proposed developments and in-fill growth within EVWD's service area offer a significant potential for growth. The planning and sizing of new facilities to serve the new developments are an important focus in this 2019 WSMP.

1.2 OBJECTIVES

The primary objective of this 2019 WSMP is to provide cost-effective and fiscally responsible water services that meet the quality and reliability requirements of EVWD's customers. This 2019 WSMP assists EVWD achieve this objective by meeting the following goals:

- Developing an infrastructure plan that balances reliability and cost
- Maximizing the ability of EVWD to serve water from multiple sources entering at different locations in the water system
- Accommodating planned development and infill within the service area

- Minimizing pumping and operations costs
- Addressing areas of the system where water is not being conveyed efficiently (areas of high head loss)
- Creating an accurate and usable calibrated hydraulic model
- Evaluating water system performance and water resources
- Identifying needed capital improvement projects

For this 2019 WSMP, Stantec, along with our partner Sedaru, have updated EVWD’s extended period simulation (EPS) computer model of the water system. The calibrated water model includes all water pipelines within EVWD’s water system. Future system elements necessary to meet the near and long-term service conditions are added to analyze the future conditions and define system improvements.

Recommended System Improvements includes all facility recommendations to meet the water system needs. These improvements are identified by analyzing the system under existing and future demand conditions. The Recommended System Improvements includes a list of new facilities, proposed phasing of those facilities, and opinions of probable construction cost. The Recommended System Improvements will provide EVWD with a water system planning road map for the future.

1.3 SCOPE OF WORK

The Scope of Work for this 2019 WSMP consists of the following tasks:

- Project management and administration
- Data collection and review of EVWD documents and records
- Project water system demands in the service area
- Perform a water supply analysis
- Update EVWD’s existing hydraulic model
- Conduct storage, booster station, and system reliability analysis
- Analyze the water distribution system under existing conditions
- Analyze the water distribution system under future conditions
- Identify water system improvements
- Prepare a Capital Improvement Program for the water system
- Produce a draft and final 2019 WSMP
- Perform GIS management analysis

1.4 DATA SOURCES

In preparing this update, EVWD's staff supplied many reports, maps and other sources of information. In addition, multiple meetings with EVWD staff were held to obtain a thorough understanding of EVWD's available data, goals for the service area, operational issues, condition of current infrastructure, and general information on the distribution system. Pertinent materials included water system atlas maps, historical production and billing data, planning and development information, land use information, aerial photography and Geographic Information System (GIS) information. A list of references used for this 2019 WSMP is shown in Appendix A.

1.5 ACKNOWLEDGEMENTS

Stantec wishes to acknowledge and thank all of EVWD's staff for their support and assistance in completing this project. Special thanks go to the following key staff:

CEO/General Manager:	John Mura
Director of Engineering and Operations:	Jeff Noelte
Project Manager and Senior Engineer:	Eliseo Ochoa
Senior Engineering Technician:	Leida Thomas

1.6 PROJECT STAFF

The following Stantec staff members were principally involved in the preparation of this report:

Principal-in-Charge:	Venu Kolli
Technical Reviewer:	Nicholas Anderson
	Paul Marshall
Project Manager:	Jim Cathcart
Project Engineers:	Oliver Slosser
	Areeba Syed
	Michael Steele
GIS Specialist:	Chisa Whelan
Sedaru	Paul Hauffen (Principal)
	Jennifer Wood (Project Manager)
	Matt Sellers (Project Engineer and Lead Modeler)
	Sal Sailik (Project Engineer)

1.7 REPORT OUTLINE

This 2019 WSMP is divided into 8 sections. Section 2 discusses the existing water system, while Section 3 discusses population, land use, and water demands. The water system computer model update and calibration is described in Section 4. Planning criteria are discussed in Section 5, the system evaluation is discussed in Section 6, and the GIS management evaluation is described in Section 7. Based on the system evaluations, the Recommended System

Improvements for the water system is developed and is discussed in Section 8. A description of the topics discussed within each section can be found in the Table of Contents.

2.0 EXISTING WATER SYSTEM

This section describes East Valley Water District's (EVWD) existing water system facilities and provides an understanding of the water system operations. The existing water system consists of 18 storage reservoirs, 31 booster pumping stations, 21 groundwater wells (active and inactive), 14 pressure reducing stations, and approximately 301 miles of pipeline. A summary of the water system components is shown in Table 2-1. The locations of the water facilities are shown on Figure 2 1. A hydraulic schematic representation of all facilities and their interactions is presented on Figure 2-2. Information presented in this section regarding the current conditions of EVWD facilities was collected in a meeting with operations staff conducted on April 3, 2018; meeting notes are presented in Appendix B.

Table 2-1: Summary of Water Distribution System Components

Facility Type	Number
Storage Reservoirs	18
Booster Pump Stations	31
Groundwater Wells (active) (1)	16
Groundwater Wells (inactive)	5
Imported Water Connection	1
Surface Water Connection	1
Pipeline (miles)	301
Pressure Reducing Stations	14
Surface Water Treatment Plant	1
Groundwater Treatment Plants	4
Hydrants	3,025
Valves	8,225
Customer Meters (as of 2017)	22,907

(1) EVWD reported detection of radionuclides at Well 9 and has temporarily removed the well from production.
Source: EVWD GIS data and supplemental information (2017 Plant Location Information)

A computer hydraulic model has been developed that represents the existing water system, including all water facilities. This model is used for the evaluation of existing and future conditions, as well as to identify areas for improvements. The model creation and calibration are described in Section 4, while the system analyses for the existing and future conditions are described in Section 6.

2.1 PRESSURE ZONES

The current water system is divided into six main pressure zones, the Lower Zone, the Intermediate Zone, the Upper Zone, the Foothill Zone, the Canal Zone, and the Mountain Zone. The Canal Zone consists of three hydraulically disconnected zones that are, for the purposes of this report, referred to as Canal 1 Zone, Canal 2 Zone, and Canal 3

Zone. There is no redundancy in the Canal 1 and Canal 2 Zones. The Canal zones may be tied together in the future. Water does not flow from the Upper Zone to the west easily. Upper zone reservoirs routinely operate at different levels, there can be as much as a 10 ft. different in tank water levels during the day.

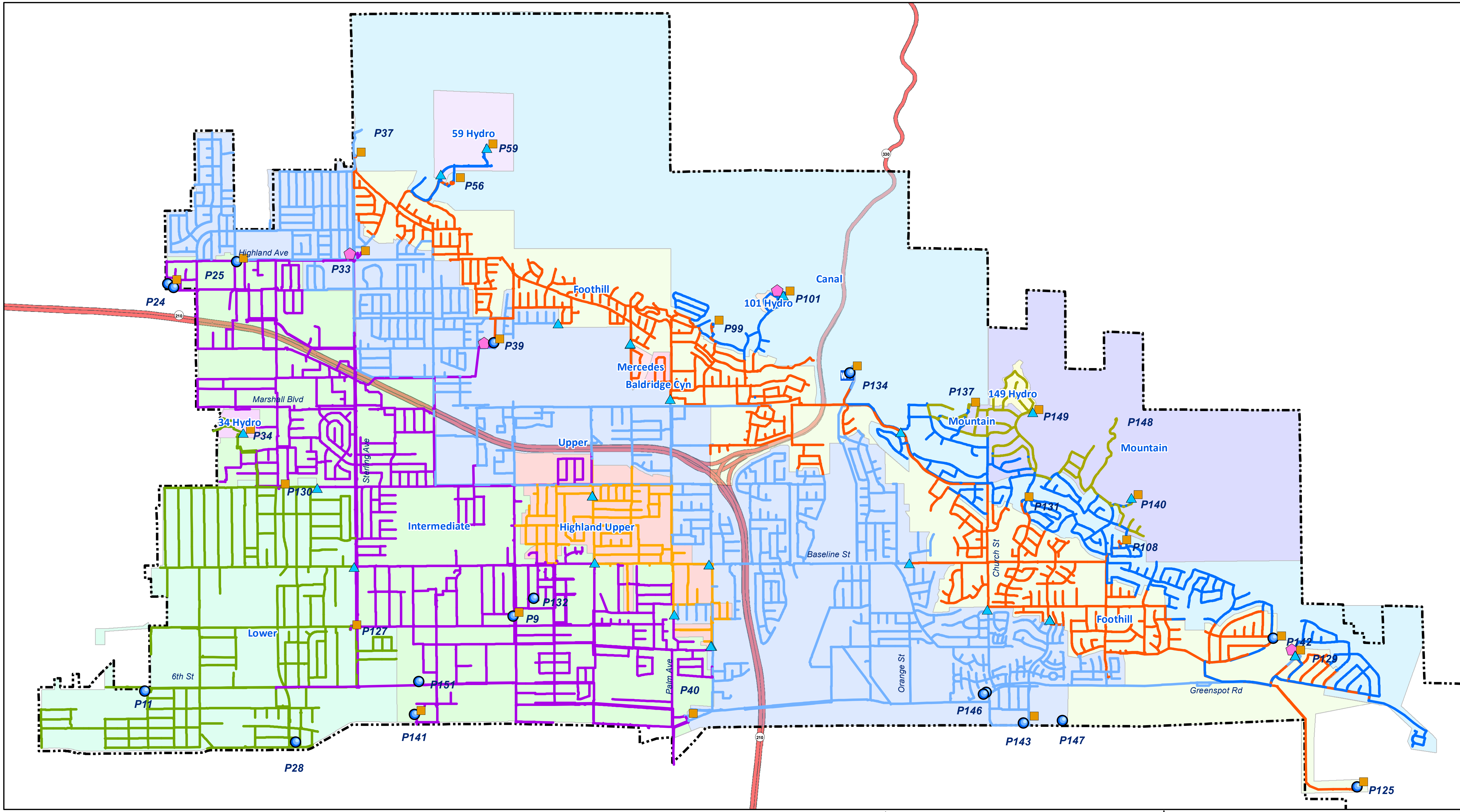
There are four small hydropneumatic zones and three zones that are supplied through pressure reducing valves (PRVs). The hydropneumatic zones are designated: Hydro Zone 59, Hydro Zone 101, Hydro Zone 149, and Hydro Zone 34. The PRV supplied zones are designated: Highland Upper Zone, Mercedes Zone, and Baldridge Canyon Zone. The maximum hydraulic grade elevation for each main pressure zone is determined by the high-water level of the reservoirs feeding the zone. All pressure zones in the existing and future system are gravity-fed from storage reservoirs, through pressure reducing stations, or by hydropneumatic tanks. Booster pumping stations are used to pump water from lower to higher pressure zones, where needed. The names of the pressure zones and their respective hydraulic characteristics are listed in Table 2 2 and the pressure zone boundaries are shown on Figure 2 1. Static pressure ranges presented in Table 2 2 represent pressure ranges based on elevations at demand nodes.

Table 2-2: EVWD Pressure Zones

Pressure Zone Name	Area (square miles)	Hydraulic Grade Elevation (feet-msl(1))	Ground Elevation Range (feet-msl)	Static Pressure Range (2) (psi)
Lower Zone	2.29	1,248	1,032-1,212	12-101
Intermediate Zone	4.16	1,368	1,086-1,353	6-108
Upper Zone	5.73	1,560	1,170-1,513	20-162
Foothill Zone	3.75	1,690	1,315-1,682	3-166
Canal 1 Zone	6.16(3)	1,820	1,432-1,783	16-135
Canal 2 Zone		1,852	1,557-1,825	12-130
Canal 3 Zone		1,838	1,468-1,852	7-170
Mountain Zone	1.93	2,015	1,668-2,016	12-165
Hydro 59	0.26	1,931	1,686-1,827	45-116
Hydro 101	0.01	2,020	1,751-1,824	85-116
Hydro 149	0.05	2,198	1,918-2,058	61-121
Hydro 34	0.05	1,479	1,171-1,256	97-133
Baldridge Canyon	0.03	1,566	1,389-1,443	43-67
Mercedes	0.02	1,669	1,382-1,427	80-99
Highland Upper	0.72	1,440	1,151-1,326	45-120

(1) Feet above mean sea level
(2) Calculated based on difference between hydraulic grade elevation and ground elevation range
(3) Area for all three Canal zones is presented

The largest individual pressure zone in the system is Upper Zone which covers approximately 30 percent of the existing water service area. This zone contains the surface water treatment plant (Plant 134), four groundwater wells, and four reservoirs with a combined storage capacity of approximately 12.9 million gallons (MG). Pressure zones are separated by closed valves, check valves, pressure regulating stations, and booster stations. The delineation of the pressure zone boundaries was obtained from EVWD and shown on Figure 2 1.



Legend

- PRV Station
- Well
- Booster Station
- Reservoir
- WTP

Pipeline by Pressure Zone

- Lower
- Intermediate
- Upper
- Highland Upper
- Foothill
- Canal
- Mountain

- Service Area Boundary
- freeway

Note: Icons have been shifted in order to display different infrastructure in similar locations clearly.

East Valley Water District

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: V:\2245\active\224501161\GIS\MXDs\Figures\Water\Sedaru_ExistingWaterSystemFacilities.mxd by cwhelan

Date: 5/13/2019

Existing Water System Facilities

SEDARU

Figure 2-1

EAST VALLEY WATER DISTRICT HYDRAULIC SCHEMATIC
2018

EVWD operations staff noted that the pipeline along Highland Avenue traveling westward from the treatment plant is 16" and constricts flow to the west. They also noted that the area around Pumps 59 and 56 may need to be isolated in their own zone as that area experiences high pressures. EVWD should monitor pressures in that zone and establish a PRV zone specific to the area where pressures regularly exceed EVWD standards.

2.2 WATER SUPPLY

EVWD has three existing principal sources of water supply: local groundwater pumped from EVWD-owned wells, imported water from the State Water Project, and local surface water from the Santa Ana River (North Fork Water).

2.2.1 Groundwater Wells

There are 22 wells within EVWD's water system, of which 16 wells are currently active and 6 are inactive. The physical and operational data of EVWD's wells are presented in Table 2-3:, while the locations of the groundwater wells are shown on Figure 2-1. The well capacity of the 16 listed wells is approximately 23,042 gallons per minute (gpm) (33.2 million gallons per day (MGD). The well capacities are obtained from 2017 Southern California Edison Company (SCE) pump efficiency test points and the 2014 WSMP. The capacities listed in Table 2-3 were the capacities used for modeling purposes.

2.2.1.1 Existing Conditions of Groundwater Wells

Discussions with EVWD staff of current well condition and operational issues identified the following information:

- Wells number 12, 27, 40, 107, and 120 are inactive due to water quality issues and are not included in Table 2-3**:**
- Uranium was found in samples from Well 40
- Perchlorate and nitrates have been found in samples from Well 107.
- Well 9 is in questionable status due to detection of radionuclides.
- Wells 24A and 24B operate one at a time due to high power costs associated with running concurrently.
- Well 146 and 146A operate one at a time because the aquifer in that area cannot support concurrent operation.
- Well 28A uses granular activated carbon to remove TCE and PCE.
- Entrained air has been seen from Wells 147, 146, 146A and 143. The reservoir at 143 is used to off-gas or release entrained air coming from these wells caused by cascading water in the wells.
- EVWD has been injecting polyphosphates for corrosion control at Wells 142, 143, 146, 146A, 147, and Plant 134.
- Well 39 is a blending facility due to high fluoride concentration and pumps to a forebay that feeds two boosters to Upper and Foothill zones.
- EVWD is evaluating if they can pack off sections of production zones to isolate good quality water. The Canal 1, Canal 2, Canal 3, and Mountain zones do not have any groundwater wells.

Table 2-3: Active Groundwater Well Charateristics

No.	Location	Status	Pressure Zone	Capacity (gpm) (1)	Pump Head (feet)	Water Surface Elevation (feet)	Ground Elevation (feet)	Hydraulic Grade (feet)	Discharge Pressure (psi)
9A(2)	26493 Temple St.	Questionable	Intermediate	1,112	229	926	1,149	1,155	3
11A(2)	6th/Pedley	Active	Lower	1,953	198	874	1,058	1,072	6
24A	1 Harrison/Lynwood	Active	Intermediate	795	366	928	1,268	1,281	6
24B	30 Harrison/Lynwood	Active	Intermediate	2,215	408	873	1,206	1,217	5
25A	3187 N. Mountain Ave.	Active	Intermediate	799	471	935	1,258	1,384	55
28A(2)	25385 Court St.	Active	Lower	1,505	397	872	1,091	1,269	77
39	2683/2695 E. Citrus St.	Active	Intermediate	1,530	454	944	1,336	1,358	10
125	2129 Plant H5	Active	Foothill	1,293	284	1,417	1,663	1,676	6
132	7479 San Francisco	Active	Intermediate	2,337	478	917	1,154	1,375	96
141	2287 E. 5th Street	Active	Intermediate	1,925	525	882	1,103	1,369	115
142	7695 Vista Rio	Active	Foothill	895	308	1,361	1,607	1,650	19
143(2)	29090 Abbey Way	Active	Upper	1,202	771	1,006	1,340	1,777	189
146	7938 Church Street	Active	Upper	420	408	1,079	1,425	1,469	19
146A	7938 Church Street	Active	Upper	845	491	1,020	1,378	1,424	20
147	29250 Abbey Way	Active	Upper	1,630	301	1,216	1,414	1,450	15
151	6032 6th St.	Active	Intermediate	2,586	488	1,414	1,627	1,882	110
Total Capacity				**23,042**					

(1) Data for wells obtained from the most recent SCE pump tests performed in 2016 and 2017.
(2) Current pump test data were not available from SCE. Well characteristics were used from the 2014 WSMP and confirmed with EVWD.

2.2.2 Imported Water

EVWD purchases imported State Water Project (SWP) water from the San Bernardino Valley Municipal Water District (Valley District) to meet a portion of system water demands. This water is treated in conjunction with Santa Ana River water at EVWD's surface water treatment plant, Plant 134 which has a design and modeled capacity of 8 MGD. EVWD currently is allocated 15 percent of Valley District allocation of SWP water. Valley District entitlement is 102,600 AFY (91.6 MGD), of which 15,390 AFY (13.74 MGD) would be available to EVWD.

Based on the historic Table A allocations for Valley District, the average SWP supply has ranged from 6.53 to 8.17 MGD depending on the period considered (10, 20, 30, or 40-year average). The 10-year average is 6.53 MGD. It is noted that in the 10-year record, there is a large amount of variability in what EVWD can expect year to year, from 0.69 to 11.68 MGD.

2.2.3 North Fork Mutual Water Company

As a shareholder of the North Fork Mutual Water Company (NFMWC), EVWD obtains water from the Santa Ana River. Based on its current shares, EVWD is entitled to 4 MGD from NFMWC. EVWD is in the process of purchasing additional stock that will ultimately give EVWD rights to an additional 2.5 MGD of Santa Ana River water. This water is treated in conjunction with any State Water Project water at EVWD's surface water treatment plant.

Stantec reviewed EVWD's current agreement for North Fork water and historic flow for the Santa Ana River, and found that over the last 10-years, EVWD's average available water from this source was 5.23 MGD. This is based on the allocation EVWD is entitled to during summer and fall months, and 25 percent allocation based on river flow during winter and spring months. The analysis of average Santa Ana River availability is presented in Table 2-4 below.

Table 2-4: North Fork Santa Ana River 10-Year Average Water Availability

Month	Allocation				10-year Average Santa Ana River Flow from March 2019 DFR Request		EVWD Allocation		Average Days
	Miner's Inches	cfs	MGD	Based on SAR Flow (%)	cfs[1]	MGD[1]	MGD (25% of Total)	MGD	Days
Jan				25	17.6	11.3	2.8	2.8	31
Feb				25	21.3	13.8	3.4	3.4	28
Mar				25	27.1	17.5	4.4	4.4	31
Apr				25	30.5	19.7	4.9	4.9	30
May				25	24.9	16.1	4.0	4.0	31
Jun	500	10	6.46					6.5	30
Jul	600	12	7.76					7.8	31
Aug	600	12	7.76					7.8	31
Sep	550	11	7.11					7.1	30
Oct	450	9	5.82					5.8	31
Nov	400	8	5.17					5.2	30
Dec				25	18.3	11.9	3.0	3.0	31
Annual Average[2]									**5.23**
1: Value is calculated by summing the "BV RPU" column and "SAR PH#3 Penstock" values in the DFR Report and using the 10-year average value for each month									
2: Annual Average is weighted by days in each month									

2.3 BOOSTER PUMPING STATIONS

EVWD operates 31 booster pumping stations. These booster pumping stations either transfer water between zones or pump groundwater into the distribution system. The number of pumps at each station ranges from one to eight booster pumps. The individual booster pump capacities vary from about 170 gpm to 2,950 gpm (0.24 MGD to 4.2 MGD). The total capacity of all booster stations is approximately 70,400 gpm (101 MGD).

The total capacity assumes that each pump runs at its rated capacity (capacities are listed on Table 6-4). These capacities are based on duty pumps only and does not assume the standby pump. The firm capacity is rated by assuming the largest pump is out of service at that pump station. It is noted that the standby pump is available when a pump goes down, however the firm capacity analysis assumes a loss of functionality in the largest pump with no standby availability as a conservative assumption.

The booster pumping stations are operated when either the adjacent well is on or when reservoirs in higher zones need replenishment. Details of each booster station are summarized in Table 2-5:. The booster pumping station locations are shown on Figure 2-1 and are schematically represented on Figure 2-2.

Table 2-5: Booster Pumping Stations Characteristics

Booster Pump	Motor Horsepower[2] (hp)	Total Head[2] (ft)	Capacity[2] (gpm)	Overall Efficiency[2] (Percent)	Suction Zone[2]	Discharge Zone[2]
PMP_9_1[1]	75	278	542	50.9	Plant 9	Intermediate
PMP_9_2[1]	75	291	612	61.2	Plant 9	Intermediate
PMP_12_1[1]	150	194	2,187	75.3	Plant 11	Lower
PMP_12_2[1]	100	203	1,467	74.2	Plant 11	Lower
PMP_12_3[1]	60	199	865	66.8	Plant 11	Lower
PMP_24_1	100	150	980	36.3	Plant 24	Intermediate
PMP_24_2	75	138	850	38.4	Plant 24	Intermediate
PMP_24_3	75	137	760	36.5	Plant 24	Intermediate
PMP_25_1	60	203	798	72.2	Plant 25	Upper
PMP_33_1	100	197	1,553	66	Intermediate	Upper
PMP_33_2	75	201	1,004	65.4	Intermediate	Upper
PMP_33_3	60	199	934	76.8	Intermediate	Upper
PMP_34_1	15	77	285	33	Lower	Hydro 34
PMP_34_2	40	119	892	49.8	Lower	Hydro 34
PMP_37_1	100	234	835	57.9	Upper	Foothill
PMP_37_2	75	216	795	57.8	Upper	Foothill
PMP_39_1	40	190	425	46.7	Intermediate	Upper
PMP_39_2	50	204	725	78.1	Intermediate	Foothill
PMP_39_3	125	383	970	72.8	Intermediate	Foothill
PMP_39_4	125	360	863	55.9	Intermediate	Foothill
PMP_39_5	20	22	1,698	45.6	Intermediate	Forebay
PMP_39_6	20	20	1,720	41	Intermediate	Forebay
PMP_40_1	100	199	1,301	65.4	Intermediate	Upper
PMP_40_2	100	196	1,293	62.9	Intermediate	Upper
PMP_40_3	100	199	1,295	64.7	Intermediate	Upper
PMP_40_4	100	196	1,308	63.9	Intermediate	Upper
PMP_56_1	50	149	1,119	63.5	Foothill	Canal1
PMP_56_2	40	149	532	48.1	Foothill	Canal1
PMP_59_1	30	126	647	66.9	Canal1	Hydro59
PMP_59_2	30	122	615	62.9	Canal1	Hydro59
PMP_59_3	15	125	286	53.9	Canal1	Hydro59
PMP_99_1	40	174	624	68.7	Foothill	Canal2

Booster Pump	Motor Horsepower(2) (hp)	Total Head(2) (ft)	Capacity(2) (gpm)	Overall Efficiency(2) (Percent)	Suction Zone(2)	Discharge Zone(2)
PMP_99_2	40	172	541	65.5	Foothill	Canal2
PMP_101_1	30	76	992	51.3	Canal2	Hydro101
PMP_101_2	30	73	1004	49.9	Canal2	Hydro101
PMP_108_1(1)	100	163	1,278	63.1	Foothill	Canal3
PMP_108_2(1)	100	158	1,207	59.2	Foothill	Canal3
PMP_125_1	40	97	1,187	66.3	Plant 125	Foothill
PMP_125_2	20	92	595	63.4	Plant 125	Foothill
PMP_127_1	75	168	1,285	66.7	Lower	Intermediate
PMP_127_2	75	167	1,361	70.9	Lower	Intermediate
PMP_129_1(1)	100	175	1,647	75.9	Upper	Foothill
PMP_129_2(1)	100	172	1,636	71.6	Upper	Foothill
PMP_129_3(1)	100	175	1,648	71.6	Upper	Foothill
PMP_129_4(1)	100	304	980	68.9	Upper	Canal3
PMP_129_5(1)	100	302	971	68	Upper	Canal3
PMP_130_1	60	136	847	52.4	Lower	Intermediate
PMP_130_2	60	135	807	44.8	Lower	Intermediate
PMP_131_1	40	156	442	56.8	Foothill	Canal3
PMP_131_2	25	157	345	52.1	Foothill	Canal3
PMP_131_3	30	165	358	54.9	Foothill	Canal3
PMP_134_1	75	172	905	72.2	Upper	Foothill
PMP_134_2	75	153	860	58.6	Upper	Foothill
PMP_134_3	75	159	869	59.9	Upper	Foothill
PMP_134_4	60	182	896	68.3	Upper	Foothill
PMP_134_5	60	201	833	73.2	Upper	Foothill
PMP_134_6	75	325	627	64.6	Upper	Canal3
PMP_134_7	75	329	660	65.9	Upper	Canal3
PMP_134_8	100	321	853	76.4	Upper	Canal3
PMP_137_1	40	212	530	67.8	Canal3	Mountain
PMP_137_2	40	208	523	66.2	Canal3	Mountain
PMP_140_1(1)	60	217	777	70.1	Canal3	Mountain
PMP_140_2(1)	60	219	800	71.8	Canal3	Mountain
PMP_142_1	50	168	977	67.3	Plant 142	Foothill
PMP_142_2	30	164	498	61.8	Plant 142	Foothill

Booster Pump	Motor Horsepower[(2)] (hp)	Total Head[(2)] (ft)	Capacity[(2)] (gpm)	Overall Efficiency[(2)] (Percent)	Suction Zone[(2)]	Discharge Zone[(2)]
PMP_142_3	50	189	820	60.6	Plant 142	Canal3
PMP_143_1	250	199	2950	66.1	Wells	Upper
PMP_143_2	250	198	2280	67.6	Wells	Upper
PMP_149_1	15	119	173	53.6	Mountain	Hydro149
PMP_149_2	15	113	215	60.3	Mountain	Hydro149
PMP_149_3	100	106	1,786	48.8	Mountain	Hydro149
PMP_149_4	100	135	1,690	59.8	Mountain	Hydro149
Total Average Capacity		**70,433**				

(1) Current pump test data were not available from SCE. Well characteristics were used from the 2014 WSMP and confirmed with EVWD.
(2) Source: SCE Pump Tests, schematics, and other data provided by EVWD

2.3.1 Existing Conditions of Booster Pumping Stations

Discussions with EVWD staff regarding existing conditions of booster pumping stations identified the following information:

- Currently, approximately four pumps in the system are replaced each year as part of ongoing system maintenance.
- Pumps 149_1 and 149_2 were being replaced during this 2019 WSMP.
- EVWD is concerned that pumps 56 and 59 may be too small to serve the planned 500 room hotel and casino in the Canal 1 Zone. The pumps themselves appear to have enough capacity (3 MGD) to serve both the existing and future demands in this zone. However, it is recommended that EVWD conduct a study prior to the Casino expansion considering resizing of Plant 59 hydropneumatics tank, changes in tank settings, sizing of tank at Plant 134, and possible changes to the pumps at Plant 56 and 59 to evaluate the most efficient way to serve this new development.
- Pump 59 pumps into a closed hydro zone and cycles excessively and may need to be upsized. The pump appears to have enough capacity to serve both existing and future demand, but it is recommended the study described above be initiated in order to serve the new demand as efficiently as possible.
- There are 5 VFDs on permeate pumps at Plant 134, and 2 VFDs at Plant 143.
- Booster site 127 has a pressure reducing valve to bring water from the intermediate zone to the lower zone, the set point of which is based on Plant 34 level.
- Several of the pumps have efficiency issues and may need to be resized. SCE does efficiency tests every other year which were used to populate Table 2-5:.

2.4 WATER STORAGE RESERVOIRS

There are 18 storage reservoirs, not including forebays, in EVWD's system with capacities ranging from 0.07 million gallons (MG) to 4 MG. EVWD has a total reservoir storage capacity of approximately 27.6 MG. The hydraulic grade elevation in each pressure zone is controlled by the high-water elevation of the reservoirs that feed the zones by gravity. Table 2-6 shows the details of EVWD's storage reservoirs. Table 2-7 summarizes the reservoir capacities by their respective pressure zones. Their locations are shown on Figure 2-1 and are schematically represented on Figure 2-2.

Table 2-6: Storage Reservoir Characteristics

Reservoir ID	Pressure Zone	Volume (MG)	Bottom Elevation (ft)	High Water Elevation (ft)	Height (ft)	Dia. (ft)	Year Built
Plant 33_1	Intermediate	1.0	1,330	1,365	34.75	70.0	1956
Plant 33_2	Intermediate	2.5	1,330	1,365	34.75	110.0	1957
Plant 33_3	Intermediate	1.0	1,330	1,365	34.75	70.0	1957
Plant 34	Lower	1.0	1,210	1,248	38.0	66.5	1957
Plant 37	Upper	4.0	1,520	1,560	40.0	132.0	2003
Plant 39_1	Intermediate	0.9	1,343	1,366	23.2	80.0	1961
Plant 39_2	Intermediate	1.4	1,343	1,366	23.2	100.0	1983
Plant 56	Foothill	0.5	1,666	1,690	23.5	60.0	1968
Plant 59	Canal 1	0.7	1,800	1,820	20.0	78.0	1986
Plant 99	Foothill	0.5	1,666	1,690	23.5	60.0	1968
Plant 101	Canal 2	1.4	1,820	1,852	31.5	85.0	1978
Plant 108	Foothill	2.0	1,662	1,710	47.5	84.0	1980
Plant 129_1	Upper	3.0	1,530	1,560	30.0	130.0	1993
Plant 129_2	Upper	3.0	1,530	1,560	30.0	130.0	1993
Plant 134	Upper	3.0	1,520	1,560	40.0	113.0	1996
Plant 137	Canal 3	0.07	1,816	1,838	22.0	23.5	1960
Plant 140	Canal 3	2.0	1,820	1,850	30.0	106.0	1990
Plant 148	Mountain	0.75	2,015	2,044	29.0	65.0	2002
Total Capacity		**27.6**					

Table 2-7: Storage Reservoir Capacity by Pressure Zone

Pressure Zone	Storage Capacity (MG)	Percent Total
Lower	1.00	3.6
Intermediate	6.80	24.6
Upper	12.90	46.7
Foothill	3.00	10.9
Canal 1	0.70	2.5
Canal 2	1.40	5.1
Canal 3	2.07	7.5
Mountain	0.75	2.7
Total Storage Capacity	**27.60**	**100.0**

2.4.1 Existing Conditions of Reservoirs

Based on conversations with EVWD operational staff, the following information on the current condition of EVWD reservoirs were identified:

- Corrosion has been observed at Plant 140 and the reservoir needs rehabilitation. Plant 140 cannot be taken down for maintenance without a temporary system supply as Plant 137 volume is too small to support the Canal 3 zone.
- Plant 134 is a concrete tank at grade, and Plant 37 is a buried concrete tank, all others are steel tanks.
- Plant 59 needs rehabilitation, but it cannot be taken out of service without a temporary system supply.
- Plant 34 and Plant 101 need to be rehabilitated or replaced.
- Tanks are inspected by divers every 4-6 years to assess if recoating is required. Hydro tanks should to be inspected but cannot be taken out of service. Some are undersized, and some may have corrosion problems.
- Tank water age is contributing to higher THM concentrations in the distribution system. Most tanks are single inlet and outlet, contributing to water age issues. Adding mixers or a second inlet should be considered to reduce nitrification.
- Canal Zones tanks do not float well together due to hydraulic constriction in the pipelines connecting them.
- Plant 99 and 101 tanks do not float together due to hydraulic constriction in the pipelines connecting them. This constriction is addressed in the transmission piping recommendations in Section 8.
- Due to inadequate storage in Foothill Zone, Plant 108 water levels drop regardless of how much is pumped into it, especially during summer months.

- Plant 134 has a seismic valve while other tanks are not seismically retrofitted. It is recommended that seismic retrofitting be performed on all EVWD tanks.
- The area around Plant 134 was connected to a residential zone and is now serving many additional customers on the San Manuel Reservation, the tank is undersized to serve the additional consumers. This deficiency is addressed through a storage recommendation for the Foothill Zone in the existing scenario (Section 8).

2.5 PRESSURE REDUCING STATIONS

There are fourteen pressure reducing stations (PRSs) in EVWD's water service area. Most pressure reducing stations have two or more pressure reducing valves (PRVs), a main valve, and one or more supplemental valve(s). The main valve, the smallest in diameter, is normally open and has the highest-pressure setting. Water continuously flows through this main valve with a downstream pressure equal to the main valve's pressure setting. Supplemental valves are larger in diameter and have a slightly lower pressure setting than the main valve. If the downstream water pressure drops (due to large water demand) below the supplemental valve's pressure setting, the supplemental valve will open to provide additional water. In addition, pressure relief valves are generally present at each PRS. These valves protect the water system from abnormally high pressure should the regulating valves fail to work properly. In the model, it is assumed that there is a 2-psi difference between the smaller and larger valve settings. Table 2-8: summarizes the details of all pressure regulating stations as modeled. The pressure regulating stations are shown in Figure 2-1 and are schematically represented on Figure 2-2.

Table 2-8: Pressure Regulation Stations

Station No.	From Zone	To Zone	Pressure Setting (psi)	Ground Elevation (ft)
33	Upper	Intermediate	SCADA Controlled	1,333
40	Upper	Intermediate	SCADA Controlled	1,200
108	Canal	Foothill	SCADA Controlled	1,665
127	Intermediate	Lower	SCADA Controlled	1,109
301	Highland Upper	Intermediate	92	1,214
302	Foothill	Baldridge Canyon	70	1,405
305	Foothill	Upper	57	1,424
306	Highland Upper	Intermediate	98	1,205
308	Foothill	Mercedes	105	1,426
309	Intermediate	Lower	62	1,108
311	Intermediate	Lower	48	1,134
324	Foothill	Upper	56	1,429
325	Upper	Highland Upper	88	1,237
326	Upper	Highland Upper	82	1,261

Source: EVWD Staff

2.6 DISTRIBUTION SYSTEM NETWORK

All pipes in EVWD's water distribution system network were installed between year 1929 and year 2017. As shown in Table 2-9, approximately 16 percent of the pipelines have an unknown installation date, while approximately 18 percent of the pipelines have been installed in the partial decade of 2010-2017.

EVWD's distribution system network consists of approximately 301 miles of pipeline, which range in diameter from 1-inch to 36-inches. The distribution of pipeline diameters is summarized in Table 2-10:, and mapped in Figure 2-3. It should be noted that the numbers presented in Table 2-10 are based on the water main pipelines, and do not include service laterals. Approximately 60 percent of the distribution system network consists of pipes with diameters between 6 inches and 8 inches, while 19 percent of the distribution system network is comprised of pipes that are 12 inches in diameter.

Table 2-11: summarizes the total lengths of pipelines by material type, and Figure 2-4 maps the pipeline material distribution. The most common pipe material is asbestos cement, which makes up approximately 47 percent of the total pipeline length in the system.

Table 2-9: Summary of Pipeline by Installation Period

Installation Period	Length (ft)	Length (miles)	Total (percent)
1920-1939	464	0.1	0.0
1940-1949	5,097	1.0	0.3
1950-1959	95,238	18.0	6.0
1960-1969	236,890	44.9	14.9
1970-1979	145,359	27.5	9.1
1980-1989	201,684	38.2	12.7
1990-1999	193,700	36.7	12.2
2000-2009	191,554	36.3	12.1
2010-2017	277,141	52.5	17.4
Unknown	242,415	45.9	15.3
Total	**1,589,541**	**301.0**	**100**

Source: EVWD's GIS data

Table 2-10: Summary of Pipeline by Diameter

Diameter	Total Length (ft)	Total Length (miles)	Percent of Total Length
Unknown	412	0.1	0.0
2"	7,033	1.3	0.4
3"	9,114	1.7	0.6
4"	64,559	12.2	4.1
5"	121	0.0	0.0
	427,878	81.0	26.9
8"	532,723	100.9	33.5
10"	33,822	6.4	2.1
12"	298,342	56.5	18.8
14"	11,363	2.2	0.7
16"	110,598	20.9	7.0
18"	521	0.1	0.0
20"	43,154	8.2	2.7
21"	7,478	1.4	0.5
24"	10,191	1.9	0.6
30"	16,439	3.1	1.0
36"	15,793	3.0	1.0
Total	**1,589,541**	**301.0**	**100**

Source: EVWD's GIS database

Table 2-11: Summary of Pipeline by Material Type

Material	Total Length (ft)	Total Length (miles)	Total Length (percent)
Steel			
Cement Lined & Coated (CL&C)	138,286	26.2	8.7
Cement Lined & Wrapped (CL&W)	48,537	9.2	3.1
Cement Mortar Lined (CML)	1,663	0.3	0.1
Dipped & Wrapped (D&W)	66,270	12.6	4.2
Double Dipped & Wrapped (DD&W)	91,125	17.3	5.7
Steel (Unspecified)	47,986	9.1	3.0
Subtotal Steel Pipes	***393,868***	***75***	***24.8***
Iron			
Cast Iron Pipe	3,298	0.6	0.2
Ductile Iron	421,238	79.8	26.5
Galvanized Iron Pipe	359	0.1	0.0
Subtotal Iron Pipes	***424,895***	***80***	***26.7***
Other Materials			
Asbestos Cement (AC)	752,089	142.4	47.3
Copper	107	0.0	0.0
Polyvinyl Chloride (PVC)	15,185	2.9	1.0
Reinforced Concrete (RCP)	897	0.2	0.1
Subtotal Other Material Pipes	***768,278***	***146***	***48.3***
Unknown	**2,500**	**0.5**	**0.2**
Grand Total	**1,589,541**	**301**	**100**

Source: EVWD's GIS data
Note: Subtotals and grand total may not add up due to rounding.

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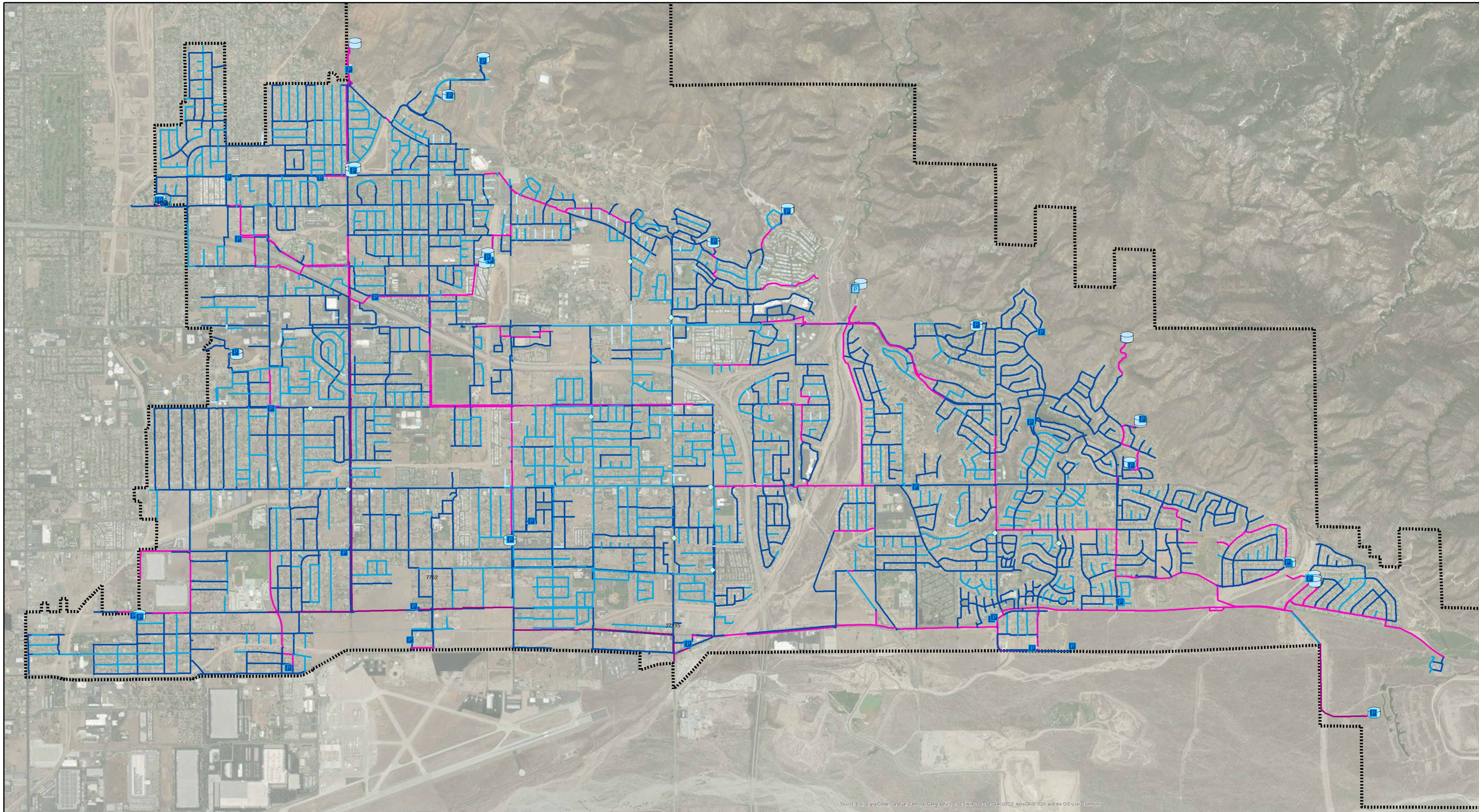

Legend

- Pressure Reducing Station
- WTP 134
- Plant
- Tank
- Service Area Boundary

Pipeline by Diameter (inches)

- < 4 inches
- 4 - 7 inches
- 8 - 13 inches
- 14 - 24 inches
- > 24 inches

N

0 0.2 0.4 0.8 Miles

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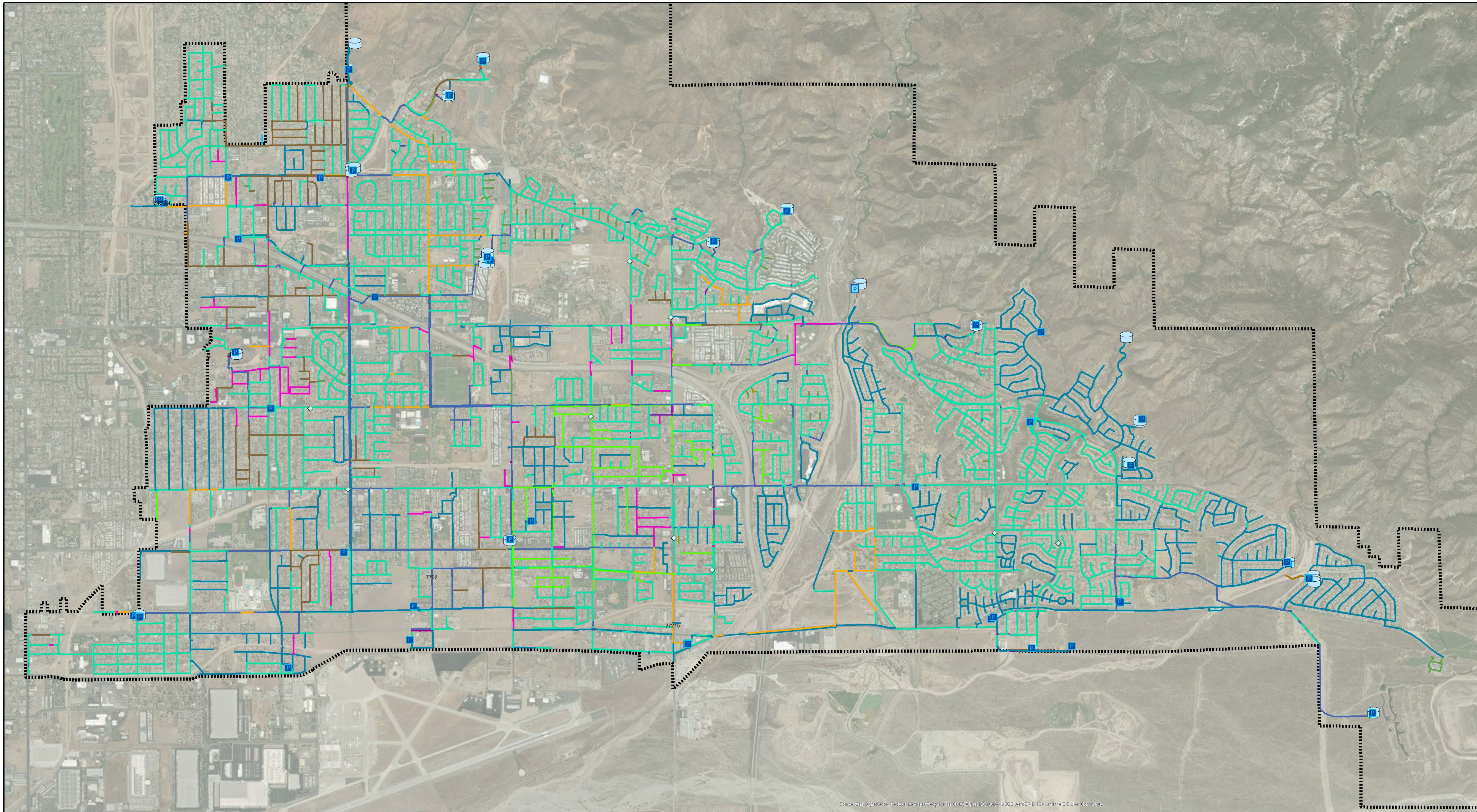
Date: June 1, 2018

Pipeline by Diameter

Stantec

Figure 2-3



Legend

- Pressure Reducing Station
- WTP 134
- Plant
- Tank
- Service Area Boundary

Material

- Asbestos Cement Pipe
- Cast Iron Pipe
- Cement Lined & Wrapped
- Cement Mortar Lined
- Cement lined & coated
- Copper
- Dipped & Wrapped
- Double Dipped & Wrapped
- Ductile Iron Pipe
- Galvanized Iron Pipe
- Polyvinyl Chloride
- Reinforced Concrete Pipe
- Steel
- Unknown

N

0 0.2 0.4 0.8 Miles

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Date: June 1, 2018

Pipeline by Material

Stantec

Figure 2-4

2.7 OTHER FACILITIES AND ASSETS

In addition to the facilities described above, EVWD's system includes many other smaller facilities, including valves, fire hydrants, customer meters, a Supervisory Control and Data Acquisition (SCADA) system to control and monitor system facilities, and a GIS database.

2.7.1 Valves

EVWD's distribution system network includes approximately 8,225 valves, which range in diameter from 1-inch to 36-inches. The distribution of valve diameters is summarized in Table 2-12. About 67 percent of the distribution system valves consist of valves that are 6 or 8 inches in diameter.

Table 2-12: Summary of Valves by Diameter

Diameter (inches)	Total Number of Valves	Percentage of Total Valves
1	311	3.8
1-1/2	1	0.0
2	194	2.4
3	13	0.2
4	703	8.5
4-1/2	6	0.1
5-1/2	1	0.0
6	3,680	44.7
6-5/8	50	0.6
8	1,799	21.9
8-5/8	38	0.5
10	55	0.7
10-3/4	22	0.3
12	750	9.1
12-3/4	73	0.9
14	19	0.2
14-1/2	1	0.0
16	239	2.9
18	3	0.0
20	59	0.7
21-25/32	6	0.1
24	14	0.2
30	9	0.1
36	13	0.2
Unknown	166	2.0
Total	**8,225**	**100**

Source: EVWD GIS data

The 8,225 valves within EVWD's water distribution system can be categorized broadly into eight types. The distribution of valve type within EVWD's system is shown in Table 2-13. Approximately 89 percent of the distribution system valves are gate valves.

Table 2-13: Summary of Valves by Type

Type	Total Number of Valves	Percentage of Total Valves (percent)
Air Vacuum	418	5.1
Butterfly	391	4.8
Check Valve	3	0.0
Control	2	0.0
Curb Stop	4	0.0
Double Detector Check	73	0.9
Gate	7,295	88.7
Pressure Reducing Device	4	0.0
Unknown	35	0.4
Total	**8,225**	**100**

Source: EVWD GIS data

2.7.2 Fire Hydrants

EVWD's distribution system network consists of approximately 3,025 fire hydrants, which range in diameter from 1-inch to 12-inches. The distribution of fire hydrant diameters is summarized in Table 2-14. Roughly 95 percent of the distribution system hydrants have diameters that are either 4 inches or 6 inches.

Table 2-14: Summary of Fire Hydrants by Diameter

Diameter (inches)	Total Number of Hydrants	Percentage of Total Hydrants
1"	7	0.2
2"	76	2.5
4"	483	16.0
6"	2,400	79.3
12"	3	0.1
Unknown	56	1.9
Total	**3,025**	**100**

Source: EVWD's GIS data

Of the 3,025 fire hydrants in EVWD's water distribution system, there are a total of five hydrant types. The distribution of hydrant types is shown in Table 2-15. Approximately 76 percent of the distribution system fire hydrants are pumper hydrants.

Table 2-15: Summary of Fire Hydrants by Type

Type	Total Number of Hydrants	Percentage of Total Hydrants
Standard	183	6.0
Pumper	2,303	76.1
Blow off	456	15.1
Flush out	35	1.2
Standard (2 Outlets)	45	1.5
Unknown	3	0.1
Total	**3,025**	**100**

Source: EVWD's GIS data

2.7.3 Customer Meters

EVWD's distribution system network includes approximately 22,907 customer meters, which range in diameter from 5/8-inches to 10-inches. The distribution of meter diameters is summarized in Table 2-16.

Table 2-16: Summary of Meters by Diameter

Diameter	Total Number of Meters	Percentage of Total Meters
$\frac{5}{8}$"	86	0.4
$\frac{3}{4}$"	19,597	85.6
1"	1,918	8.4
1 $\frac{1}{2}$"	252	1.1
2"	279	1.2
3"	85	0.4
4"	65	0.3
6"	109	0.5
8"	58	0.3
10"	9	0.0
Unknown	449	2.0
Total	**22,907**	**100**

Source: EVWD's GIS data

Of the 22,907 meters in EVWD's water distribution system, there are five unique meter types: domestic, irrigation, commercial, fire, and multi-family. The distribution of meter types is summarized in Table 2-17. Approximately 90 percent of the distribution system meters are domestic meters.

Table 2-17: Summary of Meters by Type

Type	Total Number of Hydrants	Percentage of Total Hydrants
Commercial	799	3.5
Domestic	20,377	89.0
Fire	347	1.5
Irrigation	1,343	5.9
Multi-Family	30	0.1
Unknown	11	0.0
Total	**22,907**	**100**

Source: EVWD's GIS data

2.7.4 Supervisory Control and Data Acquisition System (SCADA)

EVWD has a SCADA system that allows it to remotely monitor and control system facilities within the water system. Much of the SCADA system is approximately 25 years old. SCADA functionality includes monitoring tank levels, well status, booster pump status, treatment units, and meter readings and sounding alarms at some of the facilities. EVWD also has the capability to turn pumps and wells on and off remotely. The current SCADA system has been evaluated and upgraded under a previous Capital Improvement Plan (CIP).

2.7.5 Geographic Information System (GIS)

EVWD maintains geographic information system (GIS) data of its existing facilities. Data are stored as feature classes within a geodatabase, with separate feature classes for facility types. GIS data include laterals, mains, manholes, meters, treatment plants, pumps, pressure regulating stations, and valves. Data for each facility include installation year, material, diameter, etc. as appropriate. Data are updated as old facilities are repaired or replaced and as new facilities are installed. GIS data were used to compile most of the information presented in this section.

3.0 LAND USE, POPULATION, AND WATER DEMANDS

This section describes the existing water demands, population projections, and projected future water demands for EVWD's service area. The future water demands are calculated based on population through year 2040 and EVWD's will-serve list for future developments. System build-out demands are calculated based on land use information obtained from General Plans and water duty factors developed for various land use types. This 2019 WSMP evaluates the existing system under two future scenarios, the near-term scenario and the ultimate build-out scenario. It is noted that for the purposes of projecting demands the year 2025 and 2040 were used for comparison to the near term and build-out conditions. However, the timing of the near-term and build-out scenario are dependent upon growth and may occur before or after these dates. EVWD should monitor growth and development in the system to guide when recommendations made in this 2019 WSMP should be implemented.

3.1 HISTORICAL WATER PRODUCTION AND PEAKING FACTORS

The historical water production for 2009 through 2017 along with the maximum month production (MMP) is presented in Table 3-1. This information was summarized from EVWD's yearly Groundwater Recordation Worksheets, which also lists the amount of surface water produced from Plant 134. The water production numbers represent all water produced from groundwater and surface water sources. The average annual water production in this period is approximately 19,786 acre-feet per year (AFY) with the highest production occurring in 2009 (22,723 AFY) and the lowest production in 2016 (17,164 AFY). The maximum month production (MMP) peaking factors range from 1.31 to 1.48.

Table 3-1: Historical Water Production

Calendar Year	Annual Total (AF)	Average Month (AF)	Maximum Month (AF)	MMP Peaking Factor
2009	22,723	1,894	2,702	1.43
2010	20,663	1,722	2,546	1.48
2011[1]	18,375	1,531	2,253	1.47
2012	21,917	1,826	2,648	1.45
2013	21,493	1,791	2,514	1.40
2014	19,920	1,660	2,277	1.37
2015	17,165	1,430	1,879	1.31
2016	17,164	1,430	2,024	1.42
2017	18,655	1,555	2,173	1.40
Average	19,786	1,649	2,335	1.41
Maximum	22,723	1,894	2,702	1.48

[1] Note: 2011 Production Data from EVWD did not include surface water production.

Average day demand (ADD) is a baseline for computing peaking factors. ADD is computed by dividing the total water produced during the year by 365 days. The max monthly demand (MMD) is a daily amount of water computed by dividing the sum of water produced during the maximum month by the number of days in that month. For example, in

2009, the most water was produced during the month of July (2,702 AF) which has 31 days, for a daily MMD of 2,702 AF / 31 = 87.2 AF = 28.4 MGD. The ADD and MMD from 2009 to 2017 are summarized in Table 3-2.

Table 3-2: Historical Daily Demands

Year	ADD (mgd)	MMD (mgd)	Peaking Factor
2009	20.29	28.40	1.40
2010	18.45	26.76	1.45
2011	16.40	23.68	1.44
2012	19.57	27.84	1.42
2013	19.19	26.43	1.38
2014	17.78	23.93	1.35
2015	15.32	19.75	1.29
2016	15.32	21.27	1.39
2017	16.65	22.84	1.37
Average	17.66	24.54	1.39
Maximum	20.29	28.40	1.45

The maximum day demand (MDD), peaking factor and peak hour demand (PHD) factors are used to scale up the ADD to estimate MDD and PHD, metrics that are used to evaluate the updated hydraulic model. The MDD and PHD are the demand conditions used to size water distribution system pipelines and facilities. Daily production data from 2017 was analyzed to establish a conservative MDD/ADD peaking factor of 1.8, which is consistent with the 2014 WSMP. The PHD factor of 2.72 was established using the MDD factor of 1.8 and applying the diurnal curve for the system. Creation of the diurnal curve is discussed in Section 4.1.11. Table 3-3 summarizes the established demands and peaking factors used for this 2019 WSMP. A value of 20.29 MGD was selected for the existing system water demand based on 10 years of historical data analyzed for the system and represents the maximum yearly demand from that period. This value is higher than the demand EVWD saw in the previous three years but reflects the upward trend in demand over the last few years of record. This is a conservative estimate of existing demands that accounts for changes in efficiency and infill growth that may happen between 2017 and when the recommendations from the 2019 WSMP can be implemented.

Table 3-3: Demands and Peaking Factors

ADD (mgd)	MDD/ADD Peaking Factor	MDD (mgd)	PHD Peaking Factor
20.29	1.8	36.52	2.72

3.2 HISTORICAL WATER CONSUMPTION

Annual historical water consumption information from 2008 to 2017 was provided by EVWD through their billing records. Consumption is defined as all water uses tracked by EVWD and is typically less than the water produced. The difference between historical consumption and production is water losses in the system. Historical water production was used to establish multi-year trends in water consumption, as well as to establish patterns in use over a single year (i.e. MMD, MDD, ADD, and PHD). This information was used in conjunction with the 2014 WSMP, as well as supporting planning documents such as the 2015 San Bernardino Valley Regional Urban Water Management Plan (SBVRUWMP). Annual historical water consumption is summarized in Table 3-4**, and** plotted on Figure 3-1.

Table 3-4: Historical Water Consumption

Year	Water Consumed (acre-feet)
2009[1]	21,100
2010[1]	18,600
2011[2]	18,567
2012[2]	19,562
2013[2]	19,586
2014[3]	19,006
2015[3]	15,459
2016[3]	15,743
2017[3]	16,692

[1] 2014 WSMP, confirmed with billing data
[2] 2015 San Bernardino Valley Regional Urban Water Management Plan
[3] EVWD Metered Consumption Data

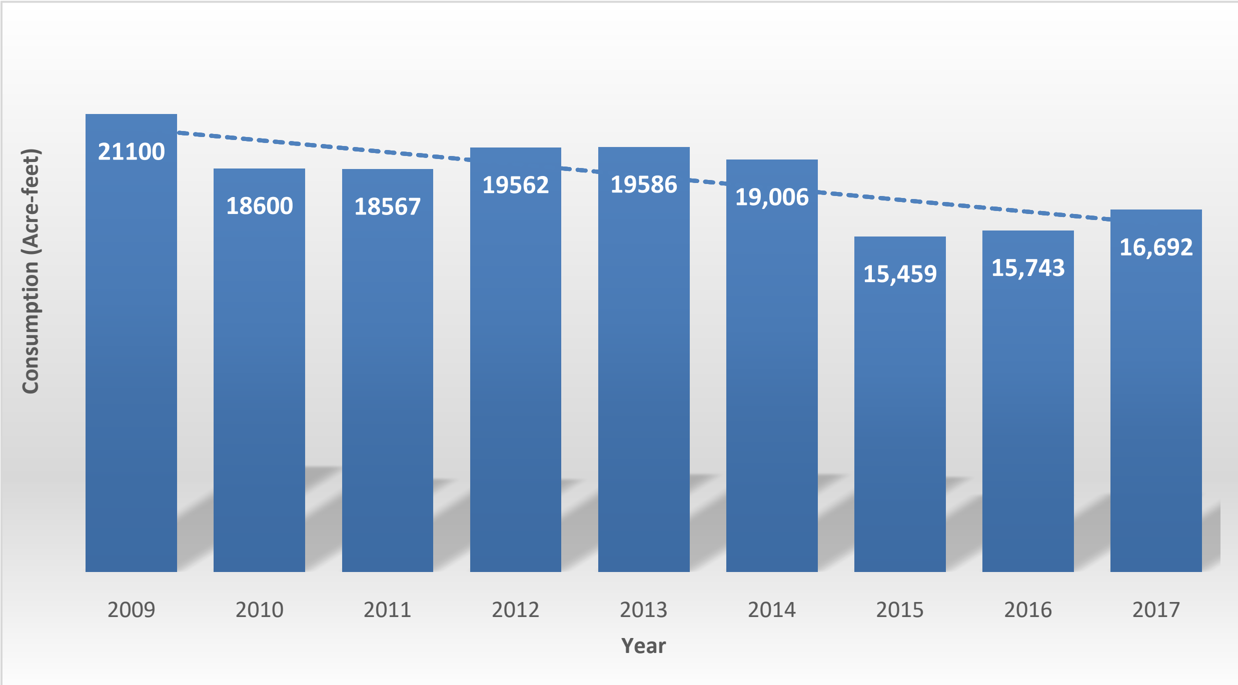


Figure 3-1: Historical Water Consumption

As shown on Figure 3-1, the total average water consumption was greatest in 2009, at 21,100 AF. After 2009, water consumption declined through 2011. Factors contributing to this decrease in demand include the economic downturn associated with the collapse of the housing market. Due to drought conditions and the conservation efforts of EVWD, water consumption also declined from 2012 to a low in 2015 of 15,459 AF. Consumption increased in 2016 and 2017; water demand in 2017 was 16,692 AF. 2017 was the last full year of data available for this 2019 WSMP.

The difference in volumes between water produced and water consumed is defined as “unaccounted-for water”, or the water losses within a system. Unaccounted-for water may be attributed to accounting and metering errors, leaking pipes, unmetered water use, water theft or any other event causing water to be withdrawn and not measured or accounted for in EVWD billing data. Other sources of unaccounted for water include reservoir overflows or leakage as well as hydrant flushing and firefighting. Average percentages of unaccounted-for water per year are shown in Table 3-5.

Table 3-5: Unaccounted-for Water

Year	Water Produced (AF)	Water Consumed (AF)	Unaccounted-For Water (percent)
2009	22,723	21,100	7.1
2010	20,663	18,600	10.0
2012	21,917	19,562	10.7
2013	21,493	19,586	8.9

Year	Water Produced (AF)	Water Consumed (AF)	Unaccounted-For Water (percent)
2014	19,920	19,006	4.6
2015	17,165	15,459	9.9
2016	17,164	15,743	8.3
2017	18,655	16,692	10.5
Average	**18,879**	**17,297**	**8.8**

Note: 2011 Omitted due to lack of surface water production data.

3.3 POPULATION PROJECTIONS FOR EVWD'S SERVICE AREA

Population within EVWD's service area is utilized to analyze existing and future water needs. The population data were obtained from the following sources:

- United States Census Bureau
- Southern California Association of Governments (SCAG)
- California Department of Finance

Details regarding the existing and future population for EVWD's service area are presented in the following paragraphs.

3.3.1 Baseline Population – Year 2010 to 2017

EVWD's service area population was analyzed for the years 2010 through 2017. The population from 2017 is used as the baseline population for the service area, while the historical record is considered to capture patterns in population growth over the last eight years. The 2017 population serves as the basis for the existing scenario, as well as for future water demand projections and the evaluation of water conservation effectiveness. Population within the service area was estimated by analyzing the baseline population established in the 2014 WSMP and applying estimated growth rates for 2010 to 2017 from California Department of Finance, as well as from the SBVRUWMP and Census data.

Population estimates were calculated for each census block located within the service area. For census blocks partially located within the service area, the estimated population was adjusted based on the percentage of the census block area located within the service area. Census blocks were also visually inspected against aerial imagery to validate the adjustments made for blocks that are partially located within the service area. The 2017 population estimate within the service area is 103,249 people. Table 3-6 summarized the calculated population and growth from 2010 through 2017.

Table 3-6: Population from 2010 through 2017

Year	2010	2011	2012	2013	2014	2015	2016	2017
Population	97,001	97,893	98,786	99,678	100,571	101,464	102,356	103,249
Baseline	97,001	97,001	97,001	97,001	97,001	97,001	97,001	97,001
Growth	0	893	1,785	2,678	3,570	4,463	5,355	6,248

3.3.2 Future Population Projections

Population forecasts developed by SCAG form the basis of the projections developed by Stantec for EVWD's service area. Stantec developed population projections for the following four scenarios:

- Scenario 1: Based on SCAG Projections through year 2040 using current population numbers for 2018 and applying projections thereafter.
- Scenario 2: SCAG Projections from 2021 through 2040. No growth in the service area until 2020. This scenario assumes longer recovery from current population levels to those assumed in the SCAG projections but with the same rate of increase.
- Scenario 3: SCAG Projections through year 2040. All major developments are constructed between year 2018 and year 2025. This scenario assumes a greater rate of population increase in the near-term based on the assumption that will serve development will occur within seven years, and subsequent growth will occur at the rate assumed in the SCAG projections
- Scenario 4: SCAG Projections through year 2040. All major developments are constructed between year 2025 and year 2040. This assumes that the growth from known developments occur between 2025 and 2040, and the rate of growth until 2025 occurs at the rate assumed in the SCAG projections

Scenarios 3 and 4 assume that growth associated with the major developments are not included in the SCAG projections. Figure 3-2 shows the population projections for these scenarios.

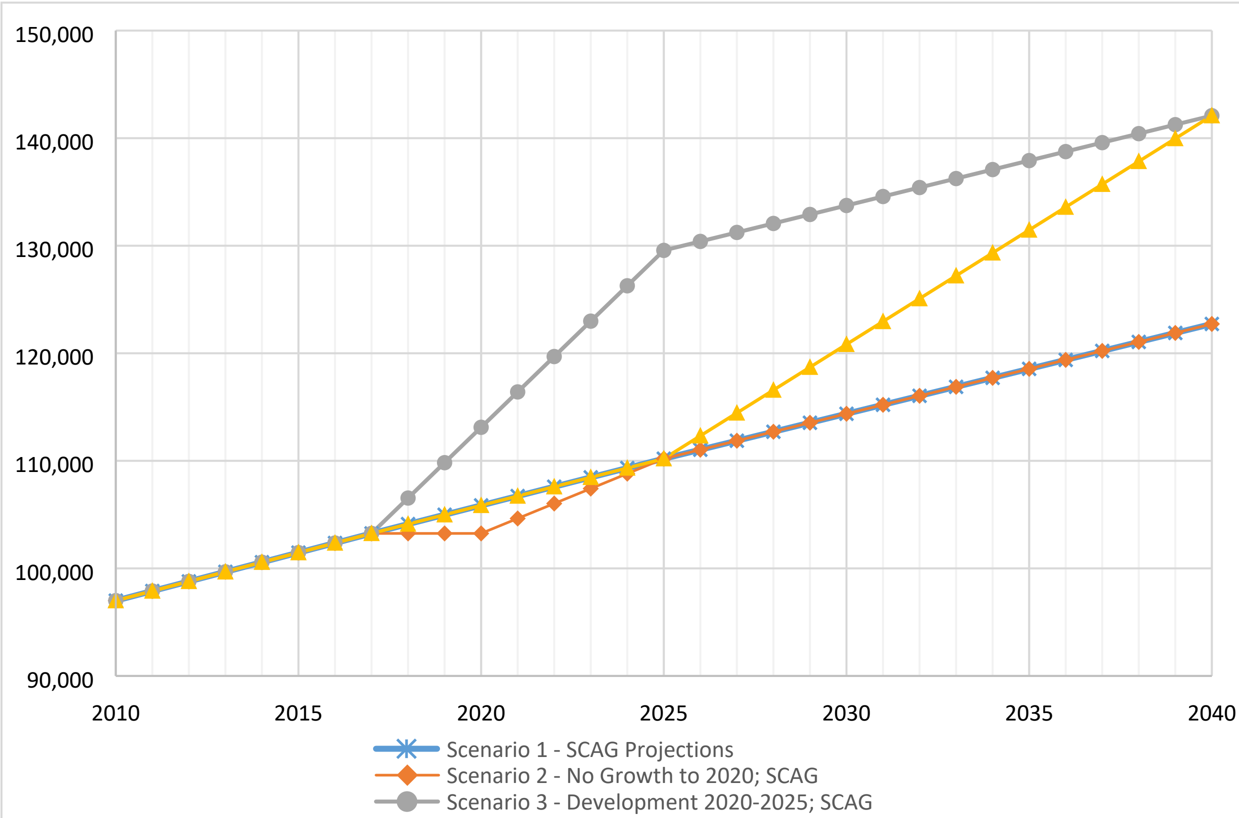


Figure 3-2: Population Projections for EVWD's Service Area

The projections range from approximately 123,000 people by year 2040 in Scenarios 1 and 2 to approximately 142,000 people by year 2040 in Scenarios 3 and 4. Scenarios 1 and 2 represent a 19 percent increase in population from the year 2017. Scenarios 3 and 4 represent a 37 percent increase from the year 2017. Populations for Scenarios 3 and 4 are different from Scenarios 1 and 2 as they include major proposed developments (summarized in Table 3-7). It cannot be verified whether populations for these developments are captured in the population projections developed by SCAG, which is why they have been added to scenarios 3 and 4 as a conservative estimate.

Table 3-7 shows major developments anticipated for the EVWD service area. The projected populations from these developments at build-out were taken from supporting information provided by EVWD. For this 2019 WSMP, known developments reflected in the EVWD will serve list are assumed to be built in the near-term scenario. In order to compare demands and population of the near-term scenario with other planning documents, it was assumed that the near-term demands could happen as soon as 2025. However, near-term demands may occur later than 2025 and as such no specific year is attributed to the near-term scenario in the 2019 WSMP. Figure 3-2 shows the population change if the will serve developments were to occur by 2025.

Table 3-7: Major Future Developments

Development	Population Projections at Build-out	Percent of Total
Harmony	11,986	62
Greenspot Village and Marketplace	2,640	14
Highland Hills Ranch	2,145	11
Sunland Communities	1,980	10
Arnott Ranch	248	1
Centerstone	195	1
Total	**19,194**	**100**

A comparison between the Scenario 3 population estimates developed by Stantec and the population estimates presented in the 2015 SBVRUWMP are summarized in Table 3-8. The final population projections for the EVWD service area are slightly less than those presented in the SBVRUWMP, which is reflective of the growth that has occurred since that document was created and the updated data available to Stantec for this analysis.

Table 3-8: Population Estimate Comparisons

	2020	2025	2030	2035	2040
Stantec Estimate – Scenario 3	105,855	129,391	133,567	137,742	141,918
2015 SBVRUWMP Estimate	124,062	130,391	135,690	141,205	146,945

3.3.3 Existing Per Capita Water Use

Average per capita water use has generally decreased in the service area over the past 10 years, due to the economic downturn, drought conditions, and EVWD conservation programs. The average water production from 2013 to 2017 divided by the 2017 baseline estimated population yields an average demand of 163 gallons per capita per day. To avoid using a year with lower than normal water production, a variety of years and sources were analyzed. According to the 2015 SBVRUWMP, EVWD has met both its 2015 and 2020 compliance targets. Even if per capita demand increases from the recent low totals, it is expected to stay within the 2020 compliance target of 175 gallons per capita per day. This information is summarized Table 3-9.

Table 3-9: Per Capita Demand

Criteria	Gallons Per Capita per Day
2004-2008 (5-year UWMP baseline)[1]	209
2015 UWMP compliance target[1]	195
2015 actual demand[1]	145
2020 UWMP compliance target[1]	175
2009-2012 average demand[2]	197
2013-2017 average demand	163
Estimated Existing and Future Per Capita Demand	**175**

[1] Source: 2015 SBVRUWMP
[2] Source: 2014 WSMP

3.3.4 Future Per Capita Water Use due to Conservation Update

Per capita water use for future customers presented in the 2014 WSMP was reviewed and updated for this 2019 WSMP. In the previous analysis, per capita water use for residential customers was estimated to be 130 gallons per capita per day (gpcd) while per capita water use for commercial, industrial, and institutional customers was estimated to be 42 gpcd, for a total per capita use of 172 gpcd. Table 3-10 presents the updated estimates per capita water use for residential customers was estimated to be 129 gpcd while per capita water use for commercial, industrial, and institutional customers was estimated to be 40 gpcd, for a total per capita use of 168 gpcd.

The future per capita water use of 168 gpcd represents 3 percent increase from the 2013-2017 average demand per capita water use of 163 gpcd, and 15 percent conservation from the 2009-2012 average demand per capita water usage. It also represents a 2.3 percent decrease in the anticipated demand for future customers and reflects an overall gain in conservation for EVWD since the 2014 WSMP. The estimates for future per capita use are consistent with Method 2 for calculating Compliance Water Use Targets published in the guidebook for the 2015 UWMP.

Table 3-10: Future Per Capita Use for EVWD Service Area

No.	Parameter	Value
Per Capita Water Use for Residential Customers		
A	Average Lot Size for Single Family Residences for EVWD's Service Area	10,000 square feet
B	Assumed Average Irrigated Area	50 percent
C	Estimated Irrigated Area (A x B)	5,000 square feet
D	ETo (based on California Irrigation Management Information System data)	55.6 inches
E	Plant Factor (based on the Highland Landscape ordinance for a mix of turf and low to moderate water using plants)	0.7
F	Estimated Water Use (C x D x E x 0.62 x 7.48/0.8)	94,015 gallons
G	Persons per dwelling unit (Estimates for the City of Highland)	3.48
H	Per Capita Water Use (F/365/G)	74 gpcd
I	Indoor Water Use (Target Indoor Water Use per Method 2 of the UWMP)	55 gpcd
J	**Total Residential Water Use (H+I)**	**129 gpcd**
Per Capita Water Use for Commercial, Industrial, and Institutional Customers		
K	2009-2012 Average Commercial Industrial and Institutional (CII) Water Use	4,532,540 gpd
L	2010 or Baseline Population	103,249
M	CII Water Use (K/L)	43.9 gpcd
N	10 percent savings on CII Water Use (0.1 x M) (per Method 2 of the UWMP)	4.39 gpcd
O	**Total Commercial, Industrial, and Institutional Water Use (M - N)**	**40 gpcd**
P	**Per Capita Water Use for Future Customers**	**168 gpcd**

3.4 DEMAND PROJECTIONS FOR EVWD'S SERVICE AREA (POPULATION METHODOLOGY)

Future water requirements for EVWD's service area are estimated as the product of the population estimates, and the per capita water use discussed earlier in this section. Per capita water use for existing and future customers is assumed to be 175 gpcd as a conservative estimate, based on the analysis in Table 3-10 and conversations with EVWD staff. Demands based on population for EVWD's service area are presented on Figure 3-3.

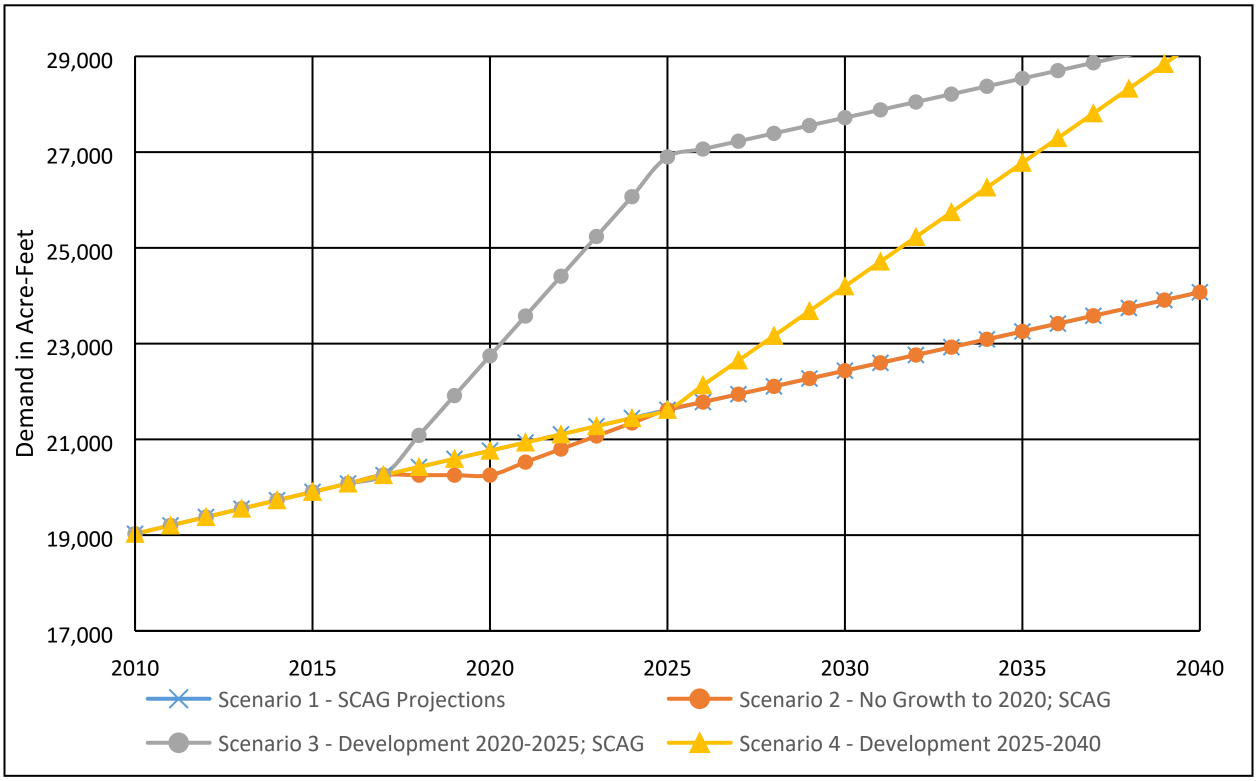


Figure 3-3: Water Demand Projections for EVWD's Service Area (Population-based)

Demands for Scenarios 3 and 4 differ from Scenarios 1 and 2 as they include the proposed developments summarized in Table 3-11 and assumes these developments occur prior to 2025. After discussion with EVWD staff, the demand projections shown in Table 3-11 were used to project demand for will serve developments assumed to occur in the near-term scenario, while the land-use based method presented in the following subsection was used to project overall demand in the build-out scenario.

Table 3-11: Demand Estimates for Proposed Developments

Development	Demand (AFY)
Harmony	3,168
San Manuel Hotel Casino Expansion	1,049
Greenspot Village and Marketplace	405
Highland Hills Ranch	310
Sunland communities	286
Arnott	36
Centerstone	28
Total	**5,284**

3.5 WATER DEMAND PROJECTIONS – LAND USE METHODOLOGY

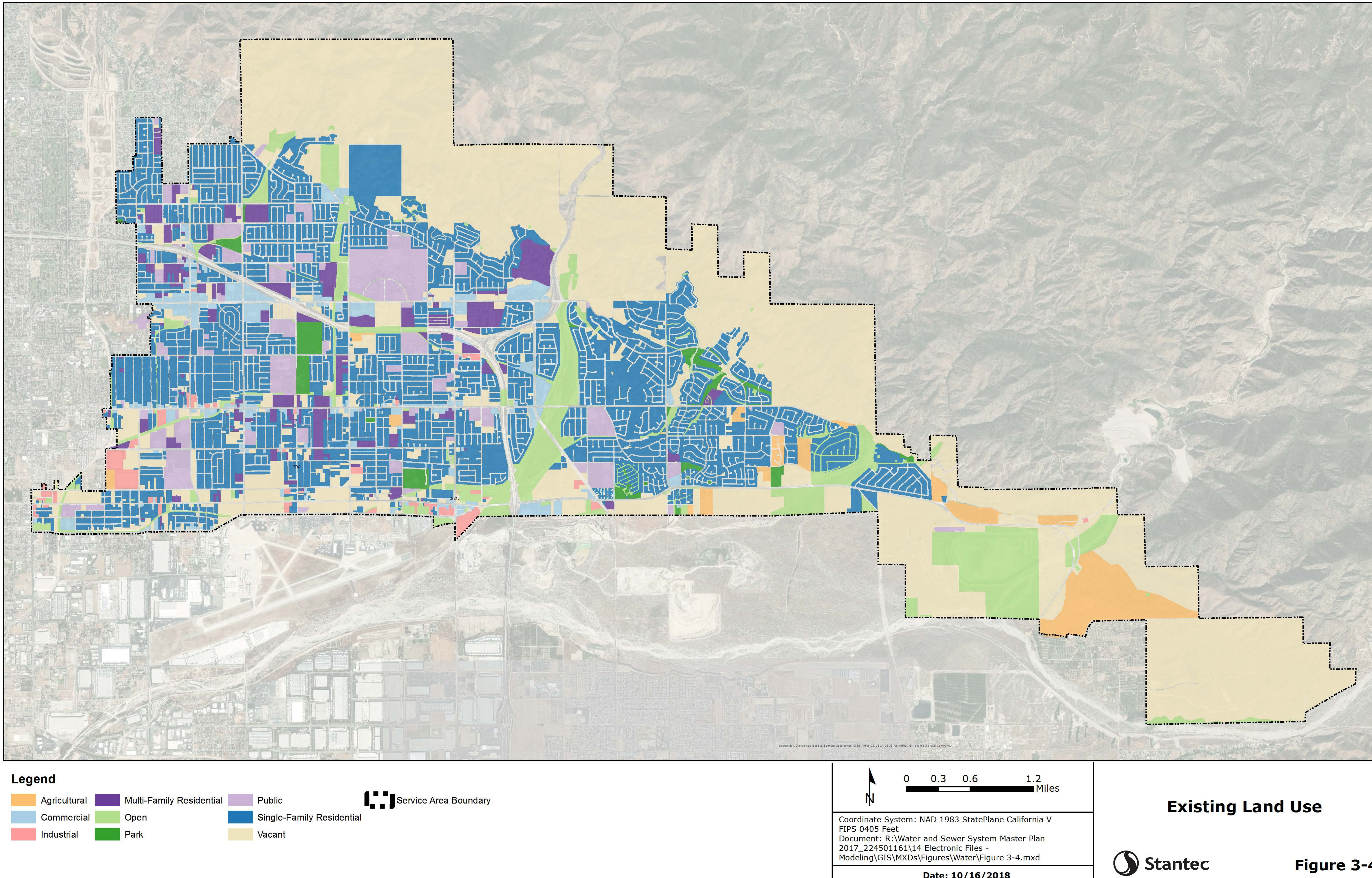
Existing and future production requirements for EVWD's service area were estimated based on development projections, land use classifications, and water duty factors. A water duty factor is the average water use of a given land use type (in gallons per day per acre). Establishing water duty factors for EVWD's service area requires consumption data within the system, locations of water meters, and existing and future land use designations. The development of water duty factors using GIS (Geographic Information System) software is presented in the following paragraphs.

