Steward Mesa Water Company
Improvement Project
Final Report

Submitted to
Colorado Water Conservation Board
1580 Logan, Suite 200
Denver, CO 80203

Submitted by
Stewart Mesa Water Company
PO Box 1315
Paonia, CO 81428
(970) 527-4336

March 25, 2015

Project Personnel

CWCB Project Manager
Craig Godbout, Program Manager
Colorado Water Conservation Board
Water Supply Planning Section
1580 Logan Street, Suite 200
Denver CO 80203

Stewart Mesa Water Company
Dave Herz, Project Manager
Travis Loberg, Implementation Support
Michael Drake, Analysis Support
Kerry Smith, SMWC Secretary/Treasurer

Subcontractor to SMWC
Buckhorn Geoteck – Dan Quigley, Analysis Project Lead

Kendall Construction

Acronyms List

CWCB – Colorado Water Conservation Board
GPS – Global Positioning System
RFP – Request for Proposal
SMWC – Stewart Mesa Water Company
SOW – Statement of Work

Table of Contents

Section 1 Problem Background

The Stewart Mesa Water Company (SMWC) began providing shareholders agricultural and domestic water around 1900 and was incorporated as a not-for-profit company in 1909. Since 1906, SMWC operates as a consecutive water system by direct connection to an 8" water main owned by the Town of Paonia, in Delta County. Originally, SMWC had about 30 taps. Today the system has 79 taps of which 75 are active. Ownership in the Company is represented with the receipt of a stock certificate. Each stock certificate represents two shares. One share is for the member's household use and the other share is for the watering of livestock and other limited agricultural use. All system related work, including repairs and /or infrastructure improvements, is completed by company volunteers or a combination of contractors and volunteers.

The SMWC improvement project focused on two areas in the water distribution system. The first area was the completion of the system monitor meter program by installing the last two monitor meters. The installation of monitor meters completes a system-wide water auditing tool used in the company's leak detection program. The second area of the project was the completion of a system engineering analysis of the entire water system. Our hundred-plus-year-old system has been enlarge and extended multiple times. At no time has a hydraulic analysis been performed. Contemporary system water load demands require the company have an expanded knowledge of the systems strengths and weaknesses. We can no longer make accurate infrastructure improvement or expansion decisions without the information the analysis will provide. Additionally, leak detection and control are high priority issues for SMWC as we are presently leaking approximately 25 % of purchased water. The funding requested will enable the company to begin implementation of our plan to get leakage under 10%. The proposed system analysis defined structural improvements to eliminate leak issues and better ways to identify, locate, and repair leaks.

Section 2 Task Results

Our project consisted of three specific tasks as follows:

- Task 1 – Installation of improvements to the Main Line and the McFarland Service Branch (Task1A), and the Main Line and the Travie Service Branch (Task 1B).
- Task 2 – Completion of an engineering analysis of our delivery system defining issues such as system capacity, improvements required to increase capacity, prioritizing improvements to reduce maintenance and enhance system sustainability, leak analysis including recommendations for leak reductions and recommendations on providing water for firefighting support.
- Task 3 – Complete the Final Report documenting all project efforts and results.

The efforts and results from the three tasks completed are detailed in the following subsections. The contact information for all of the key people/organizations involved in the project are contained in Appendix A.

2.1 TASK 1 – Installation of improvements to the Main Line, the McFarland Service Branch, and the Travie Service Branch.

2.1.1 Task 1A – Installation of Improvements on the Main Line and McFarland Branch

Description of Task

Task 1A completed the installation of monitor meters at the McFarland Branch and the main line, and additional improvements to the main line in that connection point area. These improvements will result in reduced maintenance costs, increased system reliability and increased system leak detection.

The main line effort included a main line pressure reduction device and a monitoring meter installed just upstream of the McFarland branch connection point to the main line. The pressure reduction device at this location provides a redundancy in main line water control. The monitoring meter enables the detection of leakage in the main line between the connection to the Paonia water line and our first service point. The main line installation included shut off valves, a strainer, a monitoring meter, a pressure reduction device, and pressure gauges. The McFarland branch effort started at the McFarland connection point to the main line and included shutoff valves, a pressure reduction device, a monitor meter and a pressure gauge.

Method/Procedure

As with all infrastructure improvements or modifications the SMWC Board identified the need and developed a working budget and associated work scope. The installation complexity at the McFarland service line required that the effort be done with both SMWC volunteer labor and a contractor with potable water installation expertise. A design with the necessary components was determined as well as the installation layouts. Company policy requires installations of this type be completed using underground water-proof concrete vaults for protection and easier maintenance.

Prior to actual installation the Company met with the contractor and went over the design of the new installation as well as the installation procedure. It was decided at that time that because of the number of pieces and parts in this underground installation, a 1500-gallon vault would be required with two openings to provide proper ventilation when working inside the vault. Materials were ordered and inventoried, and an assembly procedure determined. A state inspector was on site during the course of installation to ensure compliance with state potable water installation procedures. When installation was complete, operational pressure reduction devices were balanced before the water system was activated.

Figure 1 – Vault Site Prep

Details of Work Completed

Infrastructure improvements involving main line pressure control and metering, and the McFarland service line monitor meter zone were relatively straight forward. Typical of all company improvements a procedure and schematic was generated by the company.

Figure 2 – Vault Placement

On May 4, 2014 the company contractor Kendall Excavating completed the first step by digging and prepping the required hole for the vault installation. Figure 1 shows the Kendall Excavating team working in the finished hole. Dick Kendall is measuring where the main line will be cut to receive the new vault while Richard Kendall racks out 3/4 minus gravel bedding.

Upon completion of the vault ground work, the vault was delivered to the site and placed in the ground. In Figure 2 you can see the truck that delivered the vault and the vault placed in the ground.

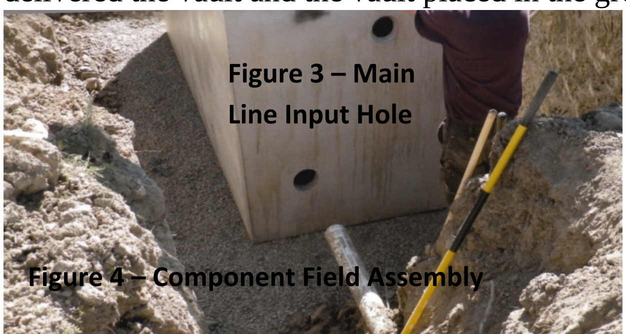
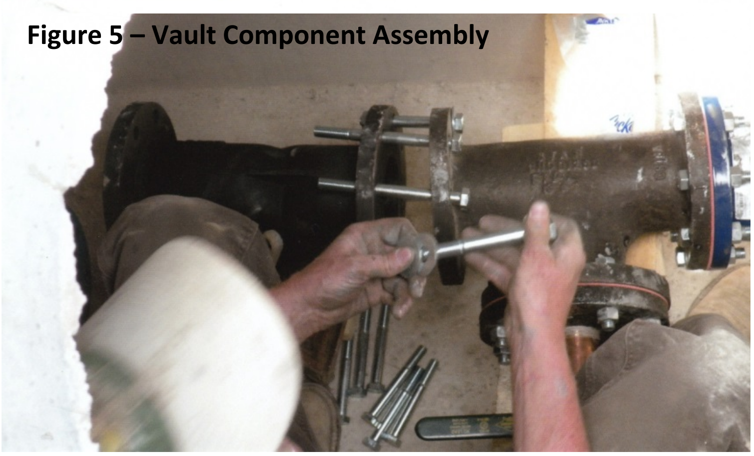


Figure 3 – Main Line Input Hole

Figure 4 – Component Field Assembly

Figure 3 provides a view of the downstream side of the vault installation. You can see the vault seated on a bed of gravel and the downstream portion of the 4-inch main line is shown not yet connected. The vault was designed to offset the entry of the main line to one side of the vault enabling better access inside the vault for the installation and assembly of the service line tee for the McFarland connection and the components required to complete the connection. This approach is best practices for water connections. The positioning of the main line and the connection assembly also will enable easier completion of any future required maintenance work in the vault.

Figure 5 – Vault Component Assembly



The next step in the process is to build subassemblies that will complete the connections required in the vault. Figure 4 illustrates this process using the back end of a pickup truck as the field assembly table. Here you can see the two tee subassemblies that will enable the connection of the McFarland service line connection and the bypass line around the main line pressure reduction device and monitor meter. The bypass line enables keeping the main line live when maintenance is needed on either the pressure reduction devise or the monitor meter. Note in Figure 4, the silver stainless steel bolts in use in the tee subassemblies. These stainless steel bolts are used throughout the installation because of the highly alkaline nature of the local environment.

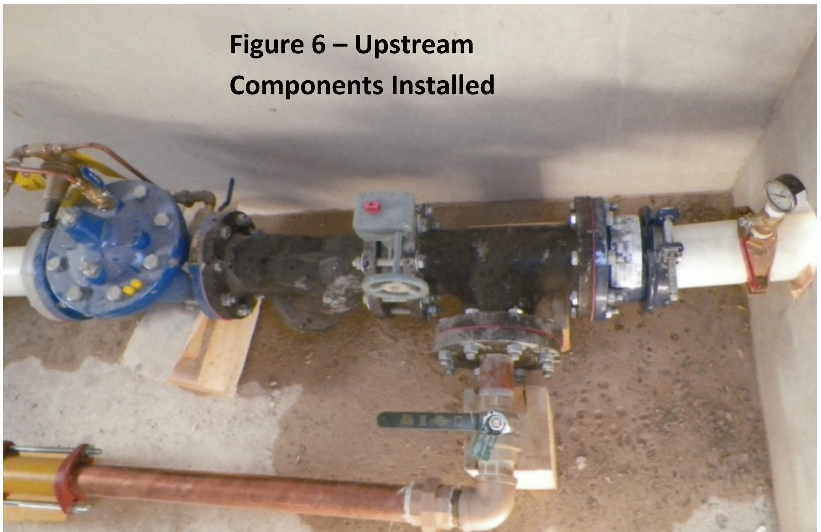


Figure 6 – Upstream Components Installed

Figure 5 illustrates assembling the Tee subassembly onto the upstream mainline with the Hymax flanged connector on the right and the wafer shut off valve on the left.

Figure 6 shows the upstream assembly in the vault where the upstream main line enters. Pictured from right to left are the white 4-inch main line, a pressure gauge on the main line at far right side, the Hymax flanged connector, the cast 4-inch tee, the wafer shut off valve, y strainer and blue epoxy painted pressure reduction device. The 2-inch pipe coming out if the tee is the upstream starting point for the water bypass line.

Figure 7 – Downstream Components Installed

The pressure gauge on the right side of Figure 6 measures the incoming pressure on the main line. The installation of this pressure gauge, and the pressure reduction device located downstream out of this picture, provides our system with an easy place to read the pressure in the main line. This pressure reading will indicate that the pressure reduction device placed just downstream of our connection to the Paonia water line is working or not. The new pressure reduction device installed just downstream out of this picture provides us with a pressure reduction back to protect the downstream portion of our water system.

In Figure 7 one can see the rest of the

downstream vault installation, which includes the pressure reduction device, the McFarland main line monitoring meter, a shutoff valve, the tee for the McFarland service line connection and finally a pressure gage. Between the pressure reduction device and the main line monitor meter is short section of white 4-inch PVC pipe. This section of pipe is required to insure that water entering the meter has no adverse turbulence which would impact meter accuracy. The monitoring meter enables the detection of leakage in the main line between the connection to the Paonia water line and our first service point.

Beyond the main line monitor meter is a shutoff valve, a tee for the McFarland service line and finally a pressure gauge to monitor outgoing pressure. This final pressure gauge provides a check point to insure that the pressure reduction device just upstream will function properly.


