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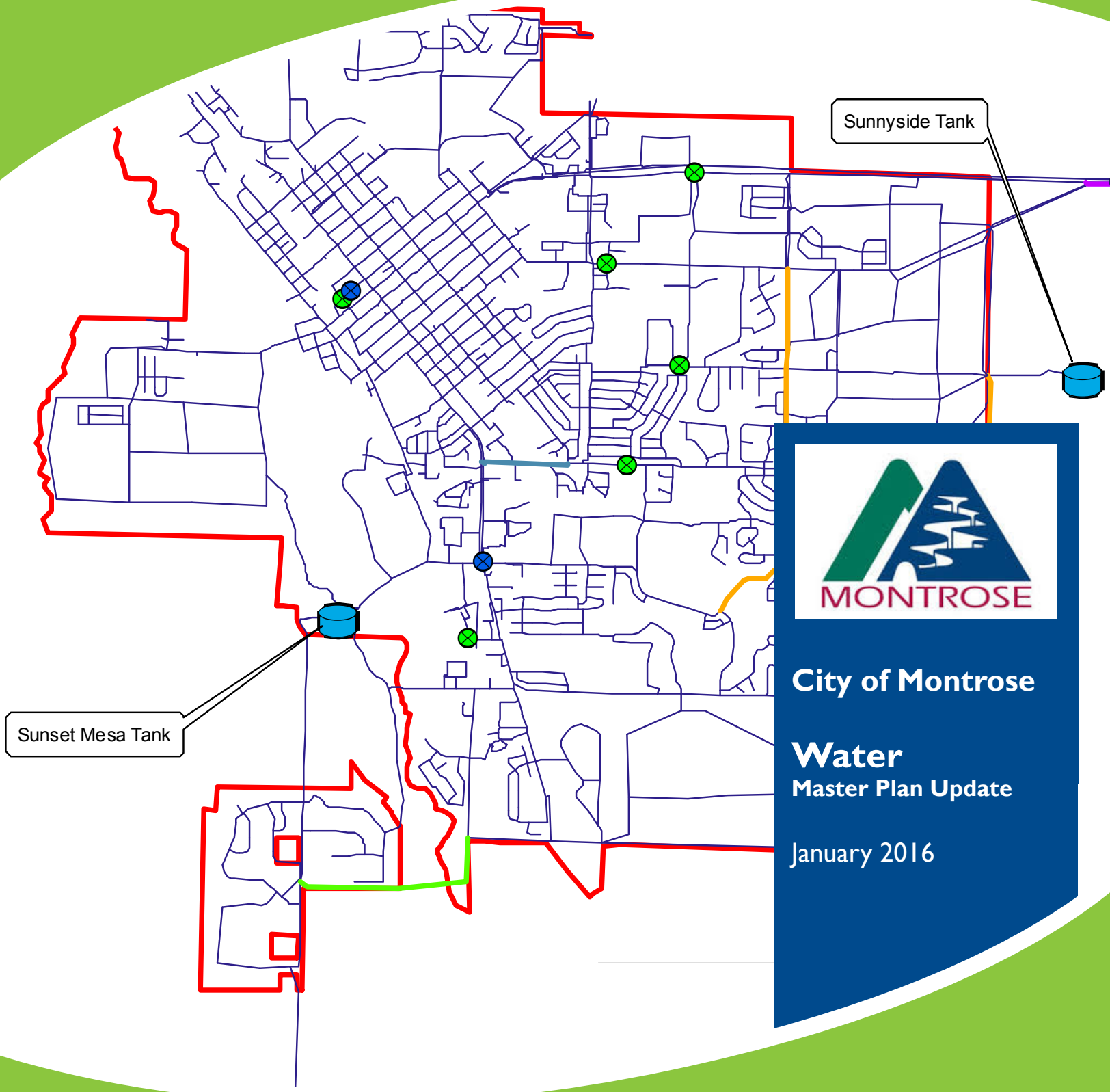

MONTROSE

City of Montrose

Water
Master Plan Update

January 2016

Final Report

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I. Executive Summary

A. Purpose

The purpose of this report is to amend and update the 2009 Water Master Plan for the City of Montrose. We focus on ways to improve performance of the existing system by making minor modifications. This report also explores the impacts of growth, up to and including a doubling of system demands and recommends capital improvement projects (CIP's) to address growth through 2030. Additional CIP's for later years are also mentioned.

B. Scope

Specific tasks involved in the preparation of the Water Master Plan for the City include:

1. Reviewing the City's comprehensive Plan and Land Use Plan, historic population information, population projections provided by the state, and adjacent water district boundaries to produce population and tap projections for the City's service area.
2. Update and calibrate distribution system hydraulic model in the GIS based software (InfoWATER), which will reflect the system service areas, existing infrastructure locations, configurations, and different pressure zone interconnections.
    a. Existing models were calibrated based on field verification, SCADA data, hydrant testing reports, water meter data and Itron pressure sensor data.
    b. Extended Period Simulation, or EPS, was used to model water age and quality in the system. The EPS model is calibrated using SCADA data from tank levels, PRV pressures, flow meters, pump station settings, and diurnal demand curves.
3. Using GIS tools Itron AMI records were used to develop demand locations, rates, and curves.
4. Analyze waterline adequacy and redundancy, this analysis includes the benefits and potential consequences of removing or adding certain waterlines and PRVs identified through modelling efforts and communications with City staff.
5. Determine critical fire flow locations and identify ways to improve deficient areas.
6. Determine tank turnover times and identify ways to improve water age.
7. Analyze system zone pressures, and identify any necessary changes that might improve pressures in the system.
8. Analyze system storage needs and difficulties, particularly investigating high demand seasons and low demand seasons.
9. Provide City with optimized PRV and PSV settings to improve water age, system pressures, fire flows, and system storage / tank turnover.
10. Analyze system SCADA controls, and identify any needed or recommended improvements.
11. Analyze each pump station for adequacy and redundancy.
12. Review of City's operation of their system and provide recommendations for improvement based on modelling results.
13. Identify capital improvement projects and provide planning level cost estimates for each. Specific attention is given to projects recommended for implementation within the next ten years.
14. Analysis and recommendations regarding the existing Sunset Mesa Tank is included in this report.

C. Recommendations

Recommended capital improvement projects are based upon growth needs, fire flow improvements, and water age concerns. Refer to the "Proposed Improvements" section of the report for estimated costs and detailed explanations for each project. Project 1 is needed to provide redundancy. Projects 2, through 4 are recommendations that improve water age by increasing tank turnover rates. Projects 5, 6, and 7 will increase system capacity and redundancy west of the Uncompahgre River. Projects 8, 9, and 10 address future capacity issues particularly when the Max Day system demand reaches 10 MGD. Projects 11 and 12 are recommendations to increase fire flow. Refer to the large map included in the back pocket of this report for an image showing the location of the CIP's.

Table 1 – Recommended CIP List through Year 2030 (Years based on growth projections, future costs based on 3.5% inflation)

CIP#	Year	Est. Cost		Project
		(2016 $'s)	(Inflated $'s)	
1	2016	$ 100,000	$ 100,000	Main Segment at Ogden/Woodgate
2	2016	$ 150,000	$ 150,000	SCADA/Instrumentation System-related improvements
3	2016	$ 195,000	$ 195,000	Pavilion Control valve for SE Tank
4	2017	$ 551,200	$ 571,000	24" Main to Sunnyside Tank, incl. 24" connection for CIP 6
5	2020	$1,358,500	$1,559,000	12" Main River Crossing from Odelle to New Mesa Tank
6	2020	$4,550,000	$5,222,000	1.5 MG Mesa Standpipe Tank and Site piping and PRV
7	2020	$ 520,000	$ 597,000	Booster PS for Irrigation and emergency Zone 3 use
8	2025	$1,001,000	$1,365,000	24" Transmission Main from Hwy 50/Miami to Sunnyside 24" of CIP 4
9	2026	$2,600,000	$3,668,000	24" Transmission Main from Sunnyside Tank to Peyton Vault
10	2027	$ 656,500	$ 959,000	12" Transmission Main Peyton to Ogden Rd
11	2018	$ 494,000	$ 530,000	Booster Zone 10" Loop Main on East Oak Grove
12	2018	$ 260,000	$ 279,000	8" Loop line on 6600 Road

Timing and relevance will depend upon many factors including, where growth actually occurs and what the demand patterns are in the future.

Potential CIPs beyond 2030:

- Second Sunset Mesa 1.5 MG Stand Pipe Tank
- Additional 1.5 MG Tank at Sunnyside Tank location
- 16-inch Pipe along Otter Rd. to increase East-West capacity in the Southern Pressure Zone

II. Design Criteria

A. Population Projections

1. Population Projections

The City expects the population within the Urban Growth Boundary to grow between 1 and 2 % annually. The 2009 Comprehensive plan states higher growth rates, but since 2009 growth has been less than 1 %. Growth rates are believed to have been slowed due to the recent economic recession and are expected to increase. Population projections are less important when analyzing

a water distribution system because pipe sizes are often driven by fire flow needs, and system demands are significantly increased by irrigation practices rather than personal use.

As with the Sewer Master Plan and the capital improvement schedule, needs are based upon system demand rather than a strict timeline. For the sake of this report, a build out system demand of 14 MGD has been assumed, reflecting the projected maximum-day demand for a water service area population at about 40,000.

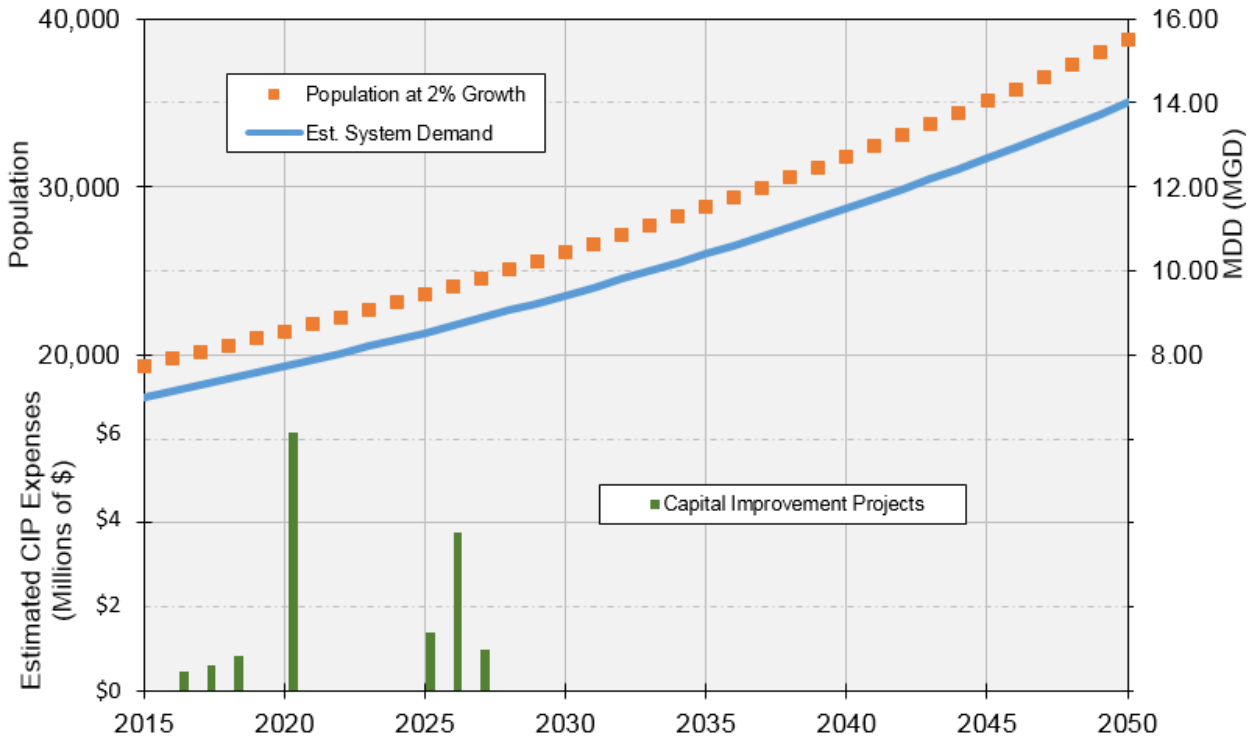


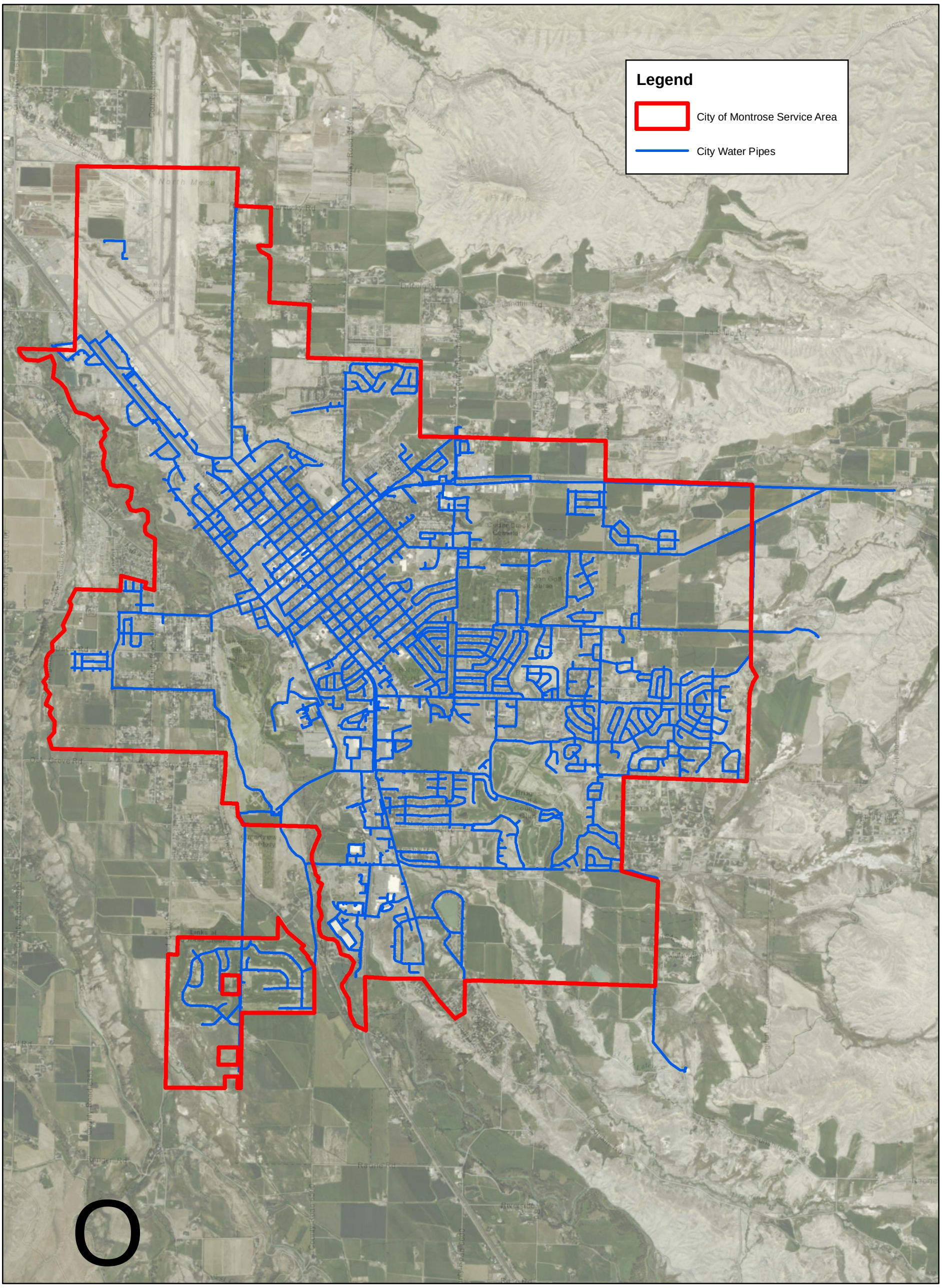
Figure 1 – Montrose Water Service Population and System Demand Growth Projections

2. Water Service Area

The City of Montrose water service area is not expected to change significantly as the surrounding areas are served by the water districts Chipeta, Tri-County, and Menoken. Within the City's system, the infrastructure to service the area is largely already in place and only needs improvements to meet increased demands as infill occurs. The only exception is a 600 acre undeveloped portion of the southeastern boundary. This area can be easily served from the Sunshine Tank with pipe network additions as development occurs. Exhibit 1 shows the existing infrastructure within the Montrose Water Service Area. All future scenarios in this report have assumed no increase in the service area, only increased demands within the existing boundary.

B. Usage Pattern

The City provided AMI water use data for each tap in the City. The AMI data were used to accurately define the number of taps in the system and provided real usage data for each tap. Refined July 29th 2015 AMI data was used as the model's base system demand. Four usage patterns were developed for the Max Day Demand and distributed among the same usage basin as in the sewer model. Modeled usage pattern multipliers are included in the Appendix. The water model and sewer model have different tap counts because; 1 – the water and sewer service boundaries are different, and 2 – duplexes and apartments only have one water tap (with real data) whereas multiple sewer taps (equivalent taps) are associated. This is a reasonable assumption since irrigation practices tend to be the highest percent of water usage, but sewer



0 0.5 1 Miles

1/15/2016

Montrose Water System

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Water Service Boundary & Pipes

Exhibit 1

flows are primarily related to per capita contributions. Model input demands based on AMI data are shown in Exhibit 2.

