Appendix C. Task 301 Technology Equipment and Software – Flow Control

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TASK 301 - TECHNOLOGY, EQUIPMENT, AND SOFTWARE – FLOW CONTROL OPPORTUNITIES

PROJECT NO. 401414

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1.0 Introduction and TM Organization

This technical memorandum (TM) summarizes the options for the City of Santa Rosa (City) Water Department to address flow control issues that were discovered during the Tubbs fire. Some options were provided in the "Evaluation of the Water System's Response in Fountaingrove to the October 2017 Fire" TM released in August 2018. That report recommended several areas for additional research. In 2019, City issued the Water System Reliability Study to perform additional research. This TM is one of the required TMs to meet the requirements of the Water System Reliability Study.

Flow control opportunities will focus on:

- Evaluating available technology for remotely closing valves from automatic metering infrastructure (AMI) or supervisory control and data acquisition (SCADA), or automatically.
- Identifying flow sensors, such as AMI and SCADA, to address the need to control flow and potential isolation at very high flow rates.
- The Task 300 scope in Flow Control Opportunities included "Use GIS and/or the City's water model to help identify critical locations and isolation opportunities." This requirement is being addressed in the Task 400 TM.

This TM is organized into the following sections:

- Section 2.0, Project Background
- Section 3.0, Flow Control Opportunities (which includes residential customer isolation, commercial customer isolation, and isolation within the distribution system).

2.0 Project Background

2.1 AMI INTRODUCTION

AMI is an automated system for reading consumption water meters and passing information to the billing system. Electronics can be added to brass consumption meters, or the entire meter can be replaced with the electronics embedded. The electronics are battery powered. The meters periodically broadcast their identification and meter reading. Gateways (or collectors) are strategically placed around the city listening to the broadcasted readings. The gateways gather the readings from the meters they heard and send them to a meter reading database. The meter reading database provides data to the billing system. The City has standardized on the Sensus AMI system. There are three Sensus models of water meters discussed in this TM:

Figure 1 SR II Brass Meter with AMI Electronics

- SR II: A brass mechanical meter that utilizes a positive displacement piston to measure flow. An electronic package is added to the mechanical meter that replaces the mechanical wheel display shown on Figure 1. This meter is rated for 20 gallons per minute (gpm) and costs approximately $75. It was determined that these mechanical meters may not be able to provide adequate flow for houses with fire suppression sprinklers. In addition, this meter does not have remote isolation capabilities. Isolation is provided by the manual curb stop valve that is directly upstream of the meter.

- iPerl: A magnetic flow meter. This meter is capable of 35 gpm and meets the fire sprinkler flow requirement shown on Figure 2. These cost approximately $80 each. Isolation is provided by the manual curb stop valve that is directly upstream of the meter.
- ally: Sensus offers an integrated flow meter and isolation valve shown on Figure 3. The valve can be opened or closed remotely from the AMI system. No ally meters are installed in the City's distribution system. These combined meters with valves cost approximately $300 each.

Figure 2 iPerl AMI Meter

Figure 3 ally AMI Meter

2.2 TASK 301 EFFORT

The Black & Veatch Instrumentation and Control (I&C) Manager met with the City I&C Supervisors on May 6, 2019, to review the existing SCADA System. They reviewed the SCADA technologies at the utilities field office (UFO) building. They traveled into the field and visited several locations including Reservoir 17, Pump Station 18, Pump Station 4, Reservoir 3 and other locations. Additional details about the SCADA system can be found in the Task 200 TM.

Black & Veatch I&C Manager met with the City AMI Manager on May 7, 2019 and they reviewed the AMI system capabilities and options.

Before the Tubbs fire, the City was in the process of replacing all existing water meters with new AMI meters. As of May 2019, the City was approximately 75 percent complete with this replacement project, with approximately 8,000 meters remaining. The Tubbs fire delayed the implementation schedule and allowed the City to evaluate the flowmeter selection. The Federal Emergency Management Agency (FEMA) provided funds to return the system back to original condition or the current standard. The current standard when the fire occurred was the iPerl Sensus AMI consumption meter.

