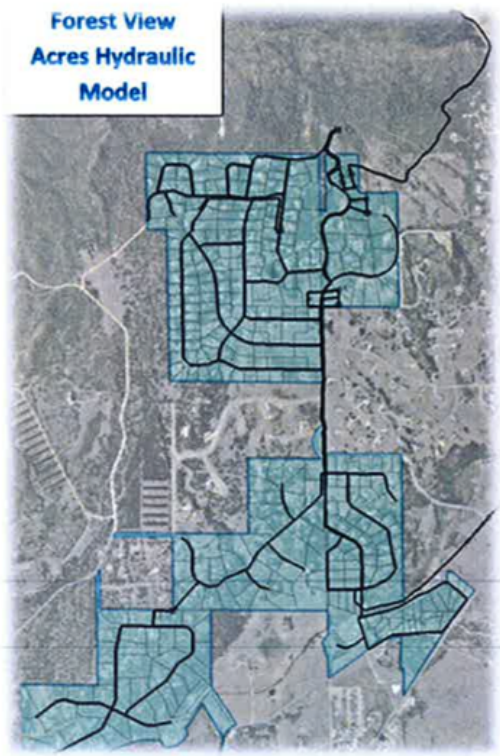
Prepared for:

Forest View Acres Water District
18852 Rockbrook Rd.
Monument Springs, Colorado 80132

WATER DISTRIBUTION SYSTEM MASTER PLAN – JUNE 2013



Final
June 4, 2013

BASELINE
Engineering · Planning · Surveying

FVAWD Master Plan
Summary

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MASTER PLAN SELECTED ALTERNATIVE SUMMARY

This Master Plan is a large document that contains very detailed design information. This document:

- Describes the Forest View Acres Water District's (FVAWD) present situation.
- Identifies existing infrastructure problems related to the potable water distribution system.
- Provides unique solutions.
- Makes a recommendation and gives a sustainable path for the FVAWD to follow for upgrading their distribution system.

At the request of the FVAWD, this section was created to provide future members with a description of the chosen design Alternative without having to read through the entire document. The entire Master Plan document follows this section if additional detailed information is needed.

INTRODUCTION

Baseline Engineering Corp. was retained by the FVAWD in August of 2012 to develop a hydraulic model of the distribution system and subsequent Master Plan that will be a roadmap for capital deployment over the next 20 years. A Master Plan is a planning document that provides communities with a roadmap into the future. The goal of this Master Plan is to provide the FVAWD with technical, economic, and operational support for upgrades to their distribution system. These goals will be followed by corrective actions or proposed additions to the existing water systems. Alternative methods to achieve these goals will be reviewed and evaluated based upon economic, societal, and environmental impacts. Prioritization of these improvements outlined chronologically over a 20 year planning period will establish the framework for this Master Plan.

OBJECTIVES

FVAWD identified that there are several deficiencies with the existing water infrastructure ranging from supply, treatment, storage, and distribution. Due to the extremely high water loss rate in the distribution system, the main objective of the Master Plan is to identify and recommend upgrades to the aging distribution infrastructure in an effort to significantly reduce water loss. These upgrades will result in a robust system that is easy to operate and maintain while consuming as little power as possible.

Hydraulic Modeling Design Philosophy

In order to develop a robust Master Plan, a reliable hydraulic model must be developed that utilizes state-of-the-art software, industry standard hydraulic modeling practices, and sustainable engineering concepts. Land surveying is typically the first technical aspect of creating a reliable hydraulic model. A survey defines the vertical and horizontal layout of the land along with vertical topographic information. A sound survey is critical in establishing accurate base information by which to create proposed designs.

After a survey is complete the hydraulic model can be created by inputting record drawing information of existing infrastructure that will be repurposed and strategically entering system demands. The result of this hydraulic model will yield a list of recommendations ranging from where to place additional storage, what lines should be upsized, where pipe looping should be implemented, which pump stations need upgrades, and more. Coupled with these recommendations, conceptual designs and associated opinion of probable costs for the upgrades in Section 6 were generated.

Summary of Distribution System Upgrades

A new distribution system was designed to re-purpose all of existing pipe that was installed in the past 5-yrs, which accounts for 20% of the existing pipe. At the request of FVAWD all of the existing piping in the distribution system, with the exception of the 20% re-purposed, was to be modeled as new pipe. The new system eliminates water loss and improves water quality. It also significantly reduces power consumption by utilizing the 650-ft of vertical drop across the system to provide a three-zone, gravity-fed distribution network that results in consistent pressures while meeting all demands including fire flows.

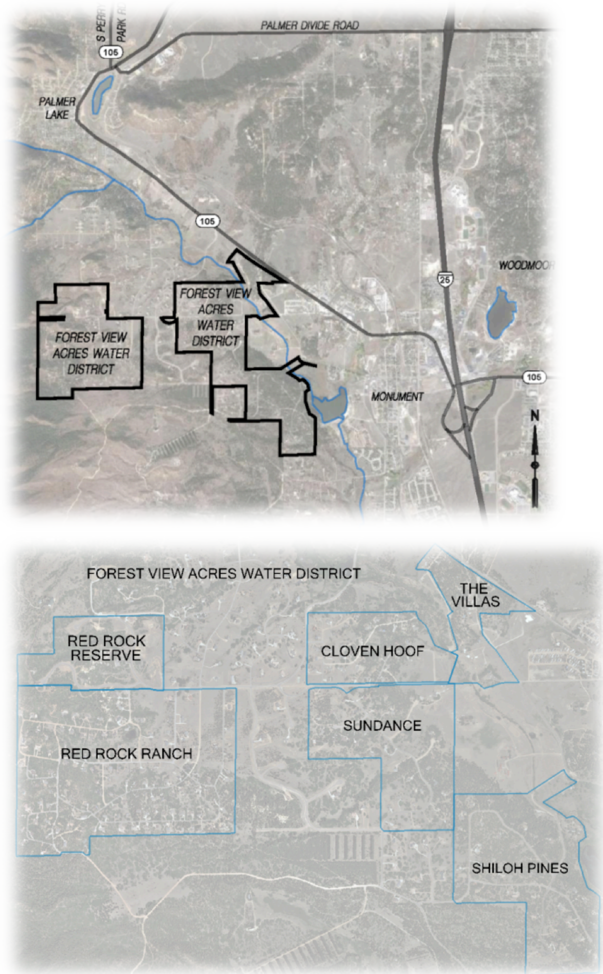
In order to provide robust control (and power to select sites currently relying on solar) a fiber optic system will be primarily installed in open pipe trenches that will connect the critical components of the FVA infrastructure.

Location

The FVAWD is located in the northwest corner of unincorporated El Paso County, Colorado between the base of Mount Herman and Colorado State Route 105. The FVAWD serves customers in three non-contiguous areas of land. Within the six subdivisions of the FVAWD, there are approximately 352 residential lots, 299 of which currently have houses built on them. The subdivisions served by the FVAWD are Cloven

Hoof, Red Rock Ranch, Red Rock Reserve, Shiloh Pines, Sundance, and The Villas. A site location and layout map of the FVAWD can be seen below.

Site Location and Layout Map of the FVAWD



Growth Areas & Population Trends

FVAWD's service area comprises of 100% residential customers. Currently, there are 352 lots, 299 of which are occupied. The subdivisions served by the FVAWD are Cloven Hoof, Red Rock Ranch, Red Rock Reserve, Shiloh Pines, Sundance, and The Villas. Please refer to the following table that depicts the water demand of each sub-division and the respective number of built-out lots versus vacant lots.

FVAWD Subdivision Lot / Demand Breakdown

Neighborhood	Current Lot	2012 Avg. Day Demand (gpd/neighborhood)	Vacant Lot	Future Avg. Day Demand at Build-Out (gpd/neighborhood)	Total Lots
Cloven Hoof	44	9,438	13	12,675	**57**
Red Rock Ranch	141	35,391	18	39,873	**159**
Red Rock Reserve	8	2,498	18	6,980	**26**
Shiloh Pines	44	13,919	2	14,417	**46**
Sundance	40	9,363	0	9,363	**40**
The Villas	22	3,722	2	4,220	**24**
Total	**299**	**74,331**	**53**	**87,528**	**352**

It is anticipated that the remaining service area will be built out over the next 10-15 years. There are no definite plans for expanding the service area to adjacent lands. Therefore, it has been assumed that no expansion of the water FVAWD boundaries will occur.