3.5.1 Assigning Average Demand and Land Use Types

Water consumption data and the spatial location of water meters in the system was used for establishing existing water duty factors. By analyzing EVWD's geocoded GIS water meter information, a link between the spatial location of the meters and the water consumption billing data was established. Water meters for which billing data exists were located by matching the billing addresses to existing geo-located meters. The largest remaining consumptive meters were manually located. A three-year average (2015-2017) demand was developed for these meters, and any meter that was inactive for the final two months of 2017 was assumed to be inactive. Existing Land Use and General Plan Land Use shapefiles were obtained from the SCAG website. Based on their spatial locations within the service area, a land use type was assigned for each meter and current land use designations were assigned to all parcels within EVWD's service area. The resulting current land use is shown in shown on Figure 3-4. The General Plan Land Use was used to establish a future land use designation for all parcels, as shown on Figure 3-5. Table 3-12 tabulates the existing and future land use classifications within the service area.

Table 3-12: Land Use Classifications and Acreage

Land Use	Current Area (Acres)	Percent of Total (%)	Future Planned Area (Acres)	Percent of Total (%)
Agricultural	536	3	0	0
Commercial	481	3	990	6
Industrial	154	1	163	1
Multi-Family Residential	618	4	1,543	9
Open Land	1,558	9	1,031	6
Parks	212	1	173	1
Public	825	5	749	4
Single-Family Residential	5,004	30	8,136	48
Vacant	7,490	44	4,093	24
Total (MGD)	**16,878**	**100**	**16,878**	**100**



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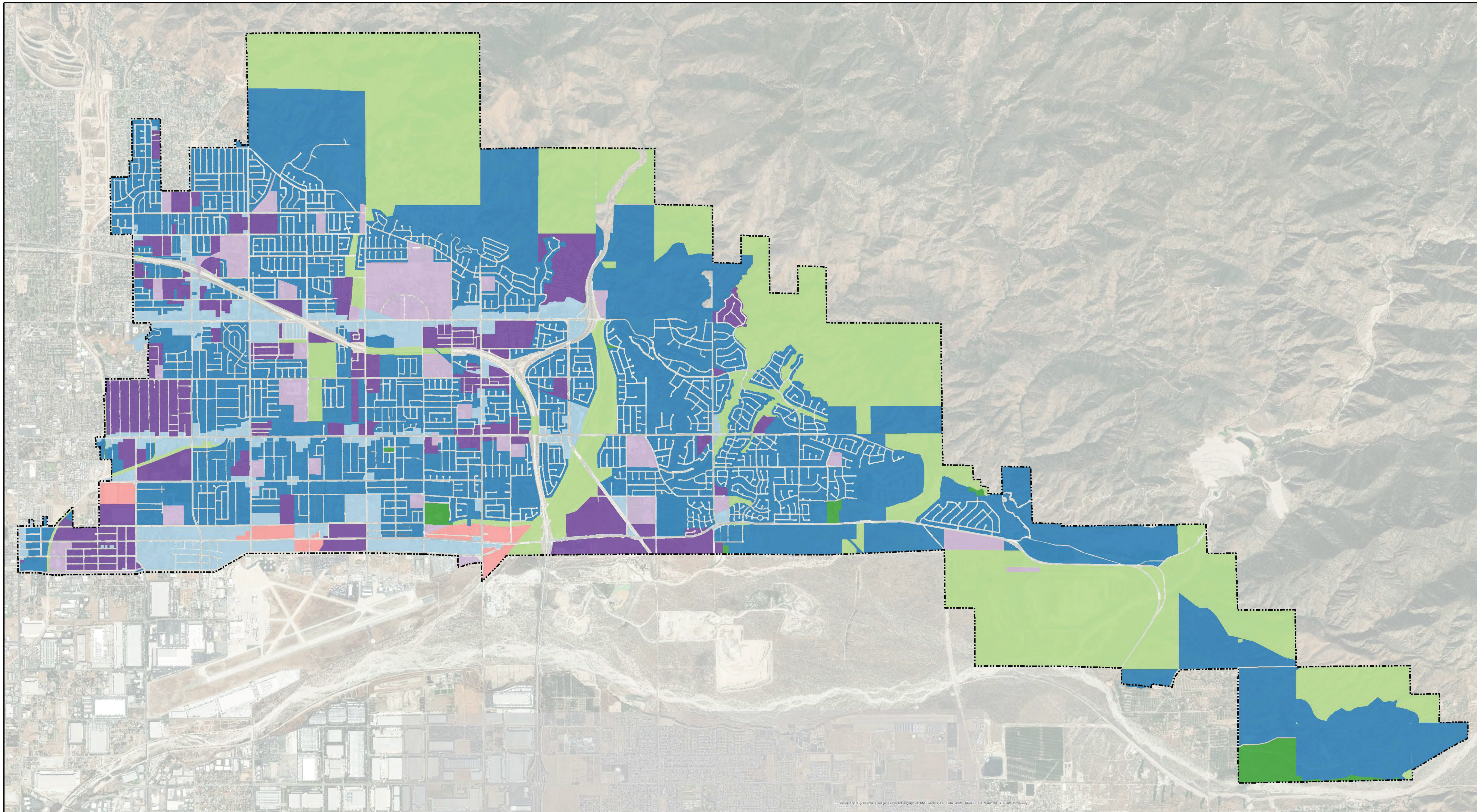
Date: 10/16/2018

Existing Land Use

Stantec

Figure 3-4



Legend

- Commercial
- Industrial
- Multi-Family Residential
- Open
- Park
- Public
- Single-Family Residential
- Service Area Boundary

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: R:\Water and Sewer System Master Plan 2017_224501161\14 Electronic Files - Modeling\GIS\MXDs\Figures\Water\Figure 3-5.mxd

Date: 10/16/2018

Future Land Use

Stantec

Figure 3-5

3.5.2 Water Duty Factors

After designating land use types for every parcel, the meters with consumption data were overlaid on the parcels to associate consumption with the land use types and the acreage of each parcel. Due to irregularities in digitization, there are locations where meters do not directly overlap with parcels. While these meters are carefully reviewed and some of these meters are attributed to the correct parcel, some of these meters are also omitted from the analysis in order to not skew the water duty factors with erroneous data. Parcels removed from the analysis are not thought to have a significant effect as these are generalized factors to be applied to the system as whole. Since water duty factors are only calculated for those parcels that have an overlying meter, the omission of a few meters and parcels has negligible impact on the water duty factors.

A water duty factor for each land use type is calculated by dividing the three-year average demand for each meter overlying a parcel (from 2015-2017) in gallons per day (gpd) by the area (in acres) of the parcel it serves. These values are then averaged by land use type and rounded to get a generalized value. Aerial photography is reviewed to ensure that vacant parcels are omitted, and to verify land use for larger parcels.

Table 3-13 presents the water duty factors for the different land use types based on consumption. The product of the water duty factor expressed in gpd per acre and the corresponding area of the parcel in acres represents the total demand for EVWD's service area.

Table 3-13: Calculated Water Duty Factors

	Consumption 2015-2017 (acre feet)	Current land use (acres)	2015-2017 factor [1] (gpd/acre)
Agricultural	7,183	536	**1,000**
Commercial	969,571	481	**2,000**
Industrial	101,631	154	**800**
Multi-Family Residential	2,105,543	618	**3,500**
Open Land	158,604	1,558	**1,000**
Parks	411,592	212	**3,000**
Public	1,216,046	825	**3,000**
Single-Family Residential	9,521,113	5,004	**2,000**
Vacant	167,481	7,490	**0**

(1) Water duty factors are been rounded to nearest hundred

The factors presented in Table 3-13 were used as a starting off point for assigning demands in the model and were subsequently adjusted based on calibration results.

3.5.3 Build-out Water Demand Projections – Land Use Methodology

Using the water duty factors described previously in this section, build-out water demand projections are estimated based on General Plan Land Use designations obtained from San Bernardino Associated Governments (SANBAG).

Build-out demands for parcels that are currently occupied are estimated using the existing duty factor estimated for the land use types.

This analysis yielded a 2040 demand of 27.69 MGD, which was significantly higher than the total calculated based on population. Given the more detailed methodology of projecting demand through land use and considering the projections from the 2014 WSMP and the trends in the historical data, the value of 27.69 MGD was used for the 2040 scenario in the model.

3.6 MODELED DEMANDS

3.6.1 Near-Term Planning Scenario

The near-term planning horizon accounts for the specific growth in the system based on the will serve list and developments such as the Casino expansion and the Harmony Development. For this scenario, the demand from the specific developments was assigned to the model based on provided information. For developments that did not have a demand calculated, demand was estimated by using average persons per household data from the US Census, and the 175 gpcd compliance target from the RUWMP. The specific developments from the will serve list accounted for an additional ADD of 5.05 MGD, which was added to the existing demand of 20.29 MGD for a total near-term demand of 25.34 MGD.

3.6.2 Build-out Planning Scenario

Build-out demand for the model was analyzed by looking at both population and land use projections. Population estimates were taken from SANBAG information and US Census data. The 2040 population was estimated to be 122,802, which was used to define the Build-out scenario. It is noted that the recommendations for this scenario should be implemented based on development trends and not based on year.

A per capita usage of 175 gpcd was then applied to this population estimate which yielded a total demand of 21.49 MGD. The 175 gpcd value was based on the RUWMP compliance target for EVWD and agrees with the value used in the 2014 WSMP. Based on historical data for EVWD, the current per capita usage averaged 163 gpcd over the last three years, however the 175 gpcd accounts for changes in efficiency that may occur in the future and is reflective of a realistic long-term goal for per capita usage as presented in the SBVRUWMP

Results for the population and land-use base methods for projecting future demand are presented in Table 3-14. This table presents demands in million gallons per day, and presents final demands used for the hydraulic model. Hydraulic model demands account for the demands calculated by both the population and land-use based methodologies, as well as accounting for non-revenue water and specific demands for major developments. Near-term projections for demand exceed the projections for 2025 shown in Table 3-14 as it was assumed major will serve developments would be built prior to the near-term planning year, although the full growth associated with these developments may happen later. For the purposes of comparison, 2025 was used to assess the projections of the near-term scenario, but the near-term demand is dependent upon the progression of development and not connected to a specific year. Build-out growth is consistent with the land use-based methodology.

Table 3-14: Demand Projection Comparisons (MGD)

Demand Source	2018	2020	2025	2040
2015 SBVRUWMP Subtotal	-	22.24	23.37	26.34
Population based demand (using UWMP compliance target for per capita usage)	18.07	18.45	19.33	21.49
Land Use Based	18.58	19.41	21.48	27.69
Model Scenarios	**Existing**		**Near-Term**	**Build-out**
Demand in Model (ADD)	**20.29**	**-**	**25.34**	**27.69**
Demand in Model (MDD)	**36.52**		**45.62**	**49.84**

Note: Total demands for the near-term and build-out scenario were compared to 2025 and 2040, respectively, however the timing of recommendations made for these scenarios are based on development drivers and may be needed earlier or later.

3.7 RECOMMENDATIONS

The effects of the recession on future growth were significant, and the future economic conditions for the service area cannot fully be anticipated. While economic factors may slow growth in the short-term, it is likely that growth will resume and steadily continue within the service area during the planning horizons of this 2019 WSMP. This is also indicated by the resumption in development activity within EVWD's service area with proposed developments such as the Harmony Development. To be conservative for the purposes of planning, it is recommended the most aggressive growth projection for year 2040 (Scenarios 3) be utilized for the purposes of sizing infrastructure to serve future growth and was used to develop the build-out demand projections for this 2019 WSMP. Infrastructure recommendations contingent upon a major development or based upon these growth assumptions should be reevaluated before construction to confirm the necessity of the project and the accuracy of the demand projections against field data.

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4.0 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

This section describes the processes used to update and calibrate the hydraulic model of EVWD's water system. The existing model was updated to include changes in EVWD's GIS, ground elevations for new elements, the allocation of water demands, and modifications to represent current operational controls. This section concludes with a discussion of the model calibration process that is performed to verify the model results with field measurements. Model calibration was performed in two phases: steady-state (SS) and extended period simulation (EPS) calibration. In preparation for the steady-state calibration, ten hydrant test locations were identified throughout the system and plotted on a map. This along with guidance on the fire hydrant testing procedures, equipment list, and data collection form was presented to EVWD to perform the hydrant testing. The calibrated model will be used to evaluate the existing system under existing demand conditions and future demand conditions.

4.1 HYDRAULIC MODEL DEVELOPMENT

EVWD has an existing hydraulic model of the water system that was developed in 2014 as part of the 2014 WSMP using Innovyze's InfoWater software, which is based on ESRI's ArcGIS platform. The existing system model was updated by identifying new or abandoned elements as compared to the latest ArcGIS geodatabase provided by EVWD. Pipes, along with their connection junctions, identified as new, with a major alignment change, or hydraulically significant were included as part of the model update.

The updated hydraulic model contains pipelines as discussed above and facilities (booster pumps, storage tanks, wells, and pressure reducing valves) currently in the ArcGIS geodatabase provided by EVWD. The model was also updated to reflect the current system SCADA operation logic and settings for all facilities (booster pumps, storage tanks, wells, and pressure reducing valves) as provided by EVWD. Existing water system facilities are shown on Figure 4-1.

4.1.1 Data Collection

Data used for the development of the hydraulic model is obtained from a variety of sources. Key information includes:

- GIS geodatabase of all water mains, fittings, valves, fire hydrants, laterals, and water facilities
- Hydraulic water system schematic
- Pump curves and performance tests for wells and booster pumps
- Pump controls and settings of pressure regulating valves
- Water production records (2015-2017)
- Customer usage records (2015-2017)
- Supervisory Control and Data Acquisition (SCADA) data
- General Plan and land-use information
- Ground elevation contour lines
- Street centerline data
- Aerial photography coverage
- Dimensions for new storage reservoirs

4.1.2 Pipelines

Pipelines in the existing hydraulic model were compared with the corresponding elements in the wMain pipeline feature class—pipes that are new, abandoned, had significant alignment change, or are hydraulically significant were identified. The hydraulic model was updated accordingly by importing new pipes and removing abandoned ones. Since EVWD does not maintain a feature class for facility piping (internal pipes associated with facilities), pipes for any new facilities were drawn manually to establish connectivity of these facilities with the system.

Model attributes for pipelines include the pipe ID, pipeline length, diameter, material, roughness, and pressure zone. The pipe roughness remained unchanged from the 2014 WSMP, which was based on the age and material, as shown in Table 4-1. Pipelines color-coded by diameter and material are shown on Figure 4-2 and Figure 4-3, respectively.

Table 4-1: Pipe Roughness

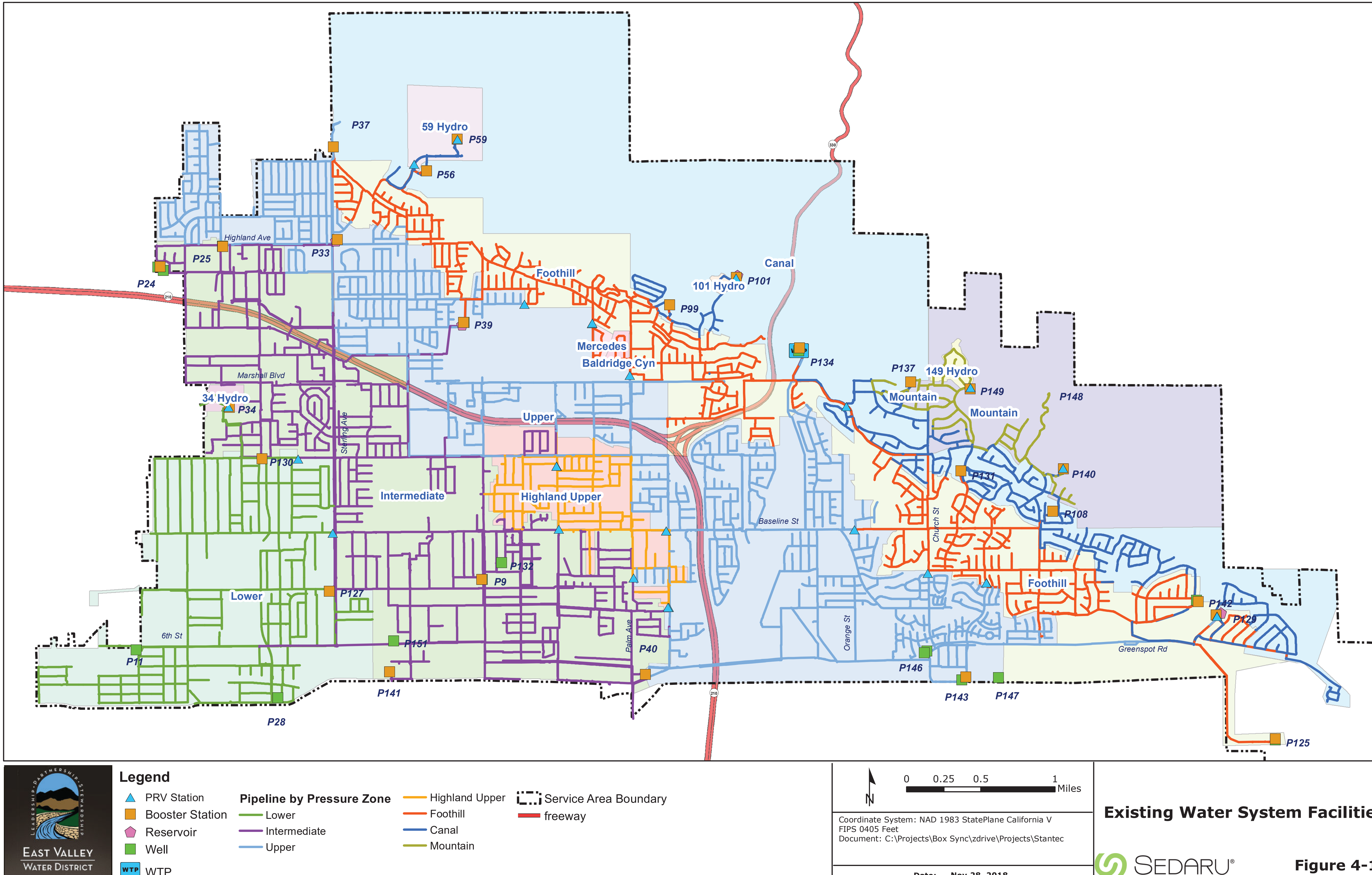
Material	Hazen Williams C-Factor
Asbestos Cement	130
Cement Mortar Line Steel	125
Cast Iron	64
Dipped and Wrapped Steel	100
Ductile Iron	130
Copper	125
PVC	140
Steel	135
Unknown	100

4.1.3 Valves and Junctions

Junctions are defined as the intersections of two or more pipelines, at the location where any pipeline changes diameter or material and represents fittings such as bends, crosses, tees, reducers, caps, etc. Fittings, as provided in the wFitting feature class, that split pipe were modeled as junctions. Fire hydrants are modeled as junctions, and the fire flow demands are recorded in the model at these junctions. Attribute data populated for junctions include elevation, demand, and pressure zone.

Valves are usually modeled as junctions, except for control valves and closed zone isolation valves, which are modeled as valves. Modeling pressure regulating valves (PRVs) requires two attributes, which are valve diameter and valve setting. During the model update, one pressure reducing station (PRS_317) was identified as abandoned, no new control valves were added, and control valve settings were updated as provided by EVWD.

Zone isolation valves are modeled where the geodatabase indicates the presence of normally closed valves. The zone isolation valves are modeled as flow control valves with an initial status set to “CLOSED.”



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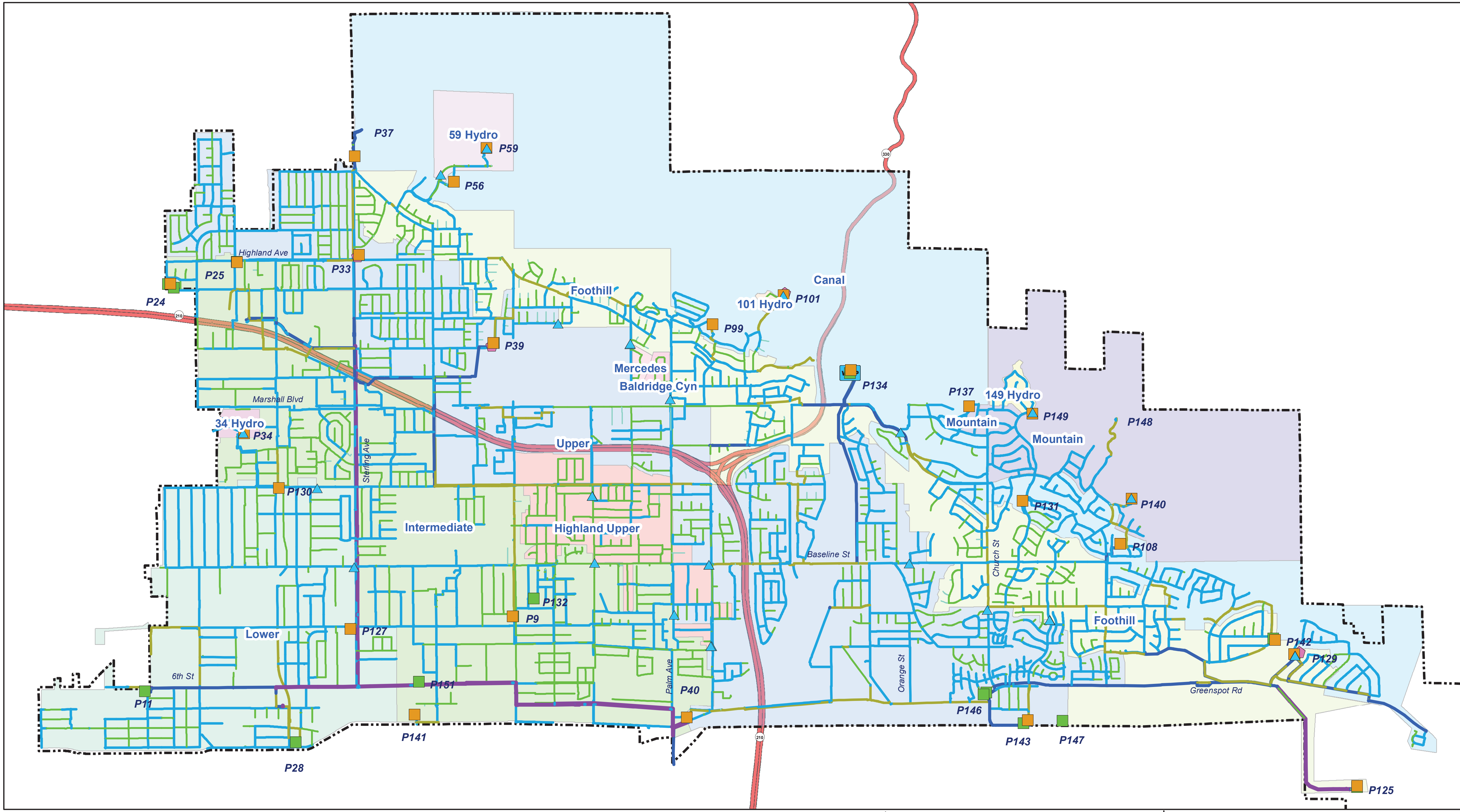
Existing Water System Facilities

SEDARU®

Figure 4-1



Legend

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

Pipeline by Diameter

- < 4 inch (165)
- 4 - 7 inch (4,786)
- 8 - 13 inch (8,620)
- 14 - 18 inch (1,183)
- 20 - 24 inch (438)
- > 24 inch (153)

- Service Area Boundary
- freeway

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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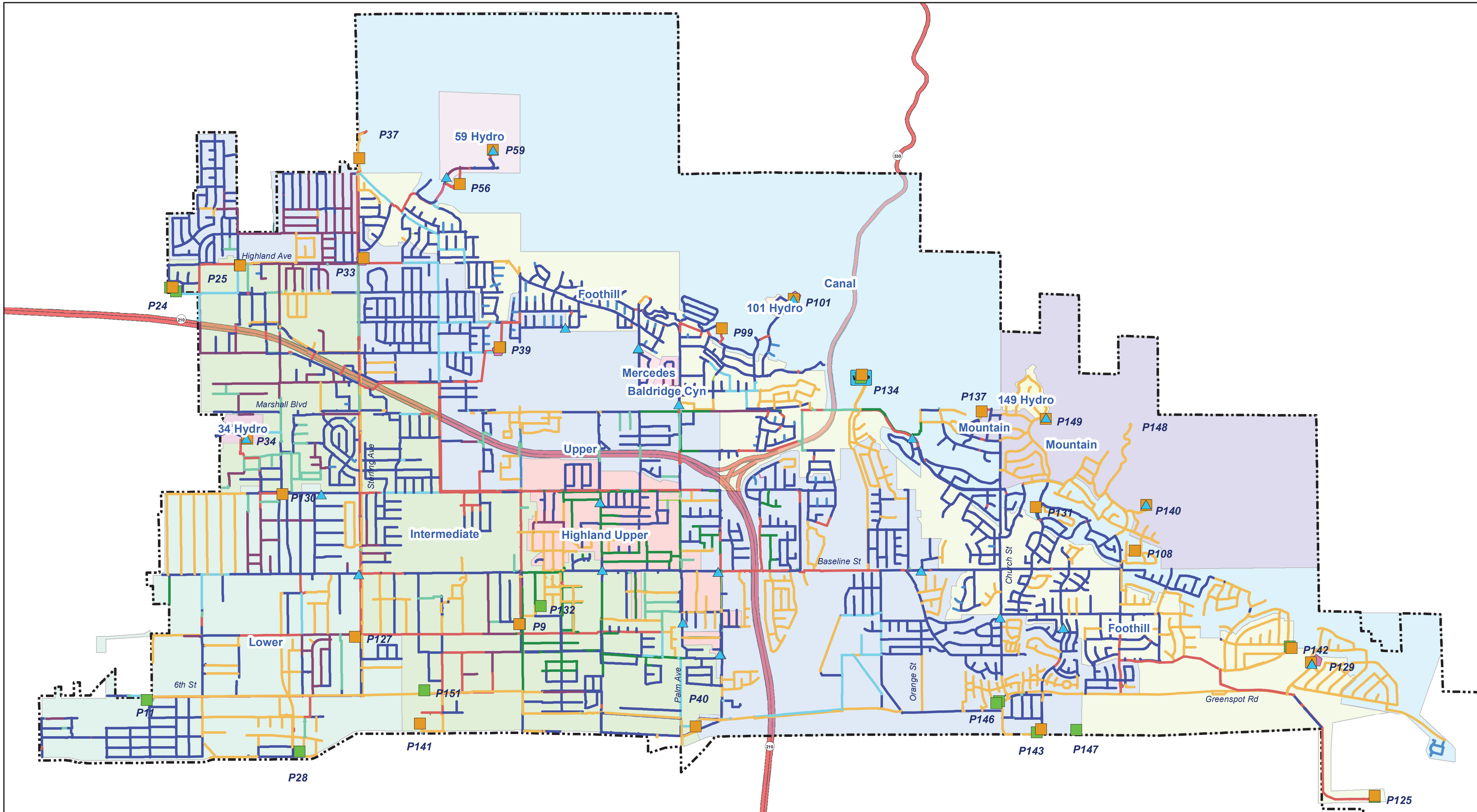
East Valley Water District

SEDARU

Pipelines by Diameter

Figure 4-2



East Valley Water District

Legend

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

Pipeline by Material

- ACP (6,891)
- CIP (25)
- CL&C (1,288)
- CL&W (317)
- CML (102)
- COP (81)
- D&W (507)
- DD&W (551)
- DIP (4,510)
- PVC (201)
- STL (679)
- UNK (78)
- ABS (1); CLB (7); DI (1); GIP (4); TRANS (2) (15)
- Service Area Boundary
- freeway

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Nov 28, 2018

Pipelines by Material

SEDARU®

Figure 4-3

4.1.4 Storage Tanks

Storage tanks are modeled as cylindrical tanks. The legacy model contains all existing tanks and relevant attributes associated with each tank, such as elevation, diameter, tank height, and installation year. During the model update, only one new tank was added to the system, which is associated with Plant 143. For model calibration, the initial water level of each tank is set to the recorded water depth. The initial water level represents the water depth at the beginning of a hydraulic simulation (midnight).

Hydropneumatic tanks are also included in the model. These were modeled as elevated tanks, with initial and maximum elevations inferred from SCADA pressure readings at the downstream side of each facility. Pressures experienced in a hydro-pneumatic zone can be satisfactorily simulated by using this modeling technique.

4.1.5 Pumps and Wells

During the model update, new pumps at Plant 40 and Plant 134 were added to the system and Plant 12 was abandoned. Per EVWD, well 9 was modeled as inactive in the existing scenario based on EVWD feedback that it is currently out of service but retained in the model so it can be turned on in later planning horizons. Some adjacent wells cannot be operated simultaneously and include Wells 24A and 24B and Wells 146 and 146A. Several updated pump tests were performed since the 2014 WSMP, and the model was updated to reflect the new reported design points.

Well pumps were modeled as flow control valves, which eliminates the impact of the seasonal variation of groundwater elevations on well-pumping rates. This will result in simulated flows from the wells that are closely matching observed flows and will help reduce inaccuracies in the model calibration

4.1.6 Surface Water Treatment Plant

The surface water treatment facility at Plant 134 is modeled with its associated booster pumps and tank supplying the Upper, Foothill, and Canal zones. The treatment facility is modeled as a fixed head reservoir connected to a flow control valve ensuring a steady flow of water into the system. The flow from the plant is adjusted based on the average flow observed for each calibration period. Per EVWD, Plant 134 has a limited capacity due to process limitations and can only produce 5.2 MGD for an extended period instead of its rated capacity of 8.0 MGD. For the evaluations, it was assumed EVWD would use the full 8.0 MGD during MDD as this would only be for a few days at most. In addition, it was assumed that process issues would be addressed in the near-term. The model was updated to include the three pumps that were added to Plant 134 since the 2014 WSMP.

4.1.7 Facility Nomenclature

The identification scheme used in the existing system model is based on the type of facility. Tanks begin with the letter “T”, booster pumps with the letter “PMP”, well pumps with the letters “WELL”, and pressure reducing stations with the letters “PRS”. This prefix is followed by the number of the plant and lastly a sequential number if there are multiple facilities at the site. For example, T_134 is the tank at Plant 134 while PMP_134_4 is pump number 4 at the same plant. This nomenclature makes model navigation easier for the user.

4.1.8 Facility Elevation Data

Elevations for new facilities added to the model are derived from contour data (one-foot intervals) provided by EVWD. Using the contour data, ground elevations are extracted and assigned to all junctions and facilities (except for storage reservoirs) in the model. Elevations for storage reservoirs are assigned based on information contained in the drawings provided by EVWD.

4.1.9 Geocoding

The process of geographically locating each billing record is known as geocoding. The billing data received from EVWD was spatially located in a GIS geodatabase, where each meter is located at the centroid of the parcel. The billing data and meter layer were used to allocate demand to the model which was then scaled up to account for the water losses in the system.

Billing data at meter locations are allocated to “demand” junctions based on proximity. The updated system model is comprised of nearly 21,000 pipelines and 19,900 junctions. To incorporate the demands into the hydraulic model, demand nodes are selected that represent a small area of multiple accounts. Meters were associated with demand junctions based on pressure zone boundaries and proximity. Junctions associated with water facilities or transmission pipes were excluded from the demand allocation process, except when a lateral connects a water meter with such pipes. The wLateral layer was also used at pressure zone boundary locations or where there were parallel pipes to correctly assign billing data to the correct water main.

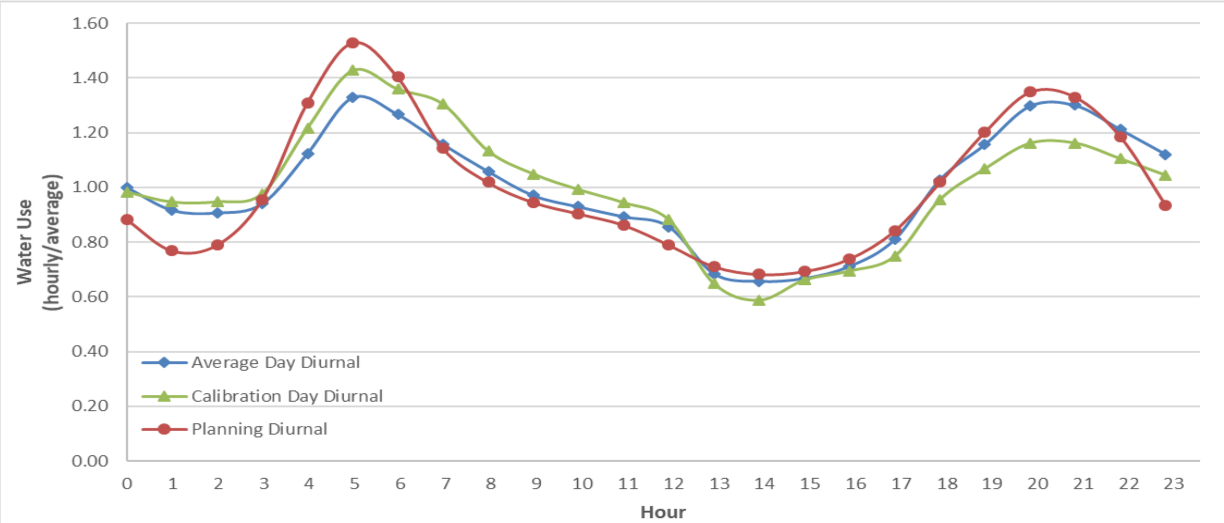
Future demands are allocated geographically based on the location of vacant parcels in the existing land use GIS coverage. Information regarding the locations of proposed developments (described in Section 3) is considered. The total demand for each parcel (or group of parcels) is calculated based on the size of the parcel, future land use classification, and the water duty factor. Once the future demands are determined, the demands are assigned to the closest existing demand node in the hydraulic model.

4.1.10 Diurnal Curve

A diurnal curve represents the average hourly demand fluctuation in a water system. The diurnal curve for EVWD’s water distribution system is created by preparing an hourly mass balance using well production, imported water supplies, and change in storage, as recorded by the SCADA system. Where flows at wells and booster pump stations are not recorded in SCADA, pump ON/OFF times are used along with the flow rates obtained from the SCE test data to estimate the volume of water produced at the pumping facilities. Total system inflow data is based on the production data provided by EVWD. The calculated average day diurnal curve is presented on Figure 4-4 and represents the average hourly demand fluctuation in the system for a weekday during April 2018. The diurnal curve shows a unique demand pattern with low peaking factors during evening usage compared with those commonly seen in most systems that are predominantly residential. Individual diurnal curves for each pressure zone could not be created due to data limitations such as the lack of flow meters to record inter-zonal transfers at the pressure reducing stations and pumping stations.

Also, shown on Figure 4-4 are the calibration day curve and the planning curve. The planning diurnal was developed by adjusting the average diurnal to have a peak multiplier of 1.53.

Figure 4-4: System-Wide Diurnal Curves



4.2 MODEL CALIBRATION

The hydraulic model with the existing system configuration and demands is calibrated to improve the accuracy of the model in predicting system performance, which then can be used to identify system deficiencies and recommend pipelines and facilities to address system deficiencies.

Model calibration is the process of comparing model results with field results and adjusting model parameters where appropriate until the model results match corresponding field measurement data, within an acceptable difference. Typical adjustments include adjustments to system connectivity, operational controls, facility configurations, diurnal patterns, elevations, roughness coefficients for pipelines, etc. Several indicators are utilized to determine if the model accurately simulates field conditions: water levels in storage tanks, the run times for pumps, and static and residual pressures from the fire flow tests. This also acts as the “debugging” phase for the hydraulic model where any modeling discrepancies or data input errors are discovered and corrected.

The hydraulic model is calibrated for two scenarios:

- Steady-State Calibration: Simulating fire hydrant flow tests to match field results (April 12th and 17th, 2018)
- 24-hour EPS Calibration: Modifying the model until it mimics the field operations on the day of calibration (April 19, 2018)

4.2.1 Steady-State Calibration

The objective of the steady-state calibration is to validate the assumed pipeline roughness coefficients (C-factors) in the hydraulic model and make modifications, where appropriate. Fire hydrant tests are conducted at ten locations throughout the distribution system. Each test consists of opening a fire hydrant (indicated as flowing hydrant) and flowing the open hydrant until the residual pressure at an adjacent hydrant (indicated as the gauging hydrant) stabilizes at least 10 pounds per square inch (psi) lower than the static pressure recorded at the gauging hydrant.

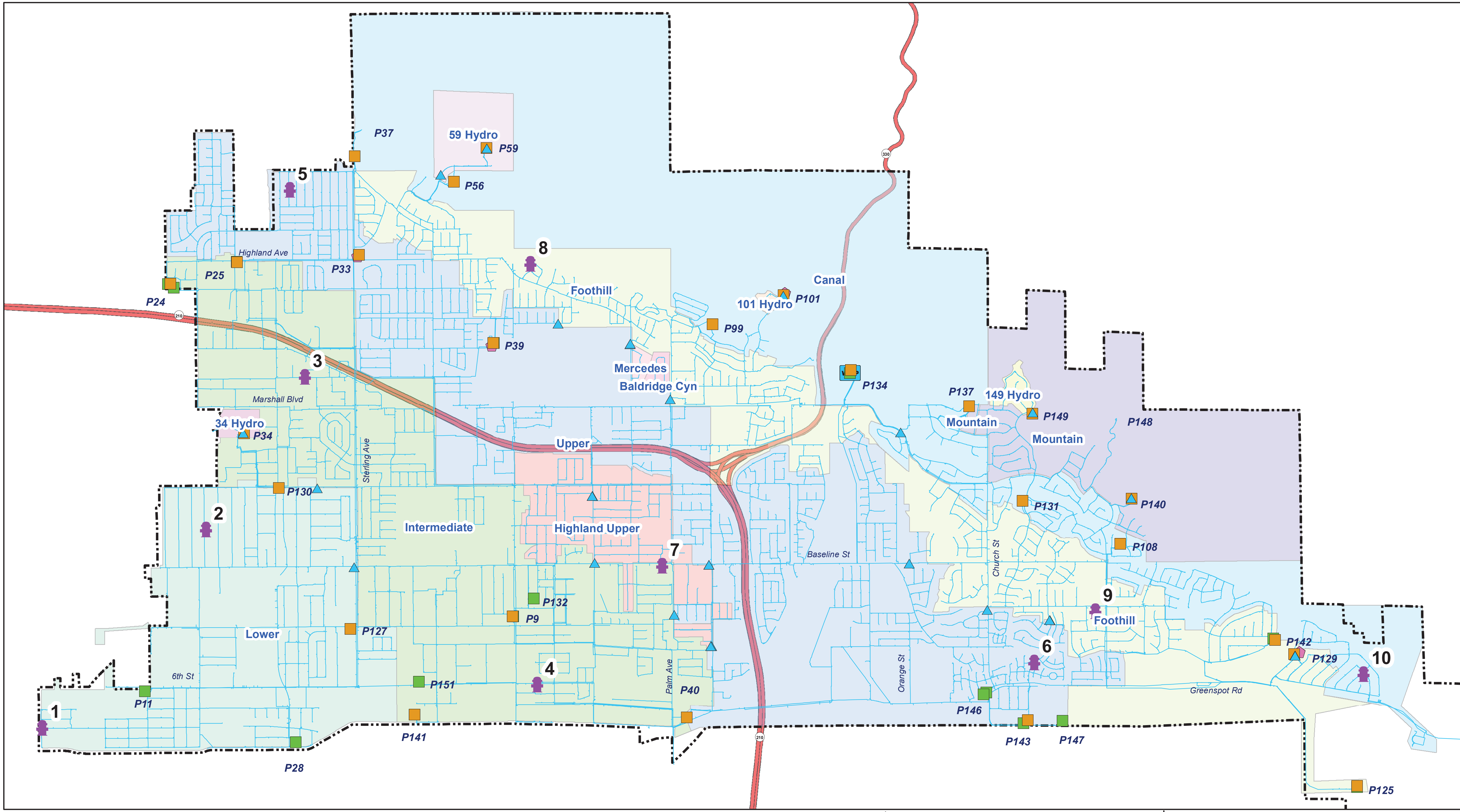
The flow measured at the hydrant is then input in the hydraulic model as an additional demand and the pressures at the node that represents the gauging hydrant location with and without this fire flow demand is then compared with the field results.

The locations of the ten fire hydrant tests are shown on Figure 4-5**.** Table 4-2 presents information on hydrant location, hydrant number, static and residual pressure, and actual flow. The results of the fire flow test calibration are also summarized in Table 4-2. The static and residual pressures in the field are compared with the residual and static pressures predicted with the hydraulic model.

As shown in Table 4-2, 80 percent of the model results for the steady-state calibration are within 5 psi of the observed field data as promulgated by AWWA's Computer Modeling Manual M32. In order to achieve a better steady-state calibration, several assumptions about closed valves and partially closed valves were made. It should be noted that EVWD checked for closed valves nearby tests (1, 2, 4, and 8) but did not find any. It is recommended that EVWD investigate these areas further as the hydraulic model indicated unknown bottlenecks. The valve adjustments used for the steady-state calibration were not made permanent in the model. Two tests (Location Numbers 2 and 10) were outside the acceptable limits, where the number of system changes needed to achieve a good calibration match was deemed unrealistic.

Common causes for discrepancies that can be further investigated by EVWD are provided below:

- Open or closed valves in the immediate vicinity of the fire flow area can significantly change the measured flow and pressures.
- Heavily tuberculated pipe can result in a significant reduction in fire flow capacity.
- Fire flow pitot tube measurements and/or calculations can have a manual error. While unlikely, this can happen from time to time. The most efficient way to confirm a fire flow result in question is to look up historical tests for that hydrant or re-run the test.
- Unknown boundary condition not accounted for in the model. For example, a pump station was on in the field but not in the model.
- GIS discrepancies such as connectivity issues or wrong diameter information can lead to a discrepancy between the model and field data.



Legend

- Hydrant Test Location
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe
- Service Area Boundary
- freeway

0 0.25 0.5 1 Miles

N

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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Date: Nov 28, 2018

EAST VALLEY WATER DISTRICT

SEDARU

Hydrant Test Locations

Figure 4-5

Table 4-2: Steady-State Hydrant Test Calibration Results

Test #	Zone	Test Date/Time	Gauging hydrant ID	Gauging hydrant address	Measured Flow (gpm)	d_Static (psi) (M-F)	d_Res (psi) (M-F)	d_Drop (psi) (M-F)	Pressure Drop Comments
1	Lower	4/12/18 10:25 AM	FH_M1_104	405 N Waterman Ave	654	-12	3	0	Closing pipe M1_1036 brings d-drop from -15 to 0
2	Lower	4/12/18 11:00 AM	WV_J3_198	7101 Garden Dr	534	-4	15	-19	Closing pipes I3_1162 & K3_1028 made minimal difference
3	Intermediate	4/12/18 11:50 AM	FH_G4_124	25446 Pumalo St	534	-1	4	-4	
4	Intermediate	4/12/18 11:45 AM	FH_M7_129	26607 6Th St	827	-4	18	-4	Closing pipe M7_1057 brings d-drop from -22 to -4 psi.
5	Upper	4/12/18 1:35 PM	FH_D4_105	5391 Dogwood St	1013	-4	1	-5	drop variance is acceptable
6	Intermediate	4/17/18 11:10 AM	FH_L12_148	On Clubview (Rear Of 29125)	860	-2	1	-3	
7	Highland Upper	4/17/18 10:35 AM	FIT_K8_600	27245 Baseline	924	6	8	-2	
8	Foothill	4/17/18 10:00 AM	FH_F7_100	3154 Cactus Cir	1307	6	11	0	Partially closed valve. Added Minor loss 40 to pipe F7_1031. d-drop changes from -5 to 0.
9	Foothill	4/17/18 8:55 AM	FH_K13_145	7508 Lochinvar Ct	1067	-6	-1	-4	
10	Canal 3	4/17/18 8:25 AM	FH_L16_115	7852 Santa Paula St	844	-6	17	-23	Closing multiple pipes made minimal difference

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4.2.2 Extended Period Simulation

A model calibrated for a steady-state scenario provides an instantaneous snapshot of a water distribution system. As steady-state modeling does not involve time-steps, the behavior of a water distribution system over time cannot be analyzed. An EPS model provides a better understanding of the operations of a water distribution system than a steady-state model. The goal of the EPS calibration is to estimate the accuracy with which the model simulates the field operations over a 24-hour period. The EPS calibration is performed for the 24-hour period between midnight April 18, 2018 and midnight April 19, 2018. The total water production on this day was calculated to be 11,567 gpm (16.66 MGD). This is equal to 82 percent of the Average Day Demand (ADD) for the 2015-2017 period.

Calibration criteria are presented in Table 4-3. Model calibration was considered achieved when the difference between model output and field data were within the tolerances listed in the table. If these tolerances could not be “Excellent” or “Good”, an explanation is provided justifying why calibration could not be achieved. These explanations are included in the calibration summary table provided in Appendix C.

Table 4-3: Calibration Criteria

Measurement	Calibration Criteria		
	Excellent	Good	Fair
Flow (gpm)	<=10%	10%-20%	>20%
Pressure (psi)	<=3	3-5	>5
Level (ft)	<=3	3-6	>6

The model was calibrated against 50 total locations: flows recorded at 24 locations, pressures recorded at 7 locations, and water levels recorded at 19 locations. The model results are compared with the field data to determine if the model reflects the actual system operating conditions over a 24-hour period. A summary of the calibration results are presented in Table 4-4. Detailed results of modeled versus field data for the storage tanks, booster stations, and groundwater wells on calibration day are presented in Appendix C.

Table 4-4: Summary of Calibration Results

Measurement	Count per Calibration Criteria			Total
	Excellent	Good	Fair	
Flow (gpm)	20	3	1	**24**
Pressure (psi)	5	1	1	**7**
Level (ft)	17	2	0	**19**
Total	**42**	**6**	**2**	**50**

4.3 CALIBRATION CONCLUSIONS

Consistent with the above-mentioned calibration criteria, it can be concluded that the results from the hydraulic model are satisfactory for the purposes of long-term planning, where 48 out of 50 (96 percent) measurements are within the calibration criteria. While this model can be used for long-term planning, it is important to understand the inherent errors in the model are due to the input data used to develop the model. While the inherent errors may not result in the output to exceed the calibration criteria, it is important to understand where discrepancies are most likely going to come from within the EVWD model. The following list gives common causes for discrepancies between the model and field data.

- Temporal variation in demand between EPS and steady-state calibration days. The diurnal curve created for the calibration day is also used to determine demand at each hour for the fire flow tests. However, customer demands change from day to day and hour to hour resulting in different diurnal curves on different days.

- Demand variance in different pressure zones. A lack of sufficient flow meter data for each pressure zone of the system results in the use of a generalized diurnal curve for the entire system. With individual pressure zone diurnal curves, a more accurate demand can be captured as some zones have little to no irrigation demand and others have high irrigation demand.

- Inaccuracies in elevation data. Elevations used throughout the system for junctions, pump stations, and valves are based on ground elevation. A PRV setting is based on the pressure in the hydraulic model, however, it references the ground elevation in the model to calculate the downstream pressure. If the elevation value is off by even a few feet, the PRV flow can be significantly different than that in the field.

- Inaccuracies in observed pump flow. Because most of the flows calculated for the pump stations are based on on/off times and flow rates from SCE tests, the actual flow from any of these devices could vary.

- Inaccuracies in pump curves: EVWD has limited information on pump curves and therefore, the model creates a generic pump curve based on a single design point. This can significantly change the flow versus head relationship for each pump station resulting in flow or head variances from field conditions if the pump does not operate near its design point. The lack of SCADA data to record flows at pump stations compounds these inaccuracies.

- Unknown groundwater level: Changes in depth to groundwater are not accounted for in the model. Groundwater levels vary throughout the year and from year to year. The groundwater elevations used throughout the system are based on the depth of water during the most recent SCE tests provided by EVWD. However, groundwater drawdown can vary significantly depending on the pumping rate and the static groundwater level conditions. These factors introduce additional inaccuracies in the model. In most cases recent groundwater data was not available, therefore well pumps were replaced by flow control valves in the model so observed flow could be simulated very closely. This helped reduce inaccuracies in the model calibration.

Based on the findings from the steady-state and the EPS calibration, the following items are recommended to improve and refine the predictive capability of the model in the future:

- Installation of flow meters at pump stations that lack flow monitoring.

- Installation of pressure loggers to capture pressures at key points in the system such as the suction and discharge pressures at pump stations or critical points of the system. Pressures at these loggers should be relayed to EVWD’s SCADA system.

- Using manufacturer’s pump curves adjusted for SCE test data rather than design point curves in the hydraulic model.

5.0 PLANNING CRITERIA

This section presents the design criteria and methodologies for analysis used to evaluate the existing distribution system and its facilities and to size future improvements.

5.1 DESIGN CRITERIA

Design criteria are established for the evaluation of EVWD's water system. Peaking factors for EVWD's system are determined based on a review of daily production data for the years 2015 to 2017. The criteria are developed using the typical planning criteria used in the systems of similar water utilities, local codes, engineering judgment, and commonly accepted industry standards. The "industry standards" are typical ranges of values that are acceptable for the criteria in question and, therefore, are used more as a check to confirm that the values being developed are reasonable. The design criteria and analytical methodologies used to conduct this evaluation are presented in Table 5-1.

Table 5-1: Water System Evaluation Criteria

Evaluation Criteria	Value	Units(1)	Evaluation Demand Conditions(2)
Peaking Factors			
MDD/ADD	1.8	-	-
PHD/ADD	2.75	-	-
System Pressure			
Maximum Pressure	125	psi	ADD
Minimum Pressure, normal conditions	40	psi	PHD
Minimum Pressure, with fire flow	20	psi	MDD
Minimum Pressure, transmission mains with no water services	5	psi	PHD
Maximum Pipeline Velocity			
Existing Pipelines (excluding fire hydrant runs)	6	fps	MDD
New Distributions Pipelines (≤ 12-inch in diameter)	4(4)	fps	MDD
New Transmission Mains (>12-inch in diameter)	6(4)	fps	MDD
Pump Station suction pipelines	4	fps	MDD
Distribution System			
Pipeline Life Expectancy	75	years	n/a
Minimum Diameter for New Pipelines	8	inches	n/a

Storage Volume			
Operational	25% of MDD	MG	MDD
Fire Fighting	Highest fire flow requirement per zone	MG	MDD
Emergency	100% of MDD	MG	MDD
Fire Flow Requirements (3)			
Single Family Residential	1,500 gpm	2 hours	MDD
Multi-Family Residential	2,500 gpm	2 hours	MDD
Commercial	3,000 gpm	3 hours	MDD
Public	3,000 gpm	3 hours	MDD
Industrial	4,000 gpm	4 hours	MDD
Agricultural	1,500 gpm	2 hours	MDD
Supply Capacity			
Entire System	Provide MDD with largest single source out of service		MDD
By Pressure Zone	Provide MDD with firm transfer/booster capacity between zones		MDD
Tank Replenishment	Provide sufficient supply and transmission capacity to refill reservoirs to operating HGL in 24 hours. (i.e. replenish water used during MDD within 24 hours)		MDD
System Reliability			
Pipe Breaks	Maintain service with a single transmission pipeline out of service		MDD
No Wells	Maintain service for 7 days with all groundwater wells out of service		MDD
No Purchased Water	Maintain service for 7 days with no imported water from Valley District (i.e. without SWP supplies to Plant 134)		MDD
Single Largest Source Out of Service per Pressure Zone	Maintain service for 7 days with a single source out of service in each pressure zone		MDD

(5) psi = pounds per square inch, fps = feet per second, gpm = gallons per minute, MG = million gallons

(6) PHD = peak hour demand, MDD = maximum day demand, ADD = average day demand

(7) Based on 2014 WSMP and generally accepted planning standards

(8) Maximum pipeline velocities up to 15 fps are acceptable for new pipelines under fire flow scenarios.

5.1.1 System Pressures

Minimum system pressures are evaluated under two different scenarios: PHD and MDD plus fire flow. The minimum pressure criterion for normal PHD conditions is 40 pounds per square inch (psi), while the minimum pressure criterion under MDD with fire flow conditions is 20 psi. The pressure analysis is limited to demand nodes because only locations with service connections need to meet such pressure requirements. Lower pressures are acceptable for junctions at water system facilities and on transmission mains that have no service demands; however, no pressure shall be less than 5 psi except for short lengths near reservoir inlets and outlets where the water main is on premises owned, leased or controlled by EVWD per state regulations.

5.1.2 Pipeline Velocities

Pipeline velocities are evaluated for the future system for three different conditions as listed in Table 5-1. The maximum recommended velocity is 6 feet per second (fps) provided that the system pressures are sufficient. This criterion is intended to minimize head-loss, and subsequent added pumping costs. This criterion does not apply to flow in fire hydrant laterals. Under fire flow conditions, maximum pipeline velocities up to 15 fps are acceptable for new pipelines. New distributions system pipelines (≤12-inch in diameter) that are installed within the EVWD's system should have a maximum design velocity of 4 fps under MDD conditions. The maximum velocity for transmission mains (> 12-inch in diameter), or suction pipelines at booster stations, should be 4-6 fps under MDD conditions based on trade-offs between pipeline cost and energy usage. The design velocity for transmission mains should consider energy requirements and pipeline length to determine the optimal diameter rather than use a fixed velocity criterion.

5.1.3 Storage

The total storage recommended for a water system is evaluated in three parts: 1) storage for operational use 2) storage for firefighting and 3) storage for emergencies. These three components are determined by pressure zone in order to evaluate the ability of the water system to meet the storage criteria on both an inter-zone basis as well as a system-wide basis. These three storage components are discussed in more detail below.

5.1.3.1 Operational Storage

Operational storage is defined as the quantity of water that is required to balance daily fluctuations in demand and water production. It is necessary to coordinate the water source production rates and the available storage capacity in a water system to provide a continuous treated water supply to the system. Water systems are usually designed to supply the average demand on the maximum day and use reservoir storage to supply water for peak hour flows that typically occur in the mornings and late afternoons. This operational storage is replenished during off-peak hours that typically occur during nighttime when the demand is less. The American Water Works Association (AWWA) recommends that an operational supply volume ranging from one-quarter to one-third of the demand experienced during one maximum day. It is recommended that each pressure zone in the EVWD have an operational storage of at least 25 percent of MDD.

5.1.3.2 Fire Flow Storage and Criteria

The fire flow volume requirements for the various land use types are listed in Table 5-1. Fire flow storage is determined based on the highest fire flow requirement of each pressure zone multiplied by the corresponding duration. The fire flow duration is dependent on the fire flow criteria and is based on the Uniform Fire Code requirements. For flows less than or equal to 2,500 gpm, the fire flow storage volume is based on a duration of 2 hours. Similarly, for flows of 4,000 gpm and greater, a duration of 4 hours is used.

For example, if the highest fire flow of a zone is 4,000 gpm for the duration of 4 hours, the recommended fire flow storage for that zone is 0.96 million gallons (MG). For analysis purposes, it is assumed that there will only be one fire per pressure zone at any one time.

5.1.3.3 **Emergency Storage**

The volume of water that is needed during an emergency is usually based on the estimated amount of time expected to elapse before the emergency is corrected. Possible emergencies include earthquakes, water contamination, several simultaneous fires, unplanned electrical outages or pipeline ruptures or other unplanned events. The occurrence and magnitude of emergencies are difficult to predict; therefore, the emergency storage criterion is based on experience and engineering judgment. Typically, emergency storage is set as a percentage of MDD. However, this percentage needs to be based on the water system layout and facilities. Water systems that have only one source of supply are more vulnerable in emergencies such as an earthquake or supply outage than water systems with other sources such as groundwater wells that are located throughout the distribution system. For the purposes of the WSMP, it is assumed that the emergency storage criterion for EVWD's system is 100 percent of MDD. By setting emergency storage at 100 percent of MDD demand, it ensures that EVWD staff have at least 24 hours to address any emergency loss of supply during peak summer demand conditions, and almost two days during average demand conditions.

5.1.4 Supply Capacity

The water supply reliability is evaluated for the entire system and on a pressure zone basis using a spreadsheet model that calculates the water supply balance by pressure zone including zone transfers. The firm well capacity, all wells except for the largest well, is used as the available groundwater supply for most scenarios. The system demands should be met under MDD conditions with the largest well out of service. The hydraulic model is used to verify that 1) the system can move water between zones according to the transfers calculated using the spreadsheet model, 2) system pressure criteria are met, and 3) that all storage tanks replenish in a 24-hour period.

5.1.5 System Reliability

Two evaluation criteria are established for the system reliability evaluation. EVWD should have adequate source water to:

- Maintain service with a single transmission pipeline out of service during MDD conditions (3 individual locations are analyzed)
- Maintain service for seven days with no imported water during MDD conditions, where imported water is defined as State Water Project (SWP) water purchased through San Bernardino Valley Municipal Water District (Valley District).

The intent of these reliability criteria is to identify storage needs during emergencies to provide reliable service to customers. EVWD's system is evaluated against these criteria and results are presented in Section 6.

6.0 SYSTEM EVALUATION

This section describes the evaluation of the water distribution system under existing and future conditions, i.e. the planning horizons for near-term and build-out. Hydraulic deficiencies based on the evaluations are identified and infrastructure improvements are recommended to address the deficiencies. The following information is presented in this section for existing, near-term, and build-out demand conditions:

- A description of the criteria used for the distribution system evaluation,
- An evaluation of the distribution system for system pressures under different demand conditions,
- An evaluation of the distribution system for system pressures under fire flow conditions,
- An evaluation of the adequacy of the storage and pumping facilities within EVWD's service area, and
- Supply analyses, both system-wide and by pressure zone, and
- Reliability analyses.

The design criteria and analytical methodologies used to conduct this evaluation are presented in detail in Section 5 of this WSMP. Recommendations are made for each of these evaluations, which are combined in a summary of recommendations and proposed improvements at the end of this section.

6.1 EXISTING SYSTEM DISTRIBUTION ANALYSIS

The distribution system analysis consists of evaluations that are conducted for each planning horizon (Existing, near-term, and build-out). Improvements identified for each planning horizon are incorporated in the model for subsequent planning horizons. Hence, each improvement listed in this section is only included in one category and is summarized at the end of each planning horizon evaluation. This approach provides a limited amount of phasing, where further phasing and prioritization is discussed in Section 8.

The EVWD hydraulic model is used to evaluate the system pressures for the following scenarios:

- Meet Existing PHD while maintaining a minimum pressure of 40 psi at all demand junctions associated with customer services
- Meet Existing ADD while not exceeding a maximum pressure of 125 psi
- Meet Existing MDD plus fire flow while maintaining a minimum pressure of 20 psi at all demand junctions

6.1.1 Minimum Pressure During Peak Hour Demand (PHD)

For the first criterion, the model is run for 24 hours under MDD conditions. As described earlier in this section, the minimum pressure criterion under PHD conditions is 40 psi. This criterion does not apply to junctions on transmission mains or junctions at water facilities (such as reservoirs, wells, etc.) provided that the minimum pressure at such locations exceeds 5 psi (consistent with California Department of Drinking Water). The evaluation is performed for over 6,700 demand junctions (out of approximately 20,800 junctions total). The results from this are shown on Figure 6-1. As shown on the figure, the hydraulic simulation identified 43 demand junctions with pressures below 40 psi. Low pressures at these 43 demand junctions varied between 6 and less than 40 psi. Inspection of the low-pressure areas reveals that all are a function of ground elevation and not due to pipe capacity (high velocities and or high head losses). These areas are called out as Area 1, 2, and 3 on Figure 6-1**.** Model nodes in these areas have elevations that are very close to their pressure zone's hydraulic grade established by tank level. These model nodes will still have low-pressure even with significantly reduced demands and reduced head loss between the supplying tank and low-pressure area. If warranted, these areas could be improved by moving pressure zone boundaries so low-pressure areas could be served from a higher HGL zone.

Infrastructure is not needed to specifically address the 43 demand junctions below 40 psi under existing demands. It is recommended that EVWD monitor pressure in Areas 1, 2, and 3 specifically during higher demand conditions. EVWD can also investigate if pressure complaints have been received for these areas and cross-reference fire flow results to see if there are any critical customers that may need to be shifted to higher zone and/or upgraded pipe size**.**

In addition to analyzing pressures, high-velocity pipelines are analyzed to find potential bottlenecks in the system. There are several pipelines that experience high velocities in the existing system, most of which are near facilities. None of these pipelines identified with higher velocities in the existing system prevent water delivery to current customers. However, one pipeline connecting the Plant 134 surface water treatment plant to the Foothill Zone limits the amount of water that can be transferred from the newly expanded plant. In addition, this 8-inch pipe experiences velocities close to 8 fps when Plant 134 boosters supply the Foothill Zone, and it was constructed in the 1960s. Given this pipe limits Plant 134 and the pipe age, it is recommended to replace this pipe with a 16-inch.

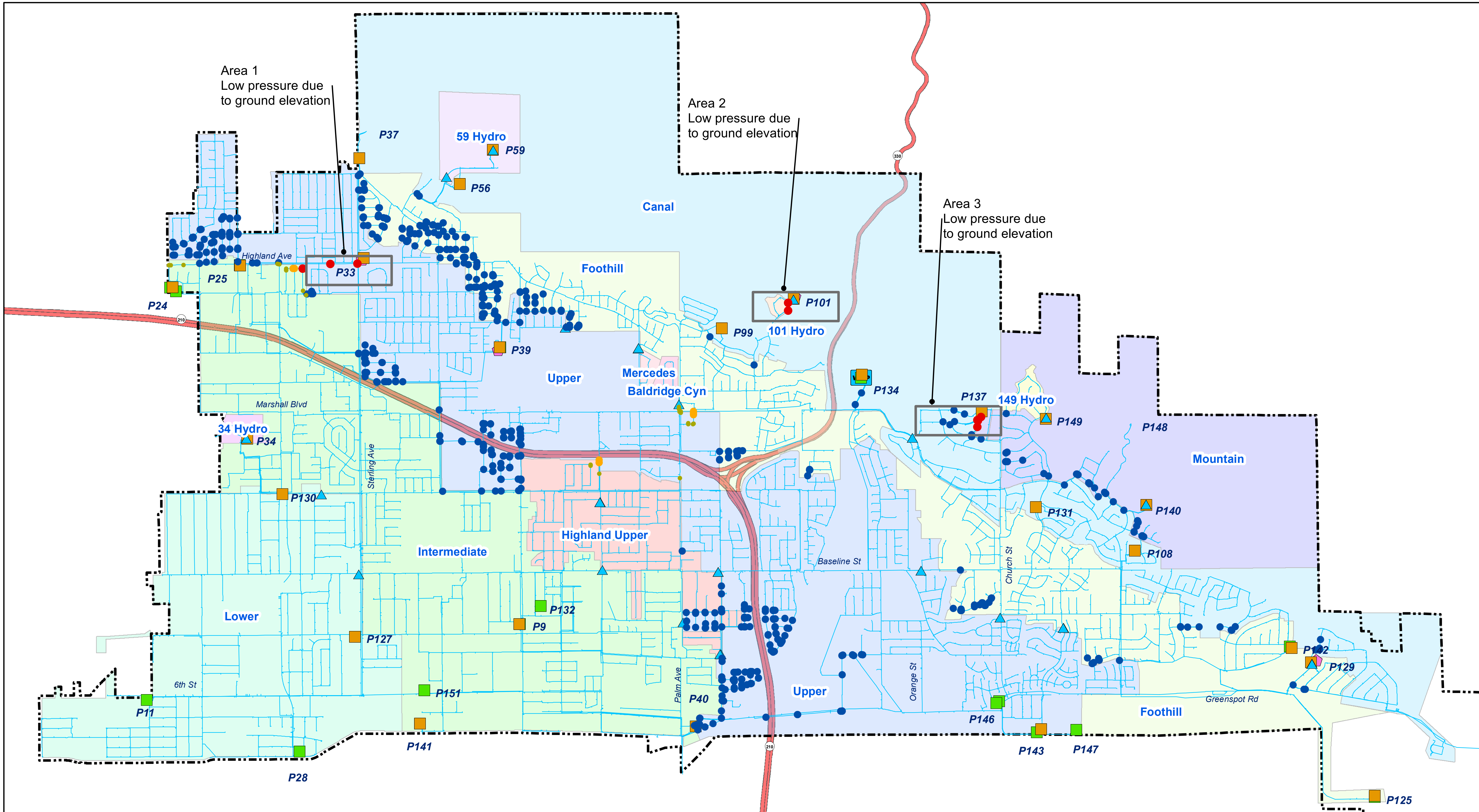
Figure 6-2 shows the maximum velocities observed during the existing EPS MDD simulation. Note that pipes with velocities above 6 fps are colored purple with thick lines, and pipes above 8 fps are colored red with thick lines. Figure 6-2 shows the location of the bottleneck pipeline which is described as T-1 in Table 6-1. T-1 included on the existing system recommendations map on Figure 8-1. It has been noted by EVWD that this project has been completed and as such, the costs are not included in the summary of recommendations presented on Table 8-5.

The T-1 pipeline project is summarized in Table 6-1.

Table 6-1: Transmission Improvements – Existing Conditions

Pipe ID	Diameter (inches)	Length (feet)	Trigger/Need**	Project Description
T-1*	16	2,100	Reduce water velocities below 6 fps	Along Highland Ave, from Plant 134 to Orchard Road

* This project is complete
** Information for the Trigger/Need for each project provided by EVWD staff



Legend

Pressure

- min pressure less than 30 psi
- min pressure is 30 to 35 psi
- min pressure is 35 to 40 psi
- max pressure is more than 125 psi

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Service Area Boundary
- freeway

East Valley Water District

0 0.25 0.5 1 Miles

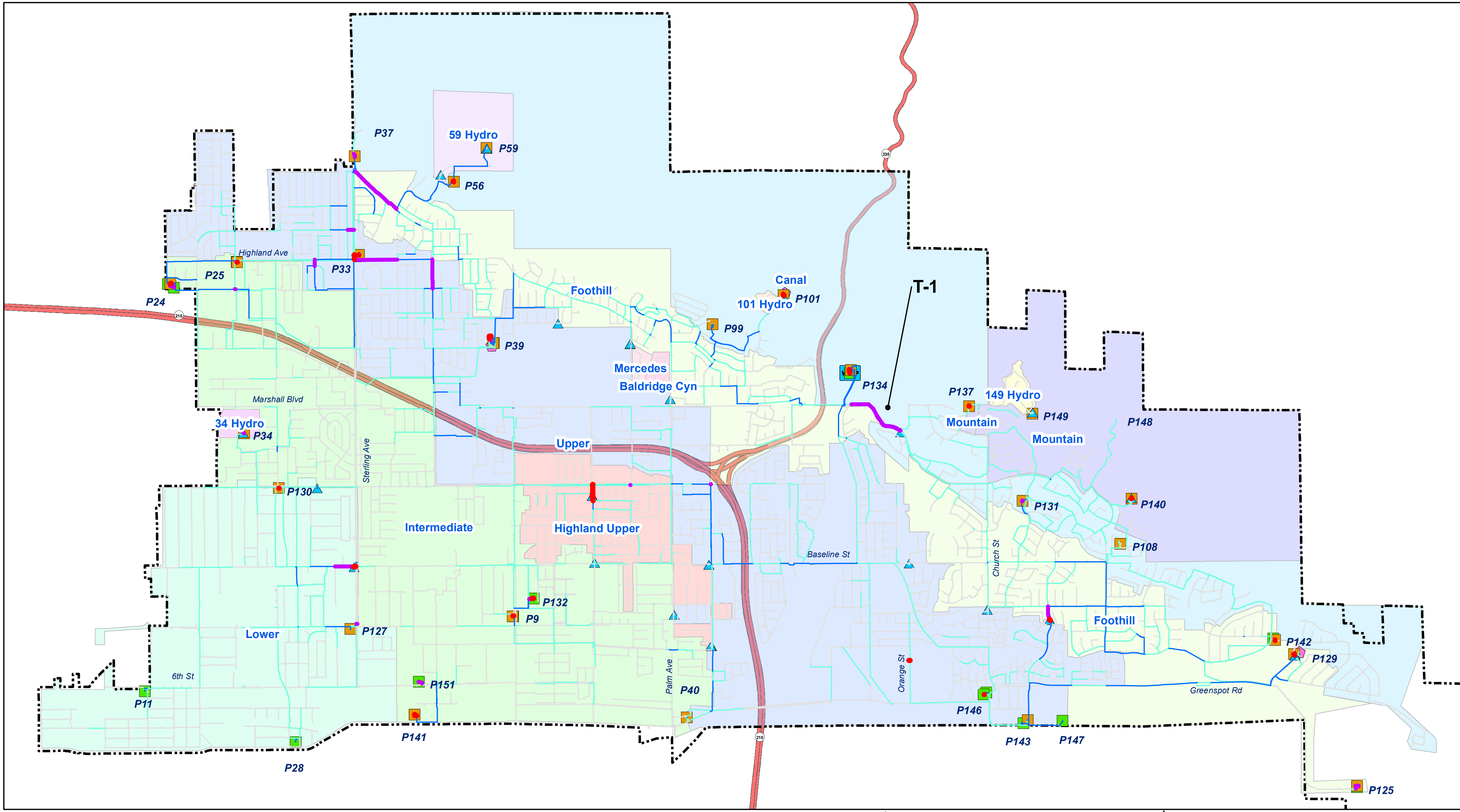
Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Sep 20, 2018

Existing System Pressure Analysis

SEDARU

Figure 6-1



Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet

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Date: Sep 20, 2018

Existing System Velocity Analysis

SEDARU

Figure 6-2

6.1.2 Maximum Pressure During Average Daily Demand (ADD)

The hydraulic model is also used to identify areas where the maximum pressure exceeds 125 psi. This evaluation is conducted under ADD conditions. There are 615 demand junctions or approximately three percent of the system where the system pressures exceed 125 psi. High pressures at these demand junctions vary between 125 psi and 170 psi. These high-pressure areas are depicted on Figure 6-1. High-pressures are mostly found in the lowest elevations of the pressure zones where static pressures increase due to lower ground elevations. If not properly designed for high pressures, there is an increased risk of pipe leaks or breaks.

As mentioned in the 2014 WSMP, EVWD's Operations staff expressed that these high pressures do not affect normal distribution system operations. In the 2014 WSMP, pipe leak records were reviewed and compared against the high-pressure areas identified and found no conclusive correlation between pipe leaks and high pressures in EVWD's system. While these same high pressures exist today, EVWD has not indicated they are affecting operations, and therefore no pressure zone boundary shifting is recommended. It is assumed that individual customer pressure regulating valves are installed in this area to reduce pressures to 80 psi as required per the Uniform Plumbing Code. Future developments in this part of the system should also include the installation of pressure regulators at the meter connections.

6.1.3 Minimum Pressure with MDD plus Fire Flow

The hydraulic model is also used to evaluate the impact of fire flows on the distribution system. For this analysis, an InfoWater design fire flow simulation is used per pressure zone, which simultaneously checks the available fire flow at each hydrant. Each hydrant simulation's goal is to keep residual pressure at each demand junction within its pressure zone at or above 20 psi and meet the recommended fire flow. Recommended fire flows were used from the 2014 WSMP, which were assigned to each parcel based on the existing land-use category. Only new pipes added in the model update had new fire flow requirements assigned based on reviewing aerial imagery. The fire flow requirements for each land use type are listed in Table 6-2. Each of the 2,627 hydrants in the service area is correlated to a junction in the model that is designated as a hydrant. The hydrant junction is then assigned the highest fire flow demand for all parcels nearest to that junction. Using the MDD as the base system demand, the model then computes the residual pressure at the recommended fire flow for each hydrant junction. Hydrants that cannot supply MDD plus fire flow (within 10 percent) at a minimum pressure of 20 psi at all demand junctions within the pressure zone are identified as not meeting criteria. Hydrants that do not meet the fire flow criteria within 10 percent are shown on Figure 6-3. Flows within 10% are shown on this figure as well for EVWD reference.

Fire hydrants not meeting criteria are a common situation as fire flow requirements and land use change over time and as such the criteria by which the hydrants are evaluated change. This analysis looks at hydrants on an individual basis, and firefighting typically makes use of multiple hydrants simultaneously, which may or may not be located on separate water lines. Because the model cannot evaluate all permutations of hydrants that may be used during a fire and the resultant flow and pressure available in these situations, fire hydrants are evaluated individually to assess each hydrant response to the fire flow demand.

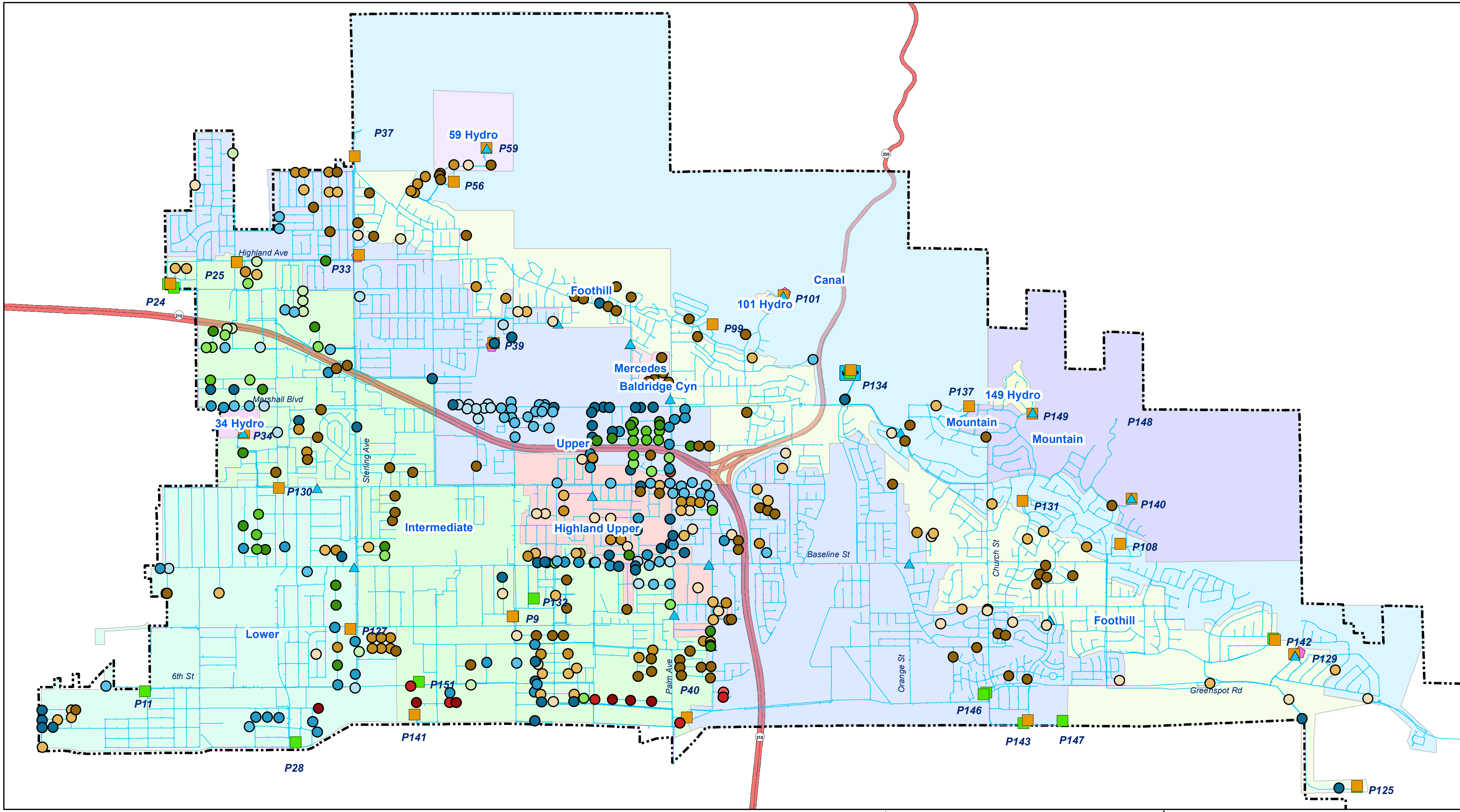
This analysis is also performed during MDD, or the most extreme demand condition defined in the model, to identify as many hydrants as possible that may benefit from improvements to the transmission system. This analysis is intended to be a guide for EVWD to help prioritize maintenance and improvement activity in the water system, so that any infrastructure projects undertaken by EVWD can be coordinated with hydrant replacements and/or additional pipe lines to provide higher fire flow and pressures. Coordination of these projects can allow EVWD to save costs, decrease disruption from construction activities, and help determine the impact of new development in the system compared to available fire flow.

Table 6-2: Fire Flow Requirement Estimations Based on Land Use

Land Use Type	Fire Flow (gpm)
Single Family Residential	1,500
Multi-Family Residential	2,500
Commercial	3,000
Public	3,000
Industrial	4,000
Agricultural	1,500

The model simulation results show that the fire flow demands can be met at 84 percent of the hydrant junctions, while maintaining the minimum pressure criteria of 20 psi at all demand junctions within each pressure zone. A total of 426 hydrant junctions, approximately 16 percent of the existing system, did not meet the residual pressure criterion of 20 psi when the entire fire flow demand is supplied from one location as depicted on Figure 6-3.

To identify areas that would benefit most from fire flow improvement projects, hydrants were prioritized by percent shortfall of the recommended flow. Areas with a cluster of hydrants that fell short of the recommended flow were grouped into ten priority fire flow areas. Recommendations were made for each of the ten areas to improve fire flow availability of each of the hydrants not meeting criteria within the ten areas. These recommendations are presented in Appendix D.



Legend

1500 gpm	2500 gpm	3000 gpm	4000 gpm	
< 50%	< 50%	< 50%	< 50%	PRV Station
50% - 75%	50% - 75%	50% - 75%	50% - 75%	Booster Station
75% - 90%	75% - 90%	75% - 90%	75% - 90%	Reservoir
> 90%	> 90%	> 90%	> 90%	Well
				WTP

Model Pipe
Service Area Boundary
freeway

0 0.25 0.5 1 Miles

N

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Nov 26, 2018

Existing System Fire Flow Analysis

Hydrants Not Meeting Criteria
Percent Fire Flow Available

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Figure 6-3

6.2 EXISTING SYSTEM STORAGE EVALUATION

The existing distribution system contains 18 storage reservoirs with a total storage volume of 27.8 MG. The storage and emergency supply analyses are performed separately for each pressure zone. Storage criteria are discussed earlier in Section 5**.** The total recommended storage is a combination of three components:

1. Operational storage,
2. Fire flow storage, and
3. Emergency storage.

The recommended storage is compared with the actual storage for the entire system and by individual pressure zone. A summary of the recommended and available storage volumes is presented in Table 6-3 by pressure zone. Any sub-zones supplied only by pressure reducing stations are assumed to be a part of the supplying zone for the storage analysis. For example, the Highland Upper Zone has several PRVs that are fed by the Upper Zone. Therefore, the demand in Highland Upper is included in Upper in Table 6-3. This table indicates that EVWD has an apparent net deficiency of approximately 22.5 MG for the existing system. However, this does not consider the ability of EVWD to move water from other pressure zones and thus the final recommended storage for individual zones is considerably less than this net deficit.

Construction of additional storage will provide additional capability to withstand power outages or other emergency supply interruptions. The storage analysis was refined to include supply from wells having standby power that would be available during local power failures. Available supply during a power failure is included when either a power transfer switch or backup generators are available on-site. The available groundwater supply during power failure provides 27.8 MGD of supply.

A zone by zone comparison of available and recommended storage depicts deficits in the Lower, Foothill, Upper, and Mountain Zones if only storage is evaluated. Once available supply during a power failure is included, only Lower, Foothill, and Mountain have storage deficits. Since pressure reducing stations or PRVs allow transfer from higher zones to lower zones, it is recommended that storage improvements be constructed in higher elevation pressure zones to the extent possible as this will allow for use of the storage in lower zones without pumping. A detailed phasing plan for the storage improvements is presented in Section 8.