Figure 8 – McFarland Components Installed

Figure 7 also provides a view of the downstream bypass of the main line section containing both the pressure reduction device and the monitoring meter. You can see that the downstream connection for the bypass line double as the connection to the McFarland service line.

Figure 8 provides a better view of the McFarland service line connection. You can see the shutoff valve from the main line for both the bypass line and the McFarland line. You can also see the McFarland shutoff valve and the McFarland line monitor meter. In Figure 8 the contractor is hooking up monitor meter for the McFarland service line.

Figure 9 depicts the main line pipe coming out of the downstream side of the vault and the installation connecting the vault output to the main line downstream continuation using a Hymax bolted connector.

Figure 9 – Downstream Main Line Connection to Vault

The main line components installation was completed on May 5. This enabled the company to get the water back on to all but the McFarland users in one day. The McFarland line components were installed on May 6. The vault hole was not back filled immediately as a caution against failure. After two months with no failures, in early August a 2-inch drain line was installed at the west end of the vault and the vault was back filled. The completed installation has been operating flawlessly since that time.

2.1.2 TASK 1B – Installation of Improvements on the Main Line and Travie Branch

Description of Task

A necessary component to water company water audit and leak management is the concept of monitor meter zones. In keeping with this operational policy the SMWC initiated a monitor meter program identifying and defining the seven monitoring zones that accurately covered our water system. The Travie monitor meter zone was the final installation required to complete our monitoring meter system.

Task 1B completed the installation of a monitor meter for the Travie service branch and additional improvements to the main line in that connection point area. This effort started at the diversion point from the main company line and will include shutoff valves, a pressure reduction device, a monitor meter and a pressure gauge. These improvements will result in reduced maintenance costs, increased system reliability and increased system leak detection.

Method/Procedure

The method and procedure followed the typical SMWC installation process. However, the installation at the Travie service branch is less complex and was completed by SMWC volunteer labor and shareholder equipment. Finding the exact location and run of the main line in the area of the Travie service branch did require contractual support.

Details of Work Completed

The initial step in Task 1B was to define the main line run in the area of the Travie service line. Due to poor record keeping early in the company's history, there simply was no knowledge of the exact main line run in the area of the Travie service line. At the same time, there was no knowledge of where portions of the Travie service line ran or the exact connection point to the main line.

The company did have one known point on the Travie service line. We chose to extrapolate and decided that from the known point the service line should be running due west to the top of a knoll. A contractor was hired to do an electromagnetic imagining scan on a north-south line to locate a second point on the service line and as expected the water line was located.

A lay-line was established by sighting from the known point to the point established by the imaging scan. With the lay-line established it was possible to follow the direction of the pipe with a listening device. Using a Gen -Ear listening device, we tracked the service line piping to where it intersected the main line. With confidence, we proceeded to dig up the area around the connection point.

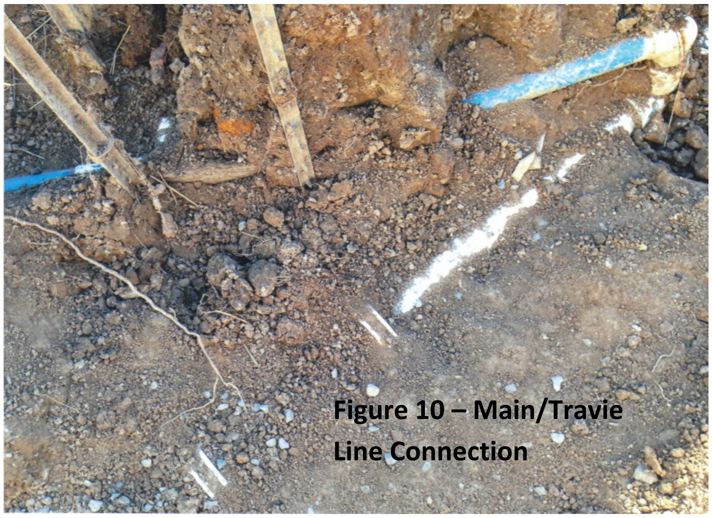


Figure 10 – Main/Travie Line Connection

Figure 10 shows the main line (white pipe) running diagonally from the top right corner toward the bottom left corner. Above the main line is a blue service line pipe. This service line not only provided service for the Travie line, but also included the service to the Todd house. Between the tee posts and to the left is the partially uncovered white tee joint in the service line that leads to the Todd house meter pit adjacent to the line. To the right of the tee joint and left of the right hand tee post there is a corroded gate valve, which was the old shutoff valve from the main line. Above the white tee joint there is the red plastic covered handle of a quarter turn ball valve, which was the old shutoff valve for the Todd house. The condition of the valves seen in Figure 10 indicates neither valve was operable.

Figure 11 – Close-up View of Main Line /Travie Line Connection

Figure 11is an up close view of the service line/main line connection. The corroded nine wire is probably from original installation.

Just upstream from the connection point, Figure 12 shows a main line shutoff valve just above the flanges of an old main line repair coupling. This valve also was inoperable with the valve handle frozen in the open position.

Figure 12 – Main Line with Repair Coupling and Shutoff Valve Handle Shown

Figure 13 shows the Travie service line running to the east. The blue service line in center of photo is deformed from improper bedding when originally installed.

The entire service line/main line connection area was improved through this project. The damaged service pipe section, tee to the Todd house and all the valves on the service line were replaced. The main line section from above the old service line connection past the inoperable valve was replaced. Figure 14 shows all of the service/main connection replacements.

Figure 13 – Service Line Deformation Downstream From the Main Line Connection Point

In Figure 14 you can see that the new main line 4 inch pipe section was attached with Hymax 4" connectors at the top and the bottom of the new pipe. The red main line shutoff valve is just below upper Hymax connector. Just below the main line shutoff valve is the new 2-inch saddle connection, with shutoff valve, that connects the Travie service line to main line. You also can see the new Purcor poly piping coming out of that saddle connection that connects to the Travie line monitor meter outside of the picture. The monitoring meter connects to existing Travie service line. Below the Travie connection is the new 3/4" saddle connection, with shutoff, that connects the Todd house to the main line. The new Purcor poly piping coming out of the Todd saddle connection connects to the existing Todd meter and connection line.

Figure 15 provides a close-up view of both the Hymax connector and the shutoff valve on the main line.

Figure 14 – New Service Line Pipe Section

Figure 15 – Close-up View of Upper Main Line Hymax Connector and Shutoff Valve

Figure 16 – Close-up View Main Line Connectors and Shutoff Valves

Figure 16 provides a close-up view of the two saddle connections used to connect the two service lines to the main line.

Please note that all new components used were either glass, stainless steel, or epoxy coated. The highly corrosive soils in our area require the use of these highly corrosive resistant coatings on all components place on the ground or underground.

Figure 17 shows the existing Todd house meter pit and cover. As can be seen, this meter housing construction is very old, but still functional. It is constructed using a fifty-five gallon barrel, which represents a typical old-time farmer designed installation.

Figure 18 shows modern monitor meter pit with 2-inch monitor meter installed on the Travie service line. The coil of wire at the bottom of the pit is for a remote read register to be mounted on a post outside of the pit to enable meter reading without having to open the pit.

Figure 19 shows the completed main/Travie line installation. The Travie monitor meter pit can be seen without a cover. The existing Todd house meter pit is to the left of the Travie pit. The White 12-inch disk in the center of the figure is the riser for the main line shutoff. The main line runs from middle of right hand edge of Figure 19 diagonally to top left hand corner. The service line runs directly toward viewer.

Figure 17 – Todd House Meter Pit

Figure 18 – Travie Service Line Monitoring Meter

Figure 19 – Finished Main and Travie Service Line Construction

2.2 TASK 2 – Engineering Analysis of the SMWC System

Task 2 was completed through the execution of the following two efforts:

- Completing a competitive procurement for the analysis effort
- Completing the engineering analysis effort

2.2.1 – Competitive Procurement

The analysis objectives were developed from the needs of the company. The company objectives for the analysis were:

- Current system capacity and improvements required to increase capacity
- Prioritizing improvements to reduce maintenance requirements and enhance system sustainability
- Leak analysis including recommendations for leak reductions
- System modification requirements for delivery of firefighting water support

The starting point for the analysis will include:

- Current delivery system drawings, including identification of all repairs and modifications completed since the completion of the drawings
- Current system requirements defined in our contract with the Town of Paonia

The objectives and starting point information above were included in our Statement of Work (SOW), along with all necessary requirements from SMWC's contract with Colorado Water Conservation Board (CWCB).

Two companies with known expertise in the required areas were sent a request for quote and a SOW for the effort. The companies were Buckhorn Geotech (Montrose) and McLaughlin Water Engineers (Denver, a Division of Merrick and Company). Proposals from both companies were received.

The proposals were reviewed by the SMWC Board. In the technical portion of the evaluation both bidders scored well. Buckhorn Geotech was the low cost bidder. Therefore, from a low risk/high value standpoint, the contract was awarded to Buckhorn Geotech on May 19, 2014.

2.2.2 Engineering Analysis Effort

The efforts completed to develop the hydraulic analysis of the SMWC water delivery system are detailed in the following paragraphs.

After the contract was awarded to Buckhorn Geotech, the analysis effort started with supplying the lead engineer, Dan Quigley, all relevant information on the SMWC's system. The data included:

- Historic water usage data in an Excel file
- Budget information for 2014-2015
- Sample bill, including rates
- September 2014 usage data
- SMDWC Map 2013
- SMWC Bylaws
- SMWC/Town of Paonia agreement

- Usage with Monitor meter Zones
- Water Use analysis 2014
- Usage data for the new monitor at the McFarland branch in November

The initial data set including the water system map and an Excel file containing historic water usage was sent in mid-June 2014.

The analysis Kickoff Meeting was held on August 22, 2014. The attendees at this meeting included Dan Quigley from Buckhorn Geotech, SMWC board members David Herz, Michael Drake, Travis Loberg, and Walt Wright, and SMWC Secretary/Treasurer Kerry Smith. The meeting started at 10:00 AM. The Kickoff meeting was held to insure that Buckhorn and SMWC were in agreement on the goals and objectives of the analysis effort. The SOW was discussed in detail and both Buckhorn and SMWC were in agreement on the work to be performed. Additionally, the initial questions on the data supplied to Buckhorn were answered. The complete minutes from that meeting are contained in Appendix B.

On September 5, 2104, David Herz and Travis Loberg supported a technical site visit/walk through for Dan Quigley. The site visit focused on insuring that Quigley understood the exact locations of critical infrastructure and had a good understanding of the entire system. Existing critical infrastructure items GPS data was provided and addition data that Quigley deemed important was collected during the visit. The site visit took 5 hours.

Additional data including a sample bill with water rates and the historic usage by monitor meter zones was sent in September 2014.

On November 5, 2014, a meeting focused on discussions of the details of the data and the functional operations used in the massive Excel sheet was held. Buckhorn found inconsistencies in the data for the monitor meter near the Todd Wood branch that indicate that the meter is malfunctioning occasionally.

On November 10, 2014 usage data from the monitor meter installed on the main line during Task 1A and an updated usage spreadsheet containing the September/October meter readings was sent to Buckhorn. The new main line monitor meter data indicated a major leak (about a 1,000 gallon a day) in the upper section of the main line. Two SMWC board members went looking for signs of the leak but could not locate any indication of leakage.

On November 20, 2014 the company bylaws that contained boundary information were sent to Buckhorn.

On December 1, 2014 the date when SMWC put a moratorium on new taps was sent to Buckhorn, along with an additional spreadsheet containing system pressure readings for use in the analysis and a financial spread sheet so that Buckhorn could calculate leak cost for every year.