Water Demands

The demands are based on monthly meter readings provided by the FVAWD from January to September of 2012 which are reported to the closest 100 gallons. Each resident was broken into an Average Day Winter and Average Day Summer. For the winter demands the total monthly demands of January and February were added and divided by 60 days (2012 was a leap year) to get an average daily demand. Likewise, the summer demands were taken as the total of the months of June, July, and August divided by 92 days. These values for each residence where then converted to gallons per minute and geographically assigned to nodes in the hydraulic model.

Typical peaking factors for Maximum Day Demand generally range from 1.2 to 3.0. Since the FVAWD was on watering restrictions during the time the meter readings were taken the Maximum Daily Demand was determined by multiplying the Average Day Demand by a peaking factor of 3.0.

From the monthly meter readings the average daily demand was determined to be 74,331 gallons per day which equates to 249 gallons per day per residence. To obtain the average daily build-out demand, the 53 vacant lots were multiplied by 249 gallons and added to the current demand. This equates to an average daily demand of 87,528 gallons per day. In the Preliminary Engineering Report prepared by RG and Associates, it has the 2011 average demand at 83,535 gallons per day and the build-out (2031) average demand at 104,049 gallons per day. This discrepancy in demands is most likely due to the fact that the district was on watering restrictions in 2012. To accommodate for this a peaking factor of 3.0 has been used while previously a peaking factor of only 1.42 was used. It is recommended that watering restrictions that took place in 2012 are continued to help conserve water and lessen the demand on the system.

To better approximate the time-varying demands, a diurnal curve was applied to all of the demands in the system. A figure of a diurnal curve can be seen below.

Diurnal Demand Curve for Typical Residential Community

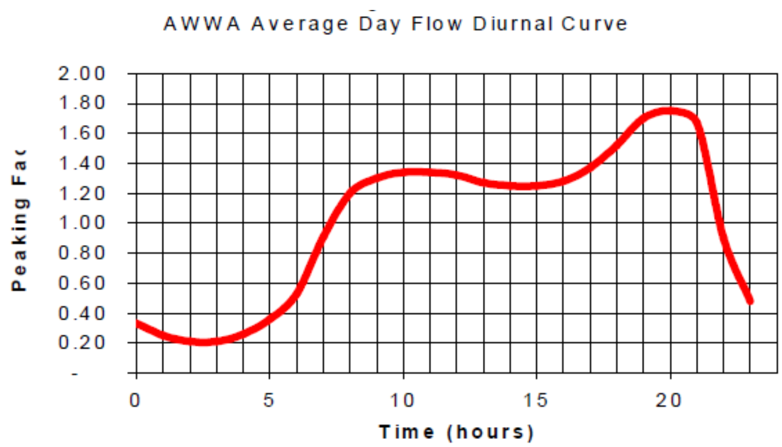


Figure 2
AWWA Average Day Flow Diurnal Curve
(Source: AWWA Manual M32)

PROPOSED PROJECT

Alternative #2 was selected because it satisfied the scope criteria and was the least expensive to implement. A phased implementation of the Project, as identified in the CIP in Section 6, should result in immediate improvements to operation and maintenance costs.

PROJECT DESIGN – ALTERNATIVE #2

The following major improvements are being proposed for the distribution system upgrades under Alternative #2:

Zone Dedicated Storage Tanks - Utilizing existing 250,000-gal UZ and new 10,000-gal MZ and LZ tank:

- Provide a reliable driving force to move the water throughout the distribution system while satisfying all pressure criteria for various demand conditions eliminating 7 of the 9 exsiting PRVs
- Provide water storage to satisfy the max day demand equalization storage, plus the larger of the fire storage or emergency storage
- Power and controls can be placed in new dedicated fill / drain pipe trench for the UZ tank mods

PRVs - Strategically adding two line PRVs and several customer PRVs in the distribution system:

- Allows for robust pressure management, so as not to exceed 80-psi
- Allows high flow events in distribution system not to be restricted at PRV station
- Remoteness of PRV prevented energy recovery portential use through micro-turbine

PSVs - Strategically adding parallel PSVs at LZ and MZ fill line from UZ tank:

- Prevents fill water from UZ tank from taking the path of least resistence to LZ tank only
- Backpressure from UZ tank provides ample fill pressure and flows to accomodate smaller 10,000-gal LZ and MZ tanks
- Minimal flow and runtime prevented the use of micro-turbine for energy recovery...ROI exceeded 20-yrs

Modified Distribution System Configuration - Properly sized, looped distribution network connected to new gravity tanks :

- Promotes flow of water throughout the pipes for all demand scenarios within the headloss and velocity criteria
- Results in water ages less than industry standard of 10-days at all points in the distribution system
- Allows redundant feed between UZ and MZ through emergency PRV interconnect

Modified Pumping - AWTP delivery chain modification to ILBPS and from ILBPS to UZ tank:

- Allows existing pumps to be re-purposed with slight modifactions to controls that promote consistent operation in BEP and firm capacity with addition of one more 20-HP pump
- PSVs on ILBPS discharge to be replaced with slow closing check valves, while PSVs are re-purposed for the fill line at the LZ tank
- Controls on fill line at LZ tank prevent ILBPS from pumping in circle

Definitions:

- UZ Tank – (Upper Zone) This is the existing 250,000-gal tank at the top of the system
- MZ Tank – (Middle Zone) This the new 10,000-gal tank that will be installed at the Surface Water Treatment Plant (SWTP)
- LZ Tank – (Lower Zone) This the new 10,000-gal tank that will be installed at the In-line Booster Pump Station (ILBPS) on the suction side of the pumps
- PRV – (Pressure Reducing Valve) This valve regulates pressure to maintain pre-set downstream settings
- PSV – (Pressure Sustaining Valve) This valve regulates pressure to maintain pre-set upstream settings
- AWTP – (Arapahoe Water Treatment Plant)
- CDPHE – (Colorado Department of Public Health & Environment) The state agency that approves all tank designs

General Control Description – Alternative #2

This section reveals the supervisory control description for Alternative #2. The purpose of this section is not to get into the detailed controls of each component but rather how they communicate and rely on each other to move water from the treatment plants to the customer. Please refer to the overall Alternative #2 Schematic on the following page.

The supply chain components consist primarily of the:

1. SWTP treatment and booster pump
2. AWP, AWTP and in-line booster pump station at the AWTP (not shown)

The distribution chain components consist primarily of the:

1. UZ tank - existing 250,000-gal tank
2. MZ tank and fill / drain lines - new 10,000-gal tank at SWTP
3. LZ tank, LZ pump station and fill / drain lines – new 10,000-gal tank at ILBPS
4. Two duty PRVs - 1 in Shiloh Pines; 1 in the Villas
5. One emergency PRV Interconnect in Red Rock Ranch connecting UZ to MZ
6. Associated distribution system piping consisting of 4-in, 6-in, and 8-in pipe

The primary source of water continues to be the SWTP due to its quality and higher elevation allows for gravity feed to the lower zones. The AWTP is the secondary water source and is turned on to augment the demand when either the SWTP cannot keep up, or if the water in Monument Creek is not available due to freezing or scarcity.

Prior to the upgrades, the UZ tank was a true “floating” tank that had a common inlet and outlet. Both the AWTP and the SWTP turned on/off based off of levels in the UZ tank. In Alternative#2, the SWTP continues to turn on/off based on this level in the UZ tank, but the AWTP now looks at the LZ tank for on/off permission, as described in further detail below.

Currently, the SWTP requires a chlorine contact loop just outside of the facility in order to meet disinfection CT requirements, set forth by CDPHE, prior to delivery to the first customer. The new configuration leaving the SWTP eliminates the contact loop and enters directly into the UZ tank in a dedicated fill line so as to promote efficient mixing, meet CT requirements, and eliminate dead spots. A dedicated drain line feeds the homes in the UZ and fills the MZ and LZ tanks via the existing 4, 6 and 8-inch transmission line as indicated through local level control at the tanks.

Note: All percent full levels in the following description are just general guidelines effectively used in the extended period simulations. Percent full levels should be variables in the control logic that can be easily changed to allow dynamic control of the system depending on the time of the year.