The following advantages were discussed during the meeting with the City AMI Manager:

- The City has selected and standardized on the Sensus AMI system.
- The AMI meters installed in the meter boxes survived the fire for the most part. The exception is when there was something on top of the meter box (such as the resident's large plastic trash container) that was completely consumed with fire and melted. Similar damage to the AMI meter occurred if there was a vehicle that was engulfed in flames near the meter box.
- The City established the default residential meter from a brass meter with an electronics package capable of 20 gpm to a magnetic meter capable of 35 gpm.

The following opportunities were discussed:

- Sensus offers a combined flow meter with isolation valve, called ally, that can be operated through the AMI system. However, the City would need to purchase an upgrade for the Sensus software to utilize these meters with isolation valves and open and shut the valves from the AMI software.

- Other vendors provide valves (without a flow meter) that could be commanded via the Sensus AMI. The meters offered by other vendors are available up to 1 inch maximum in size.

On August 5, 2019, Black & Veatch coordinated a meeting to discuss the options presented in this document. In general, the consensus of the meeting was not to add any isolation valves presented in this TM. The largest concern is liability to the City if any of these valves were to close inappropriately.

The completely mechanical valves that are without electricity and unmonitored are particularly concerning. The City and Black & Veatch both have experiences with completely mechanical valves that have failed on occasion (i.e., the valve froze in position). Another failure that has been experienced was when the valve moved when it should not have. These failures are rare but have happened. Because they are not monitored, the first indication of an undesired isolation would be phone calls to the Water Department from a client.

An unannounced, unplanned non-emergency of isolation of water could expose the city to significant liability.

3.0 Flow Control Opportunities

3.1 PROBLEM STATEMENT

During the Tubbs fire, several structures were completely engulfed in flames and burned to the foundation. The buried water pipes from the meter box, including the meter, to the building generally withstood the fire conditions. When the service line came abovegrade, the pipes failed. This led to the uncontrolled release of water that flowed at the full capacity of the pipe diameter at the supplied pressure. The result was the draining of some reservoirs.

This TM focuses on three types of isolations: residential customers, commercial customers and internal to distribution system districts.

A typical residential water service line is 0.75 inch in diameter. If the pipe is severed and source pressure is at 60 pound per square inch gauge (psig), then a flow rate of 90 gpm is possible.

There are commercial line sizes between 4 inches and 10 inches. A typical commercial water line is 6 inches in diameter. If a 6 inch pipe is severed, and source pressure is at 60 psig, then a flow rate of 5,800 gpm is possible.

Mains within the City's distribution system are generally between 4 inch and 12 inch in diameter, with the vast majority being 6 inch or 8 inch. These mains are buried and were not damaged by the fire. The manual isolation valves in these mains could provide isolation of several buildings or residences within an area. Several valves would need to be closed to isolate an area. The City currently has a valve isolation plan in place to allow isolating parts of the distribution system under emergency or maintenance conditions.

3.2 RESIDENTIAL CUSTOMER ISOLATION

Because Sensus offers an isolation option, SCADA and mechanical isolation were not considered.

Residential isolation options include the following.

3.2.1 Option 1 – Residential Isolation – No Change

Continue with the current installation and do not add any automatic or remote isolation capabilities to any residential homes.

3.2.2 Option 2 – Residential Isolation – Replace Remaining AMI Meters with ally AMI Meter

Change the current standard of residential flowmeter from the iPerl to the ally for the rest of the implementation.

Advantage – Some houses would be able to be isolated during a fire.

Opportunities include the following:

- This would result in two different types of AMI meters in the City's distribution system.
- The selection of houses would be based on what is scheduled to be replaced.

3.2.3 Option 3 – Residential Isolation – Replace High-Risk Residence with ally AMI Meter

Specific "high risk" houses or areas would be selected to install the ally AMI meters, which come equipped with integral isolation valves. The high-risk houses could be those that are more prone to fire (perhaps on the outskirts or in heavily wooded areas).

Advantage – The City may see some value in this approach because high risk houses could be isolated.

Opportunity – May result in two different types of AMI meters in the system.

3.2.4 Option 4 – Residential Isolation – Consider ally Meter During Next Replacement Phase

When the current replacement metering program is fully implemented, the batteries are expected to last 10 to 15 years. As meters approach the end of their useful life, the City may consider researching the advantages and disadvantages to implement the ally AMI meters or equivalent in the future.

Advantage - Meter technology is continuing to improve. Several meter vendors are researching meters with integrated water pressure, water temperature and or water quality sensing. The latest available technologies in the future could be reviewed to select meters that incorporate integral isolation capabilities.