As with any system, water loss or unmetered use needs to be accounted for in the model to accurately represent the true water use in the system. To account for unmetered water use/loss, Project 7 meter data was compared to Montrose tank level SCADA data and AMI data. The difference between Project 7 metered flows and AMI data represents the amount of apparent water loss or "non-metered use" in the system, assuming the tank levels are unchanged or accounted for. To account for this, the last week of July 2015 meter data was analyzed. Figure 2 shows the daily volume of metered flows into the Montrose system from Project 7, and out of the system through AMI meters to customers. Notice the apparent amount of water loss is not constant. After accounting for daily tank volume change, an average of 0.9 MGD over the week is unmetered each day. This doesn't necessarily mean all this water is loss due to leakage. Much of the loss may be due to unmetered use such as parks, fire hydrant flushes, etc. Since the location of these unmetered losses is unknown the model has applied the difference uniformly across each node in the system.

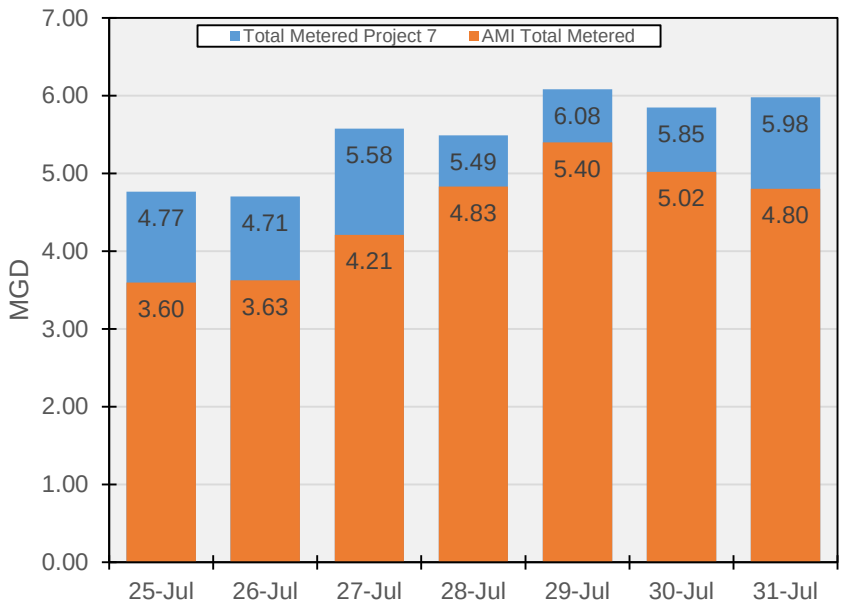
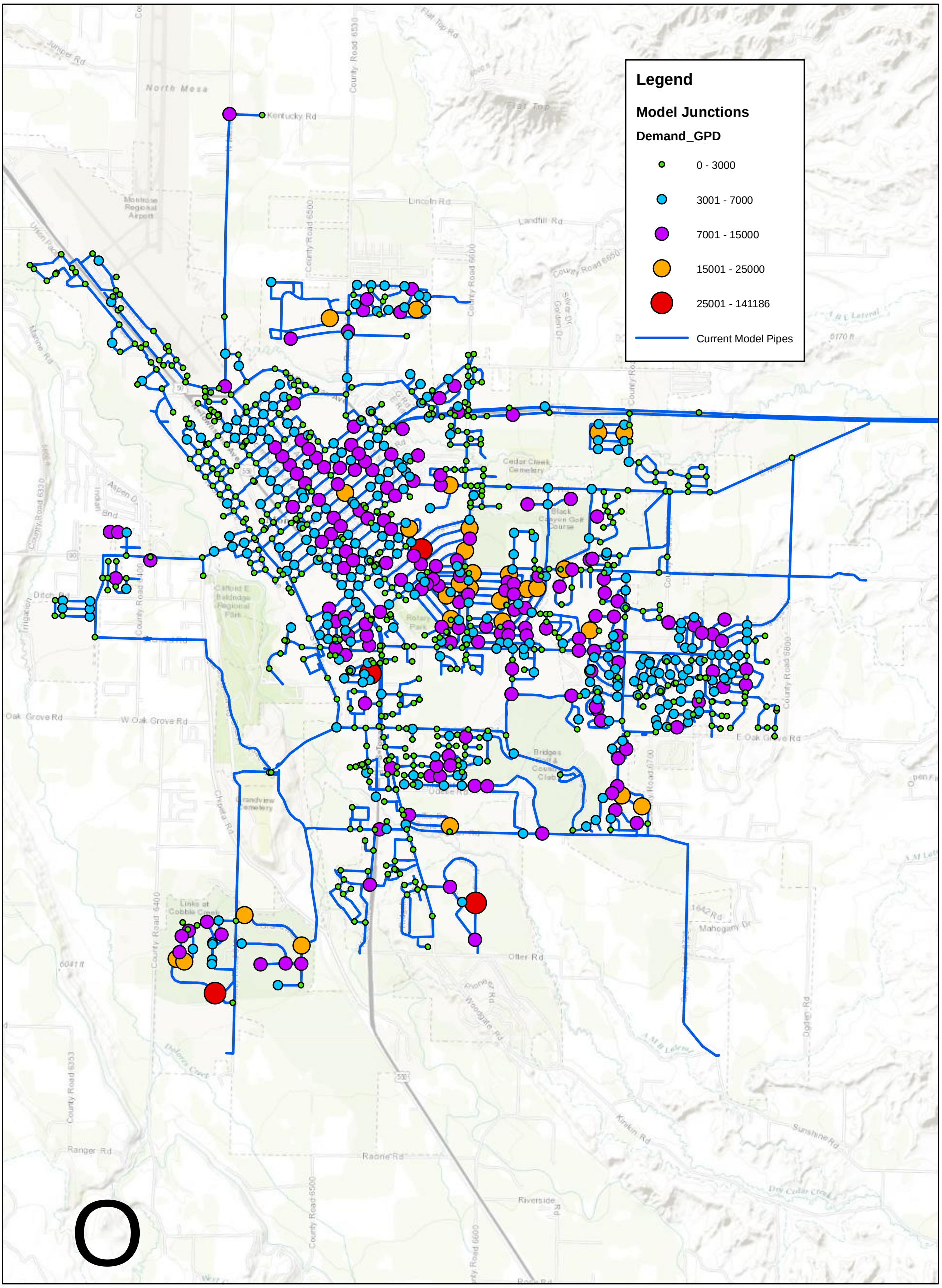


Figure 2 – Project 7 Metered Daily Volume vs. AMI Metered Volume for the last week of July 2015

The base total system demand in the model from 2009 (summing all the node demands) is 4.62 MGD. This number represents the AMI data pulled into the model after trimming a handful of meters that metered flows in different units. From Figure 2, July 29th had a total system demand of 6.08 MGD. Therefore, 4.62 MGD is not representative of actual system demand on July 29th. To account for this difference a Global Demand Multiplier of 1.3 was applied to the system to increase system demand from 4.62 MGD to 6.08 MGD. Similarly, Global Demand Multipliers were used to increase demand to Max Day demands and Future demands as discussed in the next Sections C and E.

C. Model Structure

The model was updated using the previous Master Plan's structure. New lines were added according Exhibit 3, based upon City's GIS data, along with the Peyton valve and Sunshine Tank project. The model analysis was performed using InfoWater software. Therefore the basic model structure is GIS based. All system settings, demands, elevations, element sizes, lengths, and locations are stored in shape files and .dbf tables. The InfoWater Scenario Manager was used to develop scenarios listed in Table 2.
j



0 0.5 1 Miles

1/13/2016

Montrose Water System

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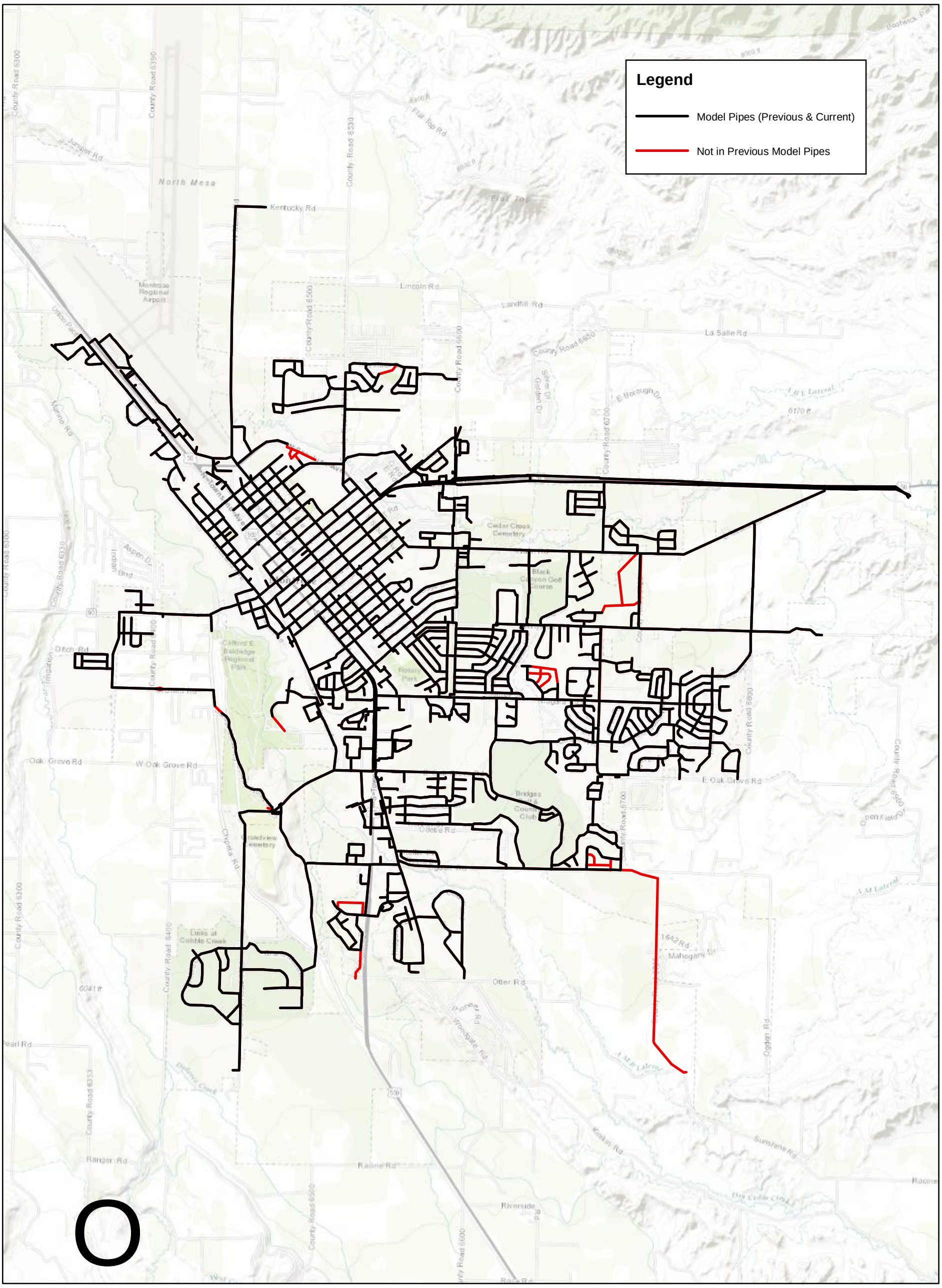
2015 Model Demands

Exhibit 2



0 0.5 1 Miles

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Montrose Water System

Compare Previous and Current Model Pipes

Exhibit 3

Table 2 – Summary of Modeled Scenarios

Scenario	Demand	Improvements
Existing Conditions (July 29th, 2015)	Calibration Day (6.08 MGD)	No improvements
Existing Conditions	Max Day (7 MGD)	PRV settings
Existing Conditions	Winter Day (1.85 MGD)	PRV settings
Existing Conditions- Fire Flows	Max Day (7 MGD)	CIPs 11 & 12
Phase 1	Max Day (7 MGD)	CIP 4
Phase 1	Winter Day (1.85 MGD)	CIP 4
Phase 2	Max Day (7 MGD)	CIPs 4, 9 & 10
Phase 2	Winter Day (1.85 MGD)	CIPs 4, 9 & 10
Phase 3	Max Day (7 MGD)	CIPs 4, 8, 9 & 10
Phase 3	Winter Day (1.85 MGD)	CIPs 4, 8, 9 & 10
Phase 3	Varies (7 to 14 MGD)	CIPs 4, 8, 9 & 10
Phase 4	Max Day (7 MGD)	CIPs 5, 6 & 7
Phase 4	Winter Day (1.85 MGD)	CIPs 5, 6 & 7
Future Conditions	Future Day (14 MGD)	All improvements together

Each scenario has a specific valve and control set table which allows the system to be modeled with different 'intelligent' setting namely the PRV settings and Peyton and Pavilion control valve settings. Five simulation settings were used to analyze the model; July 29th (Ave. Day), Max Day, Max Day – Fire Flow, Winter Day, and Future Day. The only variation between these simulations are the Global Demand Multiplier, and the fire flow analysis was performed by adding fire flows to a specific node as a second demand with a unique 2 hour demand pattern. Figure 3 shows the simulation settings used for all simulation runs. The Global Demand Multiplier is located under the "Demand" tab.

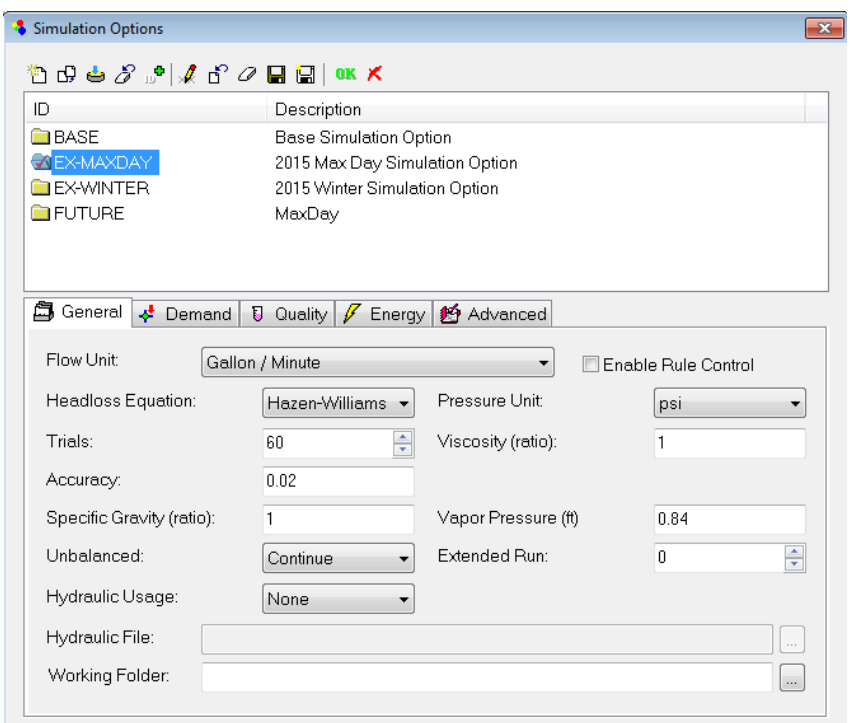


Figure 3 – Example of Simulation Settings Used

D. Calibration

Calibration of the model included fire flow tests, pressure loggers, Project 7 and SCADA flow meter and tank level data. In general the model was calibrated to represent July 29th, 2015 as recorded by trending and metering data. Calibration and settings of the model also represent knowledge of City staff. Due to the difficulty of calculating and modeling PRV interactions some assumptions were made regarding the opening and closing of the valves, Table 3 on Page 10 summarizes these changes.

During the calibration process PRV settings were altered to best represent the field collected pressure and flow data. Therefore, PRV pressure settings may vary slightly from actual settings. The variation is likely due to the difference in elevation between the model, which uses assumed ground elevation, and the actual elevation which maybe underground.

This process included matching Project 7 metered flows at Cascade and the treatment facility to flows in the model. At the Highway 50 meter actual hourly flows ranged from 1,500 gpm to 3,700 gpm. At the Cascade meter actual hourly flows ranged from 800 gpm to 1,700 gpm. Modeled flows were 2,100 gpm to 4,000 gpm and 800 gpm to 1,700 gpm for the Highway 50 and Cascade meters respectively. After calibration, the actual vs. model results were much closer. Figure 4 represents the closest ratio we were able to achieve between the two meters. The only significant difference between recorded flows and modeled flows is the flow variation coming through the Highway 50 master meter. The difference variation maybe a result of usage patterns applied to the system nodes which were developed using AMI data.

Modeled tank fluctuations at Sunnyside and Sunshine varied between 3 ft and 2.5 ft respectively, which correlated well with SCADA records. Also, when modeling Max Day flows, 70% of the total Project 7 flows come through the Highway 50 meter which is essentially identical to the 71% value found in the actual field data. The number of PRVs in the system makes calibrating very challenging.