<u>High Demand Scenario Logic (> 50 gpm)</u>

As the level in the UZ tank drops below, 80% full, the SWTP plant turns on until the water level reaches 85% full, provided there is water to flow from the creek and the SWTP is in operating condition. Otherwise the SWTP is offline and the AWTP chain is filling the system. If the level in the UZ tank continues to drop to < 75% full with the SWTP on, and if LZ tank is above 75% full, the LZ pumps energize to move the water out of the LZ tank and into the UZ tank to help augment flow until the level in the LZ tank drops to below 50% full, at which point the LZ pumps turn off. The LZ pump sequence should always start with the smaller 7.5-HP pump as the lead, followed by the larger 20-HP only, then followed by both the 20-HP and 7.5-HP pump operating in parallel to satisfy the highest demand event in the either the UZ or MZ. Some of this water from the LZ pumps may be shed to fill the MZ tank on the way up to the UZ tank to help augment demands in the MZ. As the water drops below 75% full in the LZ tank, the AWTP well pump and in-line booster chain energizes and follows the same start-up sequence as is currently implemented to try and maintain a 75% to 80% full target in the LZ tank. The only difference in the AWTP pump chain is that now the system turns on/off to maintain a relatively constant level in the LZ tank as opposed to the UZ tank. If the water in the LZ tank drops below 50% full while the LZ pumps are on, the LZ pumps turn off to let the level rebound to 80% full in the LZ tank as the AWTP pump chain fills the tank.

If the LZ tank gets above 80% and the UZ tank is > 80% full, the system acts as if it is in a "Low Demand Scenario" logic, and tries to maintain a 75% to 80% full status for all the tanks as detailed below.

Low Demand Scenario Logic (<= 50 gpm)

In a low demand scenario, the AWTP pump chain never turns on, and the SWTP feeds the UZ tank that feeds the entire distribution system, provided the SWTP is available. The UZ will be fed directly from the UZ tank. The UZ tank will also feed the MZ and LZ tanks. Level control in the MZ and LZ tanks will open the smaller of the two parallel PSVs to fill the tank accordingly. A ratio valve control set-up on the PSVs will open more as the level drops and throttle back as it reaches the high water level. If the smaller PSV cannot keep up with the level in the LZ or MZ tank at full open, the larger of the two PSVs turns on in parallel, until the level rebounds to 75% full at which point the larger PSV slowly closes so as not to hammer the system.

If the level in the UZ tank drops below, 80% full, the SWTP plant turns on until the water gets the level back to 85% full provided there is water to flow from the creek and the SWTP is in operating condition. If the level in the UZ tank continues to drop to < 75% full with the SWTP on, it prompts a "High Demand Scenario" logic and the system responds per high demand logic previously stated.

Distribution System Pressure Management - PRVs

As water moves through the distribution system there are two areas that require main line PRVs, the Villas and Shiloh Pines. There is an additional emergency interconnect PRV station located in Red Rocks Ranch that can be opened manually in the event the MZ tank was out of service it can feed the MZ from the UZ. These three PRV stations will be housed in sub-grade concrete vaults and configured as detailed in Section 5.2.4. The Villas and Shiloh Pines PRVs will passively manage system pressure with hydraulic pilot controls that will require periodic maintenance. In a parallel configuration the secondary PRV (ie: the larger of the two) downstream setting should be 7-psi greater than primary (ie: smaller) PRV downstream setting. This will allow the primary PRV to handle the lower flows, and in the event a high demand scenario occurs downstream of the PRV the secondary PRV will open. A parallel configuration will also allow for maintenance of one PRV while the other can still operate on a temporary basis as the duty.

Upgrades – Alternative #2

As a general note regarding enhancement to the overall control and operation of the FVAWD supply and distribution chain, installing power and control conduit in open pipe trenches that connect the UZ tank to the SWTP, MZ tank, LZ tank and AWTP is recommended. Conductors and fiber optics can be pulled whenever it makes financial sense. However, according to the Cost Estimate, this is not a costly upgrade if can be placed in an open trench.

The major system upgrades under Alternative #2 can be classified as follows. Reasoning behind the specific upgrade is provided.

ZONE DEDICATED GRAVITY TANKS

Storage tanks in distribution systems serve three main purposes:

- **PRESSURE - Provide the driving force to move the water throughout the distribution system while satisfying all pressure criteria for various demand conditions.**

  A gravity fed distribution system is the most efficient method of delivering water to customers when sized and located properly. Fortunately, FVAWD owns land where intermediate tanks can be placed approximately every 200 vertical feet throughout the distribution system, while utilizing the existing 250,000-gal UZ tank as the highest water source. Currently, the UZ tank, located 650-ft in elevation higher than the lowest customer, floats the entire system. PRVs are placed throughout the distribution system to reduce the pressures where needed, however the best method of dedicating a zone is to break the pressure head by using a storage tank located at the proper elevation.

  If the difference in hydraulic grade lines between the water surface elevation in the tank and the elevation of the lowest customer exceeds 231-ft, or 100-psi:

  1) PRVs may be needed per CDPHE to reduce the household pressure to within acceptable limits.
  2) The storage tank should be located at a lower elevation if it makes financial sense
  3) Both 1) and 2).

  For this alternative, the existing land and supporting infrastructure allowed two main line PRV stations and several individual home PRVs, as indicated in Section 6.3.2 – PRVs, to be strategically placed. Please refer to Section 5.2.5 – Storage Tank Design Criteria for a graphical explanation of the elevation/pressure relationship. Also, please refer to the 72-hr Average Day Model Output tables in APPENDIX F to see where the excessive pressure may occur.

  The risk of high pressure spikes (otherwise known as “water hammer” or “hydraulic transient”) from pumps turning on/off should no longer be an issue, because the entire distribution system is gravity fed from the water surface of the tank. Any transient that may occur with a quick closing valve will dampen in the storage tank closest to the source of the transient. Properly sized hydropneumatic tanks will also assist in surge dampening during pump transitioning.

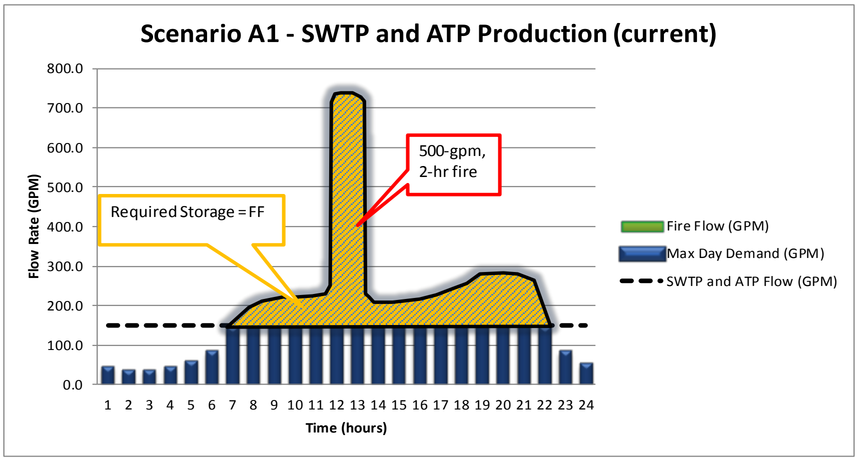
- **STORAGE - Provide water storage to satisfy the max day demand equalization storage, plus the larger of the fire storage or emergency storage, while not oversizing the system in order to avoid water quality issues due to excessive water age.**

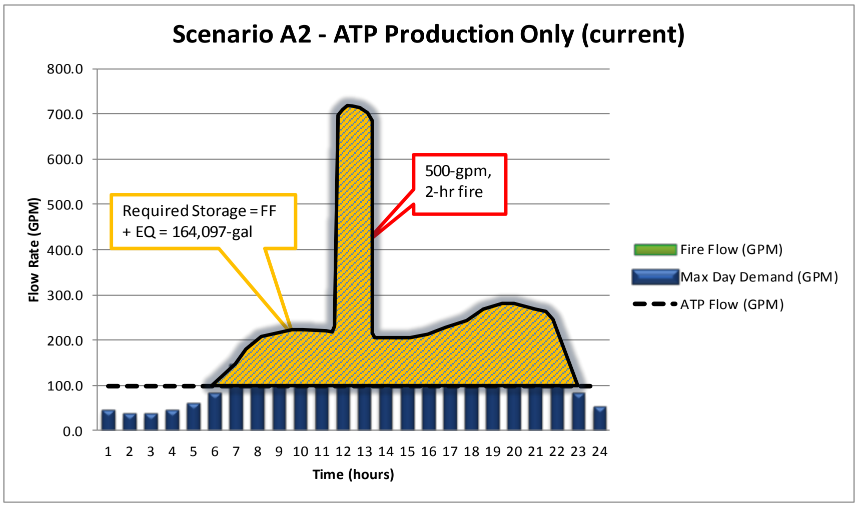
  Various demand scenarios were modeled during the 72-hour EPS to see how the system responded to the changing hydraulics. The two main scenarios used to validate the 270,000-gallons of storage in Alternative #2 (250,000 UZ tank + 10,000-gal MZ tank + 10,000-gal LZ tank) was Max Day + Fire Flow (current = A) and Max Day + Fire Flow (future – build out condition = B). Each demand scenario has three sub-scenarios as follows:

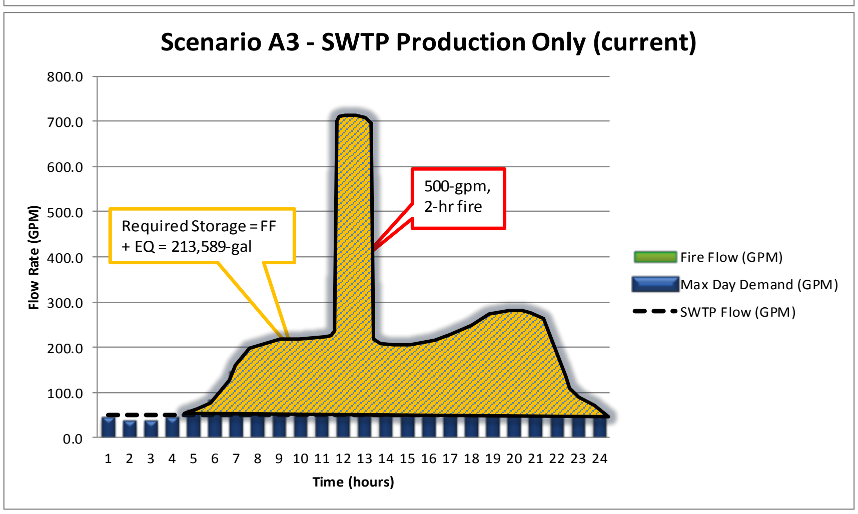
  1 – SWTP and AWTP Production
  2 – AWTP Production Only
  3 – SWTP Production Only

The 270,000-gal of storage is ample to supply water for the Max Day + Fire Flow for both current and build-out scenarios as can be seen in the Current Storage Tank Sizing Analysis and Build-Out Storage Tank Sizing Analysis figures on the following pages. However please refer to the Critical Facilities Analysis discussed in Section 6.3.8 to see how the system responds to a 3-day outage of either production facility or both production facilities.

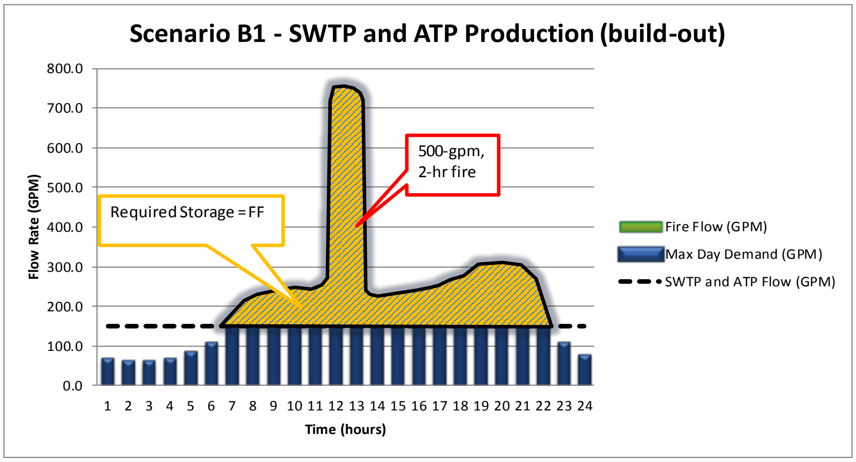
Storage Tank Sizing Analysis (current)

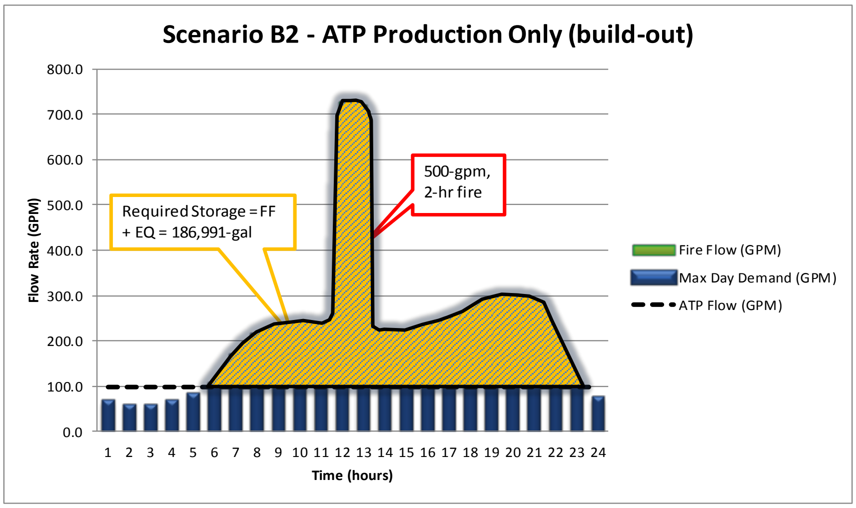


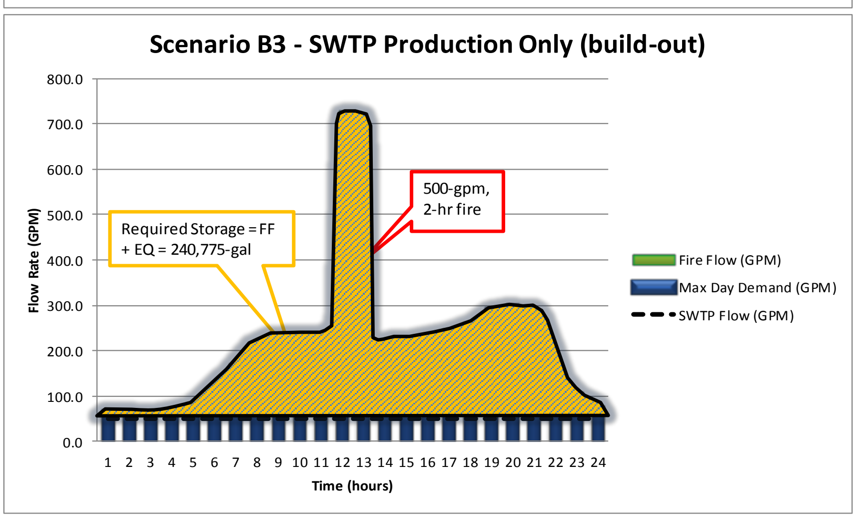




Storage Tank Sizing Analysis (build-out)


Scenario B1 - SWTP and ATP Production (build-out)
Flow Rate (GPM)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)
500-gpm, 2-hr fire
Required Storage = FF
Fire Flow (GPM)
Max Day Demand (GPM)
SWTP and ATP Flow (GPM)


Scenario B2 - ATP Production Only (build-out)
Flow Rate (GPM)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)
500-gpm, 2-hr fire
Required Storage = FF + EQ = 186,991-gal
Fire Flow (GPM)
Max Day Demand (GPM)
ATP Flow (GPM)


Scenario B3 - SWTP Production Only (build-out)
Flow Rate (GPM)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (hours)
500-gpm, 2-hr fire
Required Storage = FF + EQ = 240,775-gal
Fire Flow (GPM)
Max Day Demand (GPM)
SWTP Flow (GPM)

- **CHLORINATION - Provide an opportunity to re-boost the free chlorine residual as needed and provide the contact time volume requirements needed to properly disinfect water.**

  Under the new SWTP / UZ tank configuration, there is plenty of disinfection contact time (CT) in the UZ tank now that it operates on a dedicated fill and drain line prior to going to the first customer. No changes need to be made to the existing SWTP chlorination system. However, it is recommended that a liquid sodium hypochlorite disinfection system with compound loop controls be installed at the MZ and LZ tank in order to boost the free chlorine levels at the tank if they were to ever fall below range per Section 6.3.1.1 – Support Equipment. No changes need to be made to the SWTP chlorination if a dedicated fill line is installed. The contact chlorine loop is still needed to meet disinfection CT criteria, if the common fill line remains in service.