3.2.5 Recommendation

At the meeting on August 5, 2019, the City indicated that Option 4 best suits their needs. The remaining meters will be installed using the current meter. The City may consider changing the standard during the next replacement cycle in approximately 10 to 15 years.

3.3 AMI LEAK DETECTION REPORT

The City indicated that the AMI system can generate a leak detection report based on the flow data collected from the AMI meters.

A version of the report may be able to be created with a geographic information system (GIS) heat map to guide the responding water crew(s) to areas and specific addresses to isolate.

Advantage – Can help focus isolation effort.

Disadvantage – May need detailed instructions to trigger the consumptions meter data "on demand"

3.4 COMMERCIAL CUSTOMER ISOLATION

Commercial buildings and big box stores that were lost in the Tubbs fire are considered the largest loss of water. A broken six-inch water line with 60 psi can result in 5,800 gpm. At this rate, a reservoir or elevated tank with one million gallons of storage would be drained in less than 175 minutes.

The intent is to research valves to isolate a commercial building during a catastrophic failure such as a wide area fire or massive earthquake.

The following are disadvantages for all of the options:

- Liability – The completely mechanical valves without electricity and unmonitored are particularly concerning. The City and Black & Veatch both have experiences with completely mechanical valves that have failed on occasion (i.e., the valve froze in position). Another failure has been experienced when the valve moved when it should not have. These failures are rare but have happened. Because they are not monitored, the first indication of an undesired isolation would be phone calls to the Water Department from a client. An unannounced, unplanned non-emergency isolation of water could expose the city to significant liability.
- Ownership – There is a strong desire to have the isolation valve ownership go to the property owner and not the city. To have it be the property of the owner, the isolation valve would need to be placed downstream of the billing flowmeter if not in the building. That would mean the building codes would need to be changed. This may be a significant effort.

3.4.1 Option 1 – AMI Isolation Valves

The maximum diameter available for Sensus AMI is 0.75 inch. The valve could be opened or closed remotely. The Sensus website indicates that 2-inch valve will be available soon.

Advantages – None.

Disadvantages include the following:

- Currently, these are too small to use for the desired commercial application.

- Something could be engineered to use the AMI isolation valve electronics to drive a larger valve. This would be a special engineering solution that has not been used anywhere else before. Motive force (likely electricity but could be water pressure) would be needed to shut and open the valve.
- Sensus software would need to be purchased to get the isolation valves to function.

3.4.2 Option 2 – SCADA Isolation Valves

Valves for this option can be powered and connected to the SCADA system to provide remote opening, closing, and position indication capabilities. The valve could be closed upon sensing excess flow as measured by a SCADA flowmeter provided with this valve. The design would need an electronics cabinet and a motive force (likely electricity but could be water pressure) to manipulate the valve. This type of installation can cost as much as $100,000 per installation. Several factors impact pricing such as valve size, remote control and monitoring capabilities, valve installation, electronics, and power supply. There would be an ongoing cost of the electrical meter to supply power to this type of valve installation.

Disadvantage – A loss of electricity will stop the valve from shutting. During the Tubbs fire, there was a sustained loss of electricity in multiple locations.

3.4.3 Option 3 – Mechanically Operated – Fusible Link Actuated Valves

The oil and gas industry uses fusible link actuators for some critical valves at refineries. These valves are typically provided at the bottom of tanks that are full of flammable liquid. If a fire occurs, the fusible link melts on high temperature and spring energy with a reduction gear shuts the valve to stop the flow of fuel for the fire. The valve must be manually reopened and reset. The valve can be operated open and shut without impacting the effectiveness of the fusible link operation.

Advantages – No electricity is needed for operation of this type of valve.

Disadvantages include the following:

- There are no known installations present where water valves are fitted with a fusible link actuator. The actuator couplings are standard size and could be attached to an American Water Works Association (AWWA) potable water valve.
- The fusible links cannot be in direct sunlight, as this may cause a non-emergency/false activation of the valve. Even in recommended environmental conditions, the fusible link needs to be replaced annually to prevent a non-emergency activation of the valve.
- This valve will activate and isolate only in the event of fire. The City is in an earthquake prone zone. This valve will not provide any protection if an earthquake were to break a waterline downstream of the valve.