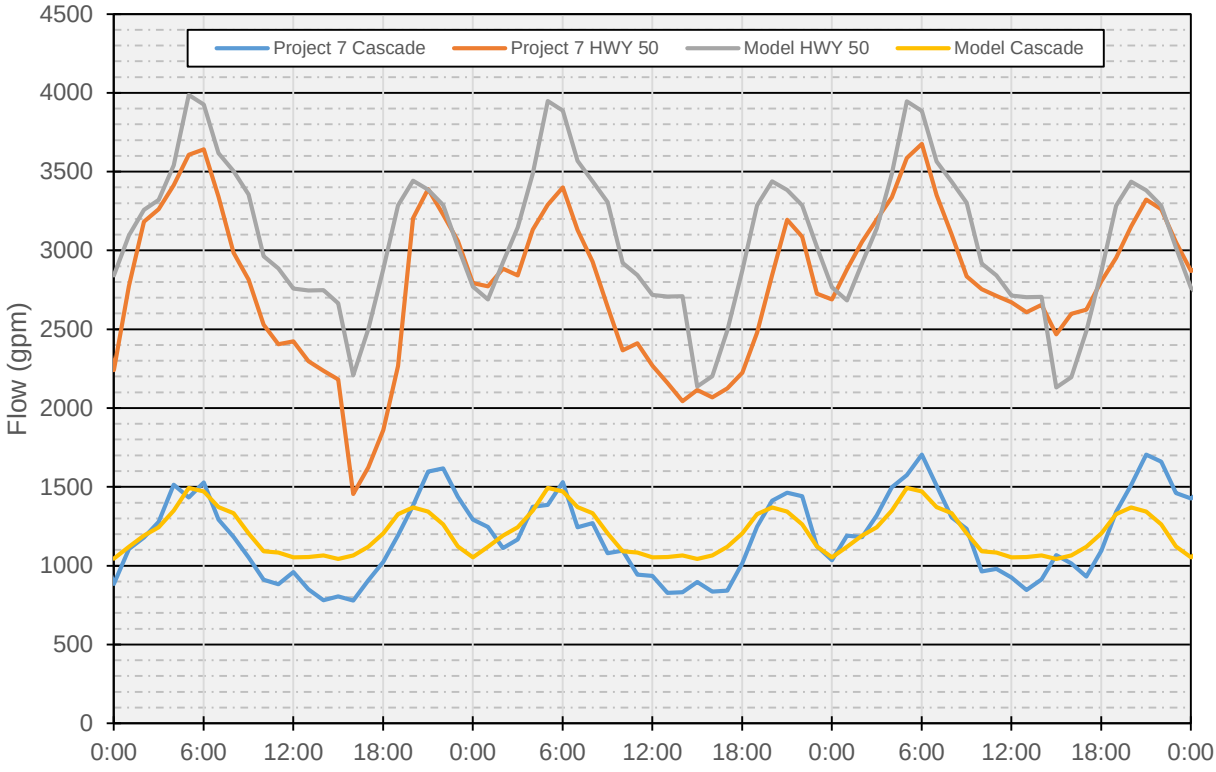


Figure 4 – Comparison of Project Hourly Meter Data and Model Output Data of July 27th to July 30th 2015

PRV settings were calibrated as best as possible to match the flows as recorded in the SCADA data. However,

not every PRV has trending data. In most cases the modeled PRV flows are in the general range of recorded flows.

E. Projected Demands

1. Average (Calibration) Day Demand (6.08 MGD)

July 29th,2015 was selected to calibrate the model. This day had good SCADA, Project 7 meter, and AMI data that enabled sounds calibration techniques. To produce a system demand of 6.08 MGD a Global Demand Multiplier of 1.3 was applied to the model.

2. Current Winter Day Demand (1.85 MGD)

Winter day demands are estimated at 1.85 MGD, and are only used as an analysis for water age, and tank turnover. City staff are aware of water age issues during winter seasons, and it is to be expected given that the total storage of the system is 6.0 MG (3.0 MG Sunnyside, and 3.0 MG Sunshine). To produce a system demand of 1.85 MGD a Global Demand Multiplier of 0.4 was applied to the model.

3. Current Maximum Day Demand (7 MGD)

According to 2015 Project 7 water metering the City of Montrose Max Day use is about 7 MGD. This year was especially wet in early summer months so higher Max Day demands can be expected even without a population increase. To produce a system demand of 7 MGD a Global Demand Multiplier of 1.5 was applied to the model.

4. Future Max Day Demand (14 MGD)

Future Max Day demand has been assumed to be 14 MGD. This represents the system demand used to appropriately size capital improvement projects for future growth. This demand corresponds to a population of 40,000 within the service boundary. To produce a system demand of 14 MGD a Global Demand Multiplier of 3 was applied to the model.

III. System Analysis

A. Transmission Lines

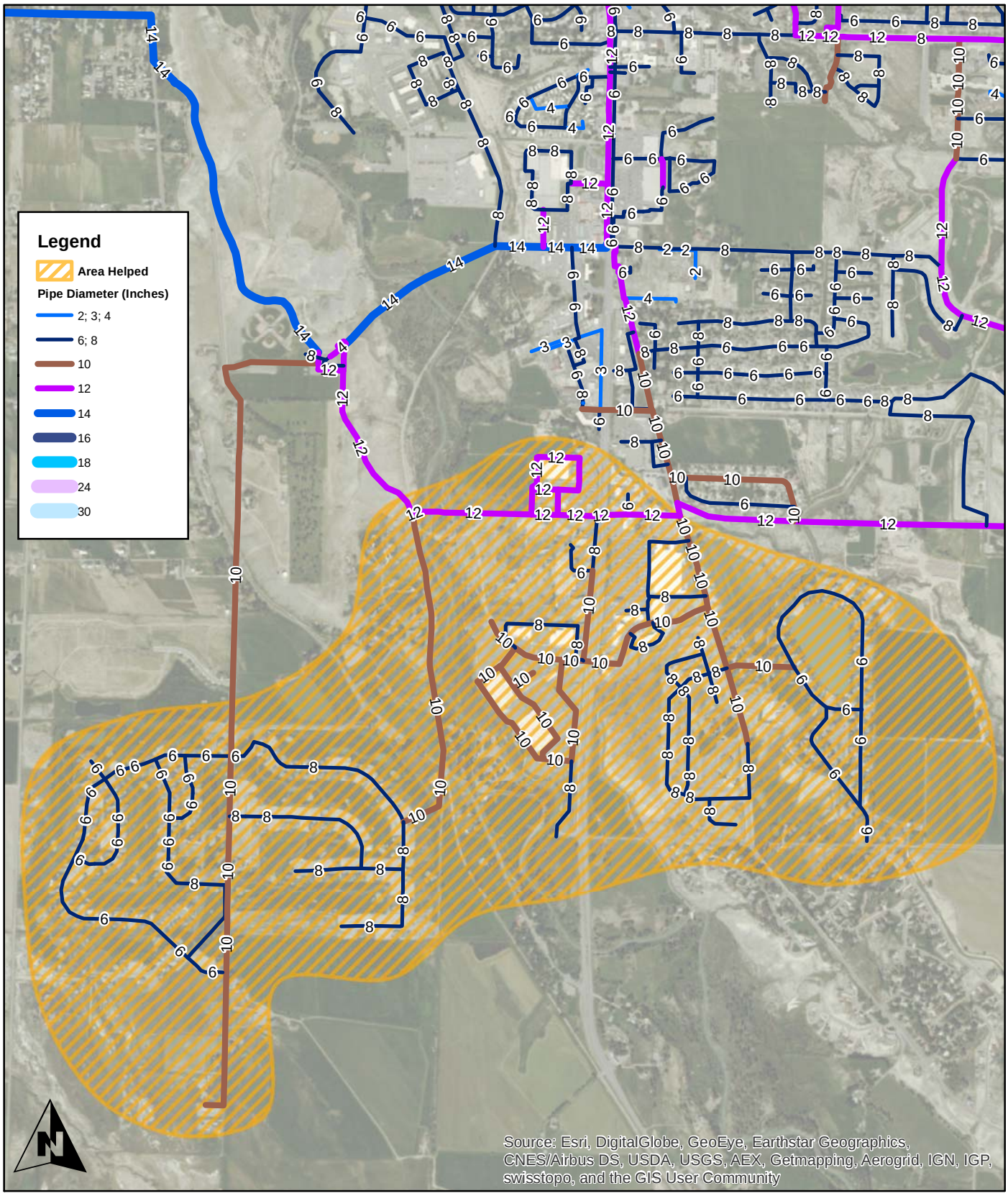
The distribution system has few dedicated transmissions lines aside from the 24-inch from Project 7, and associated 18-inch running along Highway 50, a 16-inch running down Miami Rd., and a 12-inch toward 6800 Rd. The Sunnyside Tank has a single fill and drain, 12-inch line approximately 2,500 feet long, as does the Sunshine Tank with an 8,600 feet long, 16-inch pipe. Though the tank pipes are not usually considered transmission lines, they do represent bottle necks in the system, which during maximum demand days prevent the tanks from being able to fill and drain quick enough.

A single 12-inch pipe crosses the Uncompahgre River and serves the Cobble Creek area. Though capacity through this line is currently sufficient, however a redundant crossing is recommended. Similarly, a single 12-inch serves the area shown in Exhibit 4. The addition of a 12-inch pipe would provide redundancy here. This is not a valving issue because a single section of pipe serves the entire southwest portion of the Southern pressure zone.

B. Pressure Zones

Four pressures zones are identified in the system based on pressure and supply. Figure 5 is a schematic of the hydraulic profile showing pressure zones and tank elevations.

Northeastern Zone 1 represents the area highest in elevation served on the pressure gradient supplied by Project 7 WTP and the Sunnyside Tank. The zone is generally defined by Highway 50 to the north, the



0 1,000 2,000 Feet

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Service Area Helped by

CIP 1 Exhibit 4

eastern boundary of the system, Oak Grove Rd. to the south, and a series of PRVs to the west that separate Zone 1 from Zone 4.

Downtown Zone 2 represents the Downtown, or lower elevations, of the system. This zone is served by a series of PRVs breaking pressures from Zone 1 and Zone 3, and is generally defined by the north and west boundary of the system, Oak Grove Rd. to the south, and Zone 1 to the east.

Southern Zone 3 is hydraulically set at the same pressure gradient as Zone 1, but is separated by the Peyton Control Valve, and a closed valve in Pavilion Dr. Zones 1 and 3 are separated to encourage turnover in the Sunshine Tank. Zone 3 represents the southern portion of the system including Cobble Creek. By isolating Zone 3 from Zone 1 water is only supplied to Zone 3 via the Sunshine Tank. With a single 8,600-feet long, tank levels must drop at least one foot to pull any water from the tank. Otherwise, water essentially shunts up and down the 16-inch pipeline. The Peyton Control Valve is programed to open when the level in the Sunshine Tank drops to 6 ft below full, and closes when full again.

Booster Zone 4 is a small closed loop boosted pressure zone near Oak Grove Rd. west of 6800 Rd. This area is too high in elevation to be served on Zone 1 or Zone 3.

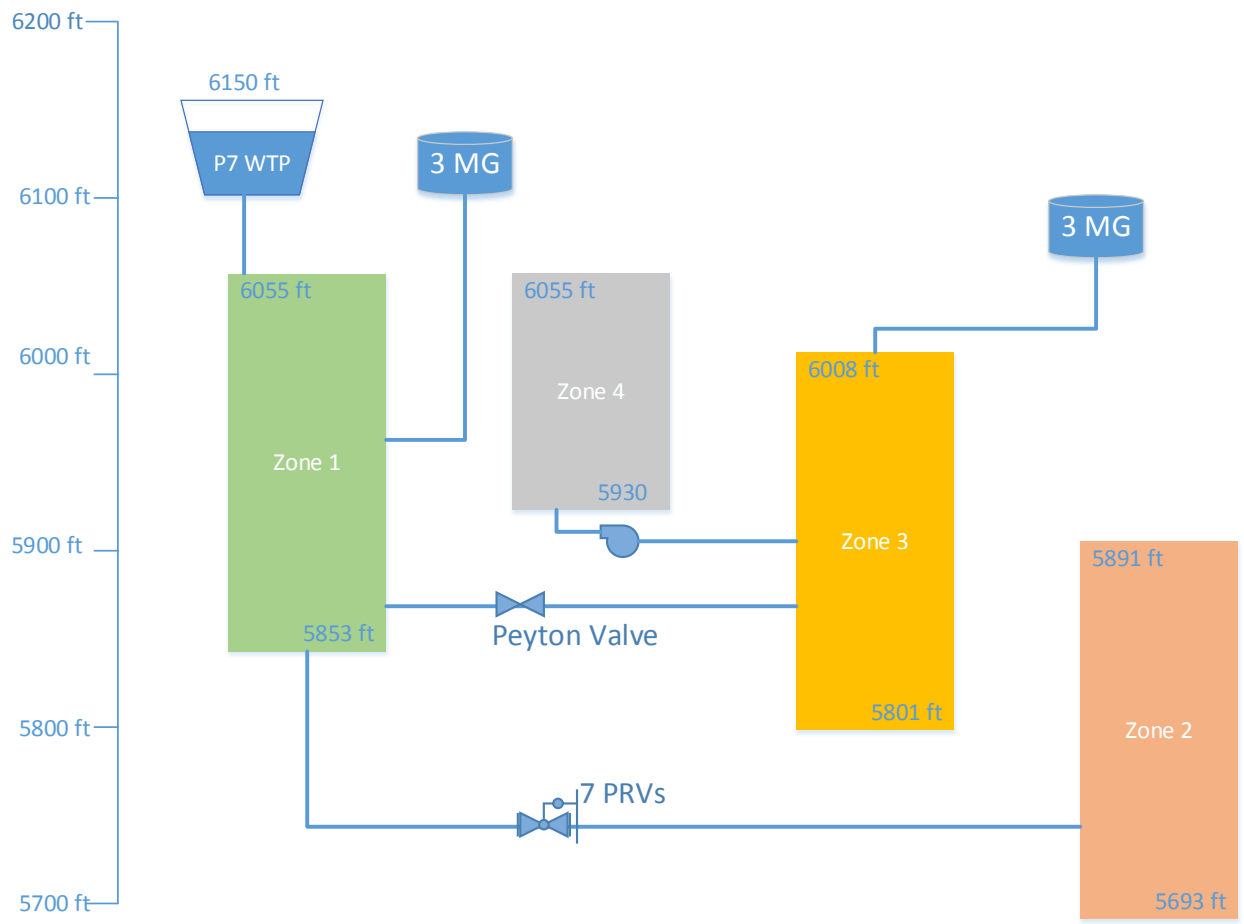


Figure 5 – System Hydraulic Profile Map

C. Pressure Reducing and Control Valves

The City's water system contains seven pressure reducing valves and one control valve. Three of the seven PRVs are trending pressure and flow data. The control valve is located at Peyton Dr. and 6700 Rd. and is generally referred to as the Peyton Valve. The Peyton Valve is used to control Sunshine Tank fill and drawdown cycles, and is currently the only connection between the Southern Zone 3 and Northeastern Zone 1.

Pressure reducing valves serve the Downtown Zone 2 from the Northeastern Zone 1 and Southern Zone 3. The Highway 50 location has a 4-inch and 14-inch PRV each with pressure sustaining features. The Miami Rd. location has a 2-inch and 12-inch PRV. The Sunnyside Rd. location has a 4-inch and 10-inch PRV each with pressure sustaining features. One 8-inch PRV is located at Niagara Rd. A single 6-inch PRV is located at Oak Grove Rd. The Commercial Way location has a 3-inch and 6-inch PRV. The Orchard location has a 3-inch and 8-inch PRV. Also, each tank is fitted with an altitude valve to prevent overflow.

Pressure settings at each PRV in the model are listed in Table 3. Due to computational limitations in the model, some valves were modeled as closed even though in practice these valves would be set high enough to not open unless a significant pressure drop occurred such as a fire flow. So valves listed as closed are modeling notes only. It is not recommended that any of the PRVs be prevented from opening.

Table 3 – Model Valve Settings for Existing Conditions MDD and Winter Day

PRV	Model ID	Size (in)	MDD Setting	Winter Setting	Recommended Flows Summer/Winter gpm
Miami	1307	12	60 – Closed	60 – Closed	Fire Only
Sunnyside	1308	4	50	50 – Closed	0 to 500 / 0
Niagara	1309	8	45 – Closed	45 – Closed	Fire Only
Project 7 Cascade	1310	6	101	90	500 to 1800 / Fire Only
Miami	1315	2	61.5	59	0 to 500 / 0 to 200
Highway 50	2928	14	44 – Closed	44 – Closed	Fire Only
Commercial Way	3377	6	55 – Closed	55 – Closed	Fire Only
Commercial Way	3380	3	59	59	300 / 300
Orchard	PRV-10	8	85 – Closed	85 – Closed	Fire Only
Oak Grove	V8002	6	62	55 – Closed	Fire Only
Orchard	V8004	3	90	85	50 / 50
Sunnyside	V8006	10	45 - Closed	45 - Closed	Fire Only
Highway 50	V8008	4	48	45	0 to 800 / 0 to 500

D. Storage Requirements

The city currently has three storage tanks, two 3 MG tanks, and the 2.6 MG Sunset Mesa tank which is currently offline (See Section H). Assuming the Sunset Mesa tank remains offline the City owns 6 MG total of storage, which is basically equivalent to the existing average day demand. AWWA (American Water Works Association) recommends a distribution system have storage volume equal to equalization plus

maximum fire and emergency reserve.[1] Equalization storage is generally only a concern for systems that pump their water supply which is not the case for Montrose. Emergency reserve depends on the duration of an emergency that the provider wants to be prepared for, and fire volume depends on the flow and duration of the fire event.