The total recommended storage to meet existing system needs on a zone-by-zone basis, with consideration of transfer from other zones, is 5.5 MG. Note that the volumes specified below come from the deficits volume and rounding to the nearest 0.25 MG. It is recommended to consider phasing and future growth when determining final tank volumes. Recommendations from the existing zone-by-zone system storage evaluation are summarized below, and are based upon the analysis presented in Table 6-3:

- Construct 3.5 MG of additional storage in the Lower Zone
- Construct 1.5 MG of additional storage in the Foothill Zone
- Construct 0.5 MG of additional storage in the Mountain Zone

It is noted that building storage in higher zones allows for more flexibility and benefits lower zones. The driver for these recommendations is the current storage deficiency in the system to serve existing demands and meet fire flow and emergency requirements.

Table 6-3: Existing Water System Storage Capacity Evaluation

Pressure Zone	Demands			Storage Required						Storage Evaluation			
	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs.)	Fire Flow[1] (MG)	Operational[2] (MG)	Emergency[3] (MG)	Required (MG)	Available (MG)	Avail. Supply During Power Failure[7] (MG)	Surplus/ Deficit[4] (MG)	Recommended[6] (MG)
Lower	**2.22**	**1.8**	**4.00**	**4,000**	**4**	**0.96**	**1.00**	**4.00**	**5.96**	**0.99**	**2.00**	**-2.97**	**3.50**
Sub-zone Hydro34	0.01	1.8	0.03	3,000	3	0.54	0.01	0.03	0.57	0.00	0.00	-0.57	-
Intermediate	**4.87**	**1.8**	**8.77**	**4,000**	**4**	**0.96**	**2.19**	**8.77**	**11.93**	**6.80**	**10.00**	**4.88**	**-**
Upper	**6.89**	**1.8**	**12.41**	**4,000**	**4**	**0.96**	**3.10**	**12.41**	**16.47**	**13.05**	**8.90**	**5.48**	**-**
Foothill	**4.14**	**1.8**	**7.44**	**3,000**	**3**	**0.54**	**1.86**	**7.44**	**9.84**	**3.07**	**5.20**	**-1.57**	**1.50**
Canal1	**0.03**	**1.8**	**0.05**	**1,500**	**2**	**0.18**	**0.01**	**0.05**	**0.25**	**0.71**	**0.00**	**0.47**	**-**
Sub-zone Hydro59	0.04	1.8	0.07	1,500	2	0.18	0.02	0.07	0.27	0.00	0.00	-0.27	-
Canal2	**0.24**	**1.8**	**0.43**	**1,500**	**2**	**0.18**	**0.11**	**0.43**	**0.72**	**1.34**	**0.00**	**0.62**	**-**
Sub-zone Hydro101	0.02	1.8	0.04	1,500	2	0.18	0.01	0.04	0.23	0.00	0.00	-0.22	-
Canal3	**1.42**	**1.8**	**2.56**	**3,000**	**3**	**0.54**	**0.64**	**2.56**	**3.74**	**2.05**	**1.70**	**0.01**	**-**
Mountain	**0.32**	**1.8**	**0.57**	**1,500**	**2**	**0.18**	**0.14**	**0.57**	**0.89**	**0.72**	**0.00**	**-0.17**	**0.50**
Sub-zone Hydro149	0.08	1.8	0.15	1,500	2	0.18	0.04	0.15	0.36	0.00	0.00	-0.36	-
Grand Total	**20.29**	**N/A**	**36.52**	**N/A**	**N/A**	**5.58**	**9.13**	**36.52**	**51.23**	**28.75**	**27.80**	**5.31**	**5.50**

Notes:

1. Fire flow based on highest estimated requirement per zone
2. Operational Storage equals 0.25 times MDD
3. Emergency Storage equals 1.0 times MDD
4. Surplus is positive, and deficit is negative
5. Storage capacity recommended could be provided in the deficient zone or in higher pressure zones
6. Storage capacity recommendations are rounded to nearest 0.25 MG.
7. Available supply during power failure is based on well and WTP capacity with a transfer power switch or backup generators.

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6.3 EXISTING SYSTEM SUPPLY ANALYSIS

A discussion of the supply sources for EVWD's existing system and their adequacy under existing demand conditions is presented.

6.3.1 Existing Supply Sources

Currently, EVWD has two primary sources of water: a network of 15 active groundwater wells and one surface water treatment plant (Plant 134). The capacity of the 15 in-service wells equals 29.1 million gallons per day (MGD) as shown in Figure 6-4. Note that the available capacity is 3.8 MGD less than rated capacity. Available capacity is assumed more accurate as this is from the calibration which used recent SCADA data to calibrate the hydraulic model. It is common for well capacity to decrease over time due to decreasing well water levels and/or lower performance as the pump and motor age over time.

Table 6-4: Water Supply Analysis – Existing Active Well Capacities

Well #	Rated Capacity[a] (MGD)	Available Capacity [b] (MGD)	Operation Comments
Well 11	1.7	1.7	
Well 24 A	1.6	0.0	Wells at Plant 24 are not operated simultaneously due to high power cost considerations.
Well 24 B	3.9	3.9	
Well 25	1.3	1.3	
Well 28 A	2.0	2.0	
Well 39	2.2	2.2	
Well 125	1.8	1.8	
Well 132	3.1	3.1	
Well 141	3.0	3.0	
Well 142	1.5	1.5	
Well 143	1.6	1.6	
Well 146	0.7	0.0	Wells at Plant 146 are not operated simultaneously due to aquifer capacity in this area.
Well 146 A	1.5	1.5	
Well 147	2.4	2.4	
Well 151	3.2	3.2	
TOTAL	**32.9**	**29.1**	

Notes:
(a) Rated capacity is from available data such as model design point curve and SCE tests.
(b) Available capacity is based on the calibrated model.

As a non-plaintiff party to the 1969 Western Judgment (Western Municipal Water District of Riverside County et al. v. East San Bernardino County Water District, et al. Case No. 78426), EVWD can pump groundwater to meet the needs of their customers, even in excess of their production rights (14,217 AFY, 12.69 MG), and Valley District has the responsibility to replenish the groundwater basin.

EVWD holds water rights to Santa Ana River water through its stock ownership in the North Fork Mutual Water Company, which entitles EVWD to 4 MGD on average. Plant 134 treats water from the Santa Ana River using membrane microfiltration and supplements this supply with imported water from the State Water Project (SWP) purchased from Valley District. EVWD completed the expansion of Plant 134 from 4 MGD to 8 MGD in early 2013, which results in a combined system wide supply capacity of 37.1 MGD from both ground and surface water sources.

6.3.2 System-wide Supply Evaluation

A water supply analysis was performed to determine whether available water sources are sufficient to meet MDD under normal and emergency operations. Under normal operating conditions in this scenario, the excess supply is 0.6 MGD. When the largest source, Plant 134, is out of service, there is a deficit supply capacity of 7.4 MGD. Results from the system-wide supply evaluation are presented in Table 6-5.

Table 6-5: Water Supply Analysis – Existing Conditions

Description	Wells	Plant 134	Total	MDD	Available
	Value (MGD)				
All Supply Sources	29.1	8.0	37.1	36.5	0.6
Largest Source Out of Service (Plant 134)	29.1	0.0	29.1	36.5	(7.4)

6.3.3 Pressure Zone Supply Analysis

In addition to evaluating the system supply and demand as a whole, it is important that each zone has sufficient pumping capacity and supply to meet MDD in that zone while transferring excess supply to other pressure zones. In this analysis, pump capacity and available supply are used to calculate the pressure zone supply analysis. Three supply scenarios were evaluated for each pressure zone, where pumping capacity is the differentiating factor for each:

1. **Total capacity analysis:** Each pump station is assumed to run at its rated capacity as shown in Table 6-4. These capacities are based on duty pump capacity and not running the standby pump.

2. **Firm capacity analysis:** Each pump station has the largest pump removed from available supply per pressure zone. It is noted that the standby pump is available when a pump goes down, however the firm capacity analysis assumes a loss of functionality in the largest pump with no standby availability.

3. **Largest single source out of service:** Each pressure zone has the largest single source out of service. A “source” is a well or Plant 134 or the largest booster pump supplying that zone.

Note that all scenarios limit pump station capacity if the supplying zone’s transfer capacity is less than the pump station capacity (either full or firm).

Supply of each pressure zone is compared with the total demand for the pressure zone to calculate the available supply and is referred to as “**Surplus/Deficit”** in each pressure zone analysis. Total demand is MDD for the zone plus any zone transfer flow from that zone through zone transfer valves, PRVs, or boosters. To consider redundancy, the supply analysis is evaluated with the largest single-water source out of service for the pressure zone.

Transfer valve flow is only considered a demand if the downstream zone relies on this flow to meet the supply deficit. If demand is not met by either a well or WTP then it must be boosted or transferred through a valve from an adjacent zone**.** This is referred to as "**Supply Needed from Boosters or Zone Transfer"** in this analysis and is estimated in addition to the surplus/deficit. Knowing the supply needed from a booster or zone transfer is valuable information for EVWD when a supply source goes out of service, where major operational adjustments are needed to make up for the lost supply. Flow transferred between zones are a function of the surplus amount available to be transferred and booster pump capacity was not the limiting factor for these transfers.

A summary table for the existing system supply analysis is shown in Table 6-6. The total capacity and firm capacity analysis produces the same surplus of 0.5 MGD. This means the system is limited by source capacity and there is generally ample booster capacity. The single largest source analysis indicates there are supply deficits for each pressure zone except for the Intermediate Zone. In summary, the system has limited redundancy if any water sources are off-line during MDD conditions.

Table 6-6: Water Supply Analysis by Zone – Existing Conditions

Zone	MDD	Total Demand (includes zone transfers)	Total Capacity: Surplus/Deficit	Firm Capacity: Surplus/Deficit	Largest Single Source: Surplus/Deficit
	Value (MGD)				
Lower	4.0	4.0	0.0	0.0	(0.5)
Intermediate	8.8	13.9	0.5	0.5	(4.8)
Upper	12.4	12.4	0.0	0.0	(7.2)
Foothill	7.4	8.2	0.0	0.0	(5.0)
Canal1	0.1	0.1	0.0	0.0	0.0
Canal2	0.5	0.5	0.0	0.0	0.0
Canal3	2.6	3.3	0.0	0.0	(3.3)
Mountain	0.7	0.7	0.0	0.0	0.0
Total (MGD)	**36.5**		**0.5**	**0.5**	**(20.8)**

The following sections provide the supply evaluation for all three scenarios listed above per pressure zone.

Lower Zone Supply Analysis

The Lower Zone is supplied directly by Well 11, Well 28A, and several PRV and transfer valves from the Intermediate Zone. The Lower Zone has the lowest hydraulic grade in the system. The Lower Zone does not have enough well capacity to satisfy the Lower Zone MDD of 4 MGD, therefore, additional supply is provided through the PRVs and transfer valves from the Intermediate Zone. It is assumed the flow at Plants 137 and 130 from the Lower Zone to the Intermediate Zone is zero.

Based on the analysis in Table 6-7**,** there is surplus available supply except for when the largest source out of service for that zone (Well 28A). If Well 28A is out of service, the Lower Zone would have a deficit of -0.51 MGD. This is due to the limiting supply available in the Intermediate Zone, where only 1.78 MGD would be available to transfer, however, the Lower Zone needs 2.29 MGD.

Table 6-7: Lower Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells				
Well 11	Lower	1.73	1.73	1.73
Well 28 A	Lower	1.98	1.98	
Subtotal, Wells		3.71	3.71	1.73
Zone Transfers (Incoming)				
PRVs & DV (1)	Intermediate	0.31	0.31	1.78
Subtotal, Zone Transfers (Incoming)		0.31	0.31	1.78
Total Supply		4.02	4.02	3.51
Demands				
Zone Demand (MDD)		4.02	4.02	4.02
Zone Transfers (Outgoing)				
Booster 137/130	Intermediate	0.00	0.00	0.00
Subtotal, Zone Transfers (Outgoing)		0.00	0.00	0.00
Total Demand		**4.02**	**4.02**	**4.02**
Surplus/Deficit		**0.00**	**0.00**	**-0.51**
Supply Needed from Boosters or Zone Transfer		**0.31**	**0.31**	**2.29**

Notes:

(1) DV = drop valve between zones, PRV = pressure reducing valve

Intermediate Zone Supply Analysis

The Intermediate Zone is supplied directly by seven wells, two booster stations, and several PRVs from the Highland Upper Zone. The Intermediate Zone has surplus capacity to meet its MDD of 8.77 MGD, therefore, additional supply is delivered to the Upper, Foothill, and Lower Zones. After these transfers, the Intermediate Zone has an excess of 0.53 MGD.

Based on the analysis in Table 6-8 there is surplus available supply except for the largest source out of service for that zone (Well 24B) during which the excess supply to Upper and Foothill is assumed zero leaving zero surplus supply.

Table 6-8: Intermediate Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells				
Well 9	Well	Out of service due to water quality		
Well 24 A	Well	Well 24A and B do not run at the same time		
Well 24 B	Well	3.89	3.89	
Well 25	Well	1.30	1.30	1.30
Well 132	Well	3.14	3.14	3.14
Well 141	Well	2.95	2.95	2.95
Well 151	Well	3.17	3.17	3.17
Subtotal, Wells		14.44	14.44	10.55
Boosters (Incoming)				
Booster 130 - 1	Lower	1.30		1.30
Booster 130 - 2	Lower	0.92	0.92	0.92
Booster 127 - 1	Lower	1.91	1.91	1.91
Booster 127 - 2	Lower	1.92		1.92
Subtotal, Boosters (Incoming)		6.05	2.83	6.05
Subtotal, Boosters (supply limited) (1)		0.00	0.00	0.00
Total Supply		**14.44**	**14.44**	**10.55**
Demands				
Zone Demand (MDD)		8.77	8.77	8.77
Zone Transfers (Outgoing)				
Boosters	Upper	4.78	4.78	4.78
Boosters	Foothill	0.05	0.05	0.05
PRV/DV (2)	Lower	0.31	0.31	1.78
Subtotal, Zone Transfers (Outgoing)		5.14	5.14	6.61
Total Demand		**13.91**	**13.91**	**15.38**
Surplus/Deficit		**0.53**	**0.53**	**-4.83**
Supply Needed from Boosters or Zone Transfer		**0.00**	**0.00**	**4.83**

Notes:

(1) Surplus supply is not available from the Lower Zone

(2) DV = drop valve between zones, PRV = pressure reducing valve

Upper Zone Supply Analysis

The Upper Zone is supplied directly by five wells, four booster stations, and several PRVs from the Foothill Zone. Note that the Highland Upper Zone is assumed to be a part of the Upper Zone. The Upper Zone does not have surplus capacity to meet its MDD of 12.41 MGD and must rely on adjacent zones to meet the supply deficit.

Based on the analysis in Table 6-9 there is zero surplus supply for the total capacity and firm capacity analysis. With the largest source out of service for that zone (Well 147) there is a deficit of -2.45 MGD. The booster station capacity is ample even with only firm capacity considered. The limiting factor is the source capacity from adjacent zones, where only 4.78 MGD is available for transfer.

Table 6-9: Upper Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells				
Well 143	Well	1.56	1.56	1.56
Well 146[(a)]	Well	Well 146 and 146A do not run simultaneously.		
Well 146 A	Well	1.47	1.47	1.47
Well 147	Well	2.45	2.45	
Well 39	Well	2.16	2.16	2.16
Subtotal, Wells		7.63	7.63	5.18
Boosters (Incoming)				
Booster 25 - 1	Intermediate	0.83		0.83
Booster 33 - 1	Intermediate	2.34		2.34
Booster 33 - 2	Intermediate	1.44	1.44	1.44
Booster 33 - 3	Intermediate	1.07	1.07	1.07
Booster 39 - 1	Intermediate	0.61	0.61	0.61
Booster 39 - 2	Intermediate	1.04		1.04
Booster 40 - 1	Intermediate	1.44	1.44	1.44
Booster 40 - 2	Intermediate	1.44	1.44	1.44
Booster 40 - 3	Intermediate	1.44		1.44
Booster 40 - 4	Intermediate	1.44		1.44
Subtotal, Boosters (Incoming)		13.10	6.01	13.10
Subtotal, Boosters (supply limited)[(1)]		4.78	4.78	4.78
Total Supply		**12.41**	**12.41**	**9.96**
Demands				
Zone Demand (MDD)		12.41	12.41	12.41
Zone Transfers (Outgoing)				

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Boosters	Foothill	0.00	0.00	0.00
Boosters	Canal3	0.00	0.00	0.00
Subtotal, Zone Transfers (Outgoing)		0.00	0.00	0.00
Total Demand		**12.41**	**12.41**	**12.41**
Surplus/Deficit		**0.00**	**0.00**	**-2.45**
Supply Needed from Boosters or Zone Transfer		**4.78**	**4.78**	**2.45**

Notes:
1. Surplus supply available from the Intermediate Zone
2. DV = drop valve between zones
3. PRV = pressure reducing valve

Foothill Zone Supply Analysis

The Foothill Zone is supplied directly by two wells, Plant 134, and three booster stations. The Baldridge Canyon and Mercedes Zone are also considered a part of the Foothill Zone for this analysis. The Foothill Zone does not have surplus capacity to meet its MDD of 7.44 MGD and must rely on adjacent zones to meet the supply deficit.

Based on the analysis in Table 6-10 there is zero surplus supply for the total capacity and firm capacity analysis. With the largest source out of service for that zone (Plant 134) there is a deficit of -4.18 MGD. The booster station capacity is ample even with only firm capacity considered. The limiting factor is the source capacity from adjacent zones, where only 0.05 MGD is available for transfer from Intermediate and Upper Zones. It is assumed that the Intermediate Zone will be transferring water to Upper and Lower and will only have 0.05 MGD left for the Foothill Zone.

Table 6-10: Foothill Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells				
Well 142	Well	1.47	1.47	1.47
Well 125	Well	1.80	1.80	1.80
Subtotal, Wells		3.27	3.27	3.27
SWTP				
Booster 134 - 1	Supply SWTP	1.30		
Booster 134 - 2	Supply SWTP	1.24	1.24	
Booster 134 - 3	Supply SWTP	1.25	1.25	
Booster 134 - 4	Supply SWTP	1.29	1.29	
Booster 134 - 5	Supply SWTP	1.20	1.20	

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Subtotal, SWTP (from Booster 134)		6.28	4.98	
Subtotal, SWTP (supply limited)(1)		4.92	4.92	
Subtotal Well + SWTP		8.19	8.19	3.27
Boosters (Incoming)				
Booster 39 - 3	Intermediate	1.40		1.40
Booster 39 - 4	Intermediate	1.24	1.24	1.24
Booster 37 - 1	Upper	1.57	1.57	1.57
Booster 37 - 2	Upper	1.58		1.58
Booster 129 - 1	Upper	2.37	2.37	2.37
Booster 129 - 2	Upper	2.36	2.36	2.36
Booster 129 - 3	Upper	2.37		2.37
Subtotal, Boosters (Incoming)		12.89	7.54	12.89
Boosters Intermediate (Supply limited)(2)		0.05	0.05	0.00
Boosters Upper (Supply limited)(2)		0.00	0.00	0.00
Total Supply		**8.24**	**8.24**	**3.27**
Demands				
Zone Demand (MDD)		**7.44**	**7.44**	**7.44**
Zone Transfers (Outgoing)				
Booster 56	Canal 1	0.13	0.13	0.00
Booster 99	Canal 2	0.47	0.47	0.00
Booster 108/131	Canal 3	0.20	0.20	0.00
Subtotal, Zone Transfers (Outgoing)		0.80	0.80	0.00
Total Demand		**8.24**	**8.24**	**7.44**
Surplus/Deficit		**0.00**	**0.00**	**-4.18**
Supply Needed from Boosters or Zone Transfer		**0.00**	**0.00**	**4.18**

Notes:

1. SWTP booster pumps to the Foothill Zone is supply limited as it supplied both Foothill and Upper.
2. Boosters are supply limited as Intermediate and Upper do not have surplus supply for the Foothill Zone.
3. DV = drop valve between zones
4. PRV = pressure reducing valve

Canal 1 Zone Supply Analysis

The Canal 1 Zone is supplied directly by Booster Station 56. This station has ample capacity (3 MGD) to meet Canal 3 MDD of 0.13 MGD.

Based on the analysis in Table 6-11 there is zero surplus supply for the total, firm, and largest single source capacity analysis. While not shown in the table, it should be noted that if Plant 134 was out of service, the Canal 1 Zone would not be served since Foothill is supplied by Plant 134.

Table 6-11: Canal 1 Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells		0.00		0.00
Boosters (Incoming)				
Booster 56 - 1	Foothill	1.01	1.01	1.01
Booster 56 - 2	Foothill	2.02		
Subtotal, Boosters (Incoming)		3.02	1.01	1.01
Subtotal, Boosters (supply limited)		0.13	0.13	0.13
Total Supply		**0.13**	**0.13**	**0.13**
Demands				
Zone Demand (MDD)		0.13	0.13	0.13
Zone Transfers (Outgoing)				
		0.00	0.00	0.00
Subtotal, Zone Transfers (Outgoing)		0.00	0.00	0.00
Total Demand		**0.13**	**0.13**	**0.13**
Surplus/Deficit		**0.00**	**0.00**	**0.00**
Supply Needed from Boosters or Zone Transfer		**0.13**	**0.13**	**0.13**

Notes:

1. DV = drop valve between zones
2. PRV = pressure reducing valve

Canal 2 Zone Supply Analysis

The Canal 2 Zone is supplied directly by Booster Station 99. This station has ample capacity (1.73 MGD) to meet Canal 3 MDD of 0.47 MGD.

Based on the analysis in Table 6-12 there is zero surplus supply for the total, firm, and largest single source capacity analysis. While not shown in the table, it should be noted that if Plant 134 was out of service, the Canal 2 Zone would not be served since Foothill is supplied by Plant 134.

Table 6-12: Canal 2 Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells		0.00		0.00
Boosters (Incoming)				
Booster 99 - 1	Foothill	0.96		
Booster 99 - 2	Foothill	0.77	0.77	0.77
Subtotal, Boosters (Incoming)		1.73	0.77	0.77
Boosters (supply limited)		0.47	0.47	0.47
Total Supply		**0.47**	**0.47**	**0.47**
Demands				
Zone Demand (MDD)		0.47	0.47	0.47
Zone Transfers (Outgoing)				
Subtotal, Zone Transfers (Outgoing)		0.00	0.00	0.00
Total Demand		**0.47**	**0.47**	**0.47**
Surplus/Deficit		**0.00**	**0.00**	**0.00**
Supply Needed from Boosters or Zone Transfer		**0.47**	**0.47**	**0.47**

Notes:
1. DV = drop valve between zones
2. PRV = pressure reducing valve

Canal 3 Zone Supply Analysis

The Canal 3 Zone is the largest Canal Zone. It is supplied directly by Plant 134, and boosters 129, 131, 108, and 142. The booster stations have ample capacity (8.93 MGD) to meet Canal 3 MDD of 2.56 MGD, however, these boosters are supply limited and are unable to contribute much flow for long durations during MDD conditions. Therefore, during MDD, Canal 3 Zone relies heavily on Plant 134 to meet its MDD of 2.56 MGD and the 0.72 MGD that is pumped to the Mountain Zone from Canal 3.

Based on the analysis in Table 6-13 there is zero surplus supply for the total capacity and firm capacity analysis. With the largest source out of service for that zone (Plant 134) there is a deficit of -3.28 MGD.

Table 6-13: Canal 3 Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells				
SWTP				
Booster 134 - 6	Supply SWTP	0.90	0.90	
Booster 134 - 7	Supply SWTP	0.95	0.95	
Booster 134 - 8	Supply SWTP	1.23	1.23	
Subtotal, SWTP		3.08	3.08	0.00
Subtotal Well + SWTP		3.08	3.08	0.00
Boosters (Incoming)				
Booster 129 - 4	Upper	1.41		1.41
Booster 129 - 5	Upper	1.40	1.40	1.40
Booster 131 - 1	Foothill	0.73		0.73
Booster 131 - 2	Foothill	0.39	0.39	0.39
Booster 131 - 3	Foothill	0.42	0.42	0.42
Booster 108 - 1	Foothill	1.73	1.73	1.73
Booster 108 - 2	Foothill	1.74		1.74
Booster 142 - 3	Foothill	1.12		1.12
Subtotal, Boosters (Incoming)		8.93	3.93	8.93
Boosters Upper (Supply limited)		0.00	0.00	0.00
Boosters Foothill (Supply limited)		0.20	0.20	0.00
Total Supply		**3.28**	**3.28**	**0.00**
Demands				
Zone Demand (MDD)		2.56	2.56	2.56
Zone Transfers (Outgoing)				

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Boosters 137/140	Mountain	0.72	0.72	0.72
Subtotal, Zone Transfers (Outgoing)		0.72	0.72	0.72
Total Demand		**3.28**	**3.28**	**3.28**
Surplus/Deficit		**0.00**	**0.00**	**-3.28**
Supply Needed from Boosters or Zone Transfer		**0.00**	**0.00**	**3.28**

Notes:

1. DV = drop valve between zones
2. PRV = pressure reducing valve

Mountain Zone Supply Analysis

The Mountain Zone is supplied directly by Plant 134, and boosters 129, 131, 108, and 142. The booster stations have ample capacity (3.85 MGD) to meet Mountain Zone's MDD of 0.72 MGD. The Mountain Zone relies 100 percent on Canal 3.

Based on the analysis in Table 6-14 there is zero surplus supply for the total capacity and firm capacity analysis. With the largest source out of service for that zone (Booster 140-2), the remaining boosters can meet MDD for Mountain Zone. While not shown in the table, it should be noted that if Plant 134 was out of service, the Mountain Zone would not be served since Canal 3 is heavily dependent on Plant 134.

Table 6-14: Mountain Zone Existing Supply Analysis

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Supply				
Wells		0.00	0.00	0.00
Boosters (Incoming)				
Booster 137 - 1	Canal3	0.79		0.79
Booster 137 - 2	Canal3	0.79	0.79	0.79
Booster 140 - 1	Canal3	1.12	1.12	1.12
Booster 140 - 2	Canal3	1.15		
Subtotal, Boosters (Incoming)		3.85	1.91	2.70
Boosters (supply limited)		0.72	0.72	0.72
Total Supply		**0.72**	**0.72**	**0.72**
Demands				
Zone Demand (MDD)		0.72	0.72	0.72

Source	Zone	Total Capacity (MGD)	Firm Capacity (MGD)	Capacity w/ Largest Source Out (MGD)
Zone Transfers (Outgoing)				
Subtotal, Zone Transfers (Outgoing)		0.00	0.00	0.00
Total Demand		**0.72**	**0.72**	**0.72**
Surplus/Deficit		**0.00**	**0.00**	**0.00**
Supply Needed from Boosters or Zone Transfer		**0.72**	**0.72**	**0.72**

Notes:

1. DV = drop valve between zones
2. PRV = pressure reducing valve

Pressure Zone Supply Analysis Summary

The pressure zone evaluation indicates that the system would use almost all available supply sources during MDD. Most pressure zones have a deficit in supply when their single largest supply source is offline. With that said, it is likely EVWD can supply deficit pressure zones from neighboring zones for a few days if needed. However, this temporary solution has limited duration during MDD conditions. Intermediate, Upper, and Foothill would all benefit from additional supply sources, such as a new well or WTP. The recommended supply amount for existing conditions is specified in the next section.

6.4 RELIABILITY ANALYSIS

6.4.1 Major Transmission Breaks

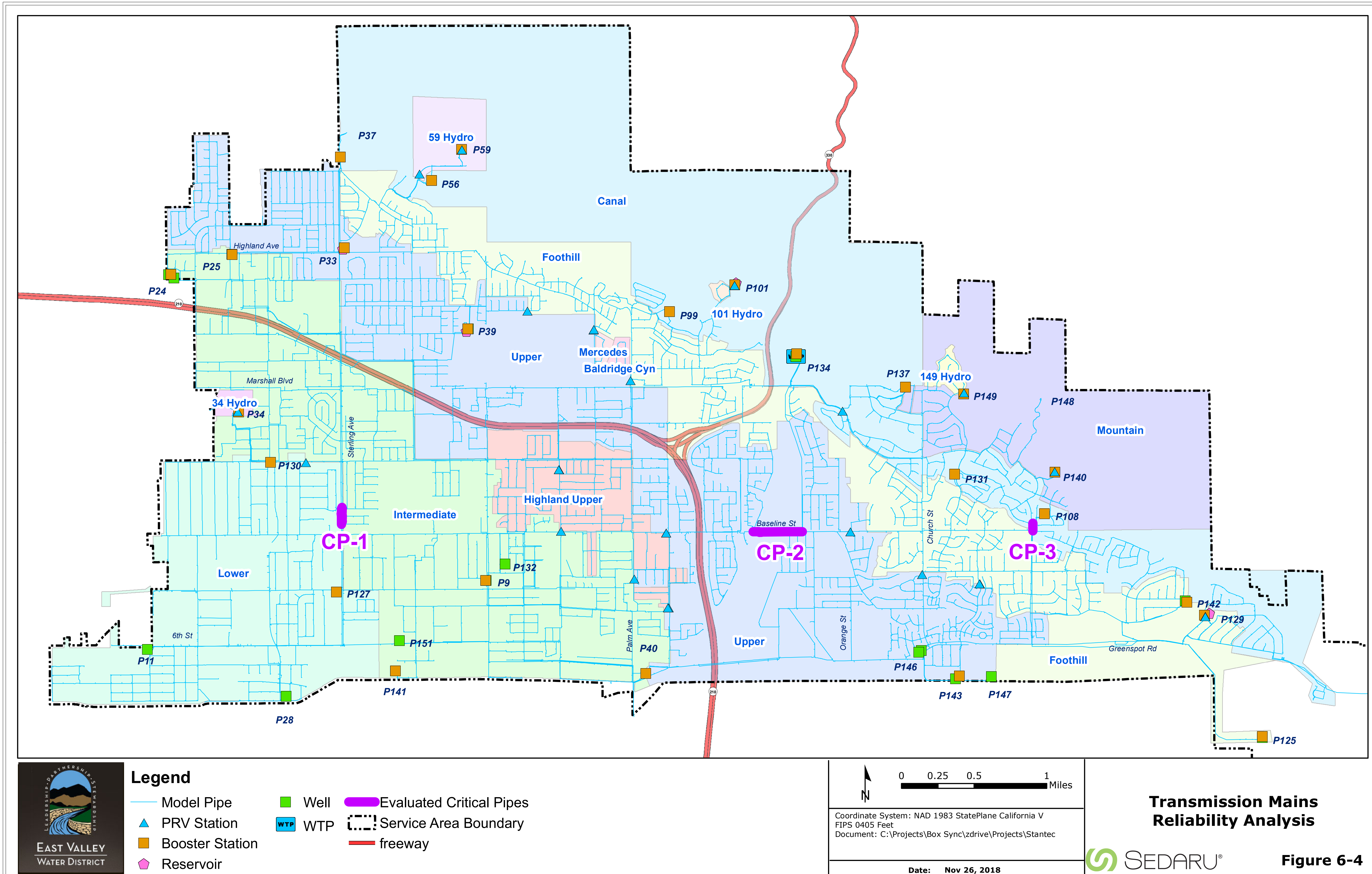
The hydraulic model was used to evaluate the impact of transmission main breaks on the distribution system. Three critical pipeline failures were tested to measure system impacts. Pipe breaks are identified as critical when pressures are insufficient, water demands cannot be met, or a combination of both. Based on the hydraulic model simulations, the list below provides a description of the failure impacts and proposed solutions to mitigate each failure. The critical pipes (CP) are shown on Figure 6-4**.**

- **CP-1**: 190 linear feet of 36-inch diameter (Intermediate Zone) pipe at the intersection of Sterling Avenue and 13th Street, which supplies the zone from Well 141 and Well 151. If this pipeline fails, there should not be a significant loss of service. Plant 132 can continue to supply the zone and the system would not be affected significantly while the pipeline is repaired.

- **CP-2**: 2,300 linear feet of 16-inch diameter (Upper Zone) pipe on Base Line Road, between Tarnell Road and Boulder Avenue. The hydraulic model indicates that the pressure in proximity to the pipeline failure will just meet the 40-psi requirement when served from the Upper Zone. System pressures will be significantly lower should a fire occur under this mode of operation.

- **CP-3**: 300 linear feet of 12-inch diameter (Canal 3 Zone) pipeline on Weaver Street between Clear View Lane and Base Line Road. This pipeline supplies Canal 3 Zone from Plant 108. If a pipe breaks along this alignment, water service will be interrupted for customers in Canal 3 Zone east of Plant 108. To mitigate the service interruption while the main is being repaired, EVWD should either operate Canal 3 pumps in Plant 129 or Pump 3 at Plant 142 (PMP_142_3). This break will result in the service area being a closed system.

As described above, solutions to mitigate each critical pipe failure can be achieved through short term operational changes. It is assumed that it would be acceptable to interrupt water service temporarily in these areas while the main break is being repaired and the temporary emergency response is put in place. To limit the duration of interrupted water service, it is recommended that EVWD develop an emergency response plan to mitigate interruptions to its customers during a failure of a major supply line.



Transmission Mains Reliability Analysis

Figure 6-4

6.4.2 Imported Water Out of Service for Seven Days

The existing system is evaluated for a scenario in which Plant 134 is out of service for seven consecutive maximum demand days. The system has sufficient supply and booster pumping capabilities to meet one day but will reach a storage deficit by the end of four days. A 7-day outage of Plant 134 would need an additional 23.3 MG of storage that could be delivered to the system. It is noted that the analysis assumes MDD demands during the outage, and during average demand conditions the system could meet demands for longer than 4 days. Table 6-15 provides a summary of each scenario.

Should the surface water treatment plant at Plant 134 be out of service for a 7-day period, operations of each pump station would have to be reviewed to ensure that the pumps remain operational during the outage to transfer water between pressure zones in the system. Also, during an outage scenario such as this, customer consumption would likely be cut back while the service interruption is repaired.

Table 6-15: Existing Water Source Reliability – Plant 134 Out of Service

	1 day (MG)	4 days (MG)	7 days (MG)
Water Demand			
MDD	36.5	146.0	255.5
Water Supply Sources			
Groundwater	29.1	116.2	203.4
Imported water(1)	0	0	0.0
Emergency Storage	28.8	28.8	28.8
Total Available Water Supply	**57.8**	**145.0**	**232.2**
Surplus/Deficit meeting MDD(2)	**21.3**	**-1.0**	**-23.3**

1. Plant 134 is the only imported water source for the existing system, which is out of service rendering 0 mgd capacity
2. Surplus/Deficit = Total available Water Supply - MDD

The total additional daily supply needed to meet the existing system 7-day outage is 3.30 MGD (23.3/7).

The recommendation for the existing system reliability evaluation is to construct 2,000 gpm of well capacity in the Intermediate, Upper, or Foothill Zones. The zones have excess booster station capacity and can transfer water to other parts of the system. Per EVWD, one new well would range between 1,500 and 2,000 gpm (2.14 and 2.88 MGD). Assuming one new well at 2.88 MGD, a deficit of 0.42 MGD would remain.

6.5 NEAR-TERM SYSTEM DISTRIBUTION ANALYSIS

This section identifies the infrastructure needed to address near-term demands based on water demand projections through the near-term as presented in Section 3. Recommended improvements are summarized at the end of this section, while the Recommended System Improvements with cost estimates and proposed phasing for these improvements is presented in Section 8.

The hydraulic model reflecting the existing distribution system is used to evaluate the system under the near-term demand conditions for the following three criteria and the results of these analyses are discussed below.

- Meet Near-Term Peak Hour Demand (PHD) while maintaining a minimum pressure of 40 psi
- Meet Near-Term Maximum Day Demand (MDD) with fire flow while maintaining a minimum residual pressure of 20 psi
- Meet Near-Term Minimum Day Demand (ADD) while not exceeding a maximum pressure of 125 psi

The same approach used in the existing evaluation is used for near-term evaluations. The system is run with the existing system recommendations incorporated into the model, and any additional deficiencies are addressed with additional recommendations.

6.5.1 Minimum Pressure During Peak Hour Demand (PHD)

For the first criterion, the model is run for 24 hours under near-term MDD conditions. The results from this are shown on **Figure 6-5**. As shown on the figure, the hydraulic simulation identified 37 demand junctions with pressures below 40 psi. Low pressures at these 37 demand junctions varied between 8 and less than 40 psi. Similar to the existing system evaluation, inspection of the low-pressure areas reveals that the deficiencies are caused by ground elevation and not pipe capacity (high velocities and or high head losses). In addition, it should be noted that there are fewer junctions below 40 psi than in the existing system pressure evaluation. The difference is due to the existing system being evaluated under an EPS MDD scenario versus a steady-state PHD. EPS is preferred if possible; however, the supply shortage under near-term demand is too large for the model to successfully finish a near-term MDD EPS model run. The existing system MDD EPS has more nodes below 40 psi because of system changes, such as a pump turning on, that might drop pressure slightly outside of peak hour. This difference is considered negligible.

The low-pressure areas are called out as Area 1, 2, and 3 on Figure 6-5. Model nodes in these areas have elevations that are very close to their pressure zone's hydraulic grade established by tank level. These model nodes will have low-pressure even with significantly reduced demands and reduced head loss between the supplying tank and low-pressure area.

Infrastructure is not needed to specifically address the 37 demand junctions below 40 psi under near-term demands. As with the existing system demands, it is recommended that EVWD monitor pressure in Areas 1, 2, and 3 specifically during higher demand conditions.

In addition to analyzing pressures, high-velocity pipelines are analyzed to find any hydraulic restrictions in the system. Figure 6-6 shows the maximum velocities observed during the near-term EPS MDD simulation. Note that pipes with velocities above 6 fps are colored purple with thick lines, and pipes above 8 fps are colored red with thick lines.

A large amount of future demand is projected in the eastern part of the system in Canal 3. There would be significant pipeline capacity issues that would require transmission pipe upgrades if the water were conveyed through the Canal 3 zone. A significant amount of transmission upgrades can be avoided by connecting future developments to the Foothill Zone, as the Foothill Zone has larger transmission mains that reach the eastern part of the system. Therefore, the Foothill Zone would be used to convey the water to the east, and then the water would be pumped into the higher elevations of the developments from that Zone.

The large transmission main in the Foothill Zone should be connected to the existing 20-inch line along Greenspot Road that is supplied by the Canal Zone. This zone serves EVWD headquarters and is planned to serve the future Mediterra Development. An analysis of the Mediterra Development and recommendation on new infrastructure to serve this development was conducted by Stantec and Sedaru, and is presented in Appendix E.

Connecting this area to the Foothill Zone as opposed to serving from the Canal 3 Zone would require less infrastructure improvements than adding new transmission piping in Canal 3. The Foothill Zone 20-inch pipeline supplying the projected growth to the eastern part of the system has a velocity of 3.2 fps, which does not exceed design criteria. Additional pumping, storage, and pipelines will be needed to provide service for the planned Harmony Development and other development in the eastern part of the system. A pump station and storage tank will lower the head loss in the 20-inch line and minimize pressure in the southeast part of the Foothill Zone. The recommended pump station and storage locations are shown on Figure 8-2.

Figure 6-5 shows the proposed connection to the foothill zone in detail which is described as T-2 in Table 6-16. T-2 is included on the near-term system recommendations map on Figure 8-2.

The near-term pipeline, storage, and pumping recommendations that address minimum pressures are summarized in Table 6-16, Table 6-17, and Table 6-18 respectively. Note that additional recommendations are provided later in the near-term evaluation.

Based on conversations with EVWD regarding the Harmony development and the results of the model, three projects are recommended to specifically address the growth from this development. The Harmony Transmission Pipeline, tank S-1, and PMP-1 are all recommended to specifically serve this development in the eastern portion of the service area. These recommendations are accounted for when making further recommendations for the system.

Table 6-16: Transmission Improvements – Near-Term Conditions

Pipe ID	Diameter (inches)	Length (feet)	Trigger/Need*	Project Description
T-2	20	50	Sunland Development	Reconfiguration of pipe at Greenspot Rd and Santa Paula St
Harmony Transmission Pipe	24	5,500	Harmony Development	Dependent on growth in the eastern part of the system (Harmony Development).

*Information for the Trigger/Need for each project provided by EVWD staff

Table 6-17: Storage Improvements – Near-Term Conditions

Tank ID	Size (MG)	Trigger/Need*	Project Description
S-1	4.5	Harmony and other eastern service area development	Proposed tank in future growth area in the eastern part of the system.

*Information for the Trigger/Need for each project provided by EVWD staff

Table 6-18: Pumping Improvements – Near-Term Conditions

Pump ID	Size (MGD @ TDH)	Trigger/Need*	Project Description
PMP-1	3.7 MGD @ 250 FT	Harmony and other eastern service area development	Proposed booster station for future growth in eastern part of system.

*Information for the Trigger/Need for each project provided by EVWD staff

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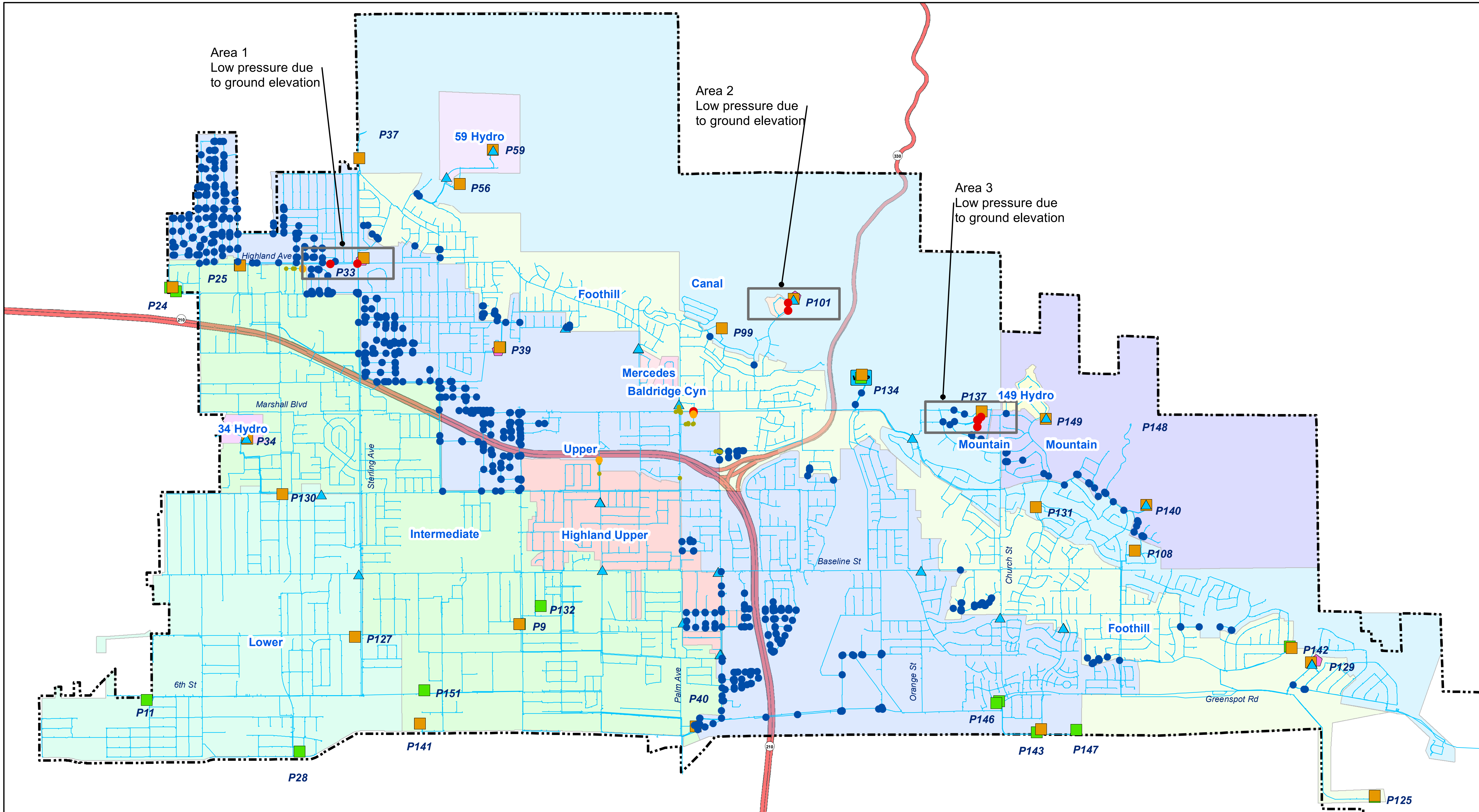


Legend

Pressure

- min pressure less than 30 psi
- min pressure is 30 to 35 psi
- min pressure is 35 to 40 psi
- max pressure is more than 125 psi

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe
- Service Area Boundary
- freeway

0 0.25 0.5 1 Miles

N

Coordinate System: NAD 1983 StatePlane California V
FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

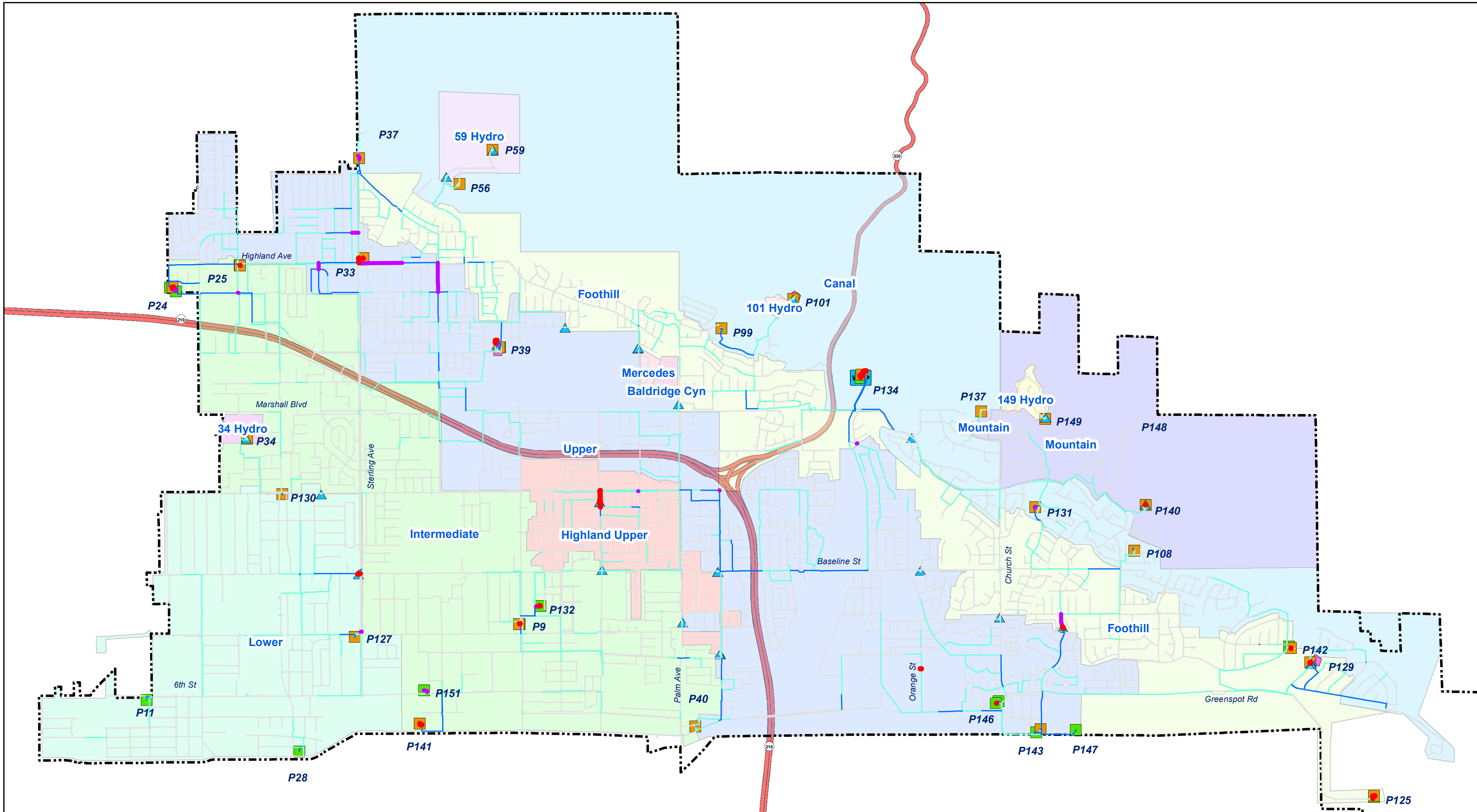
Date: Dec 20, 2018

East Valley Water District

Sedaru

Near-Term System Pressure Analysis

Figure 6-5



Legend

Maximum Velocity

- < 1 fps
- 1-3 fps
- 3-6 fps
- 6-8 fps
- > 8 fps
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Service Area Boundary
- freeway

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
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Date: Dec 20, 2018

East Valley Water District

SEDARU

Near-Term System Velocity Analysis

Figure 6-6

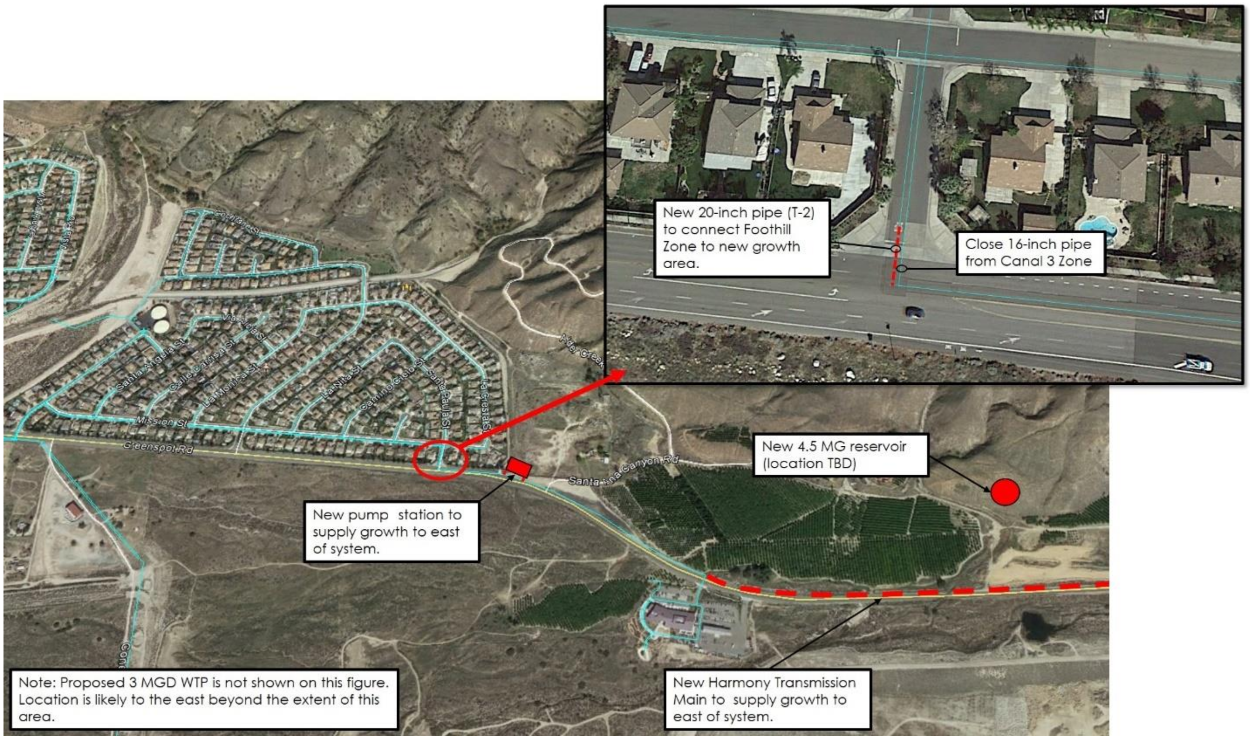

Figure 6-7: Proposed Infrastructure to Address Growth in East Part of System

Note: Storage recommended for this development would be supplied from the Foothill Zone and should be sited at an elevation sufficient to provide adequate pressure to the development based on final design of phases.

6.5.2 Maximum Pressure during Average Daily Demand (ADD)

The hydraulic model is used to identify areas where the maximum pressure exceeded 125 psi under near-term ADD. Maximum system pressures are largely dependent on tank levels and pressure zone boundaries. Because no recommendations on zone boundary changes are made, the analysis for maximum pressures in the near-term system does not change from the analysis in the existing system. These findings are verified in the model with future demands as well and no improvements are recommended. Maximum pressure results are included on Figure 6-5.

6.5.3 Minimum Pressure with MDD Plus Fire Flow

The hydraulic model is used to evaluate the impact of fire flows on the distribution system under near-term MDD conditions. The near-term fire flow is tested without the existing system fire flow recommendations to fully evaluate the current system's capability to handle fire flow with near-term demands. The same approach and criteria used in the existing system fire flow are used for the near-term evaluation. Hydrants that cannot supply MDD plus fire flow within 10 percent of required flow rate, at a minimum pressure of 20 psi within the pressure zone are identified as not meeting criteria. Hydrants that do not meet the fire flow criteria are shown on Figure 6-8. Flows within 10% are shown on this figure as well for EVWD reference.

The model simulation results show that the fire flow demands can be met at 83 percent of the hydrant junctions while maintaining the minimum pressure criteria of 20 psi at all demand junctions within each pressure zone. A total of 426 hydrant junctions, approximately 17 percent of the existing system, did not meet the residual pressure criterion of 20 psi when the entire fire flow demand is supplied from one location as depicted on Figure 6-8. However, firefighting often requires the use of multiple fire hydrants to produce the needed flow. The model evaluates fire flow availability by looking at a single hydrant under the highest (MDD) demand conditions as a conservative analysis. The analysis is intended to identify any areas where fire flow performance can be improved so EVWD can coordinate these activities with other system improvements.

The near-term fire flow results are very similar to the results from the existing system analysis; only 8 additional hydrants do not meet recommended criteria.

6.6 NEAR-TERM SYSTEM STORAGE EVALUATION

The storage and emergency supply analyses are performed for each pressure zone with near-term MDD. Storage criteria are presented in Section 5 of this report. A summary of the required and available storage volumes is presented in Table 6-19 by pressure zone. This table indicates that EVWD will have a total deficiency of approximately 14.75 MG storage capacity for the system in the near-term. This represents a net deficiency of 9.25 MG for the near-term assuming the 5.5 MG of storage recommendations for the existing system are implemented.

Recommendations from the near-term system storage evaluation are summarized below and are based upon the analysis presented in Table 6-19 and the resultant storage deficit that is calculated. These recommendations assume the additional storage recommendations from the existing system evaluation have been implemented: All recommendations for storage in the near-term scenario are driven by the growth projected from the will serve list.

- Construct 4.5 MG of storage (Tank S-1) in the east part of the system to serve the Harmony Development, connected to the eastern Canal Zone or Foothill Zone. This storage is accounted for when addressing deficiency in the Foothill Zone.
- Construct 2.75 MG of additional storage in the Foothill Zone.
- Construct 2.0 MG of additional storage in the Canal 3 Zone

Storage recommendations are listed by pressure zone except for S-1. This tank is needed to supply future growth east of the system. A storage evaluation of this new area was completed based on the near-term and build-out demand projections. The analysis assumed a commercial fire flow demand of 3,000 gpm is required for this area and that new supply has backup power. This resulted in a storage deficit of 4.0 and 4.5 for near-term and build-out system, respectively. Therefore, it is recommended to construct 4.5 MG of storage for the near-term.

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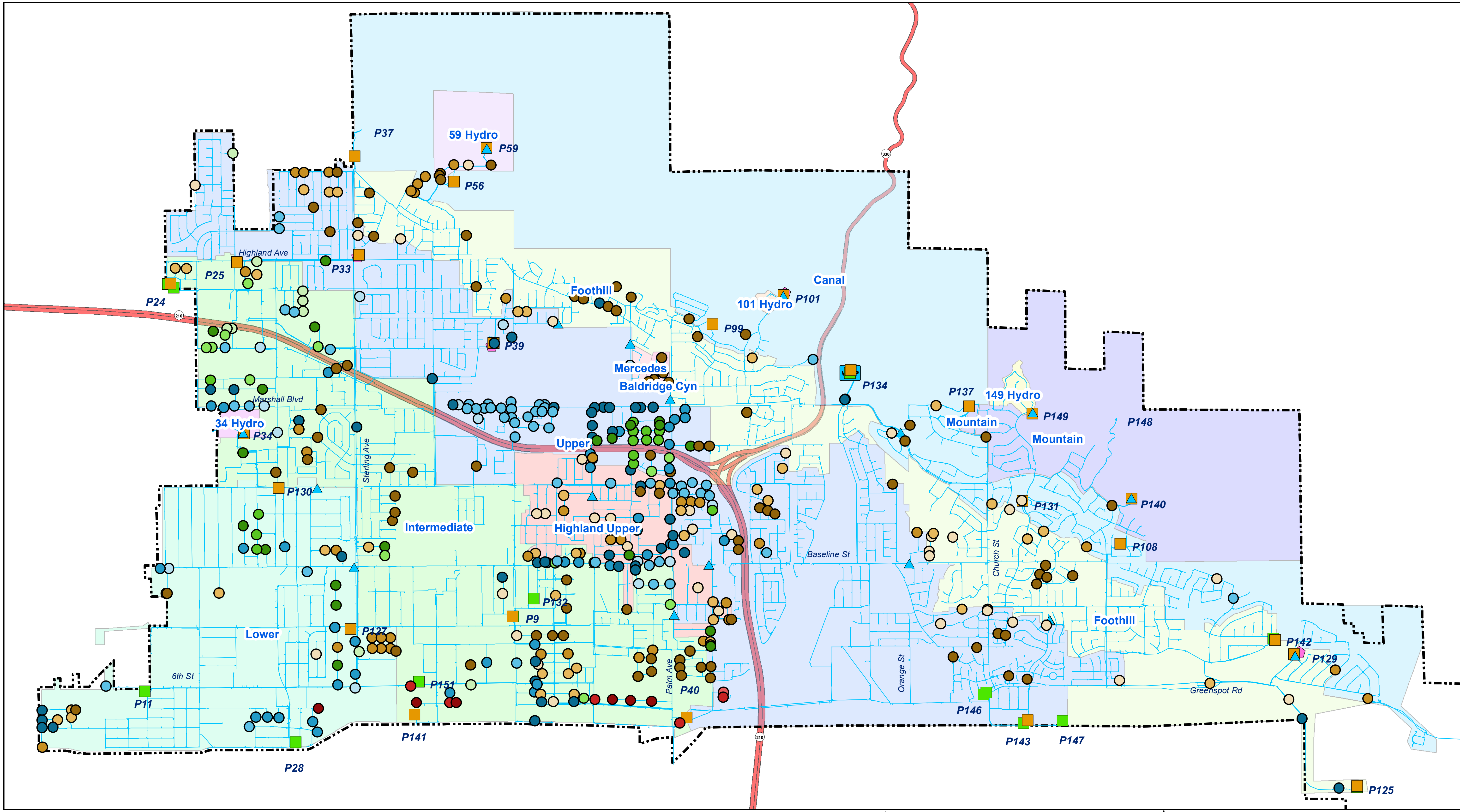

Legend

1500 gpm	2500 gpm	3000 gpm	4000 gpm
< 50%	< 50%	< 50%	< 50%
50% - 75%	50% - 75%	50% - 75%	50% - 75%
75% - 90%	75% - 90%	75% - 90%	75% - 90%
> 90%	> 90%	> 90%	> 90%

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe
- Service Area Boundary
- freeway

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Dec 20, 2018

EAST VALLEY WATER DISTRICT

Near-Term System

Fire Flow Analysis

Hydrants Not Meeting Criteria

Percent Fire Flow Available

SEDARU

Figure 6-8

Table 6-19: Near-Term Water System Storage Capacity Evaluation

Pressure Zone	Demands			Storage Required						Storage Evaluation			
	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs.)	Fire Flow (MG)	Operational (MG)	Emergency (MG)	Required (MG)	Available (MG)	Available Supply During Power Failure (MG)	Surplus/Deficit (MG)	Recommended (MG)
Lower	**2.26**	**1.8**	**4.06**	**4,000**	**4**	**0.96**	**1.02**	**4.06**	**6.04**	**0.99**	**2.00**	**-3.05**	**3.50**
Sub-zone Hydro34	0.02	1.8	0.03	3,000	3	0.54	0.01	0.03	0.57	0.00	0.00	-0.57	-
Intermediate	**4.92**	**1.8**	**8.85**	**4,000**	**4**	**0.96**	**2.21**	**8.85**	**12.03**	**6.80**	**10.00**	**4.78**	**-**
Upper	**7.73**	**1.8**	**13.92**	**4,000**	**4**	**0.96**	**3.48**	**13.92**	**18.36**	**13.05**	**8.90**	**3.60**	**-**
Foothill	**7.37**	**1.8**	**13.27**	**3,000**	**3**	**0.54**	**3.32**	**13.27**	**17.12**	**3.07**	**5.20**	**-8.85**	**8.75**
Canal1	**0.05**	**1.8**	**0.09**	**1,500**	**2**	**0.18**	**0.02**	**0.09**	**0.29**	**0.71**	**0.00**	**0.42**	**-**
Sub-zone Hydro59	0.04	1.8	0.07	1,500	2	0.18	0.02	0.07	0.27	0.00	0.00	-0.27	-
Canal2	**0.29**	**1.8**	**0.52**	**1,500**	**2**	**0.18**	**0.13**	**0.52**	**0.83**	**1.34**	**0.00**	**0.50**	**-**
Sub-zone Hydro101	0.02	1.8	0.04	1,500	2	0.18	0.01	0.04	0.23	0.00	0.00	-0.22	-
Canal3	**2.24**	**1.8**	**4.03**	**3,000**	**3**	**0.54**	**1.01**	**4.03**	**5.58**	**2.05**	**1.70**	**-1.83**	**2.00**
Mountain	**0.32**	**1.8**	**0.57**	**1,500**	**2**	**0.18**	**0.14**	**0.57**	**0.90**	**0.72**	**0.00**	**-0.18**	**0.50**
Sub-zone Hydro149	0.09	1.8	0.17	1,500	2	0.18	0.04	0.17	0.39	0.00	0.00	-0.39	-
Grand Total	**25.34**	**N/A**	**45.62**	**N/A**	**N/A**	**5.58**	**11.40**	**45.62**	**62.60**	**28.75**	**27.80**	**-6.05**	**14.75**
Recommended Storage in Existing Scenario (MG)													**5.5**
Net Near-Term Deficiency (MG)													**9.25**

Notes:

1. Fire flow based on highest estimated requirement per zone
2. Operational Storage equals 0.25 times MDD
3. Emergency Storage equals 1.0 times MDD
4. Surplus is positive, and deficit is negative
5. Storage capacity recommended could be provided in the deficient zone or in higher pressure zones
6. Storage capacity recommendations are rounded to nearest 0.25 MG.
7. Available supply during a power failure is based on well and WTP capacity with a transfer power switch or backup generators.
8. Near-term storage evaluation table does not include any proposed supply with secondary power

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6.7 NEAR-TERM SYSTEM SUPPLY ANALYSIS

A discussion of the supply sources for EVWD's existing system and their adequacy under near-term demand conditions is presented.

6.7.1 System-wide Supply Evaluation

A water supply analysis is performed to determine whether available water sources are sufficient to meet near-term MDD. Under normal operating conditions in this scenario, the deficit supply is 8.56 MGD. When the largest source, Plant 134, is out of service, there is a deficit supply of 16.56 MGD. This indicates that there is a deficiency in supply under the near-term system with the largest supply source out of service. Results from the system-wide supply evaluation are presented in Table 6-20.

Table 6-20: Water Supply Analysis – Near-Term Conditions

	Well Supply (MGD)	Plant 134 Capacity (MGD)	Total Supplies (MGD)	MDD (MGD)	Excess Supply (MGD)
All Supply Sources	29.06	8.00	37.06	45.62	(8.56)
Largest Source Out of Service (Plant 134)	29.06	0.00	29.06	45.62	(16.56)

New supply sources are needed based on near-term MDD conditions. These supply recommendations are provided in the following section.

6.7.2 Pressure Zone Supply Analysis

In addition to evaluating the system supply and demand system wide, it is important that each zone has sufficient pumping capacity and supply to meet MDD in that zone while transferring excess supply to other pressure zones. In this analysis, pump capacity and available supply are used to calculate the pressure zone supply analysis. Three supply scenarios were evaluated for each pressure zone, where pumping capacity is the differentiating factor for each:

1. **Total capacity analysis:** Each pump station is assumed to run at rated capacity as shown in Table 6-4. These capacities are based on duty pump capacity and not running the standby pump.

2. **Firm capacity analysis:** Each pump station has the largest pump removed from available supply per pressure zone.

3. **Largest single source out of service:** Each pressure zone has the largest single source out of service. A "source" is a well or Plant 134 or the largest booster pump supplying that zone.

Note that all scenarios limit pump station capacity if the supplying zone's transfer capacity is less than the pump station capacity (either full or firm). Refer to the Existing System Supply Analysis for a detailed explanation of the methodology.

A summary table for the near-term system supply analysis is shown in Table 6-21. When compared with the existing system pressure zone analysis, demand is the only variable, therefore only the summary table is provided in this section. Evaluations for each zone were performed on a desktop spreadsheet analysis. The total capacity and firm capacity analysis produce the same deficit of 8.6 MGD. This means the system is limited by source capacity and there is generally ample booster capacity. The single largest source analysis indicates there are supply deficits for each pressure zone except for the Intermediate Zone.

Table 6-21: Water Supply Analysis by Zone – Near-Term Conditions

Zone	MDD	Total Demand (includes zone transfers)	Total Capacity: Surplus/Deficit	Firm Capacity: Surplus/Deficit	Largest Single Source: Surplus/Deficit
	Value (MGD)				
Lower	4.1	4.1	0.0	0.0	(0.7)
Intermediate	8.9	14.4	0.0	0.0	0.0
Upper	13.9	13.9	(1.1)	(1.1)	(8.7)
Foothill	8.8	8.8	(0.6)	(0.6)	(5.6)
Canal1	0.2	0.2	(0.2)	(0.2)	(0.2)
Canal2	0.6	0.6	(0.6)	(0.6)	(0.6)
Canal3	8.5	8.5	(5.4)	(5.4)	(8.5)
Mountain	0.7	0.7	(0.7)	(0.7)	(0.7)
Total (MGD)	**45.6**		**(8.6)**	**(8.6)**	**(24.9)**

The total recommended additional supply to meet near-term system needs is 8.6 MG. Recommendations from the near-term system reliability evaluation are summarized below:

- Construct one 2,083 gpm (3.0 MGD) capacity SWTP or 2,000 gpm well east of the system where growth is projected in order to serve North Fork Santa Ana River water.
- Construct two 2,000 gpm capacity wells in the Intermediate, Upper, or Foothill Zones. This is in addition to the one well recommended in existing system evaluation. The zones have excess booster station capacity and can transfer water to other parts of the system. Per EVWD, a new well would range between 1,500 and 2,000 gpm (2.14 and 2.88 MGD).

The above supply recommendations would give the near-term system a surplus of 3.0 MGD; however, the model indicated this excess supply is needed as not all wells are at 100 percent production due to pump output based on tank level and several tanks emptied if only two wells and the proposed SWTP are active.

6.8 BUILD-OUT SYSTEM DISTRIBUTION ANALYSIS

This section identifies the infrastructure needed to address build-out demands based on water demand projections through the year 2040 as presented in Section 3. Recommended improvements are summarized at the end of this section, while the Recommended System Improvements with cost estimates and proposed phasing for these improvements is presented in Section 8.

6.8.1 Minimum Pressure during Peak Hour Demand (PHD)

The pressure analysis results for the build-out evaluation are shown on Figure 6-9. As shown on the figure, the hydraulic simulation identified 41 demand junctions with pressures below 40 psi. Low pressures at these 41 demand junctions varied between 9 and less than 40 psi. These areas are called out as Area 1, 2, and 3 on Figure 6-9**.** Model nodes on these areas have elevations that are very close to their pressure zone's hydraulic grade established by tank level. Infrastructure is not needed to specifically address the 41 demand junctions below 40 psi under build-out demands. It is recommended that EVWD monitor pressure in Areas 1, 2, and 3 specifically during higher demand conditions.

In addition to analyzing pressures, high-velocity pipelines are analyzed to find hydraulic restrictions in the system. Figure 6-10 shows the maximum velocities observed during the build-out EPS MDD simulation. Note that pipes with velocities above 6 fps are colored purple with thick lines, and pipes above 8 fps are colored red with thick lines. None of the bottlenecks in the system prevent water delivery to current and future customers.

There are no build-out recommendations made that directly address minimum pressure issues. Recommendations for additional storage and supply is provided later in the build-out analysis.

6.8.2 Maximum Pressure during Average Daily Demand (ADD)

The hydraulic model is used to identify areas where the maximum pressure exceeded 125 psi under build-out ADD. As mentioned in the existing and near-term analysis, no recommendations on zone boundary changes are made and no improvements are recommended for the build-out system. Maximum pressure results are included on Figure 6-9.

6.8.3 Minimum Pressure with MDD plus Fire Flow

The build-out fire flow is tested without the existing system fire flow recommendations to fully evaluate the current system's capability to handle fire flow with build-out demands. The same approach and criteria used in the existing and near-term system fire flow evaluation are used for the build-out evaluation. Hydrants that cannot supply MDD plus fire flow within 10 percent at a minimum pressure of 20 psi at all demand junctions within the pressure zone are identified as not meeting criteria. Hydrants that do not meet the fire flow criteria are shown on Figure 6-11. Flows within 10% are shown on this figure as well for EVWD reference.

The build-out fire flow results are very similar to the existing and near-term, where only 8 additional hydrants do not meet criteria. Given that build-out demand is based on growth, no further fire flow improvements are recommended.

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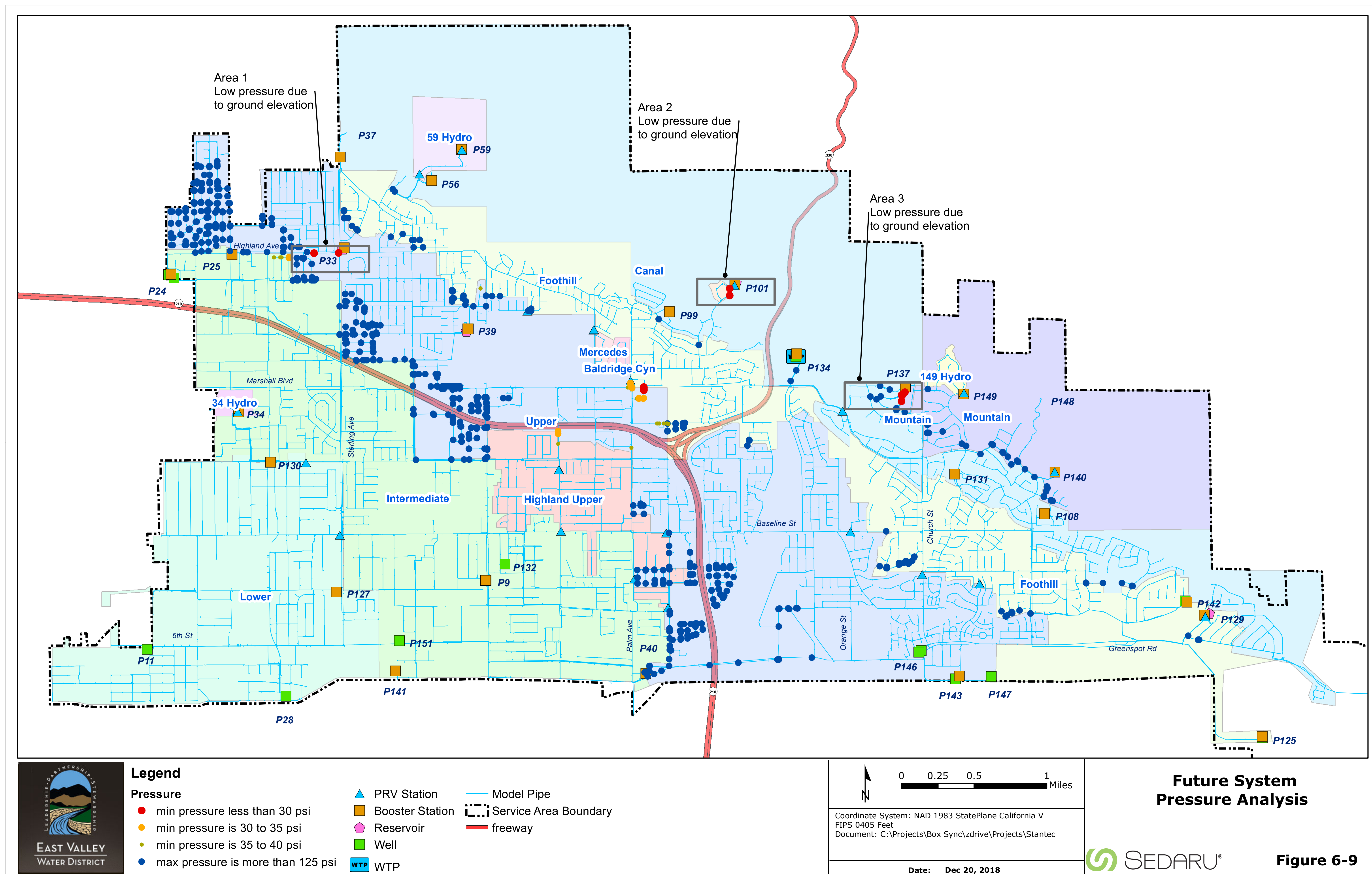
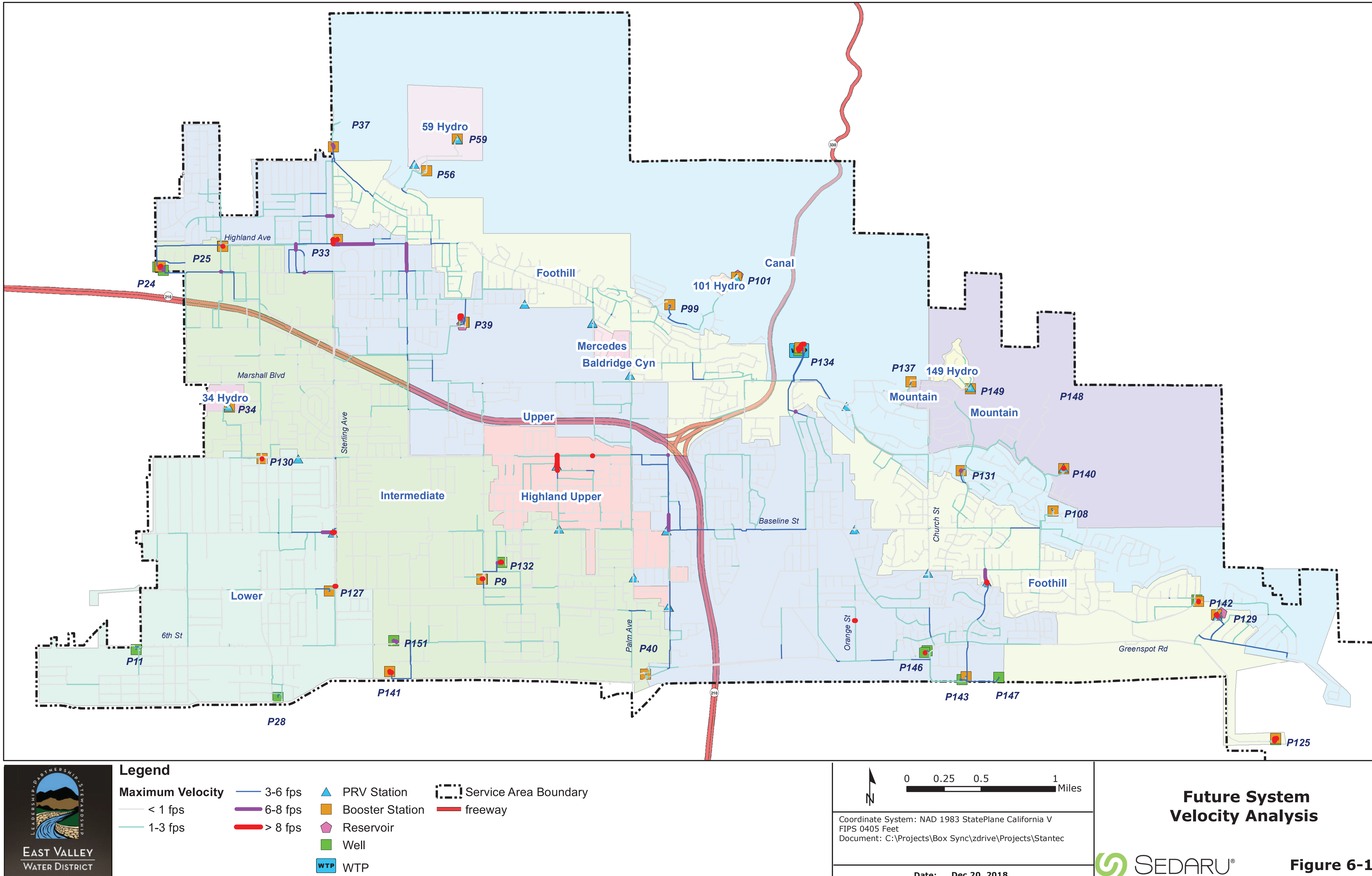

Area 1
Low pressure due
to ground elevation
Area 2
Low pressure due
to ground elevation
Area 3
Low pressure due
to ground elevation
P37
59 Hydro
P59
P56
Highland Ave
P33
P25
P24
Foothill
Canal
P101
P99
P39
Mercedes
Baldridge Cyn
P134
P137
149 Hydro
P149
P148
Mountain
Mountain
Marshall Blvd
34 Hydro
P34
Upper
Sterling Ave
P130
P131
P140
Intermediate
Highland Upper
P108
Baseline St
Church St
P132
P9
Lower
P127
Foothill
P142
P129
6th St
P11
P151
Palm Ave
P40
Orange St
Greenspot Rd
P146
P141
P143
P147
P28
P125
Legend
Pressure
min pressure less than 30 psi
min pressure is 30 to 35 psi
min pressure is 35 to 40 psi
max pressure is more than 125 psi
PRV Station
Booster Station
Reservoir
Well
WTP
WTP
Model Pipe
Service Area Boundary
freeway
East Valley
Water District
N
0
0.25
0.5
1
Miles
Coordinate System: NAD 1983 StatePlane California V
FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec
Date: Dec 20, 2018
Future System
Pressure Analysis
SEDARU
Figure 6-9



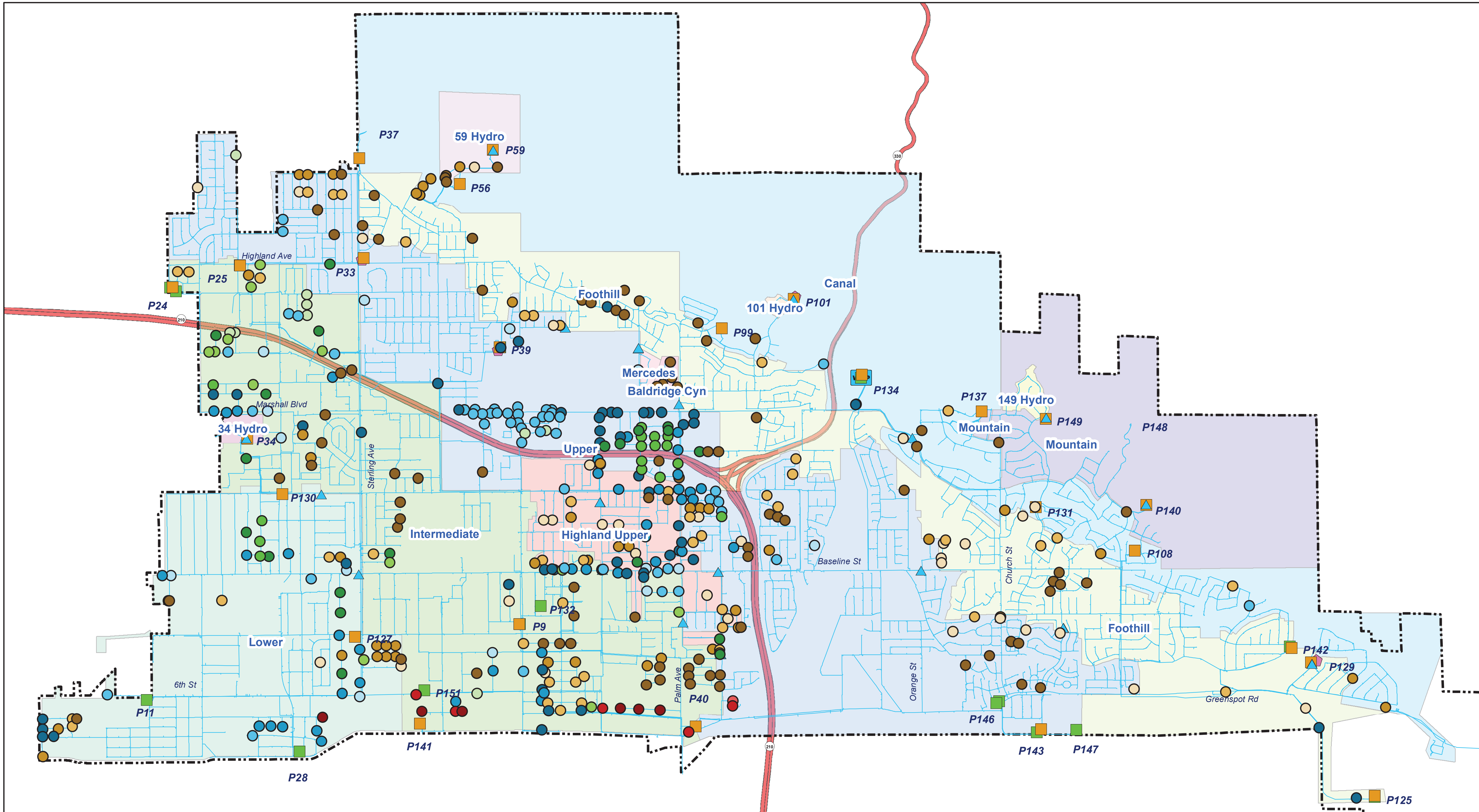
Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Dec 20, 2018

Future System Velocity Analysis

SEDARU®

Figure 6-10



Legend

1500 gpm	2500 gpm	3000 gpm	4000 gpm
< 50%	< 50%	< 50%	< 50%
50% - 75%	50% - 75%	50% - 75%	50% - 75%
75% - 90%	75% - 90%	75% - 90%	75% - 90%
> 90%	> 90%	> 90%	> 90%

- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe
- Service Area Boundary
- freeway

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Dec 20, 2018

East Valley Water District

Future System Fire Flow Analysis

Hydrants Not Meeting Criteria
Percent Fire Flow Available

SEDARU®

Figure 6-11

6.9 BUILD-OUT SYSTEM STORAGE EVALUATION

The storage and emergency supply analysis is performed for each pressure zone with build-out MDD. Storage criteria are presented in Section 5 of this report.