3.4.4 Option 4 – Hydraulically Operated – Pressure Maintaining Valves

Pressure maintaining valves ensure that a minimum upstream pressure is maintained. The valve closes if the inlet pressure drops below a setpoint. The valve will need to be manually reset and opened if the valve is tripped on low inlet pressure. The intent is to maintain pressure for a critical customer. These valves are commonly used in water applications.

Advantages include the following:

- No electricity is needed for operation of this type of valve
- Can be provided to supply line to critical commercial customers
- If there is a large enough burst inside the commercial store, it could lower the pressure on the supply side of the valve to trigger the closure of the valve

Disadvantages include the following:

- Any event that causes a low pressure of the distribution system would shut many of the valves. For example, a burst somewhere in the distribution system that lowers distribution pressure could cause this valve to shut down supply to other commercial customers. Similarly, loss of power could result in distribution system pressure loss, which may activate this valve type.
- If a breach were to occur in a big box store, the reservoir providing water may go empty before the distribution side sees low pressure to close the valve.

3.4.5 Option 5 – Hydraulically Operated – Burst / Breach Control Valves

These valves are hydraulically actuated and designed to close on high flow rate through the valve. High water flow is detected by measuring the differential pressure across the valve. The valve is provided with a pilot actuator assembly, which measures the differential pressure across the valve. The valve is fully open during normal operation. Differential pressure across the open valve increases as flow increases. The sensitivity of the pilot actuator assembly is adjustable. When the set differential pressure is achieved, the pilot triggers and uses the line pressure to close the valve. These types of valves are commonly used for protecting commercial building water systems and also in the main drinking water distribution systems

3.4.5.1 Option 5A – Hydraulically Operated – Burst / Breach Control – Commercial Building Water System Valves

In this application, the valves are strategically placed to protect a water system within a commercial building (such as fire, potable water, or chill water system). The valves prevent significant water loss and resultant damage and allows limited continued service when a water system is damaged because of a natural event or human error.

Advantages include the following:

- No electricity is needed.
- The valve will automatically reopen when downstream pressure is retuned close to upstream pressure.
- Isolation only occurs for locations that have excessive flow.
- The valves are available up to 8 inches in diameter and should meet most of the applications for commercial customers.

Disadvantages include the following:

- It is not clear from the valve literature if these valves are National Science Foundation (NSF) approved for drinking water applications. Correspondence with the valve manufacturer is ongoing.
- There are some 10 inch and 12 inch commercial connections. The sizes are not available from the vendors presented in this TM.

3.4.5.2 Option 5B – Hydraulically Operated – Burst / Breach Control – Distribution System Valves

In this application, the valves used meet the NSF 61 drinking water requirements. The valves are located in the distribution main at strategic locations to protect upstream water supply.

Advantages include the following:

- No electricity is needed to operate this type of valve.
- The valves are designed to meet drinking water requirements. They are available in sizes from 1.5 inches to 36 inches.
- If a burst valve is desired for commercial isolation and the distribution system for larger sizes, the same model could be used for both applications, reducing training and spares.

Disadvantages/other considerations include the following:

- These valves can be in supply lines to commercial buildings. If located outside the building, depending on the location, it could be located aboveground or belowground in a traffic rated vault and downstream of the revenue meter. If located inside the building, the valve can be located aboveground in the riser inside the building. Ownership and maintenance of the valve needs to be discussed between the City and the property owner.
- It takes human intervention to manually reset the pilot actuator by opening the bleed port to relieve pressure and open the valve.

3.4.6 Valve Manufacturers

Table 1 summarizes manufacturers and models that were researched for the evaluation of the options presented above. The cutsheets are included as Appendix A to this TM. There are models from other manufacturers that are available and can be considered.