The CDPHE "Design Criteria for Potable Water Systems" Section 7.0.1 recommends three criteria for system storage:

1. Volume equal to no less than average daily system demand
2. Do not over size volume to prevent water age issues
3. Provide water for fire flows in accordance with ISO agreements

System demand in late July was around 6 MGD, and assuming a maximum fire flow of 3,500 gpm for 3 hours fire flow minimum volume storage is 0.63 MG. The City owns 6 MG and Project 7 Water Authority also has storage tanks equal to about 10 MG. Given that the City has two meter connections to large capacity pipes originating from these tanks they serve as a significant volume of stored water, albeit shared with the other Project 7 entities. So the City is not in need of immediate additional storage from a system wide analysis if the Project 7 tanks are included.

Because Cobble Creek is served on Zone 3 which has only one connection crossing the river, There is concern regarding storage volume in the system on the West side of the river. A new, elevated storage tank west of the river would provide a place to store any water that may be pumped "up" from Zone 1 while the river crossing is being repaired, in the event of a wash out or other damage, and would provide a local fire flow volume. The existing Sunset Mesa Tank was historically used to serve this area but is currently offline, and its fate is unknown. Also, Cobble Creek can only be served from the existing Sunset Mesa Tank if water is pumped, since the tank is on a lower hydraulic gradient. See Section H for more on the existing Sunset Mesa Tank.

A summary of water storage by pressure zone and future design years is provided in Table 4 and Figure 6. Current Average Day Demand is probably less than 6 MGD, but we have used this number as it is a typical summer day demand. The summary also excludes any contributions from Project 7, which as mentioned early are significant if included.

Another concern with the existing system's storage is water age. The Sunnyside and Sunshine tanks each operate on a single in/out pipe, 8,600 feet long for the Sunshine Tank and 2,400 feet long for the Sunnyside Tank. Each tank only turns over if the level in the tank is drawn down enough, which only occurs if pressures are fluctuated throughout the system. This proves to be difficult to accomplish in the Sunnyside Tank with the existing pipe network, but has been effectively accomplished in the Sunshine Tank using the Peyton Control Valve.

[1] Ulasir, Murat; Czachorski, Robert; Kaunelis, Vyto, "Determining Distribution System Storage Needs", *Opflow* Vol. 31 #9, Sept. 2005

Table 4 - System Storage Analysis

	2015	Design Year 1	Design Year 2
System Wide Storage			
Approximate Population	19,500	31,000	40,000
MDD (MGD)	7.00	9.27	11.04
Emergency (1 ADD)	6.00	7.94	9.46
Fire (3,500 gpm for 3 hrs)	0.63	0.63	0.63
Total	*6.63*	*8.57*	*10.09*
Ex. Available Storage	6.00		
Storage Need	***6.63***	***8.57***	***10.09***
Northern Zone (1) Storage			
MDD (MGD)	1.54	2.04	2.43
Emergency (1 ADD)	1.32	1.75	2.08
Fire (3,500 gpm for 3 hrs)	0.63	0.63	0.63
Total	*1.95*	*2.38*	*2.71*
Ex. Available Storage	3.00		
Storage Need	***1.95***	***2.38***	***2.71***
Downtown Zone (2) Storage			
MDD (MGD)	3.86	5.11	6.09
Emergency (1 ADD)	3.31	4.38	5.22
Fire (3,500 gpm for 3 hrs)	0.63	0.63	0.63
Total	*3.94*	*5.01*	*5.85*
Ex. Available Storage	0.00		
Storage Need	***3.94***	***5.01***	***5.85***
Southern Zone (3) Storage			
MDD (MGD)	1.37	1.82	2.16
Emergency (1 ADD)	1.18	1.56	1.85
Fire (3,500 gpm for 3 hrs)	0.63	0.63	0.63
Total	*1.81*	*2.19*	*2.48*
Ex. Available Storage	3.00		
Storage Need	***1.81***	***2.19***	***2.48***
Southern Zone (3) West of River Only Storage			
MDD (MGD)	0.58	0.77	0.92
Emergency (1 ADD)	0.50	0.66	0.79
Fire (1,000 gpm for 3 hrs)	0.18	0.18	0.18
Total	*0.68*	*0.84*	*0.97*
Ex. Available Storage	0.00		
Storage Need	***0.68***	***0.84***	***0.97***
Booster Zone (4) Storage			
MDD (MGD)	0.23	0.30	0.36
Emergency (1 ADD)	0.20	0.26	0.31
Fire (1,000 gpm for 3 hrs)	0.18	0.18	0.18
Total	*0.38*	*0.44*	*0.49*
Ex. Available Storage	0.00		
Storage Need	***0.38***	***0.44***	***0.49***

** 2015 Average Day Demand (ADD) assumed to be 6 MGD*

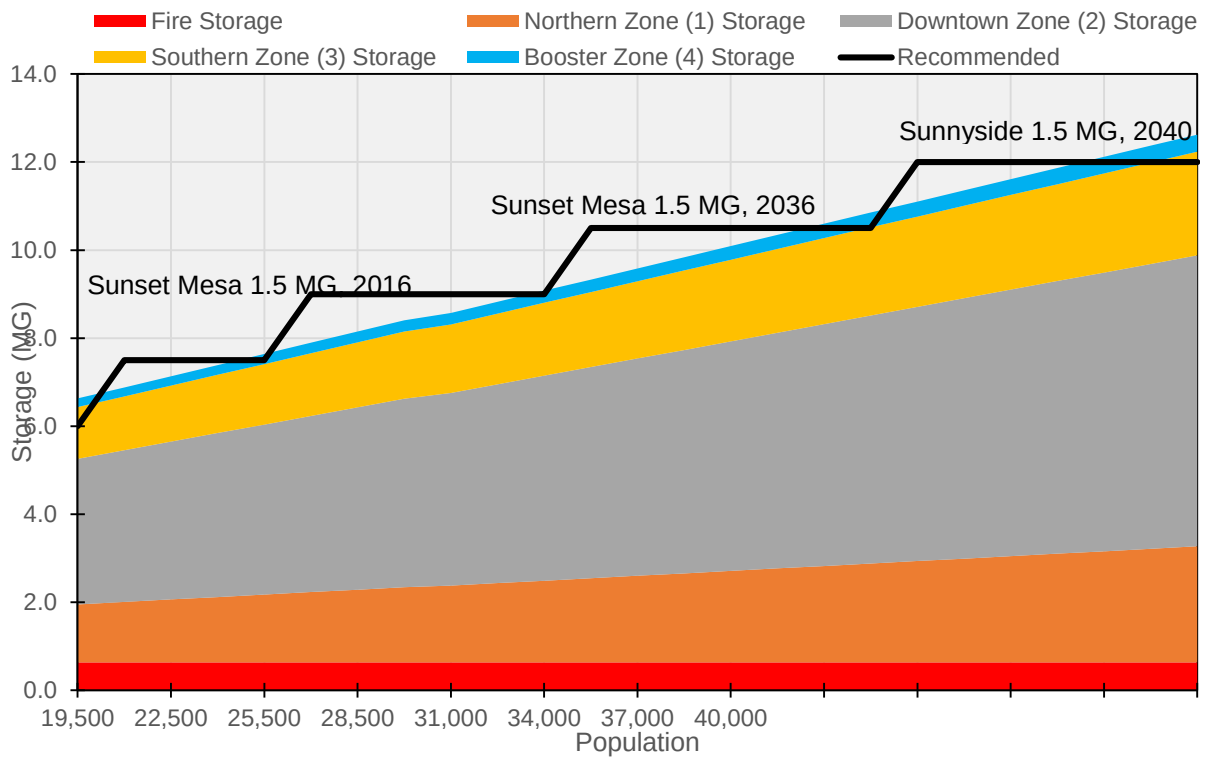


Figure 6 – Water Storage Requirements

This figure shows when additional storage is required, assuming tanks are added as recommended in the CIP's.

E. Pump Stations

The system contains two pump stations, one at Oak Grove Rd. and 6700 Rd. and the other at Sunset Mesa. The Oak Grove pump station serves approximately 160 single family homes. The pumps at Oak Grove are sufficient for fire flow demands, but are limited due to the pipe size of the some of the network. Fire flows throughout the booster zone are over 1,000 gpm except at the top of the booster zone where fire flows are limited to 600 gpm. Figure 7 shows the general layout of the Oak Grove Booster Zone and highlights the nodes that cannot provide fire flows of 1,000 gpm in red. This is because a single 6" pipe serves the top of the booster zone, CIP 11 would increase fire flows to over 1,000 gpm in the top of the booster zone.

The pump station at Sunset Mesa is used primarily for irrigation water at the ball fields on top of the Mesa. However, the pumps are capable of pumping to Cobble Creek from the Sunset Mesa tank. This past summer the City was able to operate the irrigation sprinklers without use of the pumps, so the pumps may not be needed in the future. Refer to the discussion of the Sunset Mesa Tank in Section H below and the discussion for CIP 7, for explanation of how this existing pump is recommended for replacement as part of a new standpipe solution on the Mesa.

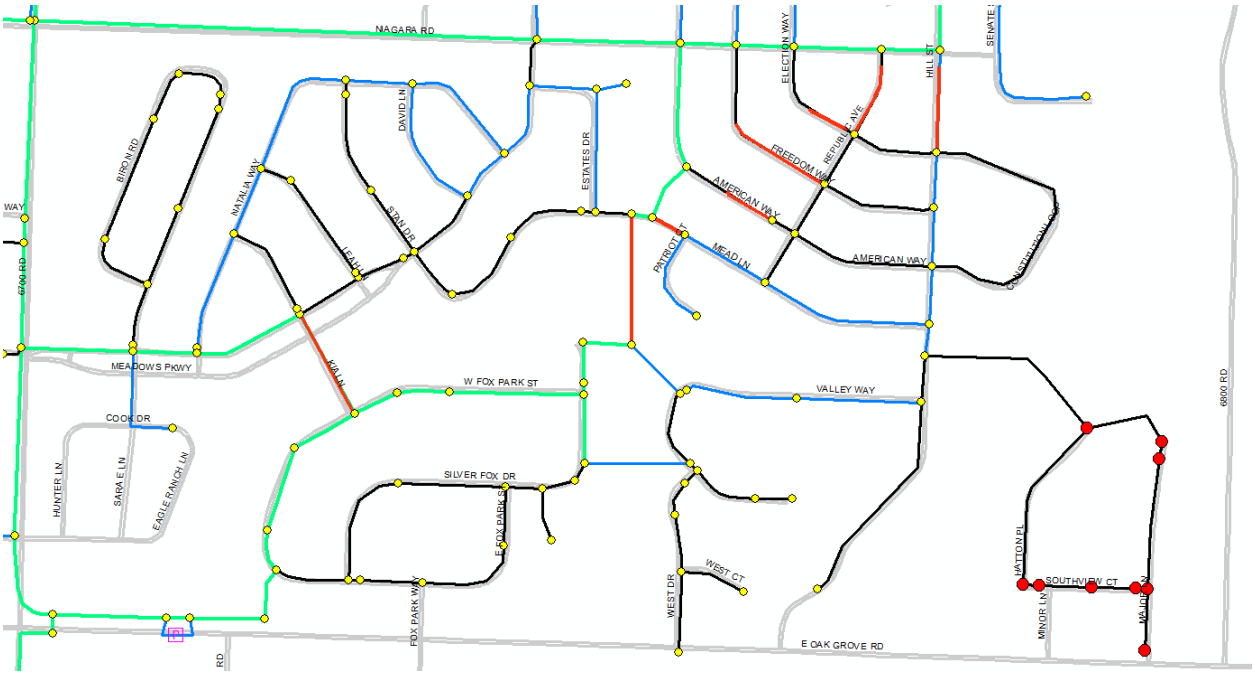


Figure 7 - Oak Grove Booster Zone, Red Pipes are closed, Red Nodes have insufficient fire flows

F. SCADA controls and System Intelligence

The current distribution system has SCADA controls and trending records at some key components of the system. All tanks within the system have trending level records, and flows are trended at the following PRVs: Highway 50, Sunnyside Rd., Miami Rd., and Oak Grove Rd. Monthly meter data is also provided to the City from Project 7 Water Authority. SCADA controls are used to drive turnover in the Sunshine Tank by opening and closing the Peyton valve based on tank level. We recommend expanding SCADA to include key data at all PRV locations.

G. Altering the Service Area Boundary

No altering of the service area boundary is expected.

H. Sunset Mesa Tank Alternatives

Background and History

The Sunset Mesa Tank is currently offline due to the condition and the elevation of the tank. The tank sits at too low of an elevation to serve the Downtown Pressure Zone 2. In the past the City has pumped from the tank to serve the nearby ballfields and Cobble Creek. However, this past summer, both these areas were able to be served off the Sunshine Tank along with the rest of Zone 3. The City staff observed that the tank potentially leaks: the tank level dropped a foot in a day or two while all valves were closed. No leakage past the valves is suspected as the pressure in the inlet/outlet pipes is higher than the tank pressure. The tank also has suffered significant deterioration due to corrosion as documented in the 2015 Sunset Mesa Tank Assessment performed by Del-Mont.

Rick Weaver, P.E. with Del-Mont Consultants previously performed a condition assessment of the Sunset Mesa Tank, so we invited Mr. Weaver to join our discussions with the City regarding the condition of, and future recommendations for the tank. The tank currently has a liner separating the concrete base from contact with stored water; it is in disrepair since no known NSF approved patching methods are available.

Until this liner is removed the structural integrity of the tank cannot be determined. Mr. Weaver explained the City would have to remove a portion of the liner to better understand the condition of the structural concrete. Repairing the lining system is required at a minimum if the tank is to remain in service. However, we recommend the tank be abandoned – see below.

The Sunset Mesa Tank has a high and low level elevation of 5976 feet and 5953.6 feet, respectively. The elevation range of the Northeastern Zone 1 is 6055 feet to 5853 feet. Cobble Creek alone is in the 5935 feet to 5865 feet range, which makes the Sunset Mesa Tank too low in elevation to serve the Southern Zone 3 without pumping. The Downtown Zone 2 ranges in elevation from 5897 feet to 5683 feet, which puts the highest pressure the Sunset Mesa Tank could provide to the highest point in the Downtown Zone 2 by gravity at about 34 psi. Therefore, the Sunset Mesa Tank cannot provide enough pressure by gravity to any of the service pressure zones by today's standards.

Recommendation

We suggest abandoning the Sunset Mesa Tank. According to simulation results using the InfoWater model during a Max Day demand pressures at Cobble Creek will remain above 40 psi except at the very end of the 6450 Rd pipe which will experience pressures slightly below 40 psi during the peak of the day. Fire flows up to 1,000 gpm can be maintained throughout Cobble Creek with minimum pressures above 20 psi at hour 9:00 am according to the model, except for the dead end in Cobble Dr. which is limited to 900 gpm.

Though the existing system is able to maintain AWWA minimum pressures and fire flows up to 1,000 gpm at the current MDD of 7 MGD, by the time the system demand equals 9 MGD pressures during MDD drop below 40 psi, and fire flows are limited to less than 500 gpm. Therefore a local storage tank is required to handle equalization and fire flow storage. We recommend the City install a new elevated tank or standpipe at the location of the Sunset Mesa Tank, and that the new tank operate by gravity on the Southern Zone 3 hydraulic grade line. This will provide additional volume for the Cobble Creek area during the peak and fire flow demands, and emergency storage west of the river should the river crossing pipes be compromised. Without additional storage available, future flows of 14 MGD also creates low pressures in the southern Townsend commercial area near Otter Rd. An additional pressure reducing valve could be installed to provide volume from the elevated tank to the Downtown Zone 2 pressures.

Building an elevated tank at Sunset Mesa would require verifying that the structure does not conflict with regulated flight patterns. Winter time tank turnover also could be a continued concern. This can be resolved by flowing through the tank as much as possible to maintain a low water age.

For diagrams of the recommended solution, refer to the flow schematics included in the discussion of CIP 6.

Alternatives to Constructing New Tank – not recommended.

Only two foreseeable alternatives to an elevated tank are feasible: Increase capacity going west Zone 3 from the Sunshine Tank or boost pressures to Cobble Creek.

Model analysis shows that if an additional 12-inch river crossing and an additional 12-inch going east-west in Otter Rd. from Sunshine Rd. to Woodgate Rd. are added, the system pressures throughout the Southern zone and west of the river are still below 40 psi during peak hour demands, and the system is unable to provide 1,000 gpm fire flows with a 20 psi residual.

For the first option to be effective, east-west flow capacity in the Southern pressure zone would need to be significantly increased out weighing the cost of an elevated tank. Boosting to Cobble Creek can be achieved by installing a pump station at the river crossing from the Southern pressure zone or from the old 14-inch A/C pipe from the Downtown zone. This option is not ideal since the pump would not be able to pump from a nearby tank, and Cobble Creek would still be dependent upon a single river crossing with no emergency storage. Also, east-west flow capacity improvements would need to be made east of the river for this option as well.