SUPPORT EQUIPMENT

In order for the storage tanks to operate effectively, support equipment like specialty valves, pumps, controls and booster chlorination is essential.

1. Specialty Valves

   As previously mentioned, a parallel PSV configuration is needed on the LZ tank and MZ tank inlet as described in Section 5.2.4. This parallel large/small PSV configuration will ensure the PSVs operate in their sweet spot during all flow conditions and will keep the transmission line from the LZ tank to the UZ tank pressurized at all times.

   An additional hydraulic analysis was performed due to the elevation difference between both the LZ and MZ tank HGL (water surface elevation) and the elevation of the buried tank discharge pipeline crown in the adjacent road. This hydraulic analysis revealed the HGL does not drop below the crown of the pipe at a low water level in the respective tank during a high flow, max day + fire flow, 600-gpm event thereby preventing a vacuum event.
   The micro-turbine feasibility analysis revealed that installing a micro-turbine in lieu of a PSV to keep the upstream line pressurized and create electricity was not an economical option. The amount of electricity generated from the average day flow and pressure differential would result in a payback in excess of 20-yrs. However, in the event the costs of turbines decrease in the future, or the unit cost of electricity increases from $0.10 per kWh (which was used in the model) to north of $0.20 per kWh, an extra spot in the fill manifold for the LZ and MZ tanks can be easily made to allocate a future micro-turbine.

2. Pumps

Both 20-HP and 7.5-HP pumps at the LZ tank can be re-used under the re-configured distribution system under Alternative #2 and operate in their best efficiency range. The existing PSVs on the discharge of the pumps will be re-purposed as the fill lines for the MZ tank. Slow closing check valves will replace the PSVs on the discharge side of the pumps. Prior to re-purposing the pumps, it is recommended that the pump manufacturer certify the performance of the pumps and overall condition prior to re-purposing.

The existing pumps at in the AWTP chain will remain as is with the exception of moving the on/off signal from the UZ tank to the LZ tank. The existing pump system at the SWTP will remain the same, with no changes.

3. Controls

Controls at the MZ and LZ tank site will control the status of a main line motorized isolation fill valve downstream of the PSVs. As previously mentioned, the LZ pumps energize when the level in the UZ tank drops to a predefined set-point, and de-energize when the level in the LZ tank drops below a low water level set-point, or the UZ tank rebounds to within acceptable limits. While the LZ pumps are on, the PSV fill line motorized isolation valve is slowly closed in order to prevent re-circulation of the water. When the pumps turn off, the LZ tank isolation valve opens if the tank is calling for water from the UZ tank. Water from the AWTP chain does not fill the LZ tank when the motorized isolation valve opens unless the AWTP pumps turn on per previous control description.

The following is a list of instrumentation required for each tank site along with its purpose:

- UZ Tank
    - Ultrasonic level sensor – Placed appropriately in the tank, will give reliable and accurate level measurements.
    - Magnetic flow meter – One flow meter placed on the outlet of the tank will reveal the zone demand. NOTE: Verify potable water conductivity in FVAWD system meets the conductivity requirements for typical magnetic flow meter, otherwise alternative flow measuring devices should be used.

- MZ Tank
    - Ultrasonic level sensor – Placed appropriately in the tank, will give reliable and accurate level measurements.

    - Magnetic flow meter – One flow meter placed on the outlet of the tank will reveal the zone demand. NOTE: Verify potable water conductivity in FVAWD system meets the conductivity requirements for typical magnetic flow meter, otherwise alternative flow measuring devices should be used.
    - Local Programmable Logic Controller – One PLC will control the local control of the site fill valves based on level in the tank.

- LZ Tank
    - Ultrasonic level sensor – Placed appropriately in the tank, will give reliable and accurate level measurements.
    - Magnetic flow meter – One flow meter placed on the outlet of the tank to the LZ will reveal the zone demand, and an additional bi-directional flow meter placed on the discharge of the LZ pumps, on the common fill/drain line will not only reveal the operating point and subsequent efficiency of the pumps, it will also reveal the amount of water feeding the LZ from the UZ. NOTE: Verify potable water conductivity in FVAWD system meets the conductivity requirements for typical magnetic flow meter, otherwise alternative flow measuring devices should be used. Also, an additional magnetic flow meter can be installed
    - Local Programmable Logic Controller – One PLC will control the local control of the site fill valves based on level in the tank.
    - Pressure gauges and transmitters – When installed on the suction and discharge of the pump will help reveal efficiency and operating point when coupled with flow data.

4. <u>Booster Chlorination</u>

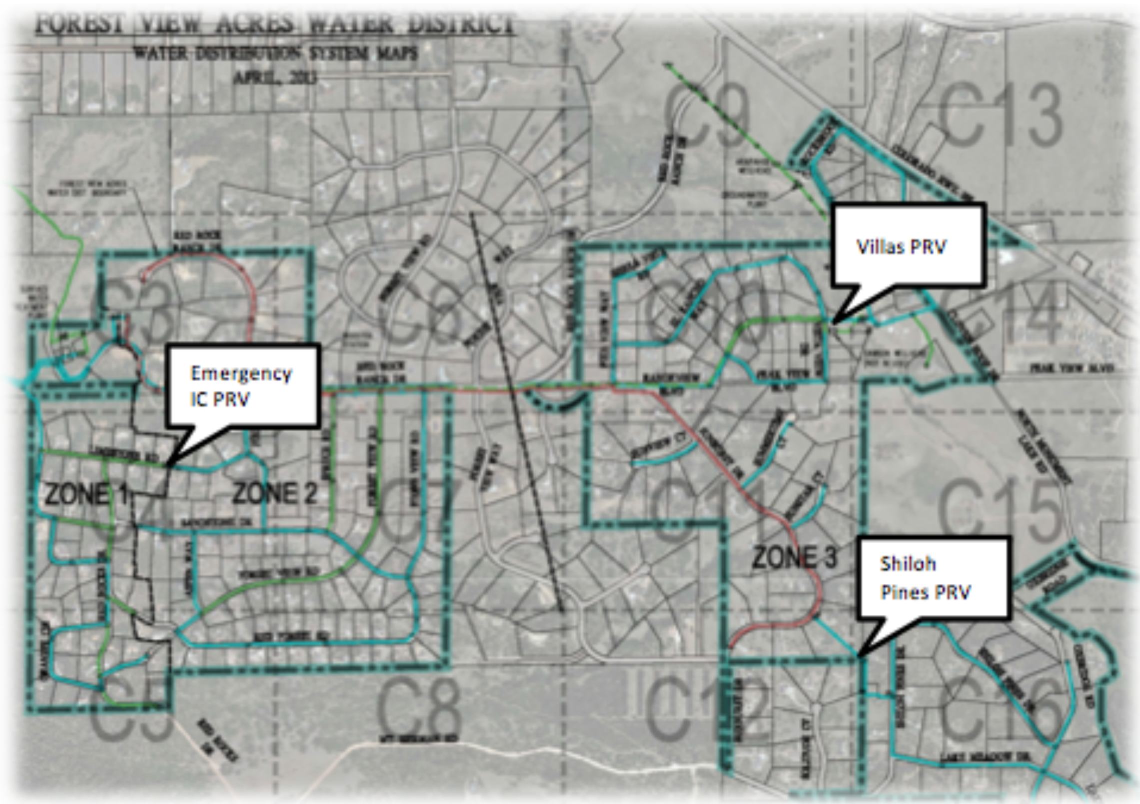
A booster chlorination system is recommended to ensure acceptable free chlorine residuals at the LZ and MZ tanks. The compound loop control utilizes an on-line free chlorine analyzer on the inlet and discharge of the LZ and MZ tank to flow pace sodium hypochlorite into the tank based on the residual upstream and downstream levels. If free chlorine residual leaving the tank is within range, the system remains offline, otherwise it flow paces accordingly.

PRVs

PRVs in distribution systems serve one main purpose:

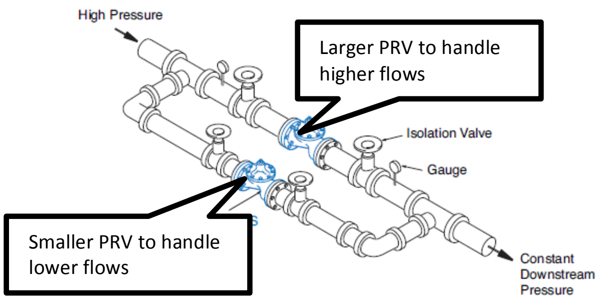
- **PRESSURE MANAGEMENT - Reduce excessive upstream pressures within a wide range of flows to within acceptable downstream limits with the use of hydraulic pilots that throttle the valve.**

There are two areas in the LZ that require duty PRVs; one in Shiloh Pines and one in the Villas. An additional emergency interconnect PRV is required in Red Rock Ranch so that the UZ can feed the MZ in the event of a tank outage. Please refer to the following Map of Three PRV's in Alternative #2 Figure for a graphical depiction of where the three PRVs are located. There are small pockets in the Villas and Shiloh Pines where individual home PRVs must be installed per the current average day demand output tables in APPENDIX F.