On December 19, 2014 the first Analysis Review Meeting was held at the Paonia Library and started at 10:00 AM. The attendees at this meeting included Dan Quigley from Buckhorn Geotech, SMWC board members David Herz, Michael Drake, and Walt Wright, and SMWC

Secretary/Treasurer Kerry Smith. Dan gave a presentation covering the preliminary engineering report. Several issues, unaddressed objectives and questions were discussed. Quigley stated these would all be addressed in the revised report and that there would be a second review meeting. The complete minutes from that meeting are contained in Appendix C.

The second review meeting consisted of Michael Drake and David Herz reviewing the Final Draft Analysis Report. Herz used the notes from that review as discussion points for his phone and email conversations with Quigley. The review and follow-up conversations covered all February and the first part of March. The final Analysis Report was received on March 15, 2015.

The conclusions of the Analysis Report are given in Section 3.

The complete final Analysis Report is contained in Appendix D.

2.3 TASK 3 – Final Report

This document is the Final Report for the Stewart Mesa Water Company Improvement Project. The effort to develop, compile and review the Final Report started on October 23, 2014. The report was completed and sent to CWCB on March 15, 2015.

Section 3 Project Conclusions

The following conclusions are based on both data collected and the analysis completed for this project:

1. The current SMWC main line pipe system is within 10 to 20 years of the system design life.
2. The current SMWC system does and will continue to meet the current demand with the current 79 taps.
3. The current system cannot accommodate any additional taps.
4. The current system cannot provide fire suppression support.
5. The completed system monitor meters will enable SMWC to define where the leaks are occurring.
6. The installed pressure reduction values now provide system redundancy that will greatly increase the system stability and reduce maintenance costs.
7. To increase the accuracy of all SMWC's meter readings, SMWC needs to coordinate the reading of their master meter to align with the Town of Paonia's reading of the town's SMWC meter.
8. It appears that differences between Town monthly readings and SMWC bimonthly readings may be creating mathematical "leaks" in system records that may or not be reflected physically as actual water leaks.
9. Three concepts for providing some fire suppression support were evaluated during the analysis effort. These concepts were:
    a. Concept 1 was to increase the main line pipe size to six inches
    b. Concept 2 was to provide a water storage tank at the North Fork Valley Airport
    c. Concept 3 was to provide a dry barrel pump at pond(s) water storage sites

10. For Concept 1 to meet the fire suppression support requirements the main line piping would have to be increased from the current four inch diameter pipe to a six-inch diameter pipe.
11. The Concept 1 cost estimate for increasing the pipe size is $687,810.00.
12. The current water contract with the Town of Paonia limits our maximum pipe size to a four-inch diameter pipe.
13. For Concept 2, two hours was defined as a reasonable period of time to provide 500 gpm for firefighting. This two-hour time limit requires at least a 60,000 gallon tank. The estimated cost for Concept 2 is $135,000.
14. The primary drawbacks for Concept 2 are the limited time availability and maintenance of the tank.
15. Concept 3 would be to excavate strategically located pond(s) to provide water storage and dry barrel hydrants to provide the required fire flow.
16. The primary drawbacks for Concept 3 are finding suitable locations for the ponds, pond maintenance, periodic cleaning the ponds of cattails and other aquatic plants, providing protection from public incursion to the pond(s) for safety reasons, and maintenance of the filter/pumping system.

Section 4 Project Recommendations

The following recommendations are based on the data collected and the analysis completed:

1. SMWC needs to start collecting an additional infrastructure maintenance fee from the shareholders for replacement of the current main line sometime in the next 10 to 20 years.
2. SMWC, the Town of Paonia, and Delta County need to start discussions to develop a plan for obtaining fire suppression support.
3. SMWC needs to coordinate the reading of the master meter with the Town of Paonia meter reader to enable a more accurate match with the town’s readings.
4. SMWC should read all system meters monthly to more quickly and accurately detect any discrepancies (ie. leaks) in the system.
5. SMWC needs to confirm that all monitoring meters are in good working order and reading accurately at all flow levels. Several monitoring meters report negative leaks which can reflect either the mathematical discrepancies outlined in Conclusions # 10 above or that the meters are not operating correctly.
6. SMWC should determine the best-practices schedule for checking accuracy of all system meters.

Appendix A - Key Project Contact List

Name	Affiliation	Address	Phone	E-mail
Dave Herz	SMWC	PO Box 1315 Paonia, CO 81428	(970) 527-7994	daveh5@tds.net
Mike Drake	SMWC	PO Box 1315 Paonia, CO 81428	(970) 527-4535	mldht1@live.com
Kerry Smith	SMWC	PO Box 1315 Paonia, CO 81428	(970) 527-4336	smwch2o@gmail.com
Travis Loberg	SMWC	PO Box 1315 Paonia, CO 81428	(303) 800-9030	
Walt Wright	SMWC	PO Box 1315 Paonia, CO 81428		
Dan Quigley	Buckhorn Geotech	222 South Park Ave, Montrose, CO, 81401	(970) 929-6366	dan@buckhorngeo.com
Richard Kendall	Kendall Excavating	42616 Minnesota Creek Road Paonia, CO 81428	(970) 527-3867	

Appendix B – Analysis Kickoff Meeting

RECORD OF PROCEEDING

Steward Mesa Water Company
Board of Directors Meeting
August 22, 2014

Board Members Present: Dan Quigley from Buckhorn Geotech, David Herz, Michael Drake, Travis Loberg, Walt Wright
Board Members Absent: Clay Sorensen

President David Herz called the meeting to order at 10:00 AM

The main purpose of this meeting was to meet with Dan and discuss the goals in obtaining an engineering analysis of the Company's water line and system.

David explained that the board desires to have an engineering analysis done because the water system is over 100 years old and there has never been a hydraulic analysis. The system contains several monitor meter zones and we are currently only one zone short. On average 25% of our purchased water is leaked. Dan had preliminarily looked at the data that Kerry sent and he was looking at a 4 year history.

David stated that with all the component data and the monitor meter zones it is hard for a lay person to interpret the information and make decisions.

Mike summarized Task 2 of the proposal which stated the objectives of the analysis to be performed and part of Task 1:

TASK 2 – Engineering Analysis

Description of Task

The purpose of this task is to complete an engineering analysis of our delivery system defining issues such as:

- *Current system capacity and improvements required to increase capacity,*
- *Prioritizing improvements to reduce maintenance requirements and enhance system sustainability,*
- *Leak analysis including recommendations for leak reductions*
- *System modification requirements for delivery of firefighting water support*

Method/Procedure

The starting point for the analysis will include:

- *Current delivery system drawings, including identification of all repairs and modifications completed since the completion of the drawings*
- *Current system requirements defined in our contract with the Town of Paonia*

The analysis effort will include evaluation of current system capacity, recommendations on operational pressures throughout the system, long-term maintenance improvements, leak analysis and recommendations to reduce leaks, water tank storage requirements for firefighting support, and other items to be defined. The engineering analysis process will incorporate the latest analysis technologies that have been proven successful in the evaluation of water delivery systems.

And from Task 1:

As with all infrastructure improvements or modifications the SMWC Board identified the need and developed a working budget and associated work scope. The installation complexity at the McFarland service line requires that the effort be done with both SMWC volunteer labor and a contractor with potable water installation expertise. The installation at the Travie service branch is less complex and will be completed by SMWC volunteer labor and shareholder equipment. The installation process to be used on the Travie branch has been used successfully numerous times before by SMWC.

A design with the necessary components has been determined as well as the installation layouts. These efforts determine the size of the underground vault that will have to be used. SMWC places installations of this type in underground water-proof concrete vaults for protection and easier maintenance. Materials will *be ordered and inventoried and an assembly procedure determined. A state inspector will be on hand during the course of installation to ensure compliance with state potable water installation procedures. After installation, operational pressure reduction devices will be balanced before the water system is activated.*

Deliverable

The installation process and results will be delivered in the final report.

Dan needs to talk with Mike at the Fire Department to discuss the fire suppression needs. Currently there is a tank located on the Airport property. The report should contain what components and what type of system is needed to full a fire truck. In David's opinion there is a need for fire support and that would require some sort of storage capacity. Dan stated that the USDA's goal is to deliver potable water to rural communities and fire suppression is just a bonus.

Dan discussed the work that Buckhorn preformed for Pitkin Mesa and how their engineering report was used for additional funding and planning.

Dan stated that the map that was sent seems to be just a schematic and there were no PRV's indicated. David will meet with Dan to do a walkthrough of the system and identify the components and locations. David has installed server PRV's and components as a laymen. He summarized that the company is currently under a moratorium. Joanne Fagan once did an analysis in the 80's of our water system. That analysis/report has been lost but the moratorium was put into effect due to that report. David would like to have that decision confirmed.

David continued to summarize the history of the water company. Due to the breaks at Dee's corner, he installed more PRV's and monitor zones. It is hard to determine what is going on because there are leaks that have been determined between zones, but it is hard to locate exactly where.

Dan stated that in looking at the data Kerry had sent, it looks like the airport had high usage in the summer. Travis stated that there is an above ground tank located up there, but there is no direct connection. Dan asked if all meters are active (yes), the age of the meters (1 year to 25 years old), and if PRV's were required on all meters (no, that is the owner responsibility).

Mike sidelined the discussion to state that as a board if there is a known leak and we historically have done nothing about it because the user is paying for it, the Water District says that is a bad attitude. The Board needs to decide what to do. Dan needs to be aware if there are service line leaks included into the overall leak number. That will effect getting below an overall leak of 25%. David believes the main leaks are on the trunk line. He would like to address the main trunk line and then the service lines. The main problem seems to be between monitor meter zones and not service lines.

David has new elevation numbers to add to the map for new work he has done.

Dan outlined his process of using watercad to generate maps and how it is used to determine fire flow capability. He can electronically upsize line size and look at the flow versus cost numbers.

Dan asked if it was important to sell taps. Overall the shareholders seem happy, but Kerry gets 1 or 2 request a year for a new tap. Currently the State and County are still allowing cisterns. David stated that the company currently operates by having enough money to cover our cost, operation expenses, infrastructure fixes, and such. There is only a little more left after that and he would like to have a capital improvements fund.

The meeting adjourned after a brief discussion on the moratorium and its status.

Kerry Smith, Secretary/Treasurer Date (seal)	David Herz, President Date

Appendix C – Preliminary Analysis Review Meeting

RECORD OF PROCEEDING

Steward Mesa Water Company
Board of Directors Meeting
December 19, 2014

Members Present: Dan Quigley from Buckhorn Geotech, David Herz, Michael Drake, Walt Wright
Members Absent: Clay Sorensen, Travis Loberg

The Board of Directors meet with Dan Quigley at 10:00 am in the Paonia Library. Dan gave a presentation on his preliminary engineering report.

Dan created a steady state base model of the SMWC lines using water cad. The model was created and calibrated using the company's real data. The model included PRV's but not gate values. There was 31 pipes in the model, 1 dozen nodes, and the pressure zones were set at 40-90 psi. The model was then adjusted to run in "Double Peaks" and look for problems.

Dan said that for fire flow, the recommended flow was 500 gpm. He added different nodes to the model to calculate fire flow capability. His analysis showed that the company cannot provide fire flow with the current system. The pipes are undersized.

The data shows that upper system contains 50% of the water loss. The new monitor meter was very useful. Some of the meter readings in the data provided showed negative usage levels when read. The leak calculation cost in his report is a worst case scenario with water leaks charged at the highest rates.

Dan then created a future model of our system with 25 additional taps and a minimum 6" pipe size. He also placed a hydrant at the highest pressure zone. The 500 gpm fire flow would be supported by a 6" pipe.

The board's response was that the initial idea for fire flow was to have one place up at the airport property. They would like the final report to have information on how to obtain a single system up at the airport. This should include information on how often to flush the pipe, payment for water, draining a tank and refilling it, and any maintenance needs. They would like these to be taking points with the town in the future so there is a clear understanding of ownership.

Dan's report included plans to upgrade to a 6" pipe size and the cost and possible phases of construction for achieving that goal.