Table 1 Summary of Valve Manufacturers for Commercial Customer Isolation

Valve Name / Model	Style Options	available Diameters (inches)	NSF 61 Approved	Pressure Range Flange Standard	Notes
AMI Valve (Option 1)					
Sensus ally	NA	Limited to 0.75 only	■	NA	• Not feasible option
SCADA Controlled Valve (Option 2)					
DeZurik, Pratt	Butterfly Globe	4 and up	■	ANSI 150 - 300	• Electrically actuated by SCADA
Fusible Link Actuated Valves (Option 3)					
BI-TORQ® Fusible Link Actuator	Butterfly Globe	Up to 6	■	ANSI 150 - 300	• Can be mounted on a BFV • Indoor installation only • Will require annual replacement of fusible link
Pressure Maintaining (Option 4)					
Singer 106-RPS 206-RPS	Globe	0.5 – 36 3 – 40	■	ANSI 150 - 300	• Closes on low inlet pressure • Opens on return of inlet pressure
Burst/Breach Control Valve – Commercial Building Water Systems (Option 5A)					
BERMAD 791-FO	Globe	2 – 8		ANSI 150 - 300	• Closes on excessive flow • Does not say if automatic or manual open after a trip.
Cla-Val 85-09-1 685-09-1	Globe Angle	2.5 – 8 3 – 10	■	ANSI 150 - 300	• Closes on excessive flow • Opens on the return of downstream pressure
Burst/Breach Control Valves – Distribution System (Option 5B)					
BERMAD 790-M	Globe	1.5 – 20	■	ANSI 150 - 300	• Closes on excessive flow • Manual reset to open
Cla-Val 85-01 685-01	Globe Angle	1.5 – 36 3 – 48	■	ANSI 150 - 300	• Closes on excessive flow • Manual reset to open

3.4.7 Recommendation

At the meeting on August 5, 2019, the City indicated that they would not select any of these options, primarily because of the potential liability due to a false or unintended closing of the valve.

3.5 ISOLATION WITHIN DISTRIBUTION SYSTEM

There was discussion at the kickoff meeting about options for isolating areas of the distribution system. This would involve considering automatic isolation of an area of the distribution system during a significant pipe break.

The City historically has between 4 inch and 10 inch mains; the vast majority are 6 inch or 8 inch in the distribution system. Relatively recently the City has installed 8 inch mains in its system. The mains typically run down the center of the streets and are tapped to provide water to customers. At street intersections, manual valves are installed to isolate parts of the water mains. The valves are typically directly buried and provided with a wrench nut actuator located at street level inside a valve cover. The valve cover provides access to a valve stem that a distribution system operator utilizes to open or close the valve. In the event of a main break, these manual valves would be closed to stop the rupture. Depending on the location, several valves would likely be needed to isolate a main break in an area.

Consideration was given to options for remotely or automatically isolating a rupture in the distribution system.

A common disadvantage for all options is the impact to downstream areas of the distribution systems. Isolating a specific area may isolate downstream areas that would are not affected by fire or other emergency and need water. Detailed isolation plans would be needed to determine the true impact of isolating a specific area and minimizing the impact to other areas.

3.5.1 Option 1 – SCADA Controlled Isolation Scheme

This isolation scheme would require installation of electric actuators on existing line valves or providing new electrically actuated valves. The valves and actuators would need to be in a traffic rated vault. The power and control cabinets for valve actuators could be located outside of the roadway at the corner of an intersection. The estimated cost of a typical installation, including four 8-inch valves, would be in the range of $150,000 to $200,000.

The City currently has a few valve vaults of this configuration, which are very maintenance intensive.

The City has experienced rain water intrusion as well as dirt and insect infestation, which has been detrimental to the actuator electronics and wiring. The valve components have become rusted because of moist conditions. This has resulted in unreliable performance of these valves in terms of open close operation.

3.5.2 Option 2 – Burst Control Valves

The burst valves that are discussed in the commercial isolation section could be used for this function. These valves could be located aboveground and outside of the driveway but could be in a buried vault. These valves are monodirectional. If the burst happens on the upstream side of the valve, the valve will not shut. This may be small concern and can be addressed if these valves are arranged to capture loss of pressure in all potential flow directions.

3.5.3 Recommendation

At the meeting on August 5, 2019, the City indicated they would not select any of these options, primarily because of the potential liability due to a false or unintended closing of the valve.

4.0 Appendix A

Appendix A contains the following cutsheets for the valves presented in this TM:

- ally Water Meter
- DeZurik AWWA Butterfly Valves
- BI-TORQ FLP-BT Series
- Singer Model 106-RPS/206-RPS
- Singer Model 206-PGM
- BERMAD BC-791
- BERMAD 790-M
- Cla-Val E-85-09-01
- Cla-Val E-85-01
- Cla-Val 85-13