Each of the three main line PRV stations will look similar to the following Sample Isometric Drawing of PRV Vault figure and will be located in a sub-grade concrete vault rated for H-20 traffic loading.

Sample Isometric Drawing of PRV Vault



PIPES

Pipes in distribution systems serve one main purpose:

- **WATER DISTRIBUTION - Effectively, reliably and safely transfer water from treatment to the individual customer.**

The revised piping configuration in Alternative #2 consist of 4-in, 6-in and 8-in pipe in order to meet the design criteria set forth in Section 5.2.1 for all demand scenarios. Looping pipe was performed wherever financially and hydraulically feasible in order to improve system hydraulics and provide redundant means of supply in the event of a line break. Please refer to the following Pressure Piping Inventory in Alternative #2 figure for a quantity breakdown of existing pipe by size and neighborhood.

Pressure Pipe Inventory in Alternative #2

Neighborhood	EX 4" TR	PRO 4"	EX 6" TR	PRO 6"	EX 8" TR	PRO 8"	EX TOTAL	PRO TOTAL	TOTAL
The Villas		550		5,234			0	5,784	5,784
Cloven Hoof		1,099		7,189			0	8,288	8,288
Red Rock Ranch		8,629		17,039			0	25,668	25,668
Shiloh Pines				9,847			0	9,847	9,847
Sundance				2,069		4,085	0	6,154	6,154
Red Rock Reserve				854	5,313		5,313	854	6,167
Transmission	12,631		3,178	850		3,310	15,809	4,160	19,969
TOTAL	**12,631**	**10,278**	**3,178**	**43,082**	**5,313**	**7,395**	**21,122**	**60,755**	**81,877**

In the associated cost breakdown there are line items for fittings, valves, meters and fire hydrants per recommended valve spacing criteria in Section 5.2.1.

WATER AGE ANALYSIS

A water age analysis serves one purpose:

- **WATER QUALITY – The longer the water stays in the system the greater the risk of water quality degradation with respect to free chlorine residual and formation of disinfection by-product precursors.**

The system configuration in Alternative #2 resulted in water ages less than 10-days under the existing Average Day Scenario as indicated in Section 4.3. Only the existing Average Day Demand Scenario was used because as demand increases water age decreases.

CRITICAL FACILITIES ANALYSIS

A critical facilities analysis serves one purpose:

- **DETERMINE VULNERABILITY – Designing a distribution system to withstand prolonged periods of outages will not make financial or operational sense. However, a Critical Facilities Analysis will give the operator an idea of how much storage is available during certain "dooms day" events, or how to manipulate the pipe network to feed homes during pipe breaks.**

A 72-hour EPS was modeled for Alternative #2 with both the current demands and build-out demands during a max day demand event for the most probable "dooms day" scenarios as follows:

1. SWTP offline + AWTP online
2. AWTP off line + SWTP online
3. Both SWTP or AWTP offline
4. LZ tank off line + SWTP and AWTP online
5. MZ tank offline + SWTP and AWTP online

In all five events it is assumed the UZ tank was available at 90% full, and there was not a fire. The probability of 1-5 occurring the same time as UZ tank was offline and there was a fire was not a realistic scenario, and therefore was not modeled. Evacuation should be considered if this occurs.

The following Critical Facilities Analysis Results figure describes the result of a 72-hour period Max Day Demand EPS and the corrective action to be taken when the event occurs.

Critical Facilities Analysis Results

SCENARIO	Current		Build-out	
	72-hr EPS Result	Corrective Action	72-hr EPS Result	Corrective Action
1	All tanks drain in 44 hrs; UZ, MZ and LZ customers do not have water	Fix issue with SWTP; arrange for bladder tank storage at UZ tank	All tanks drain in 37 hrs; UZ, MZ and LZ customers do not have water	Fix issue with SWTP; arrange for bladder tank storage at UZ tank
2	All tanks drain in 35 hrs; UZ, MZ and LZ customers do not have water	Fix issue with AWTP; arrange for bladder tank storage at UZ tank	All tanks drain in 28 hrs; UZ, MZ and LZ customers do not have water	Fix issue with AWTP; arrange for bladder tank storage at UZ tank
3	All tanks drain in 19 hrs; UZ, MZ and LZ customers do not have water	Fix issue with AWTP & SWTP; arrange for emergency IC with Palmer Lake	All tanks drain in 18 hrs; UZ, MZ and LZ customers do not have water	Fix issue with AWTP & SWTP; arrange for emergency IC with Palmer Lake
4	All tanks drain in more than 72 hrs; UZ, MZ and LZ customers do not have water	Fix issue with LZ tank; provide temporary storage to fill from AWTP and connect to existing tank drain line	All tanks drain in 72 hrs; UZ, MZ and LZ customers do not have water	Fix issue with LZ tank; provide temporary storage to fill from AWTP and connect to existing tank drain line
5	All tanks drain in more than 72 hrs; UZ, MZ and LZ customers do not have water	Fix issue with MZ tank; open emergency PRV IC in Red Rocks Ranch to feed MZ from UZ	All tanks drain in 72 hrs; UZ, MZ and LZ customers do not have water	Fix issue with MZ tank; open emergency PRV IC in Red Rocks Ranch to feed MZ from UZ

Cost Estimate

The Cost Estimate in this section provides an itemized estimate of the project cost based on the anticipated period of construction. It includes development and construction, land and rights, legal, engineering, interest, equipment, contingencies, refinancing, and other costs associated with the proposed project. These estimated costs are prioritized due to the urgency of the improvements as stated in Table 4 Section 16 of the FVAWD Draft Capital Improvement Plan dated February 23, 2012.

Unit costs were taken from the following sources:

- Hard bid numbers for similar pipe projects in the past year from the Town of Castle Rock, courtesy of Mr. Tim Friday, Engineering Manager for the Town of Castle Rock

- List prices from USA Blue Book Version 124 (2013-2014)

- EIC Electric Engineers, Scottsdale AZ – Bid tab review for projects implemented in 2012 in AZ.

- Colorado Department of Transportation 2012 Cost Data Book

A significant effort was taken to provide the most efficient deployment of the FVAWD capital. Below is a list of opportunities that will enhance the quality of the upgraded distribution while saving capital in Alternative #2:

1. Re-purposing ILBPS Pumps to transfer the water from LZ tank to UZ tank

2. Replacing the PSVs on the discharge of ILBPS pumps with slow closing check valves; re-purpose these PSVs as the parallel fill valves for the LZ tank

3. Install power and control conduit to house 480 volt / 3 phase / 40 amp conductors and single mode fiber optics cable in pipe trench for new UZ tank fill or drain line and land at SWTP. Certified electrical engineer to verify the actual KVA and feasibility of this method bringing power and controls to UZ tank site prior to implementing.

4. Install control conduit and single mode fiber optics cable in pipe trench from MZ tank / SWTP to LZ tank; land at LZ tank PLC. Certified electrical engineer to verify the feasibility of this prior to implementing.

5. Install control conduit and single mode fiber optics cable in pipe trench from LZ tank to AWTP; land at AWTP PLC to complete final leg of control for all critical sites. Certified electrical engineer to verify the feasibility of this prior to implementing.