The board responded that the contract with the town delineates pipe size. In order to upgrade to a 6" pipe for the whole system would mean renegotiation of the contract. Currently the town has oversold water and there is a moratorium on out of town taps.

Mike asked if we reconfigured the take out with town to upgrade the connection pipe from 2" to 4" would there be a problem? Dan said in a static situation that would not affect the town. The only affect would be in filling the entire system if it is empty, especially in fighting a fire. Dan will further study the effects of increasing the connection pipe to the town pipe with at 4" connection. Would this effect the hydraulic capacity?

David stated that the stockholders do not want to have the company in debt and we don't have the monetary capability to get the improvements. He would like to know if there is anything that could accommodate an emergency fire demand without high cost. Dan stated that there is a USDA loan/grant, but they will not fund fire flow. And the USDA requires a financial analysis. The company is setting at 30% leak numbers and that has the potential for a violation with contamination.

The board would like the final report to include system improvements over time that would not require huge funding amounts. Maybe even the suggestion of monthly billings or readings. The final report should be wrapped up by mid-January to early February.

Meeting adjourned at 11:08 am

RECORD OF PROCEEDING
Steward Mesa Water Company
Board of Directors Meeting
December 19, 2014

Kerry Smith, Secretary/Treasurer Date (seal)	David Herz, President Date

Appendix D – Final Analysis Report

BUCKHORN GEOTECH
Civil, Structural & Geotechnical Engineers
222 South Park Ave. • Montrose, CO 81401
Ph.: (970) 249-6828 • FAX: (970) 249-0945

FINAL HYDRAULIC REPORT

STEWART MESA WATER SYSTEM

March 12, 2015

COLORADO REGISTERED DANIEL C. QUIGLEY 38334 3-12-15 PROFESSIONAL ENGINEER

Prepared by:
Dan Quigley, PE
Buckhorn Geotech
222 S. Park Ave.
Montrose, CO 81401

Prepared for:
SMWC
13006 Crawford Road
Paonia, CO 81428

TABLE OF CONTENTS

GLOSSARY OF ABBREVIATIONS AND DEFINITIONS

A-F – Acre-Feet, equal to 325,851 gallons, it is the volume of water that would cover one acre of land one foot deep.

ARV – Air Release Valve, used to release excess air at high points in a pressurized water distribution pipeline. This prevents damage to the pipe and system components.

AWWA – American Water Works Association which provides modeling and design specifications and guidelines through published reports and industry accepted standards.

BGI - Buckhorn Geotech, Inc.

CFS – cubic feet per second, a flow rate equal to the volume of water that flows past a specified point in one second, equal to 448.83 gallons per minute.

GPM – gallons per minute, standard U.S. flow rate units used in hydraulic analyses

EPS – Extended Period Simulation. A modeling term that defines a modeling run, typically 24 hours, to verify that a model is calibrated correctly to system conditions and that it best represents actual system operations.

SMWC – Stewart Mesa Water Company

PRV – Pressure Reducing Valve, used to regulate high pressure water and reduce pressure to an acceptable range to avoid damaging pipelines or private plumbing. There are currently four company PRV's in the system as well as private PRV's as required by SMWC.

Pressure Zone – Based on the elevation head created by a column of water, zones are established to regulated pressures to avoid damaging system components. A typical range for water system pressure zones is from 40 to 90 psi. Depending on local topography, private PRV's may be required to regulate the incoming system pressure at specific locations within a water system's established pressure zones.

PSI – Pounds per square inch, unit of pressure.

PVC pipe – Polyvinyl Chloride pipe, commonly used in water systems due to ease of installation and economic value. Cost is generally independent of petroleum prices since it is made of synthetic resins.

HDPE pipe – High Density Polyethylene, used more frequently in pressurized water systems due to ability to thermally fuse long sections, longevity and durability.

Material cost is affected by petroleum pricing since it is a hydrocarbon based material.

Executive Summary

The Stewart Mesa Water Company (SMWC) currently serves 74 active and 5 inactive or standby residential water users in their service area near Paonia, Colorado. Potable water is provided by the Town of Paonia to SMWC, a consecutive water system, through a master meter located at the northeastern entrance to the SMWC service area. SMWC has undertaken several projects to upgrade or install new monitoring meters throughout the system and these meter readings indicate that several portions of the existing SMWC system are experiencing leaks which create lost revenue to the system.

Buckhorn Geotech, Inc. was commissioned by the SMWC in August 2014, to analyze the existing transmission and distribution systems using hydraulic modeling for both current and future demands in order to recommend system improvements. The current system had never been analyzed using computer hydraulic modeling and has required continual repair over the years due to aging system components. As part of the hydraulic analysis, we created a base model of existing conditions and a future improvements model with recommended system enhancements for improved flows and pressures, limited fire protection and leak minimization. We were also tasked with performing an analysis of the SMWC usage data to determine the source of leaks apparent in the system. The Town of Paonia's master meter readings are consistently higher than those of the SMWC monitoring meters and the individual service meter totals indicating leaks in several locations. The location of some of these leaks are known to SMWC, but many are not.

Although the SMWC system has sufficient potable water to supply the existing demands, the current system is unable to provide recommended fire flow of 500 gpm and cannot support additional taps being placed in the system, due to high velocities and low pressures. SMWC has had a self-imposed moratorium on new taps since 1986 and the Town of Paonia also has issued a moratorium on out-of-town taps due to limited supplies and infrastructure to serve additional customers.

SMWC pays the Town of Paonia for all water that passes through the master meter, but can only bill company users for water actually recorded on their individual water meters. Therefore, the current leakage rate of approximately 30% results in an additional annual cost of approximately $6088 to SMWC. Recommended system improvements, which would allow for additional taps and limited fire protection and their probable costs are presented in three phases in both the conclusion of the study and in the attached Improvements phasing plan. Due to the foresight of past and current boards, if recommended improvements are made, the Stewart Mesa Water Company has the opportunity to distribute adequate water resources to their members for a considerable period of time.

1.0 INTROUDUCTION

The SMWC water transmission and distribution system is served by pressurized flow from the Town of Paonia's water treatment plant through a 4-inch master meter located at northeast limit of the SMWC service area. A series of pressure reducing valves regulate the system pressure to allow for water delivery to the water meter locations within the three independent distribution zones that comprise the current distribution network. The system consists of three primary service areas: labeled as upper, middle and lower zones on the attached schematic of the system. The upper zone is served by a 4-inch PVC main, while the middle and lower zones are served by 3-inch PVC mains. The newest pipes in the SMWC system were installed in 1986 and many of the system pipes have reached their design life and are leaking as usage records indicate.
A schematic of the current systems is attached as Exhibit A of this report.

To make informed decision regarding future expansion within the SMWC service area, a series of modeling scenarios using both historic flows from the Town of Paonia maximum potential flow under the existing SMWC absolute water rights was developed. All hydraulic modeling was performed using Version 8 of Bentley Systems WaterCAD modeling software in stand-alone format. The results of the various scenarios are presented in the appendix of this report. All scenarios included fire flow analysis using a 500 gpm fire flow demand as requested by Mike Byers, the Town of Paonia Fire Chief. Exhibit B, attached herein, presents our recommended system improvement phasing plan.

2.0 SYSTEM ANALYSIS

2.1 Study Objectives

The primary objectives of this study, as identified by the SMWC board, were:

- To determine the quantity and likely location of leaks in the existing system
- To model existing and future systems to identify and prioritize system repairs or replacements
- To identify the minimum system improvements required to provide fire flow as recommended by the Town of Paonia Fire District
- To recommended improvements to the existing system that would reduce leaks below an acceptable level of 10% and to provide a minimum level of fire protection for the SMWC members
- Provide cost estimates for the recommended improvements and identify potential sources of funding for those improvements for the SMWC to pursue

2.2 Data Acquisition

Data for creating the SMWC water system base model was provided by the SMWC in a series of meetings from August to November, 2014. We attended two site visits and a board of directors' meeting to obtain additional field data for the analysis. We worked in cooperation with Ms. Kerrry Smith, SMWC secretary/treasurer to obtain detailed usage records for the system for the past several years. Data provided by SMWC included an electronic system map in AutoCAD and PDF formats, Excel spreadsheets of historic meter records and system flows and demands from 2009 to present and anecdotal information about the system from board member David Herz.

Components of this information were used to manually create a system model in WaterCAD using the USGS digital elevation model as a background for topographic control to the existing system map provided by SMWC. GIS information from Delta County was used to provide parcel ownership to assist in assigning demands and calibrating the model's attributes to real world system conditions.

2.3 Base Model

A base model was prepared to show existing conditions in the Stewart Mesa Water Company service area. It was developed by analyzing the available flows and system demands as provided by the SMWC in their historic meter records from 2009 through October 2014. We paid particular attention to the recent meter records provided by Ms. Smith since they represent the most current conditions and since SMWC has recently installed or repaired several of their monitoring meters throughout the system in an effort to trace leaks indicated by variances from individual meter usage records and the Town of Paonia master meter.

Hydraulic models use junctions (nodes) and pipes to define water distribution systems. Rather than assign water demands to 75 individual users, we grouped demands for the system onto 17 junctions to form a skeletal model to represent the existing distribution system. Existing pipe sizes were obtained from the SMWC schematic prepared by C. Nyikos dated 4/18/2010

Several modeling assumptions were made after analyzing the data provided by the SMWC to allow for consistent modeling throughout the process and they are presented in the *Calibration* section below.

2.4 Calibration

Following the initial data acquisition phase, we ran the Base Model in steady state mode to study the system operations and look for additional critical data points. Steady state allows the user to look at a distribution system at an instant of time rather than for an extended period of time. This allows the modeler to look for obvious points of discrepancy in the model set-up such as junctions without elevations or closed pipes.

After successful steady state operation, we performed a 24-hour extended period simulation (EPS) to further confirm successful operation and to identify any further required system data. To successfully calibrate a hydraulic model, it is necessary to match model operations as closely as possible with actual system conditions. This was done by using current pressure readings at specific locations in the SMWC distribution system, from the system schematic provided. After several iterations and the acquisition of more field elevation data to fine tune the calibration points, a calibrated model was completed for use in the current and future system analyses. The base model results are attached in the appendix of this report. Pressures ranged from 30 to 102 psi which appear to be consistent with those reported by SMWC.

A daily hydraulic pattern, attached herein, was established to estimate peak hour demands based on a typical residential pattern with morning and evening peak demands. A conservative peak hour multiplier of 3.0 was used for these two peaks. This value is consistent with the recommendations of CDPHE and AWWA for water distribution system modeling.

No weekly hydraulic pattern was used since in discussions with the SMWC board it was decided that no day had any greater demand than any other.

No annual hydraulic pattern was developed since the maximum monthly demand was used to develop the base demands for the system. This is a conservative assumption that looks at peak flow demands for the year. Since the Town can supply the demands of the system without concerns for supply, the base model was created assuming an endless supply while demands were calibrated to the peak month usage data provided by SMWC.

A minimum fire flow requirement of 500 gpm was used for both current and future WaterCAD models. This figure was provided by the Town of Paonia fire chief, Mike Byers, who is responsible for providing emergency services to the area served by the SMWC. All junctions in both models were analyzed for required fire flow to determine their status during that demand. A minimum system pressure of 20 psi was set to be maintained during the fire flow test and junctions that could not maintain that system pressure were determined to be incapable of meeting this minimum fire flow. This is a standard for CDPHE and AWWA for water system operations.