IV. Proposed Improvements

Using the calibrated water system model we have examined a range of options for improving water quality, system reliability (redundancy/looping), storage and optimization of PRV/PSV set points. The best way to appreciate the numerous variables is through operation and review of the actual water model. However, in order to support the CIP recommendations we are including key model output results in this report, such as tank levels, pipes flow rates, and pressures at key nodes.

Cost estimates are located in the Executive Summary at the beginning of the report.

Primary challenges faced by the existing water system:

1. The Sunnyside Tank floats on the system and has a single 12-inch pipe connecting it to the water system. The level in this tank does not fluctuate very much during low demand winter conditions, which is a concern for water quality.
2. The Sunshine Road Tank can take a long time to cycle through the approximately 6-foot elevation band necessary for turnover. This is because there is a limit to how much water can be conveyed to the southeast portion of the water system through the existing small pipelines.
3. The Sunset Mesa Tank is in poor condition and is at an elevation that does not work well with current pressure zones.
4. Irrigation water for the property on top of Sunset Mesa is currently boosted through approximately 60 psi; it would be good if there were a way to reduce the power required by reducing the magnitude of the necessary pressure boost.
5. There is only one water main that crosses the river from east to west to serve the Cobble Creek system by gravity. There is also no elevated storage on the west side of the river that can provide water to Cobble Creek in the event of a failure in this pipeline.
6. There is a short segment of pipeline at the intersection of Ogden and Woodgate that has no looped line. In other words, if this segment of pipeline were to fail there would be no water supply to a significant portion of the distribution system.(See Exhibit 3)
7. Pressures and fire flows at the higher elevations at the east end of the closed-loop booster pump station service area are (Zone 4) lower than generally provided in the water system. Pressures do satisfy AWWA recommended minimum peak hour pressures of 35 psi.

In order to address all of these challenges we recommend the following capital improvements. We show them in a suggested sequence, but given that they are all required to improve water quality and reliability of service more so than to address any needs for growth, some adjustments to the sequencing could be made depending upon City priorities.

Notice that when CIPs are recommended, the sizing of the pipe or tank is based upon what will be required for suitable system operation even at a point in the future when system demands may double their current levels. This would correspond to a water service area population of around 40,000.

CIP 1 - 2016

As a top priority for system reliability, we recommend installing an additional loop to provide redundancy to the single 12-inch pipe at the intersection of Ogden and Woodgate which currently is the only pipe serving the entire southwest corner of the Southern Zone (generally west of Woodgate Rd. and south of Ogden Rd.) The major difficulty regarding this section of pipe is an ephemeral creek which isolates the critical portion of the system. So a creek crossing will be required to create redundancy for this portion of the system. There are a variety of ways to accomplish this, and the best solution will likely consider any new lines that may be needed in this area to serve new developments. For example, the redundant line could be placed between Commercial Way and the 12-inch line looping the Home Depot, or a parallel line at the round-a-bout at the intersection of Woodgate and Ogden. The actual route and project cost is best

determined in a detailed design phase. The cost for this CIP is a budgetary estimate. Another alternative is to wait until CIPs 5 and 6 are implemented, because CIP 5 pulls water from Commercial Way and will feed back into the critical section of Odgen Rd. via the existing 12-inch pipe river crossing. However, this alternative is not a prompt solution.

<Refer to Exhibit 3 for an illustration of which parts of the system benefit from this redundant line addition>

CIP 2 - 2016

PRV Improvements: Enhance the existing SCADA system to include remote monitoring of flows and pressures, and to enable remote adjustment of set points. This is important as it provides real-time data and the ability to control or even automate how much flow is being directed through each of the PRV's that connect the high-zone with the Downtown lower elevation zone. Adjustment of when and where the flows enter the Downtown zone has a big impact on the water quality in the system, and it also enables more efficient use of the limited pipe sizes that exist, especially along the eastern side of the system.

Refer to the Water System Map for information on where we recommend flows be routed through the various PRVs in summer and in winter months. This reflects our recommendations for PRV optimization, based on the goals of reducing the load on pipes that are already near capacity, and on improving circulation for better water quality. Notice some key goals:

1. Have approximately 300 gpm flowing constantly through the PRV at the southern end of the system, Commercial Way. A flow control valve tied to the metered PRV with some active modulation via SCADA to keep the flow in the range of 250-350 gpm would be ideal. This should continue until such time as the new water main of CIP 9 is in service, at which point it is better to run the 300 gpm through that tank and into the Downtown zone instead of through Commercial Way. This flow would only be reduced if pressures in the Downtown zone approached the higher end of what is desired (around 70 psi).
2. Limit the amount of water that needs to flow south through the Northeastern Zone 1 by reducing the set point pressures at the PRV's of Oak Grove, Niagara and Sunnyside to be primarily for meeting localized fire flow demands near the low-pressure side of these PRVs. This helps save capacity for water to flow south through the Northeastern zone to the Peyton and Pavilion Control Valves when the Sunshine Road Tank needs to fill.
3. A small steady flow (say 50 gpm) through the Orchard PRV year-round is useful in keeping the water in this line fresh. This can be achieved with a ¾-inch diameter bypass according to model simulations. Assuming a 5 foot long ¾-inch bypass line pressures downstream of the Orchard PRV only increase about 1 psi.
4. In winter months the demand in the Downtown Zone 2 is sufficiently low that there need not be much if any water flowing at the Project 7 Cascade vault. Eliminating this as a primary feed is easily achieved by asking Project 7 to lower the set point pressure control so that it rarely draws water. Ideally, it should be set to respond only to a couple of hours of peak demand during the day in the winter. During the summer it will need to supply significant quantities of water, in the order of 500-1800 gpm as demands vary up to peak day diurnal demands.
5. Highway 50 PRV is owned by the City and can be set to be a primary, fairly steady supply of water, with the order of 500 gpm in the winter and closer to 800-1000 gpm during peak times in the summer.
6. The Miami PRV is in a good location to act as a reactive valve, supplying pressure when required to meet diurnal peaks, winter and summer. Winter peaks may reach in the order of 200 gpm, and summer peaks closer to 500 gpm.

Note that no field visits to the PRV location were made, so the magnitude of physical improvement required may vary and no comment or recommendations are made here. In other words, some PRV sites may require vault, electric, and site work to support a SCADA capabilities.

CIP 3 – 2016

We recommend the addition of an automated control valve on Pavilion Drive, to work in parallel with the one that currently operates at Peyton. These vaults open to allow water to fill the Sunshine Road Tank, and then close to allow it to draw down due to the demands in the Southern Zone 3, and the 350 gpm routed from the Southern Zone into the Downtown Zone at Commercial Way and Orchard, combined. This need has already been proven by operational challenges faced by the City in the summers past. The model shows that this will significantly improve the speed at which the Sunshine Rd Tank can fill, and even making the difference between it presently not filling automatically during peak demand times of year. We recommend a 12-inch, full-port, cla-val PRV with controls similar to that at Peyton Vault.

<Refer to the Model Analysis A. – Pavilion Flow Control Valve Analysis which shows how the addition of this control valve at Pavilion improves the turnover in the Sunshine Road Tank, vital to water quality.>

CIP 4 – 2017

The Sunnyside Rd Tank needs to have separate fill and draw pipes in order to improve tank turnover. Also, the tank needs to be able to remain closer to full so that there is adequate pressure to drive water through the Peyton and Pavilion control valves when Sunshine Tank fills. Pipe sizes surrounding and into this tank are presently too small. As such, we recommend a 24-inch dedicated fill pipeline be added, with a line valve normally closed, as indicated on the Water System Map. This will require a new pipeline be installed into the base of this tank. We recommend that an additional 24-inch outlet be installed at the same time in anticipation of CIP 9. This improvement is required for water quality reasons at the Sunnyside Road Tank, and it is needed to work in concert with the later recommendations of CIP 8, 9 and 10.

<Refer to Model Analysis B. – Dedicated Sunnyside Fill Pipe to see how CIP 4 improves the circulation/turnover at the Sunnyside Road Tank. The key observation here is to notice the flow rate in the 24-inch fill line; it provides a good volume of "fresh" water each day even though the tank level does not fluctuate very much.>

CIP's 5, 6 and 7 are scheduled to occur at the same time as they form one overall system of improvements. They could possibly be phased, constructed in numerical order, but the greatest benefit comes once all three are placed into service. There is a substantial amount of detailed piping changes required in the vicinity of the existing Sunset Mesa Tank, and these changes are best made all at once if CIPs 5, 6 and 7 are constructed under one contract. These three CIP's are driven by system reliability and improvements in service pressure more than they are by growth or water quality. Refer to the following flow schematic when reviewing the discussion of CIP's 5, 6 and 7.

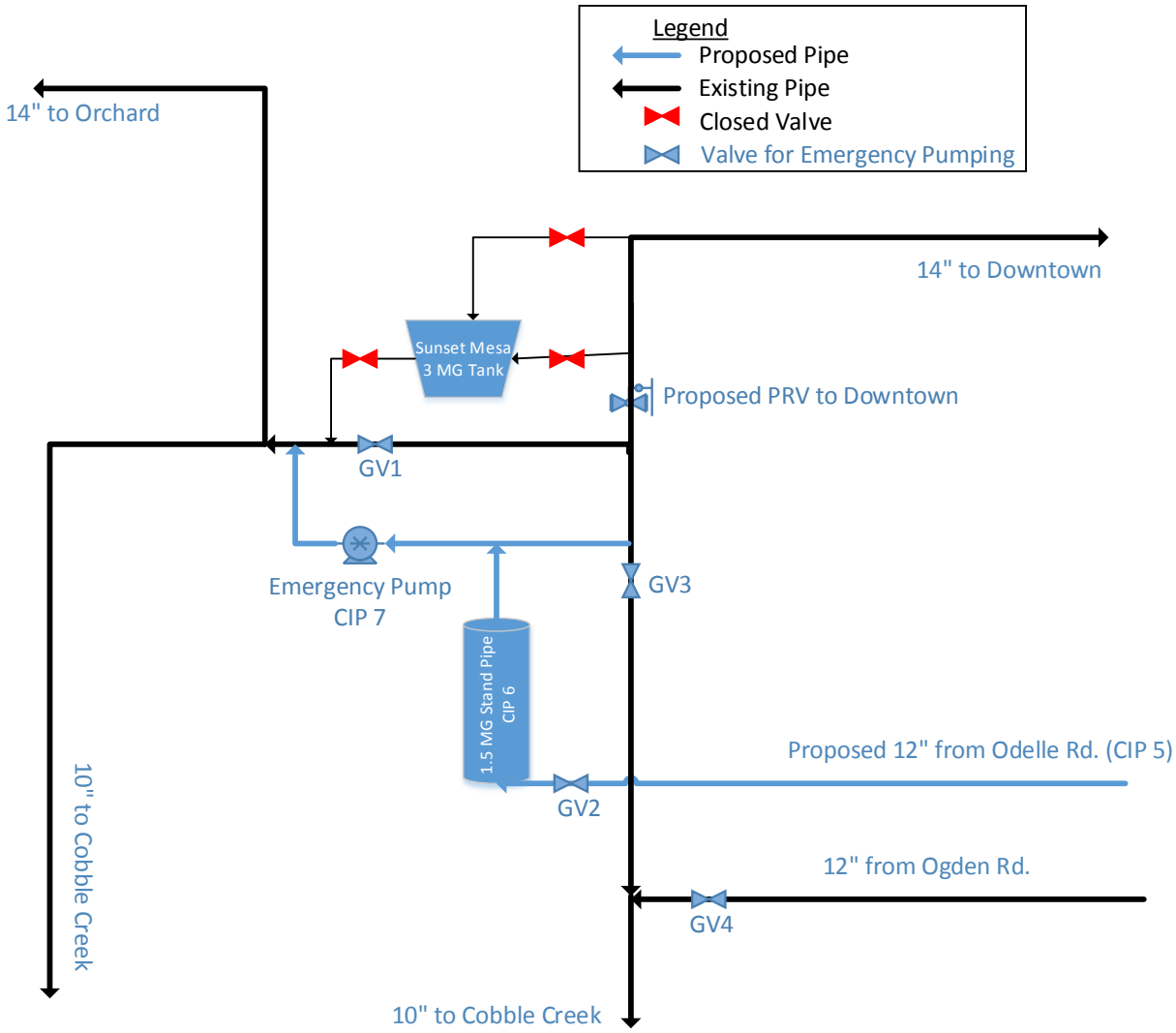


Figure 8 – Schematic of Proposed 1.5 MG Stand Pipe Tank, Odelle Rd. river crossing pipe, and emergency pump.

CIP 5 – 2020

This improvement is to provide a second water main across the river, supplementing the existing pipeline. The water main will help provide system reliability in case the existing pipeline was to fail or needed maintenance. It also will improve the delivery of water during peak demands, and thus improving pressures and fire flows. We propose an alignment running due west from the existing 10-inch main at Odelle Road, across the river and up to the location of the new tank that is proposed in CIP 6. Upon completion of CIP's 7, 8 and 9, it would be preferable from a water quality perspective to have this new pipeline be the primary connection across the river, with the existing line throttled (GV4 in the schematic) so that most flow is routed through the new tank prior to flowing south to Cobble Creek.

CIP 6 – 2020

In order to save the costs associated with rehabilitation of the old existing Sunset Mesa Tank and to provide a reasonable amount of emergency storage for Cobble Creek and other customers west of the river, we recommend the addition of a new 1.5 MG stand pipe style tank. This would likely be made of steel, and somewhat similar to the existing Chipeta water tank on the Mesa, but taller. We are recommending this

tank to be high enough that it matches the full-elevation of the Sunshine Road Tank, which would make the new tank approximately 135-feet high with a diameter of 44-feet. A stand pipe has several benefits:

1. System pressures west of the river are stabilized
2. Available fire flows in the southwestern portion of the distribution system are improved
3. In the event of breaks in the water main(s) that cross the river, emergency storage is provided by gravity from the top 100 vertical feet of the tank, rather than through pumps from the existing tank.
4. The bottom 30 ft of the stand pipe tank can be provided water by gravity from the Downtown Zone (2) via the existing 14" AC river crossing pipe and could be pumped from the tank to Cobble Creek via a new pump station, or a retrofitted "irrigation/booster station" as listed in CIP 7. This option would require valves at GV1, 2, 3, and 4 to isolate the stand pipe on the Downtown zone as shown in Figure 8.

Once the tank is completed, we recommend that approximately 300 gpm be routed to the Downtown zone through a PRV instead of the intermediate recommendation of running that flow through the Commercial Way PRV as noted in CIP 2. This change will ensure that water quality remains good in the new Sunset Mesa Tank, and that the desired enhanced drawdown of the Sunshine Road Tank continues.

CIP 7 – 2020

Once the tank is constructed, it makes sense to boost the pressure for the Sunset Mesa irrigation from this tank, as it would only require only about 15 psi to be added, instead of the 60 psi added currently from the old tank. Smart design of this pump station could allow for the pump station to also serve as an emergency pump station for use in boosting water pressure from the "middle-bottom of the new tank" to achieve pressures needed by customers in the Southern pressure zone west of the river in the unlikely event that both Zone 3 river crossings were damaged. Notice that in an emergency, the lower portion of this tank could fill by gravity from Zone 2, and then be pumped as noted above.

<Refer to Model Output D. – New Sunset Mesa Stand Pipe Tank to see how CIP's 5, 6 and 7 combine to improve the service to the west side of the river, and how the turnover at the Sunshine Road Tank is minimally impacted by the addition of new storage at Sunset Mesa. >

CIPs 8, 9 and 10 are best put into operation concurrently, or in quick succession in numerical order. The reason for this sequence/concurrency is explained in more detail in the Model Analysis section of this report. In essence, during peak demands, and as growth continues, without the added north-south capacity improvement provided by these three projects there is insufficient pipe capacity to deliver water to the Southern Zone 3, which means pressures drop and the tank(s) in Zone 3 do not fill, and the Sunshine Road tank will not turnover. It is best to improve the capacity from the upstream end, ensuring adequate supply, rather than increasing the system conveyance from the downstream (southern) end first, which exposes the system to taking larger demands that cannot be properly supplied from the north.

Timing for these three CIPs is largely dependent upon the growth in peak demands in the system, but especially any growth in the Southern Zone 3. During the summer months there is an argument that can be made that reduction of the 350 gpm "pass-though" from the Southern Zone to the Downtown zone could be reduced as there would already be enough system demand in the summer to turn over the tanks. This may extend the need for CIP's a few years, but will require active management, as is possible upon completion of the SCADA improvements recommended in CIP 2.

Model analysis shows there is benefit in these three CIPs being installed today. However, to allow planning and budgeting, and possibly to schedule them to follow CIPs 1-7, we have run a number of model scenarios to help define the "tipping point" to drive completion of these CIPs 8, 9 and 10. Refer to Model Analysis Sections C and D in Model Outputs for more information.