Alternative #2 Cost Estimate

Baseline Engineering JOB NO.: CO3114

Civil Engineers - Land Surveyors FILE: Preliminary Cost Estimate

FOREST VIEW ACRES WATER SYSTEM IMPROVEMENTS

PRELIMINARY ENGINEER'S COST OPINION - ALTERNATIVE #2

ENTIRE PROJECT

Designed by: SMB

Checked By: JW

Item #	Description	Unit		Qty	Unit Price	Capital Cost
		CONSTRUCTION MATERIAL COSTS				**$5,257,185**
1	Mobilization/Demobilization, Bonds, and Insurance	3%	of Const.	1	$157,715.55	$157,716
2	Additional Piping and Valving	5%	of Const.	1	$262,859.25	$262,859
3	Installation	20%	of Matl	1	$1,051,437	$1,051,437
4	Contractor Overhead and Profit	8%	of Const.	1	$420,575	$420,575
					SUBTOTAL	**$7,149,772**
5	Contingency	15%	of Total	1	$1,072,465.74	$1,072,466
			TOTAL CONSTRUCTION COST			**$8,222,237**
				ENGINEERING COSTS		**$406,918**
6	Design & Permitting,		LS	1	$334,012	$334,012
7	Construction Phase Services (includes RPR)		LS	1	$72,906	$72,906
				OTHER PROJECT COSTS		**$10,000**
8	Legal and Attorneys Fees to Acquire Land at ATP		LS	1	$10,000	$10,000
9	Land Acquisition at ATP		LS	1	$0	$0
10	Interim Financing (Construction Loan)		LS	1	$0	$0
11	Loan Refinance (Misc maintenance)		LS	1	$0	$0
12	Interest on Interim Financing (Loan)		LS	1	$0	$0
		TOTAL PROJECT PROBABLE PRESENT COST				**$8,639,156**
		Transmission Lines and Storage Tank Improvements				**$1,429,886**
					Villas	**$884,052**
					Red Rock Reserve	**$122,951**
					Cloven Hoof	**$1,015,330**
					Shilo Pines	**$1,207,235**
					Red Rock Ranch	**$3,104,422**
					Sundance	**$875,280**

Assumptions:

1.0 Construction Phase services assumes full time RPR for 10 hour days and assumes a pipe crew would lay 500 feet per day.

2.0 No soils report is available; therefore, soil conditon is assumed to be favorable.

3.0 Assumed deepth of bury of pipe is seven (7) feet.

4.0 In order to be conservative, all Annual O&M Costs were taken from 2009 - 2011 data for the entire FVAWD system, not just Distribution System, knowing that several categories should drastically reduce as upgrades are implemented to the system.

ANNUAL OPERATING BUDGET

INCOME

The FVAWD's current revenues are generated primarily from monthly base and user fee charges. Tap fees have historically been a source of revenue for the FVAWD, but with the downturn in the housing market these fees are not relied upon for annual budgets. The FVAWD has some of the highest rates in the state partially due to continuous costly system repairs.

<u>Forest View Acres Water Rates and Fees</u>

Water Usage	
Tier 1: 0 – 4,000 gallons	$8 per 1,000 gallons
Tier 2: 4,001 – 7,000 gallons	$12 per 1,000 gallons
Tier 3: 7,001 gallons & up	$16 per 1,000 gallons
Operations	$40
Capital Improvement	$47
Late Fee	$5

ANNUAL EXPENDITURES

The three year annual expenses for the FVAWD’s existing water system from 2009 to 2011 are listed in the following table.

Annual Expenses

Expenditures	Annual Average
Operations Manager	$65,381
Repairs and Maintenance	$88,285
Supplies and Chemicals	$7,723
Utility Pump Costs	$32,788
Water Testing	$3,576
Engineering	$11,713
$2M Loan Repayment	$100,000
District Management and Accounting	$71,424
Utility Billing	$24,773
Insurance/SDA dues	$7,907
Director’s Fees	$3,433
Legal	$35,083
Audit	$4,700

Treasurer's Fees	**$850**
Paying Agent Fees	**$267**
Other	**$13,292**
Emergency Reserve	**-**
Total Expenditures	**$471,194**

Depreciation and infrastructure project expenditures were excluded from the three year annual average expenses.

CAPITAL IMPROVEMENT PLAN

If steps are taken now to modify the existing system as describe in Alternative 2, FVAWD will start cutting costs associated with operations and maintenance of the system. Alternative 2 modifications will:

1. Increase pump efficiencies and lower utility pump costs

2. Replace old leaking pipe with new pipe. This will reduce costs associated with repairs and maintenance, and lower costs associated with supplies and chemicals as treated water will stay contained in the system.

3. Replace many dead ends with pipe loops reducing water age and increasing system flow rates.

4. Add booster chlorination to new tank sites to allow better management of chlorine residuals in the system.

5. Enhance pressure management and flow rates with new gravity storage tanks.

6. Add power and fiber optic control to the UZ tank and fiber optic control of all other major sites, such as SWTP, AWTP, MZ tank and LZ tank.

The cost reductions for operations and maintenance of the FVAWD system can be reinvested back into the system to fund additional infrastructure projects. FVAWD does not currently have enough free revenue to pursue all of the recommended modifications in Alternative 2. For this reason, a Capital Improvement Plan for FVAWD has been performed and can be seen on the following page.

Capital Improvement Plan Schedule

FVAWD Capital Improvement Plan Schedule - 2013						
URGENCY (YRS)	NAME	DESCRIPTION	OPC ($)	PROJECT IN SERVICE	PROJECT INITIATION	TRIGGER FOR INITIATION
0-5	Transmission Line / Tank Upgrades	Install 10 kgal tanks at LZ (former ILBPS) and MZ (at SWTP); pump re-configuration at LZ; hydraulicly connect LZ, MZ and UZ (250,000 gal) tanks	$1,429,886	2013	2013	Immediate need for fire flow, reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
0-5	Villas Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	$884,052	2013	2013	Immediate need for fire flow, reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
0-5	Red Rock Reserve New Pipeline	Install new pipe, hydrant, and valves	$122,951	2013	2013	Moderate need. Will be cheaper to install this piping with the transmission piping
0-5	Clovenhoof Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	$1,015,330	2017	2018	Immediate need for fire flow, reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
5-10	Red Rocks Ranch Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	$3,104,422	2019	2020	Moderate need for reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
5-10	Shiloh Pines Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	$1,207,235	2022	2023	Moderate need for reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
10-20	Sundance Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	$875,280	2027	2028	Long term need for reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency
10-20	Red Rock Reserve Neighborhood Pipeline Replacement	Replace all existing pipe per Masterplan Map Book; install new automatic meter reads at homes and hydrants where necessary	N/A	2027	2028	Moderate need for reduction in water loss / leak prevention, reliable pressure and flow, energy efficiency

If FVAWD phases the Alternative 2 recommended infrastructure projects as shown in the Capital Improvement Plan Schedule, FVAWD will start to realize operation and maintenance cost savings. If these savings are reinvested back into the system, additional infrastructure projects can be constructed. The expected operation and maintenance annual savings for each phase of Alternative 2 can be seen in the following Figure:

Baseline Engineering — JOB NO.: CO3114

Civil Engineers-Land Surveyors — FILE: Preliminary Cost Estimate

FOREST VIEW ACRES WATER SYSTEM IMPROVEMENTS
PRELIMINARY ENGINEER'S COST OPINION - ALTERNATIVE #2
ENTIRE PROJECT

Designed by: SMB
Checked By: JW

Item #	Description	Unit		Qty	Unit Price	Capital Cost
		CONSTRUCTION MATERIAL COSTS				$5,257,185
1	Mobilization/Demobilization, Bonds, and Insurance	3%	of Const.	1	$157,715.55	$157,716
2	Additional Piping and Valving	5%	of Const.	1	$262,859.25	$262,859
3	Installation	20%	of Matl	1	$1,051,437	$1,051,437
4	Contractor Overhead and Profit	8%	of Const.	1	$420,575	$420,575
					SUBTOTAL	$7,149,772
5	Contingency	15%	of Total	1	$1,072,465.74	$1,072,466
					TOTAL CONSTRUCTION COST	$8,222,237
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					OTHER PROJECT COSTS	$10,000
8	Legal and Attorneys Fees to Acquire Land at ATP		LS	1	$10,000	$10,000
9	Land Acquisition at ATP		LS	1	$0	$0
10	Interim Financing (Construction Loan)		LS	1	$0	$0
11	Loan Refinance (Misc maintenance)		LS	1	$0	$0
12	Interest on Interim Financing (Loan)		LS	1	$0	$0
					TOTAL PROJECT PRESENT COST	$8,639,156

Project Phase	Start	End	O&M Annual Savings	Present Cost
Transmission Lines and Storage Tank Improvements	2013	2033	$29,154	$1,429,886
Villas	2013	2033	$14,577	$884,052
Red Rock Reserve	2013	2033	$0	$122,951
Cloven Hoof	2018	2038	$14,577	$1,015,330
Shilo Pines	2020	2040	$9,718	$1,207,235
Red Rock Ranch	2023	2043	$24,295	$3,104,422
Sundance	2028	2048	$4,859	$875,280