2.5 Modeling Assumptions

- For the base models, an average base demand, in gpm, was assigned for all 71 meters in the system. Users were grouped into model demand nodes that match the groupings on the SMWC usage records for the various monitoring zones and their respective monitoring meter. The base demand for each group of meters in the SMWC system was derived from the 2014 July/August usage date provided by SMWC since this represented the peak demands for the system in 2014. Past data was reviewed, but due to recent system improvements such as new monitoring meters, we felt that past data did not represent current conditions. Demand nodes were created to represent groups of meters that have a monitoring meter. For example, the Todd subdivision has a system monitoring meter as well as 9 individual meters, one for each user. The average demand for the July/August reporting period for those 9 meters was 1.15 gpm. This was used as the fixed base demand flow to calibrate the model. Peak hour, peak day multipliers were applied to that base rate to analyze the system for low pressures and for fire flow capability. Table 1 below identifies the demand groups and their average base rate demand in gpm. Total system average flow was 9.60 gpm (13,824 GPD) as reported by SMWC.

- Actual field elevations, where provided by SMWC, were used for specific model components. If not provided, elevations of system junction nodes were estimated from Delta County GIS topographic data and adjusted to match field pressures at downstream junctions with those of the model.

- Existing system pressure reducing valves (PRV's) were modeled with inlet/outlet pressures as reported by SMWC.

- 30% line losses were modeled although they may be slightly high based on recent SMWC estimates of 28%. This figure represents an average of recent leakage losses. A 10% loss is identified by AWWA standards as a desirable maximum loss due to leakage.

- A fire flow demand of 500 gpm was modeled as requested by Paonia Fire Chief Mike Byers. This is a minimum that he would like to have available.

- PVC pipes were modeled with a Hazen-Williams friction coefficient of 140.

- Supply from the Town of Paonia was modeled as a reservoir in order to provide continuous supply to all models in both steady state and extended period simulation (EPS) modeling.

2.6 Summary of Base Model Results

The modeling of current conditions indicated that a fire flow of 500 gpm cannot be provided in the current SMWC system, nor should any additional taps be added due to low pressures at peak flow periods. The primary limiting factor to providing the recommended fire flow is pipe diameter since the majority of the distribution system contains no pipe larger than 4-inches in diameter. Six (6) inches is the minimum diameter recommended for fire flows in most water distribution systems, particularly those with extended lengths of pipe such as those found in the SMWC distribution system. Loss of flow capability increases with pipe length and the system demands placed on the pipes, especially high flows and low pressures associated with fire flows. For this reason, the SMWC system was subsequently modeled with 6-inch pipes for extended lengths and 4-inch pipes in short runs and local looped situations. This model, labeled as "future model" was used in the development of recommended system improvements presented in Section 4.0 below. Results of the existing or base model for SMWC are presented in Appendix B and a comparison of pressure losses for current system pipes is presented in Table 1 below..

Pipe Dia. (in)	Material	"C" Value	Pressure Loss (PSI	Velocity (fps)	Maximum # of Taps
1.0	Steel	110	54.7	1.63	3
3.0	PVC	140	49.3	1.37	29
4.0	PVC	140	49.9	4.36	53

Table 1. Hazen-Williams loss calculations for varied pipe diameters at peak hour flows and the theoretical maximum number of taps that can be supported on the system by pipe diameter.

As Table 1 indicates, current system piping doesn't allow for additional taps to be placed on the system due to increased velocities in older pipes and pressure losses which would exceed the recommended lowest pressure of 40 psi. Assumptions for this analysis are:

- Recommended pressure range is 90 to 40 psi. So maximum allowable drop is approximately 50 psi
- Peak hours flows are 6 times normal flow as recommended by AWWA and CDPHE for system modeling
- Maximum allowable velocity is 5.0 feet per second (fps)
- 2,400 feet of 1.0 steel inch pipe was analyzed for loss characteristics, whereas lengths for 3 and 4-inch system pipes were 18,607 and 8,178, respectively. Those lengths were derived from scaled distances in the WaterCAD model from approximate locations in the real system.

As indicated by the results in Table 1, the current system piping is severely undersized to support even the existing system demands, much less any new taps.

3.0 LEAKAGE ANALYSIS

Since the majority of SMWC pipes are PVC traditional acoustic leak detection offered little chance for successful leak detection. Instead, working with Ms. Smith, we analyzed the historic usage records to determine areas of concern and that show apparent leaks when comparing recently installed monitoring meters to cumulative totals for individual meters in those monitoring zones. Again some of the leaks have been well known to SMWC operations staff for some time, for example the Sunridge system leak, while other leaks can be narrowed down to sections of the existing system.

Ms. Smith has done an excellent job of preparing Excel spreadsheets of meter usage and comparing those to the respective monitoring meters to assume leakage. Looking at the SMWC date and using the three zones that Ms. Smith used in her system reports, we categorized the system losses due to leaks into Table 2 for quick reference. The monitoring zone labels match those used in the hydraulic models to describe collections of individual meters.

TABLE 2. SMWC LEAKAGE DATA				
MONITORING ZONE	**ANNUAL LOSS (GALS.)**	**ANNUAL LOST REVENUE ($)**	**PRESSURE ZONE**	**COMMENTS**
Upper System Users	829,532	$3,318	Upper	9 active taps
Todd Subdivision	32,015	$128	Upper	9 active taps
Sunridge	41,684	$168	Upper	7 active taps
Herz, et. al (Middle)	407,748	$1,631	Middle	7 active taps
McFarland, et. al	No Leak	$0	Middle	10 active taps
Gress, Wood, Lutz	No Leak	$0	Middle	3 active taps
Lower System Users	175,092	$700	Lower	10 active taps
Graceland	6,211	$25	Lower	8 active taps
Browns	29,582	$118	Lower	8 active taps
TOTALS	**1,521,864**	**$6,088**		

Table 2. SMWC Leakage Data – Revenues and losses are estimated for 2014 based on year-to-date figures through October and average figures for November-December for the past 10 years. Assumed highest cost rate of $4.00 per 1,000 gallons, rounded to nearest dollar.

As Table 2 indicates, the upper zone has the highest leakage (monthly average of 69,127 gallons) and was therefore identified as the highest priority in our future systems analysis and subsequent recommended system improvements. By eliminating the leakage loss in the upper zone, SMWC can save approximately $3,318 per year in excess costs and reduce overall loss from approximately 30% to 14%. By installing the recommended improvements to the middle zone, we estimate that an additional $1,927 can be saved annually and overall system losses would drop to approximately 5%.

4.0 RECOMMENDED SYSTEM IMPROVEMENTS

4.1 Scenarios

For future system improvements analysis, two scenarios were created and analyzed for the Stewart Mesa Water Company distribution systems.

#1- No additional taps

In this scenario, the SMWC system was analyzed using the 2014 July/August usage data provided by Ms. Smith and with increased pipe size to 6-inch diameter to replace the existing 3 and 4-inch mainlines in the system, smaller pipe diameter (eg. The 1.5-inch PVC pipe to the Graceland monitoring zone) were retained in these analyses. By upsizing the existing infrastructure piping to 6-inch PVC pipe for the primary distribution mains the entire system could satisfy a 300 gpm fire flow at all junctions without dropping below 20 psi at all junctions except the airport. A fire flow of 500 gpm can be provided along the upsized main line pipes, but those portions of the system on smaller diameter pipes experience negative pressures in that scenario. Again, since the fire flow was modeled to be in addition to peak hour demands and since the Town of Paonia provides supply to match system demands though an 8-inch pipe upstream of the master meter, the proposed system improvements allow the system meet current demands and 500-gpm fire flow, in most areas, without any additional taps, in all supply and demand scenarios for the current number of taps.

#2 – Maximum number of additional taps

Since the proposed improvements can easily meet current demands, the SMWC distribution system was next analyzed to identify the maximum number of taps that could be served by the recommended improvements. Although actual taps would be distributed throughout the distribution system, for modeling efficiency, all additional demands for the system were assigned to the demand node at the extreme west (lower) of the system model. This allows the systems to simulate serving maximum potential demands in their respective system and to determine the minimum system components (pipe, valves, etc.) necessary to supply the additional demands to the limits of the existing service area. That alternative of the future model, labeled maximum taps, indicates that a total of 25 additional taps, modeled at an average demand of 0.2 gpm could be accommodated if the proposed improvements in Phases 1 through 3 presented in section 5 are installed. The average July/August 2104 flow is 0.14 gpm, but this was increased to 0.2 gpm to be conservative and to more closely match AWWA and CDPHE assumed average daily demands for residential systems.

4.2 Recommended System Improvements

As can be seen from the modeling results summarized above, the potential maximum tap scenario depends on providing the system with a total of 14.6 gpm for average flow and 43.8 gpm for peak hour flows. In order to provide that flow and still meet fire flow recommendations, minimize system losses and generally improve system operations, we recommend the following improvements in three phases.

Phase I (green) – Upper Zone

Upper Zone Improvements – It is our understanding that the newest section of 4-inch PVC pipe installed as the main line in the upper zone from the Town's master meter to the Todd Subdivision was installed in 1986 and that many portions of the upper zone distribution mains are older than that. Generally, PVC pipe has a 40-50 year design life, so the mains in the upper zone are nearing their design life which is probably reflected in the large leakage loss in this zone as identified in the usage records reviewed in Section 2 of this report.

New PRV's – Our model analysis identified the need for two new pressure reducing valves (PRV) to define the upper zone. To match recommended system upgrades in phases 2 and 3, these should be sized to 6 inches for primary distribution mains. Additional smaller PRV's may be required in specific system areas depending on future growth. The upper zone is defined as that portion of the system from elevations of 6012 to 5804 and is present on the System Improvements Exhibit in Appendix D of this report. These PRV's would maintain system pressures from 90 psi to 40 psi to define the generally accepted pressure zone limits recommended by CDPHE and AWWA.

Distribution/Transmission Piping - We recommend that the Upper Zone distribution system piping be upsized to a minimum 6-inch diameter as mentioned above for fire flow requirements. We would recommend that a standard fire hydrant be installed at the lower end of the upper zone to provide maximum water pressure under fire flow conditions. This hydrant would be located near the Todd Subdivision which generally marks the end of the upper pressure zone.

Phase II (blue) – Middle Zone

These improvements appear in blue on the attached System Improvements Phasing Plan and consist of new 6-inch distribution mains, a new 6-inch PRV in a vault and one new standard fire hydrant to be located near the intersection of Stewart Mesa Road and Back River Road. Also recommended are three (3) 6-inch gate valves at isolation points, as necessary.

Phase III (red) – Lower Zone

As with the Upper and Middle zones, the lower zone would benefit by replacing older 3-inch PVC distribution mains with new 6-inch HDPE pipe. One PRV was identified as needing replacement to maintain recommended pressures in this zone. Again, based on Chief Byers request, we would recommend installing a new standard fire hydrant at the lower end of the lower zone where maximum system pressure for fire fighting is available.