CIP 8 – 2025

A CIP that will be required in the future, in order to handle growth and to improve performance in the Southern zone and to stabilize pressures in the southern portion of the Downtown zone, will be the addition of a parallel water main that connects Project 7 on Highway 50 with the 24-inch fill line recommended in CIP 4. The need for this addition is best illustrated by comparing the "before and after" velocities in the northeastern part of the system, and in the tank level fluctuations. This pipeline is recommended to be a 24-inch line, running across country parallel to the existing 12-inch pipeline from Miami to Sunnyside. Without this pipeline, peak demands exceed the capacity of the existing piping network in the northeast portion of the system, meaning that pressures drop, and the Sunnyside Tank operates at an ever lower level. This reduction in pressure negatively impacts the southern reaches of the Northeastern zone and prevents the Southern zone from operating adequately.

CIP 9 – 2026

In order to deliver good pressure to the Peyton and Pavilion Vaults, and to help stabilize pressures throughout the Northeastern pressure zone when the Pavilion and Peyton control valves open and close, it is necessary to provide more transmission pipeline capacity in a southerly direction from the Sunnyside Road Tank. There is presently insufficient capacity "to, through and beyond" the Peyton Vault to fill the tank quickly enough during peak summer periods. This only gets worse as growth continues. CIP 9 reflects the recommended 24-inch transmission pipeline from the Sunnyside Road Tank to the Peyton Vault. This project is key to the immediate and long-term goal of having a reliable, relatively low headloss water transmission network around the eastern side of the distribution system.

CIP 10 – 2027

In order to properly deliver water to the 16-inch pipeline that connects the Sunshine Road Tank to the southeastern part of the system it is necessary to increase the capacity connecting Peyton Vault to Ogden Road. A suggested route is along 6720 Road. This improvement increases the rate at which the Sunshine Road Tank can fill, which is important, especially as the system demands increase. A 12-inch pipeline is suitable here. If this main is too large it allows the Southern zone tank(s) to draw water too fast from the Northeastern zone, meaning that pressures drop excessively in the southern portion of the zone. If this line is too small, the tank(s) in the Southern zone are not able to fill, which means that they would operate partially full, at a steady level, generating water quality problems in the tanks and providing lower water pressures in the Southern zone.

<Refer to Model Output C. – Upstream Capacity Improvement and Peyton Transmission Pipe to see how CIP's improve the rate of filling at the Sunshine Road Tank.>

CIP 11 – 2018

The timing for this CIP is optional, as it is more to do with increasing the level of service (increasing available fire flows) in the Boosted pressure zone (4) served by the Oak Grove Booster Pump Station. The existing pipelines are small, and there is essentially no looping at the southeast end of the system. This means that pressures drop during periods of high demand. The available fire flows in the Boosted zone are all over 1,000 gpm except for the small loop of houses at Oak Grove Rd. and 6800 Rd., fire flows in this loop are no more than 600 gpm if a minimum residual pressure of 20 psi is to be maintained. A solution to provide 1,000 gpm with a 20 psi residual pressure to this loop is to install a new 10-inch main that extends east from the pump station (along Oak Grove Rd.) and connects at points along the southern side of the Boosted zone.

<The improvements to available fire flows are illustrated by comparing Model Outputs F. – Fire Flow. Also, refer to Figure 6 that shows the area with less than 1000 gpm of available fire flow. >

CIP 12 – 2018

The timing for this CIP is optional, as it is more to do with increasing the level of service (raising pressures and available fire flows) in northern portion of the Downtown zone. Installation of an 8-inch main north from Locust Road to Draft Horse Road provides this area with a looped service. This improves reliability and available fire flows.

Additional CIPs

In the distant future the system will need additional storage volume, as discussed in Part D of System Analysis. By the time system demand is 14 MGD (approximately 40,000 pop.) we recommend adding a second 1.5 MG stand pipe on Sunset Mesa to complement CIP 6, and a 1.5 MG tank near Sunnyside Tank to complement Sunnyside Tank. We recommend adding tanks as needed at these two locations because the proposed CIPs 4 and 5 provide a means to flow through tanks, which is ideal for tank farm style storage systems.

As development occurs along Otter Rd. and as demand increases through the rest of the Southern Zone 3, we recommend installing 16-inch pipe in Otter Rd. to eventually connect the 16" Sunshine Tank feed pipe to dead ends at Wolverine Dr., Woodgate Rd., and Otto Pond Cr. This provides redundancy to the system and takes flow off of the 12-inch in Ogden Rd. that experiences velocities as high as 5 ft/s during a 14 MGD MDD. We recommend the Otter Rd. 16-inch be installed by the time the MDD for the system reaches 11.5 MGD, because peak hour pressures reach 40 psi near Woodgate Rd. and Otter Rd. without it. Fire flows will also be improved in the area with the addition of the 16-inch Otter Rd. pipe.

V. Model Outputs

A. Pavilion Flow Control Valve Analysis

Current operating conditions of the system involve opening and closing the Peyton control valve based on the Sunshine Tank level which ensures the tank turns over, and helps shock the Northeastern zone system which helps draw down and turn over the Sunnyside Tank. This procedure works well for a typical existing summer day.

During a Max. Day demand the system is currently unable to fill either tank. Not enough flow is able to reach the Sunshine Tank to fill it completely, which prevents the Peyton valve from closing, which is then constantly pulling flow from the Northeastern zone preventing pressures from increasing enough to fill the Sunnyside Tank.

One simple viable option to increase tank turnover during peak summer seasons is to include a control valve that mimics the Peyton valve at Pavilion where the system it is currently isolating the Northeastern zone and the Southern zone. Tank levels fluctuate well under this condition see the green line in Figure 9 and Figure 10. Notice, in that the existing system can take days to completely fill the Sunshine Tank if at all. Also note in that under the proposed condition the Sunnyside Tank fluctuates as much as 6 feet in a day and does not completely fill. This is addressed in CIP 8.

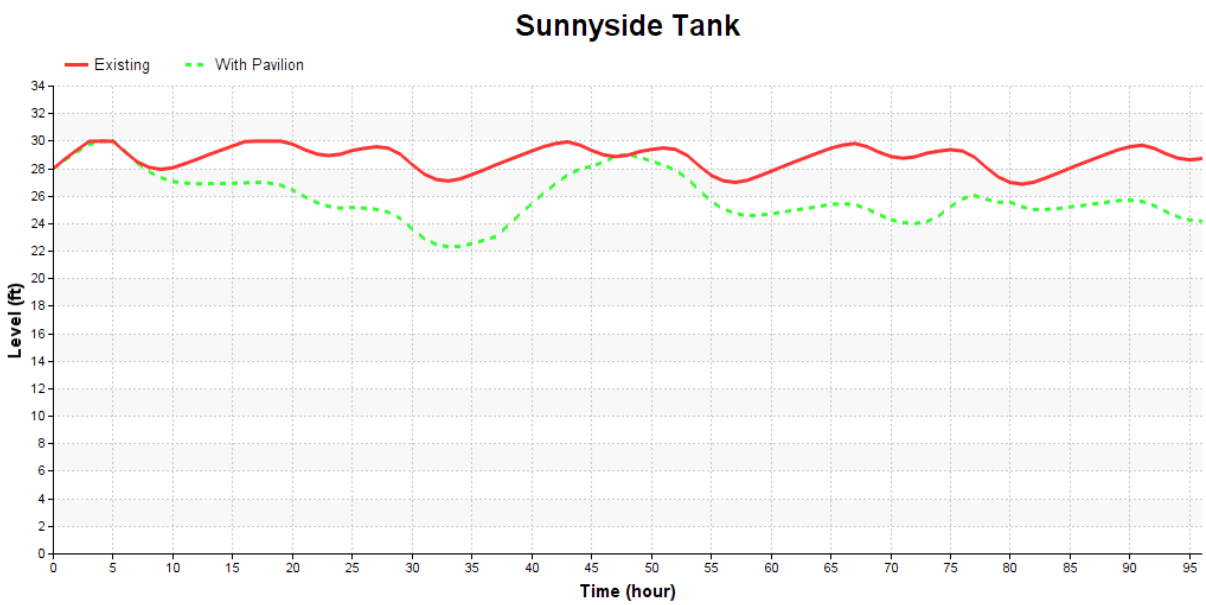


Figure 9 – Sunnyside Tank level model output with and without the proposed Pavilion Control Valve on Existing MDD.

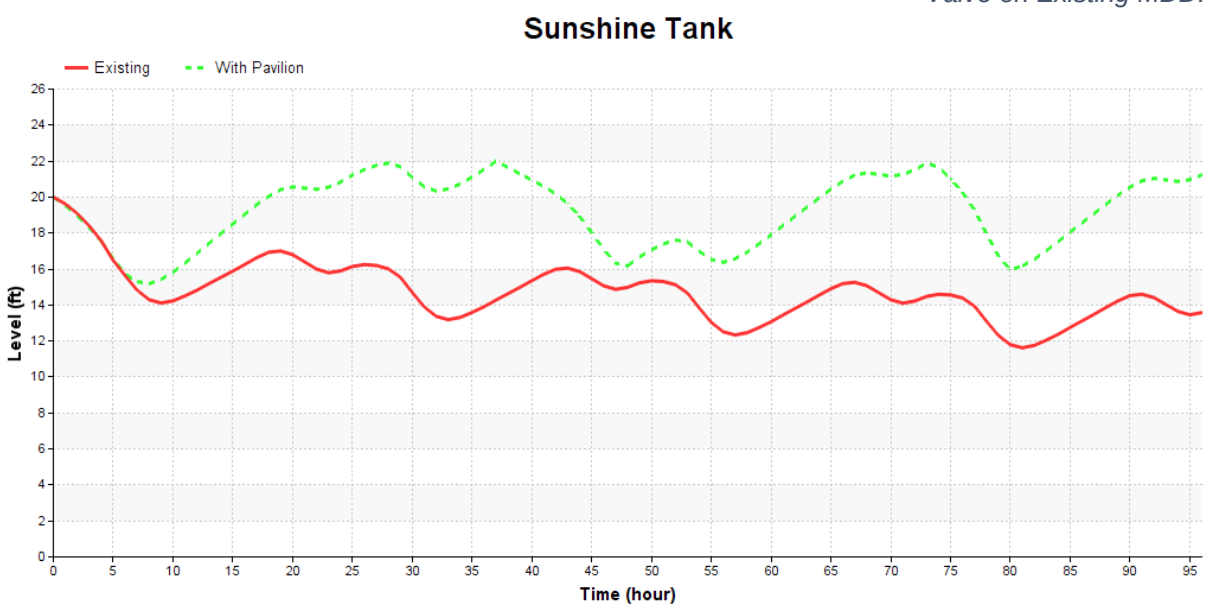


Figure 10 – Sunshine Tank level model output with and without the proposed Pavilion Control Valve on Existing MMD.

B. Dedicated Sunnyside Fill Pipe

Water turnover in the Sunshine Tank is controlled by the Peyton valve and performs reliably when supplemented with a control valve in Pavilion Dr. Turnover in Sunnyside remains a problem in winter season, due to constant higher pressures in the Northeastern zone which prevents Sunnyside from lowering. With the addition of the Pavilion Control valve not enough flow is able to reach the Sunnyside Tank to fill it after the control valves close.

To mitigate water aging in the Sunnyside Tank and increase fill time a 24-inch dedicated fill pipe was added to the 12-inch pipe between 6800 Rd. and Miami Rd. Inserting a valve on the 6800 Rd. 12-inch pipe between the 24-inch fill line and the existing 12-inch in Sunnyside Rd. forces water through the 24-inch filling the tank, and out of the existing 12-inch in the tank. A check valve was also added to the existing 12-inch pipe at the tank to prevent backflows.

During winter demands flows in the 24-inch fill pipe reach 800 gpm for 10 hours every 22 hours (see Figure 11). This means approximately 0.5 MG will be cycled through the tank every 22 hours. Recall that total winter demand is 1.85 MG per day, so about 30% of total demand is flowing through the Sunnyside Tank. The tank fill rate is limited by the flow capacity in Miami Rd. and the 12-inch pipe running toward 6800 Rd. The fill pipe would be running all day, but during the day pressures in the Northeastern zone are still too high to pull from the Sunnyside Tank.

The tank levels in winter are fairly stagnant with the exception of the occasional opening of the Peyton valve, see Figure 12. The variation in tank drawdown shown in Figure 12 is due to the time of day the Peyton valve opens (peak demand period, or low demand period). In other words, if the Peyton valve can be controlled to not open until both the Sunshine Tank is low and peak demand is occurring (6-8am) turnover in Sunnyside Tank will be increased. We only recommend these settings for winter months (system demand less than 3 MGD).

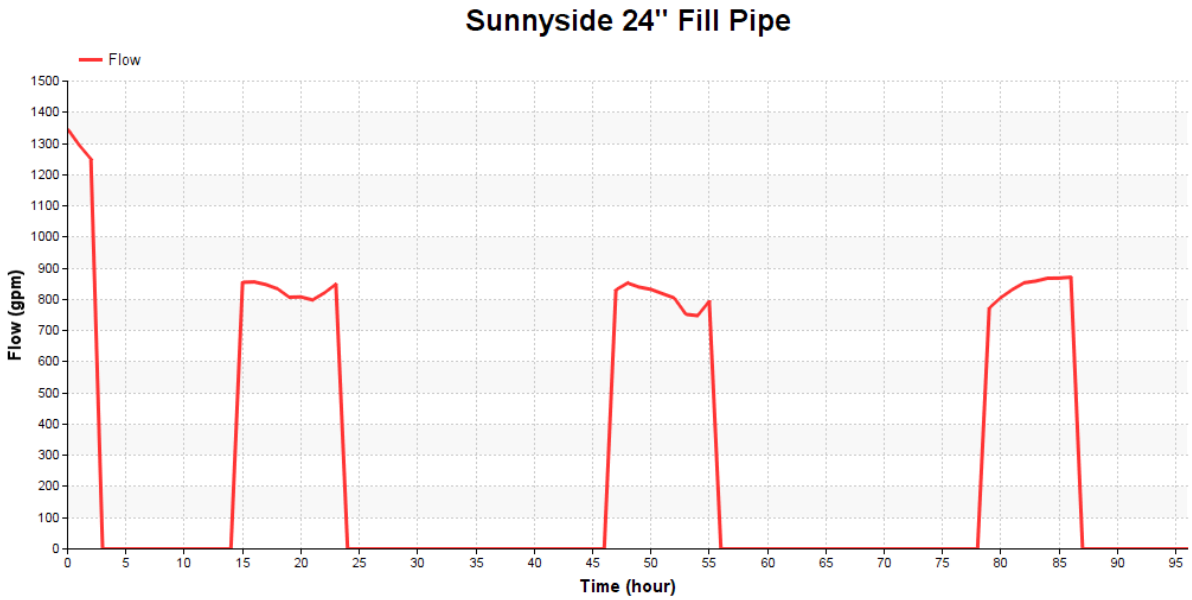


Figure 11 – Winter Season Flow in Proposed 24-inch Sunnyside Dedicated Fill Pipe

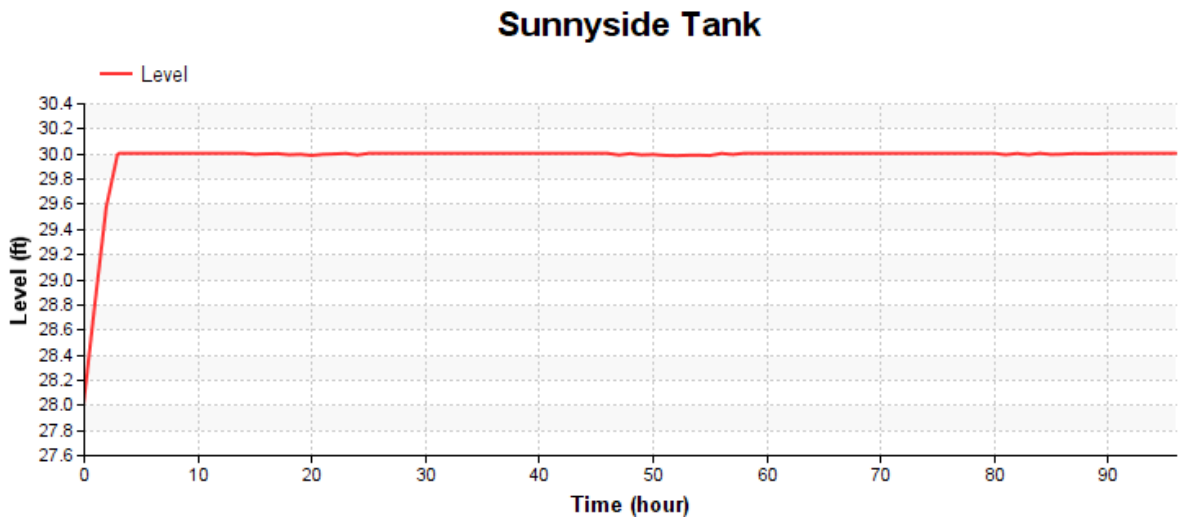


Figure 12 – Winter Season Sunnyside Tank Level with Proposed 24-inch Dedicated Fill Pipe

C. Upstream Capacity Improvement

Turnover in the Sunnyside Tank is improved with the addition of a dedicated fill pipe, but is limited due to flow restrictions toward Miami Rd. To improve flows a parallel pipe could be added to increase capacity between Highway 50 and the Sunnyside fill pipe. Figure 13 shows the model results for flows in the Sunnyside fill pipe with increased capacity. Flows increased from 800 gpm with limited capacity to 4,000 gpm with sufficient capacity upstream. Alternatives of 12-inch, 16-inch, and 24-inch pipes were tested in the model to size the parallel pipe. The 16-inch pipe would perform well in the near future, but as daily demands approach 10 MG a 16-inch would be insufficient to fill both the Sunnyside and Sunshine. Therefore a 24-inch parallel is recommended.