A summary of the recommended and available storage volumes is presented in Table 6-22 by pressure zone. This table indicates that EVWD will have a total deficiency of approximately 18.0 MG storage capacity for the build-out demand. The storage recommendations for the build-out scenario equal a combined net storage of 3.25 MG and assumes that recommendations from the earlier scenarios have been implemented

Recommendations from the build-out system storage evaluation are summarized below, and are based upon the analysis presented in Table 6-22 and the resultant storage deficit that is calculated: All of the deficiencies stem from projected growth in the service area.

- Construct 0.75 MG of additional storage in the Lower Zone
- Construct 0.50 MG of additional storage in the Foothill Zone
- Construct 0.25 MG of additional storage in the Canal 1 Zone
- Construct 0.75 MG of additional storage in the Canal 2 Zone
- Construct 0.75 MG of additional storage in the Canal 3 Zone
- Construct 0.25 MG of additional storage in the Mountain Zone.

It is recommended that EVWD consider building enhances storage in the near-term and existing scenarios that incorporate ultimate storage needs for a zone through all scenarios. For example, 0.5 MG of storage is recommended for the Mountain Zone in the existing system analysis, with another 0.25 MG recommended in this scenario; in order to efficiently implement storage projects, it is recommended that EVWD construct on 0.75 MG tank in order to address both existing and build-out deficiency.

The recommended storage of 3.25 MG assumes no additional supply will have standby power. If the proposed additional supply in the near-term has standby power, then the capacity of this supply would decrease recommended storage by 3 MG in the zone that the supply feeds.

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Table 6-22: Build-Out Water System Storage Capacity Evaluation

Pressure Zone	Demands			Storage Required						Storage Evaluation			
	ADD (mgd)	Peaking Factor	MDD (mgd)	Fire Flow (gpm)	Duration (hrs.)	Fire Flow (MG)	Operational (MG)	Emergency (MG)	Required (MG)	Available (MG)	Available Supply During Power Failure (MG)	Surplus/Deficit (MG)	Recommended (MG)
Lower	**2.57**	**1.8**	**4.63**	**4,000**	**4**	**0.96**	**1.16**	**4.63**	**6.75**	**0.99**	**2.00**	**-3.76**	**4.25**
Sub-zone Hydro34	0.02	1.8	0.04	3,000	3	0.54	0.01	0.04	0.59	0.00	0.00	-0.59	-
Intermediate	**5.32**	**1.8**	**9.58**	**4,000**	**4**	**0.96**	**2.40**	**9.58**	**12.94**	**6.80**	**10.00**	**3.86**	**-**
Upper	**8.48**	**1.8**	**15.26**	**4,000**	**4**	**0.96**	**3.81**	**15.26**	**20.03**	**13.05**	**8.90**	**1.92**	**-**
Foothill	**7.56**	**1.8**	**13.61**	**3,000**	**3**	**0.54**	**3.40**	**13.61**	**17.55**	**3.07**	**5.20**	**-9.28**	**9.25**
Canal1	**0.21**	**1.8**	**0.38**	**1,500**	**2**	**0.18**	**0.09**	**0.38**	**0.65**	**0.71**	**0.00**	**0.06**	**0.25**
Sub-zone Hydro59	0.04	1.8	0.08	1,500	2	0.18	0.02	0.08	0.28	0.00	0.00	-0.28	-
Canal2	**0.72**	**1.8**	**1.30**	**1,500**	**2**	**0.18**	**0.33**	**1.30**	**1.81**	**1.34**	**0.00**	**-0.47**	**0.75**
Sub-zone Hydro101	0.02	1.8	0.04	1,500	2	0.18	0.01	0.04	0.23	0.00	0.00	-0.22	-
Canal3	**2.61**	**1.8**	**4.69**	**3,000**	**3**	**0.54**	**1.17**	**4.69**	**6.40**	**2.05**	**1.70**	**-2.65**	**2.75**
Mountain	**0.33**	**1.8**	**0.60**	**1,500**	**2**	**0.18**	**0.15**	**0.60**	**0.93**	**0.72**	**0.00**	**-0.21**	**0.75**
Sub-zone Hydro149	0.18	1.8	0.33	1,500	2	0.18	0.08	0.33	0.59	0.00	0.00	-0.59	-
Grand Total	**28.08**	**N/A**	**50.54**	**N/A**	**N/A**	**5.58**	**12.63**	**50.54**	**68.75**	**28.75**	**27.80**	**-12.20**	**18.00**
Recommended Storage in Existing Scenario (MG)													**14.75**
Net Near-Term Deficiency (MG)													**3.25**

Notes:

1. Fire flow based on highest estimated requirement per zone
2. Operational Storage equals 0.25 times MDD
3. Emergency Storage equals 1.0 times MDD
4. Surplus is positive, and deficit is negative
5. Storage capacity recommended could be provided in the deficient zone or in higher pressure zones
6. Storage capacity recommendations are rounded to nearest 0.25 MG.
7. Available supply during a power failure is based on well and WTP capacity with a transfer power switch or backup generators.
8. Future storage evaluation table does not include any proposed supply with secondary power

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6.10 BUILD-OUT SYSTEM SUPPLY ANALYSIS

A discussion of the supply sources for EVWD's existing system and their adequacy under build-out demand conditions is presented.

6.10.1 System-wide Supply Evaluation

A water supply analysis is performed to determine whether available water sources are sufficient to meet build-out MDD. Under normal operating conditions in this scenario, the deficit supply is 13.44 MGD. When the largest source, Plant 134, is out of service, there is a deficit supply of 21.44 MGD. This indicates that there is a deficit in supply under the build-out system with the largest supply source out of service. Results from the system-wide supply evaluation are presented below in Table 6-23.

Table 6-23: Water Supply Analysis – Build-Out Conditions

	Well Supply (MGD)	Plant 134 Capacity (MGD)	Total Supplies (MGD)	MDD (MGD)	Excess Supply (MGD)
All Supply Sources	29.06	8.00	37.06	50.5	(13.44)
Largest Source Out of Service (Plant 134)	29.06	0.00	29.06	50.5	(21.44)

New supply sources are needed based on build-out MDD conditions. These supply recommendations are provided in the following section.

6.10.2 Pressure Zone Supply Analysis

A summary table for the build-out system supply analysis is shown in Table 6-24. When compared with the existing system and near-term pressure zone analysis, only the demand is the variable, therefore only the summary table is provided in this section. Evaluations for each zone were performed on a desktop spreadsheet analysis. The total capacity and firm capacity analysis produce the same deficit of 13.5 MGD. This means the system is limited by source capacity and there is generally ample booster capacity. The single largest source analysis indicates there are supply deficits for each pressure zone except for the Intermediate Zone.

Table 6-24: Water Supply Analysis by Zone – Build-Out Conditions

Zone	MDD (MGD)	Total Demand (MGD) (includes zone transfers)	Total Capacity: Surplus/Deficit (MGD)	Firm Capacity: Surplus/Deficit (MGD)	Largest Single Source: Surplus/Deficit (MGD)
Lower	4.7	4.7	0.0	0.0	(2.0)
Intermediate	9.6	14.4	0.0	0.0	0.0
Upper	15.3	15.3	(3.7)	(3.7)	(10.1)
Foothill	13.6	13.6	(5.4)	(5.4)	(10.3)
Canal1	0.5	0.5	(0.5)	(0.5)	(0.5)
Canal2	1.3	1.3	(1.3)	(1.3)	(1.3)
Canal3	4.7	4.7	(1.6)	(1.6)	(4.7)
Mountain	0.9	0.9	(0.9)	(0.9)	(0.9)
Total (MGD)	**50.5**		**(13.5)**	**(13.5)**	**(29.8)**

The total recommended additional supply to meet existing system needs is 13.5 MG. Recommendations from the build-out system reliability evaluation are summarized below:

- Construct two 2,000 gpm capacity wells in the Intermediate, Upper, or Foothill Zones. This is in addition to the supply and storage recommendations in the existing and near-term evaluations. The zones have excess booster station capacity and can transfer water to other parts of the system. Per EVWD, a new well would range between 1,500 and 2,000 gpm (2.14 and 2.88 MGD).

The addition of two wells at 2.88 MGD will provide the system with a surplus of 3.9 MGD. The hydraulic model confirmed these additional wells are needed to keep all tanks cycling during the build-out MDD EPS scenario. Given the uncertainty of existing well status in the build-out, these wells are recommended from a redundancy standpoint and a critical part of build-out supply and operations.

7.0 GIS MANAGEMENT EVALUATION

7.1 INTRODUCTION

EVWD's water GIS network was audited with the intention of helping EVWD improve the process of ensuring the GIS data are model-ready to more easily update and integrate GIS data in the hydraulic model.

In general, GIS layers representing a water system are comprehensive and not needed in entirety to develop a hydraulic model. However, there are model details that are essential for modeling, but are unnecessary when building GIS layers. Based on the audit, these critical details are identified to enable EVWD to achieve more seamless GIS integration in the future.

After reviewing the overall schema and data, a sample area was selected to import into the modeling software, identify issues with those data sets, and present EVWD with recommendations to implement into the overall GIS workflow.

7.2 GIS AUDIT

The GIS audit was performed with the required model data in mind. The model consists of the following element types:

- Nodes, which represent the following elements:
    - Junctions consisting of fittings, fire hydrants, and non-control valves
    - Valves consisting of control valves and zone boundary valves
    - Pumps
    - Tanks
- Wells, and other water sources, e.g. treatment plant and interconnections with adjacent systems
- Links, which represent pipes and consist of water distribution and transmission mains
- Operation data, such as control valve settings and pump curves/rating
- Control data, such as pump ON/OFF levels and bypass valve controls
- Demand data and fire flow requirements

7.2.1 Geodatabase Review

While the geodatabase provided by EVWD contains layers representing its water distribution system, only layers relevant to model development were reviewed, referred to as primary layers. The primary layers include wMain, wFitting, wValve, wFireHydrant, and wLateralLine, and contain comprehensive accounting of system features needed for model development. Other layers, including wTank, wPump, wBooster, wWells, wReservoirs, wPlant, wWaterStructure, and wRegulatingStation, have incomplete information about corresponding assets in the system. Also, internal facility piping connecting pumps, tanks, and wells to the system was not available in GIS. Table 7-1 includes a list of feature classes in Water.mdb geodatabase relevant for the water model development. Table 7-2 shows the primary layers, the selected attribute fields for each, and their use for model importation.

Table 7-1. Feature Classes Relevant to Water Model Development

GIS Feature Class	Data Type	Import into Model?	Comments
wFitting	Point	Yes	Deactivate any that do not split pipes.
wFireHydrant	Point	Yes	
wValve	Point	Yes	Deactivate any that do not split pipes.
wMain	Line	Yes	
wLateralLine	Line	Yes	Import fire hydrant laterals only.
wAbandonedLine	Point	No	Use as reference.
wAbandonedPoint	Point	No	Use as reference.
wBoosters	Polygon	No	Use as reference.
wLeaks	Point	No	
wManhole	Point	No	
wMeter	Point	No	Use for demand allocation in model.
wPlant	Point	No	Layer represents water sources and is currently incomplete.
wPump	Point	No	Layer represents individual pumps and is currently incomplete.
wRegulatingStation	Point	No	Layer represents regulating valves and is currently incomplete.
wReservoir	Polygon	No	Layer represents system tanks and is currently incomplete.
wSamplingStation	Point	No	
wWells	Polygon	No	
wWaterStructure	Polygon	No	Use as reference.

Table 7-2. Summary of Primary Layers and Selected Fields

GIS Feature Class	Field	# Records with Null or Empty	# Duplicate Records	Purpose
wMain	FacilityID	18	27	Import
	Enabled	0	-	Filter
	InstallDate	1	-	Import
	OperatingStatus	1	-	Filter
	Material	36	-	Import
	MainSize	5	-	Import
	PressureZone	9	-	Import
	MainlineType	0	-	Filter/Import
wFitting	FacilityID	73	36	Import
	Enabled	0	-	Filter
	InstallDate	11,915	-	Import
	OperatingStatus	1,282	-	Filter
	FittingType	0	-	Filter/Import
wValve	FacilityID	104	8	Import
	Enabled	165	-	Filter
	InstallDate	1,171	-	Import
	OperatingStatus	292	-	Filter
	ValveSize	163	-	Import
	ValveType	38	-	Import
	NormallyClosed	3	-	Import/Filter
	ValvePurpose	261	-	Import/Filter
wFireHydrant	FacilityID	2	76	Import
	Enabled	2	-	Filter
	OperatingStatus	62	-	Filter
	FireHydrantType	2	-	Import
	HydrantSize	57	-	Import
wLateralLine	FacilityID	28	20	Import
	Enabled	0	-	Filter
	OperatingStatus	236	-	Filter
	Material	1,229	-	Import
	LateralType	0	-	Filter/Import
	LateralSize	272	-	Import

As mentioned in Table 7-1, there are GIS Layers that represent primary system components and currently don't include all existing elements. These layers are as follows:

- wRegulatingStation, a point layer that includes control valves, e.g. PRV's,

- wPump, a point layer that includes individual pumps within a plant,
- wReservoir, a point layer that includes storage tanks, and
- wPlant, a point layer that includes all water sources, e.g. wells and treatment plants.

7.2.2 Facility Piping Review

Currently, piping within facilities, i.e. plants, is not maintained in EVWD's GIS. To better integrate the hydraulic model with GIS, it is recommended that the system layout within each facility be maintained in GIS. While detailed representation can be of value from asset management perspective, simple representation is sufficient for modeling purposes. Detailed representation can use complex edges, with pipes splitting at Fittings, Pumps, and/or Valves that will be included in the model, as shown on Figure 7-1.

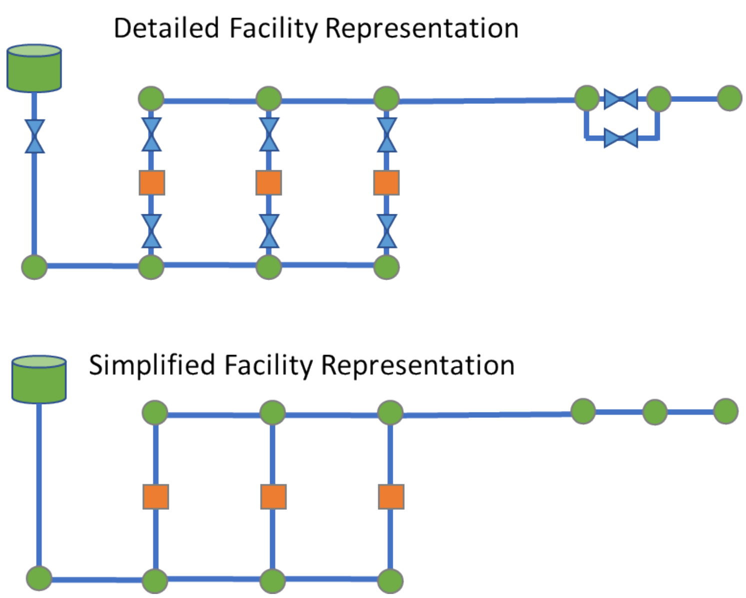


Figure 7-1. Facility Representation in GIS and Model

7.2.3 Updating GIS Layers

To build or update the hydraulic model, there are mandatory attributes and data that are required for the model to be valid, while other fields are needed for informational purposes. Shown in Table 7-3 is a list of existing GIS attributes and a listing of proposed additional fields.

Table 7-3: Layer Attributes-Required, Informational, and Proposed

GIS Feature Class	Existing Fields Required	Existing Fields Informational	Proposed Fields
wFitting	FacilityID	OperatingStatus, InstallData, FittingType	PressureZone, inModel
wFireHydrant	FacilityID	OperatingStatus, InstallData, FireHydrantType, HydrantSize	PressureZone, inModel
wValve	FacilityID	OperatingStatus, InstallData, ValveType, ValveSize, Valve Purposed, NormallyClosed	PressureZone, inModel
wPipe	FacilityID, MainSize, Shape_Length	OperatingStatus, InstallData, MainlineType, Material, Pressurezone	inModel
wLateralLine	FacilityID, LatSize, Shape_Length	OperatingStatus, InstallData, LateralType, Material	PressureZone, inModel
wRegulatingStation	FacilityID, RegulatingStationType, PressureIn, PressureOut	OperatingStatus, InstallData, RegulatingStationType, PressureZoneIn, PressureZoneOut	inModel
wPump	FacilityID, InletDiameter, RatedFlow, RatedPressure, PumpType	OperatingStatus, InstallData, Name	PressureZoneIn, PressureZoneOut, inModel
wReservoir	FacilityID	FacilityType, StructureType, Name, LocationDescription	PressureZone, inModel, Diameter*, Elevation*, Maximum Level*,
wPlant	FacilityID	OperatingStatus, InstallData, Name	Pressurezone, inModel,

*Data required to run a valid model.

- **FacilityID:** Relationship between different model elements is maintained through connectivity and a unique ID. A unique ID, which is mapped to the FacilityID attribute in GIS, should be unique not only in individual layers, but amongst all layers associated with the model. In the case of abandoning features, IDs should not be reused.
- **PressureZone:** This is helpful for all features to reference and establish connectivity in the model.

- **InModel:** A Boolean field used to identify GIS features to be included in a hydraulic model. For example, a service line would be marked with a value of NO while an active water main would be marked with a value of YES.

Other information that is required for model purposes not maintained in GIS includes operation data (e.g. control valve setting, and pump curves/rating), control data (e.g. pump ON/OFF levels, and bypass valve controls), and demands (e.g. system demand for various demand conditions, and fire flow demand).

7.3 GIS SAMPLE AREA

Only a small sample was imported in the model to identify data issues. The sample area was selected in the Upper Zone north of Plant 25 and is shown on Figure 7-2. This area contains 919 junctions (fittings and non-control valves), 958 pipes (mains and laterals), and 11 valves (zone boundary valves) which represents about 6 percent of the overall system by linear footage. Table 7-4 shows the primary layers, a summary of the filters to apply during a model import, and statistics for the whole system.

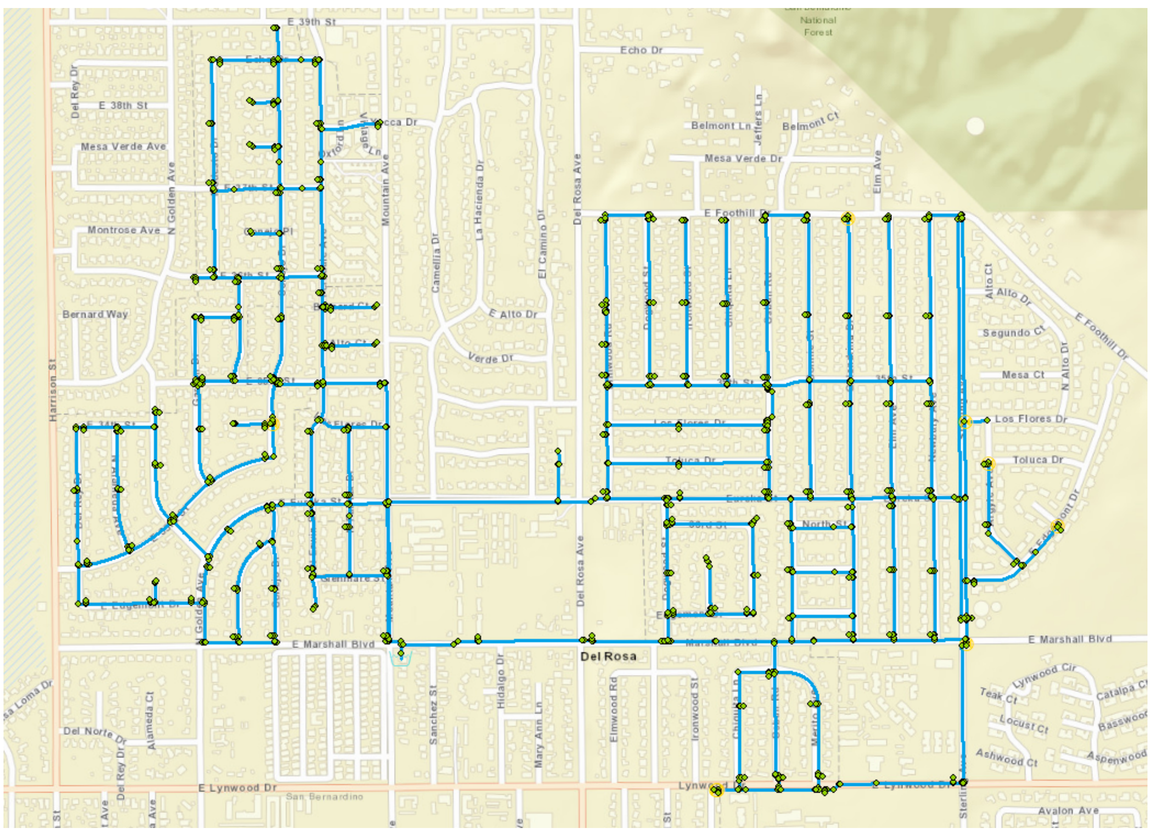


Figure 7-2 GIS Audit Sample Area

Table 7-4. Summary of Primary Layers Imported and Used for Sample Area Audit

GIS Feature Class	Model Layer	# of Features[1]	Filters for Features to be Included in Model	# Filtered Features[1]
wMain	Pipes	14,308	[OperatingStatus] = 0 (Active) AND [MainlineType] IN (0 , 2) (Main & Transmission) (Excludes: Drain)	14,195
wFitting	Junctions	32,494	[OperatingStatus] = 0 (Active) AND [MainlineType] <> 7 (Excludes: Service Saddle) (Includes: Bend, Cross, Tee, Reducer, Cap, Tapping Sleeve, Service Saddle, Pipe Change, Coupling, Corp Stop, Terminating Point, and Vertical Offset)	9,972
wValve (Normally Open)	Junctions	8,337	[OperatingStatus] = 0 (Active) AND [ValvePurpose] IN ('Main' , 'Hydrant' , 'BlowOff') (Excludes: AirRelease, FireService, MeterService)	7,107
wValve (Normally Closed)	Valves	8,337	[OperatingStatus] = 0 (Active) AND [ValvePurpose] IN ('Main' , 'Hydrant' , 'BlowOff') AND (Excludes: Air Vacuum, FireService, MeterService) [NormallyClosed] = 1 (Includes: Closed Valves)	42
wFireHydrant	Junctions	3,027	[OperatingStatus] = 0 (Active)	2,963
wLateralLine	Pipes	28,650	[OperatingStatus] = 0 (Active) AND [MainlineType] IN (1 , 4 , 5 , 10) (Includes: FireHydrant, BlowOff, Manifold, Capped) (Excludes: FireService, AirRelease, WaterServiceLine, Domestic, Commercial, Irrigation, Network, and Multi-Family)	5,711

1. Feature statistics reported for entire system.

7.4 DATA IMPORT AND CONNECTIVITY REVIEW

Hydraulic models require connectivity to be established between all model elements, which are represented by points and lines. Integration between GIS and hydraulic model is facilitated when connectivity is already established in GIS, saving time and effort in model development and update.

7.4.1 Connectivity QA/QC

To review the connectivity established in GIS with respect to the model, the primary layers were imported into the model using InfoWater's GIS Gateway tool. The GIS Gateway was set up to only import features that meet the filter criteria.

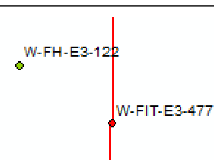
InfoWater has built-in Network Review/Fix and Connectivity tools that were used to review network connectivity and identify connectivity issues, described as follows:

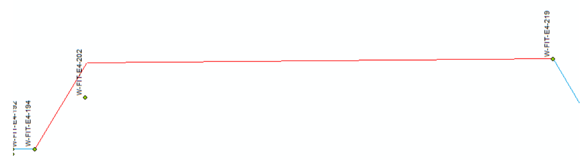
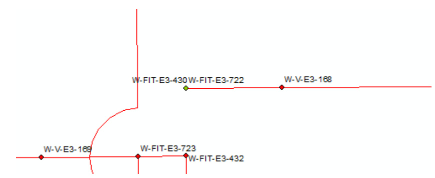
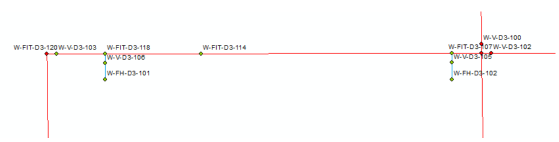
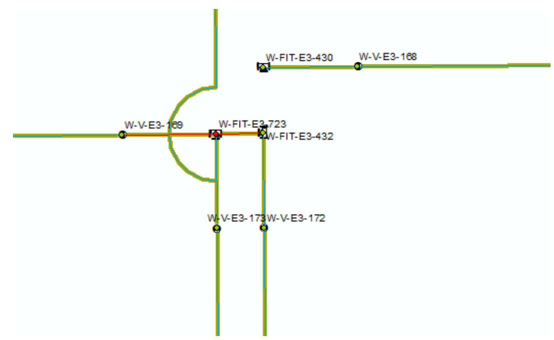
- **Trace Network Disconnect (TND)** – Nodes or pipes that are not connected to the system. Disconnected elements in a hydraulic model prevent the model from running, as they have no connection to a water source.
- **Orphan Nodes/Pipes (Orphan)** – Orphan nodes are not connected to a model pipe. An Orphan pipe is missing either a “To” node or a “From” node, or both. Most Orphan nodes will also be identified in the Trace Network command as Disconnected (TND).
- **Nodes in Close Proximity (NICP)** – Nodes that overlap or are duplicated. The NICP search tolerance is a critical parameter and can be defined as a percentage of the shortest pipe length.
- **Pipe Split Candidates (PSC)** – Nodes that lie on top of a pipe but do not split the pipe. These may have a significant impact on connectivity required by the modeling software. The PSC search tolerance is a critical parameter and can be defined as a percentage of the shortest pipe length.
- **Crossing/Intersecting Pipes (CP)** – Pipes that are crossing another pipe but do not split each other with a junction.
- **Parallel Pipes (PP)** – Multiple pipes that have the same START and END nodes but have different alignment.
- **Duplicate Pipes (DP)** – Multiple pipes that have the same START and END nodes and have the same alignment.
- **Diameter Discrepancy (DD)** – Pipes in series that change diameter significantly along a run of pipe. For example, a pipe segment that has the following diameters: 36” – 6” – 36.” This would be considered to have a diameter discrepancy. The 6” section of pipe may be the result of an input error. Diameter changes of equal to or greater than 8 inches is recommended.

7.4.2 Summary of QA/QC Findings

Based on the data import and connectivity review of the sample area shown on Figure 7-1, Table 7-5summarizes the findings and shows examples of each of the connectivity check errors found.

Table 7-5. Summary of Sample Area Connectivity Issues

Connectivity Check	Reason	# in Sample Area	Example from Sample Area
Orphan Nodes	Fitting, FH or Valve on main that was not imported or main that is not in GIS	13	

Connectivity Check	Reason	# in Sample Area	Example from Sample Area
Orphan Pipe	No junction was associated with one end of the pipe	2	
Nodes in Close Proximity	Nodes that overlap or are duplicated	1	
Trace Network Disconnect, or Pipe Split Candidates	Pipe not spilt at fitting or valve	15	
Crossing/ Intersecting Pipes		1	

7.5 CONCLUSIONS AND RECOMMENDATIONS

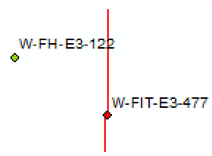
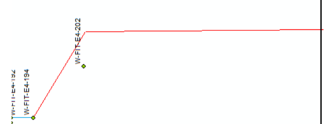
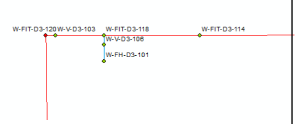
Spatial integrity amongst related GIS layers can be validated and maintained using advanced topology and geometric tools. Most connectivity checks discussed earlier in this document can be resolved by defining and applying GIS topology rules and data review checks for the network. In addition to maintaining network connectivity, it is important to identify and resolve missing or incorrect attributes in the GIS layers, prior to importing in the model. While these issues can be resolved in the model, this breaks the intended link between GIS and model data.

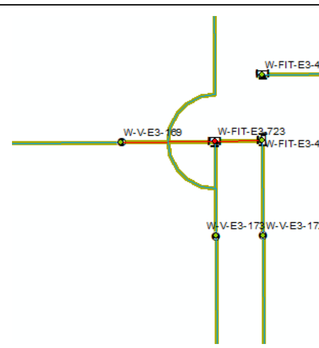
Based on the GIS audit and findings during the review of the selected sample area, the following sections outline the conclusions and recommendations for EVWD to consider incorporating in their overall GIS workflow.

7.5.1 GIS Topology Rules

To maintain data integrity, EVWD should consider using point, polygon, and line topology rules. Table 7-6 outlines topology considerations based on the findings from the sample area and typical connectivity checks performed on a model network.

Table 7-6. Summary of Topology Considerations

Connectivity Check	Reason	Example from Sample Area	Topology Consideration[1]
Orphan Nodes	Fitting, FH or Valve on main that was not imported or main that is not in GIS		**Must Be Covered by Endpoint Of:** Requires that points in one feature class must be covered by the endpoints of lines in another feature class. OR **Point Must Be Covered by Line:** Requires that points in one feature class be covered by lines in another feature class. It does not constrain the covering portion of the line to be an endpoint. This rule is useful for points that fall along a set of lines where you may not want the point to split a pipe.
Orphan Pipe	No junction was associated with on end of the pipe		**Endpoint Must Be Covered By:** Requires that the endpoints of line features must be covered by point features in another feature class.
Nodes in Close Proximity	Nodes that overlap or are duplicated		**Must Be Disjoint:** Requires that points be separated spatially from other points in the same feature class (or subtype). Any points that overlap are errors. This is useful for ensuring that points are not coincident or duplicated within the same feature class.
Trace Network Disconnect, or Pipe Split Candidates	Pipe not spilt at fitting or valve		**Must Not Intersect With:** Requires that line features from one feature class (or subtype) not cross or overlap lines from another feature class (or subtype). Lines can share endpoints. This rule is used when there are lines from two layers that should never cross each other or in cases where the intersection of lines should only occur at endpoints, such as fire hydrant laterals and main lines. AND/OR

Connectivity Check	Reason	Example from Sample Area	Topology Consideration[1]
			Must Not Intersect or Touch Interior: Requires that a line in one feature class (or subtype) must only touch other lines of the same feature class (or subtype) at endpoints. Any line segment in which features overlap or any intersection not at an endpoint is an error. This rule is useful where lines must only be connected at endpoints. AND/OR **Must Not Have Dangles:** Requires that a line feature must touch lines from the same feature class at both endpoints. An endpoint that is not connected to another line is called a dangle. It may be used in cases where lines typically connect to other lines. In this case, exceptions can be used where the rule is occasionally violated, as with cul-de-sac or dead-end street segments.
Crossing/ Intersecting Pipes			**Must Not Self-Intersect:** Requires that line features not cross or overlap themselves. This rule is useful for lines, such as contour lines, that cannot cross themselves. Note: The majority of these type of connectivity errors need to be manually reviewed.
Other Connectivity Checks Not Found in Sample Area			
Duplicate Pipes	Multiple pipes that have the same START and END nodes and have the same alignment.	**Must Not Overlap:** Requires that lines not overlap with lines in the same feature class. This rule is used where line segments should not be duplicated. Lines can cross or intersect but cannot share segments.	

2. Topology definitions provided by ESRI at arcgis.com.

7.5.2 GIS Data Validation

Where topology rules define the spatial relationship between features in a geodatabase, data validation rules can be used to find issues with features, attributes, and relationships in a geodatabase. ESRI's Data Reviewer data checks can be used in addition to topology to help maintain data quality and integrity. Below are a few checks for EVWD to consider implementing in their GIS management workflow. All data reviewer check definitions provided by ESRI at esri.com/datareviewer.

Database Validation Checks

- Connectivity Rules – finds features that are part of a geometric network and violate connectivity rules.
- Subtype – search for feature classes with improper or null subtypes.
- Topology Rules – as discussed in Section 7.5.1, find features that violate topology rules defined in the geodatabase

Polyline Checks

- Evaluate polyline length – Finds polyline segments, parts, or features that have a line length within a specified tolerance.
- Dangles – Finds polyline features with nodes that are within a user-defined tolerance but not connected to other polyline or polygon features.
- Orphan – Finds single polyline features that are not connected in the database topology.
- Unnecessary nodes – Finds features that share a node and have identical attributes in editable fields.

Duplicate Geometry Checks

- Duplicate Geometry – Finds features of the same geometry type that are collocated.
- Duplicate Vertex – Searches for vertices in selected polyline or polygon feature classes that are within a specified tolerance of each other.

Table Checks

- UniqueID – Checks the values of a set of fields across a set of tables and feature classes for uniqueness within a given workspace.

8.0 RECOMMENDED PROJECTS

This section describes the recommended projects for EVWD's water system. This section identifies the improvements necessary to address existing system deficiencies as well as new facilities recommended for increased future water demands to provide continued reliable water service through build-out. The recommended improvements are discussed first, followed by a discussion of the construction cost-estimating basis. The phasing of improvements and capital costs requirements are also discussed. This section concludes with a brief discussion on various financing sources to implement the Recommended System Improvements.

8.1 RECOMMENDED IMPROVEMENTS

The water distribution system and water facilities are evaluated using the criteria discussed in **Section 5**. This evaluation has been conducted for both existing water demand conditions and the projected future demands for system build-out. Based on these evaluations, the recommendations are divided into three categories; existing, near-term, and build-out system.

8.1.1 Existing System Improvements

The primary goal of the 2019 WSMP is to develop recommendations and projects that achieve EVWD's distribution system criteria and customer service level. This section provides a discussion of the existing system evaluation and lists specific projects for prioritization within the Recommended System Improvements. Recommendations include piping, pumping, and storage facilities to improve the existing water system.

8.1.2 System Evaluation

Key observations and insights about the distribution system can be learned through the process of updating the model, calibrating it, and performing the evaluation against EVWD design criteria. This section provides a discussion of those findings by topic.

Model Calibration: It was observed that the PRVs in the system can significantly impact hydraulics and therefore tank levels in the distribution system. It is recommended that EVWD add the most frequently used PRVs to the SCADA system. Real-time flow, pressure, and valve status of these PRVs would be valuable data for system operators.

Pump Operation: The calibration and evaluation efforts revealed some operational rigidity for plants having both wells, a forebay, and booster pumps. In most cases, small forebays do not provide sufficient operational flexibility. For example, there are times when booster station pumps turn off in order to allow the forebay water level to recover. Adding variable frequency drives (VFD) to one or more booster pumps would allow better synchronization between well and booster pumps.

Existing System Pressure Analysis: This analysis indicates there are no areas that experience low pressures (below 40 psi) during PHD. Areas in the model having pressure below 40 psi were either near tanks or had low pressure due to elevation and not accumulated head loss. In general, the system is well looped and has ample pipe capacity. Some areas see high pressures, above 125 psi; however, these high pressures are due to being in the lowest elevation range for the pressure zone.

Fire Flow Improvements: The fire flow evaluation identified some minor adjustments that could be made to one existing PRV to support better flow and pressure during a fire. PRS_302 was adjusted to 80 psi to satisfy fire flow requirements. The higher PRV pressure setting provides more flow to downstream hydrants. Also, a new PRV is proposed on the 12-inch main at 3588 E Highland Avenue, north of the intersection with Palm Avenue. The proposed PRV, at a 50-psi setting, will allow flow from Foothill to Upper Zone.

Fire Flow Evaluation: The fire flow evaluation found areas that do not meet the land use-based fire flow criteria. Solutions were developed to address the ten areas that would benefit most from improvement and are presented in **Appendix D**.

Existing System Storage Evaluation: The distribution system has an existing storage deficit of 5.5 MG on a zone-by-zone basis. The storage evaluation provides proposed storage volumes by pressure zone. However, when siting reservoirs, adjacent zones at higher hydraulic grades should be considered to provide multi-zone benefits, provided adequate transmission piping exists to deliver the recommended operational, fire protection, and emergency storage to the area needing the storage. For instance, the Lower Zone needs 3.5 MG based on the evaluation. The 3.5 MG could be provided from the Intermediate Zone or by future wells with a standby power source in the Lower Zone.

Existing System Supply Analysis: One of the significant findings of the supply analysis is that groundwater supply has decreased significantly since the 2014 WSMP. Per conversations with EVWD, the decrease in capacity is from offline wells due to water quality issues, as well as decreasing groundwater levels at some wells. EVWD has a limited amount of excess supply during MDD conditions. Therefore, a critical recommendation is to investigate maximizing current sources including new well locations. Some wells may be candidates for larger pumps and motors if significant capacity has been lost due to lowered groundwater levels, if the existing well casing and screen can accommodate a larger pump, and screen depths are sufficient to allow deeper pump settings.

Existing System Reliability Analysis: The three critical pipe segment outages tested in the reliability analysis can all be mitigated by a quick operational response. In most cases, opening nearby zone boundary valves or turning on additional pumps will maintain acceptable pressures until the pipe can be repaired.

8.1.3 Existing Water System Improvements

The system improvement projects for the existing system evaluation are provided below in Table 8-1. The projects are also displayed on Figure 8-1.

Table 8-1: Existing System Improvements

Recommended System Improvements Name	Proposed Improvements				
	Size	Quantity	Unit	Trigger/Need*	Description
Transmission Improvements					
T-1	16-inch	2,100	LF	Reduce water velocities below 6 fps	Along Highland Ave, from Plant 134 to Orchard Road. This project has been completed and is not included as part of the costs presented in Section 8.4.
Storage Improvements					
Lower Zone	3.5	-	MG	To meet current storage criteria of: -Operational (0.25 x MDD) -Emergency (1.0 x MDD) -Estimated fire flow 4,000 gpm @ 4 hr	Additional storage in Lower Zone.
Foothill Zone	1.5	-	MG	To meet current storage criteria of: -Operational (0.25 x MDD) -Emergency (1.0 x MDD) -Estimated fire flow 3,000 gpm @ 3 hr	Additional storage in Foothill Zone.
Mountain Zone	0.5	-	MG	To meet current storage criteria: -Operational (0.25 x MDD) -Emergency (1.0 x MDD), -Estimated fire flow 1,500 gpm @ 2 hr	Additional storage in Mountain Zone.
Supply Improvements					
New Well 01	2.88 MGD	1	each	Partially supply MDD with largest source (Plant 134) out of service deficiency of 16.56 MGD	Additional well for either Intermediate, Upper, or Foothill.

*Information for the Trigger/Need for each project provided by EVWD staff

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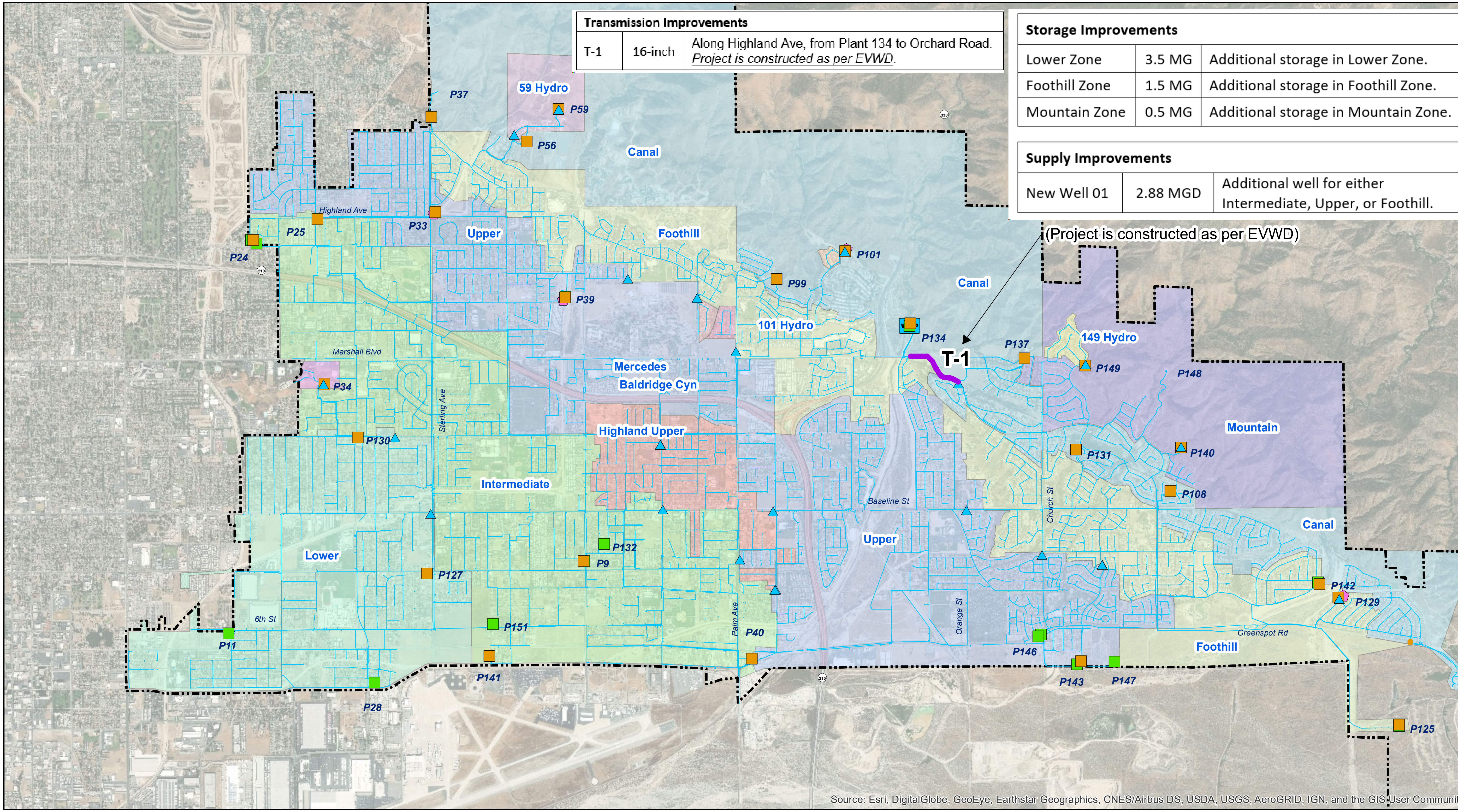

Transmission Improvements

T-1	16-inch	Along Highland Ave, from Plant 134 to Orchard Road. *Project is constructed as per EVWD.*

Storage Improvements

Lower Zone	3.5 MG	Additional storage in Lower Zone.
Foothill Zone	1.5 MG	Additional storage in Foothill Zone.
Mountain Zone	0.5 MG	Additional storage in Mountain Zone.

Supply Improvements

New Well 01	2.88 MGD	Additional well for either Intermediate, Upper, or Foothill.

East Valley Water District

Legend

Capital Projects
- New Pipe
- Pipe Upsize
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe
- Service Area Boundary
- freeway

N

0 0.25 0.5 1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Box\zdrive\Projects\Stantec

Date: Apr 23, 2019

Existing System Recommendations

SEDARU®

Figure 8-1

8.1.4 Near-Term Water System Improvements

System improvement projects for the near-term evaluation are provided below in **Table 8-2**. The projects are also displayed on **Figure 8-2**.

Table 8-2: Near-Term Capital Improvements

Recommended System Improvements Name	Proposed Improvements				
	Size	Quantity	Unit	Trigger/Need*	Description
Transmission Improvements					
T-2	20-inch	50	LF	Sunland Development	Reconfiguration of pipe at Greenspot Rd and Santa Paula Street
Harmony Transmission Pipe	24-inch	5,500	LF	Harmony Development	Dependent on growth to the east of the system (Harmony Development).
Storage Improvements					
Foothill Zone	2.75	-	MG	Harmony Development and to meet current storage criteria of: -Operational (0.25 x MDD) -Emergency (1.0 x MDD) -Estimated fire flow 3,000 gpm @ 3 hr	Storage needed in Foothill Zone.
S-1	4.5		MG	Harmony Development	S-1 is for growth to the east of the system.
Canal 3	2.0		MG	Highland Hills and Sunland Developments	Storage needed in Canal 3 Zone.
Supply Improvements					
New Well 02	2.88 MGD	1	each	Partially supply MDD with largest source (Plant 134) out of service deficiency of 24.9 MGD	Additional well for either Intermediate, Upper, or Foothill.
New Well 03	2.88 MGD	1	each	Partially supply MDD with largest source (Plant 134) out of service deficiency of 24.9 MGD	Additional well for either Intermediate, Upper, or Foothill.
New SWTP or Well(s)	3.00 MGD	1	each	Partially supply growth in east of sytem where growth is projected in order to serve North Fork Santa Ana River Water.	New SWTP or well(s) to support growth to the east of the system.

*Information for the Trigger/Need for each project provided by EVWD staff

Notes:

1. Recommended storage quantity is for the total needed by near-term.
2. Foothill Zone includes storage for growth in east part of the system. (Total recommended storage is 6.0 MG, where 4.5 MG are dedicated to area east of existing system.)

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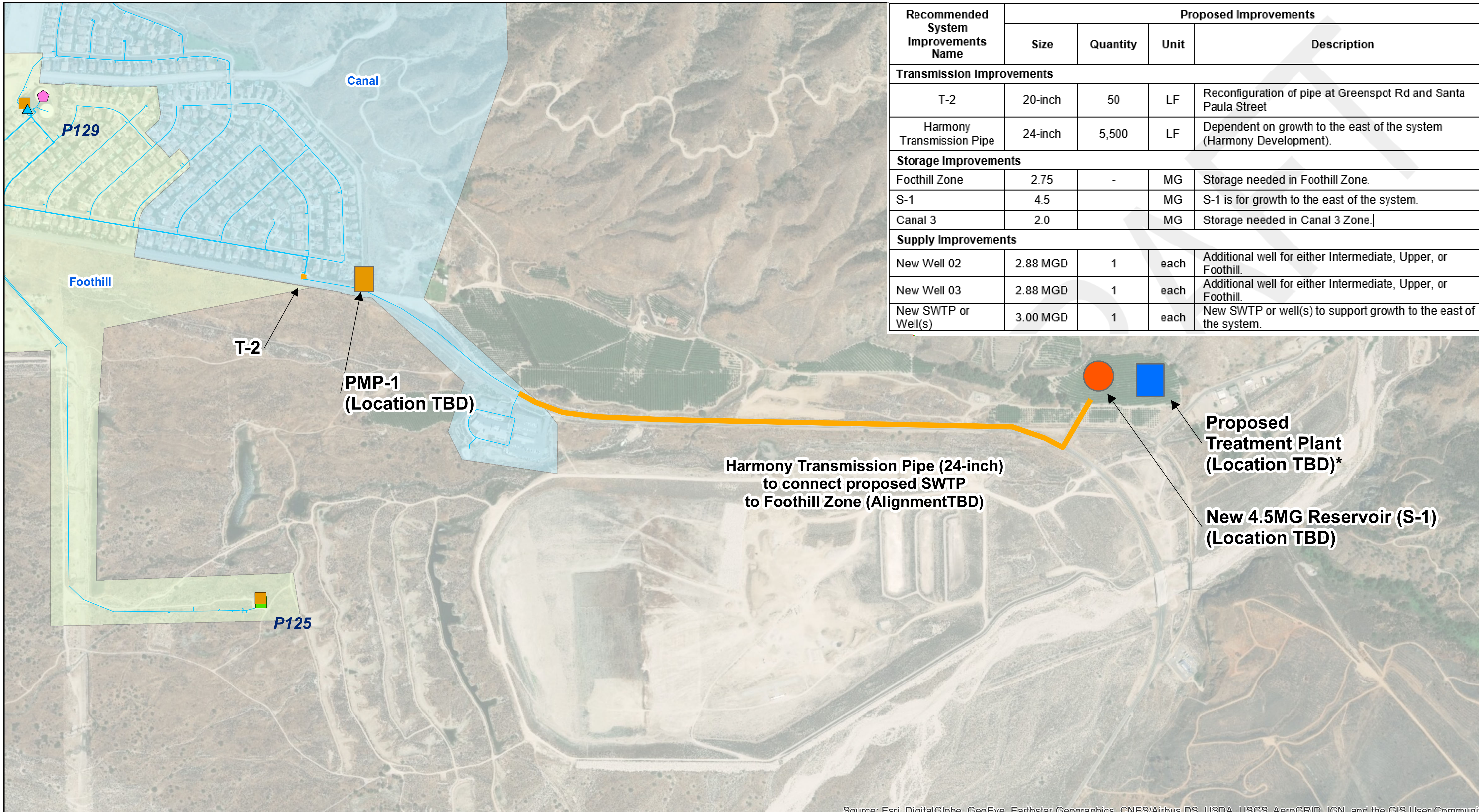

Recommended System Improvements Name	Proposed Improvements			
	Size	Quantity	Unit	Description
Transmission Improvements				
T-2	20-inch	50	LF	Reconfiguration of pipe at Greenspot Rd and Santa Paula Street
Harmony Transmission Pipe	24-inch	5,500	LF	Dependent on growth to the east of the system (Harmony Development).
Storage Improvements				
Foothill Zone	2.75	-	MG	Storage needed in Foothill Zone.
S-1	4.5		MG	S-1 is for growth to the east of the system.
Canal 3	2.0		MG	Storage needed in Canal 3 Zone.
Supply Improvements				
New Well 02	2.88 MGD	1	each	Additional well for either Intermediate, Upper, or Foothill.
New Well 03	2.88 MGD	1	each	Additional well for either Intermediate, Upper, or Foothill.
New SWTP or Well(s)	3.00 MGD	1	each	New SWTP or well(s) to support growth to the east of the system.

East Valley Water District

Legend

- Proposed CIP Pipes
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP
- Model Pipe

Note: All near-term recommendations that have been sited are included in this figure above. Well and storage improvements that are recommended by zone have not been sited and are not represented on this figure.
* Future Supply may also be satisfied through new wells or expansion to P143

N
0 0.05 0.1 0.2 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Dec 20, 2018

Near-Term System Recommendations

SEDARU

Figure 8-2

8.1.5 Build-Out Water System Improvements

System improvement projects for the build-out evaluation are provided below in **Table 8-3**. No figure is provided as there are no transmission pipeline recommendations, and tanks and wells are only located by zone.

Table 8-3: Build-Out Capital Improvements

Recommended System Improvements Name	Proposed Improvements				
	Size	Quantity	Unit	Trigger/Need*	Description
Transmission Improvements					
-	-	-	-	-	-
Storage Improvements					
Lower Zone	0.75	-	MG	Hillwood, Hispano and Projected open space Developments	Storage needed in Lower Zone.
Foothill Zone	0.5	-	MG	Harmony, Sunland, Diversified Pacific, Kemper-Highland and other projected open space Developments	Storage needed in Foothill Zone.
Canal 1	0.25	-	MG	Projected open space Developments	Storage needed in Canal 1 Zone.
Canal 2	0.75	-	MG	Projected open space Developments	Storage needed in Canal 2 Zone.
Canal 3	0.75	-	MG	Projected open space Developments	Storage needed in Canal 3 Zone.
Mountain Zone	0.25	-	MG	Projected open space Developments	Storage needed in Mountain Zone.
Supply Improvements					
New Well 04	2.88 MGD	1	each	Projected open space Developments	Additional well for either Intermediate, Upper, or Foothill.
New Well 05	2.88 MGD	1	each	Projected open space Developments	Additional well for either Intermediate, Upper, or Foothill.

*Information for the Trigger/Need for each project provided by EVWD staff

Notes:

1. Recommended storage quantity is for the total needed for build-out.
2. Foothill Zone includes storage for growth in east part of the system. (Total recommended storage is 9.25 MG, where 4.5 MG are dedicated to area east of existing system.)

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8.1.6 Phasing of Near-Term System Improvements

Existing system improvements that address the most significant system needs and impact the largest number of customers are scheduled first, while on-going projects such as pipeline rehabilitation are used to make the capital expenditures more uniform from year to year.

The following methodology is used for the project phasing:

New Reservoirs: Phasing of storage reservoirs is based on the projected demands and the storage evaluations. New reservoirs are recommended to be constructed first in the Canal, Mountain, and Foothill zones followed by zones with lower hydraulic grade lines (HGL). This phasing approach will ensure that surplus water in zones with higher HGLs can be conveyed via pressure reducing valves to zones with lower HGLs.

Pumping Facilities: The existing system evaluation identified a needed pumping capacity improvement from the Intermediate Zone to the Upper Zone. EVWD is in the process of upgrading Plant 40 with a booster station as part of the 2014 CIP (Project No. W2544). Therefore, this improvement is eliminated from the proposed near-term Recommended System Improvements.

Supply Facilities: The WSMP recommends new supply facilities in the form of new supply wells and possibly the addition of a new surface water treatment plant in the eastern portion of EVWD's service area where significant future demands have been identified. A separate supply analysis to compare the benefits of these possible sources is currently being performed for EVWD.

8.2 UNIT COSTS

The Recommended System Improvement project cost estimates in this section are planning level cost estimates. The appropriate use of this estimate is for planning and may not be an actual representation of design to construction activities and costs. This estimate was developed as an Association for the Advancement of Cost Engineering (AACE) – International Class 5 cost estimate which has an expected accuracy range of -20 to -50 percent on the low end, and +30 to +100 percent on the high end. This range depends on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Accuracy could exceed this range in unusual circumstances. The estimate was prepared using a combination of parametric estimating factors and local experience in delivering projects similar to those that constitute this Recommended Projects.

Costs were based on Stantec's experience with costs of similar projects. **Table 8-4** shows a summary of the unit costs for water mains used for this cost estimate. All improvements are assumed to take place under asphalt road, and operations and maintenance costs are not included in this estimate.

Due to fluctuations in the market and other factors, this estimate should only be used for planning purposes and a more rigorous estimate shall be prepared during the design and is recommended for any further activity. For these projects, a depth of 6 feet or less was assumed for all pipelines. Any requirements for constructing at a deeper depth should be considered when planning these improvements. This planning level estimate is meant to be conservative.

Table 8-4: Summary of Water Main Unit Costs

Diameter (in.)	Road Condition	Cost 2018 (2) ($/lf.)	Cost 2018 ($/in-diam./lf.)
8	Asphalt	258.40	32.30
10	Asphalt	272.00	27.20
12	Asphalt	340.00	28.33
14	Asphalt	348.00	24.86
16	Asphalt	367.20	22.95
18	Asphalt	380.80	21.16
20	Asphalt	408.00	19.43
24	Asphalt	408.00	17.00

1) Costs assume using PVC pipes
2) Costs include material and installation

Based on information provided by EVWD, the 2014 WSMP, and review of past projects in the area, unit costs were developed for new storage, wells, and surface water treatment. These costs do not include the cost of land acquisition. New storage reservoirs are estimated to cost $1,250,000 per MG, assuming steel tanks. Wells are estimated to cost $1,750 per gpm ($1,212,500 per MGD) which includes costs for a new well pump station at each well and the cost to drill and equip the wells, and new surface water treatment (new or expansion to existing) is estimated to cost $3 per gpd, or $3,000,000 per MGD. The cost for a SWTP and expansion do not include standby power or new pipeline.

8.3 WATER SYSTEM IMPROVEMENTS COST ESTIMATES

The cost of the water system improvements is estimated by project for each planning horizon using the cost estimating assumptions and the project phasing discussed previously. The Recommended System Improvements are presented in Table 8-5. Table 8-6 calculates a total project cost by taking the construction costs presented in Table 8-5 and adding a contingency allowance of 20% of the construction cost, and an allowance for engineering, legal, and administration costs of 30% of construction cost. Figure 8-3 presents the total project costs by planning horizon while Figure 8-4 presents the costs by asset type.

Table 8-5 Recommended Project Construction Costs

Recommended System Improvements Name	Size	Quantity	Unit	Description	Unit Cost	Construction Cost
Existing System Improvements						
	Proposed Improvements					
Transmission Improvements						
T-1	16-inch	2,100	LF	Along Highland Ave, from Plant 134 to Orchard Road.	Completed	Completed
Storage Improvements						
Lower Zone	3.5	-	MG	Additional storage in Lower Zone.	$ 1,250,000	$ 4,375,000
Foothill Zone	1.5	-	MG	Additional storage in Foothill Zone.	$ 1,250,000	$ 1,875,000
Mountain Zone	0.5	-	MG	Additional storage in Mountain Zone.	$ 1,250,000	$ 625,000
Supply Improvements						
New Well 01	2.88 MGD	1	each	Additional well for either Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
Near-Term Improvements						
Recommended System Improvements Name	**Size**	**Quantity**	**Unit**	**Description**	**Unit Cost**	**Project Cost**
Transmission Improvements						
T-2	21-inch	50	LF	Reconfiguration of pipe at Greenspot Rd and Santa Paula Street	$ 408.00	$ 20,000
Harmony Transmission Pipe	24-inch	5,500	LF	Dependent on growth to the east of the system (Harmony Development).	$ 408.00	$ 3,672,000
Storage Improvements						
Foothill Zone	2.75	-	MG	Storage needed Foothill Zone.	$ 1,250,000	$ 3,437,500
S-1	4.5		MG	S-1 is for growth to the east of the system.	$ 1,250,000	$ 5,625,000
Canal 3	2		MG	Storage needed in Canal 3 Zone.	$ 1,250,000	$ 2,500,000
Supply Improvements						
New Well 02	2.88 MGD	1	each	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well 03	2.88 MGD	1	each	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well or SWTP	3.00 MGD	1	MGD or gpd	New supply to support growth in eastern system.	$ 1,212,500 or $ 3.00	$ 3,492,000 or $ 9,000,000
Pumping Improvements						
PMP-1	3.7 MGD	1	Each	Proposed booster station for future growth in eastern part of system. Pumping to 250 ft.	None	$ 2,500,000
Build-out System Improvements						
Recommended System Improvements Name	**Size**	**Quantity**	**Unit**	**Description**	**Unit Cost**	**Project Cost**
Transmission Improvements						
-	-	-	-	-		
Storage Improvements						
Lower Zone	0.75	-	MG	Total storage needed in Lower Zone.	$ 1,250,000	$ 937,500
Foothill Zone	0.5	-	MG	Total storage needed Foothill Zone.	$ 1,250,000	$ 625,000
Canal 1	0.25		MG	Total storage needed in Canal 1 Zone.	$ 1,250,000	$ 312,500
Canal 2	0.75		MG	Total storage needed in Canal 2 Zone.	$ 1,250,000	$ 937,500
Canal 3	0.75		MG	Total storage needed in Canal 3 Zone.	$ 1,250,000	$ 937,500
Mountain Zone	0.25	-	MG	Total storage needed in Mountain Zone.	$ 1,250,000	$ 312,500
Supply Improvements						
New Well 04	2.88 MGD	1	MGD	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000
New Well 05	2.88 MGD	1	MGD	Additional well for Intermediate, Upper, or Foothill.	$ 1,212,500	$ 3,492,000

Table 8-6: Recommended Improvement Project Costs

Recommended System Improvements Name	Construction Cost	Contingency (20% of construction cost	Engineering, Legal & Administration (30% of construction cost)	Total Project Cost
	2018 US Dollars ($)			
Existing System Improvements				
Storage Improvements				
Lower Zone	4,375,000	875,000	1,312,500	6,563,000
Foothill Zone	1,875,000	375,000	562,500	2,813,000
Mountain Zone	625,000	125,000	187,500	938,000
Supply Improvements				
New Well 01	3,492,000	698,400	1,047,600	5,238,000
Near-Term Improvements				
Transmission Improvements				
T-2	20,000	4,000	6,000	30,000
Harmony Transmission Pipe	3,672,000	734,400	1,101,600	5,508,000
Storage Improvements				
Foothill Zone	3,437,500	687,500	1,031,250	5,156,000
S-1	5,625,000	1,125,000	1,687,500	8,438,000
Canal 3	2,500,000	500,000	750,000	3,750,000
Supply Improvements				
New Well 02	3,492,000	698,400	1,047,600	5,238,000
New Well 03	3,492,000	698,400	1,047,600	5,238,000
New Well	3,492,000	698,500	1,047,750	5,238,000
or	or			or
SWTP (assumed for total cost below)	9,000,000	1,800,000	2,700,000	13,500,000
Pumping Improvements				
PMP-1	2,500,000	500,000	750,000	3,750,000
Build-out System Improvements				
Storage Improvements				
Lower Zone	937,500	187,500	281,250	1,406,000
Foothill Zone	625,000	125,000	187,500	938,000
Canal 1	312,500	62,500	93,750	469,000
Canal 2	937,500	187,500	281,250	1,406,000
Canal 3	937,500	187,500	281,250	1,406,000
Mountain Zone	312,500	62,500	93,750	469,000
Supply Improvements				
New Well 04	3,492,000	698,400	1,047,600	5,238,000
New Well 05	3,492,000	698,400	1,047,600	5,238,000
TOTAL	**55,152,000**	**11,030,400**	**16,545,600**	**82,730,000**

Figure 8-3: Project Costs by Planning Horizon

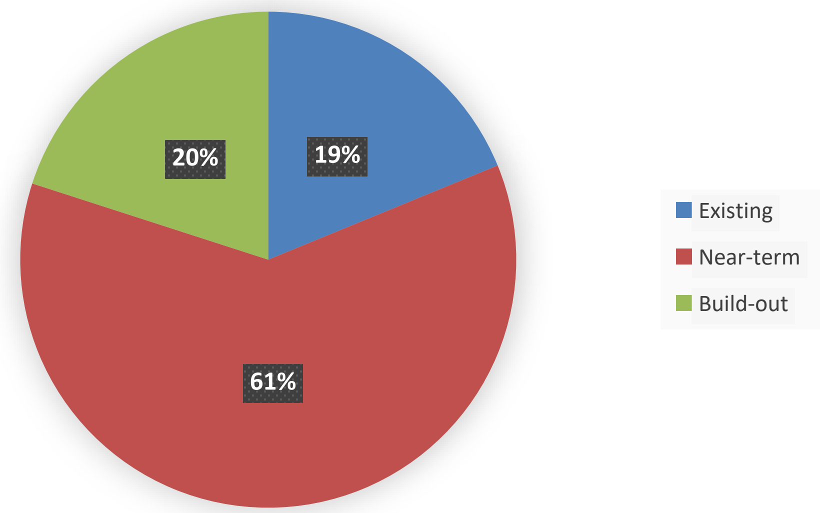
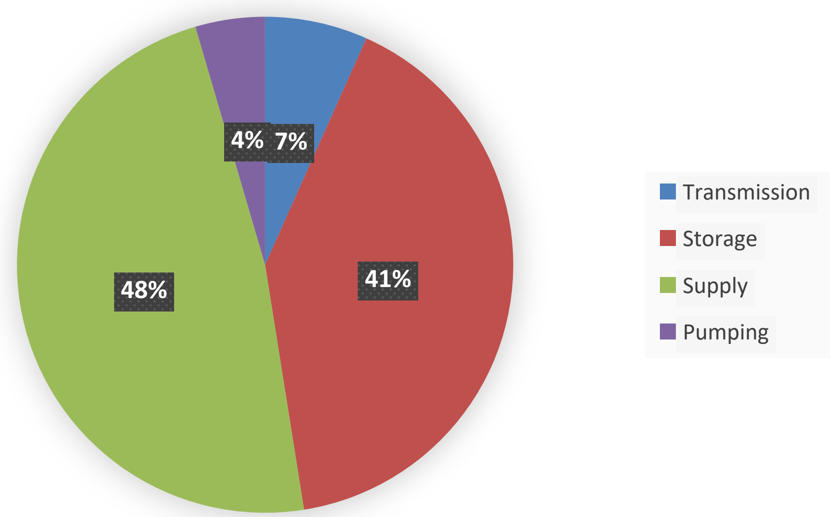


Figure 8-4: Project Cost by Asset Type



8.4 SUMMARY OF GENERAL RECOMMENDATIONS

The following items are recommended as a result of this evaluation

- Infrastructure recommendations contingent upon a major development should be reevaluated before construction to confirm the necessity of the project and the accuracy of the demand projections against field data.

Data Gathering

- It is recommended that flow meters be installed at all pumping facilities to record the transfer of water between zones. Flows at these meters should be relayed to EVWD's SCADA system.
- Installation of pressure loggers to capture pressures at key points in the system such as the suction and discharge pressures at pump stations or critical points of the system. Pressures at these loggers should be relayed to EVWD's SCADA system.
- It is recommended that EVWD input manufacturer's pump curves adjusted for SCE test data into the hydraulic model rather than design point curves for future updates.
- It is recommended that EVWD investigate causes for model discrepancies identified in Section 4.2.1 Steady-State Calibration as the hydraulic model indicated unknown bottlenecks
- PRV elevations should be surveyed to update and verify the hydraulic model.
- It is recommended that EVWD add the most frequently used PRVs to the SCADA system. Real-time flow, pressure, and valve status of these PRVs would be valuable data for system operators and future modeling.
- It is recommended that EVWD investigate areas 1,2,4, and 8 shown in Table 4 3 for bottlenecks, closed valves, or other causes of hydraulic constriction that could be causing discrepancies with the calibrated model.

Water Quality

- It is recommended that mixers or separate inlet/outlet piping be added to reduce residence time and short circuiting of water.

Operations and Maintenance

- It is recommended that seismic retrofitting be performed on all inlet/outlet lines at EVWD tanks.
- To limit the duration of interrupted water service, it is recommended that EVWD develop an emergency response plan to mitigate interruptions to its customers during a failure of a major supply line.
- It is recommended that EVWD conduct a study prior to connection to the Casino expansion considering resizing of the plant 59 hydropneumatics tank, changes in tank settings, changes to sizing of the tank at plant 134, and possible changes to the pumps at plant 56 and 59 to evaluate the most efficient way to serve this new development.

Pressure Zones

- It is recommended that EVWD monitor pressure in Areas 1, 2, and 3 specifically during higher demand conditions. EVWD can also investigate if pressure complaints have been received for these areas and cross-reference fire flow results to see if there are any critical customers that may need to be shifted to higher zone and/or upgraded pipe size.

- The area around pumps 59 and 56 should be investigated for high pressure based on model results. If high pressures are confirmed, the pumps need to be isolated on their own zone. EVWD should monitor pressures in that zone and establish a PRV zone specific to the area where pressures regularly exceed EVWD standards.

Storage

- Since pressure reducing stations or PRVs allow transfer from higher zones to lower zones, it is recommended that storage improvements be constructed in pressure zones with higher HGL to the extent possible as this will allow for use of the storage in lower zones without pumping.
- New reservoirs are recommended to be constructed first in the Canal, Mountain, and Foothill zones followed by zones with lower hydraulic grade lines (HGL).

Supply

- It is recommended that EVWD investigate maximizing current sources including new well locations. Some wells may be candidates for larger pumps and motors if significant capacity has been lost due to lowered groundwater levels, if the existing well casing and screen can accommodate a larger pump. This may minimize the need for additional wells as outlines in the water system improvements.

GIS

- To maintain data integrity, EVWD should consider utilizing point, polygon, and line topology rules.
- ESRI's Data Reviewer data checks can be used in addition to topology to help maintain data quality and integrity. Below are a few checks for EVWD to consider implementing in their GIS management workflow. (All data reviewer check definitions provided by ESRI at esri.com/datareviewer.)

Database Validation Checks

- Connectivity Rules – finds features that are part of a geometric network and violate connectivity rules.
- Subtype – search for feature classes with improper or null subtypes.
- Topology Rules – as discussed in Section 7.5.1, find features that violate topology rules defined in the geodatabase

Polyline Checks

- Evaluate polyline length – Finds polyline segments, parts, or features that have a line length within a specified tolerance.
- Dangles – Finds polyline features with nodes that are within a user-defined tolerance but not connected to other polyline or polygon features.
- Orphan – Finds single polyline features that are not connected in the database topology.

- Unnecessary nodes – Finds features that share a node and have identical attributes in editable fields.

Duplicate Geometry Checks

- Duplicate Geometry – Finds features of the same geometry type that are collocated.
- Duplicate Vertex – Searches for vertices in selected polyline or polygon feature classes that are within a specified tolerance of each other.

Table Checks

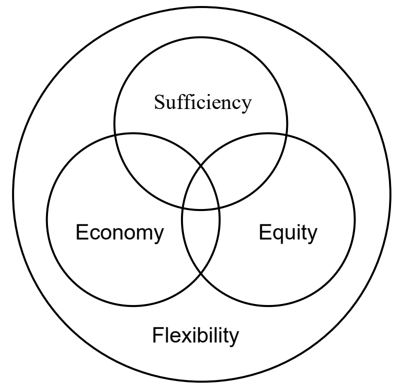
- UniqueID – Checks the values of a set of fields across a set of tables and feature classes for uniqueness within a given workspace.

9.0 FINANCING OBJECTIVES

Successful financing of large capital programs depends on optimizing three overarching financial objectives:

- Produce capital in sufficient amounts when needed;
- Produce capital at lowest cost; and
- Produce capital with greatest equity among customers, including the principle that growth-pays-for-growth.

Because EVWD projects will be implemented and refined over many years, the financial plan should be robust, yet flexible to accommodate changes in project timing, capital requirements, system and constituency requirements or changes in law.



Financing Objectives

9.1 FUNDING SOURCES

There are several possible funding sources available for the successful implementation of recommended projects, including pay-as- you-go, Drinking Water State Revolving Fund Loan Program, general obligation bonds, revenue bonds, Certificates of Participation, commercial paper (short term notes), developer impact or connection fees, and other state grants and loans. These methods are further described below.

9.1.1 Pay-As-You-Go

Pay-as-you-go funding requires that an agency (or group of agencies) have adequate revenue generation or reserves to fund capital improvements and would be funded by water rates. Reserves can be built up in advance to pay for future facility requirements by raising fees prior to the need for capital facilities. The funds can provide for either all or part of the capital costs. Using pay-as-you-go funding reduces the overall costs of capital facilities by avoiding the costs associated with arranging financing (bond issue costs, legal and financial advisers, etc.) as well as interest on borrowed money.

Pay-as-you-go funding often leads to inequities since customers today are paying the full costs for facilities that will provide benefits to future customers. To achieve a more equitable sharing of the cost burden, other funding sources usually are utilized in addition to pay-as-you-go, due to the differences in timing between accumulation of reserves and the capital spending requirements.

9.1.2 Drinking Water State Revolving Fund Loan Program

Through a jointly financed program between the federal EPA and the State of California, and administered by the State Water Board, the Drinking Water State Revolving Fund (DWSRF) Loan Program can provide low interest loans to water utilities to help pay for improvements and are loaned to a single water agency. Under the program, loans are issued for up to 20 years, and in some cases 30 years, at a fixed interest rate equal to 50 percent of the state's average interest rate paid on general obligation bonds sold during the previous calendar year. Repayment under the program must begin within six months after completion of the project.

Loans are granted based on a set of ranking criteria that give highest priority to projects that resolve deficiencies having direct health implications. Also high on the priority list is insufficient water source capacity that results in water outages. Funds are allocated to applicants based on the priority categories until all funds are obligated.

9.1.3 General Obligation Bonds

General Obligation (G.O.) bonds are backed by the full faith and credit of the issuer. As such, they also carry the pledge of the issuer to use its taxing authority to guarantee payment of interest and principal. The issuer's general obligation pledge is usually regarded by both investors and ratings agencies as the highest form of security for bond issues.

Because G.O. bonds are viewed as having lower risk than other types of bonds, they are usually issued at lower interest rates, have fewer costs for marketing and issuance, and do not require the restrictive covenants, special reserves, and higher debt service coverage typical of other types of bond issues. Issuance of G.O. bonds requires electoral approval by two-thirds of the voters.

The ultimate security for G.O. bonds is the pledge to impose a property tax to pay for debt service. G.O. bonds are typically issued by a single water agency. Use of property taxes, assessed on the value of property, may not fairly distribute the cost burden in line with the benefits received by the customers. While the ability to use the taxing authority exists, the water agency seeking G.O. bonds could choose to fund the debt service from other sources of revenues, such as water rates or from development impact fees. Use of development impact fees to pay the debt service would provide the most equitable matching of benefits with costs, since debt service on projects that benefit primarily new customers would be paid from fees collected from those new customers.

G.O. bonds are attractive due to lower interest rates, fewer restrictions, greater market acceptance, and lower issuing costs. However, the difficulties in securing a two-thirds majority of the qualified electorate make them less attractive than other alternatives, such as revenue bonds and certificates of participation.

9.1.4 Revenue Bonds

Revenue bonds are long-term debt obligations for which the revenue stream of the issuer is pledged for payment of principal and interest. Because revenue bonds are not secured by the full credit or taxing authority of the issuing agency, they are not perceived as being as secure as general obligation (G. O.) bonds. Since revenue bonds are perceived to have less security and are therefore considered riskier, they are typically sold at a slightly higher interest rate (frequently in the range of 0.5 percent to 1.0 percent higher) than the G.O. bonds. The security pledged is that the system will be operated in such a way that sufficient revenues will be generated to meet debt service obligations.

Typically, issuers provide the necessary assurances to bondholders that funds will be available to meet debt service requirements through two mechanisms. The first is provision of a debt service reserve fund or a surety. The debt service reserve fund is usually established from the proceeds of the bond issue. The amount held in reserve in most cases is based on either the maximum debt service due in any one year during the term of the bonds or the average annual debt service over the term. The funds are deposited with a trustee to be available in the event the issuer is otherwise incapable of meeting its debt service obligations in any year. The issuer pledges that any funds withdrawn from the reserve will be replenished within a short period, usually within a year.

The second assurance made by the borrower is a pledge to maintain a specified minimum coverage ratio on its outstanding revenue bond debt. The coverage ratio is determined by dividing the net revenues of the borrower by the annual revenue bond debt service for the year, where net revenues are defined as gross revenues less operation and maintenance expenses. Based on this, the perceived risk minimum coverage ratios are usually within the range of 1.1 to 1.3, meaning that net revenues would have to be from 110 percent to 130 percent of the amount of revenue bond debt service. To the extent that the borrower can demonstrate achievement of coverage ratios higher than required, the marketability and interest rates on new issues may be more favorable.

Issuance of revenue bonds may be authorized pursuant to the provisions of the Revenue Bond Law of 1941. Specific authority to issue a specified amount in revenue bonds requires approval by a simple majority of voters casting ballots and would typically be limited to a single agency seeking a revenue bond. To limit costs (and risks) associated with seeking approval through elections, authorization is typically sought for the maximum amount of bonds that will be needed over the planning period. Upon receiving authorization, the agency issues bonds as needed, up to the authorized amount.

9.1.5 Certificates of Participation

Certificates of Participation (COPs) are a form of lease-purchase financing that has the same basic features of revenue bonds except they do not require voter approval through an election. COPs represent participation in an installment purchase agreement through marketable notes, with ownership remaining with the agency. COPs typically involve four different parties — the public agency as the lessee, a private leasing company as the lessor, a bank as trustee and an underwriter who markets the certificates. Because there are more parties involved, the initial cost of issuance for the COP and level of administrative effort may be greater than for bond issues. Due to the widespread acceptance of COPs in financial markets, COPs are usually easier to issue than other forms of lease purchase financing, such as lease revenue bonds.

The certificates are usually issued in $5,000 denominations, with the revenue stream from lease payments as the source of payment to the certificate holders. From the standpoint of the agency as the lessee, any and all revenue sources can be applied to payment of the obligation, not just revenues from the projects financed, thereby providing more flexibility. Unlike revenue bonds, COPs do not require a vote of the electorate and have no bond reserve requirements, although establishing a reserve may enhance marketability. In addition, since they are not technically debt instruments, COP issues do not count against debt limitations for the agency.

While interest costs may be marginally higher than for revenue bonds, a COP transaction is a flexible and useful form of financing that should be considered for financing projects. COP transactions would be typically limited to a single water agency obtaining a COP for a specific project.

9.1.6 Commercial Paper (Short Term Notes)

To smooth out capital spending flows without the costs of frequent bond issues, many public agencies with sufficient revenue streams use short-term commercial paper debt to attenuate the peaks and valleys of capital expenses year to year. Similar to bonds issued by public agencies, commercial paper instruments are typically tax-exempt debt, thus demanding a lower interest cost to the agency than would prevail if the commercial paper were taxable. Commercial paper is usually issued for terms ranging from as short as a few days to as long as a year depending on market conditions. As the paper matures, it is resold ("rolled over") at the then prevailing market rate. Consequently, the paper can in effect "float" over an extended time, being constantly renewed. The short-term rates paid on commercial paper are frequently much lower than those on longer term debt.

The primary advantage in using commercial paper is to provide interim funding of capital projects when revenues and reserves are insufficient to fund capital projects fully. In this scenario either (1) the total amount needed is too small to justify a bond issue or (2) the funds are not currently available but will be building up in the immediate future to a level sufficient to repay the borrowing. Commercial paper funding can provide the "bridge" to smooth out the flow of funds. As with other forms of debt financing, there are costs associated with issuing commercial paper. Many of the costs are similar to those of issuing bonds. With commercial paper, however, there is often a requirement that a line of credit be established that will guarantee payment of the commercial paper should it not be possible to roll the commercial paper over at any given maturity date. The cost of the credit line is usually based on the full amount of commercial paper authorized, whether issued or not, so the total commercial paper authorization must be carefully determined to maximize the benefit while minimizing costs.

While the interest rate for a particular commercial paper issue is fixed until its maturity, the short maturities and frequent rollovers of the debt effectively make commercial paper much like a long-term variable rate bond.

Consequently, there is some exposure to interest rate risk in using commercial paper as a funding mechanism. However, unless inflationary pressure is great, the risk is relatively low.

The strategy now being used by a number of water agencies is to issue commercial paper up to the authorized limit, then pay-off the commercial paper outstanding through a revenue bond issue. The water agency gets the benefit of low short-term interest rates while still being able to convert to long term fixed rates through a bond issue. This is an appropriate strategy during relatively stable interest rates, but not when interest rates are rising or expected to rise substantially. Commercial paper programs are typically limited to a single water agency, and the agency pursuing commercial paper will need to confer with their legal and financial advisors to determine if sufficient authorization currently exists to implement a commercial paper program.

9.1.7 Property Related Debt

For many years, California has allowed a form of financing where the properties that benefit from projects pay debt service in proportion to the benefit received. The California Streets and Highways Code allows bonds to be sold under the 1911 Improvement Act or 1913 Municipal Improvement Act, under the procedure of the 1913 Act and the 1931 Majority Protest Act. Mello Roos Community Facilities District Act (1982) financing is another variation of this theme. Assessment financing, as the method was called, is useful for allocating shares of cost and debt service to properties within specific areas (called assessment districts) within which all of the financed project's benefit accrued. Assessment districts are typically used for defined geographic areas to finance specific projects which benefit the property's in that geographic area. The voting requirement of the Tax Payers' Right to Vote Act (Proposition 218) and more recent court decisions challenging certain methods of apportionment, has made the procedure less attractive. In cases where the required water infrastructure would serve only new development, such as in newly developing areas, this type of financing mechanism can be useful.