4.3 Improvement Costs

Based on the models and the recommended improvements outlined above and 2014 construction bid prices, the probable costs of the three phases are summarized in the following three tables:

Phase 1 Improvements – Upper Zone (GREEN)

ITEM #	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6-inch PRV in vault	2	EA	$ 8,000.00	$ 16,000.00
2	6" HDPE pipe & fittings	8,445	LF	$ 20.00	$ 168,900.00
3	6-inch Gate valves	3	EA	$ 1,950.00	$ 5,850.00
4	Fire Hydrant	1	EA	$ 3,500.00	$ 3,500.00
6	Stormwater Management	1	LS	$ 5,000.00	$ 5,000.00
7	Traffic Control	30	Days	$ 500.00	$ 15,000.00
8	Construction Staking	1	LS	$ 10,000.00	$ 10,000.00
9	Mobilization	1	LS	$ 10,000.00	$ 10,000.00
Sub Total					**$ 230,650.00**
Contingency (10%)					$ 23.065.00
Pay and Performance Bond (2.5%)					$ 5,800.00
Construction Management (5%)					$ 11,532.50
Total					**$ 259,515.00**

Phase 2 Improvements – Middle Zone (BLUE)

ITEM #	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6-inch PRV in vault	1	EA	$ 8,000.00	$ 8,000.00
2	6" HDPE pipe & fittings	7,100	LF	$ 20.00	$ 142,000.00
3	6-inch Gate valves	3	EA	$ 1,950.00	$ 5,850.00
4	Fire Hydrant	1	EA	$ 3,500.00	$ 3,500.00
5	Stormwater Management	1	LS	$ 5,000.00	$ 5,000.00
6	Traffic Control	30	Days	$ 500.00	$ 15,000.00
7	Construction Staking	1	LS	$ 10,000.00	$ 10,000.00
8	Mobilization	1	LS	$ 10,000.00	$ 10,000.00
Sub Total					**$ 199,350.00**
Contingency (10%)					$ 19,935.00
Pay and Performance Bond (2.5%)					$ 4,750.00
Construction Management (5%)					$ 9,500.00
Total					**$ 233,535.00**

Phase 3 Improvements – Lower Zone (RED)

ITEM #	ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	6-inch PRV in vault	1	EA	$ 8,000.00	$ 8,000.00
2	6" HDPE pipe & fittings	5,670	LF	$ 20.00	$ 113,400.00
3	6-inch Gate valves	3	EA	$ 1,950.00	$ 5,850.00
4	Fire Hydrant	1	EA	$ 3,500.00	$ 3,500.00
5	Stormwater Management	1	LS	$ 5,000.00	$ 5,000.00
6	Traffic Control	30	Days	$ 500.00	$ 15,000.00
7	Construction Staking	1	LS	$ 10,000.00	$ 10,000.00
8	Mobilization	1	LS	$ 10,000.00	$ 10,000.00
Sub Total					**$ 165,750.00**
Contingency (10%)					$ 16,575.00
Pay and Performance Bond (2.5%)					$ 4,145.00
Construction Management (5%)					$ 8,290.00
Total					**$ 194,760.00**

Total Estimated Construction Cost – 3 Phases **$ 687,810.00**

Depending on funding sources and phasing selection, we estimate that total planning and engineering costs will vary from approximately $35,000 to $75,000 for all three phases. The requirements for engineering reports and environmental assessments vary from agency to agency. Assuming the high value of $75,000 for design, a conservative estimate of $728,810 is required to design and construct the three phases as recommended herein.

5.0 Alternatives Analysis

Due to the Town of Paonia's current moratorium on additional water taps in and out of the town limits, and SMWC's desire to limit fee increase to its members, it seems unlikely that the improvements presented in Section 4.0 above will be constructed in the near future. For that reason, the SMWC board requested that we examine and discuss other system options to allow improved fire flows and/or system capacity without large expenditures.

5.1 Storage Tank at Blake Airfield – Alternative #1

This option proposes to install a tank of adequate volume to provide the desired 500 gpm fire flow for some minimum period of time. We selected two hours as a reasonable period of time to provide 500 gpm for fire-fighting. That would require a 60,000 gallon tank. The estimated cost of this alternative would be approximately $135,000 and would not benefit the entire SMWC service area. Only those areas where the elevation head would allow the required minimum system pressure of 20 psi would benefit from this alternative. It is our understanding that the fire district would be willing to assist SMWC in applying for grants that could fund a project of this type. Drawbacks to this alternative include increased maintenance of the tank, a need to periodically drain and flush the tank for water quality purposes as required by CDPHE. Additionally, any addition of storage to a public water system requires that a Basis of Design report and detailed construction plans be submitted to CDPHE prior to construction.

5.2 Storage Pond(s) for Dry Barrel Pump

If funding for a storage tank is not available, a second alternative would be to excavate strategically located pond(s) to provide storage for fire flow. This option doesn't require as much maintenance and water turnover and much of the labor to excavate the ponds could be provided by SMWC volunteers to keep costs down. Again, the fire district might be able to obtain funding for dry barrel hydrants and the ponds could be located so that natural runoff, in addition to potable water, could be used if allowed by the Colorado Division of Water Resources. Drawbacks would include needing to periodically clean the ponds of cattails and other aquatic plants and providing protection from public incursion to the pond(s) for safety reasons.

6.0 Conclusions and Recommendations

The Stewart Mesa Water Company water distribution system currently has an adequate supply to serve current needs from the Town of Paonia supply system, although there are, during peak flow periods, low pressures and velocities greater than 5.0 fps as recommended by CDPHE and AWWA. As outlined in the analysis presented above, existing system piping is aging, undersized and leaking and is not adequate to provide the recommended fire flow of 500 gpm or to allow for any additional taps to be added to the system. Systems costs can be reduced by approximately $6,100 per year by reducing leakage from the current level of 30% to approximately 5% which is well below the 10% maximum loss rate as recommended by CDPHE and AWWA.

To fund the estimate total cost of $728,810 as outlined in the three improvement phases presented in this report a variety of sources are available to the SMWC. Those funding sources include public loans and grants through either state or federal agencies such as the Colorado Department of Local Affairs (DOLA), the U.S. Department of Agriculture - Rural Development (USDA-RD), Colorado State Revolving Fund (SRF) and the Rural Community Assistance Corporation (RCAC). Private loans from lending organizations are also available, although qualifications for acceptance may be rigid and interest rates higher than public sources depending on the economy.

To assist in future analysis of the system we recommend the following:

- Coordinate reading of the master meter with the Town of Paonia meter reader to better match the town's readings. We understand that the SMWC reader does read the town's meter prior to performing the bi-monthly meter readings, but it appears there still may be some lag between the Town's readings and the SMWC cumulative two month reading totals.
- We suggest that even if the data isn't used to prepare monthly bills, that SMWC read the meters monthly to more quickly and accurately detect any discrepancies (ie. leaks) in the system. Again, it is possible that differences between Town

monthly readings and SMWC bi-monthly readings may be creating mathematical "leaks" in system records that may or not be reflected physically as actual water leaks.

- Confirm that all monitoring meters are in good working order and reading accurately at all flow levels. Several monitoring meters report negative leaks which can reflect either the mathematical discrepancies outlined above or that the meters are not operating correctly. Some meters do not read accurately at low flows.

7.0 Certification

I, Daniel C. Quigley, a duly registered professional engineer in the State of Colorado, (registration #38334), have prepared this report, related documents, and supervised the preparation of the drawings enclosed. The information included is, to the best of my knowledge, accurate and conforming to the standards presented in AWWA M-32 *Distribution Network Analysis.*

Respectfully submitted
March 12, 2015 by,

Daniel C. Quigley, PE, PG
Project Engineer

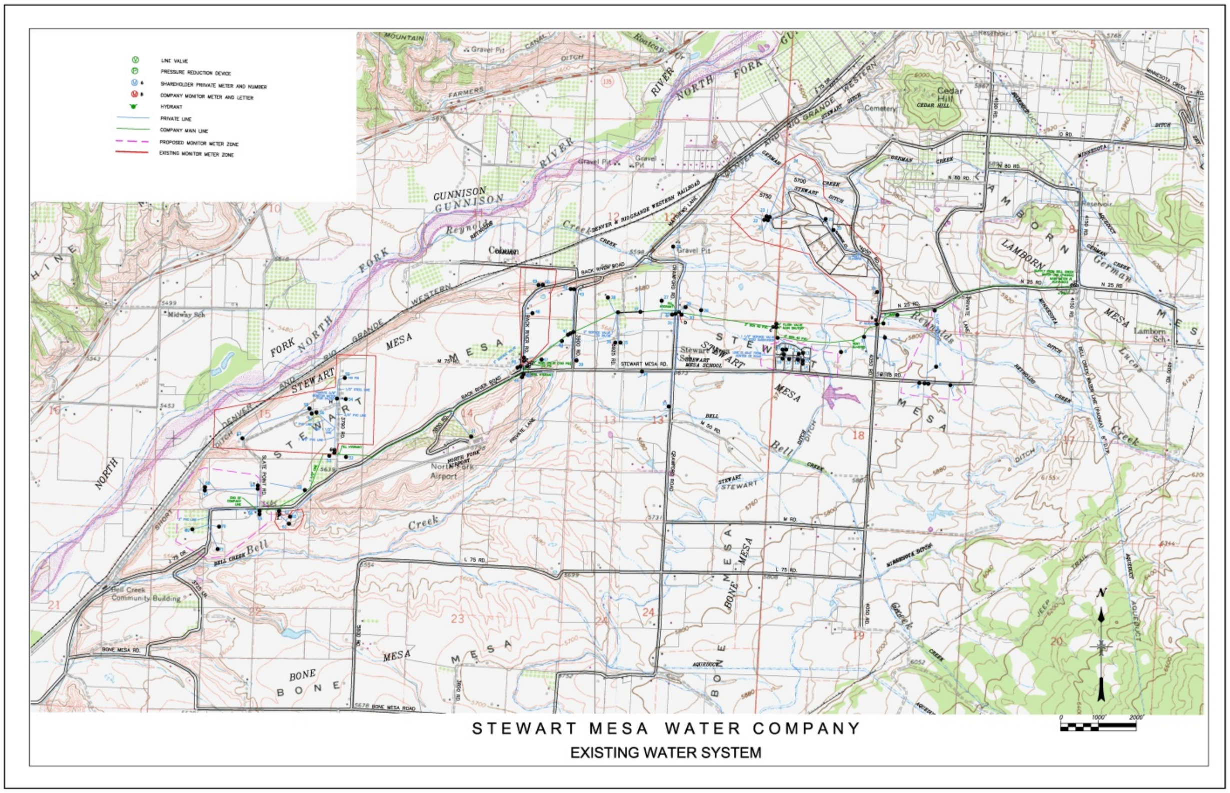
BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