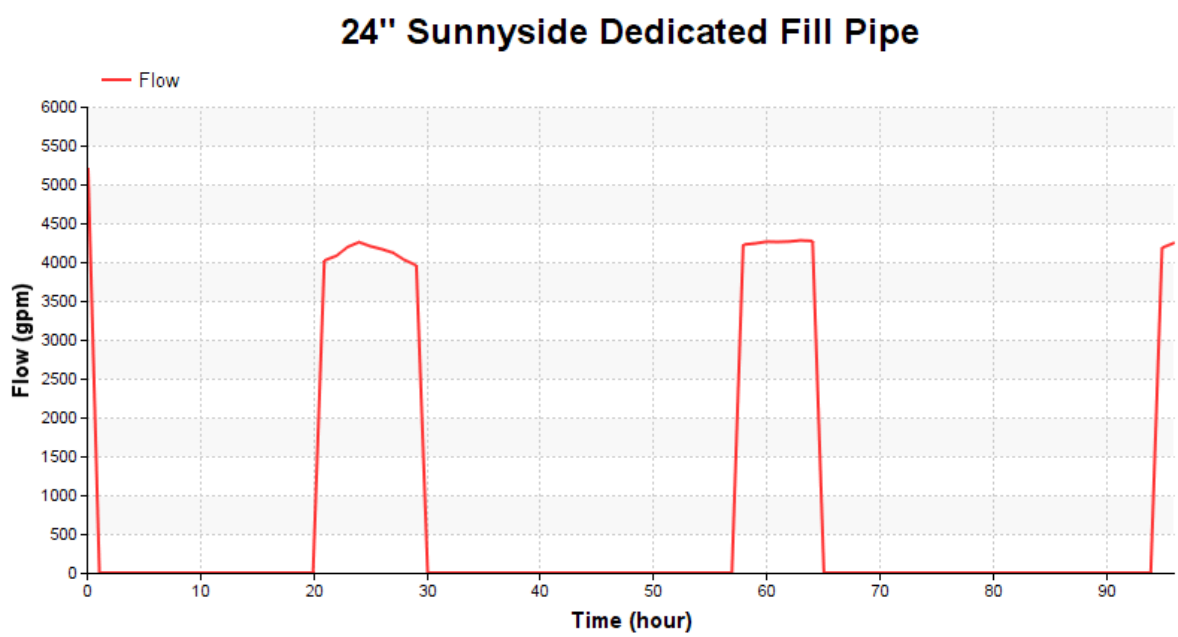


Figure 13 - Winter Season Flow in Proposed 24-inch Sunnyside Dedicated Fill Pipe with increased capacity from Miami Rd.

Current MDD velocities in the 16-inch in Miami Rd. are reduced from 4.5-feet/s without the 24-inch transmission line to 3.1-feet/s with the transmission line. Velocities in the 24-inch pipe do not exceed 2.9-feet/s. Under current MDD conditions without the upstream 24-inch transmission line the Sunnyside Tank fills completely once every couple of days, and due to the lower level in Sunnyside fill time in the Sunshine tank is also increased to over 24 hours. With the transmission line Sunnyside Tank is always full, and Sunshine fills in less than 24 hrs. Sunshine Fill time increases with the addition of CIP 9 and 10, also referred to as the Peyton Transmission Pipe.

D. Peyton Transmission Pipe

During Max. Day future scenarios the system is not able to fill the Sunshine Tank. Using a stepwise approach it was determined that the Sunshine Tank cannot be completely filled when the system demand reaches about 10 MGD. Adding the previously mentioned 24-inch parallel transmission main between Highway 50 and Sunnyside Rd. significantly improved the level in the Sunshine Tank, but does not completely fill the tank. The tank is not able to fill because headloss between the two tanks is too high. We can justify this conclusion because the Sunnyside Tank is maintained full even in a 14 MGD system demand scenario, while the Sunshine Tank drops to empty.

One potential solution is to add a direct flow path from the Sunnyside Tank to the Peyton Valve, and up to the Sunshine Tank fill pipe. We performed analysis with a variety of pipe sizes and determined that a 24-inch transmission pipe connecting the Sunnyside Tank directly to the Peyton Valve, and a 12-inch main between Peyton and the 16-inch to Sunshine Tank adequately serves the Sunshine Tank even during a future 14 MGD system demand.

Peak pipe velocities are reduced most noticeably at 6700 Rd. and 6800 Rd. south of Sunnyside Rd. and in the network of piping south of the Peyton valve. Pressures at Junction 1166, just upstream of the Peyton valve, also improved as shown in Figure 14. *Figure 15* captures the significance of the Peyton Transmission line by comparing the Sunshine Tank levels with and without the transmission pipe at a future MDD of 14 MGD. Analysis also shows that in winter conditions turnover in Sunnyside Tank is improved even if the upstream capacity improvement (CIP 8) has not been made yet.

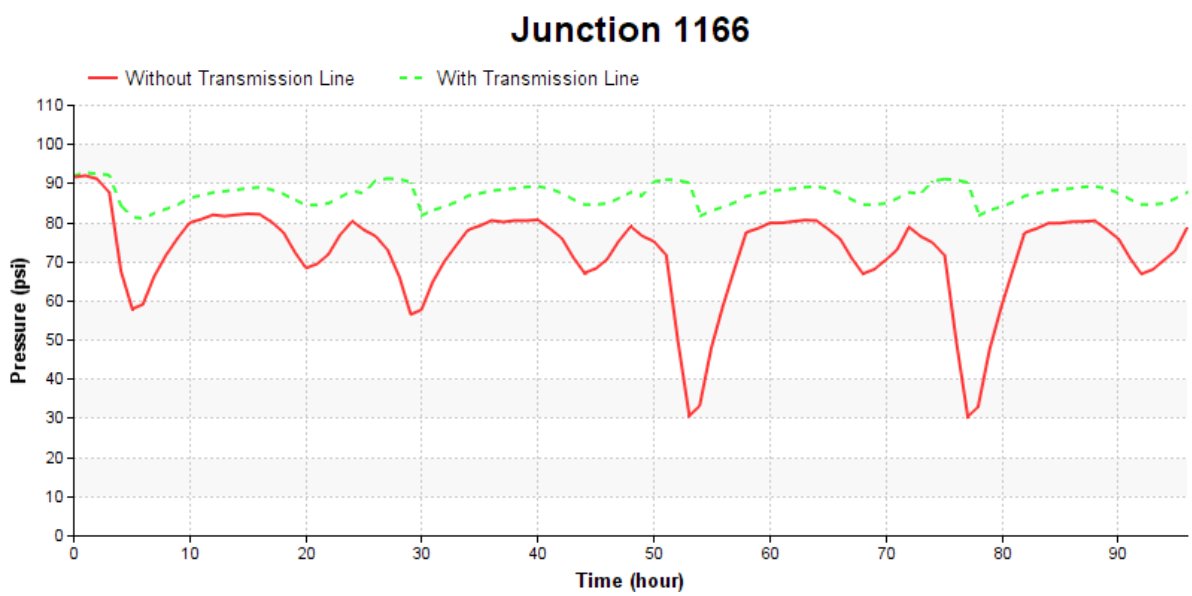


Figure 14 - Upstream Pressures of Peyton Valve with and without Peyton Transmission Line at Future Demand of 14 MGD

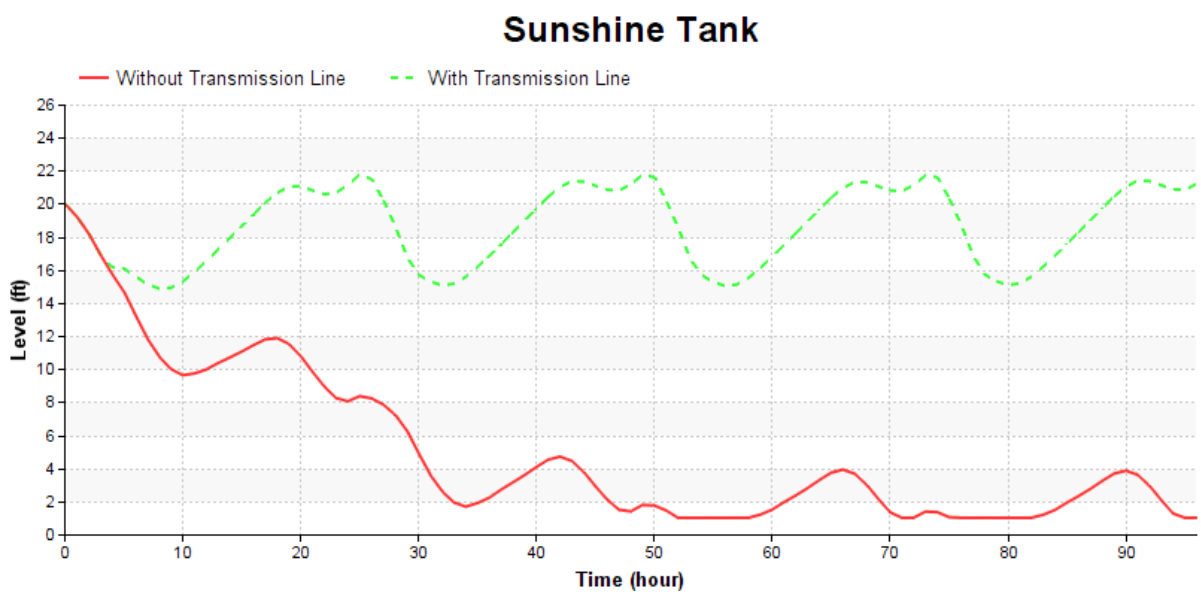


Figure 15– Comparison of Sunshine Tank levels with and without Peyton Transmission Line at Future Demand of 14 MGD

E. New Sunset Mesa Stand Pipe Tank

The existing Sunset Mesa tank is expected to be abandoned because it is deteriorated and sits at too low of a hydraulic gradient to be used for the Downtown zone. Sunset Mesa remains an ideal location for a tank to supply supplemental storage to the area west of the Uncompahgre River. Cobble Creek currently is supplied Southern zone pressure via a single river crossing from Ogden Rd, so redundancy is a concern. A tank located at Sunset Mesa would provide redundancy (at least for a period of time) and increase fire flow volumes and pressures.

We propose a stand pipe style tank at the current Sunset Mesa Tank that operates on the same gradient as the Sunshine Tank. The stand pipe would provide storage volume for Cobble Creek, Orchard, and potentially downtown. Downtown could receive water from this tank only if a new PRV is added between the existing 14-inch AC pipe and the proposed tank. In the event of a water supply break at the river crossing water from the stand pipe could be pumped using the existing irrigation pumps to maintain pressures in Cobble Creek as has historically been done via the existing tank.

As part of the Sunset Mesa stand pipe we recommend installing an additional 12-inch river crossing from Odelle Rd. to the proposed tank. This additional river crossing increases redundancy. Making this connection directly to the tank will increase tank turnover, especially if 300 gpm is sent to downtown through the stand pipe.

The addition of another tank on the Southern zone pressure gradient potentially decreases tank turnover in Sunshine. Figure 16 and Figure 17 shows the levels in the new tank and the Sunshine Tank during winter (low demand) seasons. The Sunshine Tank draws down 6 feet about once a day, which completely turnovers over the tank in about 3.5 days.

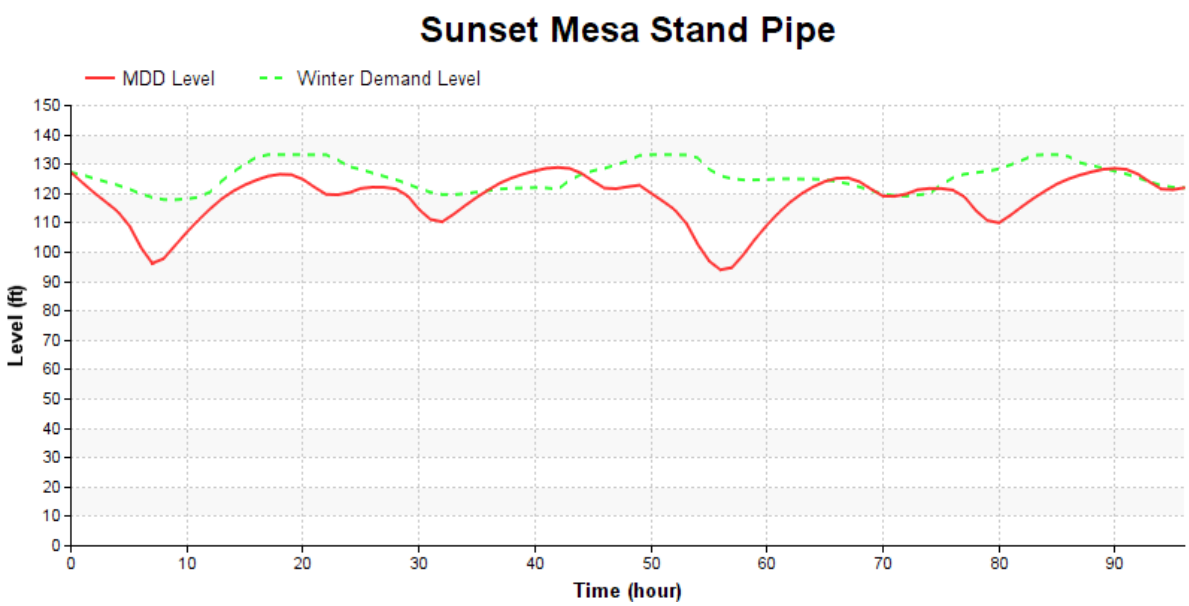


Figure 16 – Proposed Stand Pipe Tank levels during MDD and Winter Demand conditions

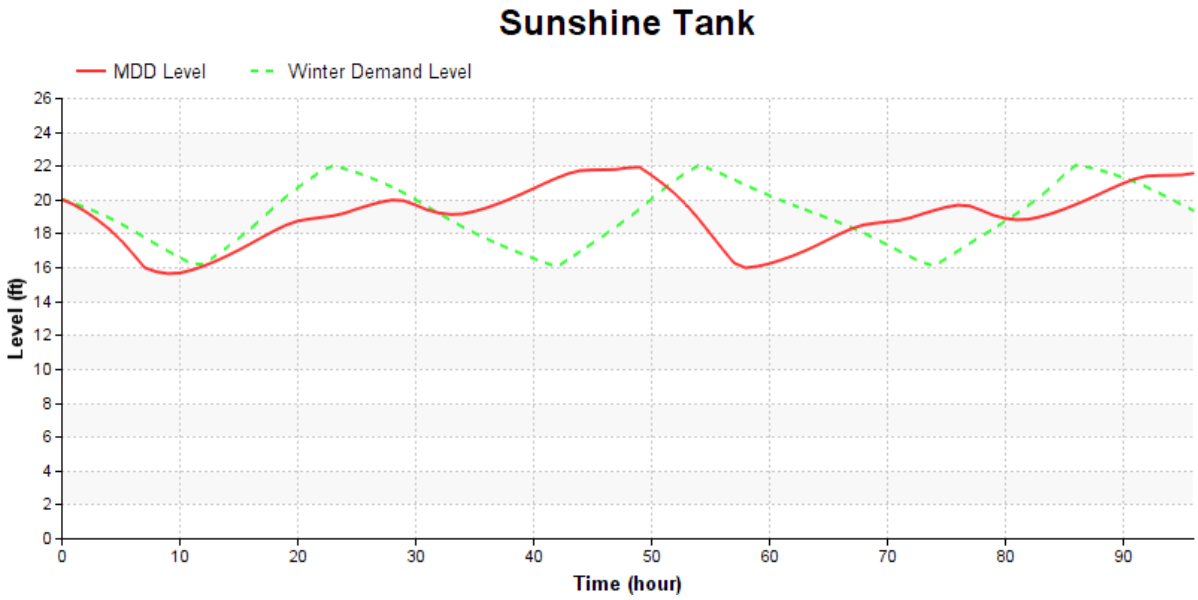


Figure 17 – Sunshine Tank levels during MDD and Winter Demand conditions

F. Fire Flows

Fire flow analysis included determining available flows at key nodes in the system while maintaining a minimum 20 psi pressure throughout the system. For the purpose of this analysis no secondary (Fire Flow) PRV's were activated, because the locations of the fire flow tests are not near a PRV and do not trigger a low enough pressure downstream to trigger a fire flow PRV opening. Fire flows were run in Cobble Creek, Haystack neighborhood, the booster zone, Orchard area and the end of the Southern zone at Otter Rd.

Existing fire flows in the Homestead Park area are below 500 gpm at many nodes. This is due to the restriction in 6530 Rd. A redundant 8-inch pipe in 6600 Rd. would increase fire flow capacities here to over 1,000 gpm.