9.1.8 Private Sector Equity

Some utilities find it convenient to enter into agreements with a private sector service provider to perform certain well-defined functions. The service provider provides the assets as well as human resources, materials, supplies and other costs of business and includes those costs in the amount charged to the utility. This procedure becomes, *de facto*, a financing technique for the utility in that the capital cost of the assets are financed by the private sector service provider since the assets are owned by it. The financing costs and interest rates are often more expensive than traditional public financing methods as the private equity firm's cost of capital is generally higher and there are income taxes considerations. The specifics can depend much on the private equity firm's other portfolio assets, but this method can reduce the capital requirement to be financed by the utility and may offer greater flexibility and creativity than other financing options.

Specific projects for engaging a private sector equity participant have not been identified. Further, any cost savings associated with this approach might depend on the specific projects, so this approach is not considered further in this financing plan. Again, this method can be a valuable tool for application in certain situations and should be considered when appropriate.

9.1.9 Developer Impact or Connection Fees

Developer impact fees or connection fees are commonly used alone, or more commonly in conjunction with user rates to finance capacity related water system improvements and to recover previous sunk costs paid by existing system users that benefit future growth. The use of the connection fees to recover sunk facility costs and to provide service to accommodate new customers is completely appropriate. Connection fees are generally calculated by estimating the overall cost of infrastructure necessary to support future growth plus the recovery of sunk costs and allocating those costs to the various benefit zones, usually by water service size. Water agencies have discretion in setting connection fees for water supply, storage, transmission and distribution pipelines as long as established computation methodologies are followed.

9.1.10 Department of Water Resources Grant Programs

There are several water-related grant programs administered by the Department of Water Resources. Funding for these programs has often come from voter approved propositions. In 2014, voters passed Proposition 1, the Water Quality, Supply, and Infrastructure Improvement Act of 2014, which authorized $7.545 billion in G.O. bonds to fund water-related projects. While there are some remaining funds available from Prop 1, the majority has been awarded.

In June 2018, California approved Proposition 68 (Prop 68), the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All, which authorized $4.1 billion in GO bonds. Of the $4.1 billion in funding, approximately $1.6 billion is directed at water-related projects to be administered by various state agencies, including the DWR. Two main funding programs administered by the DWR are discussed below.

9.1.10.1 **Integrated Regional Water Management Plan (IRWMP)**

California DWR has several Integrated Regional Water Management (IRWM) grant program funding opportunities. Current IRWM grant programs include planning, implementation, and stormwater flood management. DWR's IRWM Grant Programs are managed within DWR's Division of IRWM by the Financial Assistance Branch with assistance from the Regional Planning Branch and regional offices (IRWMP website). Funding for this program is currently provided by Prop 1 and remaining funding is anticipated to be awarded in 2019. The intent of these grants is to assist in developing regional projects benefitting multiple stakeholders. Thus, IRWMP grants are not considered a viable primary funding strategy.

9.1.10.2 **Sustainable Groundwater Grant Program (Planning and Implementation)**

DWR plans to continue its Sustainable Groundwater Planning (SGWP) Grant Program with funding from Proposition 68. This program offers competitive grants to support implementation of local and regional groundwater projects required to support sustainable groundwater management. The funding round for planning grants is anticipated to be in 2019, with draft guidelines released in the spring and solicitation opening in the summer of 2019. The next funding cycle for implementation grants is anticipated in 2020.

9.1.11 Federal Funding

9.1.11.1 **Water Infrastructure Finance and Innovation Act (WIFIA)**

The WIFIA program was established by the Water Infrastructure Finance and Innovation Act of 2014 and provides long-term, low cost supplemental loans for water infrastructure projects, including projects to build and upgrade wastewater and drinking water treatment systems. This competitive program is administered by the EPA and will provide loan funding up to 49 percent of the project cost at interest rates based on US Treasury rates. The minimum project size for a large community is $20 million and the project must be of a "regional or national significance". As WIFIA loans only fund up to 49 percent of project costs, they are intended to be combined with various funding sources such as private equity, revenue bonds, grants, and SRF loans and the repayment structure can be somewhat flexible to accommodate other potential lenders.

The application process can take up to two years and is largely a two-step process. Applicants must first submit a letter of interest. After review of these letters of interest, EPA selects projects to invite to submit a full application. The process requires significant due-diligence and up-front funding in terms of an application fee ($100,000) and credit processing fee, if project is invited to submit a full application (estimated to range from $250,000 - $500,000, to which the application fee can be applied). The amount of credit assistance offered through WIFIA is contingent on the size of congressional appropriations. The Congressional appropriation was $30 million in 2017 and $63 million in 2018. The first project applicants were approved funding in 2017 ($2.3 billion in loans). In 2018, a second round of projects were awarded to 39 applicants for a total of $5 billion in loans. The program is anticipated to continue in 2019, however the congressional appropriation has not yet been approved.

APPENDIX A – REFERENCES

2015 San Bernardino Valley Regional Urban Water Management Plan, June 2016, prepared by Water System Consulting, Inc.

Black and Veatch, 2013. Wastewater Collection System Master Plan

CDM, 2008. East Valley Water District - Water Master Plan

Kennedy/Jenks Consultants, 2010. Water Use Efficiency Plan

MWH, 2014, Water System Master Plan

RBF, 2013. Harmony Water Supply Assessment and Verification

2018 Uniform Plumbing Code. IAPMO/ANSI UPC – 1 2018

Western Municipal Water District of Riverside County et al. v. East San Bernardino County Water District, et al. Case No. 78426

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APPENDIX B – APRIL 3, 2018 OPERATIONS MEETING MINUTES

Appendix B – April 3, 2018 Operations Meeting Minutes

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Meeting Minutes

Project:	EVWD – Water and Sewer System Master Plans Update
Purpose:	Progress Meeting 2: Operations Meeting
Date and Time:	Tuesday, April 3, 2018 at 10:00 AM
Location:	31111 Greenspot Rd, Highland, CA 92346
Attendees:	EVWD Stantec IDModeling
Distribution:	Attendees, Files

AGENDA TOPICS

Action Item	Owner	Needed By
SCADA set points (list or screen shots), tags, and time series data	EVWD	ASAP
Review SCADA tags to identify fields needed for time series data	IDM/Stantec	After receipt of tag data
Provide list of sewer infrastructure added or changed since previous MP	EVWD	ASAP
Documentation of changes to the water model	IDM	4/11/2018
Demand TM	Stantec	4/13/2018
Demands to IDM for incorporation into the model	Stantec	Complete
Updated flow monitoring locations	Stantec	4/6/2018
List of areas with break in connections where hydraulics are causing localized flow issues	EVWD	ASAP
Map of flow splits and constrictions identified during model update, to be reviewed by EVWD	Stantec	4/20/2018
List of pumps that have been changed or replaced since previous master plan NOTE: EVWD has provided “ECM No. 2” document showing pump upgrades implemented with Honeywell program. Please confirm these are the only changed pumps since previous master plan or if additional will be provided	EVWD	ASAP
Report showing latest inspections of the tanks	EVWD	ASAP
GIS layer of septic customers	EVWD	ASAP
File of pipe breaks in system (GIS if available)	EVWD	ASAP
Subsewersheds created from previous MP	EVWD	ASAP

MEETING MINUTES

- **Introductions**

Jeff Noelte, Director of Engineering & Operations	**EVWD**
Eliseo Ochoa, Senior Engineer	**EVWD**
Patrick Milroy, Operations Manager	**EVWD**
Rick Bacerra	**EVWD**
Allen Williams	**EVWD**
Kyle Vasquez	**EVWD**
Daniel Davis	**EVWD**
Richard Becerra	**EVWD**
Jim Cathcart, Project Manager	**Stantec**
Oliver Slosser, Lead Engineer	**Stantec**
Christopher Mote, Condition Assessment	**Stantec**
Jennifer Wood, ID Modeling Project Manager	**IDM**
Matt Sellers, Lead Water Modeler	**IDM**
Sal Sailik, Water Modeling	**IDM**

- **Data Request List and Action Item Review**
  - **Water**
    - SCADA calibration data: SCADA screenshots were reviewed with EVWD, IDM and Stantec. EVWD to provide set points in the SCADA system for water system facilities, SCADA tags, and time series data for the week of the hydrant testing and one week before and after. IDM and Stantec will review available SCADA tags and identify which fields will be required from the time series data.
  - **Sewer**
    - List of updated facilities: EVWD to provide CIP projects completed or in progress since previous sewer master plan
- **Task Updates**
  - **Water model update**
    - Review of updated facilities by IDModeling: This item was tabled due to time. IDM will produce documentation of questions/changes to the water model based on the model update and submit to EVWD for reconciliation. Updated model will be uploaded in Sedaru for review.
  - **Demand analysis and future projections**
    - Demand analysis task is nearly complete. Stantec will provide updated demands to IDM for incorporation into the water model, and submit draft of demands TM to EVWD for review
  - **Condition assessment**
    - Discussed during this meeting, notes below
  - **Flow monitoring**
    - Stantec to review notes from ADS and provide updated locations to EVWD
  - **Sewer model update**
    - Stantec is waiting for updated facilities and then will begin update of the model
- **Operations Meeting**
  - **Operational Strategy Review-Water**
    - Stantec reviewed the overall operations strategy with EVWD and IDM.
    - Water is mainly pumped from the south east end (lower elevations) of the District through multiple pressure zones.

- Hydroelectric power station has not yet been commissioned at the State Water Project (SWP) turnout where water can flow to the North Fork Santa Ana River, and/or the water treatment plant.
- Currently bringing SWP water in at high pressure.
- North Fork Water CO (a mutual water company) among others have rights to North Fork water, EVWD is an approximate 80 percent rights holder. Rights holders are served their share of water through gravity.
- Water quality issues (high turbidity) in North Fork at times, most recently the entire month of February 2018, EVWD used only SWP water.

- **Condition of Existing Sewer Facilities**
  - Siphons:
    - List of siphons as presented in previous sewer MP is still accurate, no additional siphons.

Table 3-2 Siphons

	LOCATION	NO. OF BARRELS	DIAMETER (INCHES)	LENGTH (FEET)	MATERIAL	YEAR INSTALLED
East Valley Water District Siphons						
1	Between Elmwood Rd/Holly Vista Blvd intersection and Del Rosa Ave	2	6	64	CIP	1958
2	Pumalo St between Taylor Rd and Del Rosa Ave	2	6	103	CIP	1958
3	Pacific St between Victoria Ave and Valaria Dr	3	8	235	CIP	1970
4	North of E Third St between Palm Lane and Waterman Ave	2	8	102	CIP	1957
5	San Francisco St just north of Base Line St	3	6	66	DIP	1999
6	Plunge Creek along Greenspot Rd	3	6	326	DIP	1993
N/A	Warm Creek Siphon(2)	2	4	90	CIP	1971
East Trunk Sewer Siphons(1)						
7	E Sixth St between Cooley St and Pedley Rd	2	15 & 21	130	RCP	1958
8	S Waterman Ave between E Valley St and E Mill St	2	21 & 30	191	RCP	1958

(1) Operated and maintained by the City of San Bernardino. Siphons were identified through review of as-built drawings provided.
(2) Warm creek siphons not included in the model due to its limited service area.

- Siphons are checked weekly and cleaned monthly
- EVWD cannot get cameras under siphons
- Siphons 2 and 5 are regularly impacted by grease and require regular maintenance
- Siphon 3 has regular maintenance issues due to the State Hospital. Crews have found rags, bedsheets, and other items in the sewer system. EVWD has discussed the potential of cost sharing with the hospital for an onsite “muffin monster” or other solution to intercept the items before they enter the collection system. Stantec suggested EVWD also consider an upstream

    trash rack or traveling bar screen as the "muffin monster" may not be effective in dealing with fibrous material in large quantities.

- Diversion Structures
    - EVWD reviewed diversion structures listed in previous master plan

Table 3-3 Diversion Structures

DIVERSION NO.	MANHOLE NO.	INTERSECTION	PRIMARY FLOW DIRECTION	SECONDARY FLOW DIRECTION
1	I6-142	Pacific Street & Victoria Avenue	West	South
2	H8-118	Highland Avenue & Palm Avenue	South	West
3	G9-161	Piedmont Drive & Diablo Drive	South	West
4	I7-126	Central Avenue & Pacific Street	South	West
5	M3-118	5th Street & Whitlock Avenue	South	West

    - There is an additional structure located east of Church St. and Greenspot Ave. This structure will be added to the table.
- Flow Splits and Flow Constrictions:
    - There is a flow split at Witlock Ave. where there is a relief line. Normal flow is routed to the main line. High flows overflow to the relief line.
    - There are some connections in the system that cause non ideal flow dynamics in localized areas. They include service laterals and main lines (at Hospital) that enter manholes at 90 degree angles. These will not necessarily be modeled, but will be addressed in the condition assessment. New manhole bases, or new manholes would correct the problem. EVWD to provide these locations.
    - Stantec will identify flow splits and constrictions while updating the model and present to EVWD in a map for review. EVWD will identify where flow travels based on their experience.
    - Recent SSO at Ferndale, there is a section of pipe that has a 6 inch flow constriction between two 8 inch pipes.
- Pipelines and Manholes
    - Highland Ave experiences high amounts of fats and grease from the meat processing plant on Highland.
    - EVWD has no formal FOG program, as sewage now is treated at the San Bernardino WWTP. EVWD is addressing areas of high FOG currently and will start a FOG program when the Sterling plant comes online. Stantec will make recommendations for personnel and equipment to conduct inspections and maintenance.
    - EVWD is working through areas that need grease traps, this has led to decreases in FOG issues
    - On Webster St. south of Baseline near Emmanuel Baptist Church there is a very flat 74-ft section, and buildup of sand can cause localized backflow conditions. There is side flow from break-in connections.
    - There are a few other areas in the system with flat sections where debris builds up.
    - There are manholes located behind houses and in difficult to access areas that cause some maintenance issues.
    - EMWD will provide a speadsheet they use to track problem areas.
    - High H_2S concentrations in some of the manholes downstream of the San Manuel Casino have deteriorated the concrete.

- Septic Customers
  - EVWD maintains a GIS layer of septic customers, this will be provided to Stantec for use in the sewer master plan. Data are color coded to denote septic systems within 200-ft of a sewer, and whether they have water service or not.

- **Condition of Existing Water Facilities**
  - Pipelines
    - EVWD maintains a pipe break file and will provide to Stantec.
  - Wells
    - List of wells from previous master plan was reviewed, well 27 is missing from the list, it has sanding problems.

No.	Location	Status	Pressure Zone	Capacity (gpm)(1)	Total Head (feet)	Pumping Elevation (feet)	Ground Elevation (feet)	Hydraulic Grade (feet)	Discharge Pressure (psi)
9	26493 Temple St.	Questionable	Intermediate	1,112	229	926	1,149	1,155	3
11 A	6th/Pedley	Active	Lower	1,953	198	874	1,058	1,072	6
24 A	1 Harrison/Lynwood	Active	Intermediate	1,069	337	928	1,251	1,265	6
24 B	30 Harrison/Lynwood	Active	Intermediate	2,691	387	873	1,246	1,260	6
25	3187 N. Mountain Ave.	Active	Intermediate	950	436	935	1,248	1,371	53
28 A	25385 Court St.	Active	Lower	1,505	397	872	1,091	1,269	77
39	2683/2695 E. Citrus	Active	Intermediate	1,257	429	944	1,352	1,373	9
40	27346 E. 3rd Street	Inactive	Intermediate	1,459	613	952	1,201	1,565	158
107	1425 E Citrus St.	Inactive	Intermediate	1,133	534	1,003	1,219	1,537	138
125	2129 Plant H5	Active	Foothill	1,681	295	1,417	1,614	1,712	42
132	7479 San Francisco	Active	Intermediate	1,802	456	917	1,157	1,373	94
141	2287 E. 5th Street	Active	Intermediate	2,095	506	882	1,120	1,388	116
142	7695 Vista Rio	Active	Foothill	1,367	196	1,361	1,545	1,557	5
143	29090 Abbey Way	Active	Upper	1,202	771	1,006	1,340	1,777	189
146	7938 Church Street	Active	Upper	729	499	1,079	1,322	1,578	111
146A	7938 Church Street	Active	Upper	1,759	622	1,020	1,323	1,642	138
147	29250 Abbey Way	Active	Upper	2,410	375	1,216	1,365	1,590	97
151	6032 6th St.	Active	Intermediate	2,871	390	1,414	1,121	1,803	295
Total Capacity				**29,045**					

- There are now 15 active wells, 5 inactive wells, and 1 questionable well.
- Wells number 40 and 107 are inactive. Uranium found in samples from well 40, perchlorate and nitrates in 107. They also have perchlorate.
- Well number 9 is questionable due to detection of radionuclides. EVWD is evaluating if they can pack off sections of production zones to isolate good quality water.
- Wells 24A and 24B are only run one at a time. They are close together and if run together, pumping water levels interfere with each other and result in high power consumption.
- Well 146 and 146A have the same issues as above.
- Well 28A has GAC treatment for TCE, possibly PCE. The filters are over 20 years old.
- Entrained air comes from wells 147, 146, 146A and 143. Reservoir at 143 is used to off gas. Could be cascading water in the well.

- Wells 40, 27, and 107 had ion exchange but the maintenance contract has been terminated, and they are inactive.
- Injecting polyphosphates for corrosion control at 142, 143, 146, 146A, 147, and Plant 134
- Well 39 is a blending facility. Well pumps to forebay that feeds two boosters to Upper and Foothill zones. Blending is due to high fluoride in Well 39.
- Currently EVWD rehabs two wells per year.

- Pressure Zones
  - List of Pressure Zones from previous master plan was reviewed

Pressure Zone Name	Area (square miles)	Hydraulic Grade Elevation (feet-amsl(1))	Ground Elevation Range (feet-amsl)	Static Pressure Range(2) (psi)
Lower Zone	2.29	1,248	1,032-1,212	16-94
Intermediate Zone	4.16	1,368	1,086-1,353	6-122
Upper Zone	5.73	1,560	1,170-1,513	20-169
Foothill Zone	3.75	1,690	1,315-1,682	3-162
Canal 1 Zone	6.16(3)	1,820	1,432-1,783	16-168
Canal 2 Zone		1,852	1,557-1,825	12-128
Canal 3 Zone		1,838	1,468-1,852	7-160
Mountain Zone	1.93	2,015	1,668-2,016	12-163
Hydro 59	0.26	1,931	1,686-1,827	45-116
Hydro 101	0.01	2,020	1,751-1,824	85-116
Hydro 149	0.05	2,198	1,918-2,058	61-121
Hydro 34	0.05	1,479	1,171-1,256	97-133
Baldridge Canyon	0.03	1,566	1,389-1,443	53-77
Mercedes	0.02	1,669	1,382-1,427	105-124
Highland Upper	0.72	1,440	1,151-1,326	49-125

(1) Feet above mean sea level
(2) Calculated based on difference between hydraulic grade elevation and ground elevation range
(3) Area for Canal zone as a whole is presented

  - Little Sycamore to be added to pressure zone list.
  - Water does not flow from the Upper Zone to the west easily.
  - Upper zone reservoirs routinely operate at different levels, there can be as much as a 10 ft. different in tank water levels during the day. Stantec requested daily data to see if levels equalize during low demand periods. If so, this could indicate hydraulic restrictions in transmission system piping.
  - No redundancy in the Canal 1 and Canal 2 Zones.
  - Static max/min pressure range will represent pressure range at demand nodes and not calculated as in the current table.
  - Pipeline on Highland westward from treatment plant is 16” and constricts flow.
  - EVWD would like to tie the Canal Zones together if possible
  - Area around Pumps 59 and 56 may need to be on its own zone, experiencing high pressures.
- Booster Pump Stations
  - Reviewed list of booster pumps are listed in the previous master plan.

Booster Pump	Motor Horsepower (hp)	Design Head (ft)	Design Flow (gpm)	Overall Efficiency (%)	Suction Zone	Discharge Zone
PMP_101_1	30	83	399	31.4	Canal2	Hydro101
PMP_101_2	30	88	441	33.0	Canal2	Hydro101
PMP_108_1	100	163	1,278	63.1	Foothill	Canal3

Booster Pump	Motor Horsepower (hp)	Design Head (ft)	Design Flow (gpm)	Overall Efficiency (%)	Suction Zone	Discharge Zone
PMP_108_2	100	158	1,207	59.2	Foothill	Canal3
PMP_125_1	40	93	1,203	61.1	Plant 125	Foothill
PMP_125_2	20	89	657	66.9	Plant 125	Foothill
PMP_127_1	75	153	1,327	65.5	Lower	Intermediate
PMP_127_2	75	163	1,335	66.9	Lower	Intermediate
PMP_129_1	100	175	1,647	75.9	Upper	Foothill
PMP_129_2	100	172	1,636	71.6	Upper	Foothill
PMP_129_3	100	175	1,648	71.6	Upper	Foothill
PMP_129_4	100	304	980	68.9	Upper	Canal3
PMP_129_5	100	302	971	68.0	Upper	Canal3
PMP_12_1	150	194	2,187	75.3	Plant 11	Lower
PMP_12_2	100	203	1,467	74.2	Plant 11	Lower
PMP_12_3	60	199	865	66.8	Plant 11	Lower
PMP_130_1	60	119	475	30.2	Lower	Intermediate
PMP_130_2	60	150	637	44.1	Lower	Intermediate
PMP_131_1	40	168	504	61.9	Foothill	Canal3
PMP_131_2	25	165	270	49.2	Foothill	Canal3
PMP_131_3	30	167	290	47.1	Foothill	Canal3
PMP_134_1	75	155	1,015	69.5	Upper	Foothill
PMP_134_2	75	187	687	68.4	Upper	Foothill
PMP_134_3	75	191	557	63.3	Upper	Foothill
PMP_134_4	75	374	512	62.3	Upper	Canal3
PMP_134_5	75	386	693	80.8	Upper	Canal3
PMP_137_1	40	210	550	69.5	Canal3	Mountain
PMP_137_2	40	212	548	69.4	Canal3	Mountain
PMP_140_1	60	217	777	70.1	Canal3	Mountain
PMP_140_2	60	219	800	71.8	Canal3	Mountain
PMP_142_1	50	182	867	67.3	Plant 142	Foothill
PMP_142_2	125	182	470	66.7	Plant 142	Foothill
PMP_142_3	125	192	778	58.6	Plant 142	Canal3
PMP_149_1	15	162	80	42.0	Mountain	Hydro149
PMP_149_2	15	115	81	41.7	Mountain	Hydro149
PMP_149_3	100	193	1,530	74.9	Mountain	Hydro149
PMP_149_4	100	188	1,505	73.1	Mountain	Hydro149
PMP_24_1	100	170	1,869	78.7	Plant 24	Intermediate
PMP_24_2	75	154	1,756	73.4	Plant 24	Intermediate
PMP_24_3	75	124	1,473	64.7	Plant 24	Intermediate
PMP_25_1	60	233	573	61.6	Plant 25	Upper
PMP_33_1	100	199	1,623	68.8	Intermediate	Upper
PMP_33_2	75	207	1,003	66.4	Intermediate	Upper
PMP_33_3	60	208	746	62.8	Intermediate	Upper
PMP_34_1	15	169	199	52.3	Lower	Hydro 34
PMP_34_2	40	125	915	54.3	Lower	Hydro 34
PMP_37_1	100	159	1,089	56.6	Upper	Foothill
PMP_37_2	100	150	1,065	52.2	Upper	Foothill
PMP_39_1	40	182	662	69.1	Intermediate	Upper
PMP_39_2	50	379	287	45.0	Intermediate	Foothill
PMP_39_3	125	341	1,053	66.1	Intermediate	Foothill
PMP_39_4	125	375	1,128	78.1	Intermediate	Foothill
PMP_39_5	20	21	1,895	51.0	Intermediate	Forebay
PMP_39_6	20	21	1,735	45.8	Intermediate	Forebay

Booster Pump	Motor Horsepower (hp)	Design Head (ft)	Design Flow (gpm)	Overall Efficiency (%)	Suction Zone	Discharge Zone
PMP_56_1	50	150	802	51.7	Foothill	Canal1
PMP_56_2	50	163	1,210	77.8	Foothill	Canal1
PMP_59_1	30	91	824	57.7	Canal1	Hydro59
PMP_59_2	30	104	765	65.9	Canal1	Hydro59
PMP_59_3	15	85	541	72.0	Canal1	Hydro59
PMP_99_1	40	172	667	76.2	Foothill	Canal2
PMP_99_2	40	176	519	62.9	Foothill	Canal2
PMP_9_1	75	278	542	50.9	Plant 9	Intermediate
PMP_9_2	75	291	612	61.2	Plant 9	Intermediate
Total Average Capacity			**58,427**			

- EVWD to provide a list of pumps that have been replaced or changed since previous master plan. Current upgrade schedule is four pumps per year.
- Pumps 149_1 and 149_2 are currently being replaced.
-
- Pumps 56 and 59 may be too small to serve the planned Casino 500 room hotel.
- Pumps 59 pump into hydro zone and cycles excessively.
- 5 VFDs on permeate pumps at Plant 134, and 2 VFDs at Plant 143.
- Several of the pumps have efficiency issues and may need to be resized.
- Booster site 127 has a pressure reducing valve to drop water from the intermediate zone to the lower zone, the set point is based on Plant 34 level.
- SCE does efficiency tests every other year. EVWD will do additional testing for needed for the master plan.

- Storage Reservoirs
  - Reviewed storage reservoirs as presented in previous master plan

Reservoir ID	Pressure Zone	Volume (MG)	Bottom Elevation (ft.)	High Water Elevation (ft.)	Height (ft.)	Dia. (ft.)	Year of Const.
Plant 101	Canal 2	1.4	1,820	1,852	31.5	85.0	1978
Plant 108	Foothill	2.0	1,662	1,710	47.5	84.0	1980
Plant 129_1	Upper	3.0	1,530	1,560	30.0	130.0	1993
Plant 129_2	Upper	3.0	1,530	1,560	30.0	130.0	1993
Plant 134	Upper	3.0	1,520	1,560	40.0	113.0	1996
Plant 137	Canal 3	0.07	1,816	1,838	22.0	23.5	1960
Plant 140	Canal 3	2.0	1,820	1,850	30.0	106.0	1990
Plant 148	Mountain	0.75	2,015	2,044	29.0	65.0	2002
Plant 33_1	Intermediate	1.0	1,330	1,365	34.75	70.0	1956
Plant 33_2	Intermediate	2.5	1,330	1,365	34.75	110.0	1957
Plant 33_3	Intermediate	1.0	1,330	1,365	34.75	70.0	1957
Plant 34	Lower	1.0	1,210	1,248	38.0	66.5	1957
Plant 37	Upper	4.0	1,520	1,560	40.0	132.0	2003
Plant 39_1	Intermediate	0.9	1,343	1,366	23.2	80.0	1961
Plant 39_2	Intermediate	1.4	1,343	1,366	23.2	100.0	1983
Plant 56	Foothill	0.5	1,666	1,690	23.5	60.0	1968
Plant 59	Canal 1	0.7	1,800	1,820	20.0	78.0	1986
Plant 99	Foothill	0.5	1,666	1,690	23.5	60.0	1968
Total Capacity		**27.6**					

- Corrosion at Plant 140, needs rehabilitation, but cannot be taken down for maintenance because 137 volume is too small to support the zone.

- Plant 134 is a concrete tank, and 37 is buried concrete, all others are steel tanks.
- Plant 59 is also in need of rehabilitation but it cannot be taken out of service.
- EVWD to provide copy of report showing latest inspections of the tanks.
- Recoating of tanks is based on inspection. Tanks are inspected by divers every 4-6 years.
- Hydro tanks are in need of inspection but can't be taken out of service. Some are undersized and some may have corrosion problems.
- Tank water age is contributing to higher THM concentrations in the distribution system.
- Most tanks are single inlet and outlet, contributing to water age issues. Adding mixers or a second inlet have been considered to reduce nitrification.
- Canal Zones tanks do not float well together, and the Plant 99 and 101 tanks do not float together.
- Inadequate storage in Foothill zone, Plant 108 water levels will drop no matter how much is pumped into it, especially in summer.
- Plant 134 has a seismic valve. Other tanks are not seismically retrofitted.
- Plant 59 hydro turns on and off constantly. This area was connected to a residential zone, and is now serving many additional customers on the San Manuel Reservation, the tank is undersized.
- Plant 34 and Plant 101 need to be rehabilitated or replaced.

- Pressure Regulating Stations
  - Reviewed pressure regulating stations as presented in previous master plan

Station No.	From Zone	To Zone	Pressure Setting (psi)	Ground Elevation (feet)
301	Highland Upper	Intermediate	92	1,214
302	Foothill	Baldridge Canyon	70	1,405
305	Foothill	Upper	57	1,424
306	Highland Upper	Intermediate	98	1,205
308	Foothill	Mercedes	105	1,426
309	Intermediate	Lower	62	1,108
311	Intermediate	Lower	48	1,134
324	Foothill	Upper	56	1,429
325	Upper	Highland Upper	88	1,237
326	Upper	Highland Upper	82	1,261
33	Upper	Intermediate	SCADA Controlled	
40	Upper	Intermediate	SCADA Controlled	
108	Canal	Foothill	SCADA Controlled	
127	Intermediate	Lower	SCADA Controlled	

  - Additional PRS are shown in the above table in red.
  - PRS 308 is rarely used.
  - PRS 40 can drop water via PRV from upper to intermediate zone.

- **Future Operational Strategy Discussion**
  - Change to Surface Water Sources
    - Santa Ana River and SWP water to supply roughly 75 percent of future supply.
  - The Conservation District recharge basins can take as much water as necessary for recharge, and are not restricted by flood control operations.

- Flexibility needs to be added to the system to switch between ground and surface water as local and state water supplies vary.
- Reduce energy costs and do less pumping.
- Treatment must address THM issues in system.

- **Next Steps**
  - **Hydrant Testing**
    - EVWD to complete hydrant testing week of 4/9/18
  - **Flow Monitoring**
    - Stantec will review notes from ADS on land use specific flow monitoring sites and make new recommendations.

APPENDIX C – EPS CALIBRATION RESULTS

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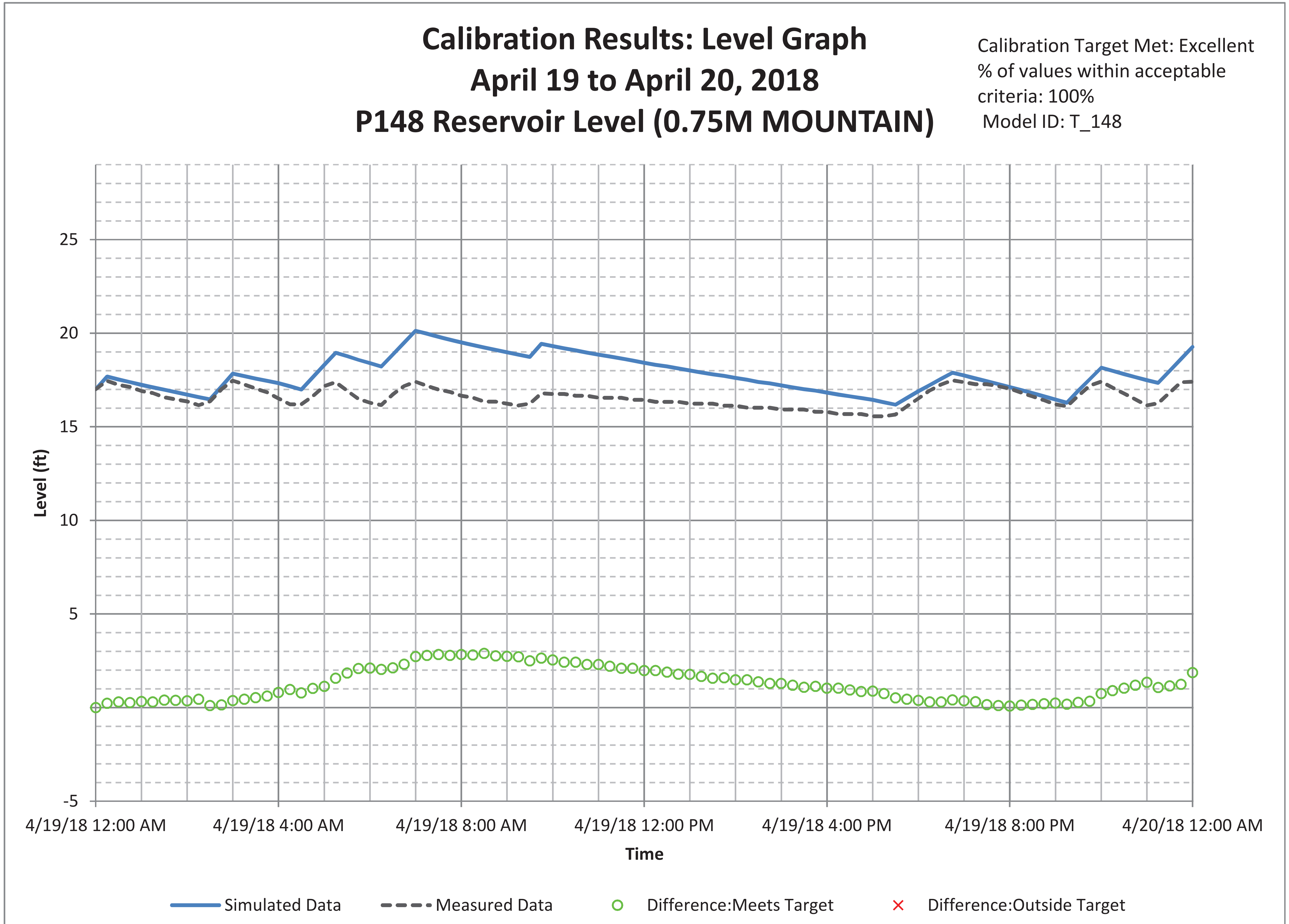
Calibration Period: April 18, 2018

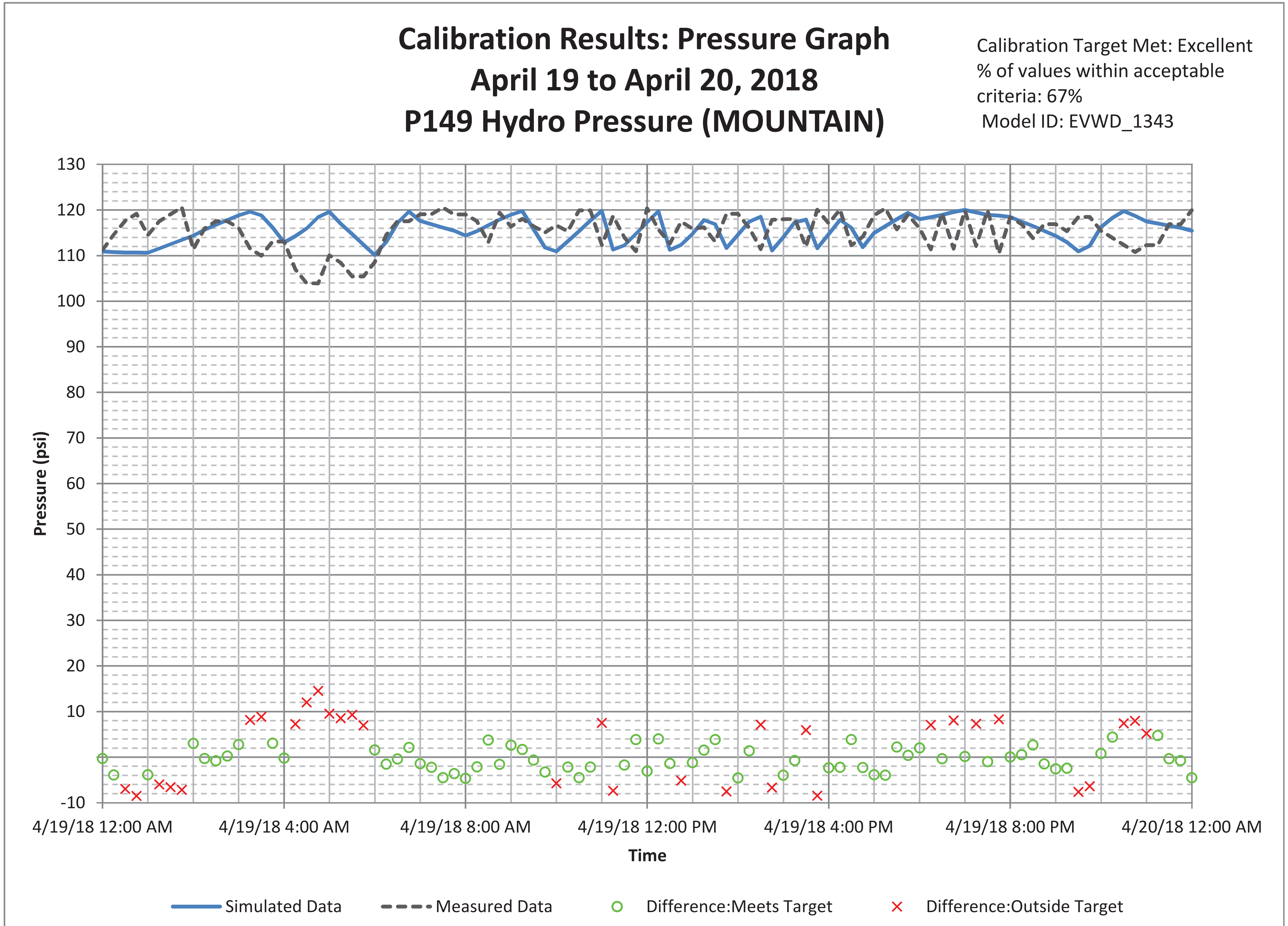
Measurement		Excellent	Good	Fair
Flow	gpm	<=10%	10% - 20%	>20%
Pressure	psi	<=3	3 - 5	>5
Level	ft	<=3	3 - 6	>6

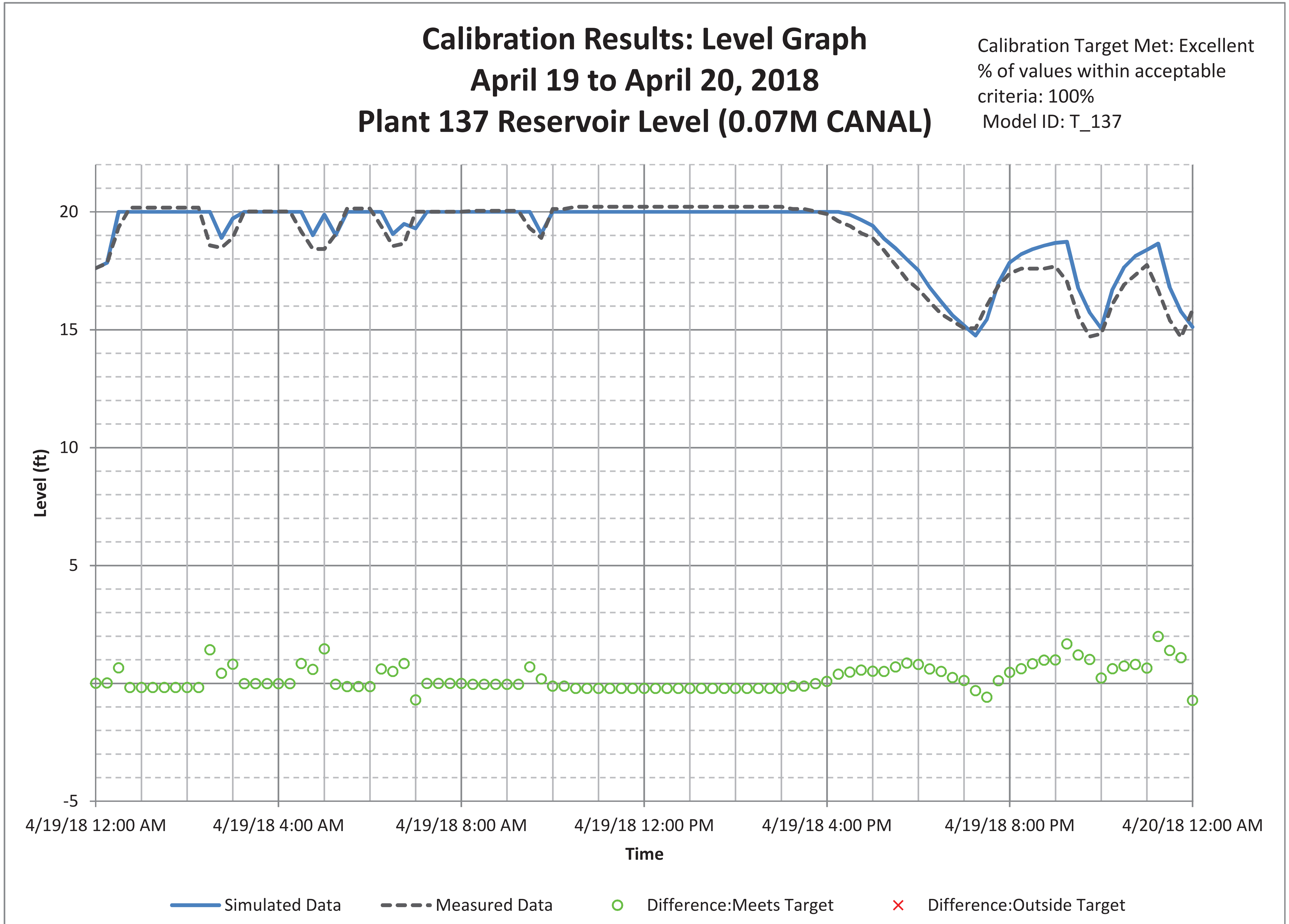
Measurement		Count per Calibration Target			Total
Flow		20	3	1	24
Pressure		5	1	1	7
Level		17	2	0	19
Total:		42	6	2	50
Total Excellent + Good:	48	96%			
Total:	50				

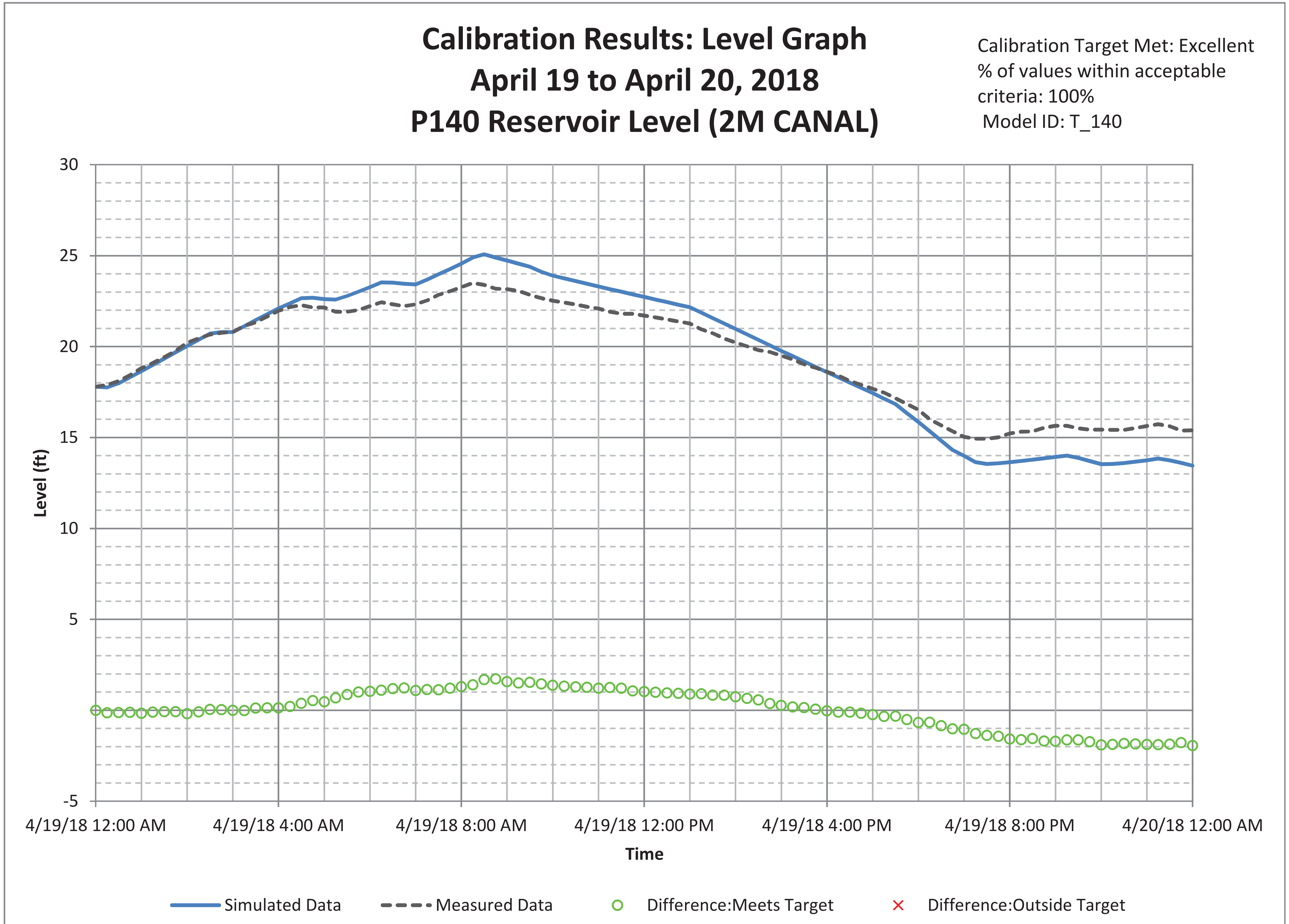
Calibration Point	Simulated Average	Measured Average	Comparison	Is Average within Criteria?	% of Time within Acceptable Criteria?	Comments
P148 Reservoir Level	18 ft	17 ft	1.2 ft	Excellent	100%	-
P149 Hydro Pressure	116 psi	115 psi	0.4 psi	Excellent	67%	-
Plant 137 Reservoir Level	19 ft	19 ft	0.2 ft	Excellent	100%	-
P140 Reservoir Level	20 ft	19 ft	0.1 ft	Excellent	100%	-
Canal Zone Pressure	131 psi	128 psi	2.5 psi	Excellent	85%	-
P131Flow Rate	302 gpm	740 gpm	59.2%	Fair	0%	SCADA provided is identical to drop valve at this pump station and does not match pump run status from SCADA.
P108 Drop Valve Flow Rate	704 gpm	740 gpm	4.8%	Excellent	100%	-
P101 Hydro Pressure	51 psi	50 psi	0.7 psi	Excellent	47%	-
P101 Reservoir Level	19 ft	17 ft	1.4 ft	Excellent	100%	-
P59 Reservoir Level	17 ft	17 ft	0.1 ft	Excellent	100%	-
P59 Hydro Pressure	58 psi	55 psi	3.2 psi	Good	51%	-
P108 Reservoir Level	29 ft	30 ft	1.0 ft	Excellent	100%	By closing PRS_324, the tank level achieves an excellent calibration match. If this valve is set to open at 58 psi, Tank 108 level drops significantly in the simulation and does not match the SCADA very well. It is recommended to field check PRS_324 to confirm if it has flow passing through the valve. It could also be the case where PRS_324 has a lower setting than 58 psi which results in the PRV closing due to a higher downstream pressure.
Plant 56 Reservoir Level	16 ft	16 ft	0.7 ft	Excellent	100%	Disabled float valve control from legacy model to improve calibration. In addition, PRS_315 was set to active at 70 psi to improve calibration (was previously closed per EVWD). Calibration indicates additional flow leaves the Foothill Zone near Tank 56 and Tank 99. PRS_315 simulates this flow leaving Foothill. It is recommended to field check PRS_315 to confirm if it has flow passing through the valve.
Plant 99 Reservoir Level	17 ft	17 ft	0.3 ft	Excellent	100%	PRS_315 was set to active at 70 psi to improve calibration (was previously closed per EVWD). Calibration indicates additional flow leaves the Foothill Zone near Tank 56 and Tank 99. PRS_315 simulates this flow leaving Foothill. It is recommended to field check PRS_315 to confirm if it has flow passing through the valve.
Well 125 Flow Rate	1,250 gpm	1,246 gpm	0.3%	Excellent	100%	-
Well 125 System Flow Rate	1,243 gpm	1,227 gpm	1.3%	Excellent	98%	-
Well 142 Flow Rate	1,020 gpm	1,037 gpm	1.6%	Excellent	100%	-
P142 Clearwell Level	3 ft	3 ft	0.4 ft	Excellent	100%	-
P142-1 Flow Rate	837 gpm	835 gpm	0.3%	Excellent	100%	-
P37 Reservoir Level	27 ft	26 ft	0.1 ft	Excellent	100%	-
P129 Reservoir Level	18 ft	18 ft	0.3 ft	Excellent	100%	-
P134 Reservoir Level	26 ft	29 ft	3.3 ft	Good	90%	-
Plant 143 Flow Rate	1,080 gpm	1,067 gpm	1.2%	Excellent	100%	-
Well 146 Flow Rate	470 gpm	472 gpm	0.3%	Excellent	100%	-
Well 146A Flow Rate	1,020 gpm	1,000 gpm	2.0%	Excellent	100%	-
W147 Flow Rate	1,700 gpm	1,700 gpm	0.0%	Excellent	100%	-
Combined Well Flow Rate	1,946 gpm	1,937 gpm	0.5%	Excellent	100%	-
Tank 100 Level	20 ft	20 ft	0.2 ft	Excellent	100%	-
Average Booster Flow Rate	1,942 gpm	1,911 gpm	1.6%	Excellent	95%	-
P25-1 Flow Rate	707 gpm	799 gpm	11.6%	Good	100%	-
Upper Zone Flow Rate	1,215 gpm	1,034 gpm	17.5%	Good	47%	Tapered flow pattern recorded by SCADA could be a result of fast change in flow not captured in the 15-minute sampling period.
P40 Upper Zone Flow Rate	1,347 gpm	1,234 gpm	9.1%	Excellent	80%	-
P40 Discharge Pressure	149 psi	142 psi	7.5 psi	Fair	1%	Plant 40 discharge pressure is about 8 psi lower in SCADA than in the model. Several attempts to lower the pressure through closing valves did not help to lower the pressure in the model. In addition, the hydrant test in Upper actually matches the simulated pressure more than the P40 pressure. It is recommended that this pressure gauge be checked for accuracy.

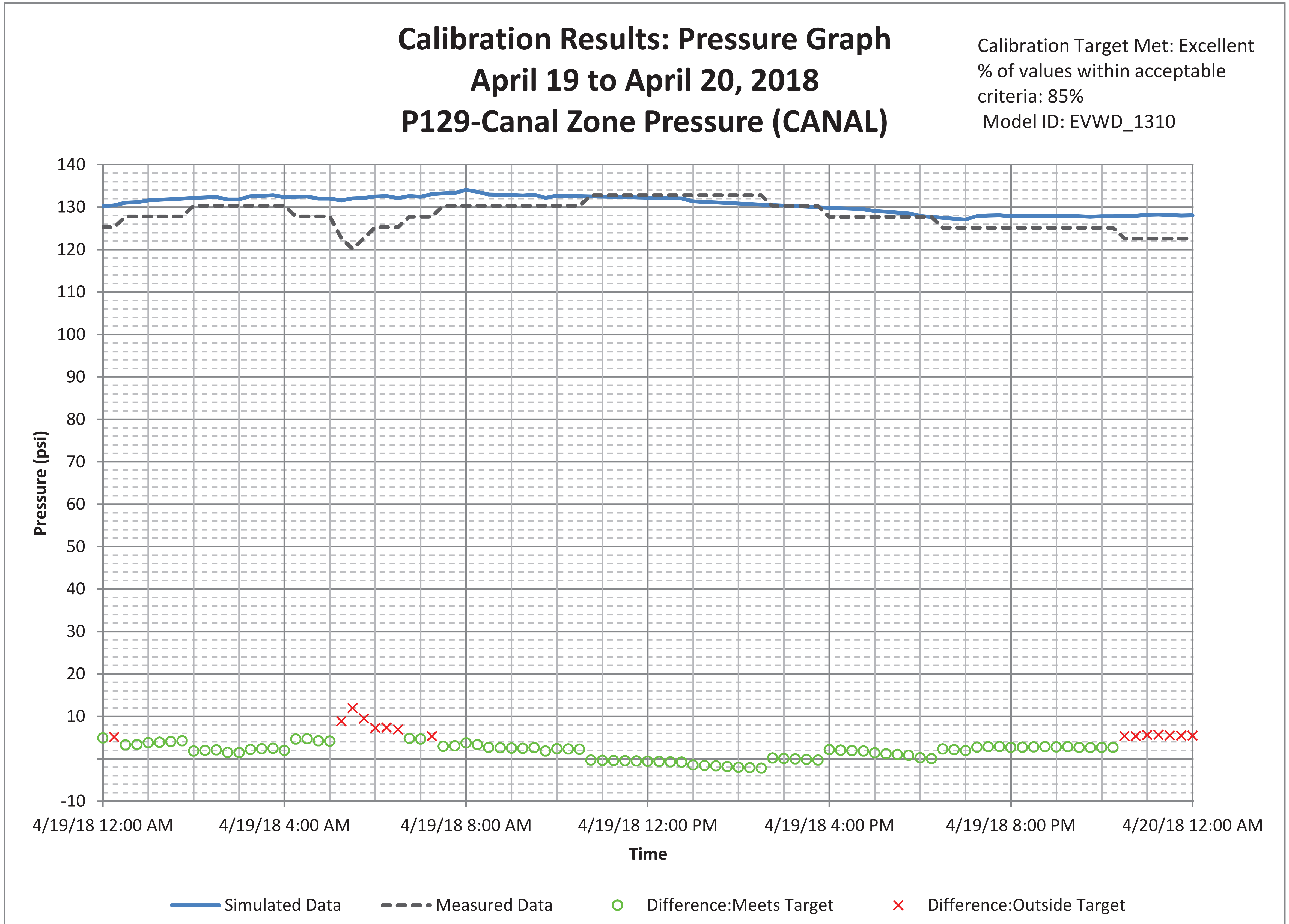
Calibration Point	Simulated Average	Measured Average	Comparison	Is Average within Criteria?	% of Time within Acceptable Criteria?	Comments
P40 Drop Valve Flow Rate	1,297 gpm	1,287 gpm	0.8%	Excellent	100%	-
Plant 33 Reservoir Level	28 ft	29 ft	0.9 ft	Excellent	100%	-
P39 Forebay Level	9 ft	13 ft	3.8 ft	Good	98%	-
P39 Reservoir Level	17 ft	18 ft	1.1 ft	Excellent	100%	While model achieves an excellent match for this T_39, it was observed that the pump tests for Pump 39 #3 and #4 had a higher recorded discharge pressure of near 180 psi, while the model is at 157 psi. There are not any pressure calibration points in the Foothill Zone to help investigate this discrepancy. It is recommended that EVWD confirm the discharge pressure at this pump station and investigate if there are any significant head losses, such as partially closed valves that might result in the 23 psi delta.
T_9 Reservoir Level	0 ft	0 ft	0.0 ft	Excellent	100%	-
W39 Flow Rate	1,500 gpm	1,499 gpm	0.1%	Excellent	100%	-
W132 Flow Rate	2,180 gpm	2,177 gpm	0.1%	Excellent	100%	-
W132 Pressure	91 psi	93 psi	1.8 psi	Excellent	99%	-
W151 Flow Rate	2,200 gpm	2,181 gpm	0.9%	Excellent	99%	-
W24B Flow Rate	2,215 gpm	2,722 gpm	18.6%	Good	100%	Updated well flow rate to match pump test, from 2,720 gpm to 2215 gpm, which resulted in better match and cycling at T-24. It is recommended to validate SCADA flow versus the pump test for Well 24B.
P24 Clearwell Level	5 ft	5 ft	0.4 ft	Excellent	100%	-
W25 Flow Rate	900 gpm	889 gpm	1.2%	Excellent	100%	-
P127 Drop Flow	1,270 gpm	1,256 gpm	1.2%	Excellent	100%	-
P130 Flow Rate	784 gpm	785 gpm	0.0%	Excellent	100%	-
P34 Reservoir Level	30 ft	33 ft	2.4 ft	Excellent	100%	-
Well 11 Flow Rate	1,200 gpm	1,170 gpm	2.6%	Excellent	100%	-
P34 Hydro Pressure	80 psi	79 psi	0.7 psi	Excellent	51%	-

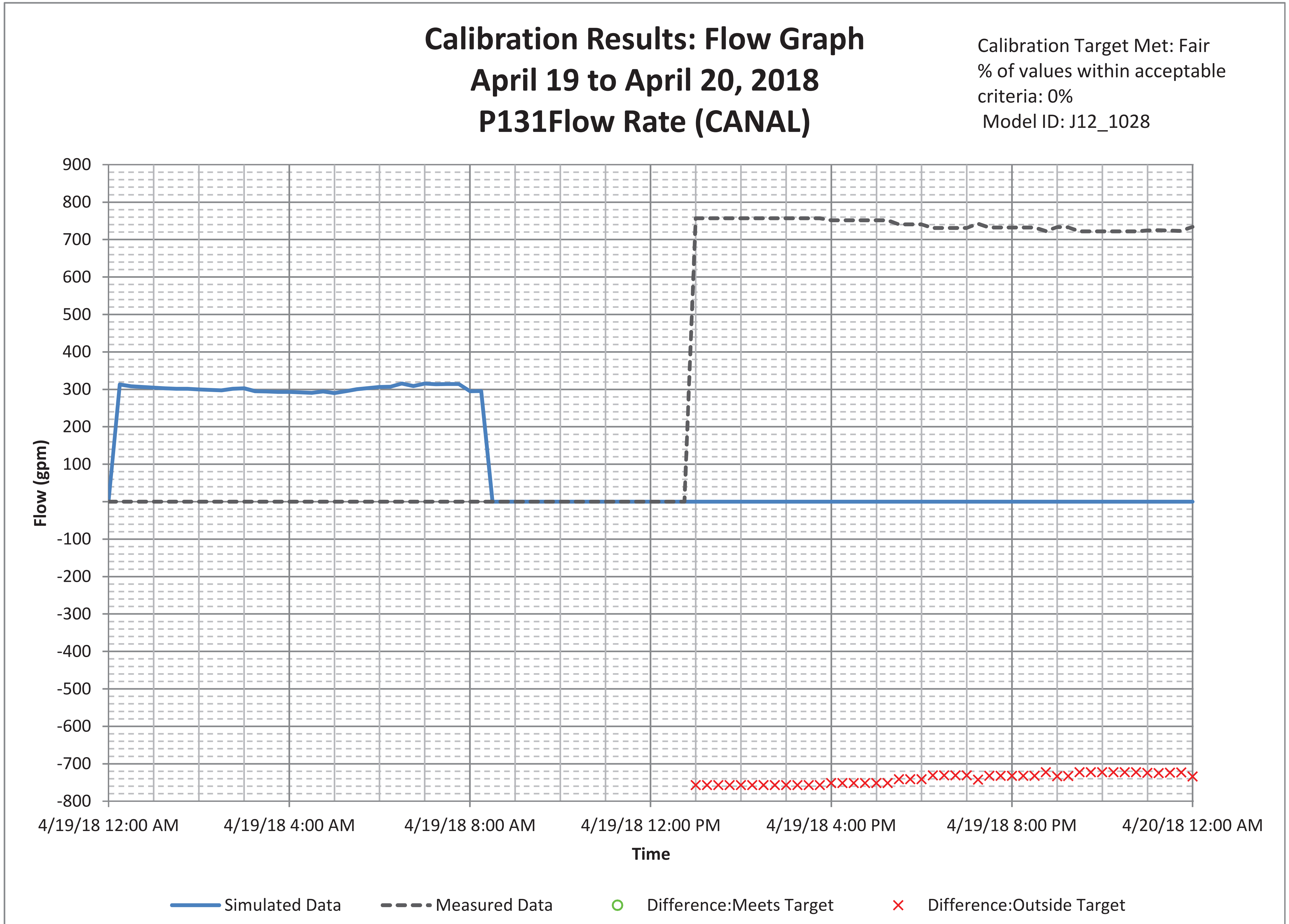

Calibration Results: Level Graph
April 19 to April 20, 2018
P148 Reservoir Level (0.75M MOUNTAIN)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_148
Level (ft)
25
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

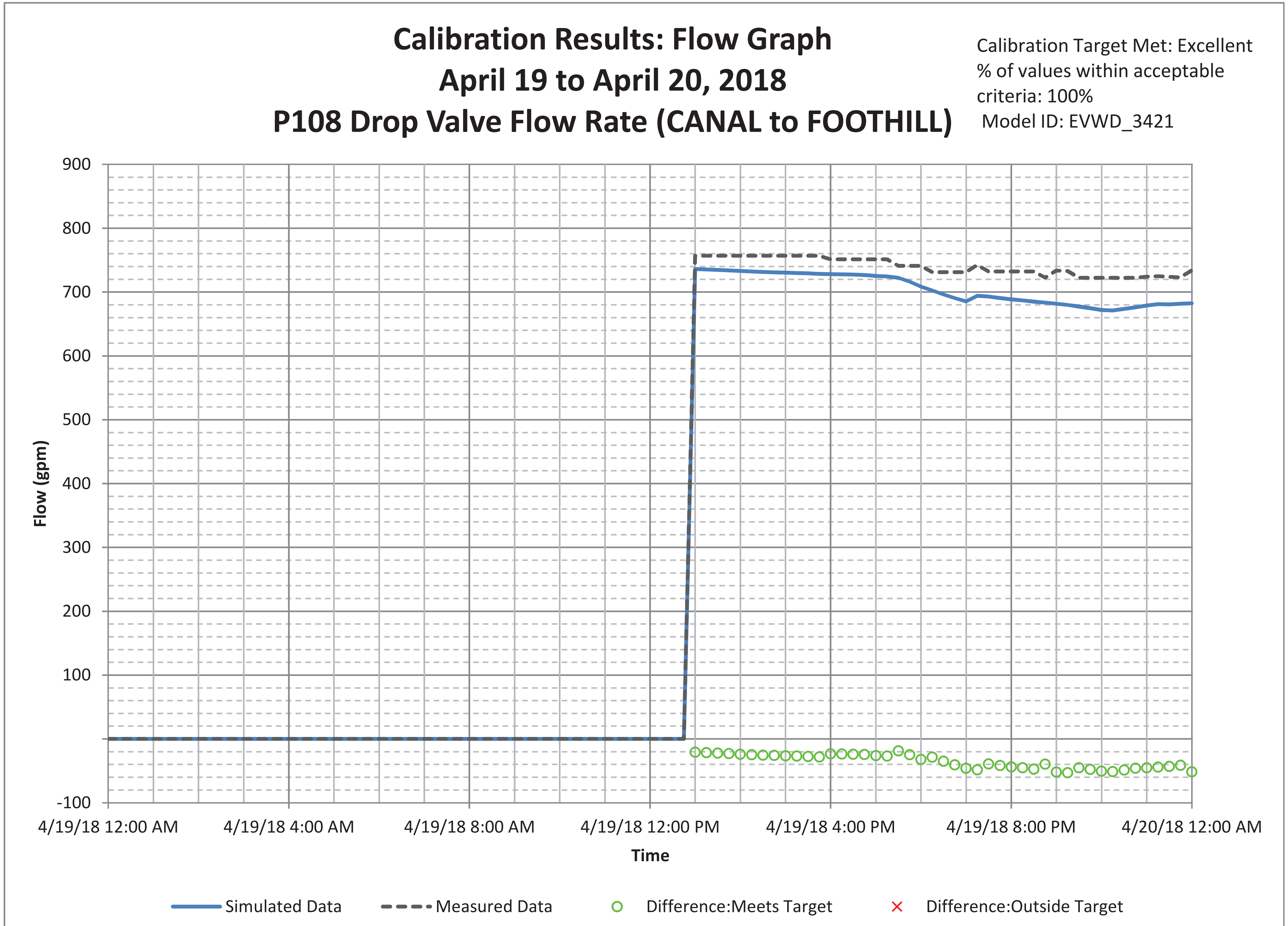

Calibration Results: Pressure Graph
April 19 to April 20, 2018
P149 Hydro Pressure (MOUNTAIN)
Calibration Target Met: Excellent
% of values within acceptable criteria: 67%
Model ID: EVWD_1343
Pressure (psi)
130
120
110
100
90
80
70
60
50
40
30
20
10
-10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

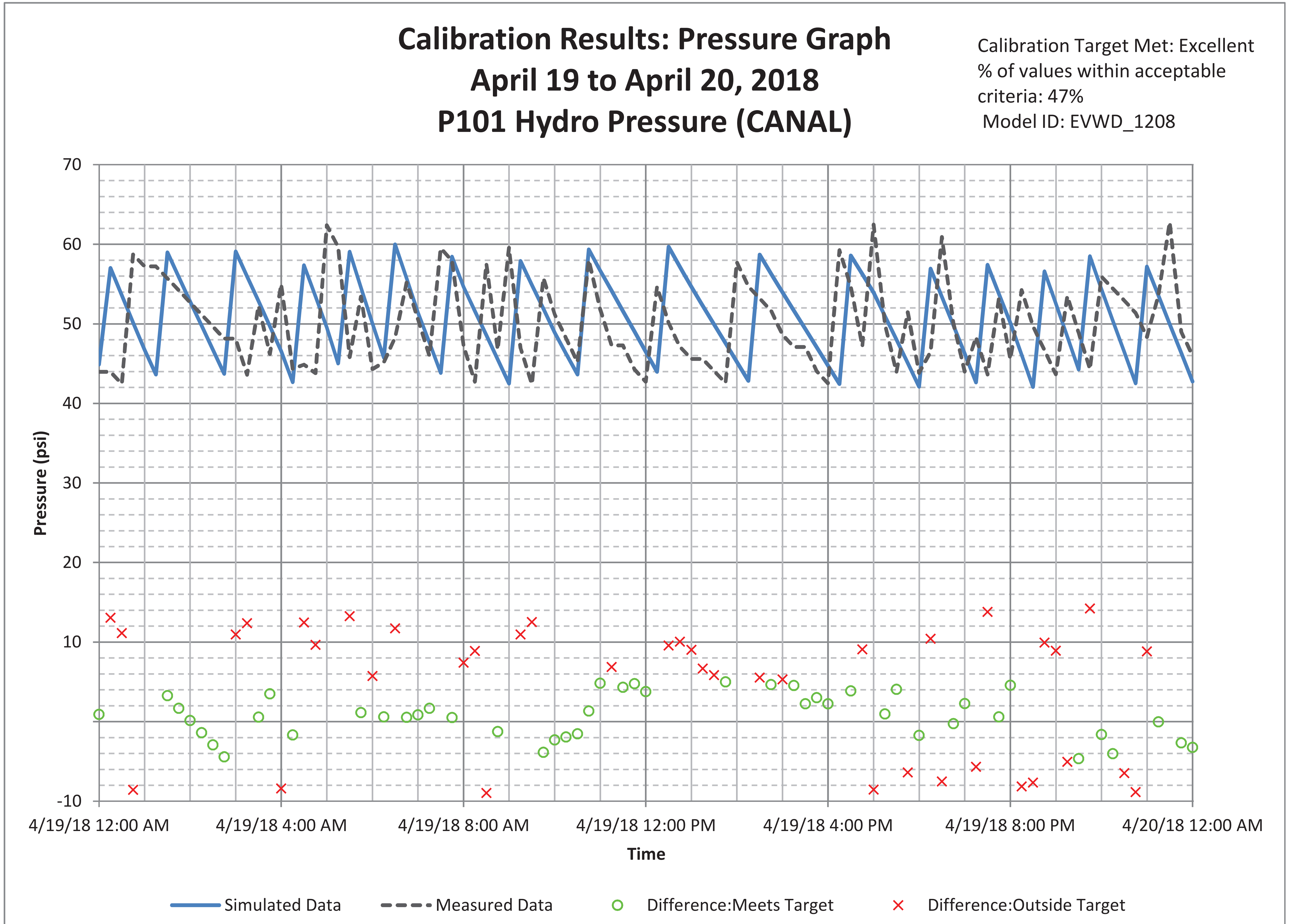

Calibration Results: Level Graph
April 19 to April 20, 2018
Plant 137 Reservoir Level (0.07M CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_137
Level (ft)
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

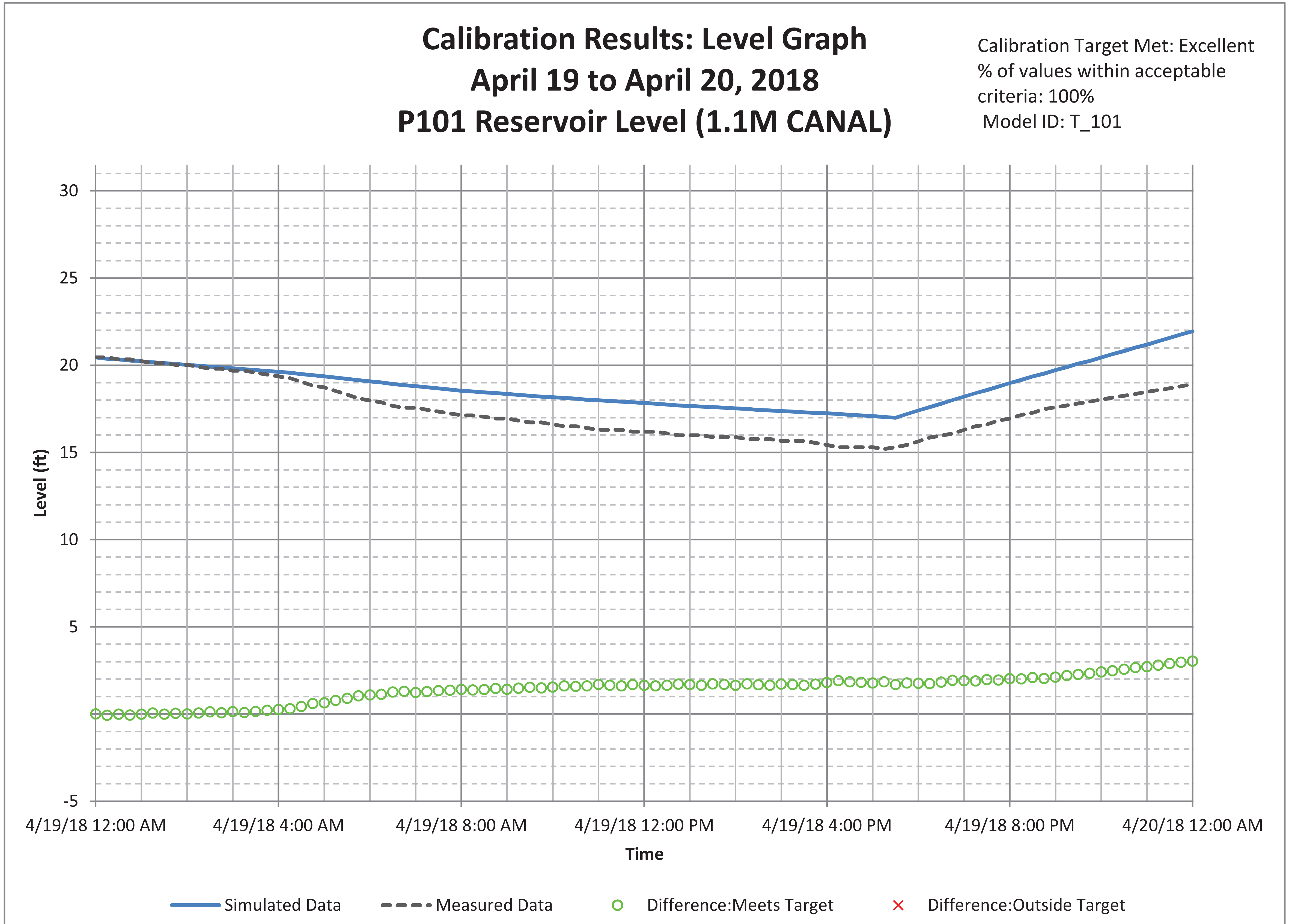

Calibration Results: Level Graph
April 19 to April 20, 2018
P140 Reservoir Level (2M CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_140
30
25
20
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

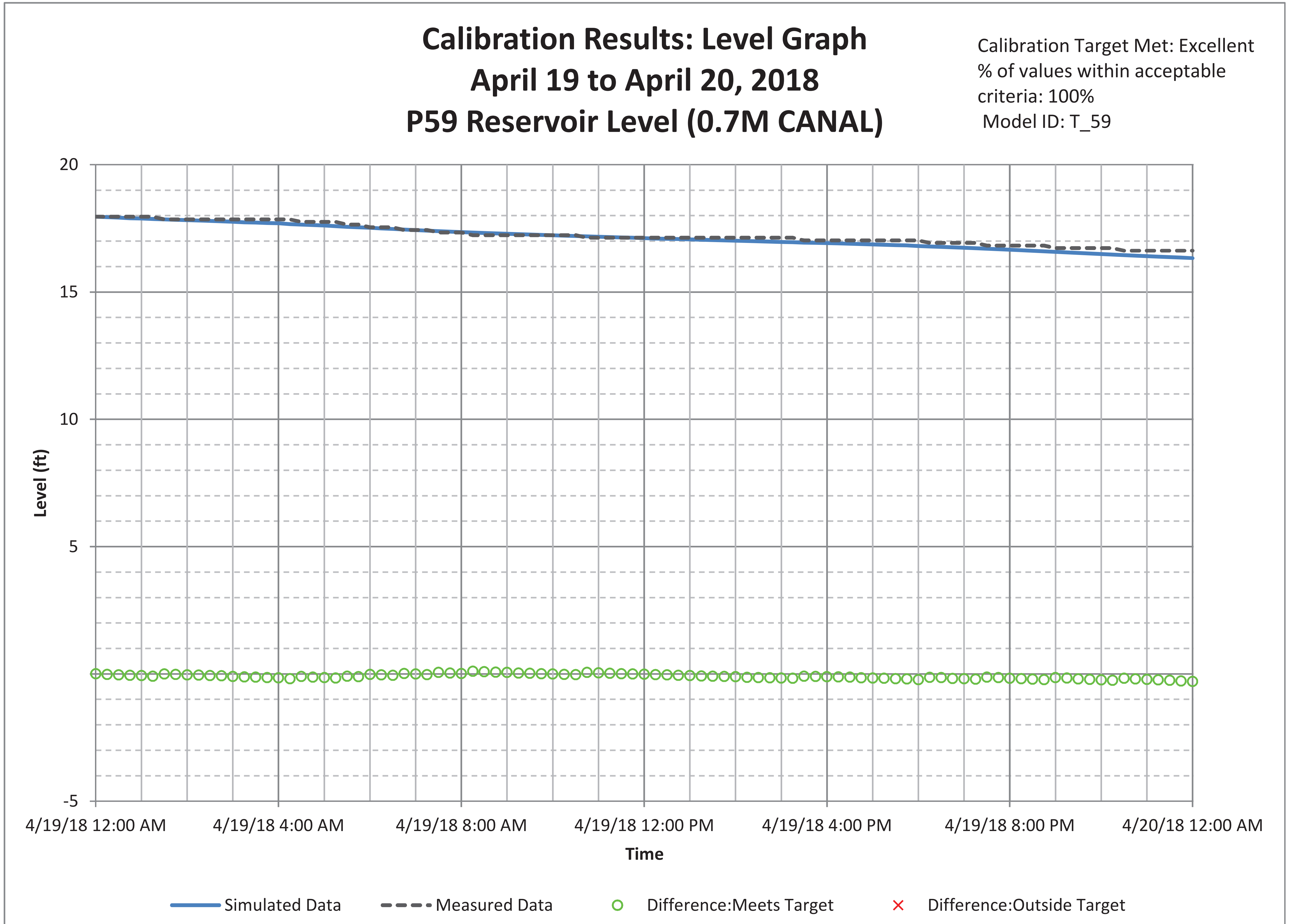

Calibration Results: Pressure Graph
April 19 to April 20, 2018
P129-Canal Zone Pressure (CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 85%
Model ID: EVWD_1310
Pressure (psi)
140
130
120
110
100
90
80
70
60
50
40
30
20
10
-10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

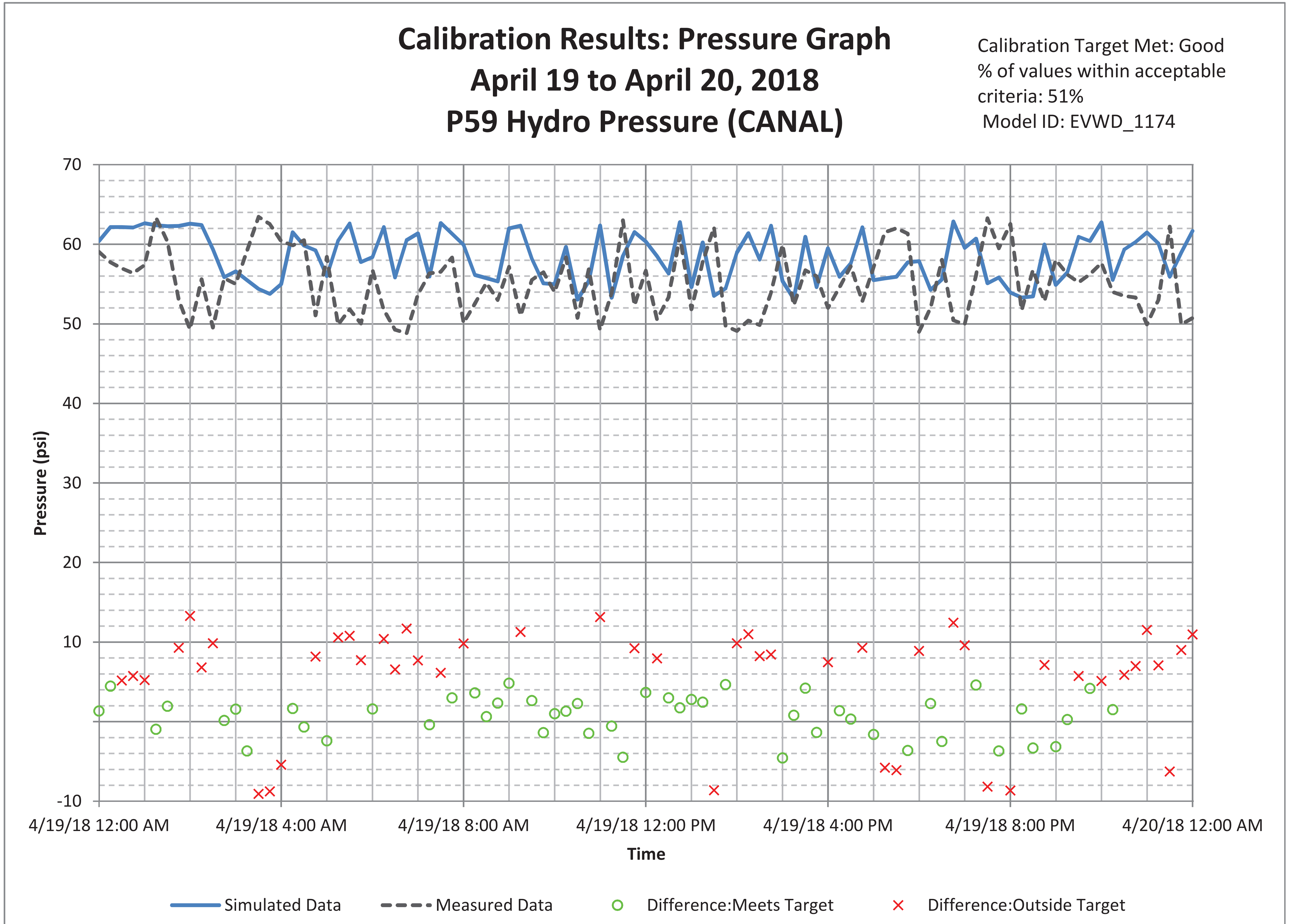

Calibration Results: Flow Graph
April 19 to April 20, 2018
P131Flow Rate (CANAL)
Calibration Target Met: Fair
% of values within acceptable criteria: 0%
Model ID: J12_1028
900
800
700
600
500
400
300
200
100
-100
-200
-300
-400
-500
-600
-700
-800
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