222 South Park Ave. • Montrose, CO 81401
Ph.: (970) 249-6828 • FAX: (970) 249-0945

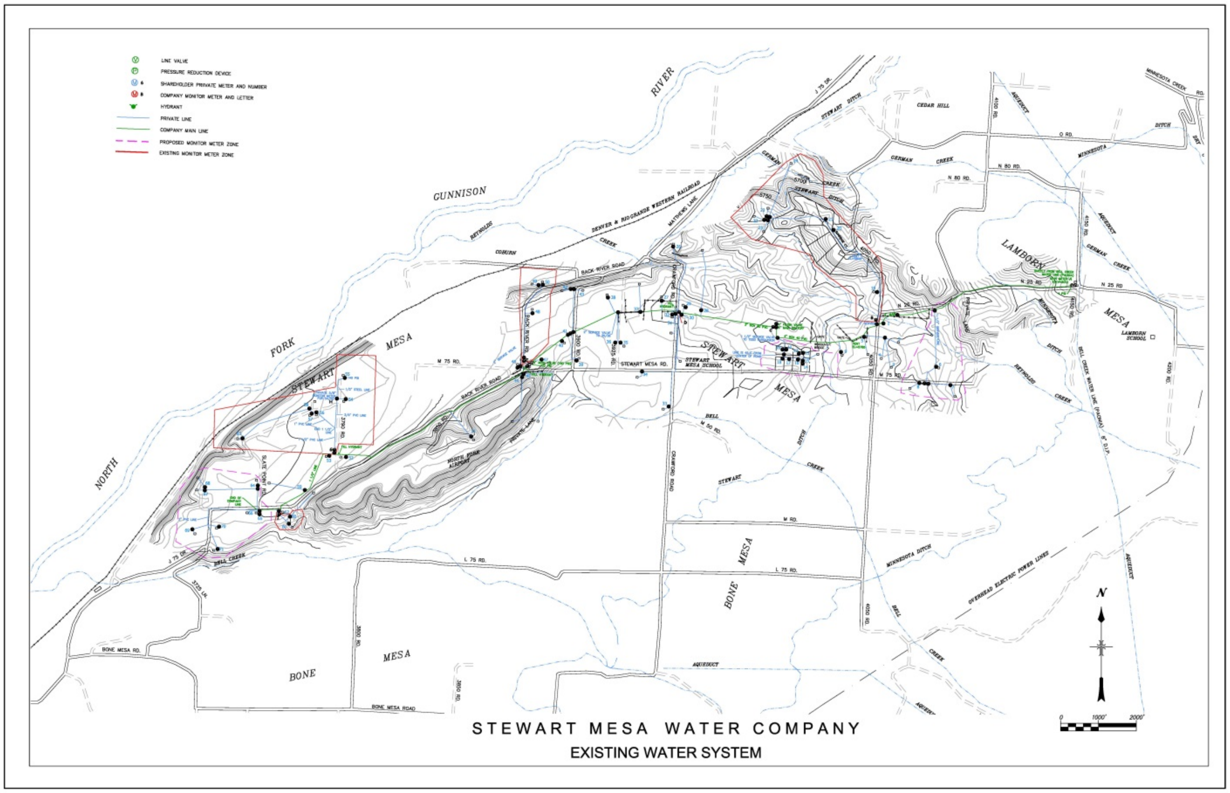
APPENDIX A

EXISTING SYSTEM EXHIBIT

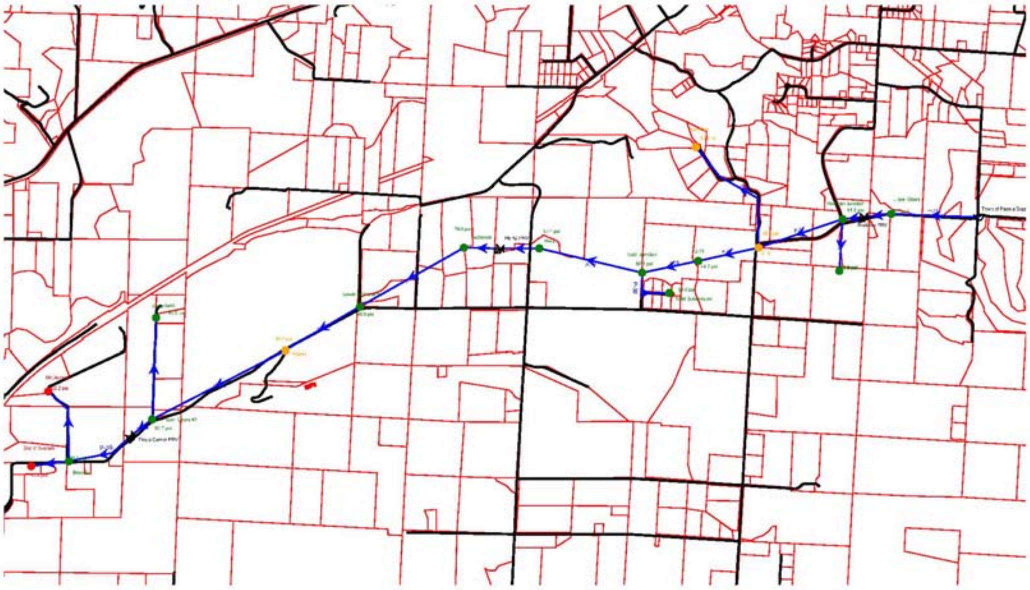

LINE VALVE
PRESSURE REDUCTION DEVICE
SHAREHOLDER PRIVATE METER AND NUMBER
COMPANY MONITOR METER AND LETTER
HYDRANT
PRIVATE LINE
COMPANY MAIN LINE
PROPOSED MONITOR METER ZONE
EXISTING MONITOR METER ZONE
GUNNISON
NORTH FORK
STEWART MESA
BONE MESA
Cedar Hill
Cemetery
North Fork Airport
Bell Creek Community Building
Midway Sch
STEWART MESA RD.
BONE MESA ROAD
STEWART MESA WATER COMPANY
EXISTING WATER SYSTEM

APPENDIX B

BASE MODEL RESULTS


LINE VALVE
PRESSURE REDUCTION DEVICE
SHAREHOLDER PRIVATE METER AND NUMBER
COMPANY MONITOR METER AND LETTER
HYDRANT
PRIVATE LINE
COMPANY MAIN LINE
PROPOSED MONITOR METER ZONE
EXISTING MONITOR METER ZONE
NORTH
FORK
GUNNISON
RIVER
STEWART
MESA
BONE
MESA
LAMBORN
MESA
DENVER & RIO GRANDE WESTERN RAILROAD
BACK RIVER ROAD
STEWART MESA RD.
STEWART MESA SCHOOL
CRAWFORD ROAD
M 75 RD.
M RD.
L 75 RD.
N 25 RD.
N 80 RD.
O RD.
BONE MESA RD.
BONE MESA ROAD
CEDAR HILL
GERMAN CREEK
BELL CREEK
MINNESOTA DITCH
OVERHEAD ELECTRIC POWER LINES
AQUEDUCT
LAMBORN SCHOOL
N
0
1000'
2000'
STEWART MESA WATER COMPANY
EXISTING WATER SYSTEM

Scenario: Base Model



SMDWC_Base Model.wtg
12/5/2014

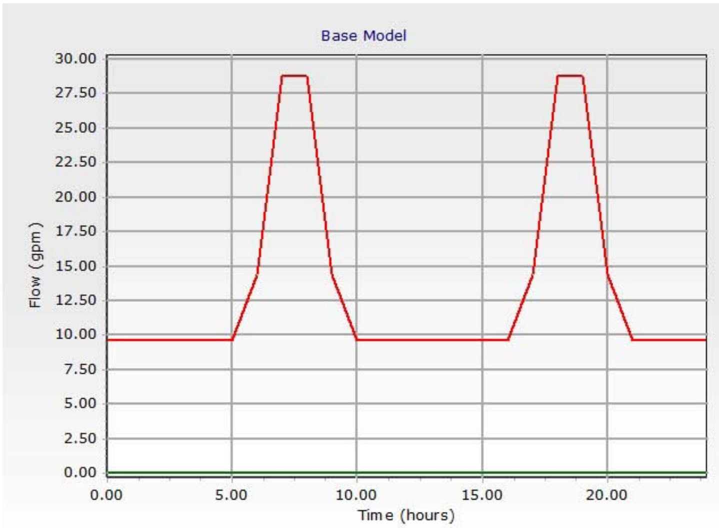
Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W Watertown, CT 06795 USA
+1-203-755-1666

Bentley WaterCAD V8i (SELECTseries 2)
[08.11.02.31]
Page 1 of 1

Calculation Summary (1: Base Model)

Time (hours)	Balanced?	Trials	Relative Flow Change	Flow Supplied (gpm)	Flow Demanded (gpm)	Flow Stored (gpm)
All Time Steps(24)	True	61	0.0000001	13.44	13.44	0.00
0.00	True	5	0.0000000	9.60	9.60	0.00
1.00	True	1	0.0000000	9.60	9.60	0.00
2.00	True	1	0.0000000	9.60	9.60	0.00
3.00	True	1	0.0000000	9.60	9.60	0.00
4.00	True	1	0.0000000	9.60	9.60	0.00
5.00	True	1	0.0000000	9.60	9.60	0.00
6.00	True	5	0.0000000	14.40	14.40	0.00
7.00	True	5	0.0000000	28.80	28.80	0.00
8.00	True	1	0.0000001	28.80	28.80	0.00
9.00	True	5	0.0000000	14.40	14.40	0.00
10.00	True	5	0.0000001	9.60	9.60	0.00
11.00	True	1	0.0000000	9.60	9.60	0.00
12.00	True	1	0.0000000	9.60	9.60	0.00
13.00	True	1	0.0000000	9.60	9.60	0.00
14.00	True	1	0.0000000	9.60	9.60	0.00
15.00	True	1	0.0000000	9.60	9.60	0.00
16.00	True	1	0.0000000	9.60	9.60	0.00
17.00	True	5	0.0000000	14.40	14.40	0.00
18.00	True	5	0.0000000	28.80	28.80	0.00
19.00	True	1	0.0000001	28.80	28.80	0.00
20.00	True	5	0.0000000	14.40	14.40	0.00
21.00	True	5	0.0000001	9.60	9.60	0.00
22.00	True	1	0.0000000	9.60	9.60	0.00
23.00	True	1	0.0000000	9.60	9.60	0.00
24.00	True	1	0.0000000	9.60	9.60	0.00

Calculation Summary (1: Base Model)



FlexTable: Pipe Table (Stewart Mesa Domestic Water System Model.wtg)

Current Time: 0.000 hours

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C
138	P-14	2,105	Rodman Junction	J-16	4.0	PVC	130.0
142	P-16	2,506	Todd Junction	Herz	3.0	PVC	130.0
146	P-18	2,830	Pecharich	Lower End Users	3.0	PVC	130.0
148	P-19	2,051	Lower End Users	Airport	3.0	PVC	130.0
152	P-21	901	Browns	End of System	3.0	PVC	130.0
154	P-22	3,554	Airport	Lower Users #2	3.0	PVC	130.0
157	P-24	2,400	Lower Users #2	Graceland	1.0	Steel	110.0
161	P-25	1,232	Rodman Junction	Rodman	1.5	PVC	150.0
163	P-26	3,110	J-16	Sunridge	3.0	PVC	130.0
165	P-27	1,868	Browns	McDermott	3.0	Ductile Iron	130.0
167	P-28	1,464	J-16	J-29	4.0	PVC	130.0
168	P-29	1,361	J-29	Todd Junction	4.0	PVC	130.0
170	P-30	1,133	Todd Junction	Todd Subdivision	1.5	PVC	130.0
172	P-31	2,091	Town of Paonia Supply	Upper Users	4.0	PVC	130.0
179	P-34	641	Upper Users	Rodman PRV	4.0	PVC	130.0
180	P-35	516	Rodman PRV	Rodman Junction	4.0	PVC	130.0
185	P-36	923	Herz	HERZ PRV	3.0	PVC	130.0
186	P-37	864	HERZ PRV	Pecharich	3.0	PVC	130.0
189	P-38	637	Lower Users #2	Dee's Corner PRV	1.5	PVC	130.0
190	P-39	1,650	Dee's Corner PRV	Browns	1.5	PVC	130.0

Flow (gpm)	Velocity (ft/s)
9.04	0.23
6.52	0.30
4.62	0.21
2.79	0.13
0.12	0.01
2.79	0.13
1.43	0.58
0.12	0.02

FlexTable: Pipe Table (Stewart Mesa Domestic Water System Model.wtg)

Current Time: 0.000 hours

Flow (gpm)	Velocity (ft/s)
1.37	0.06
0.25	0.01
7.67	0.20
7.67	0.20
1.15	0.21
9.60	0.25
9.16	0.23
9.16	0.23
5.28	0.24
5.28	0.24
1.19	0.22
1.19	0.22

Scenario: Base Model
Current Time Step: 0.000Hr
FlexTable: Pipe Table

ID	Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C	Flow (gpm)	Velocity (ft/s)
138	P-14	2,105	Rodman Junction	J-16	4.0	PVC	130.0	9.04	0.23
142	P-16	2,506	Todd Junction	Herz	3.0	PVC	130.0	6.52	0.30
146	P-18	2,830	Pecharich	Lower End Users	3.0	PVC	130.0	4.62	0.21
148	P-19	2,051	Lower End Users	Airport	3.0	PVC	130.0	2.79	0.13
152	P-21	901	Browns	End of System	3.0	PVC	130.0	0.12	0.01
154	P-22	3,554	Airport	Lower Users #2	3.0	PVC	130.0	2.79	0.13
157	P-24	2,400	Lower Users #2	Graceland	1.0	Steel	110.0	1.43	0.58
161	P-25	1,232	Rodman Junction	Rodman	1.5	PVC	150.0	0.12	0.02
163	P-26	3,110	J-16	Sunridge	3.0	PVC	130.0	1.37	0.06
165	P-27	1,868	Browns	McDermott	3.0	Ductile Iron	130.0	0.25	0.01
167	P-28	1,464	J-16	J-29	4.0	PVC	130.0	7.67	0.20
168	P-29	1,361	J-29	Todd Junction	4.0	PVC	130.0	7.67	0.20
170	P-30	1,133	Todd Junction	Todd Subdivision	1.5	PVC	130.0	1.15	0.21
172	P-31	2,091	Town of Paonia Supply	Upper Users	4.0	PVC	130.0	9.60	0.25
179	P-34	641	Upper Users	Rodman PRV	4.0	PVC	130.0	9.16	0.23
180	P-35	516	Rodman PRV	Rodman Junction	4.0	PVC	130.0	9.16	0.23
185	P-36	923	Herz	HERZ PRV	3.0	PVC	130.0	5.28	0.24
186	P-37	864	HERZ PRV	Pecharich	3.0	PVC	130.0	5.28	0.24
189	P-38	637	Lower Users #2	Dee's Corner PRV	1.5	PVC	130.0	1.19	0.22
190	P-39	1,650	Dee's Corner PRV	Browns	1.5	PVC	130.0	1.19	0.22