Transmission Lines and Storage Tank Improvements

The Transmission Lines and Storage Tank Improvements will give the FVAWD the greatest payback in terms of operation and maintenance annual savings of $29,154. This phase has probable present cost of construction equal to $1,429,886 and is the backbone of the Alternative 2 improvements. If the FVAWD transmission pipeline system is not upgraded first, improvements to other areas of the system will have little to no impact on the overall distribution problems. Design and construction of this Phase is proposed to start in 2013

Villas

The Villas Phase improvements have a probable present cost of construction equal to $884,052. The Villas are at a low elevation in the FVAWD system and are suspect of high leak rates. If a PRV were to have failed in the past, the increase in pressure would be the greatest at the lower elevations. This increase in pressure has the potential to crack piping or separate joints. The Villas are expected to have an operations and maintenance annual savings of $14,577. Design and construction of this Phase is proposed to start in 2013

Red Rock Reserve

The Red Rock Reserve Phase is recommended to start immediately only for the reason that it will be cheaper to install this piping when the Transmission Lines and Storage Tank Improvements are being constructed. This phase has a probable present cost of construction equal to $122,951 and is not expected to generate operation and maintenance annual savings. Design and construction of this Phase is proposed to start in 2013

Cloven Hoof

The Cloven Hoof Phase improvements have a probable present cost of construction of $1,015,330. This phase is recommended to start immediately; however, the FVAWD does not have enough free capital to pursue the proposed infrastructure improvements at this time. Design and Construction of this phase is proposed to start in 2018 to give the FVAWD time to acquire and reinvest operation and maintenance savings. Cloven Hoof is expected to have an operations and maintenance annual savings of $14,577.

Red Rock Ranch

The Red Rock Ranch improvements have a probable present cost of construction of $3,104,422. This Phase is expected to generate operation and maintenance annual savings of $24,295. The Red Rock Ranch proposed improvements are the greatest cost to the FVAWD. Leakage rates are not believed to be high within this community. Design and construction of this Phase is proposed to start in 2020 if the funding is available.

Shiloh Pines

The Shiloh Pines improvements have a probable present cost of construction of $1,207,235. This Phase is expected to generate operation and maintenance annual savings of $9,718. Shiloh Pines is not believed to contain high leakage rates and is rated as a moderate concern. Design and construction of this Phase is proposed to start in 2023 if the funding is available.

Sundance

The Sundance phase improvements have a probable present cost of construction of $875,280. This phase is expected to generate operation and maintenance annual savings of $4,859. Leakage rates are not believed to be high within this community. Design and construction of this Phase is proposed to start in 2028 if the funding is available.

Cost breakouts for the Alternative 2 proposed improvements can be found in Appendix L.

CONCLUSIONS & RECOMMENDATIONS

The existing FVAWD distribution pipe network does not effectively, reliably, or economically deliver potable water to the residents. This Master Plan proposes improvements that address the existing distribution system deficiencies and provides a Capital Improvement Plan (CIP) for FVAWD to follow. The steps recommended in the CIP will cut costs associated with operations and maintenance of the distribution system and manage water quality by:

1. Replacing old leaking pipe with new pipe. This will reduce costs associated with repairs and maintenance, and lower costs associated with supplies and chemicals as treated potable water will stay contained in the system.
2. Increasing pump efficiencies which will lower utility pump costs.
3. Modifying the 250,000-gallon potable water storage tank to have a dedicated fill and drain line prior to going to the first customer. This will help facilitate tank mixing and reduce the chances of short circuiting the water entering and leaving the tank.
4. Installing two (2) new 10,000-gallon potable water storage tanks, reducing the number of system PRVs to three (3), and replacing many dead end pipes with

pipe loops. This will increase system flow rates and reduce water age throughout the FVAWD distribution system.

5. Adding control conduit with fiber optics that connects all of the major infrastructure sites in the open pipe trenches. Power and control conduit will be placed in the same trench as the pipe connecting the SWTP to the 250,000-gal tank. Currently there are no dry utilities in place at the 250,000-gal tank site.

The proposed improvements in this Master Plan have a present cost of $8,426,467. Based upon FVAWD annual revenue and expenditures from 2009 to 2011, the FVAWD does not currently generate enough free revenue to pursue all of the proposed improvements. Generating additional revenue can be done by the following:

1. As steps are taken to modify the existing system as proposed, FVAWD will start seeing a return on their infrastructure investment which can be reinvested back into the system to fund additional infrastructure projects.
2. Savings in the form of residential fire insurance reductions will also be realized with the addition of fire hydrants and the new fire flow ability of the system throughout the community. Fire insurance premiums may increase in the near future due to the prolonged Colorado drought and Bark Beetle infestation. Asking residents to fund higher user fees may be acceptable if savings on fire insurance premiums can be shown to offset any water fee increases.
3. By capturing the 50% annual potable water loss, the FVAWD could sell this treated water to nearby Palmer Lake (to be evaluated further when more info is available).

MOVING FORWARD…

CDPHE does not require approval for pipeline design (only capital projects that involve storage, disinfection, pumping and treatment), it is recommended that the design of the entire system begin as soon as possible in the following phases.

PHASE I.A – TRANSMISSION LINE & TANK UPGRADES

- Begin ASAP
- Requires CDPHE and FVAWD approval

PHASE I.B - DISTRIBUTION SYSTEM CONSTRUCTION DRAWING DESIGN

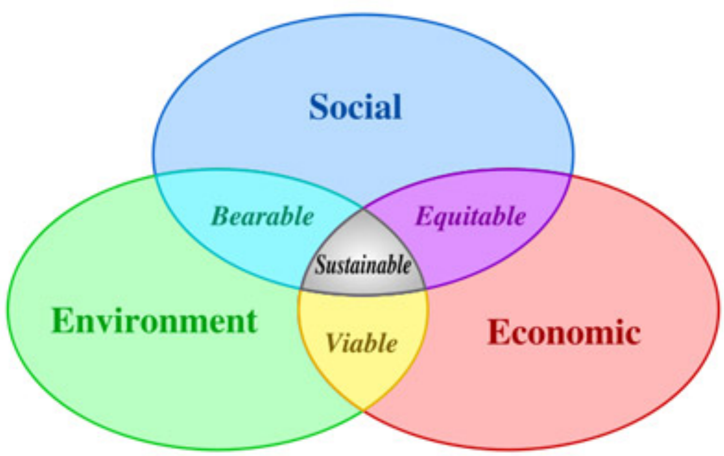
- Begin ASAP
- Requires FVAWD approval only
- Start CDs in order identified in CIP – complete entire set in 4 months from NTP

I.

PHASE II - CONSTRUCTION OF PRIORITIZED NEIGHBORHOODS

- Begin after FVAWD approval
- Requires FVAWD approval and El Paso County approval for road repair
- Begin construction in order identified in CIP

This Master Plan was developed for the FVAWD to provide a phased plan on improving the existing potable water distribution system. All practical alternatives have been reviewed with regards to social, environmental, and economic impacts to propose the most sustainable development path for Forest View Acres.



ABBREVIATION TABLE

Above mean sea level	AMSL
Arapahoe Water Treatment Plant	AWTP
Arapahoe Well Pump	AWP
Best Efficiency Point	BEP
Colorado Department of Public Health and Environment	CDPHE
Disinfection by-products	DBP
Extended Period Simulation	EPS
Federal Emergency Management Agency	FEMA
Feet	ft
Forest View Acres Water FVAWD	FVAWD
Gallon	gal
Gallon per day	gpd
Gallon per minute	gpm
Horsepower	HP
Hydraulic Grade Line	HGL
Inch	in
In-line Booster Pump Station	ILBPS
Insurance Standards Office	ISO
Linear feet	lf
Lower Zone	LZ
Middle Zone	MZ
Mill Creek Park Water Improvement Association	MCPWIA
Needed Fire Flow	NFF
Operation and Maintenance	O&M
Polyvinylchloride	PVC
Preliminary Engineering Analysis	PEA
Pressure reducing valves	PRV
Pressure sustaining valves	PSV
Programmable Logic Controller	PLC
Pump as Turbine	PAT
Surface Water Treatment Plant	SWTP
Technical, Managerial and Financial	TMF
Total dynamic head	TDH
Total Trihalomethanes	TTHM
Upper Zone	UZ
Variable Frequency Drive	VFD
Years	yr