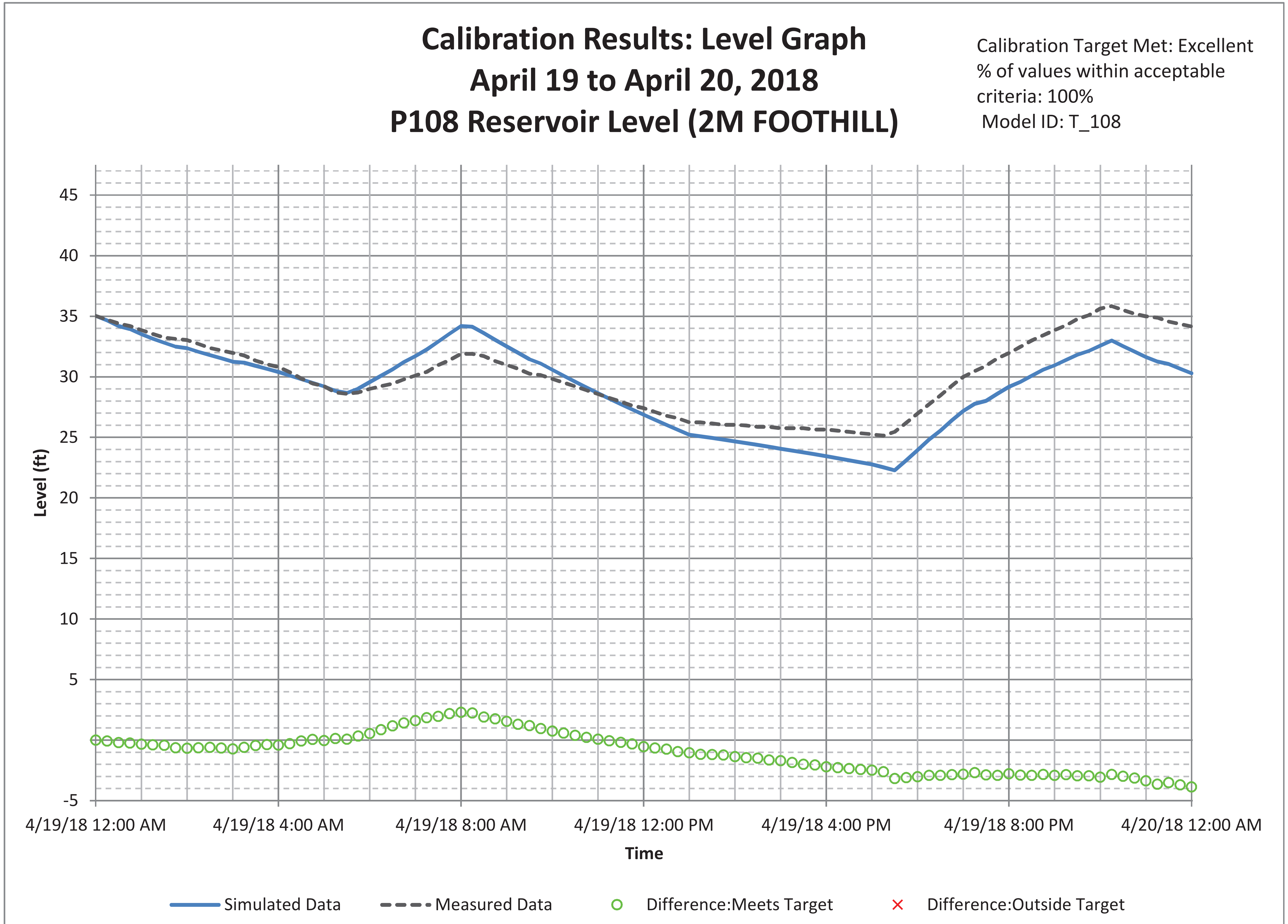

Calibration Results: Flow Graph
April 19 to April 20, 2018
P108 Drop Valve Flow Rate (CANAL to FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3421
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

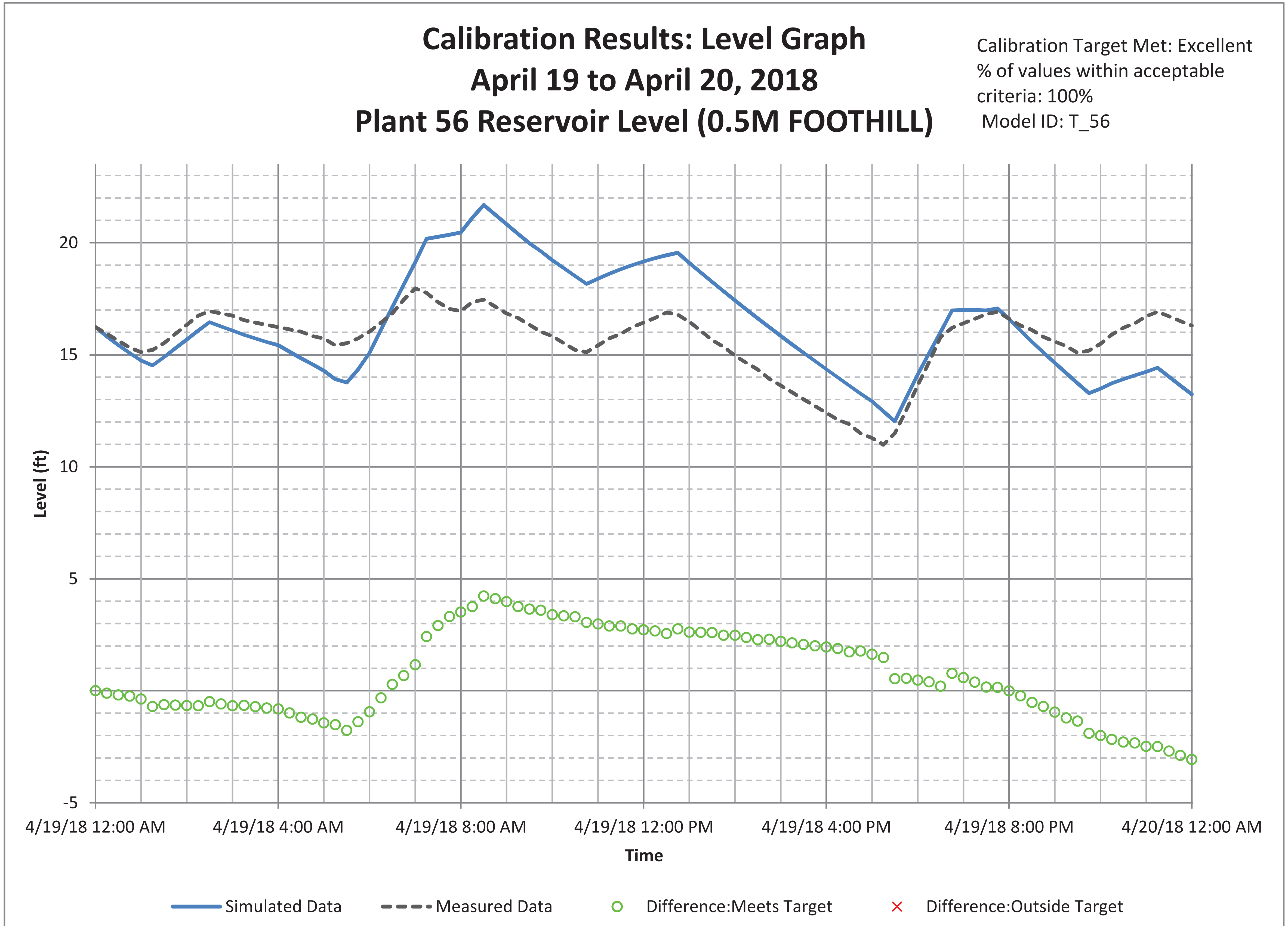

Calibration Results: Pressure Graph
April 19 to April 20, 2018
P101 Hydro Pressure (CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 47%
Model ID: EVWD_1208
Pressure (psi)
70
60
50
40
30
20
10
-10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

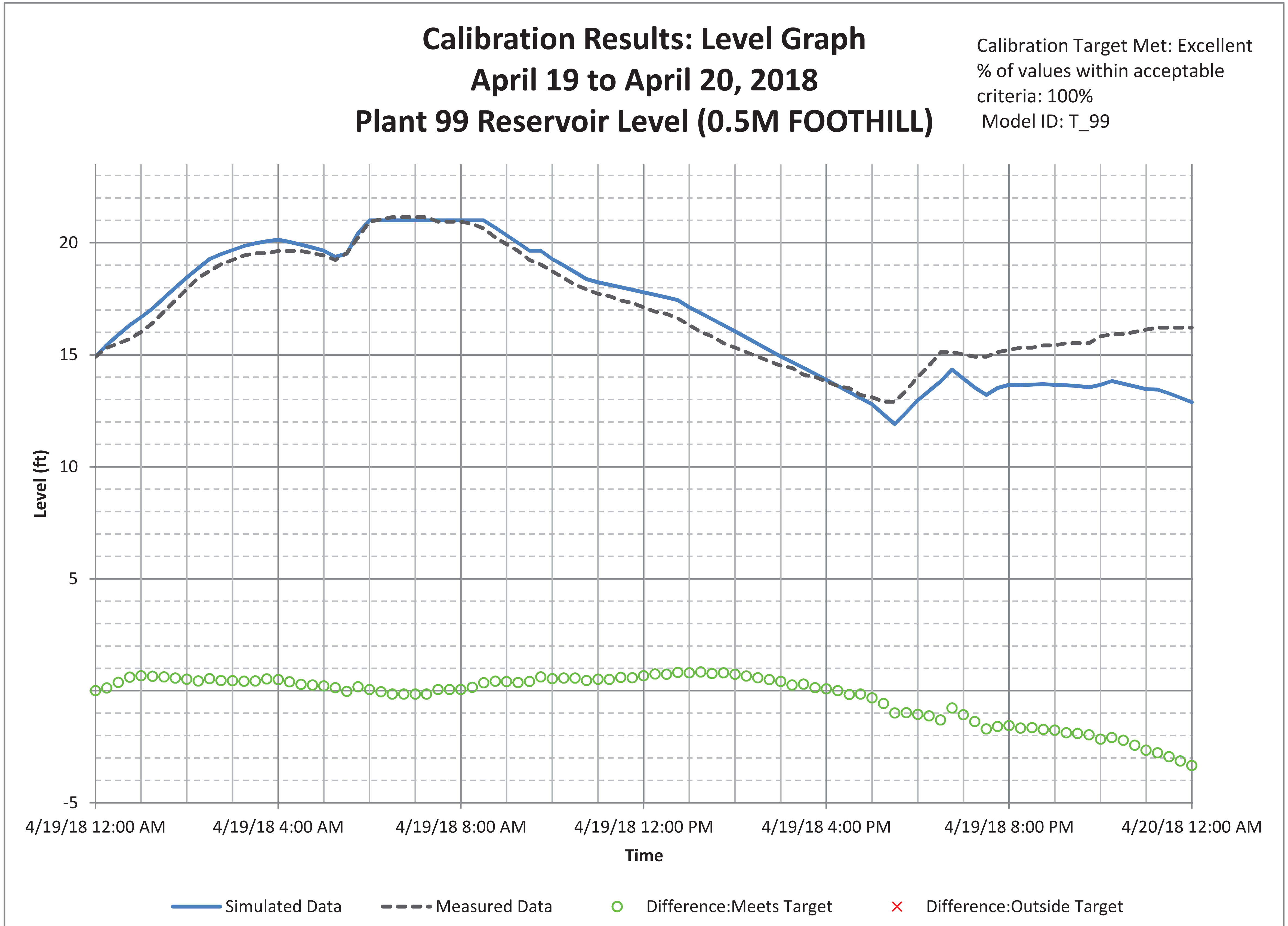

Calibration Results: Level Graph
April 19 to April 20, 2018
P101 Reservoir Level (1.1M CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_101
30
25
20
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

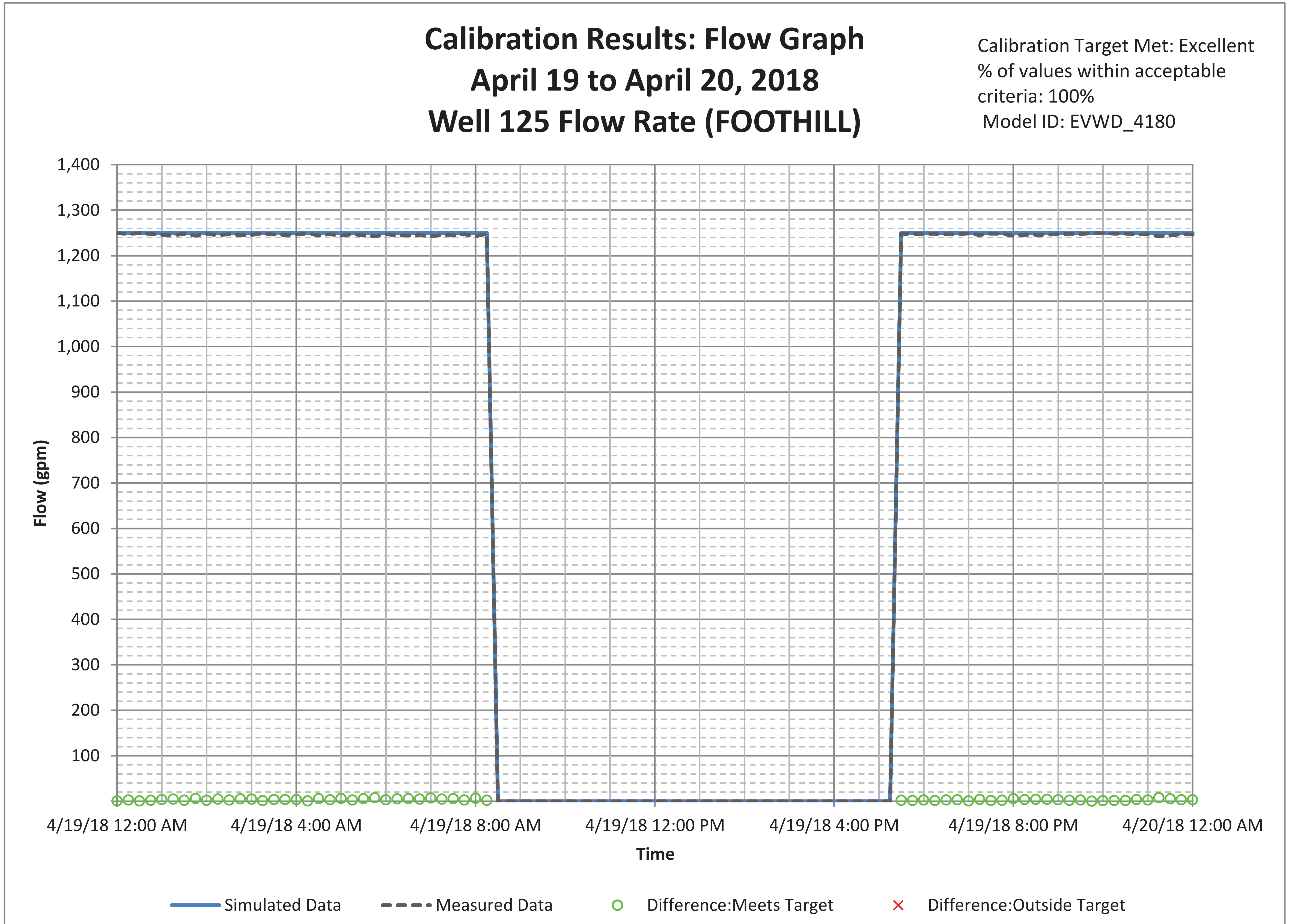

Calibration Results: Level Graph
April 19 to April 20, 2018
P59 Reservoir Level (0.7M CANAL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_59
Level (ft)
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

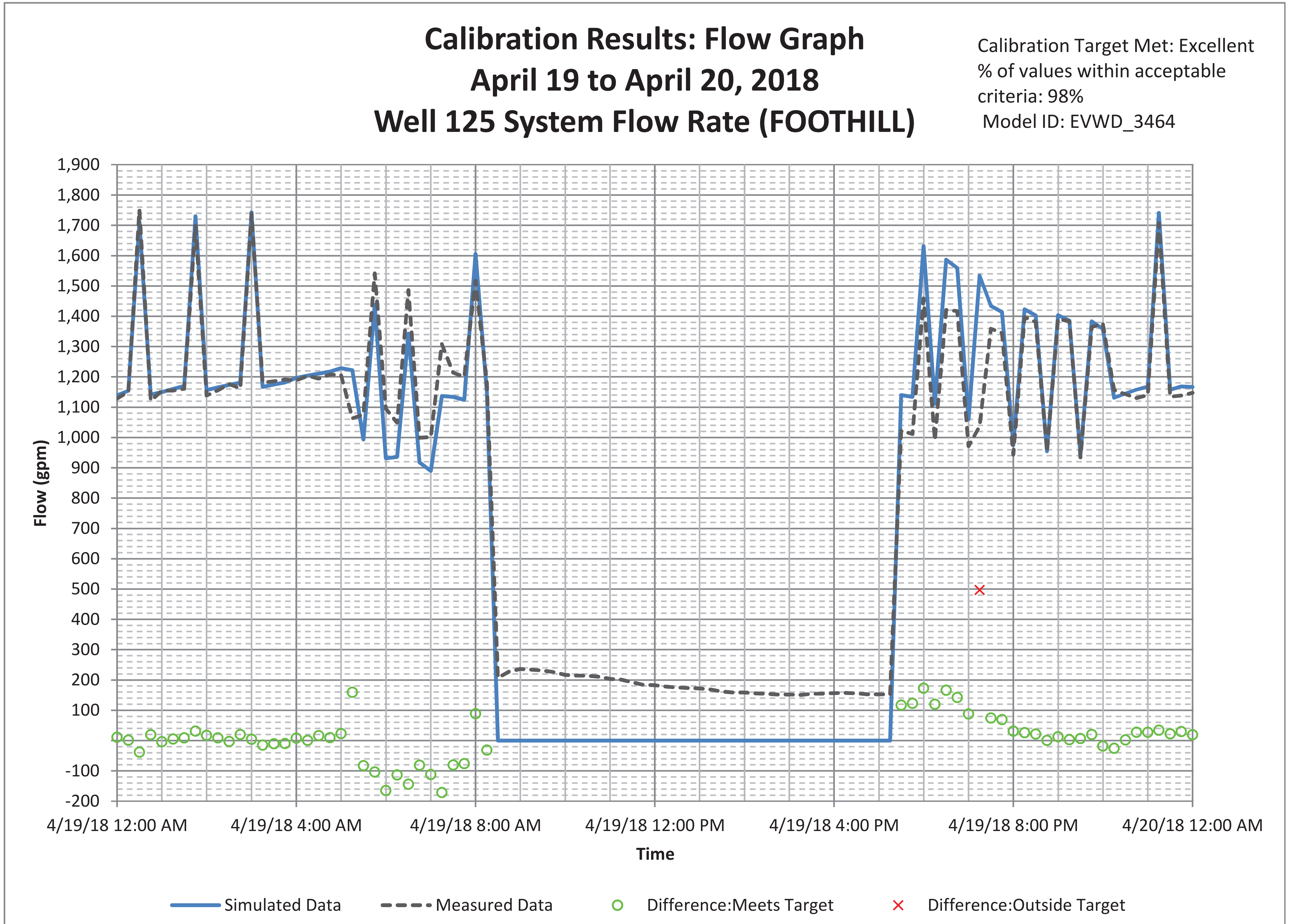

Calibration Results: Pressure Graph
April 19 to April 20, 2018
P59 Hydro Pressure (CANAL)
Calibration Target Met: Good
% of values within acceptable criteria: 51%
Model ID: EVWD_1174
Pressure (psi)
70
60
50
40
30
20
10
-10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

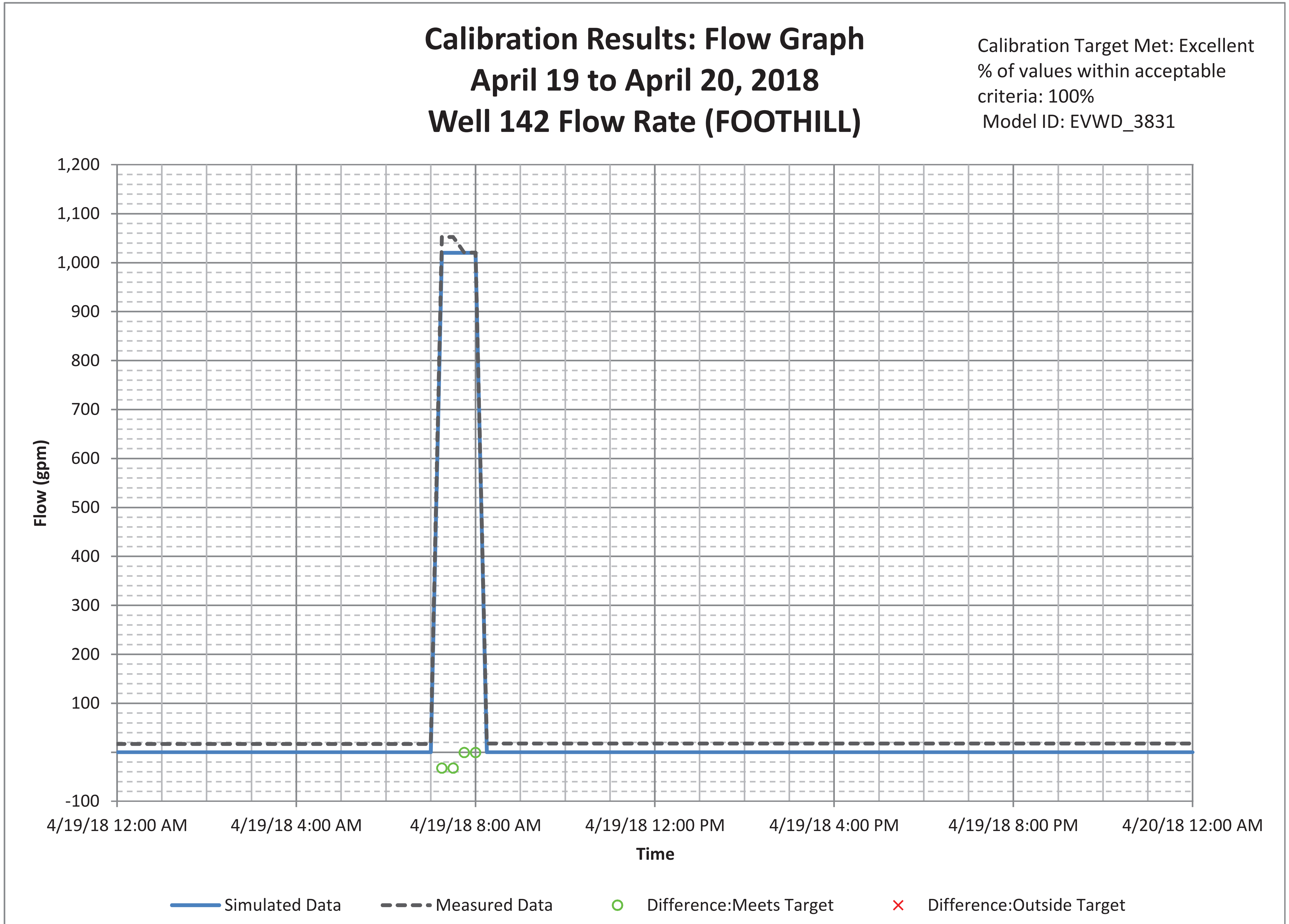

Calibration Results: Level Graph
April 19 to April 20, 2018
P108 Reservoir Level (2M FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_108
45
40
35
30
25
20
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

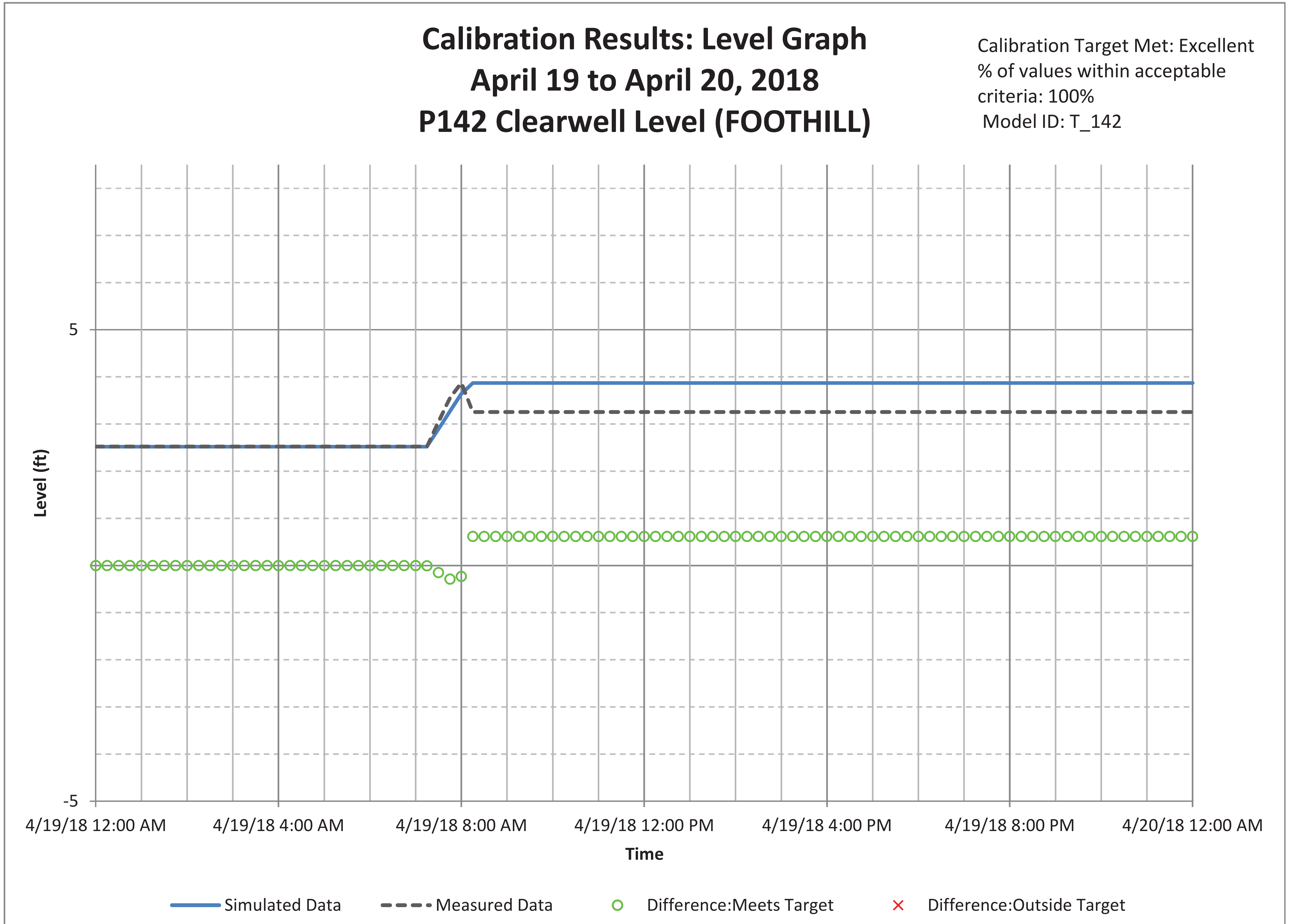

Calibration Results: Level Graph
April 19 to April 20, 2018
Plant 56 Reservoir Level (0.5M FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_56
Level (ft)
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

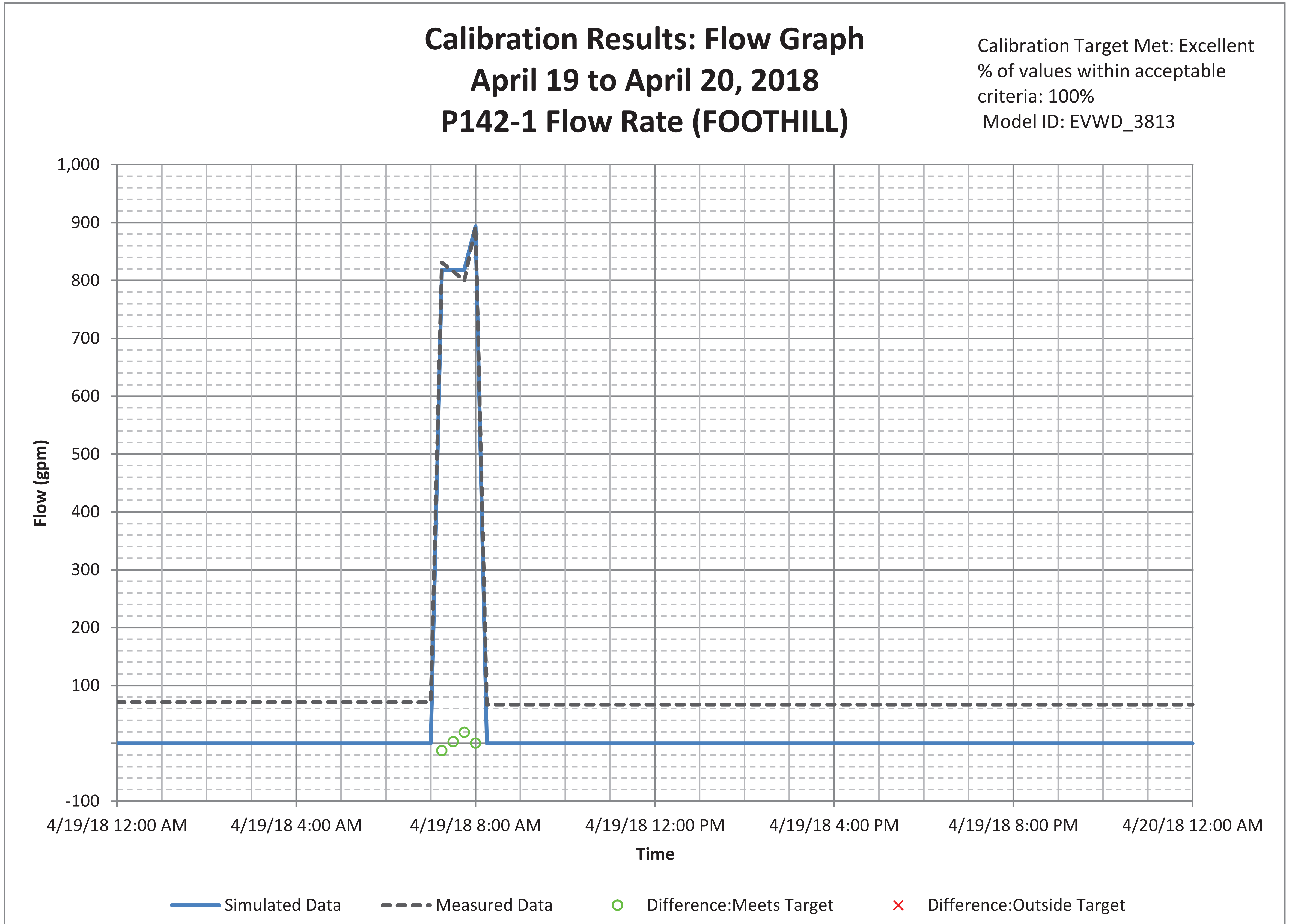

Calibration Results: Level Graph
April 19 to April 20, 2018
Plant 99 Reservoir Level (0.5M FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_99
Level (ft)
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

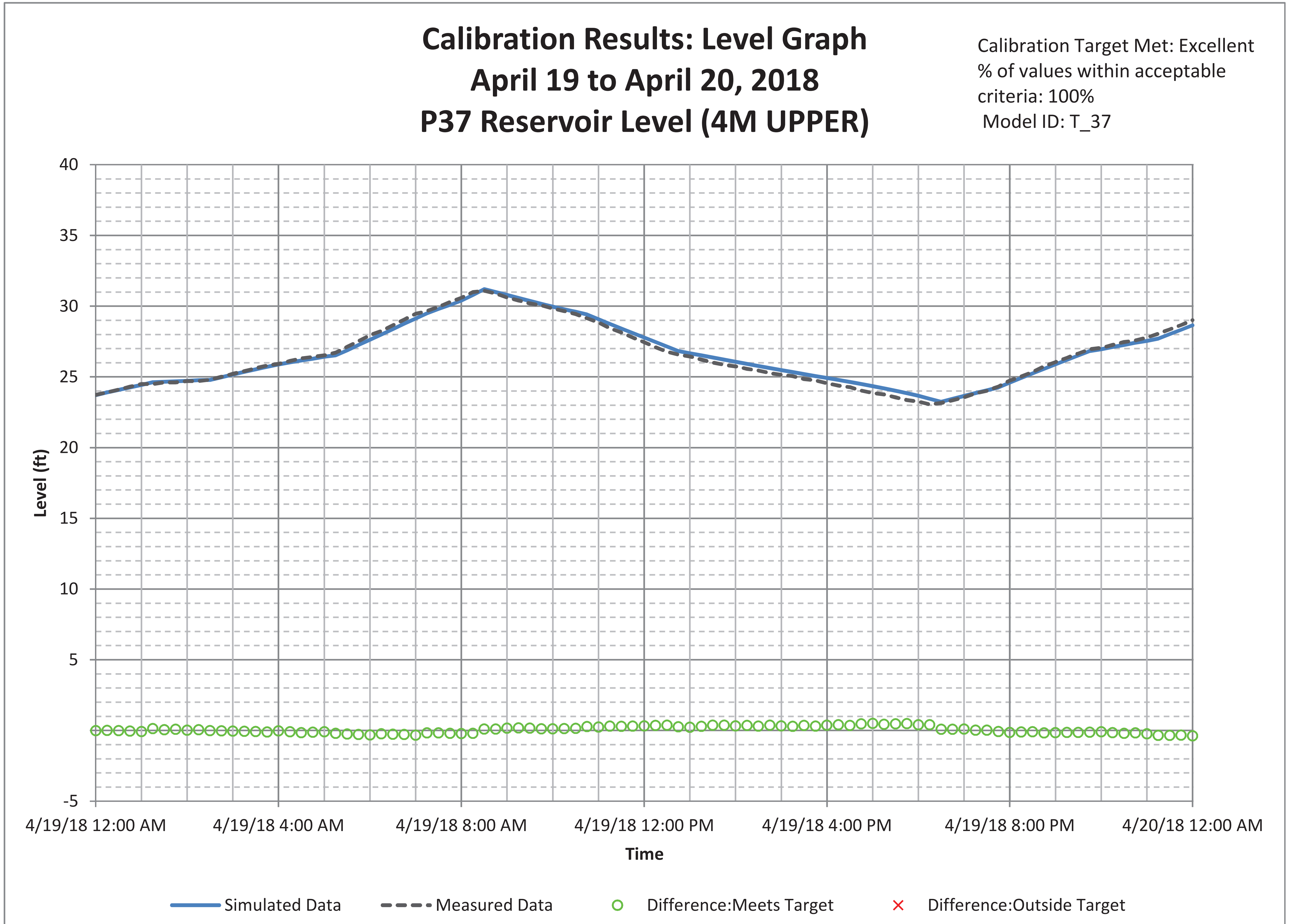

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 125 Flow Rate (FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_4180
Flow (gpm)
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

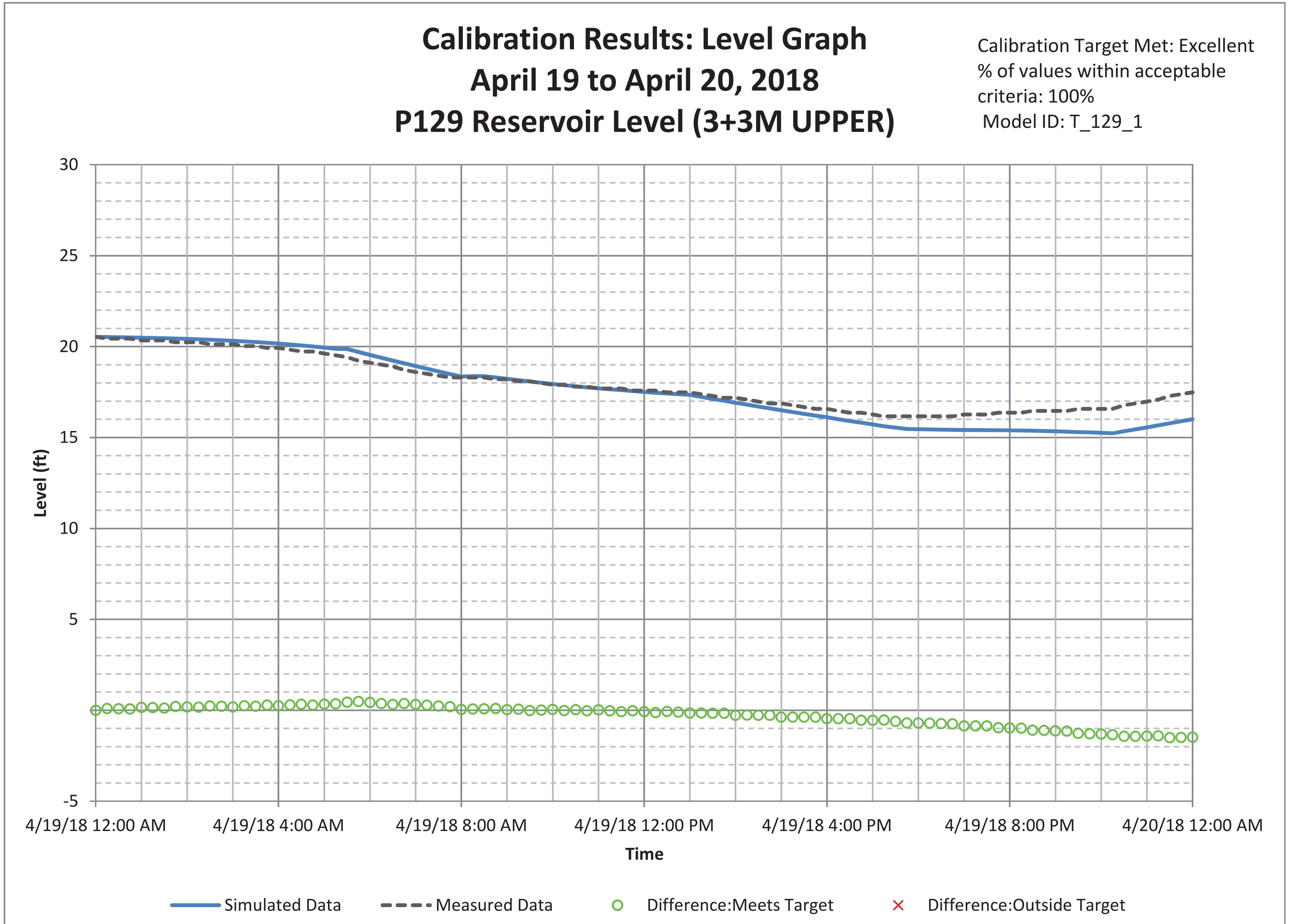

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 125 System Flow Rate (FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 98%
Model ID: EVWD_3464
Flow (gpm)
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
-200
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

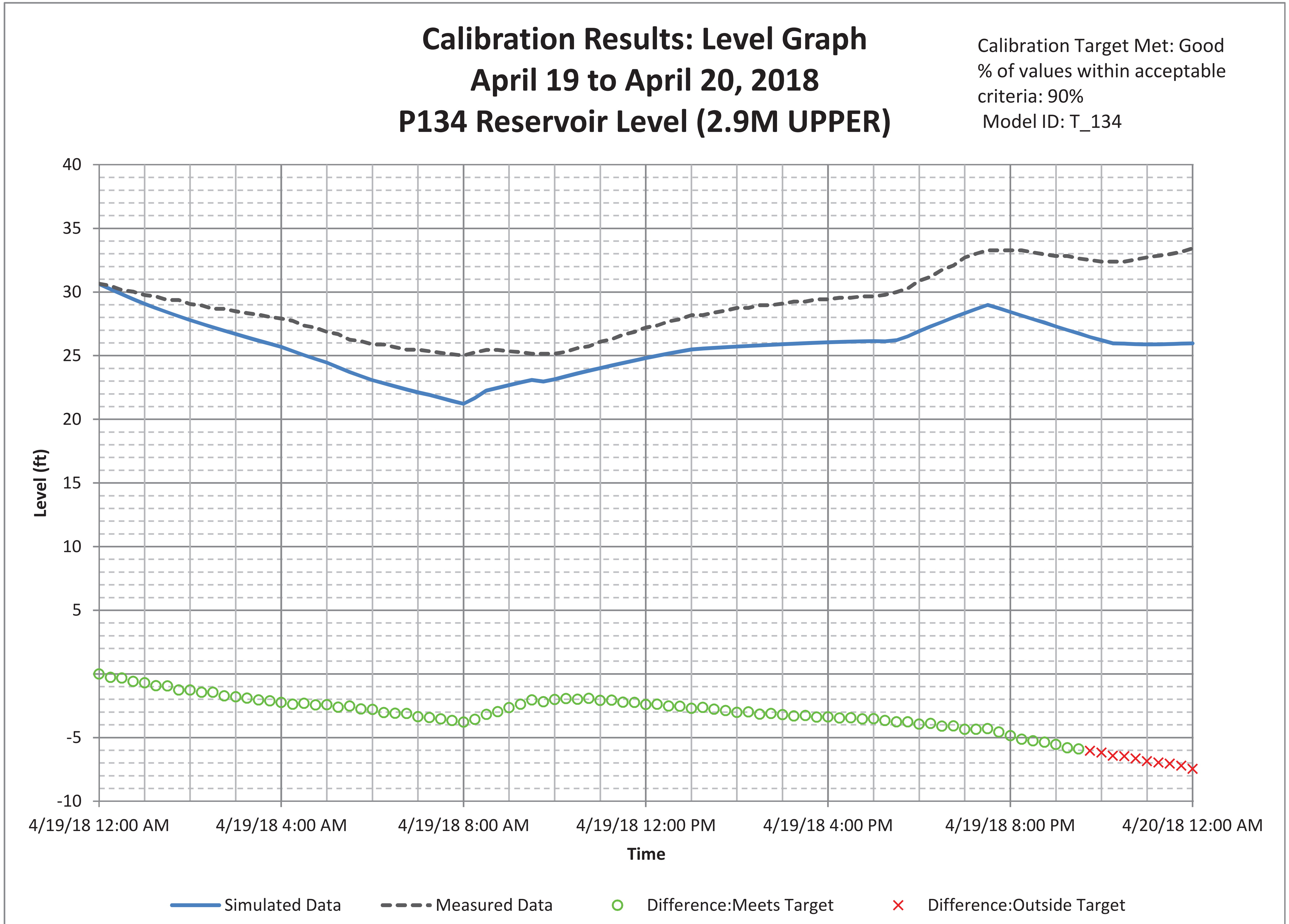

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 142 Flow Rate (FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3831
Flow (gpm)
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

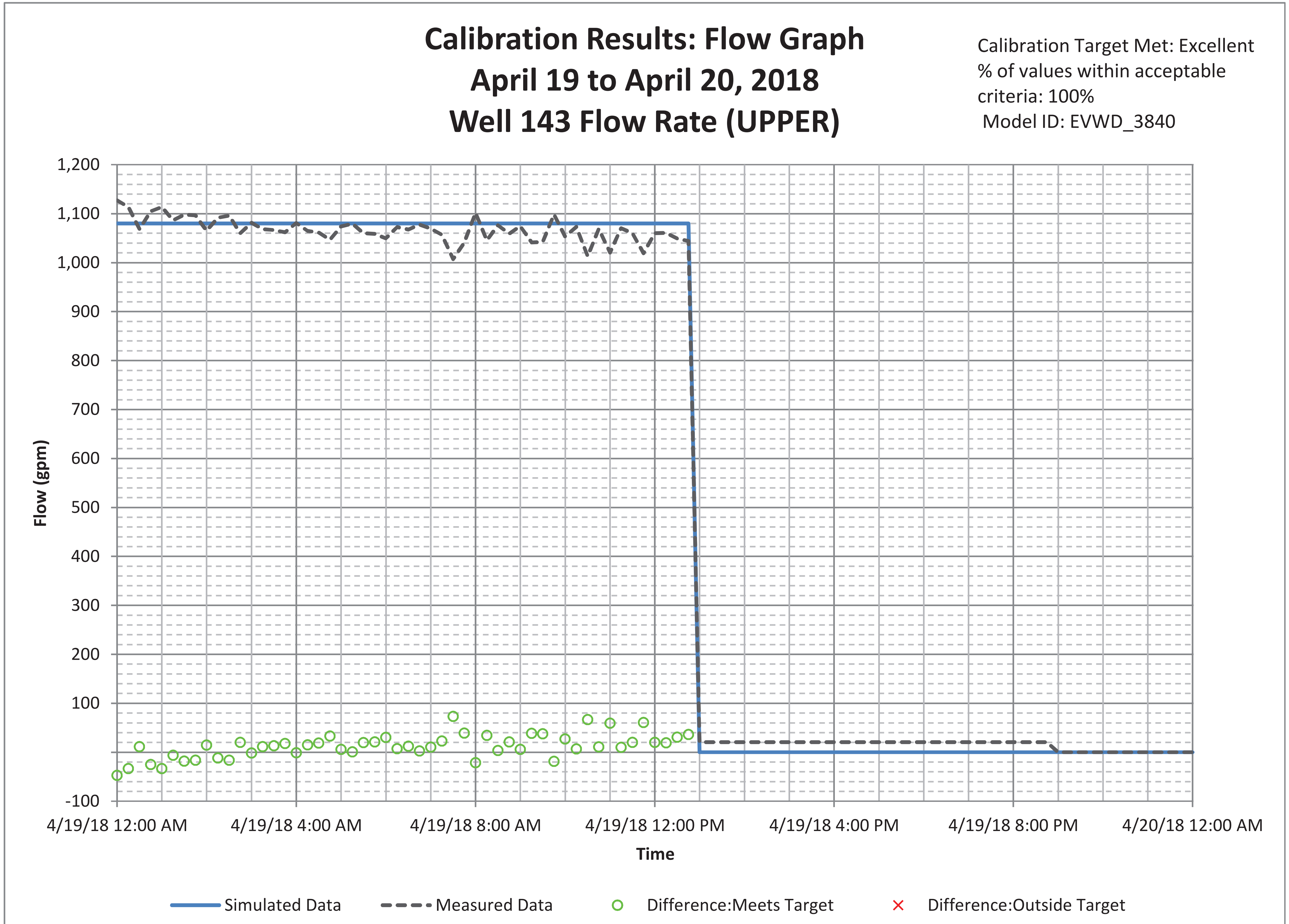

Calibration Results: Level Graph
April 19 to April 20, 2018
P142 Clearwell Level (FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_142
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

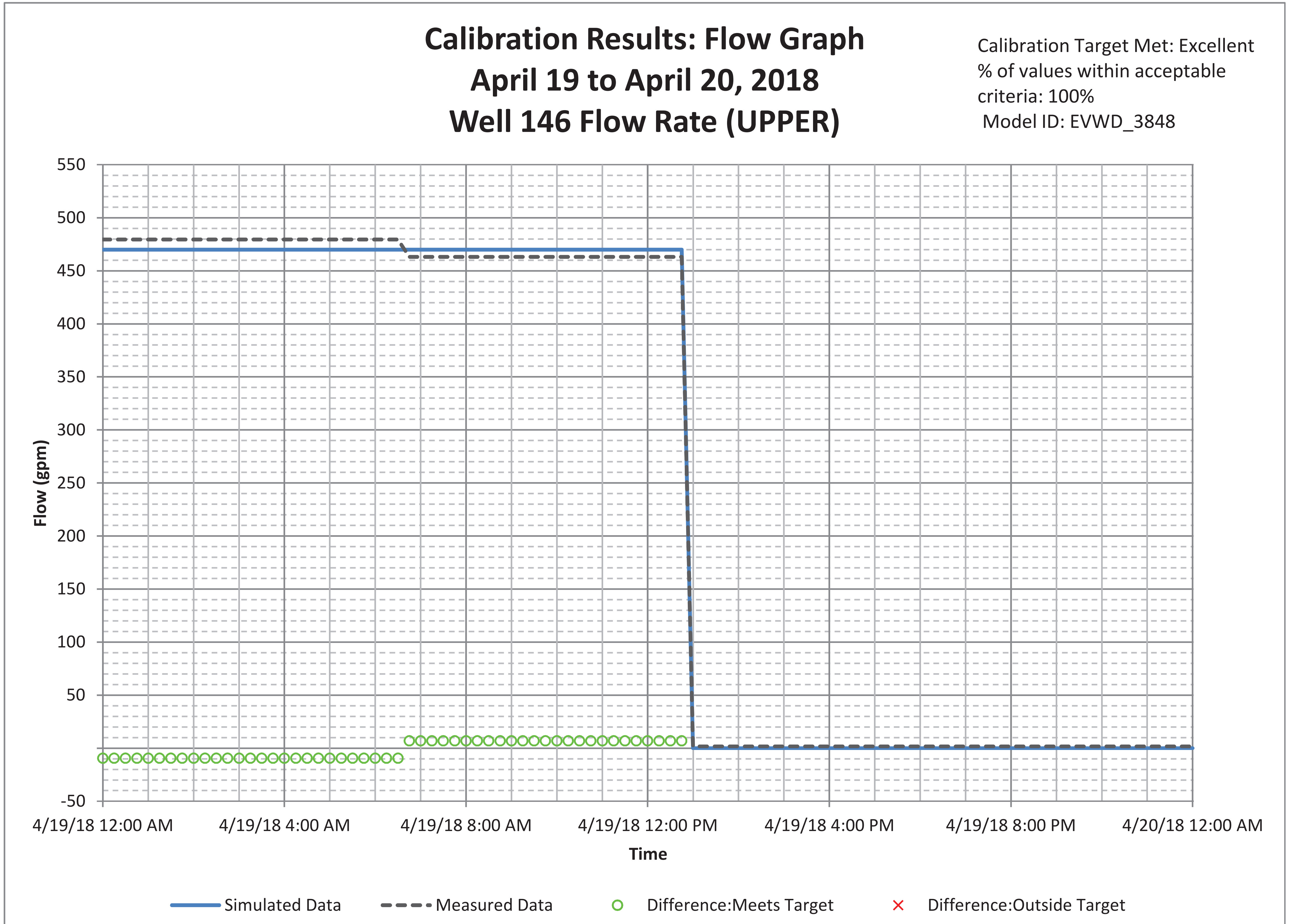

Calibration Results: Flow Graph
April 19 to April 20, 2018
P142-1 Flow Rate (FOOTHILL)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3813
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

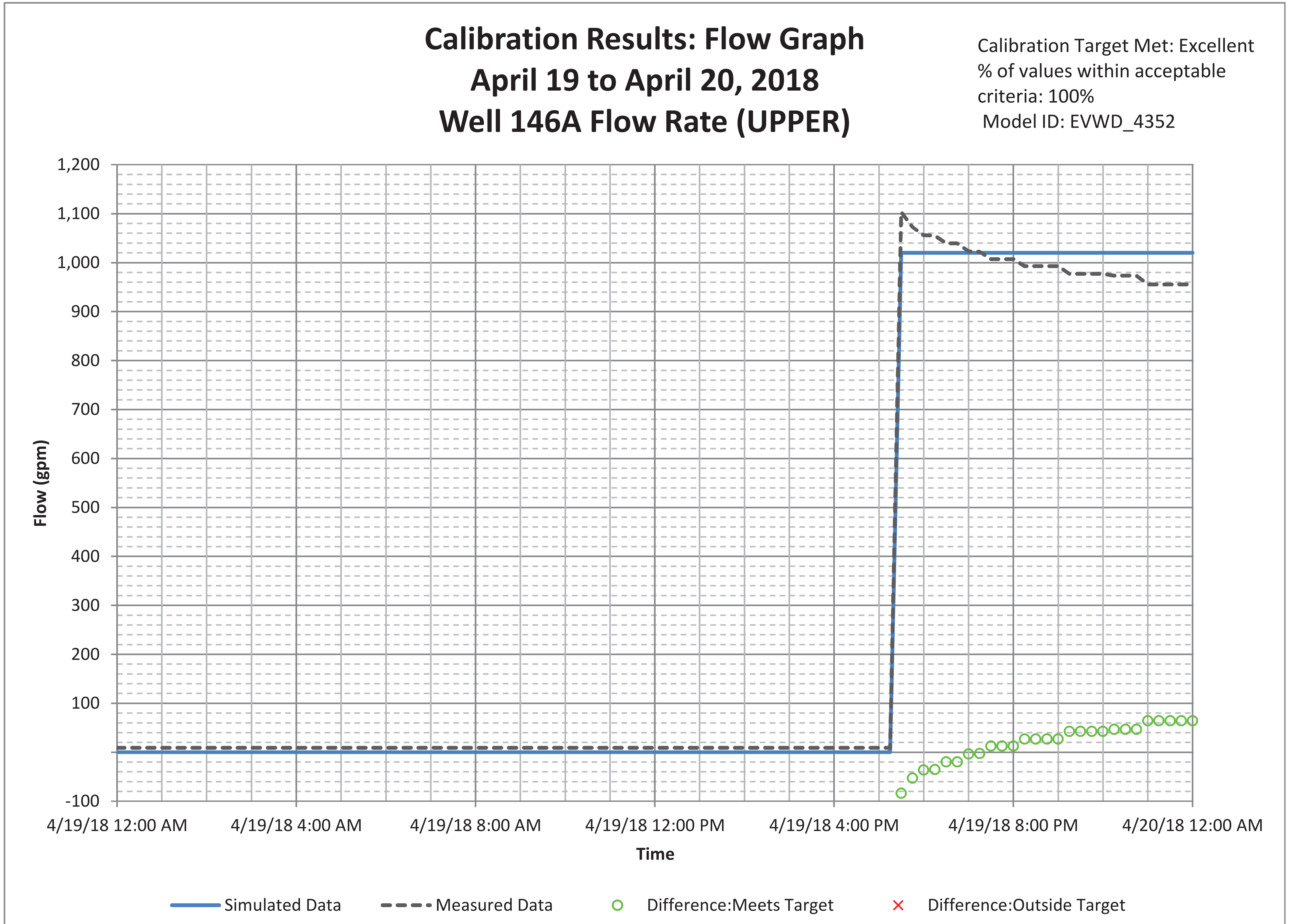

Calibration Results: Level Graph
April 19 to April 20, 2018
P37 Reservoir Level (4M UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_37
Level (ft)
40
35
30
25
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

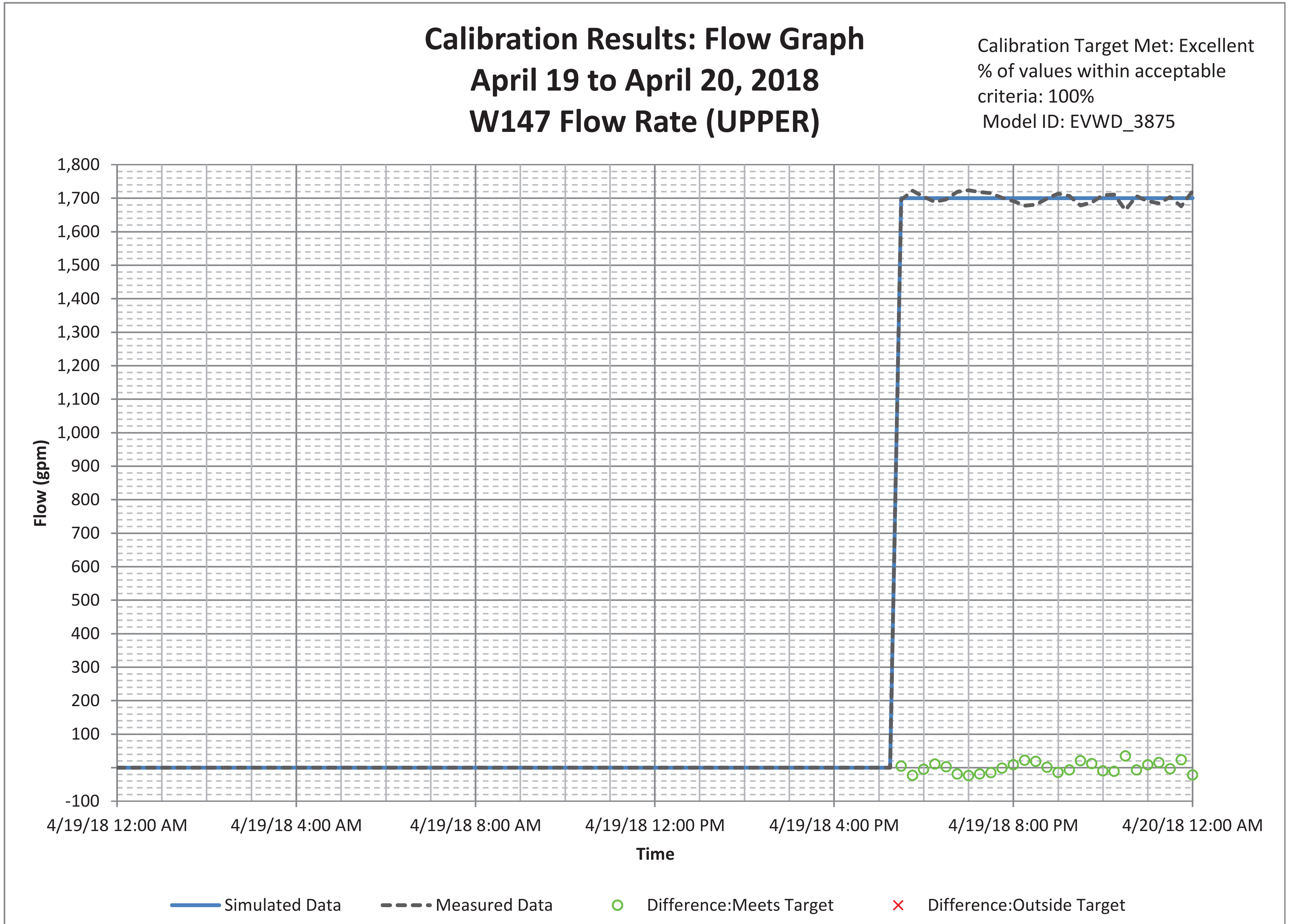

Calibration Results: Level Graph
April 19 to April 20, 2018
P129 Reservoir Level (3+3M UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_129_1
30
25
20
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

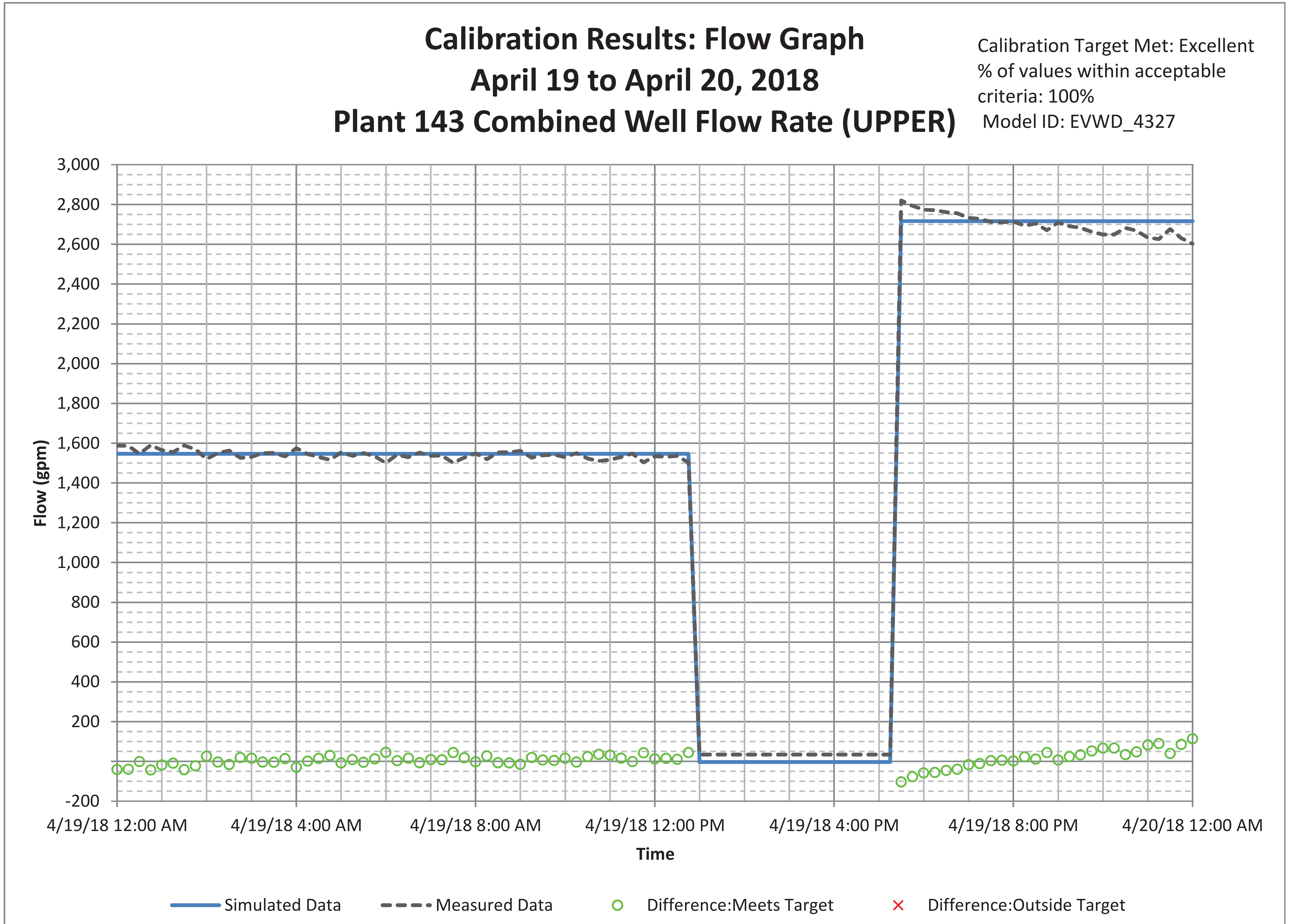

Calibration Results: Level Graph
April 19 to April 20, 2018
P134 Reservoir Level (2.9M UPPER)
Calibration Target Met: Good
% of values within acceptable criteria: 90%
Model ID: T_134
40
35
30
25
20
15
10
5
-5
-10
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

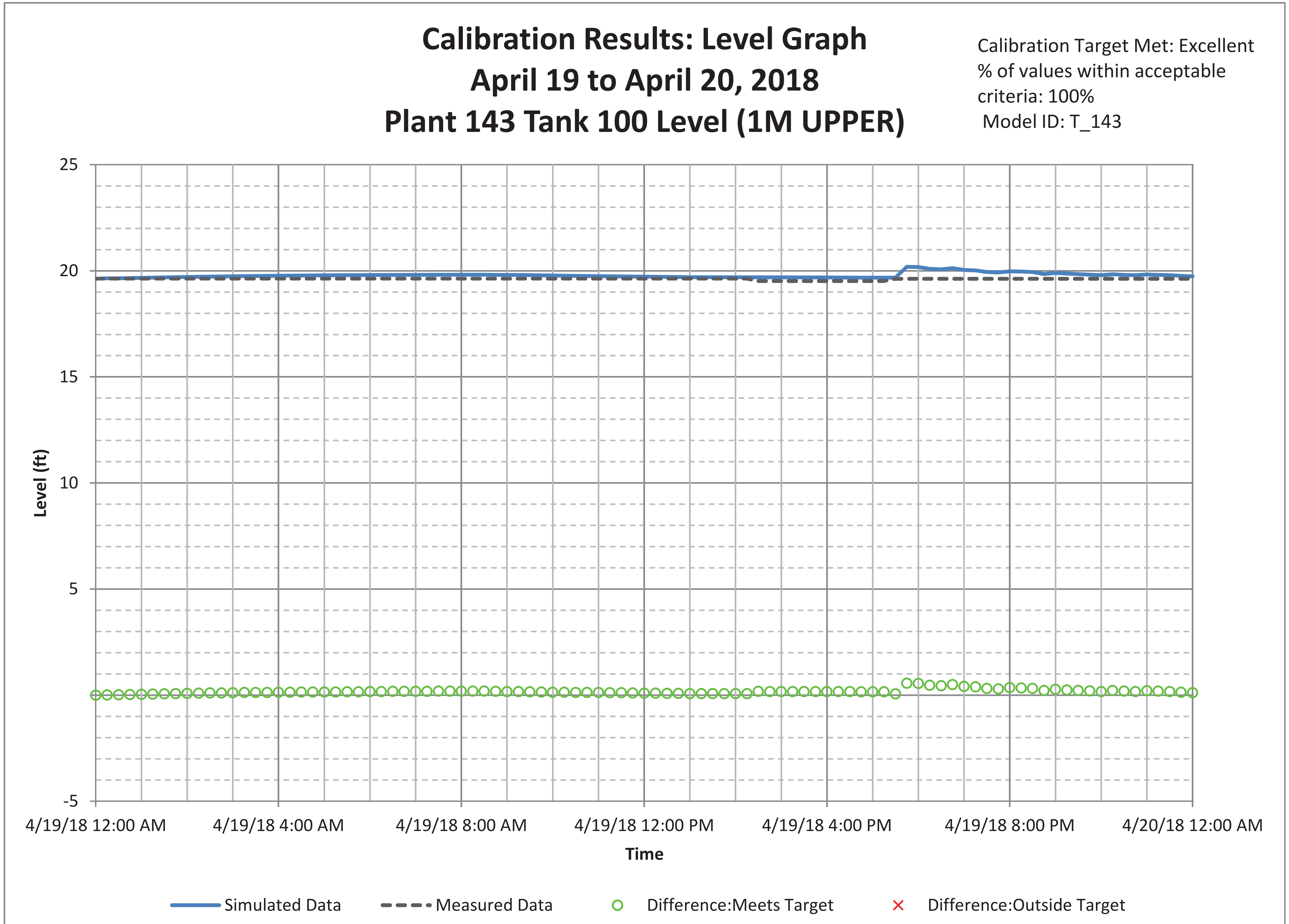

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 143 Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3840
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

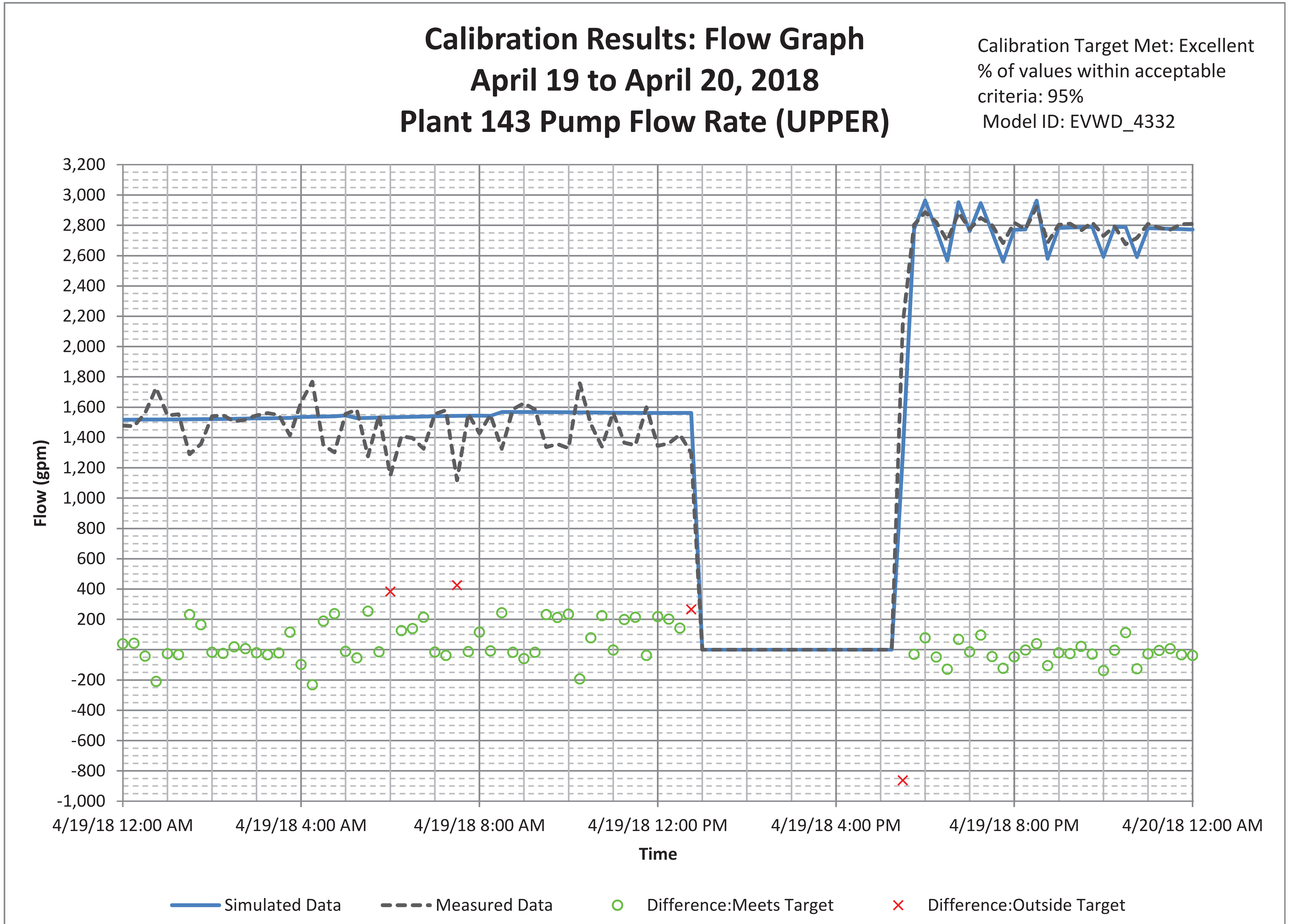

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 146 Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3848
Flow (gpm)
550
500
450
400
350
300
250
200
150
100
50
-50
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

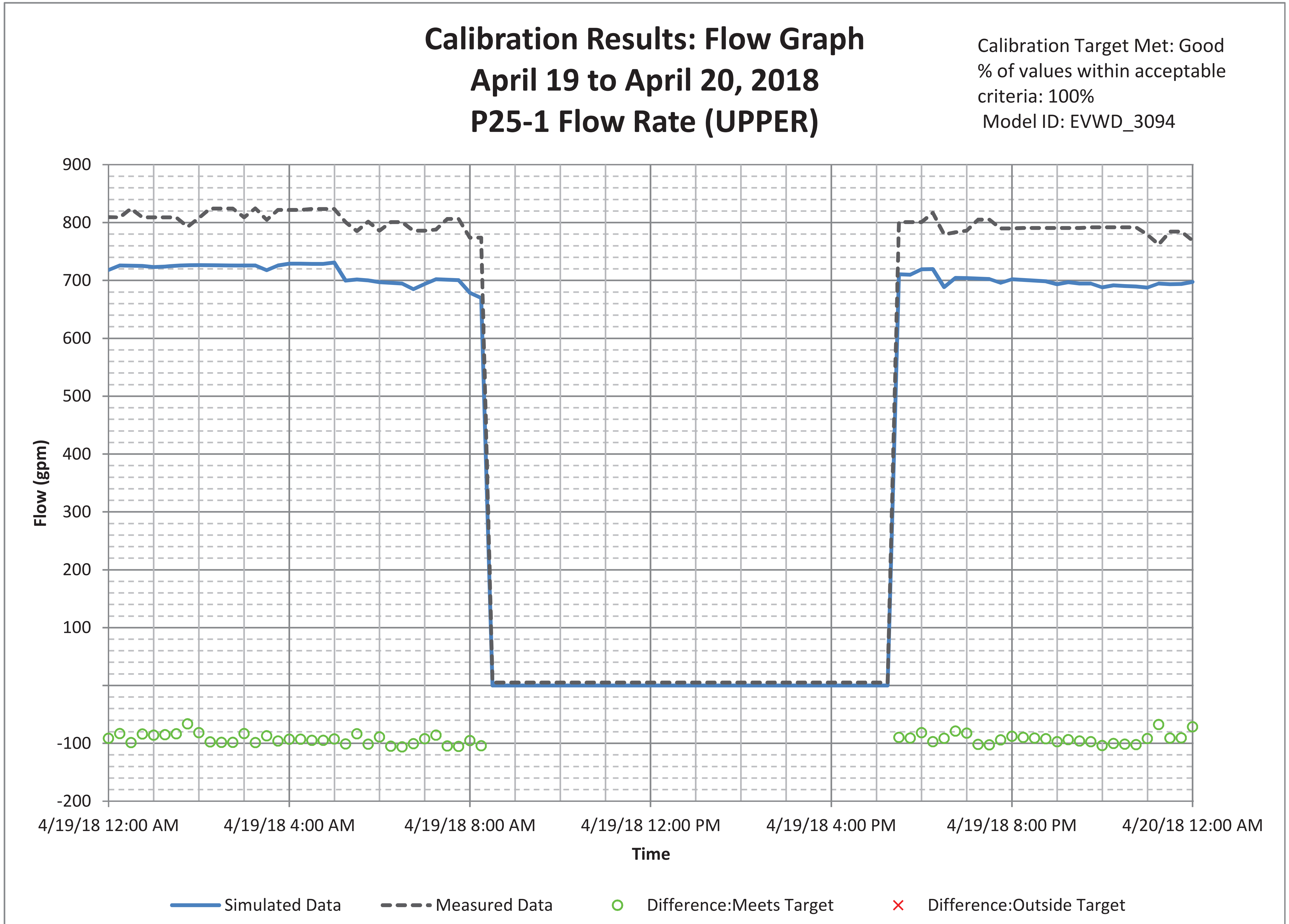

Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 146A Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_4352
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

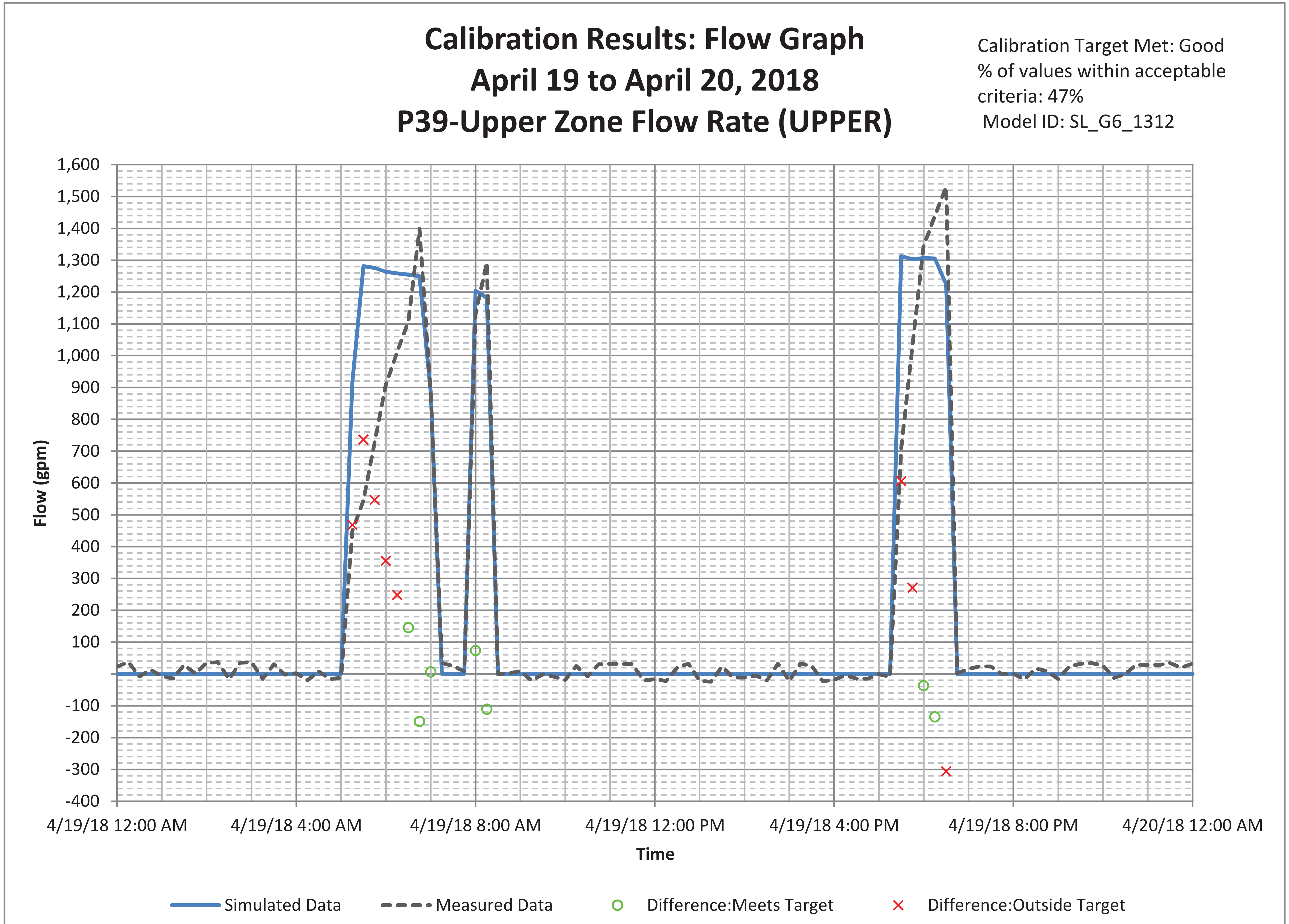

Calibration Results: Flow Graph
April 19 to April 20, 2018
W147 Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3875
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

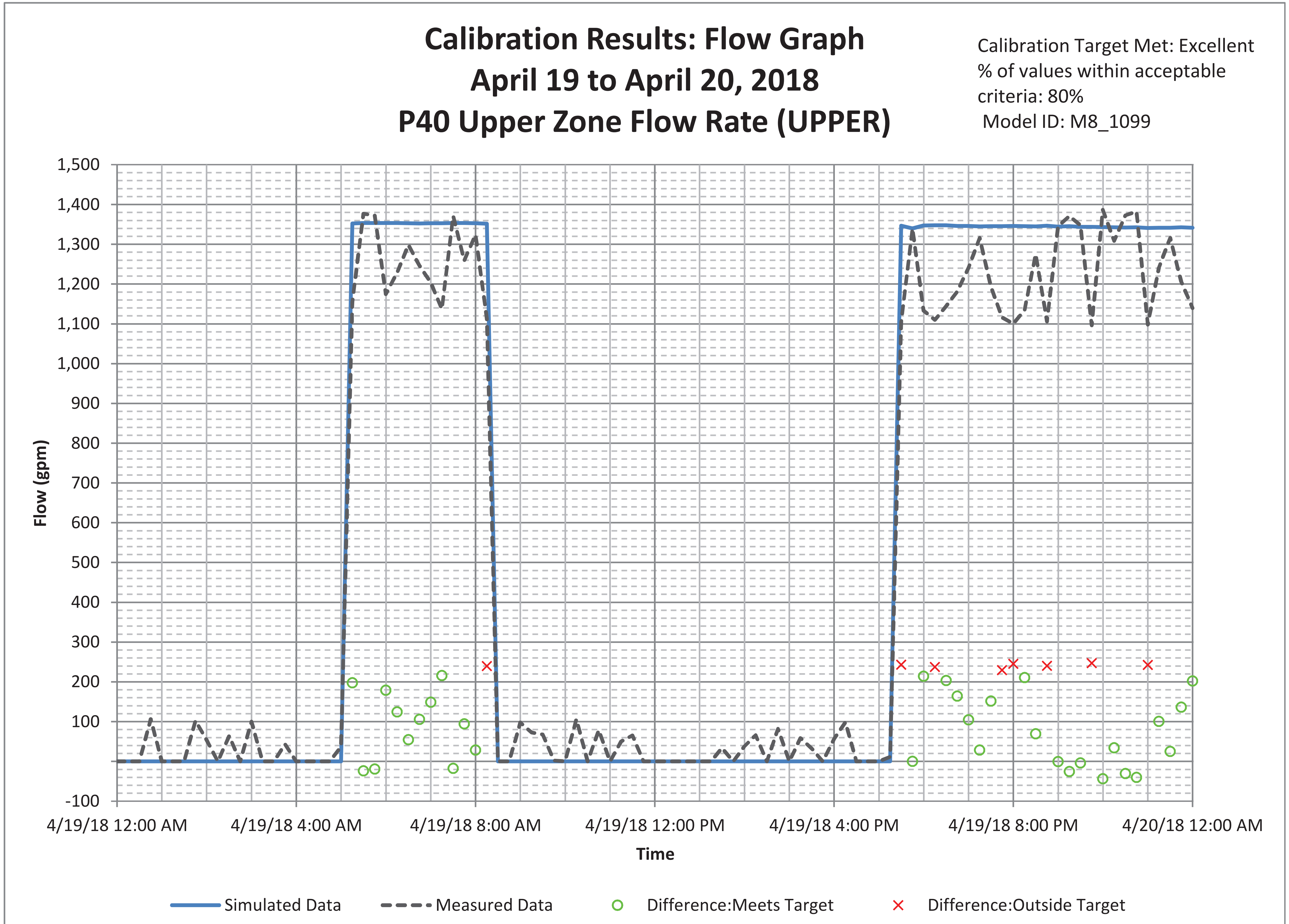

Calibration Results: Flow Graph
April 19 to April 20, 2018
Plant 143 Combined Well Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_4327
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-200
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