Existing fire flows in the Oak Grove Booster zone are limited to 600 gpm, but only in the small loop at the southeast corner of the booster zone. The rest of the booster zone is able to maintain 1,000 gpm fire flows. A redundant 10-inch pipe running along Oak Grove Rd. to the southeast loop increases fire flows to over 1,000 gpm.

Cobble Creek is currently able to handle over 1,000 gpm except at the intersection of Cobble Creek Cr. and 6450 Rd. where fire flow is limited to 850 gpm. Fire flows here could be improved with the addition of the Sunset Mesa Tank, and/or completing the Cobble Creek Circle loop to 6450 Rd.

The Orchard Rd. neighborhood is capable of supplying well over 1,000 gpm fire flows.

Proposed fire flow improvements are a 10-inch pipe line connecting the extremities of the Oak Grove pump station zone, an 8-inch line between Locust Rd. and Draft Horse Rd., and constructing the Proposed Sunset Mesa Tank.

G. 14 MGD All Proposed CIP Improvements - Review

All capital improvement recommendations have been sized to provide a future broadly applied system demand increase to 14 MGD. This section reviews the proficiency of the CIP list at 14 MGD system demand, and highlights some of the modeled deficiencies noted at such a demand. No CIP recommendations are

being made beyond 14 MGD, but highlighting the problem areas allows the City to be aware of potential shortcomings and may have opportunities to increase network capacity as development occurs.

As mentioned earlier, by the time a system MMD of 14 MGD is reached a total system storage of 10.5 MG of is required beyond the proposed Sunset Mesa Stand pipe. The storage could easily be incorporated to the Sunset Mesa Tank location and/or the Sunnyside Tank location. We recommend increase storage volume in increments of 1.5 MG to avoid excessive volume causing water quality issues, and multiple tanks at one site allow redundancy and easier maintenance.

A potential concern at this point in the future growth is east-west transmission in the Southern pressure zone. The 12-inch pipe in Ogden Rd. is carrying a significant velocity of water regularly increasing headloss, and becoming a more significantly more vital piece of the system. So we recommend as development occur in the Southwestern portion of the Southern zone install a 16-inch pipe along Otter Rd. from Sunshine Rd. to Wolverine Dr. This provides redundancy to the Ogden Rd. 12-inch and increase capacity east-west for the future beyond a system demand of 14 MGD.

Pressure reducing valves in some places may need to open the larger (typically fire flow) valves to maintain acceptable pressures throughout the Downtown zone in the future. Pressure problems in the Downtown zone are typically in the neighborhood east of Hillcrest Dr. between Sunnyside Rd. and Niagara Rd. The PRVs at Miami and Highway 50 are using the larger PRV as primary in this 14 MGD future scenario. With the system set this way the lowest pressure node is located in the Booster zone (4), the Oak Grove boosted system. Pressures slightly dip below 40 psi only during the peak hour demand in the morning. It is possible that demands in this area are overestimated given that we have doubled the demand at each node throughout the system to get to a total of 14 MGD. The only PRV modeled without flow in the future scenario is Oak Grove.

Tank levels in Sunnyside fluctuate between 20 and 30 feet, Sunshine fluctuates between 16 and 22 feet as controlled by the Peyton & Pavilion valves, and the Sunset Mesa Stand Pipe fluctuates between 75 and 125 feet, or 90 feet to 120 feet with the additional 1.5 MG stand pipe is added.

Available fire flows in the extremities of the system decrease but no significant deficiencies are noted. Extremities will likely change as infill may produce more dead end developments. The City should be careful to encourage as much looping and networking as possible between developments.

H. Additional Considerations

1. Permanent Pressure Logging Options

During the course of the study City staff expressed interest in using pressure loggers continuously at key locations in the system if the data could be shown to be valuable and worth the effort. Key locations are; Cobble Creek, Oak Grove Booster Area, the neighborhood east of Hillcrest Dr. between Sunnyside Rd. and Niagara Rd., and the northeast portion of the system by the airport. These locations have significantly lower, or higher pressures than the zone generally assigned to them.

Airport Pressure Logger:
Pressures in the area of the Downtown zone (2) near the airport along Highway 50 are regularly higher than 100 psi. The City is considering breaking pressure to this area at San Juan Ave. Installing pressure loggers in the meantime provide the City with more information regarding the need and potential benefit of breaking pressure to this area. It is recommended that a logger be located at the northeastern most loop.

Hillcrest Dr. Neighborhood
The neighborhood generally occupying the area east of Hillcrest Dr. between Sunnyside Rd. and Niagara Rd. appears to have low pressures relative the rest of the Downtown zone. This is easily

resolved by adjusting the pressure settings at Sunnyside Rd. or Niagara Rd. PRVs. However, recommendations for tank turnover require these PRVs to be set low so that they are rarely used. Pressures at the PRV's can easily be recorded, but to better understand what the pressures in the neighborhood are like it is recommended that a logger be placed in the neighborhood. Two locations would ideal for the logger; Kent Ave. and Bradford Dr. or Phillips Cr. and Margo Ct.

Oak Grove Booster Area
The Oak Grove Booster Area is known to have low pressures at high demand periods due to the elevation of the homes and the size of the pipes. Trended pressure logs from this area would be useful to evaluate different solutions, and better understand the cause of the low pressures. An ideal location for a transducer would be at the top of the hill at Hatton Pl. or Major Ln.

Cobble Creek
Cobble Creek generally represents an extremity of the system that during high demand and fire flow conditions may experience significant pressure drops, particularly if the Sunset Mesa Tank and pumps offline. Therefore, trended pressures from Cobble Creek would allow the City to quantify the severity of pressure fluctuations. A good location for a transducer would be Cobble Dr. and Collins Way.

2. SCADA Control and Trending Data

The City currently has three of the seven PRVs trending pressure and flow data. Trending the rest of the PRVs flow and pressures would help the City verify when and where flows are entering the Downtown zone. Improvements to controlling the PRVs via SCADA would improve operation of the system by allowing personnel to make real time adjustments to pressures and flows between the zones. This is particularly crucial during winter months when turnover in the tanks can be induced by adjusting flows and pressures at the PRVs.

Appendix

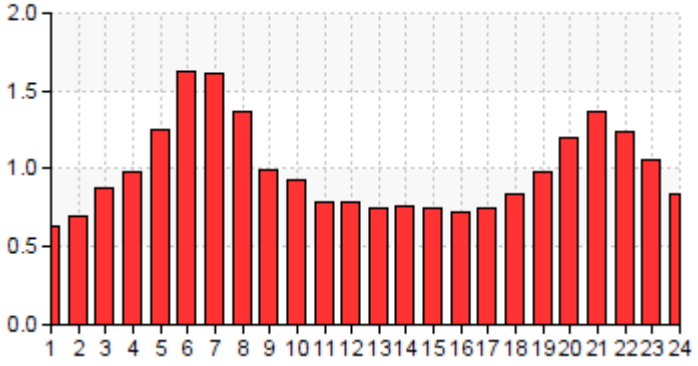


Figure 18 – C-1 Diurnal Demand Multiplier Pattern

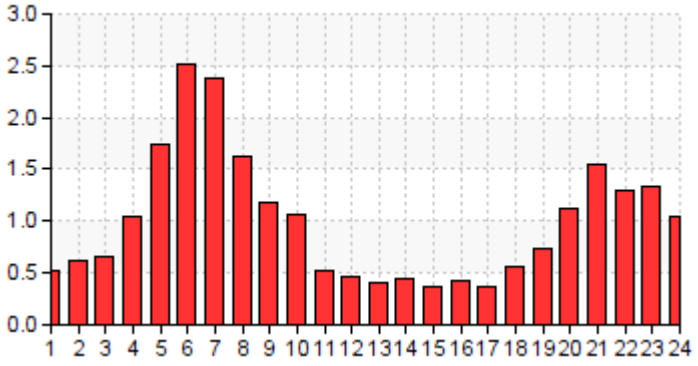


Figure 19 – R – 1 Diurnal Demand Multiplier Pattern

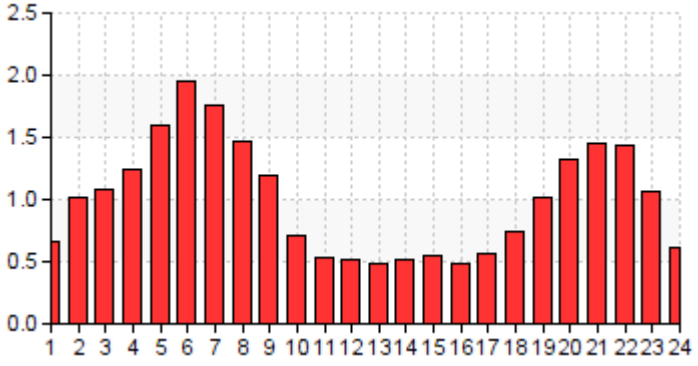
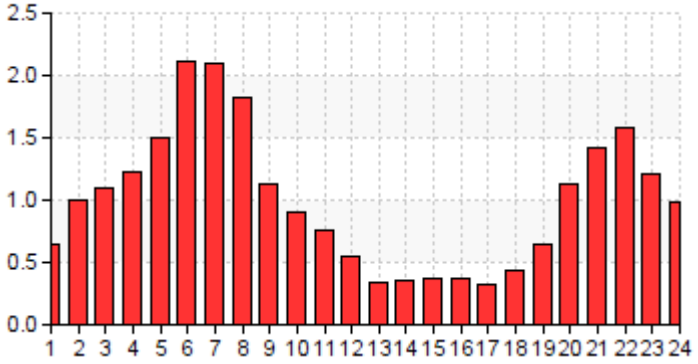
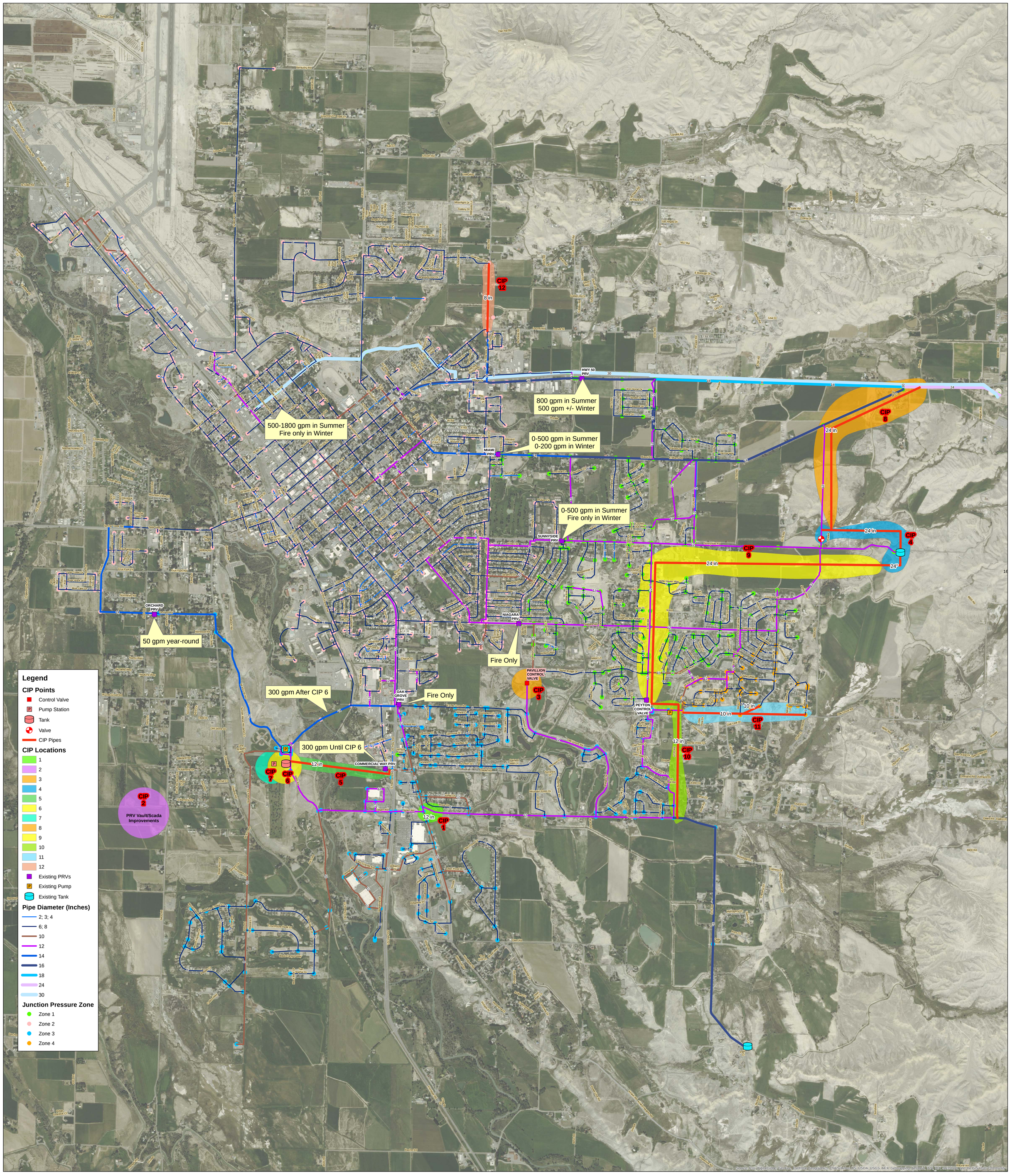


Figure 20 – R – 2 Diurnal Demand Multiplier Pattern



sFigure 21 – R – 3 Diurnal Demand Multiplier Pattern



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1/15/2016

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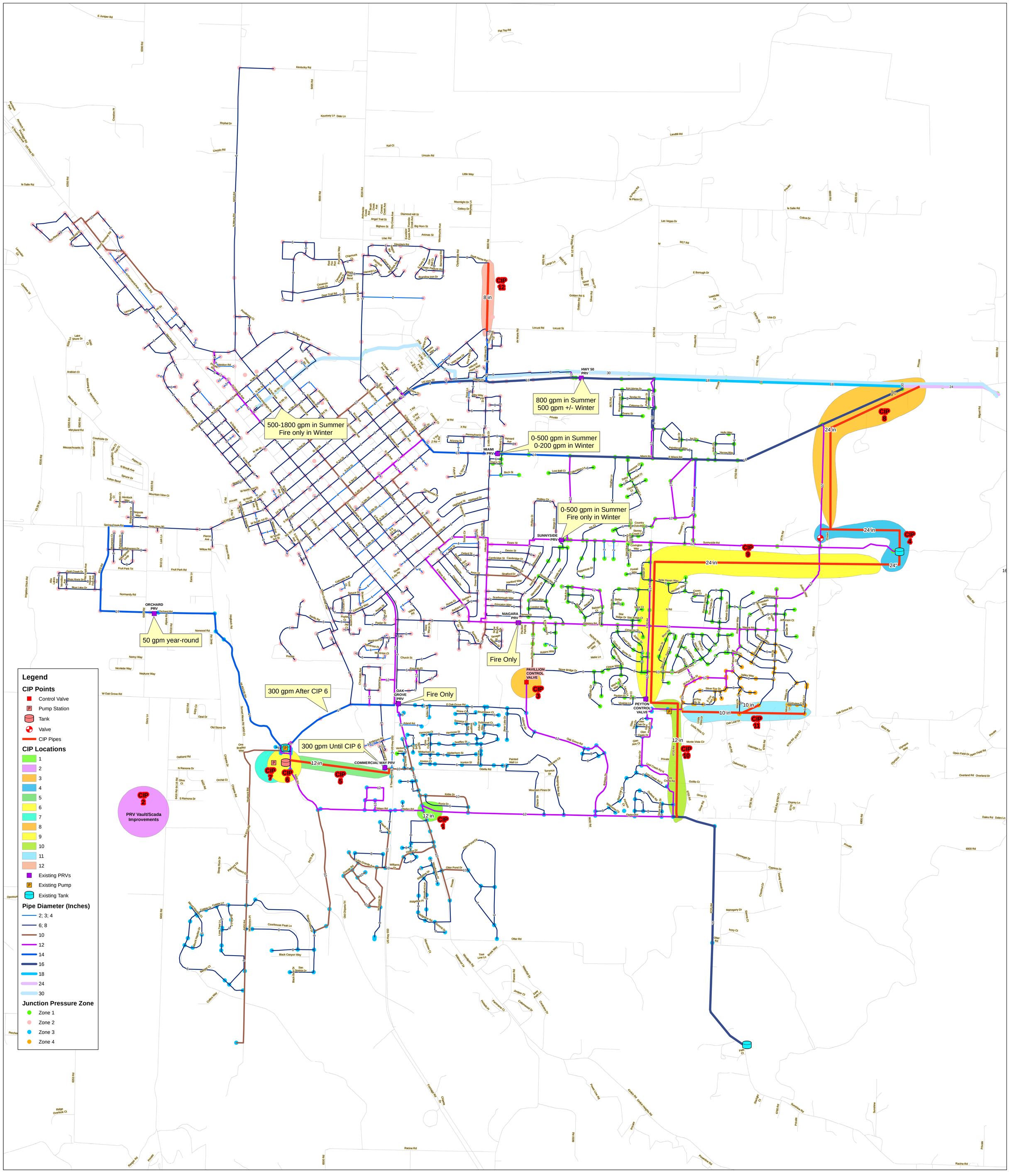
Montrose Water System CIP Map



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Montrose Water System CIP Map