Z:\2014\14-200 Stewart Mesa Water - Hydraulic Study\WaterCAD Models\Stewart Mesa Domestic Water System Model.wtg

Scenario: 500 GPM Fire Flow
Current Time Step: 0.000Hr
FlexTable: Junction Table

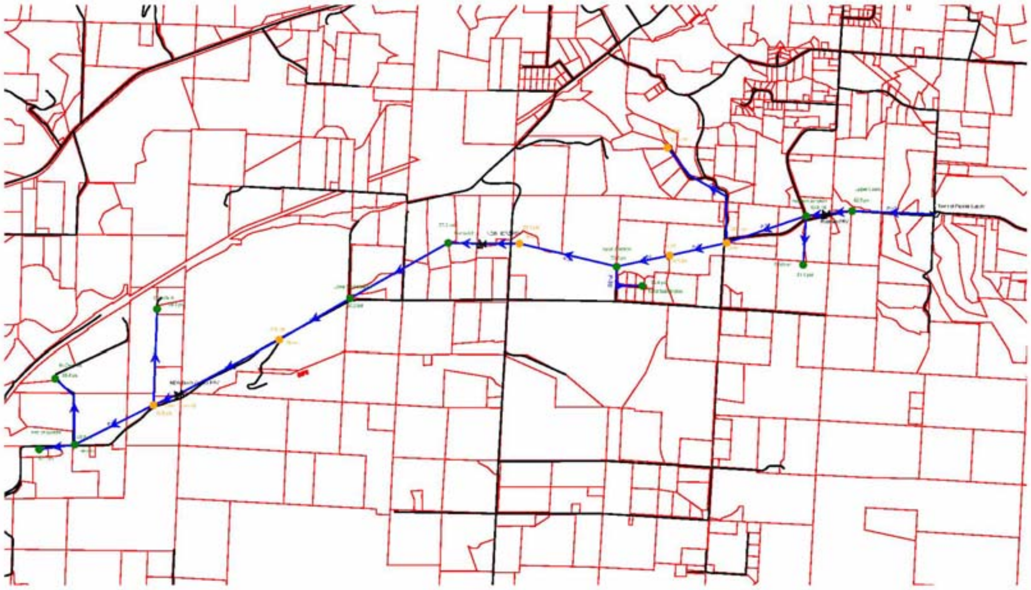
ID	Label	Elevation (ft)	Zone	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
162	Sunridge	5,800.00	<None>	<Collection: 0 items>	0.00	5,530.96	-116.4
137	J-16	5,785.00	<None>	<Collection: 0 items>	0.00	5,530.96	-109.9
135	Rodman Junction	5,770.00	<None>	<Collection: 1 item>	500.00	5,530.96	-103.4
147	Airport	5,770.00	<None>	<Collection: 0 items>	0.00	5,530.96	-103.4
166	J-29	5,770.00	<None>	<Collection: 0 items>	0.00	5,530.96	-103.4
160	Rodman	5,750.00	<None>	<Collection: 0 items>	0.00	5,530.96	-94.8
141	Herz	5,740.00	<None>	<Collection: 0 items>	0.00	5,530.96	-90.4
171	Upper Users	5,872.82	<None>	<Collection: 0 items>	0.00	5,702.32	-73.8
139	Todd Junction	5,665.00	<None>	<Collection: 0 items>	0.00	5,530.96	-58.0
169	Todd Subdivision	5,665.00	<None>	<Collection: 0 items>	0.00	5,530.96	-58.0
143	Pecharich	5,660.00	<None>	<Collection: 0 items>	0.00	5,530.96	-55.8
145	Lower End Users	5,630.00	<None>	<Collection: 0 items>	0.00	5,530.96	-42.9
153	Lower Users #2	5,630.00	<None>	<Collection: 0 items>	0.00	5,530.96	-42.9
156	Graceland	5,610.00	<None>	<Collection: 0 items>	0.00	5,530.96	-34.2
149	Browns	5,600.00	<None>	<Collection: 0 items>	0.00	5,530.96	-29.9
151	End of System	5,590.00	<None>	<Collection: 0 items>	0.00	5,530.96	-25.5
164	McDermott	5,570.00	<None>	<Collection: 0 items>	0.00	5,530.96	-16.9

Z:\2014\14-200 Stewart Mesa Water - Hydraulic Study\WaterCAD Models\SMDWC_Base Model.wtg

APPENDIX C

FUTURE MODEL SCENARIO RESULTS

Scenario: Future Model



SMDWC_Future Model.wtg
12/5/2014

Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W Watertown, CT 06795 USA
+1-203-755-1666

Bentley WaterCAD V8i (SELECTseries 2)
[08.11.02.31]
Page 1 of 1

Scenario: Future Model
Current Time Step: 0.000Hr
FlexTable: Junction Table

ID	Label	Elevation (ft)	Zone	Demand Collection	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
135	Rodman Junction	5,770.00	<None>	<Collection: 0 items>	0.00	5,869.30	43.0
137	J-16	5,785.00	<None>	<Collection: 0 items>	0.00	5,851.56	28.8
139	Todd Junction	5,665.00	<None>	<Collection: 1 item>	0.00	5,827.95	70.5
141	Herz	5,740.00	<None>	<Collection: 1 item>	1.24	5,807.14	29.1
143	Pecharich	5,660.00	<None>	<Collection: 1 item>	0.66	5,792.42	57.3
145	Lower End Users #1	5,630.00	<None>	<Collection: 1 item>	1.83	5,769.20	60.2
147	Airport	5,770.00	<None>	<Collection: 0 items>	0.00	5,752.55	-7.5
149	Browns	5,600.00	<None>	<Collection: 2 items>	300.82	5,705.93	45.8
151	End of System	5,590.00	<None>	<Collection: 1 item>	0.12	5,705.93	50.2
153	Lower Users #2	5,630.00	<None>	<Collection: 1 item>	0.17	5,723.69	40.5
156	Graceland	5,610.00	<None>	<Collection: 1 item>	1.43	5,722.98	48.9
160	Rodman	5,750.00	<None>	<Collection: 1 item>	0.12	5,869.30	51.6
162	Sunridge	5,800.00	<None>	<Collection: 1 item>	1.37	5,851.52	22.3
164	McDermott	5,570.00	<None>	<Collection: 1 item>	0.25	5,705.93	58.8
166	J-29	5,770.00	<None>	<Collection: 0 items>	0.00	5,839.32	30.0
169	Todd Subdivision	5,665.00	<None>	<Collection: 1 item>	1.15	5,827.69	70.4
171	Upper Users	5,872.82	<None>	<Collection: 1 item>	0.44	5,994.31	52.6

Z:\2014\14-200 Stewart Mesa Water - Hydraulic Study\WaterCAD Models\SMDWC_Future Model.wtg

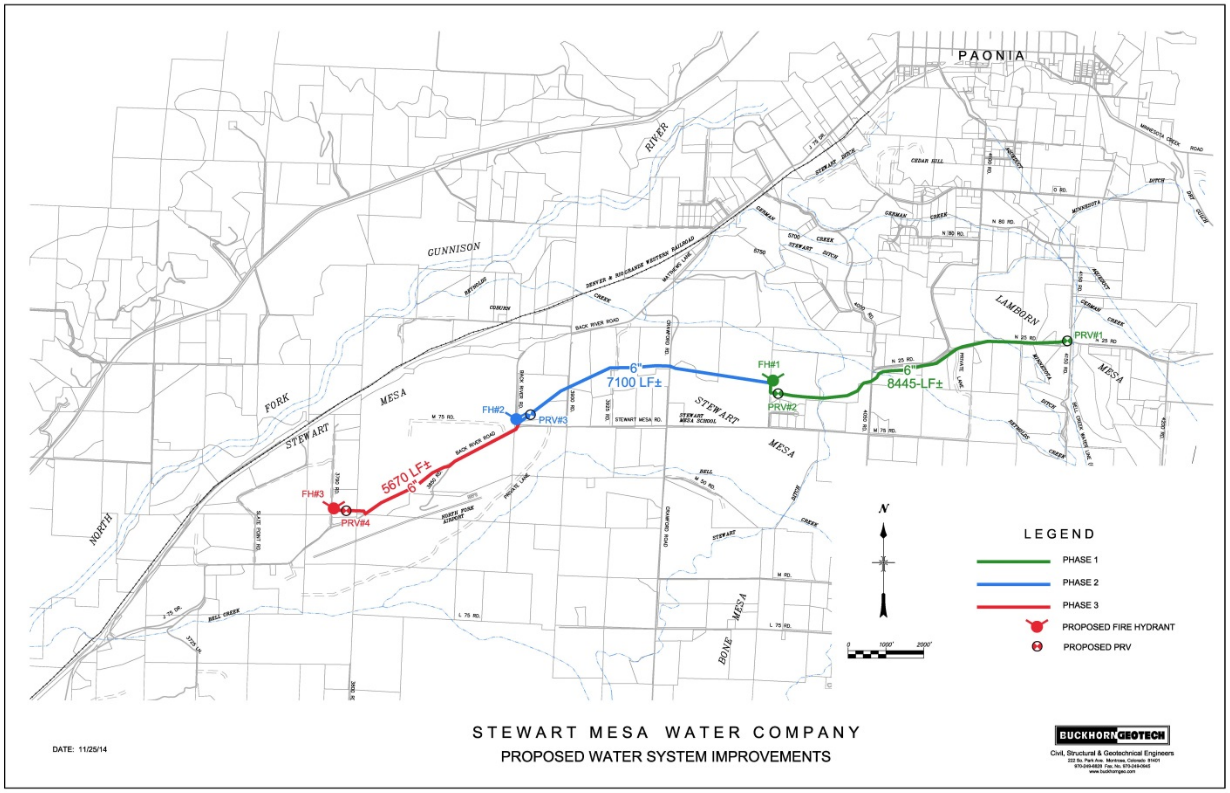
BUCKHORN GEOTECH

Civil, Structural & Geotechnical Engineers

222 South Park Ave. • Montrose, CO 81401
Ph.: (970) 249-6828 • FAX: (970) 249-0945

APPENDIX D

SYSTEM IMPROVEMENTS EXHIBIT


PAONIA
GUNNISON
RIVER
NORTH
FORK
STEWART
MESA
STEWART
MESA
LAMBORN
MESA
BONE
MESA
6"
7100 LF±
FH#1
PRV#2
6"
8445-LF±
PRV#1
FH#2
PRV#3
5670 LF±
6"
FH#3
PRV#4
N
LEGEND
PHASE 1
PHASE 2
PHASE 3
PROPOSED FIRE HYDRANT
PROPOSED PRV
STEWART MESA WATER COMPANY
PROPOSED WATER SYSTEM IMPROVEMENTS
DATE: 11/25/14
BUCKHORN GEOTECH
Civil, Structural & Geotechnical Engineers