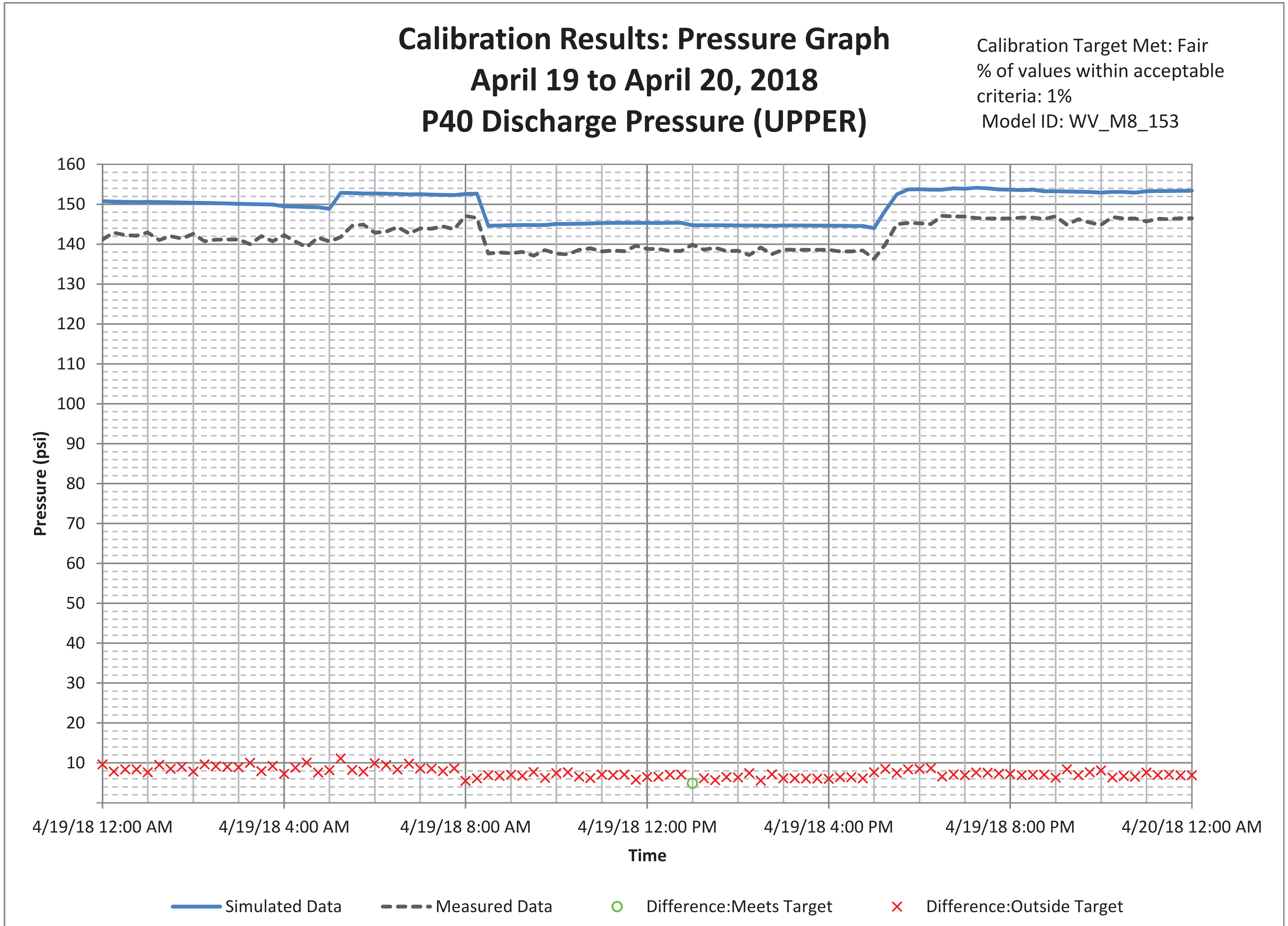

Calibration Results: Level Graph
April 19 to April 20, 2018
Plant 143 Tank 100 Level (1M UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_143
25
20
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

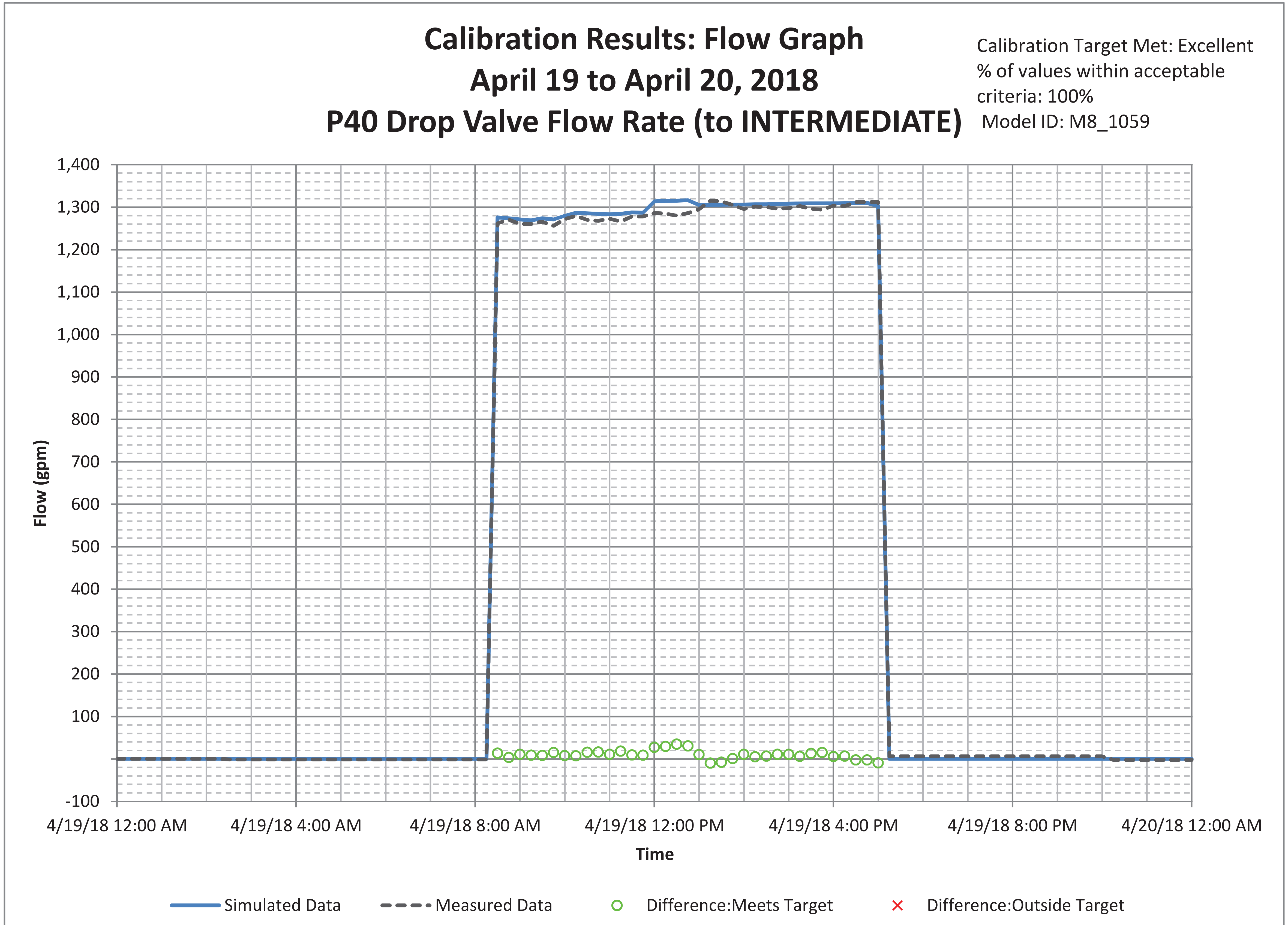

Calibration Results: Flow Graph
April 19 to April 20, 2018
Plant 143 Pump Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 95%
Model ID: EVWD_4332
Flow (gpm)
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-200
-400
-600
-800
-1,000
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

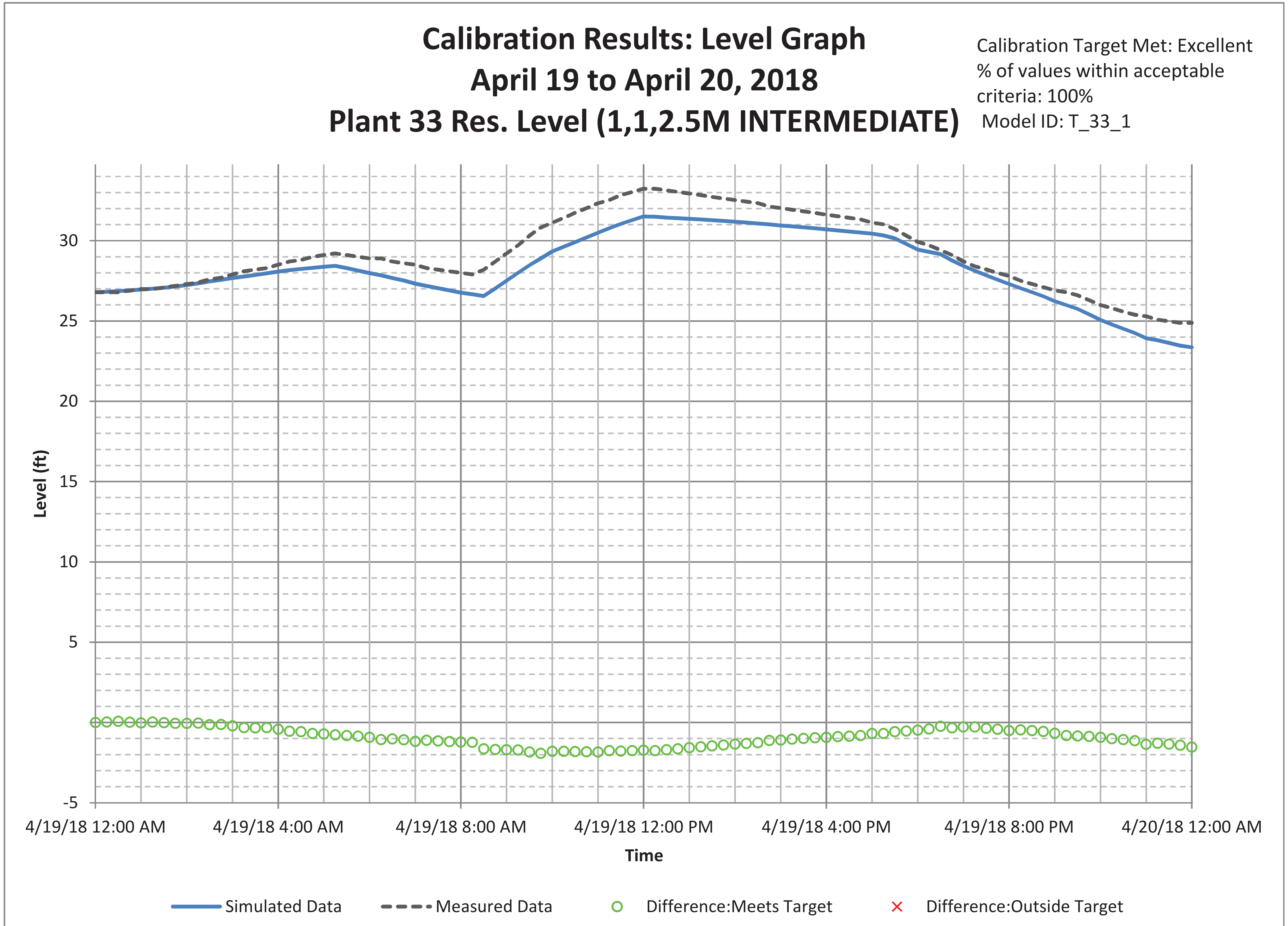

Calibration Results: Flow Graph
April 19 to April 20, 2018
P25-1 Flow Rate (UPPER)
Calibration Target Met: Good
% of values within acceptable criteria: 100%
Model ID: EVWD_3094
900
800
700
600
500
400
300
200
100
-100
-200
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

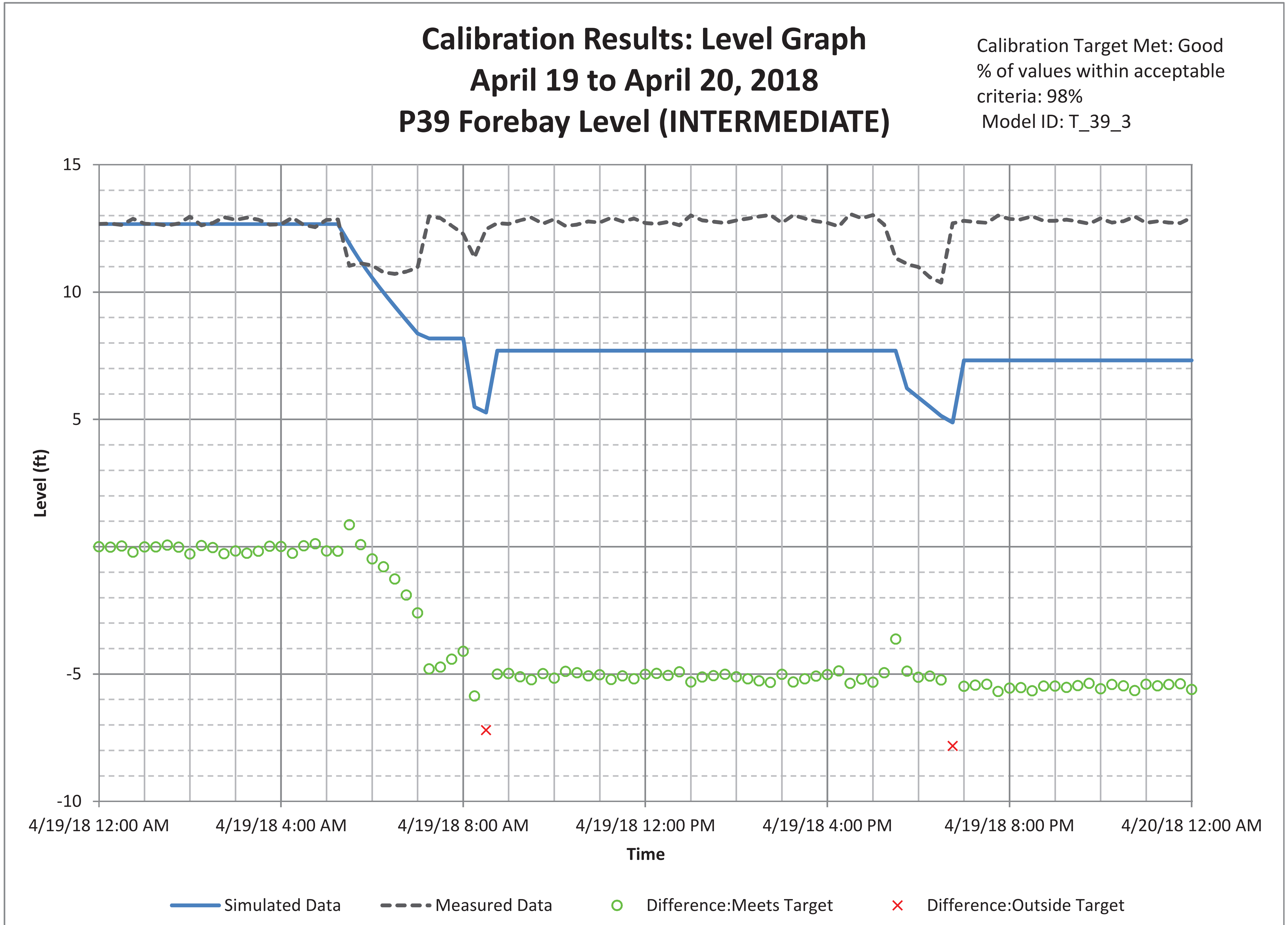

Calibration Results: Flow Graph
April 19 to April 20, 2018
P39-Upper Zone Flow Rate (UPPER)
Calibration Target Met: Good
% of values within acceptable criteria: 47%
Model ID: SL_G6_1312
Flow (gpm)
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
-200
-300
-400
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

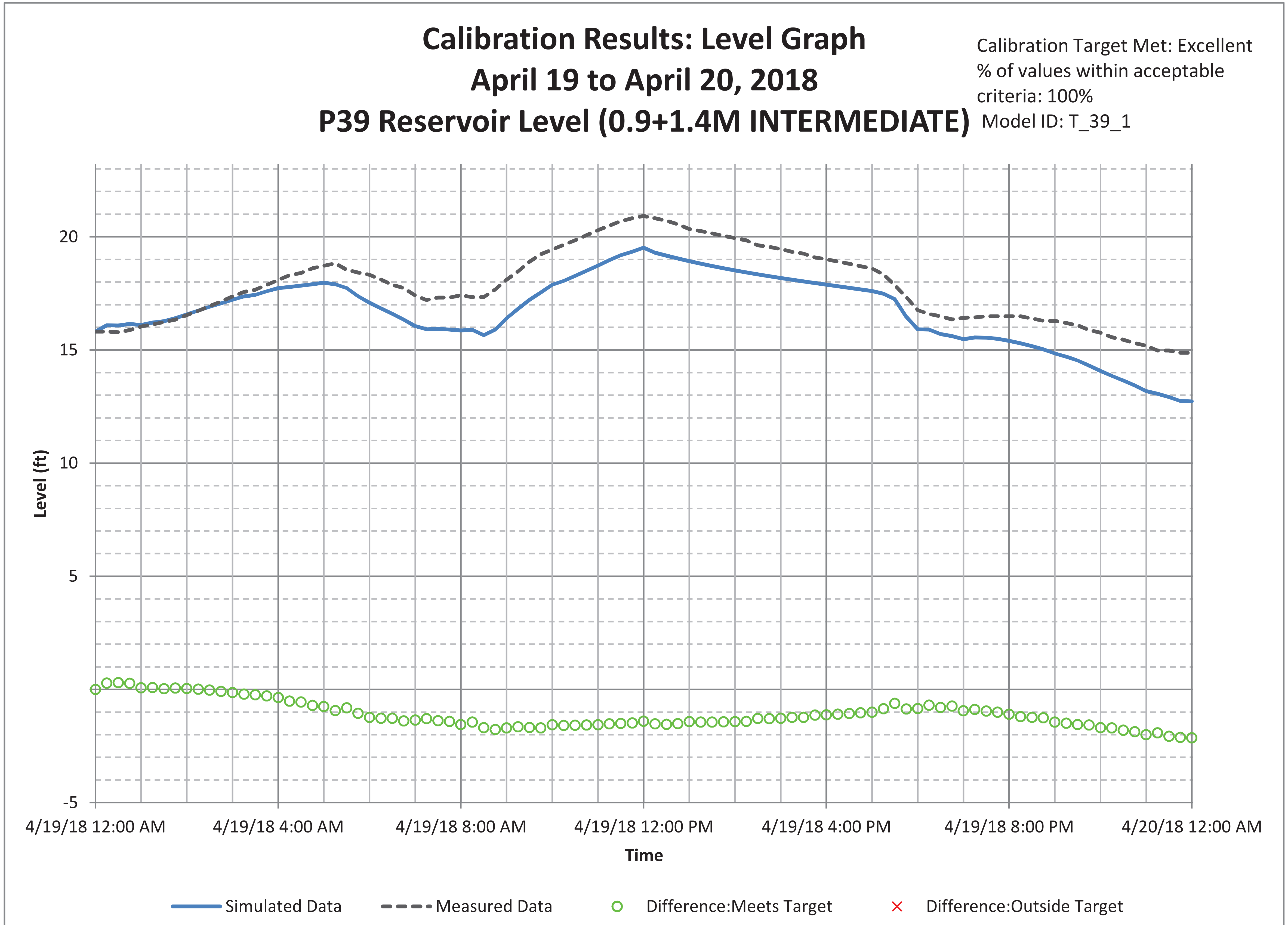

Calibration Results: Flow Graph
April 19 to April 20, 2018
P40 Upper Zone Flow Rate (UPPER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 80%
Model ID: M8_1099
Flow (gpm)
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

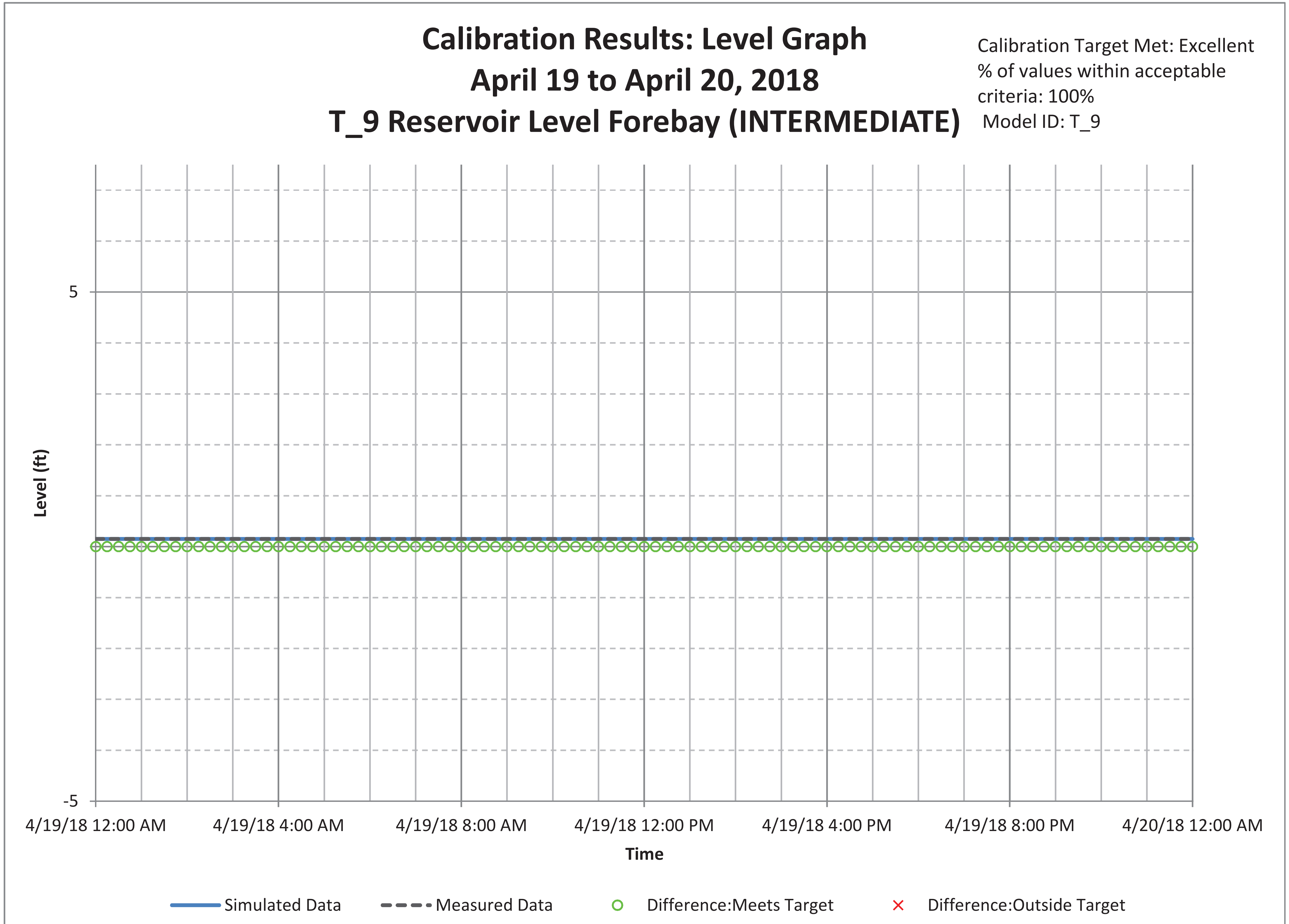

Calibration Results: Pressure Graph
April 19 to April 20, 2018
P40 Discharge Pressure (UPPER)
Calibration Target Met: Fair
% of values within acceptable criteria: 1%
Model ID: WV_M8_153
Pressure (psi)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

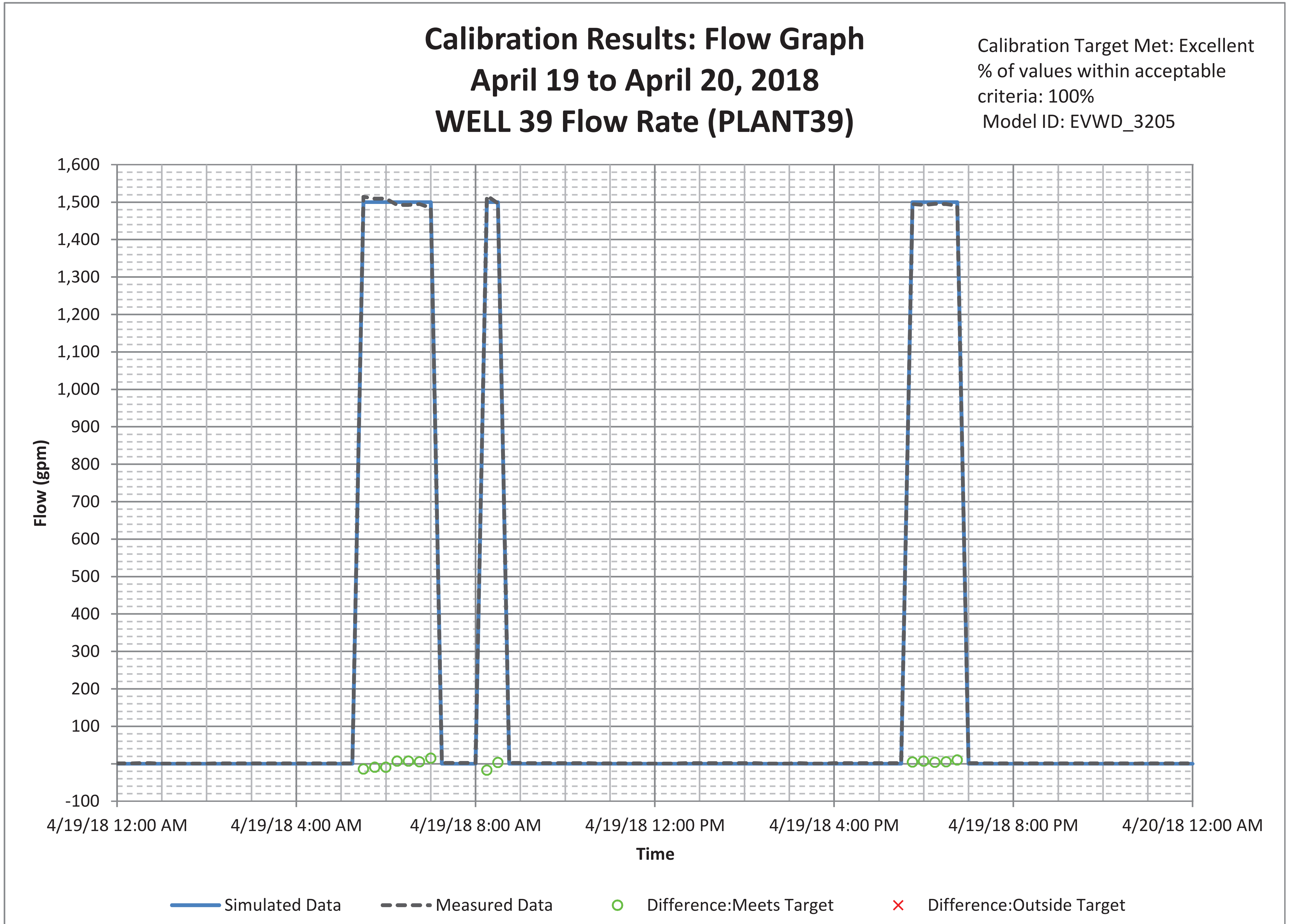

Calibration Results: Flow Graph
April 19 to April 20, 2018
P40 Drop Valve Flow Rate (to INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: M8_1059
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

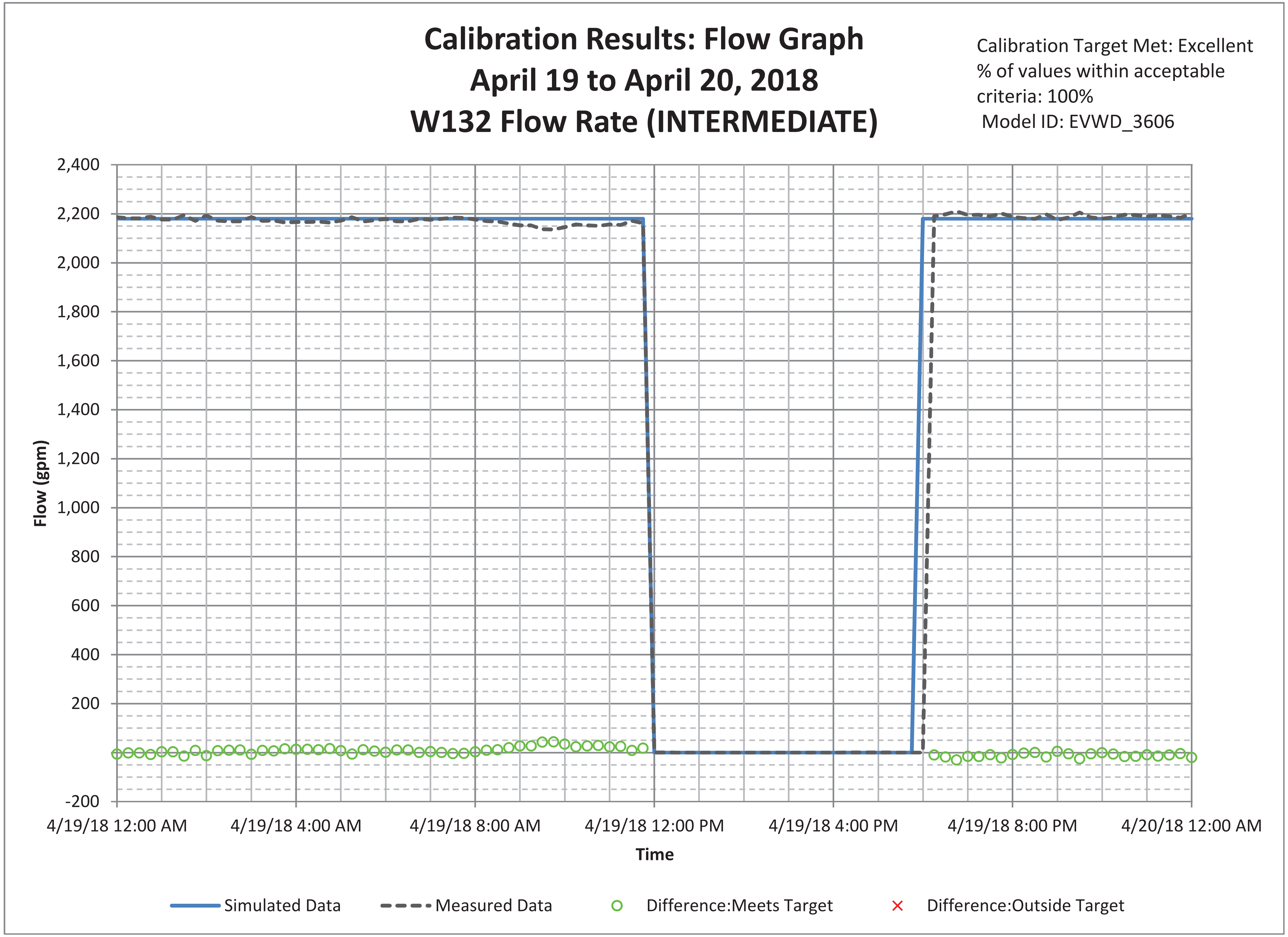

Calibration Results: Level Graph
April 19 to April 20, 2018
Plant 33 Res. Level (1,1,2.5M INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_33_1
Level (ft)
30
25
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

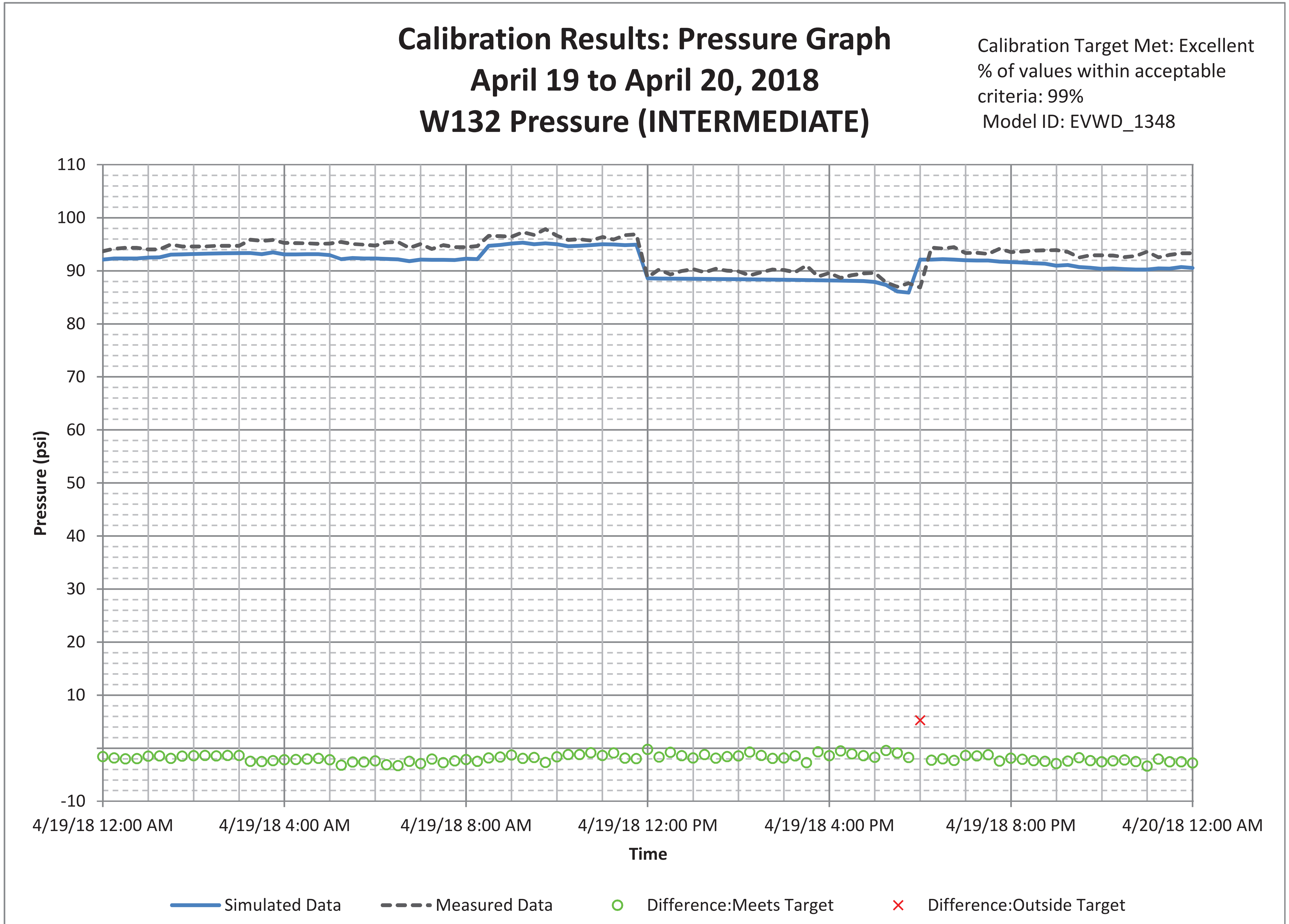

Calibration Results: Level Graph
April 19 to April 20, 2018
P39 Forebay Level (INTERMEDIATE)
Calibration Target Met: Good
% of values within acceptable criteria: 98%
Model ID: T_39_3
15
10
5
-5
-10
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

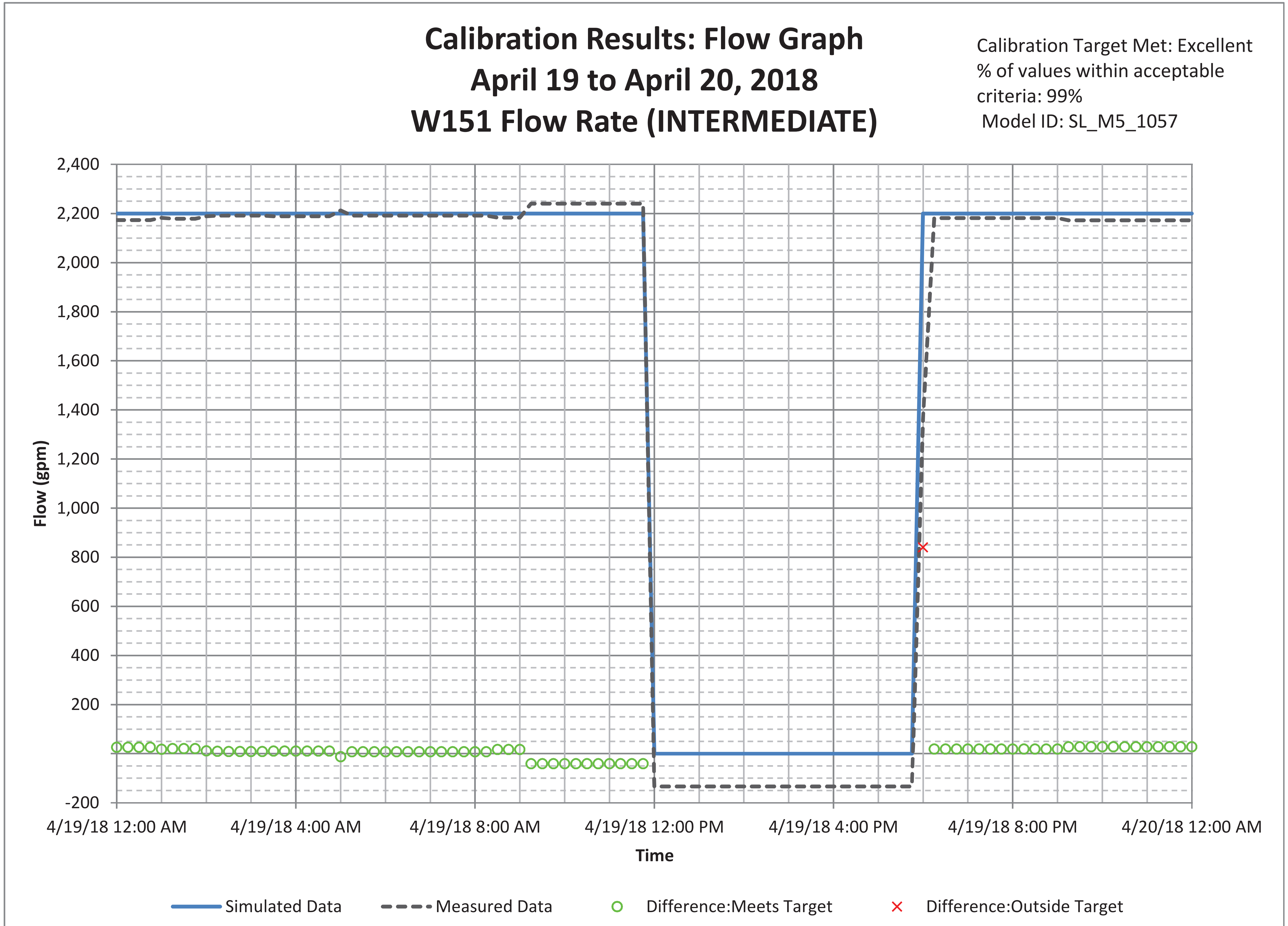

Calibration Results: Level Graph
April 19 to April 20, 2018
P39 Reservoir Level (0.9+1.4M INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_39_1
Level (ft)
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

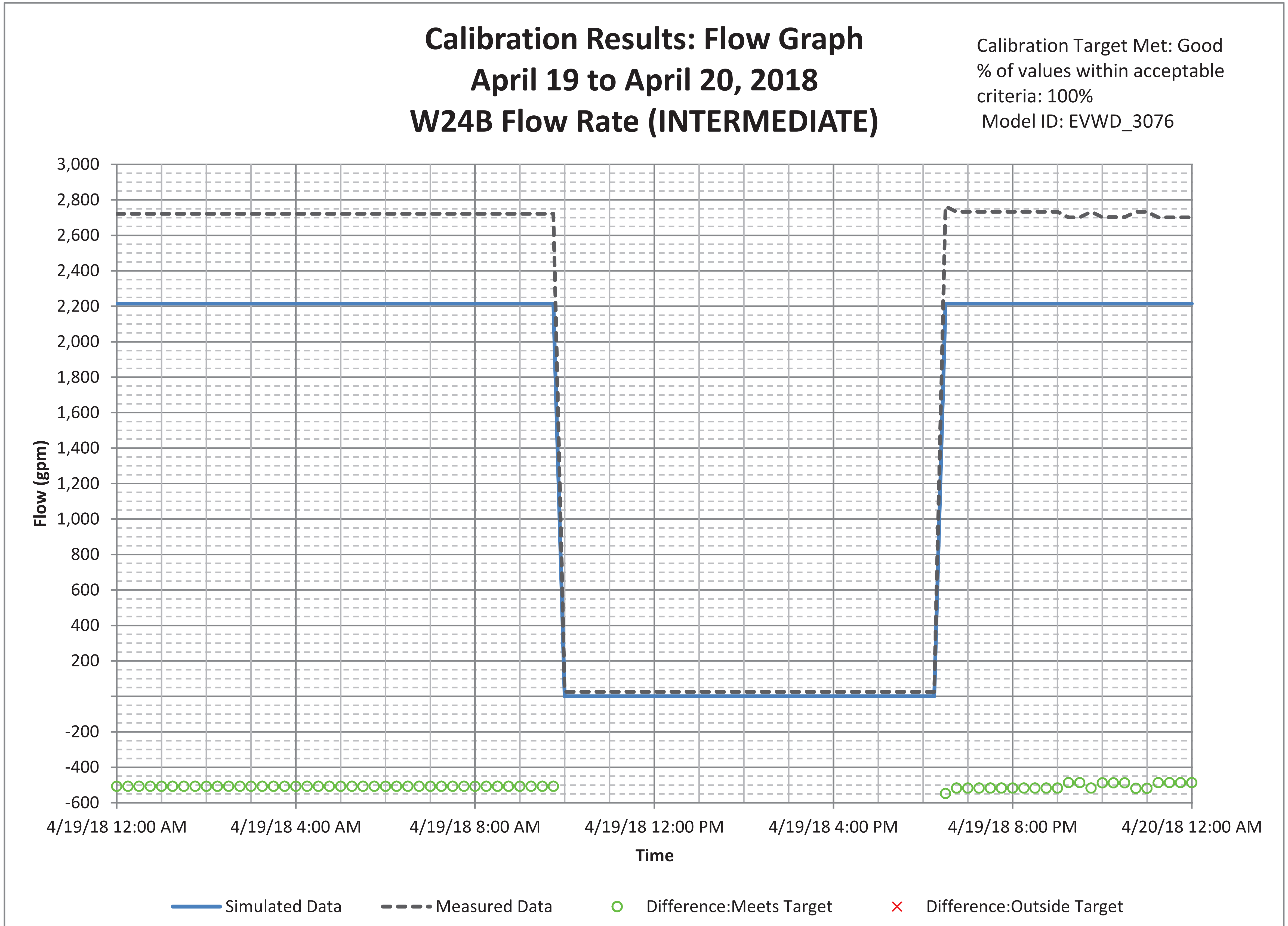

Calibration Results: Level Graph
April 19 to April 20, 2018
T_9 Reservoir Level Forebay (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_9
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

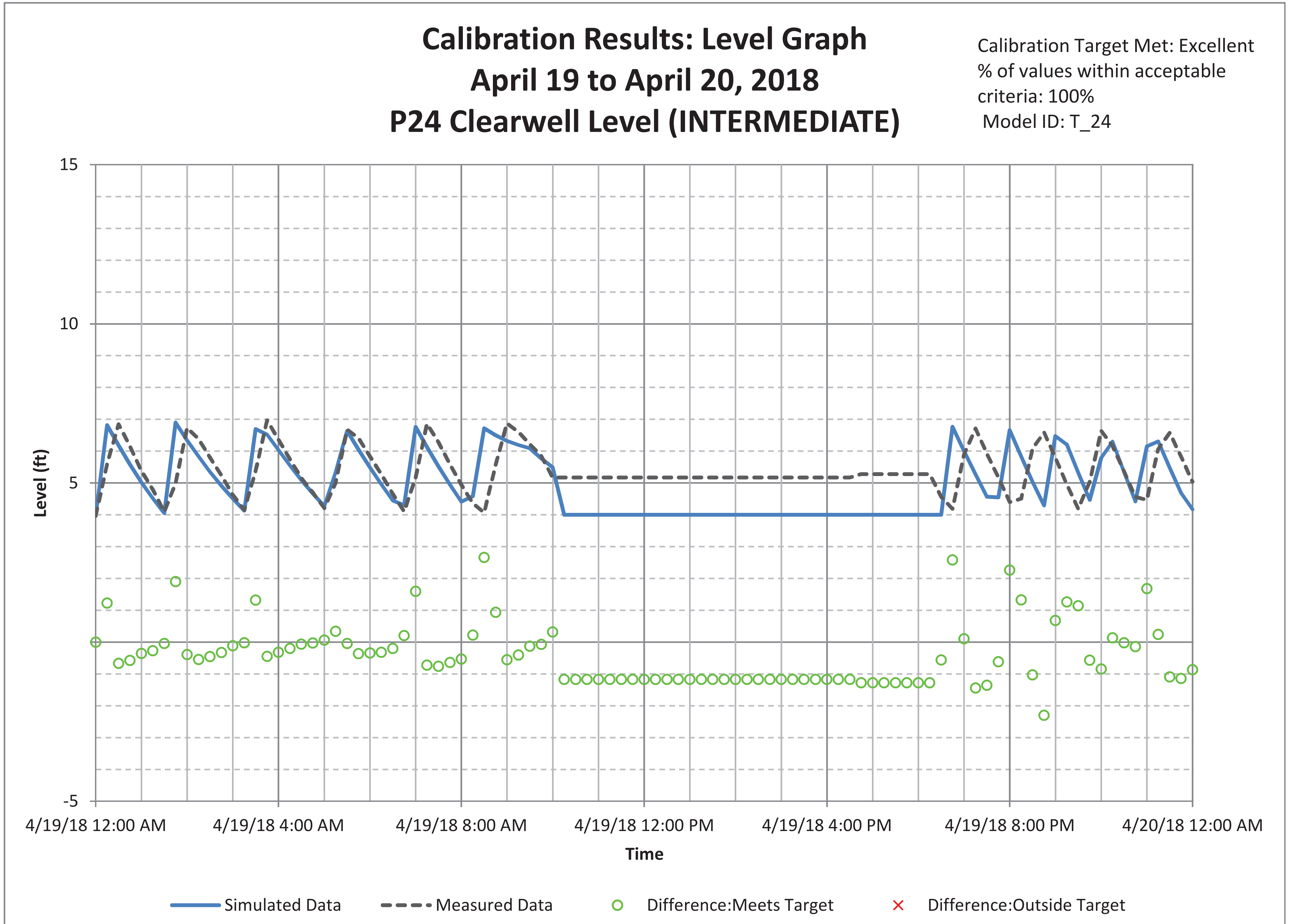

Calibration Results: Flow Graph
April 19 to April 20, 2018
WELL 39 Flow Rate (PLANT39)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3205
Flow (gpm)
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

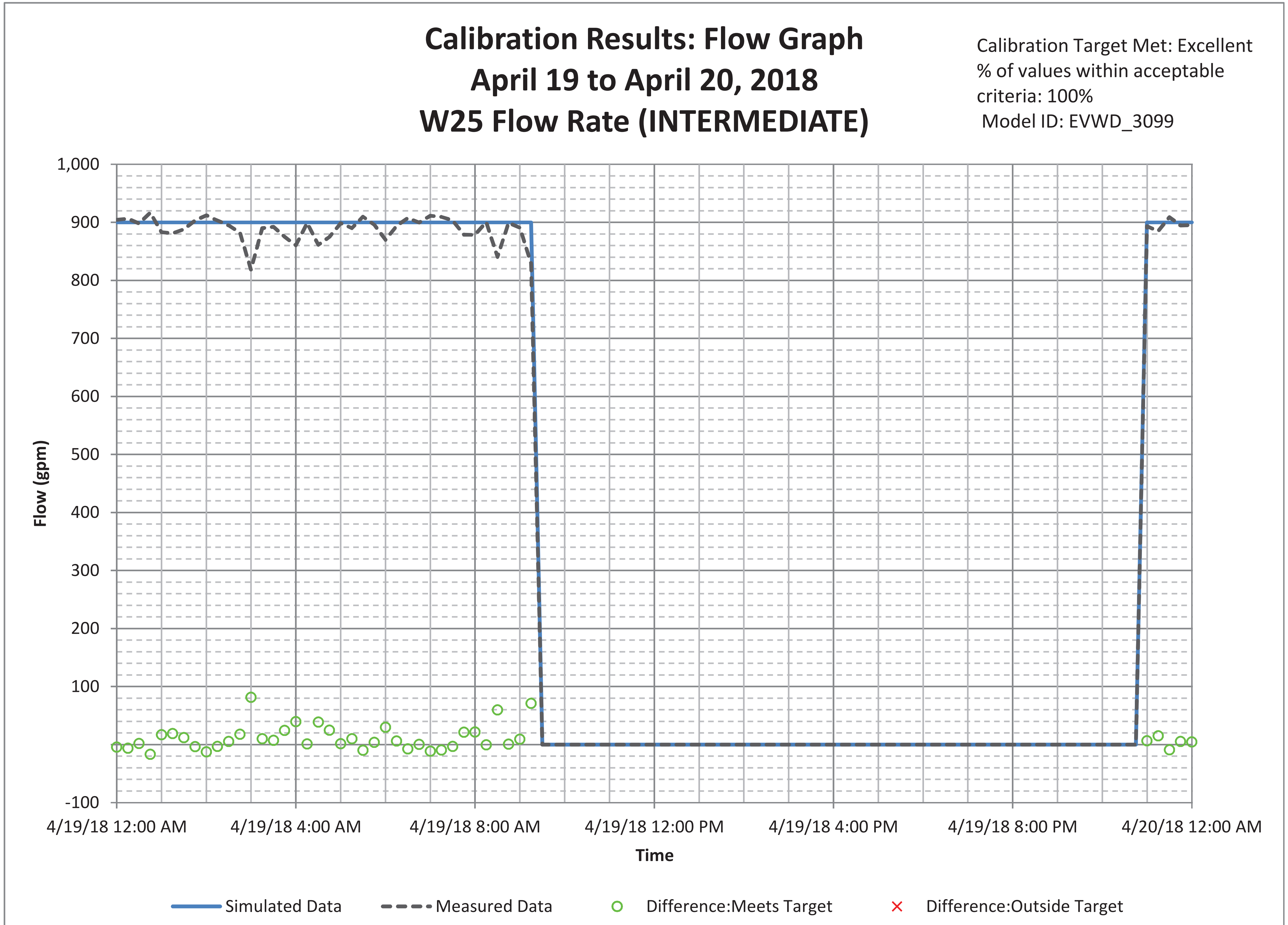

Calibration Results: Flow Graph
April 19 to April 20, 2018
W132 Flow Rate (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3606
Flow (gpm)
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-200
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

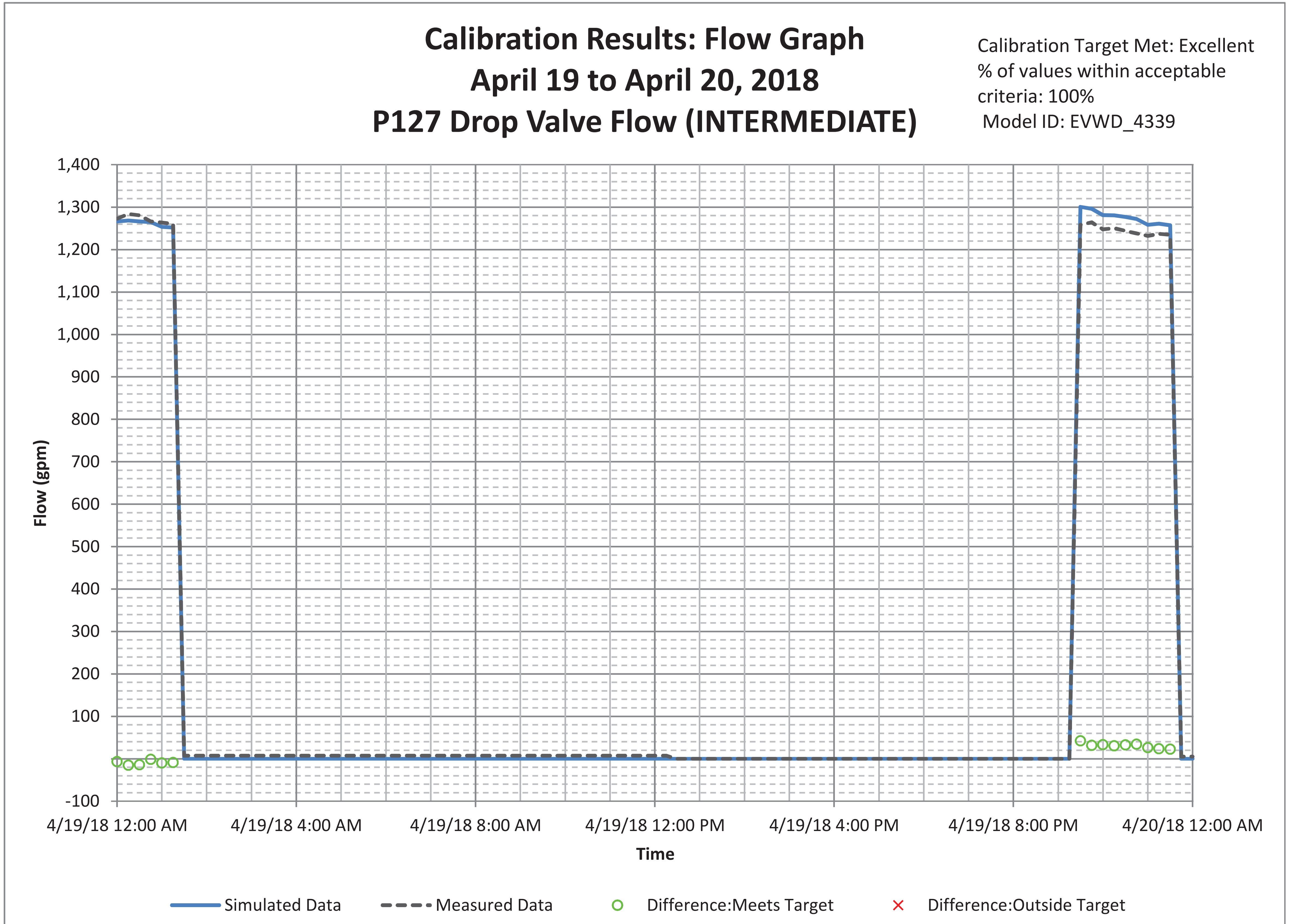

Calibration Results: Pressure Graph
April 19 to April 20, 2018
W132 Pressure (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 99%
Model ID: EVWD_1348
110
100
90
80
70
60
50
40
30
20
10
-10
Pressure (psi)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

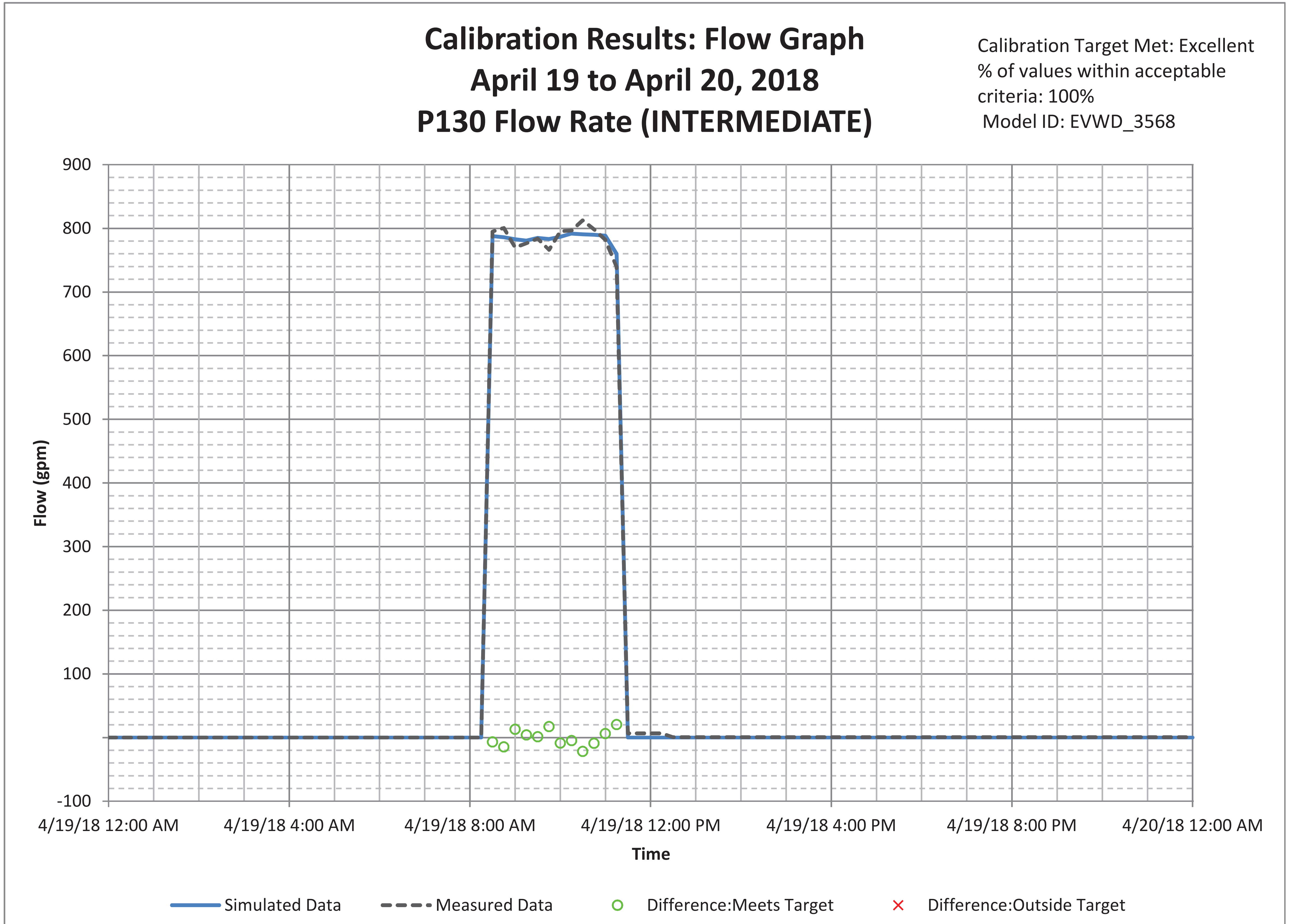

Calibration Results: Flow Graph
April 19 to April 20, 2018
W151 Flow Rate (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 99%
Model ID: SL_M5_1057
Flow (gpm)
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-200
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

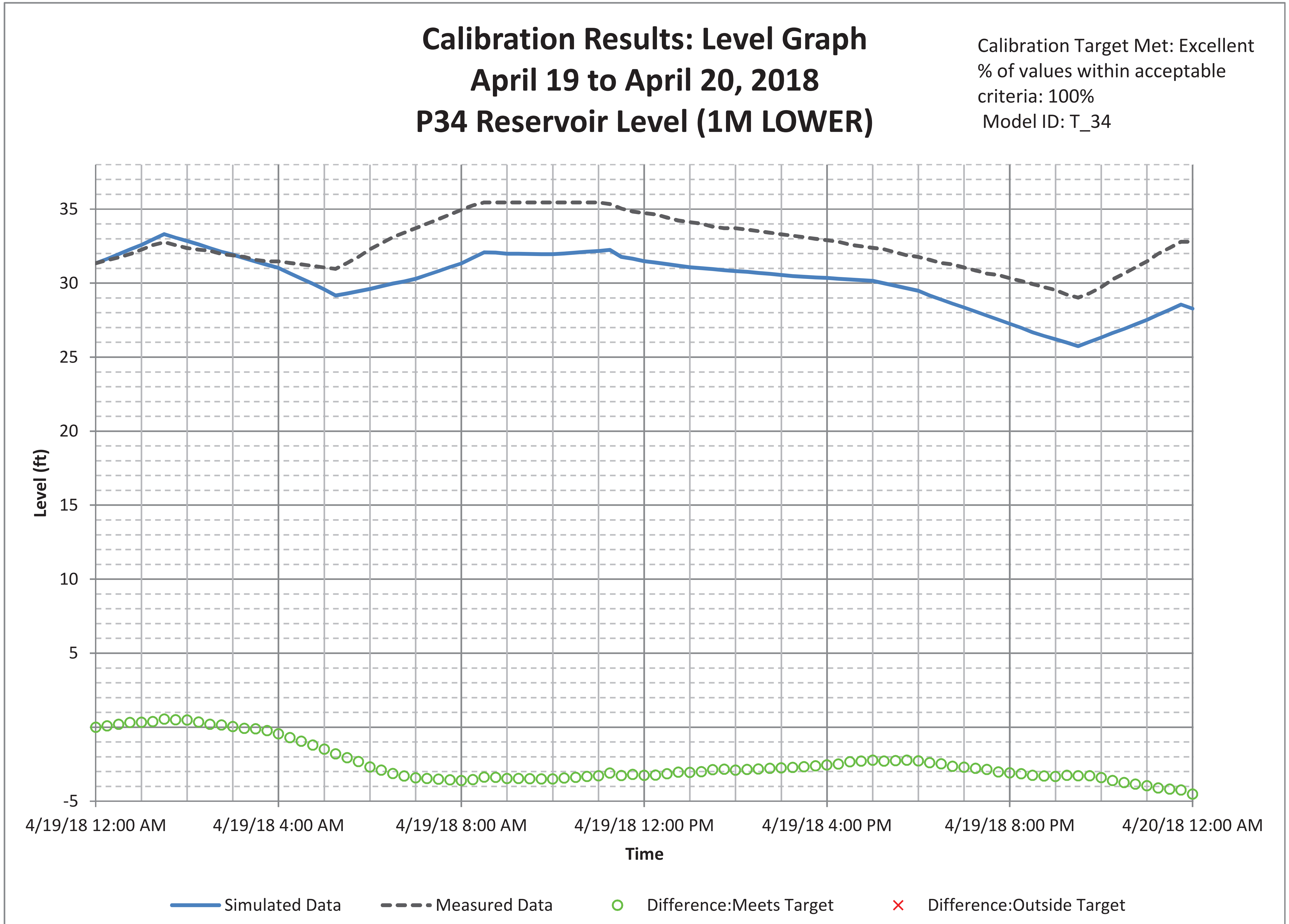

Calibration Results: Flow Graph
April 19 to April 20, 2018
W24B Flow Rate (INTERMEDIATE)
Calibration Target Met: Good
% of values within acceptable criteria: 100%
Model ID: EVWD_3076
Flow (gpm)
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-200
-400
-600
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

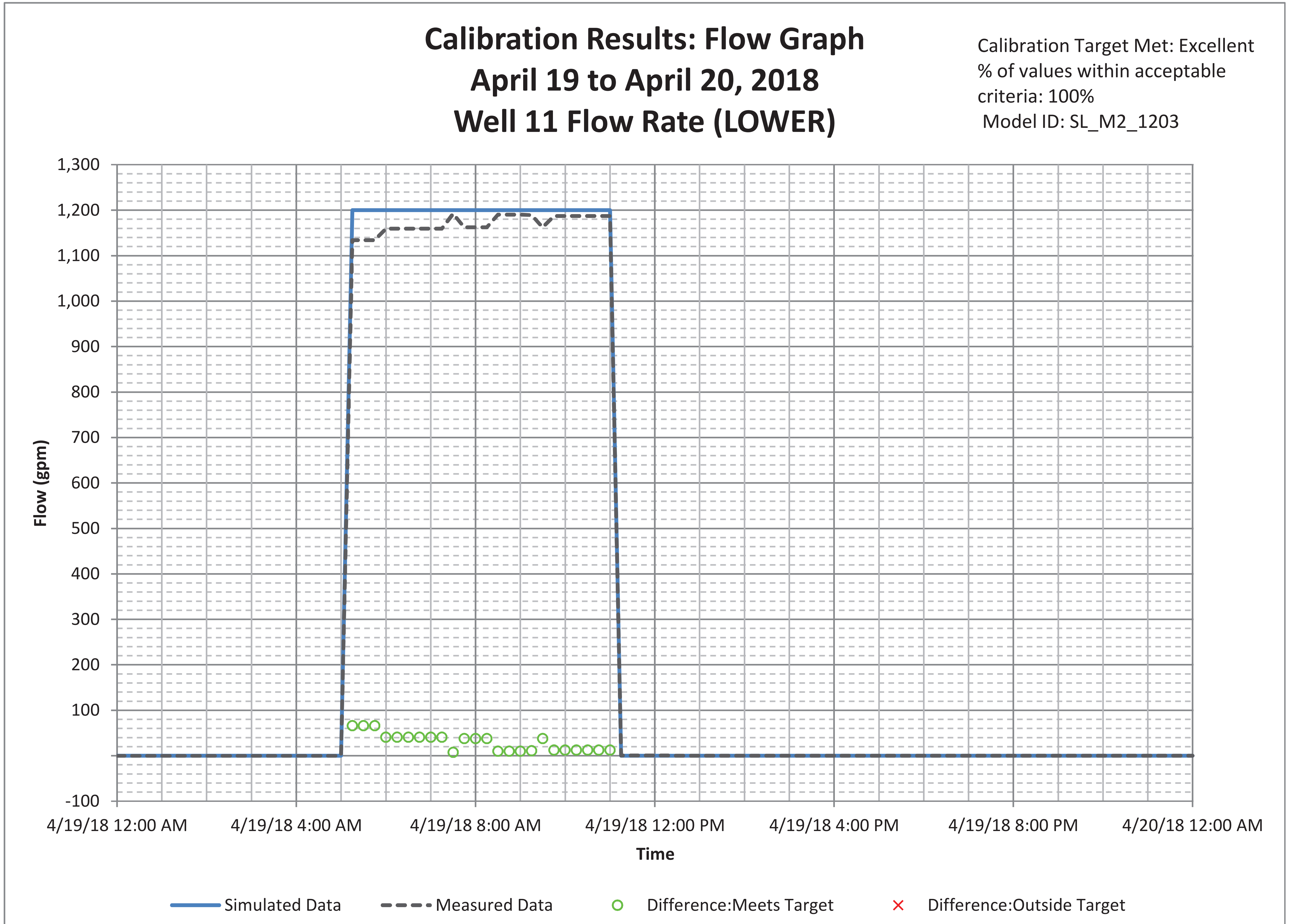

Calibration Results: Level Graph
April 19 to April 20, 2018
P24 Clearwell Level (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_24
15
10
5
-5
Level (ft)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

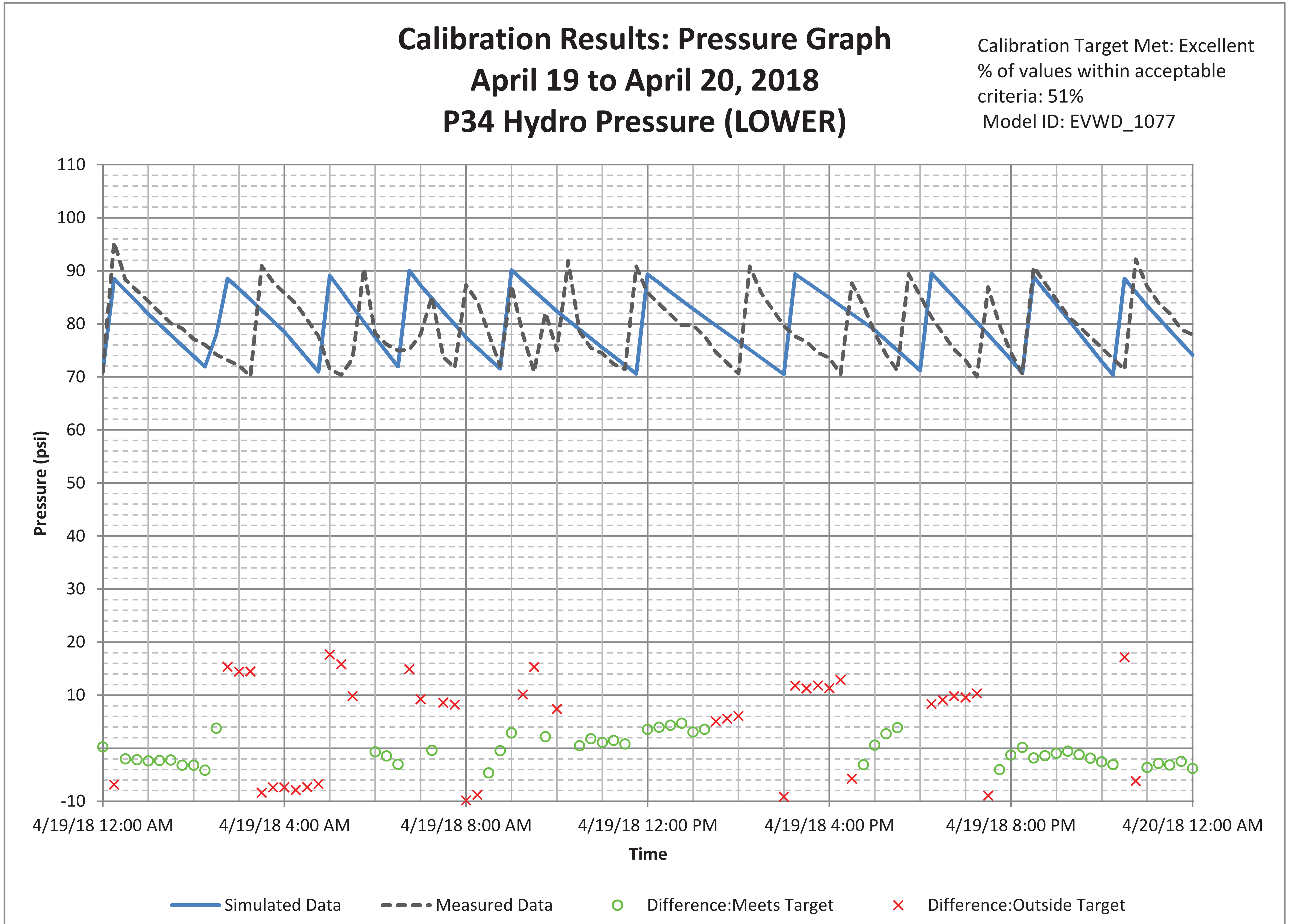

Calibration Results: Flow Graph
April 19 to April 20, 2018
W25 Flow Rate (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3099
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target


Calibration Results: Flow Graph
April 19 to April 20, 2018
P127 Drop Valve Flow (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_4339
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target


Calibration Results: Flow Graph
April 19 to April 20, 2018
P130 Flow Rate (INTERMEDIATE)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: EVWD_3568
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target


Calibration Results: Level Graph
April 19 to April 20, 2018
P34 Reservoir Level (1M LOWER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: T_34
Level (ft)
35
30
25
20
15
10
5
-5
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target


Calibration Results: Flow Graph
April 19 to April 20, 2018
Well 11 Flow Rate (LOWER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 100%
Model ID: SL_M2_1203
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
-100
Flow (gpm)
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target


Calibration Results: Pressure Graph
April 19 to April 20, 2018
P34 Hydro Pressure (LOWER)
Calibration Target Met: Excellent
% of values within acceptable criteria: 51%
Model ID: EVWD_1077
Pressure (psi)
110
100
90
80
70
60
50
40
30
20
10
-10
4/19/18 12:00 AM
4/19/18 4:00 AM
4/19/18 8:00 AM
4/19/18 12:00 PM
4/19/18 4:00 PM
4/19/18 8:00 PM
4/20/18 12:00 AM
Time
Simulated Data
Measured Data
Difference:Meets Target
Difference:Outside Target

APPENDIX D – FIRE FLOW IMPROVEMENT SUMMARY

To identify areas that would benefit most from fire flow improvement projects, hydrants were prioritized by percent shortfall of the recommended flow. Areas with a cluster of hydrants that fell short of the recommended flow were grouped into ten priority fire flow areas. Recommendations were made for each of the ten areas to improve fire flow availability of each of the hydrants not meeting criteria within each of the ten areas. The list below provides a detailed methodology of how these recommendations were developed:

- In some cases, “incorrect” fire flow demands are initially assigned to the demand junctions, due to the multiple land use types near that junction. For example, an industrial demand might be assigned to the nearest junction that is actually on a residential street. This is addressed by ensuring that the residential demand would be associated with the hydrant on the residential street and the high demand could be served by another junction nearby on a larger street. Where appropriate, the fire flow demand at that junction is revised and the model simulation is repeated with the adjusted fire flow demand.

- As shown in Table 6-2, some of the land use categories have a fire flow requirement that is greater than 2,500 gpm. These high fire flow demands typically cannot be met by a single hydrant. To simulate the use of multiple hydrants, the fire flow demand is divided among multiple adjacent hydrants and the model simulation is repeated. If the use of multiple hydrants satisfies the demand, then no recommendations are made.

- Some of the deficient junctions fall on dead end pipelines or cul-de-sacs. This is typical in a water distribution network as these pipelines can receive water only from a single direction resulting in a larger head-loss as opposed to looped configurations. In such cases, a check is made to determine if the demand can be met by making use of multiple hydrants from adjacent water mains within 500 feet. If the use of multiple hydrants satisfies the demand, then no recommendations are made. Otherwise, pipeline upsizing is recommended for the pipeline that connects to these dead-end pipelines. In a few dead-end locations where the modeled flow reaches greater than 90 percent of the recommended flow, no improvements are recommended.

The detailed investigation described above reduced the number of deficient hydrants in each of the ten areas. Recommendations to improve pressures at each hydrant not meeting criteria include upsizing pipeline diameters, replacing hydrant laterals, and creating looped networks where possible.

After replacing the small diameter pipelines in each area to either 6 or 8-inch diameter pipelines, additional fire flow deficiencies are addressed by increasing pipeline diameters and creating loops in the system. Lastly, hydrant laterals are upsized from 2 or 4-inch to 6-inch laterals if this change helps meet recommended flow. In most small lateral cases, what is described as a hydrant in the GIS may a blow off. If this is the case, replacement is not needed to address fire flow deficiency, and EVWD should confirm with visual inspection before initiating a replacement. A blow-off type hydrant may still contribute excessive head-loss which the model does not simulate.

To minimize the number of recommendations, fire flow improvements are grouped into the ten fire flow areas. All fire flow recommendations are shown in Figure D-1. A summary of the proposed small diameter pipeline improvements, upsized laterals, and new pipelines for fire flow improvements for each fire flow area is presented is in Table D-1. Approximately 8.2 miles of pipeline improvements are recommended to address fire flow deficiencies. Figures for each fire flow improvement area are provided in this Appendix.

Table D-1: Summary of Fire Flow Improvements

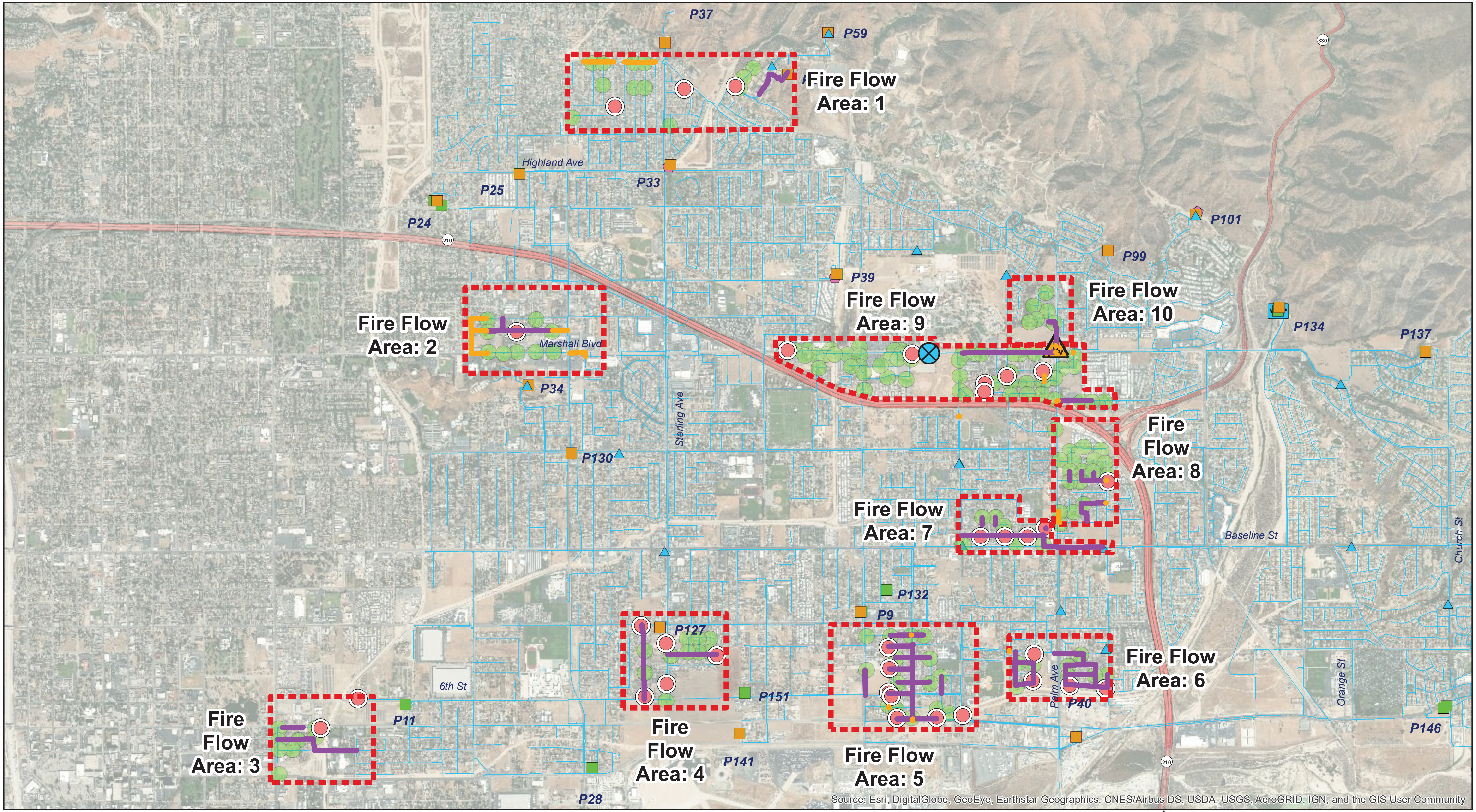
Fire Flow Area	Proposed Improvements			
	Size	Quantity	Unit	Description
1	**New**			
	8-inch	1,700	LF	Connects existing 8-inch and closes a loop.
	Replacement/Upsize			
	8-inch	1,300	LF	Replaces existing 6-inch pipe.
	Hydrant	3	each	Replaces hydrants or hydrant laterals with 2 and 4-inch size.
2	**New**			
	8-inch	2,700	LF	Connects existing 8-inch and closes a loop.
	12-inch	600	LF	Connects existing 12-inch to fire flow area.
	Replacement/Upsize			
	8-inch	2,100	LF	Replaces existing 6-inch pipe.
	hydrant	1	each	Replaces blow off hydrants or hydrant laterals with 2 and 4-inch size.
3	**New**			
	None	-	-	-
	Replacement/Upsize			
	8-inch	1,500	LF	Replaces existing 4 and 6-inch pipe.
	10-inch	400	LF	Replaces existing 8-inch pipe.
	12-inch	1,200	LF	Replaces existing 6-inch pipe.
	Hydrant	2	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
4	**New**			
	-	-	-	-
	Replacement/Upsize			
	8-inch	3,400	LF	Replaces existing 4 and 6-inch pipe.
	Hydrant	5	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
5	**New**			
	6-inch	100	LF	Connects existing 6-inch to fire flow area.
	10-inch	100	LF	Connects existing 30-inch to fire flow area.
	Replacement/Upsize			
	6-inch	3,200	LF	Replaces existing 4-inch pipe.
	8-inch	4,500	LF	Replaces existing 4 and 6-inch pipe.

Appendix D – Fire Flow Improvement Summary

Fire Flow Area	Proposed Improvements			
	Size	**Quantity**	**Unit**	**Description**
	10-inch	2,100	LF	Replaces existing 6-inch pipe.
	Hydrant	7	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
6	**New**			
	8-inch	100	LF	Connects existing 12-inch to fire flow area.
	Replacement/Upsize			
	6-inch	4,100	LF	Replaces existing 4-inch pipe.
	8-inch	2,900	LF	Replaces existing 4 and 6-inch pipe.
	Hydrant	4	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
7	**New**			
	None	-	-	-
	Replacement/Upsize			
	6-inch	400	LF	Replaces existing 4-inch pipe.
	8-inch	2,600	LF	Replaces existing 4 and 6-inch pipe.
	12-inch	1,600	LF	Replaces existing 8-inch pipe.
	Hydrant	4	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
8	New			
	6-inch	300	LF	Connects existing 6 and 8-inch to close the loop.
	8-inch	100	LF	Connects existing 12-inch to fire flow area.
	Replacement/Upsize			
	6-inch	700	LF	Replaces existing 4-inch pipe.
	8-inch	1,900	LF	Replaces existing 4 and 6-inch pipe.
	Hydrant	1	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
9	**New**			
	8-inch	200	LF	Connects existing 8-inch to close a loop.
	10-inch	100	LF	Connects existing 12-inch to fire flow area.
	12-inch	100	LF	Extends existing 12-inch to close a loop.
	8-inch PRV	1	each	New PRV North of intersection of Palm Ave and Highland Ave, connecting Upper Zone to Foothill Zone. Proposed setting is at 50 psi.
	Replacement/Upsize			
	8-inch	1,500	LF	Replaces existing 4 and 6-inch pipe.
	10-inch	1,900	LF	Replaces existing 4 and 6-inch pipe.

Fire Flow Area	Proposed Improvements			
	Size	**Quantity**	**Unit**	**Description**
	Hydrant	6	each	Replaces existing blow off hydrants served by 2 and 4-inch laterals.
	Open Closed Valve	1	each	Open Normally Closed Valve # V_H7_110.
10	**New**			
	None	-	-	-
	Replacement/Upsize			
	8-inch	900	LF	Replaces existing 6-inch pipe.
	Change PRV Setting	1	each	Change Setting for PRS_302 to 80 psi.

Laterals of 2-inch size are likely blow-offs and may not need to be replaced, however EVWD should verify this in the field.



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well

- WTP
- Model Pipe
- Fire Flow Priority Areas
- freeway

N

0 0.2 0.4 0.8 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec

Date: Nov 26, 2018

Existing System Fire Flow Recommendations

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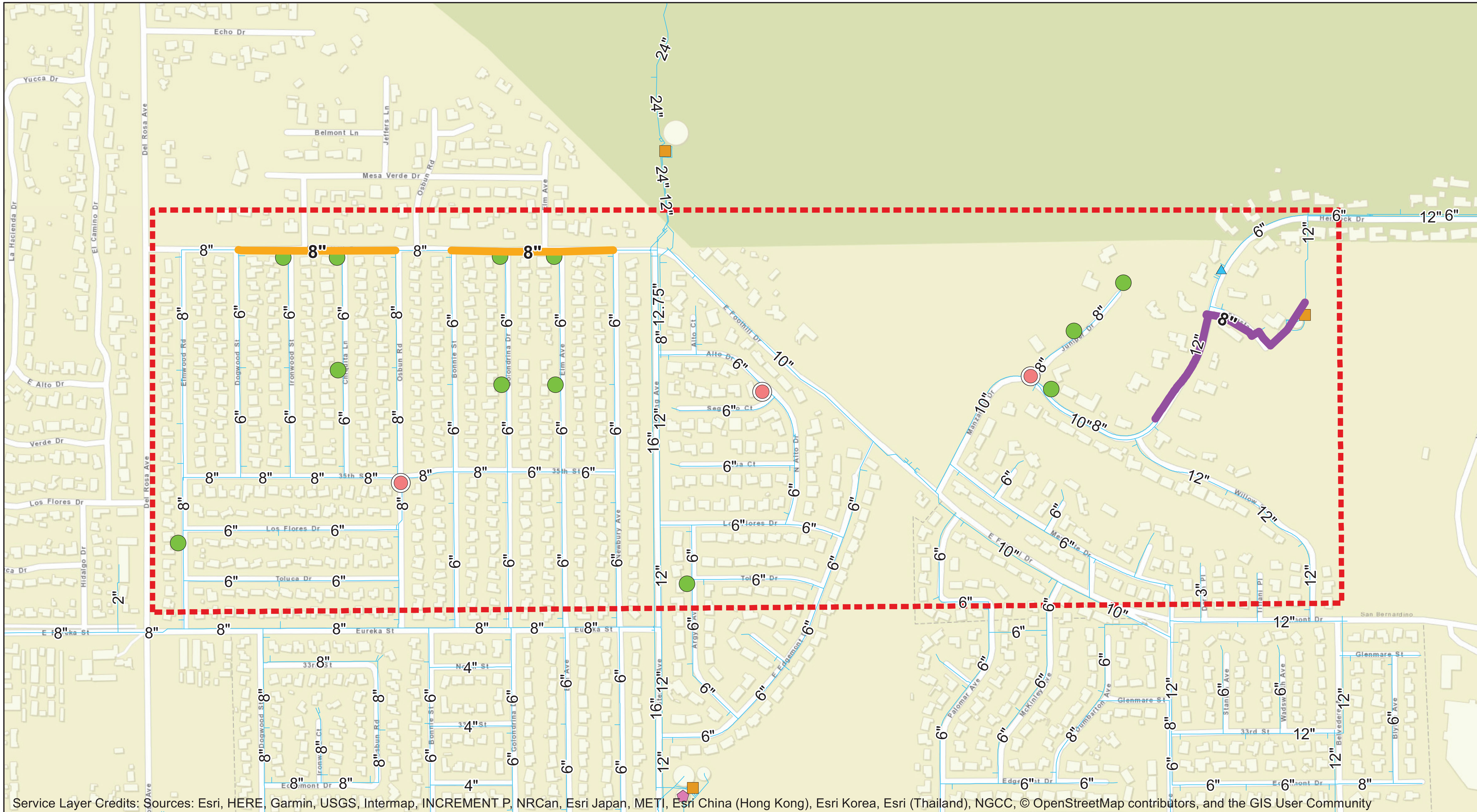
Figure D-1



Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

EAST VALLEY WATER DISTRICT

N

0 0.0375 0.075 0.15 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

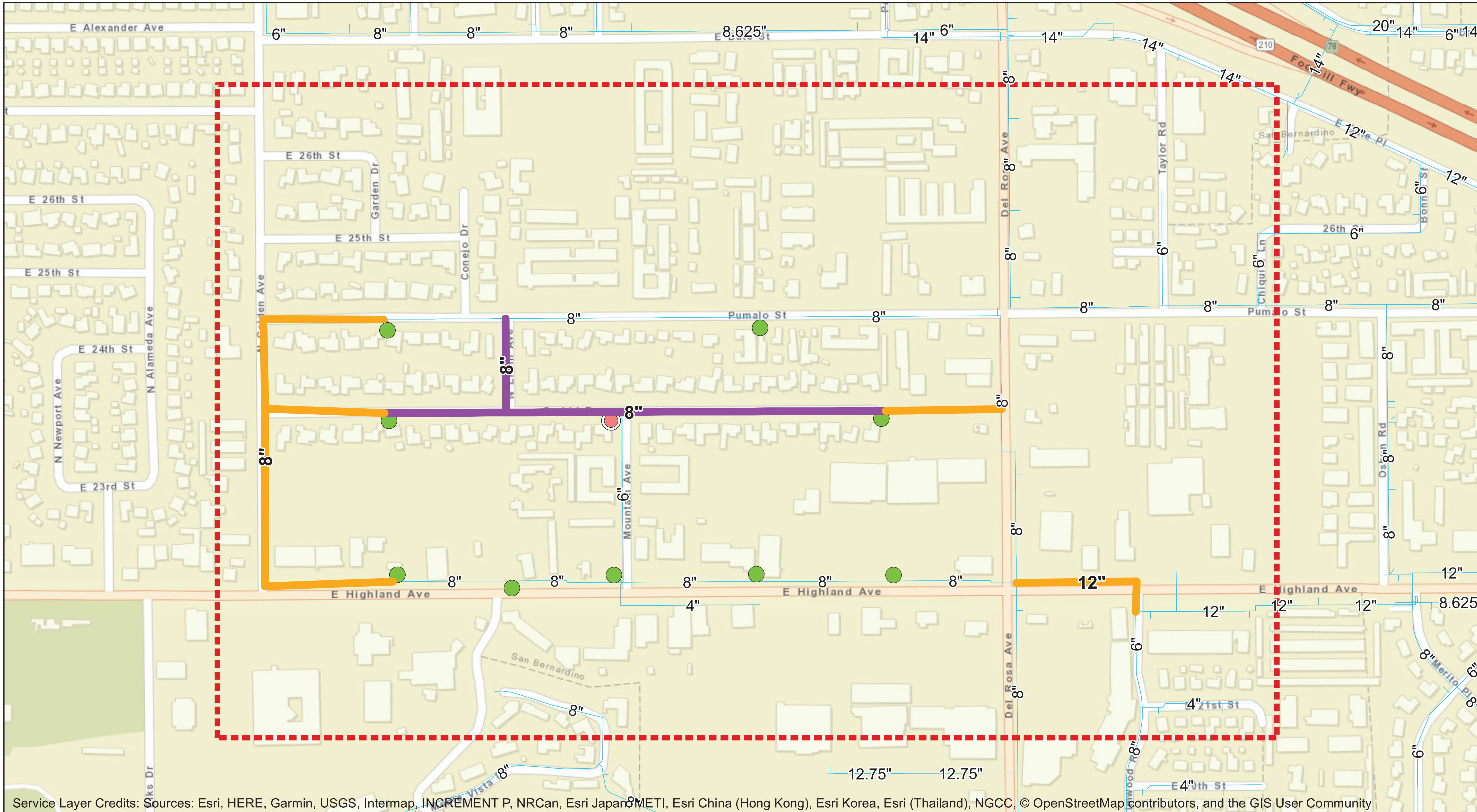
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 1

SEDARU

Figure -



East Valley Water District

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.025 0.05 0.1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 2

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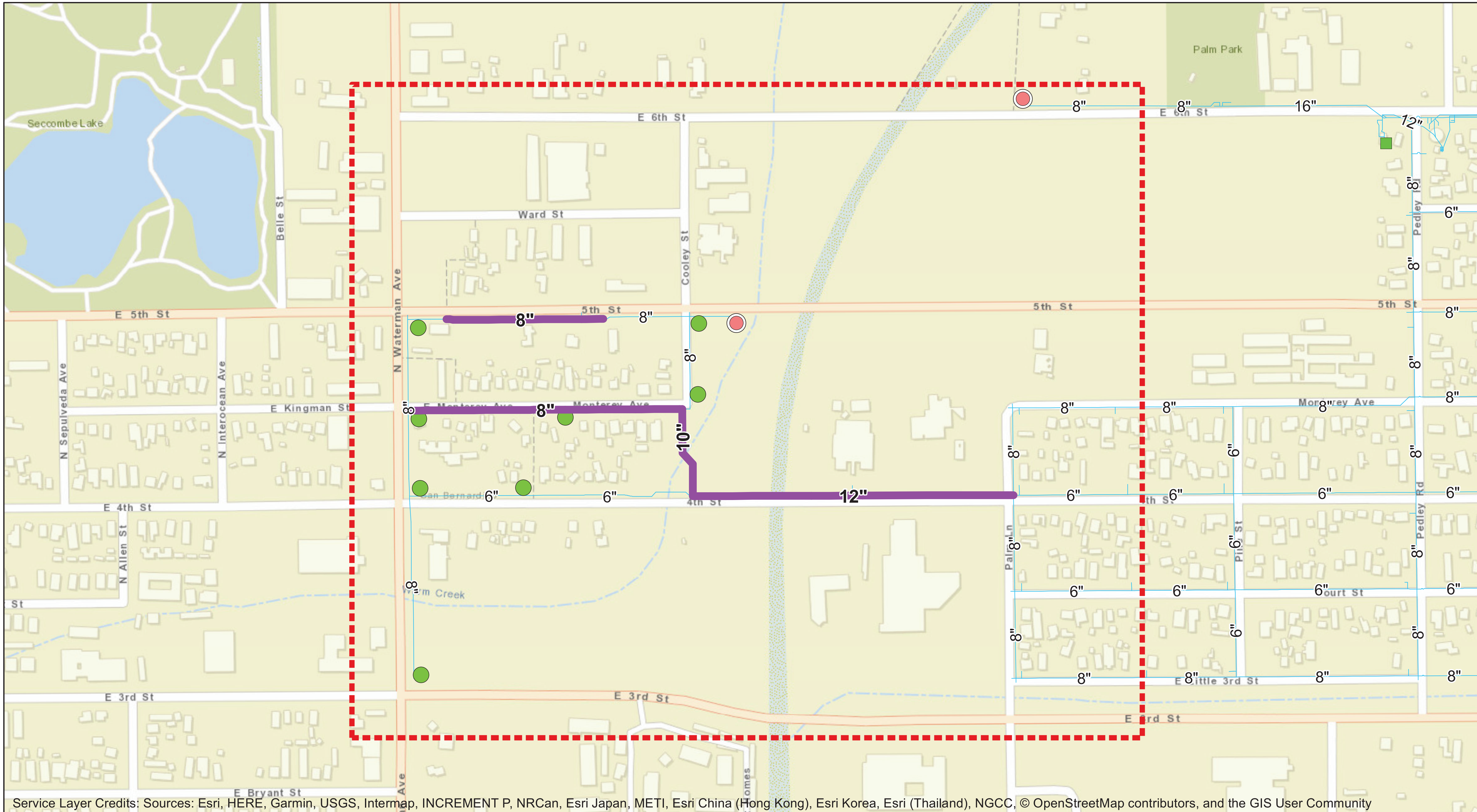
Figure -



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.025 0.05 0.1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

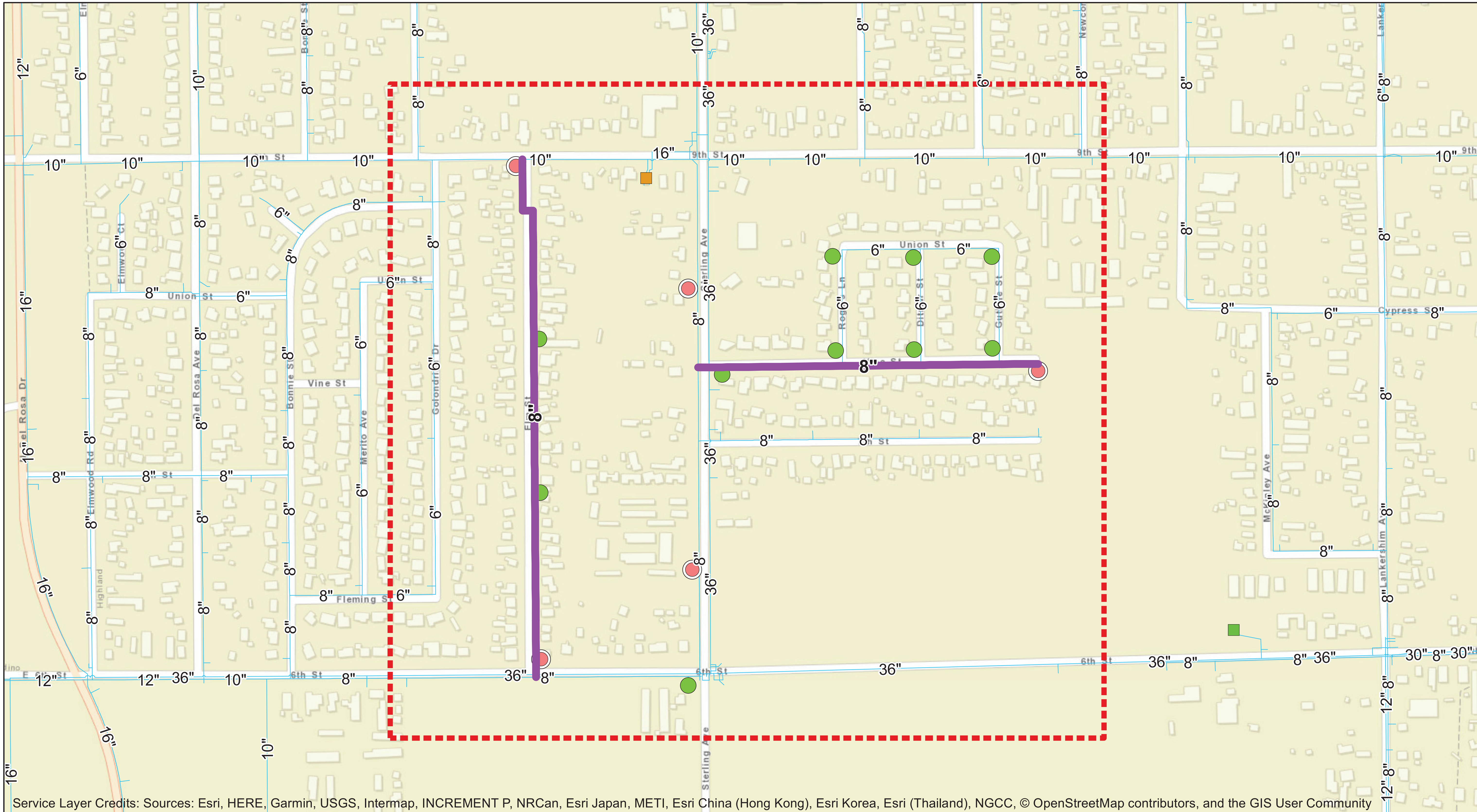
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 3

SEDARU®

Figure -



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.0275 0.055 0.11 Miles

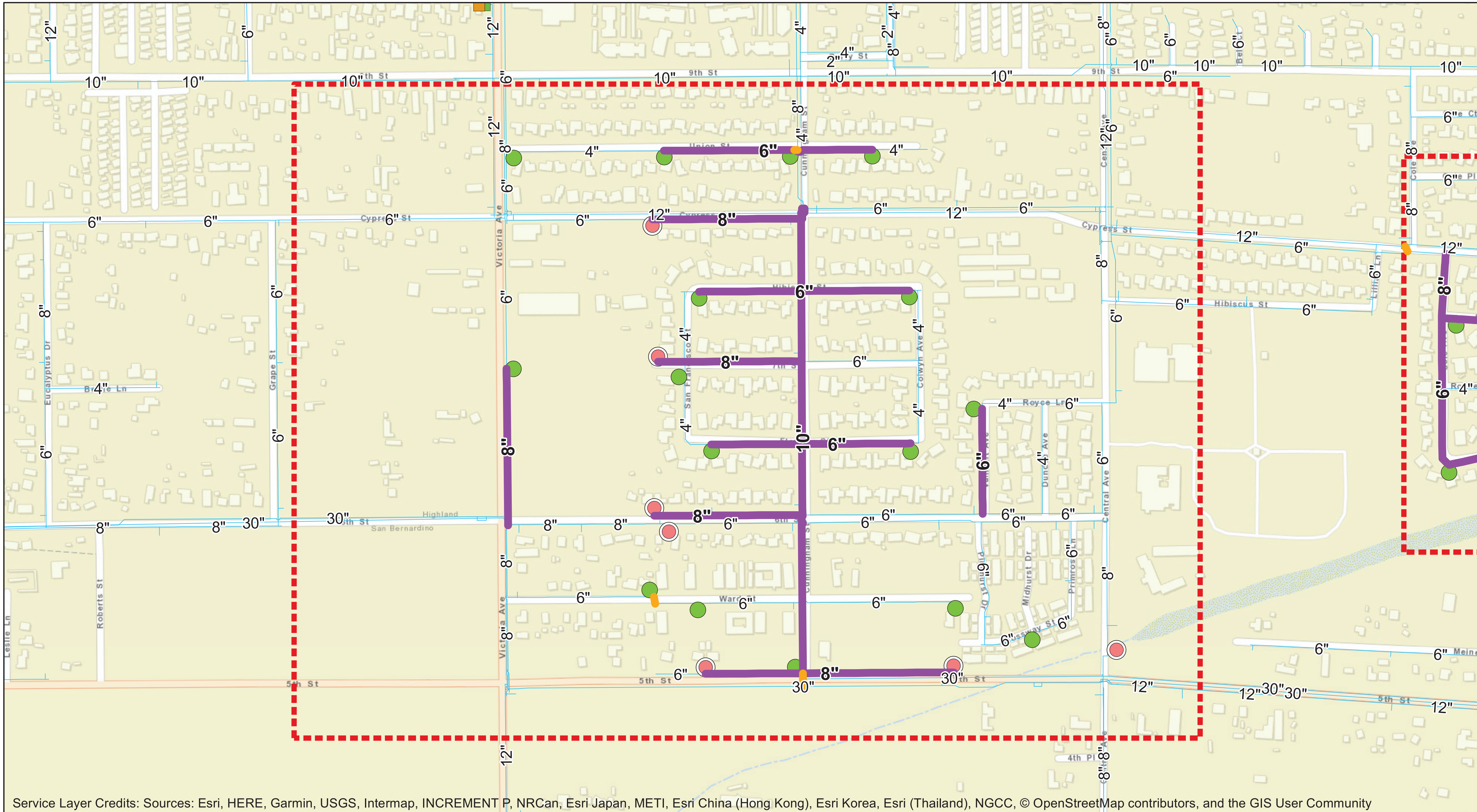
Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 4

SEDARU®

Figure -



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.0325 0.065 0.13 Miles

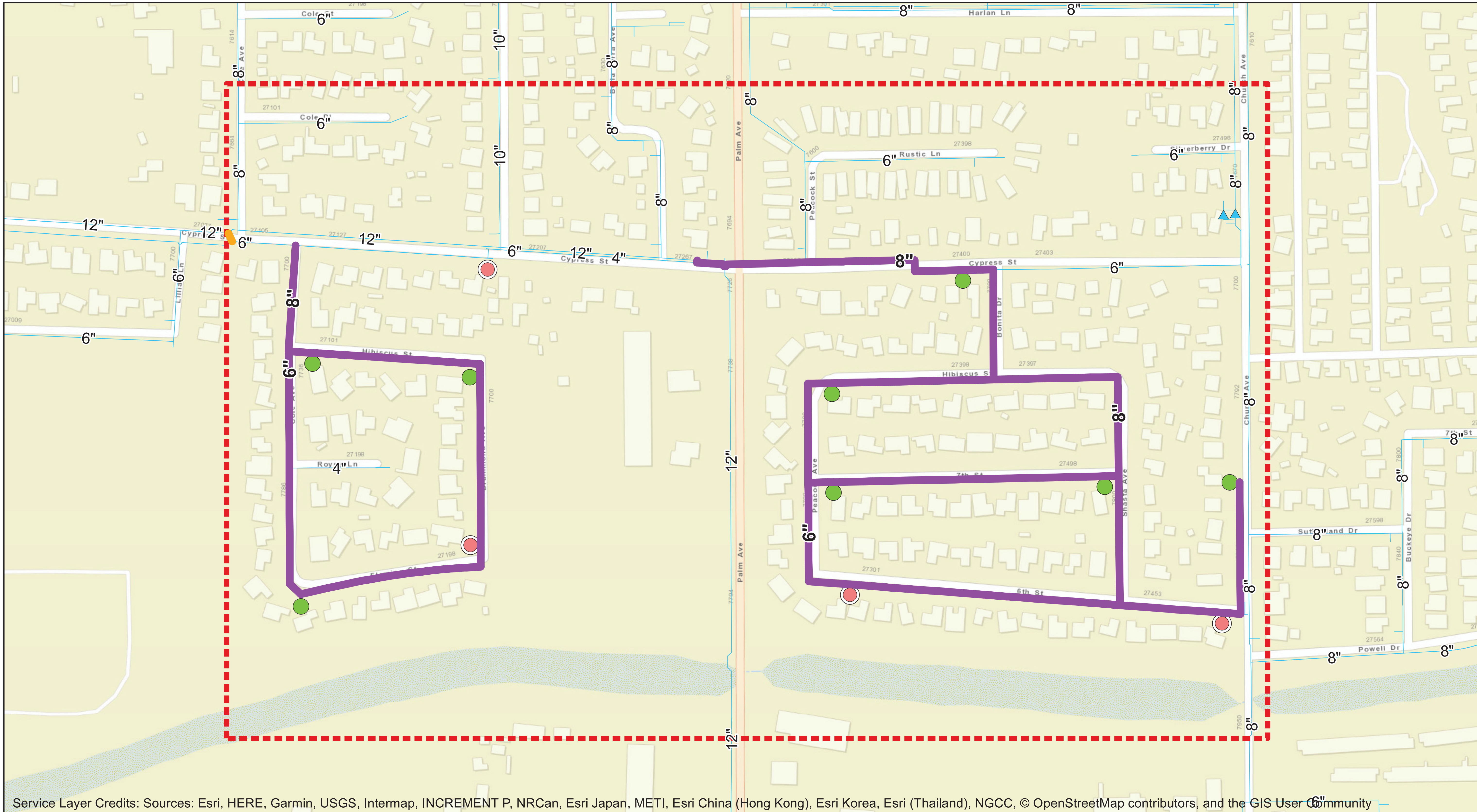
Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 5

SEDARU

Figure -



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.02 0.04 0.08 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

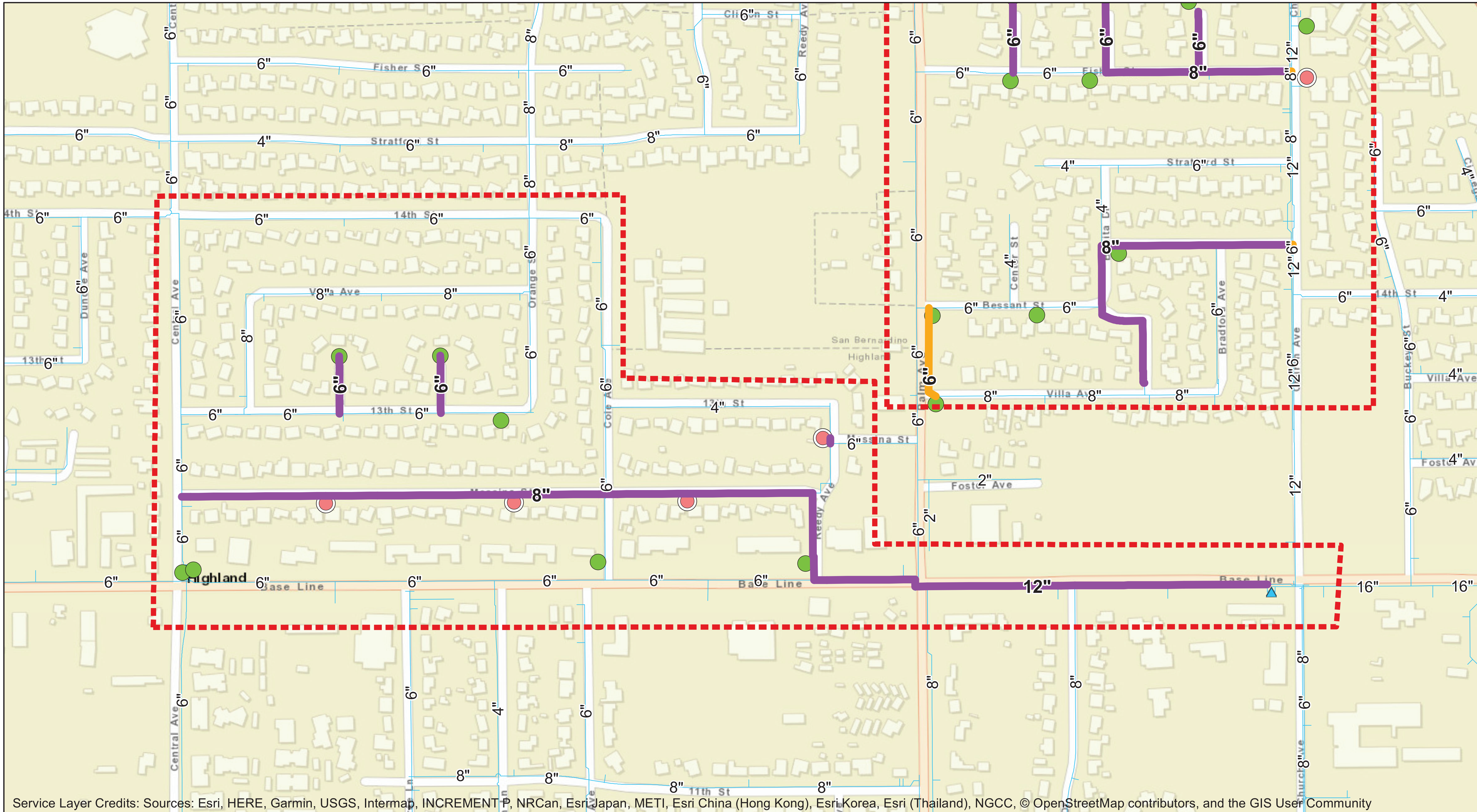
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 6

SEDARU

Figure -



East Valley Water District

Legend

Improvements (Pipes)	Improvements (Valves)		
New Pipe	New PRV	Hydrants (Do Not Meet Criteria)	Model Pipe
Pipe Upsize	PRV Setting Change	PRV Station	Fire Flow Priority Areas
Hydrants with Lateral Upsize	Valve Open	Booster Station	
		Reservoir	
		Well	
		WTP	

N

0 0.025 0.05 0.1 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 7

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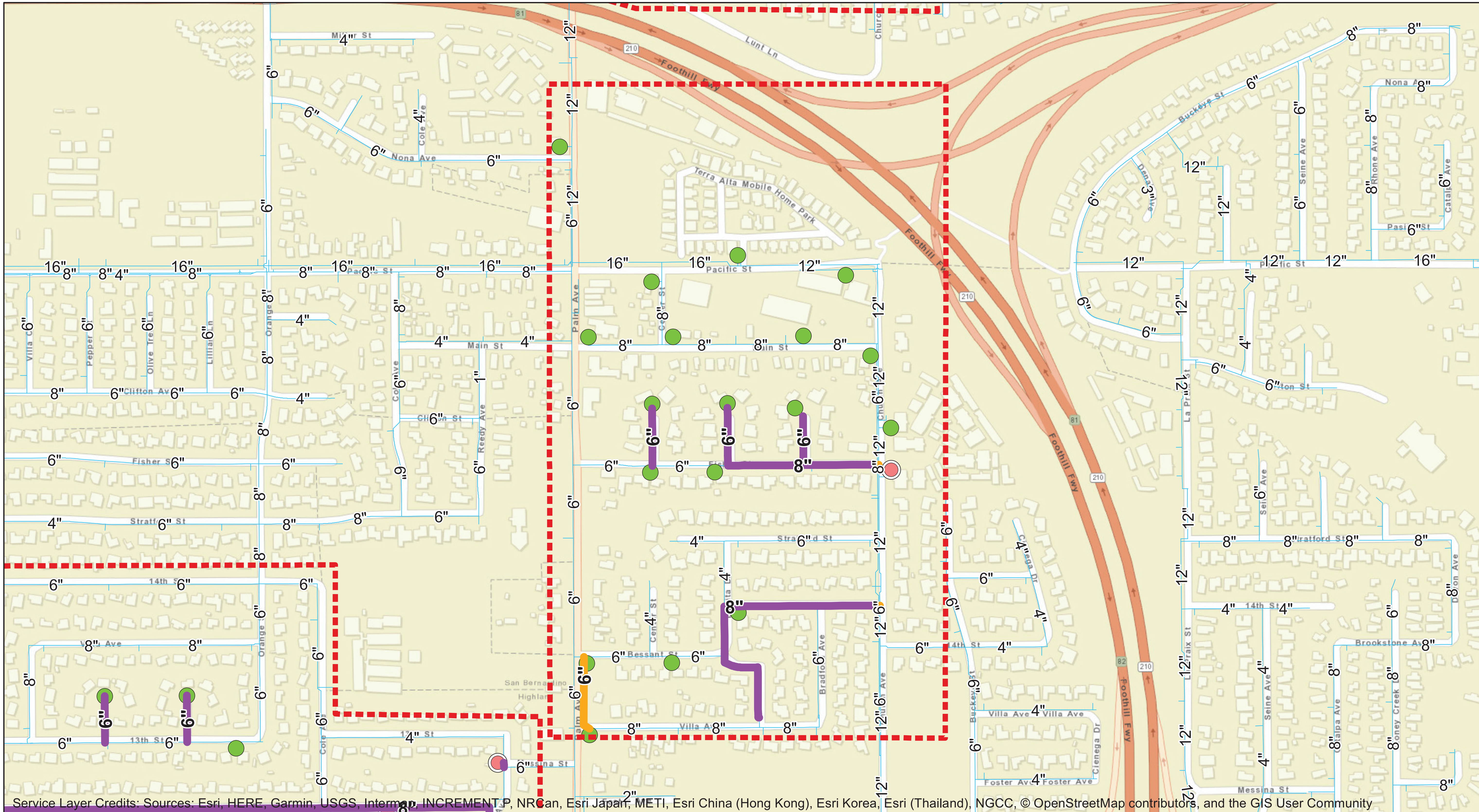
Figure -



Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

EAST VALLEY WATER DISTRICT

N

0 0.0325 0.065 0.13 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 8

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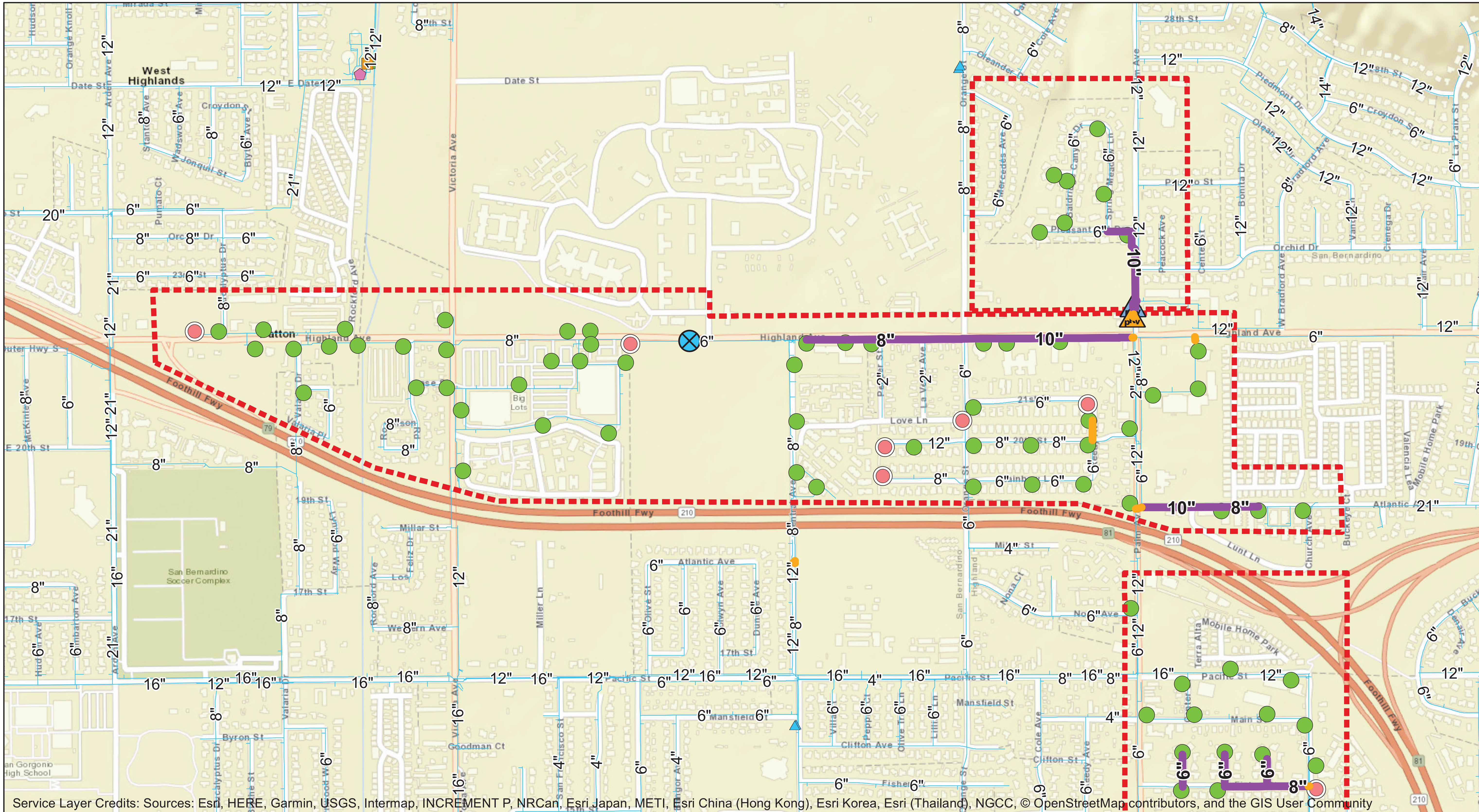
Figure -



EAST VALLEY WATER DISTRICT

Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.05 0.1 0.2 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

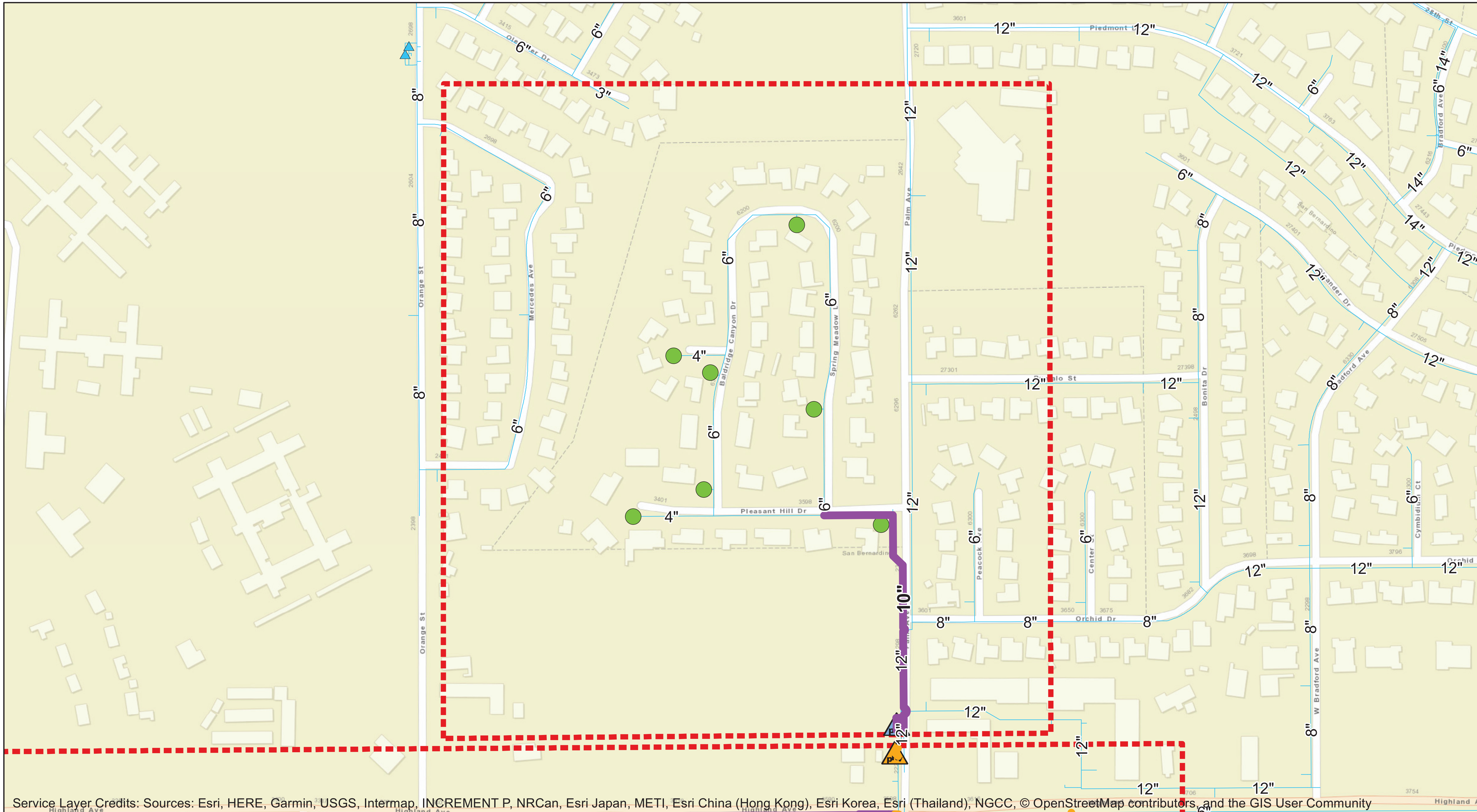
Date: Sep 20, 2018

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 9

SEDARU

Figure -



Legend

Improvements (Pipes)
- New Pipe
- Pipe Upsize
- Hydrants with Lateral Upsize

Improvements (Valves)
- New PRV
- PRV Setting Change
- Valve Open

- Hydrants (Do Not Meet Criteria)
- PRV Station
- Booster Station
- Reservoir
- Well
- WTP

- Model Pipe
- Fire Flow Priority Areas

N

0 0.02 0.04 0.08 Miles

Coordinate System: NAD 1983 StatePlane California V FIPS 0405 Feet
Document: C:\Projects\Box Sync\zdrive\Projects\Stantec 318\001_evwd_wmp\05GIS\09MapDocuments\FF Projects in Priority Areas v2.mxd

Date: Sep 20, 2018

East Valley Water District

Existing System MDD Fire Flow Improvements

Fire Flow Improvement Area 10

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Figure -

APPENDIX E – MEDITERRA ANALYSIS

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TO:	Eliseo Ochoa, P.E., EVWD
FROM:	Matt Sellers, P.E., Sedaru Jennifer Wood, P.E., Sedaru
CC:	Oliver Slosser, P.E., Stantec
DATE:	September 01, 2018

1 Introduction

This technical memorandum (TM) has been developed by Stantec and Sedaru for the East Valley Water District (EVWD) to evaluate the proposed Mediterra development. The goal of this analysis is to evaluate the available information on the development and assess the impact on the water system through analysis of the District's existing water model. The project goals are listed below:

- Estimate average day demand (ADD), maximum day demand (MDD), and peak hour demand (PHD) demands for the Mediterra development for Phase 1 and Phase 2 only.
- Evaluate the impact of adding the Mediterra demands on the EVWD water distribution system to meet fire flow requirements in the Canal Zone (at MDD).
- Evaluate the impact of adding the Mediterra demands during PHD, specifically in the Canal Zone.
- Complete a storage/supply spreadsheet analysis to validate if existing system pumping/supply and storage capacities meet the established criteria with the addition of the Mediterra demands.

Initially, it was planned for this evaluation to use the hydraulic model from the *2014 Water System Master Plan* (MWH, 2014) as the model calibration and existing demand factors had not yet been determined as part of the Master Plan Update project currently underway. However, the updated and calibrated hydraulic model has recently been approved by EVWD including existing demand factors. Therefore, it is preferred to use the updated model for this analysis. This TM includes the following sections and attachments:

Section 1 – Introduction
Section 2 – Mediterra Development
Section 3 – Mediterra Demands
Section 4 – Evaluation
Section 5 – Conclusions and Recommendations
Attachment 1 – Mediterra Overview Drawing Plan of Phase 1 and 2

2 Mediterra Development

The proposed development is located in the southeast part of the water system, specifically Canal Zone 3. **Figure 1** shows the location of the proposed Mediterra development. It is comprised of 320 lots divided

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into four phases. Per EVWD's instructions, this analysis only evaluates the system impact of Phase 1 and 2 which has 144 total residential lots. The total acreage is estimated to be 26.86 utilizing tools within ESRI's ArcMap program (this only includes residential lots), which equates to about 0.19 acres per lot. **Attachment 1** provides an overview plan of the development.

Eight (8) inch pipes and connecting junctions were drawn into the model to represent the Mediterra development. These pipes and junctions are shown on **Figure 2**. There are 37 nodes and approximately 6,980 LF of 8-inch pipe for the Mediterra development in the model. Elevations for the 37 nodes were updated based on United States Geological Survey (USGS) Digital Elevation Map (DEM). The maximum node elevation is 1,718 feet, the minimum is 1,643 feet, and the average is 1673 feet. No adjustments have been made to account for planned construction grading within the development in the model.

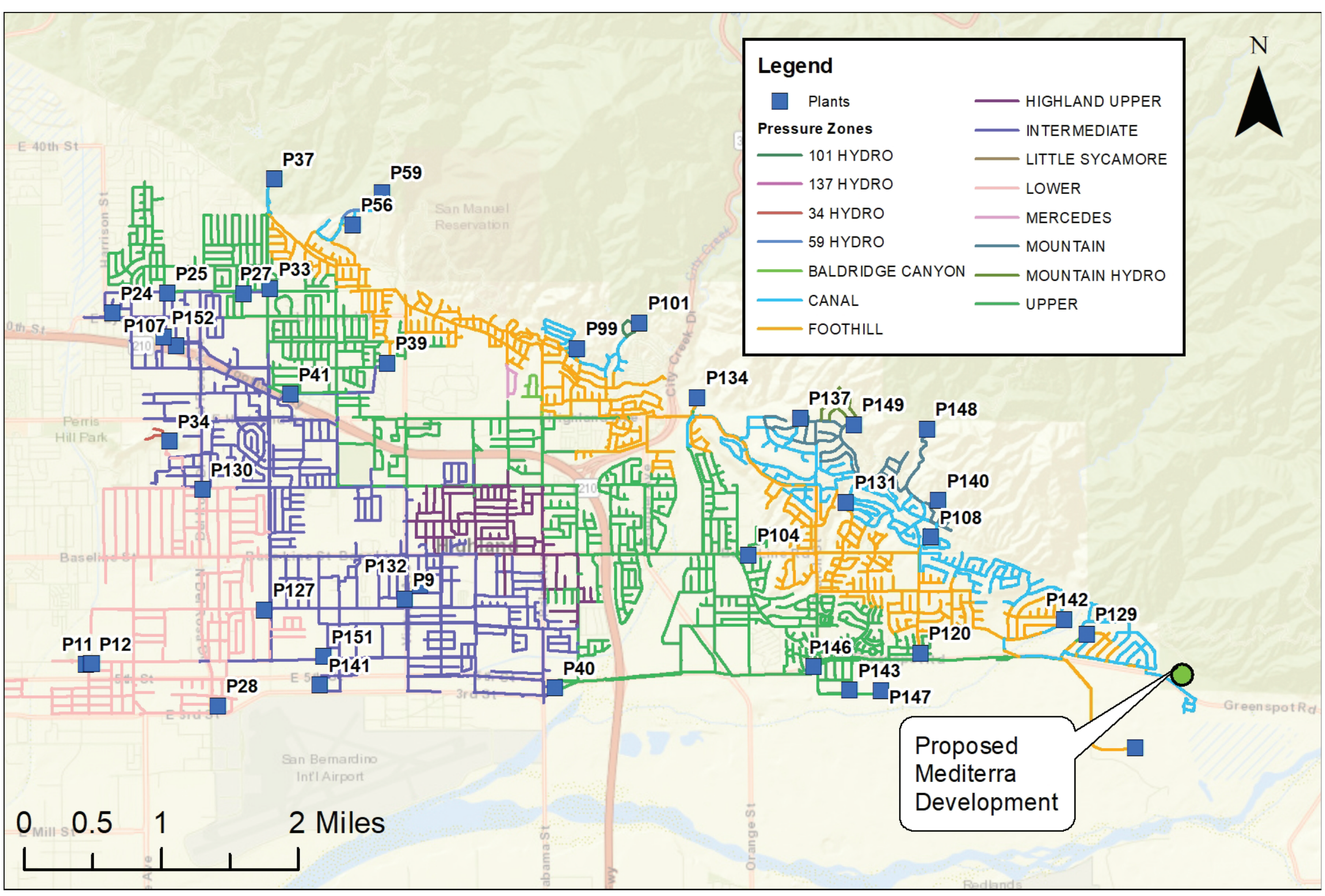

Figure 1 – System Location of Mediterra Development

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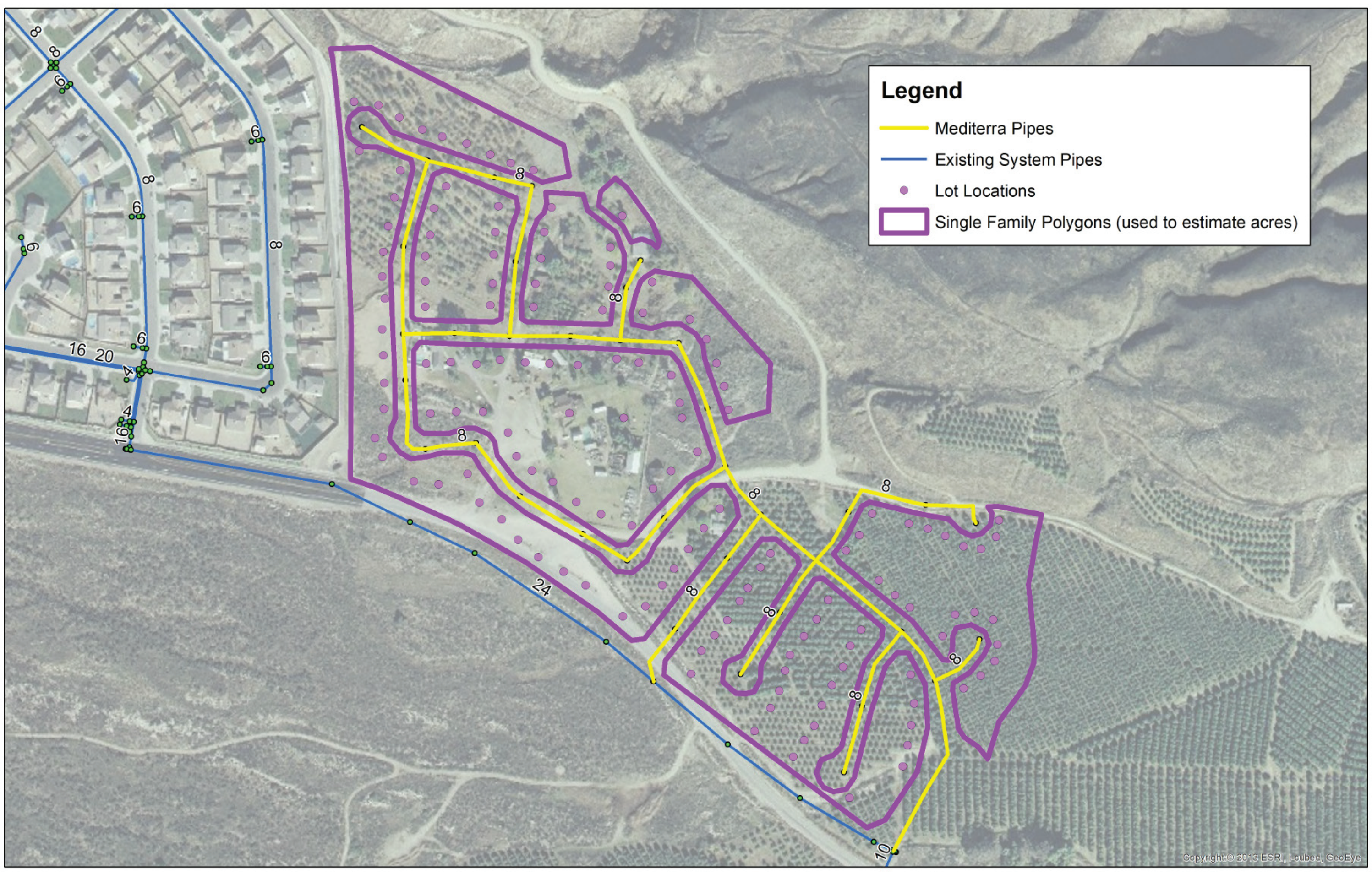

Figure 2 – Proposed Mediterra Development

3 Mediterra Demands

Future land use water duty factors from the 2014 Master Plan are used to estimate the Mediterra demands. Specifically, the single-family residential future development water duty factor (2,350 gallons per day per acre) is used to estimate Mediterra demands. Future water usage factors from the 2014 WSMP are shown in **Table 1**.

Water demand estimates for the Mediterra development are shown in **Table 2**, which includes average day demand (ADD) at 44 gpm, maximum day demand at 79 gpm, and peak hour demand at 121 gpm. The Mediterra demands will be added onto the existing demands determined from the updated Water Master Plan, which is currently being developed. While this Master Plan has not been finalized, the demands and peak hour multiplier have been approved by EVWD. The existing ADD for the EVWD system is 20.29 MGD, the MDD is 36.52 MGD, and the PHD 55.8 MGD. The Mediterra demands use the same MDD (ADD x 1.8) and PHD (MDD x 1.53) scaling factors.

The Mediterra development demands are evenly distributed across the 37 junctions created. For example, the ADD for Mediterra is 44 gpm, which is approximately 1.18 gpm per junction.

Table 1 – Build-Out System Water Duty Factors
(from 2014 WSMP, Table 3-15)

Land Use	Existing Infrastructure Water Duty Factors(1) (gallons per day per acre)	Future Developments Water Duty Factors(2) (gallons per day per acre)
Agricultural	1,600	1,400
Commercial	2,050	1,800
Industrial	1,000	850
Multi-Family Residential	3,500	3,050
Open Land	-	1,100
Parks	3,250	2,850
Public	3,250	2,850
Single-Family Residential	2,700	2,350
Total Demand	**37,600 AF**	

(1) Calculated based on land use
(2) Accounts for 13% conservation.

Table 2 – Estimated Mediterra Water Demand

Mediterra Development	Value
Total Acres (Phase 1 and 2)	26.86
Total Lots (Phase 1 and 2)	144
Single-Family Residential (gpd per acre)[1]	2,350
Average Day Demand (gpm)	44
Maximum Day Demand (gpm) (ADD x 1.8)[2]	79
Peak Hour Demand (gpm) (PHD/ADD = 2.75)[2]	121

[1]Single-Family Residential land-use demand factor originates from 2014 WSMP
[2]MDD and PHD scaling factors originate from the Water Master Plan Update (currently under development)

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4 Evaluation

Sedaru performed the following evaluations on the Mediterra development within the updated and recently calibrated hydraulic model.

- MDD + Fire Flow Evaluation (model evaluation)
- PHD Evaluation (model evaluation)
- Pumping/Supply and Storage Requirements (desktop analysis)

4.1 Evaluation Assumptions

The following assumptions are made for the evaluation:

- Existing conditions average day demand (ADD) in the model for the entire EVWD system is 14,090 gpm, or 20.29 MGD (not including Mediterra demands).
- Existing conditions maximum day demand (MDD) in the model for the entire EVWD is 1.8 x ADD, which is 25,363 gpm or 36.52 MGD (not including Mediterra demands).
- Existing conditions peak hour demand (PHD) in the model for the entire EVWD is 1.53 x MDD, which is 38,805 gpm or 55.88 MGD (not including Mediterra demands).
- The Mediterra development will be fed by the Canal Zone 3 zone.
- All pipes within the Mediterra development are assumed to be 8-inches with Hazen Williams C-factors of 120.
- All junction ground elevations in the Mediterra development are extracted from USGS DEM elevation data. No adjustments were made to proposed junction elevations based on planned grading plans by the developer.
- No future system analysis (beyond Mediterra demands) is considered as part of this evaluation.
- Criteria from the 2014 WSMP were used for this evaluation.
- Pumps 131_1, 131_2, 134_7, and 129_4 are ON for all steady state simulations. These pumps supply Canal Zone 3.
- It is assumed that storage tanks in the system will satisfy the demand above MDD for every pressure zone (PHD – MDD = tank demand). This assumption is relevant to the storage evaluation.

4.2 Evaluation Criteria

Table 3 summarizes the criteria used for this evaluation. Note the criteria specified below comes from the 2014 WSMP, and only criteria applicable to this analysis is provided in **Table 3**.

Table 3 – Evaluation Criteria
(from 2014 WSMP, Table 5-1)

Evaluation Criteria	Value	Evaluation Demand Conditions
System Pressure		
Minimum Pressure, normal conditions	40 psi	PHD
Minimum Pressure, with fire flow	20	MDD
Minimum Pressure, transmission mains with no water services	5 psi	PHD
Maximum Pipeline Velocity		
Existing Pipelines (excluding fire hydrant laterals)	6 fps	MDD
New Distributions Pipelines (≤ 12-inch in diameter)	4 fps	MDD
Pump Station suction pipelines	4 fps	MDD
Storage Volume		
Operational	25% of MDD (MGD)	MDD
Fire Fighting	Highest fire flow requirement per zone (MG)	MDD
Emergency	100% of MDD (MG)	MDD
Fire Flow Requirements		
Single-Family Residential	1,500 gpm x 2 hours	MDD
Existing Pipelines During Fire Event (excluding fire hydrant laterals)	10 fps	MDD
Supply Capacity/System Reliability		
By Pressure Zone	Provide MDD with firm transfer/booster capacity	MDD
Single Largest Source out of Service Per Pressure Zone	Provide MDD with firm transfer/booster capacity with single largest source out of service	MDD

4.3 MDD + Fire Flow Evaluation

This scenario has the following parameters and assumptions described in Section 4.1:

Demand Condition: Existing Conditions MDD (25,363 gpm) + Mediterra MDD (79 gpm) + Single-Family Residential Fire Flow (1,500 gpm)

Model Changes: Includes Mediterra development

Simulation Option: Steady State Fire Flow Analysis at MDD (Design Method)

This scenario calculated the available fire flow capacity for the junctions within the Mediterra development. The "Design Method" evaluates available flow at each junction while keeping junctions above 20 psi and pipes above 10 fps within Canal Zone 3 for each test. This method typically produces a lower available fire flow for each junction when compared to only evaluating available flow at 20 psi. However, the "Design Method" is recommended as it ensures no parts of the nearby system are below 20 psi or pipes above 10 fps due to a required fire flow demand.

Summarized fire flow results are in **Table 4** below. Results show all junctions meet the 1,500 gpm required fire flow. **Figure 3** shows the Mediterra development junctions fire flow color coded by the design flow.

Note there are 31 junctions with a design fire flow of 1,650 gpm or less. These junctions are limited by the design pipe velocity constraint of 10 fps. Note on **Figure 3** all orange or green junctions (at least <= 1,650 gpm) are downstream of a single 8-inch pipe. This is because a single 8-inch pipe has a flow of 1,566 gpm at 10 fps. If the fire flow requirement is modified to be greater than 1,500 gpm, then the development will need larger than 8-inch diameter pipe. However, based on available data and current criteria, the proposed development meets the District's fire flow requirements.

Table 4 – Mediterra MDD + Design Fire Flow Summary

Summary	Count
1,500 – 1,550 gpm @ 20 psi or greater	23
1,551 – 1,650 gpm @ 20 psi or greater	8
1,651 – 2,000 gpm @ 20 psi or greater	0
2,001 – 2,500 gpm @ 20 psi or greater	8

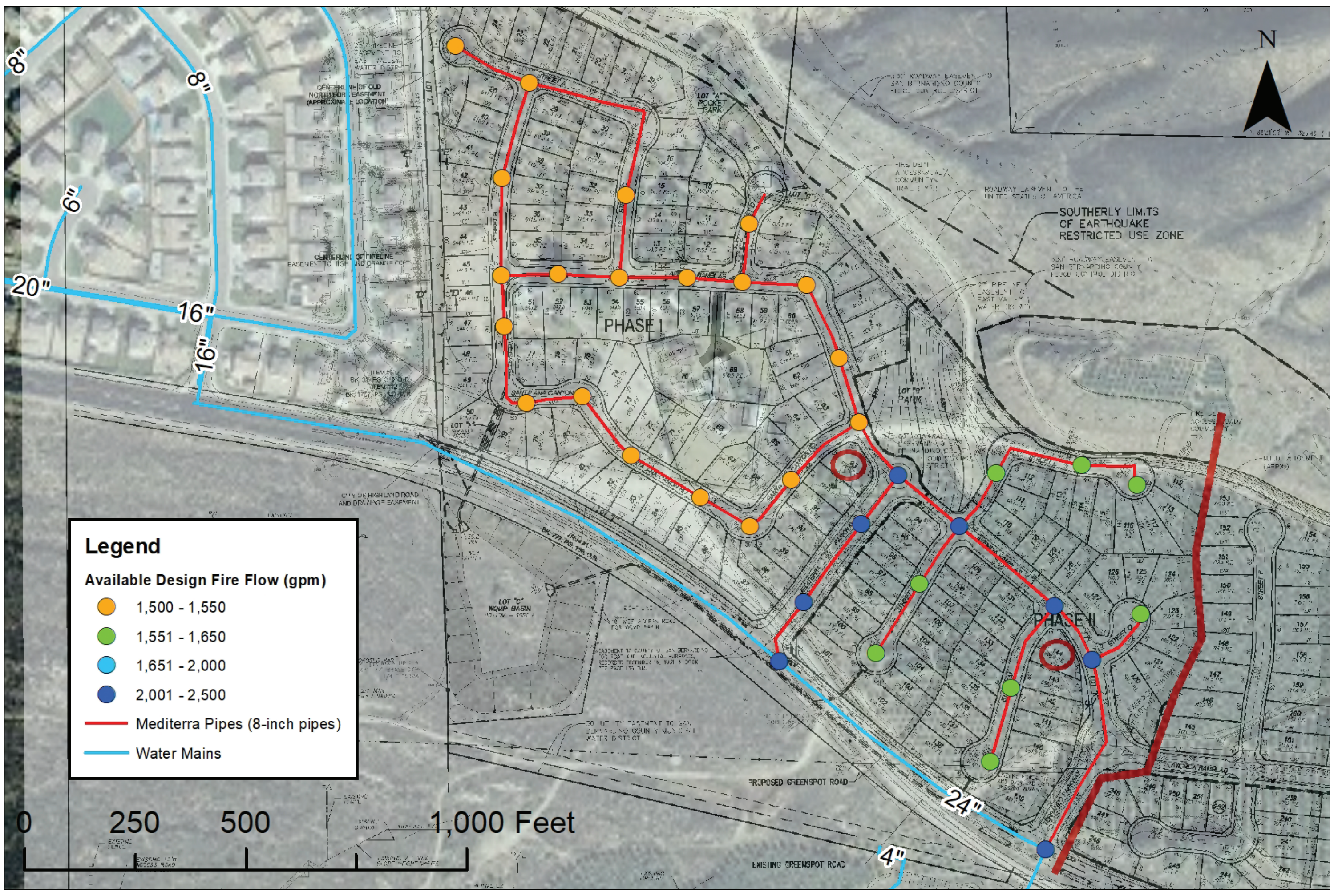

Figure 3 - Mediterra MDD + Design Fire Flow Map

4.4 PHD Evaluation

This scenario has the following parameters and assumptions described in Section 4.1:

Demand Condition: Existing Conditions PHD (38,805 gpm) + Mediterra PHD (121 gpm)

Model Changes: Includes Mediterra development

Simulation Option: Steady State at PHD

This scenario evaluates the proposed development during peak hour demand conditions against system pressure and maximum velocity criteria (refer to **Table 3**).

No pressure or velocity deficiencies are observed for the proposed Mediterra development during PHD conditions. **Figure 4** highlights the simulated system pressure and velocity for the study area. While not shown in the figure, no deficiencies are observed in the rest of Canal Zone 3 due to the Mediterra demand. Average pressure during the PHD simulation for the Mediterra junctions is 71 psi, with a minimum of 51 and maximum of 83 psi.

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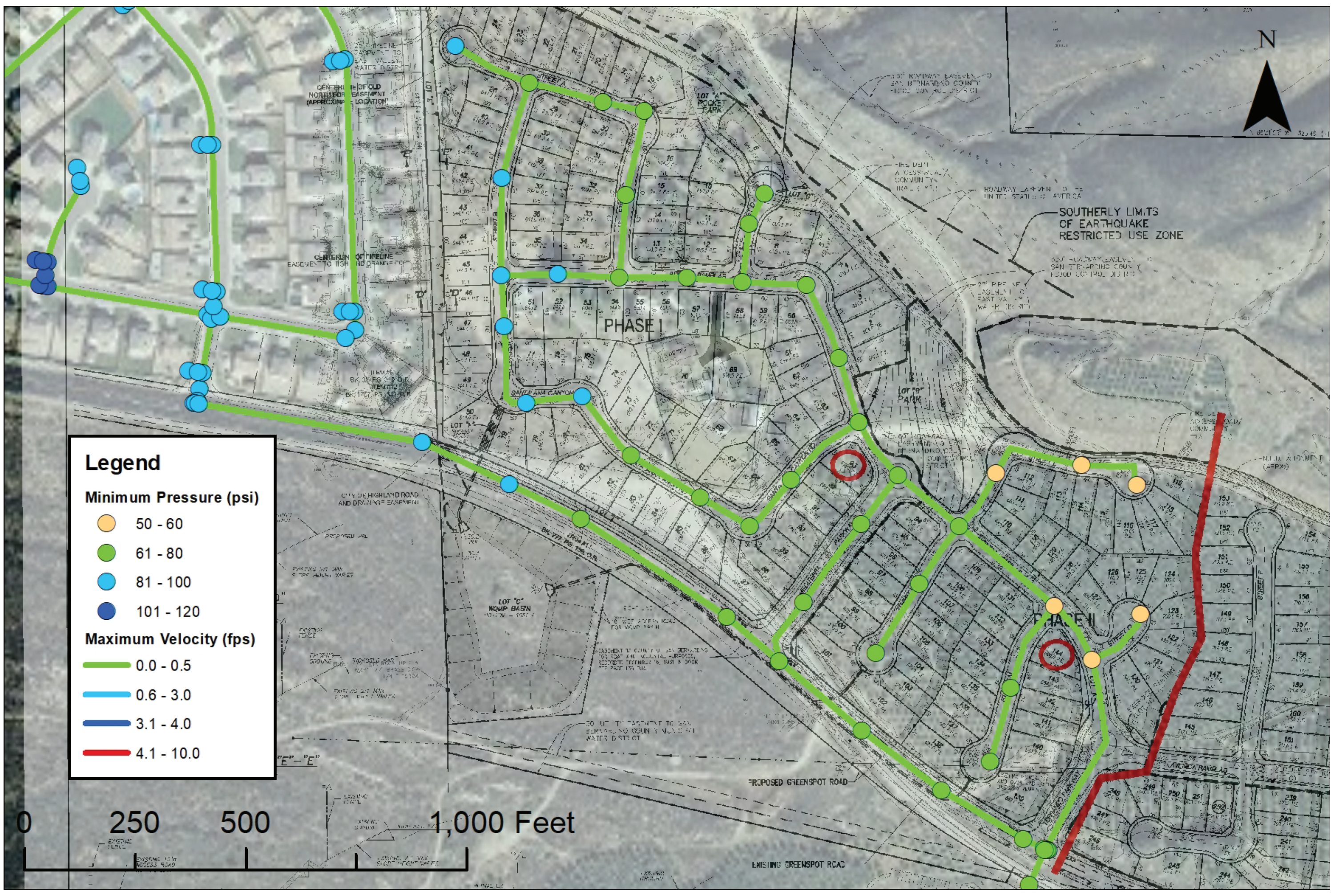

Figure 4 – PHD Results for Mediterra Development

4.5 Pumping and Storage Requirements

Pumping and storage requirements are analyzed through a spreadsheet analyses. The evaluation determines if existing system storage and pumping capacities meet the established criteria with the addition of the Mediterra Proposed Development.

Storage Evaluation

The storage evaluation compares existing MDD plus Mediterra MDD within the Canal Zone 3. The Mediterra MDD increases Canal Zone 3's demand by 0.11 MGD, resulting in a total MDD of 2.5 MGD. Based on the established storage criteria, the Canal Zone 3 has a storage deficit, regardless of the added Mediterra demands (as shown in **Table 5**). The largest criteria requirement is emergency storage at 100% of MDD, which is 2.5 MG, and the overall storage requirement based on Fireflow, Operational, and Emergency storage requirements is 3.43 MG. The Canal Zone 3 only has 2.07 MG available.

Emergency storage analysis per pressure zone is based on the assumption that no additional storage would be available from adjacent pressure zones either through pumping or transferring flow. A total power grid failure for over 24 hours would be an example emergency situation that would require this kind of emergency storage.

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A simple volume calculation shows that if the Canal Zone 3 tanks are 75% full, the tanks would empty about 40 minutes faster with the Mediterra demands, from 15.6 hours to 14.9 hours. Because the Canal Zone 3 analysis shows a deficit of the required storage based on EVWD's established criteria, it is recommended that additional storage be built in this zone prior to further development. Alternatively, EVWD may consider modification of their storage criteria with consideration of storage from neighboring zones, and possibly the addition of an emergency power source for interzonal pumps in order to maintain service during a power outage.

Pumping Evaluation

The pumping evaluation compares existing MDD plus Mediterra MDD within the Canal Zone 3. For the Canal Zone 3, the available capacity at water sources in Upper and Foothill Zones is less than the combined booster pumping capacity to the Canal Zone 3.

The Canal Zone 3 has four (4) booster stations that could supply the zone, with a combined full capacity of 10.88 MGD. However, excess supply from Upper and Foothill Zones only adds up to 3.16 MGD per the 2014 WSMP. Therefore 3.16 MGD is used as the available supply in the pumping evaluation. Canal Zone 3 has a total demand of 3.06 MGD, which includes 2.5 MGD for Canal Zone 3, 0.11 MGD for Mediterra, and 0.56 MGD for Mountain Zone. Therefore, the Canal Zone 3 has a small surplus of 0.10 MGD. A breakdown of the available supply, demand, and surplus is shown in **Table 6**.

Table 5 – Canal Zone 3 + Mediterra Demand Storage Analysis

Category		Units	Canal Zone 3
Demands[1]	ADD[1]	MGD	1.39
	MDD/ADD Factor	n/a	1.8
	MDD	MGD	2.50
Storage Required	Fire Flow[2]	gpm	2500
	Duration[2]	hrs	2
	Fire Flow[2]	MG	0.30
	Operational[3]	MG	0.63
	Emergency[4]	MG	2.50
	Required	**MG**	**3.43**
Storage Evaluation	Available[1]	MG	2.07
	Surplus/ Deficit[5]	**MG**	**-1.36**

Note: due to rounding, some totals may not add up.

[1]Includes Mediterra Demand

[2]Fire flow based on highest estimated requirement per zone (from 2014 WSMP)

[3]Operational Storage equals 0.25 times MDD

[4]Emergency Storage equals 1.0 times MDD

[5]Surplus is positive and deficit is negative

Table 6 – Canal Zone 3 + Mediterra Demand Supply Analysis

Source	Capacity (mgd)
Supply	
Boosters	
134_6	0.90
134_7	0.95
134_8	1.23
129_4	1.41
129_5	1.40
131_1	0.73
131_2	0.39
131_3	0.42
108_1	1.73
108_2	1.73
Subtotal, boosters	10.88
Available booster capacity[1]	3.16
Total Supply	**3.16**
Demands	
Canal 3 Zone MDD	2.39
Mediterra MDD	0.11
PLT 137 & PLT 140 to Mountain Zone[2]	0.56
Total Demand	**3.06**
Surplus/Deficit	**+0.10**

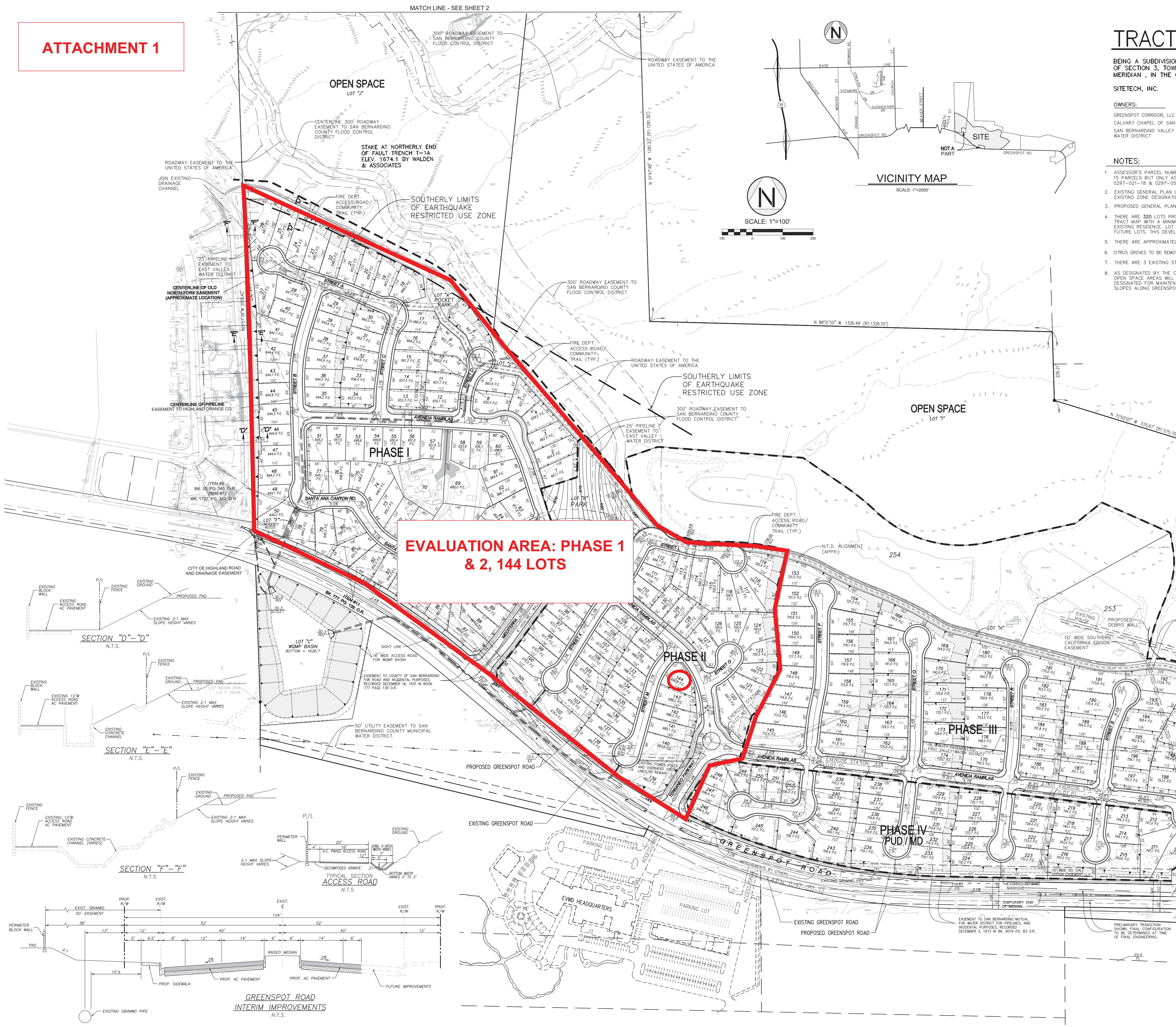
[1] Based on supply available from Upper and Foothill Zones from 2014 WSMP (Figure 6-6)
[2] Based on existing MDD demand for Mountain Zone from 2018 calibrated model.

5 Conclusion and Recommendations

This section summarizes conclusions and recommendations from the Mediterra development hydraulic evaluation.

- **Mediterra Development Pipe Sizing**. This analysis assumes all pipes within the Mediterra development are 8-inches. While no deficiencies were observed with these pipes, this analysis concludes that an 8-inch pipe is the minimum recommended size for the development. Upsizing for some segments may be required if additional base demands and/or fire flow requirements increase.
- **MDD + Fire Flow Evaluation**. For MDD conditions plus fire flow at 1,500 gpm, no deficiencies were observed for the Mediterra development for Phase 1 and 2. If fire flow criteria are increased above 1,500 gpm due to land use type changes, it is recommended that the District request for the developer to evaluate which pipes need upsizing to meet the fire flow demand and design criteria. The existing 24-inch line along Greenspot Rd in Canal Zone 3 has ample capacity to meet the Mediterra development single-family residential fire flow requirement of 1,500 gpm. More specifically, both “entrances” at Greenspot Rd to the development can supply a design fire flow of 2,400 gpm while maintaining 20 psi inside the development.
- **PHD Evaluation**. No pressure or velocity deficiencies were observed in the peak hour demand simulation for the Mediterra development.
- **Storage Requirements**. The Mediterra demands for Phase 1 and 2 add a minor increase in storage requirements to Canal Zone 3. This pressure zone already had a storage deficit from existing demands. It is recommended the District consider the likelihood of a total power grid failure and associated risk involved, where excess storage from adjacent zones would not be available to supplement Canal Zone 3. The addition of Mediterra demands only decreases the available supply by 40 minutes (from 15.6 hours to 14.9 hours) assuming the tanks are 75% full.
- **Pumping Requirements**. The pumping analysis on Canal Zone 3 with Mediterra demands found the zone still has a small surplus of 0.10 MG during MDD. Therefore, additional pumping or supply infrastructure is not required to meet the Mediterra demands. However, considering the surplus is small, it is recommended the District evaluate adding supply options to plan for additional future demand growth.

ATTACHMENT 1



IN THE CITY OF HIGHLAND

TENTATIVE

TRACT MAP NO. 18893

BEING A SUBDIVISION OF A PORTION OF THE WEST 1/2 OF THE SOUTHEAST 1/4 OF SECTION 3, TOWNSHIP 1 SOUTH, RANGE 3 WEST, SAN BERNARDINO BASE & MERIDIAN , IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA.

SITETECH, INC.

MAY, 2015

OWNERS:

GREENSPOT CORRIDOR, LLC
CALVARY CHAPEL OF SAN BERNARDINO
SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

APPLICANT:

SUNLAND COMMUNITIES, LLC
CAMILLE BAHRI
10575 OAKDALE DRIVE
RANCHO CUCAMONGA, CA 91730
PH: (909) 484-2829

ENGINEER/MAP PREPARER:

SITETECH, INC.
38248 POTATO CANYON RD.
OAK GLEN, CA. 92399
PH: (909) 864-3180

NOTES:

1. ASSESSOR'S PARCEL NUMBERS: THIS TENTATIVE MAP IS SITUATED OVER A TOTAL OF 15 PARCELS BUT ONLY ASSESSOR'S PARCEL NUMBERS 0297-061-04, 0297-201-05, 0297-021-18 & 0297-051-06 ARE AFFECTED BY THE TENTATIVE MAP.
2. EXISTING GENERAL PLAN LAND USE DESIGNATION IS AGRICULTURAL/EQUESTRIAN (0-2.0 DU/AC). EXISTING ZONE DESIGNATION IS AGRICULTURAL/EQUESTRIAN RESIDENTIAL.
3. PROPOSED GENERAL PLAN LAND USE & ZONE DESIGNATION IS PLANNED DEVELOPMENT.
4. THERE ARE **320** LOTS PROPOSED WITHIN THIS SUBDIVISION, **204** OF WHICH ARE MAPPED BY THIS TENTATIVE TRACT MAP WITH A MINIMUM LOTS SIZE OF 5,500 S.F.. LOT **205** IS TO CREATE A SEPARATE LOT FOR AN EXISTING RESIDENCE. LOT **206** CONTAINS 5 FUTURE RESIDENTIAL LOTS. LOT **253** AND **254** CONTAIN 110 FUTURE LOTS. THIS DEVELOPMENT CONTAINS **180.43** GROSS ACRES.
5. THERE ARE APPROXIMATELY 10,500 LINEAL FEET OF STREET PROPOSED WITHIN THIS DEVELOPMENT
6. CITRUS GROVES TO BE REMOVED AS A PART OF THIS PROJECT. NO NATIVE TREES EXIST.
7. THERE ARE 3 EXISTING STRUCTURES ON SITE, 1 TO REMAIN AND 2 TO BE REMOVED.
8. AS DESIGNATED BY THE CITY, AT THE TIME OF FINAL MAP PREPARATION, SLOPE AREAS, TRAIL AREAS, AND OPEN SPACE AREAS WILL BE MAPPED AS LETTERED LOTS TO ALLOW THESE AREAS TO BE PROPERLY DESIGNATED FOR MAINTENANCE PURPOSES. SLOPE AREAS INCLUDE, BUT ARE NOT LIMITED TO, ASCENDING SLOPES ALONG GREENSPOT ROAD, MEDITERRA PARKWAY AND AVENIDA RAMBLAS.

COMPANIES AND AGENCIES SERVICING THIS PROJECT ARE AS FOLLOWS:

WATER/SEWER:
EAST VALLEY WATER DISTRICT
3654 HIGHLAND AVE. SUITE 18
HIGHLAND, CA. 92346
PH: (909) 888-8986

TELEPHONE:
ATT
2828 E. CORONADO ST., 2ND FLOOR
ANAHEIM, CA. 92807
PH: (714) 666-5415

POWER:
SOUTHERN CALIFORNIA EDISON CO.
287 TENNESSEE STREET
REDLANDS, CA. 92373
PH: (909) 307-6767

CABLE:
TIME WARNER CABLE
1722 ORANGETREE LANE
REDLANDS, CA. 92374
PH: (909) 798-3588

GAS:
SOUTHERN CALIFORNIA GAS CO.
155 SOUTH "G" STREET
SAN BERNARDINO, CA. 92401
PH: (909) 335-7928

SCHOOL DISTRICT:
REDLANDS UNIFIED SCHOOL DISTRICT
20 WEST LUGONIA AVENUE
REDLANDS, CA. 92373
PH: (909) 793-2301

PHASES:

PHASE I	LOTS 1-93 & LETTERED LOT A, C, E, F, G & J
PHASE II	LOTS 94-144 & LETTERED LOT B & K
PHASE III	LOTS 145-207 & LETTERED LOT D, H & I
PHASE IV	LOTS 208-252

SHEET 1 OF 2

ACI

2155 CHICAGO AVENUE, SUITE 301
RIVERSIDE, CA 92507

Contact:

Oliver Slosser
Water Resources Engineer
P: (626) 568-6063
E: oliver.slosser@stantec.com

Design with community in mind