United States Environmental Protection Agency

Jamestown Flood Restoration Recommendations – Final Report

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Acronyms

Organizations

CDPHE	Colorado Department of Public Health and Environment
FEMA	Federal Emergency Management Agency
SEO	State Engineer’s Office
USACE	United States Army Corps of Engineers
EPA	United States Environmental Protection Agency
WERT	Water Emergency Response Team

Units

cfs/mi¬2	Cubic feet per second per square mile
gpm/sf	Gallons per minute per square foot
ntu	Nephelometric turbidity units

Other abbreviations

DIC	Dissolved inorganic carbon
HDPE	High-density polyethylene
HMGP	Hazard Mitigation Grant Program
MA	Mission Assignment
OWS	Onsite wastewater system
PVC	Polyvinyl chloride
SOP	Standard operating procedure
STEP	Septic tank effluent pumping
UPS	Uninterruptable Power Supply
WTP	Water Treatment Plant

Introduction

Colorado experienced extensive flooding and landslides from September 9 – 15, 2013. The disaster spanned more than a third of the state, from Rocky Mountain National Park to grasslands and agriculture centers on the eastern plains.

Record-breaking rainfall, topping 17 inches, caused the Big Thompson, St. Vrain and South Platte rivers, and their tributaries, to breach their banks and carve out new channels throughout three major watersheds in the State. The flooding and resulting mudslides took the lives of 10 individuals and resulted in the largest domestic evacuation operation since Hurricane Katrina. The disaster impacted homes and critical support infrastructure north to south, from Fort Collins to Manitou Springs, and east to west, from Sterling to Estes Park. The State reported at the end of September that more than 1,800 residential structures, 200 nonresidential/commercial properties, and 2,000 other minor structures were destroyed. In addition, more than 16,000 residential structures and 50 other minor structures were damaged. Eighteen counties were designated as eligible for Federal disaster assistance.

The flooding damaged or destroyed 500 miles of roads and 30 bridges and seriously damaged 20 more. Numerous access highways were compromised and made impassable. The flooding affected many businesses large and small, and impacted more than 28,000 agricultural acres, leading to more than $5 million in crop losses, according to the U.S. Department of Agriculture. The U.S. Forest Service reports that the largest affected area within its boundaries was approximately 230,000 acres in size. A total of 230 miles of trails and 20 facilities, including campgrounds, picnic areas and boating access areas, were closed because of the disaster. The flooding also damaged critical infrastructure in several communities, including water treatment and waste water treatment facilities.

Colorado Governor John Hickenlooper ordered that temporary repairs would be made and roads reopened by December 1, 2013. The goal was realized, but long-term repairs are still required and repairs will be ongoing for some time. The flooding impacts were such that the Colorado Congressional delegation was to get a provision in the bill ending the government shutdown, which occurred in October 2013, lifting the $100 million Federal Highway Administration (FHWA) emergency relief funding cap. Colorado can now access $450 million in emergency funding to rebuild roads and bridges. Once roads and bridges were attended to, many communities began to look for options to restore critical water infrastructure that had been damaged.

Several communities were evaluated for infrastructure damage immediately after the flood and the U.S. EPA Region 8‘s Water Emergency Response Team (WERT) was field deployed with the Federal Emergency Management Agency (FEMA), the Colorado Department of Public Health and Environment (CDPHE), and in coordination with the U.S. Army Corp of Engineers (USACE) to assess the damages.

One of the most severe cases of infrastructure destruction occurred in the small community of Jamestown. This storm event caused the Little James Creek to reach three times the 100-year flow and peak yield of 579 cubic feet per second per square mile (cfs/mi2) of catchment[1]. As a result of the flood, the water treatment plant was rendered inoperable, approximately 50% of the distribution system was destroyed and approximately 90% of the residents were relocated.

[1] USDA NRCS Colorado State Office report titled “Colorado Front Range Flood of 2013: Peak Flow Estimates at Selected Mountain Stream Locations,” December 2013. http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1240980&ext=pdf. Accessed February 19, 2014.

In addition to four other emergency response and assessment and clean up Mission Assignments (MAs), EPA Region 8 was tasked by FEMA, under Disaster Declaration Recovery Mission Assignment EPA 4145DR-CO-EPA-05, to complete a variety of recovery activities in support to FEMA who is supporting the State of Colorado's flood recovery efforts.

Due to resource constraints, EPA Region 8 and the EPA's Office of Water's Security Division would not be able to provide this specific water treatment resiliency advisory work to communities like Jamestown without FEMA's support through the mission assignment at this time.

Among other recovery duties, the EPA Region 8 WERT has been tasked to provide technical assistance to drinking water and wastewater facilities to support their reconstitution of damaged water systems. The WERT seeks not only to assist utilities in returning to full operations as quickly as possible, but to also assist utilities in incorporating concepts of resilience, climate change adaptation and sustainability in their rebuilding efforts. The FEMA Recovery MA's specific tasking language to EPA includes a focus on restoration work that includes resilience, sustainability, green infrastructure, climate adaptation and smart growth design principles.

Purpose and Goals

This report summarizes technical recommendations developed by the contractor team, consisting of CSC and CH2M HILL, to restore and optimize the Jamestown Water Treatment Plant (WTP) and associated facilities and piping. Each report section documents engineering evaluations and recommendations with pros and cons, according to needs, and offers opportunities for enhancing resilience and sustainability in rebuilt systems.

The majority of these recommendations are based on general best practices from CH2M HILL subject mat- ter experts (see **Attachment 1**) and do not rely on detailed information and analysis. The contractor team did not evaluate the performance of the Jamestown WTP with regards to the Safe Water Drinking Act and other state and federal regulations. In pursuing implementation of these recommendations all applicable regulations should be considered to ensure compliance. Recommendations are critical or complementary to activities to support residents returning home. All recommendations are consistent with the Guiding Principles identified by the residents of Jamestown. Specific principles that were addressed include:

- Character of the Community/Sense of Place: Make planning decisions that promote Jamestown's unique sense of place and distinctive community character.
- Autonomy, Self-Governance and Self-Reliance: Uphold Jamestown traditions which promote local autonomy, self-government and self-sufficiency.
- Infrastructure: Design infrastructure that features integrated and resilient systems that are environmentally, financially, and technologically sustainable.
- Be Economically Sustainable: Improve Town revenue levels and optimize future funding opportunities.

Summary of Recommendations

The recommendations are ranked and prioritized according to needs. The following are immediate and short-term recommendations:

1. Replace damaged distribution piping following the Jamestown ordinance by burying all fire protection pipe at least seven feet deep with 6-inch ductile iron pipe, below the flood zone, and below the scour level of

future flooding events. Consider the installation of 3-inch diameter or smaller PVC pipe for pipes where fire protection is not provided.

2. Extend the existing WTP intake into a deeper part of James Creek and, if needed, place sand bags, rocks or a constructed J-bar in the channel to direct flow towards the intake as a temporary measure until a more permanent intake structure is constructed (see longer-term recommendation 1 below).
3. Install one line break valve at the outlet of the storage tanks to prevent catastrophic draining of the system.
4. Install an Uninterruptable Power Supply (UPS) at the WTP to power controls, alarms and communications.
5. Install flood proofing on the main door to the WTP to prevent water from entering the WTP during a flood. Check and seal all wall penetrations around pipes, conduits and other gaps that would allow flood waters into the WTP.
6. Install external power connections for a portable generator to be connected to the WTP and purchase a portable generator to power the WTP. Alternatively, Jamestown could make guaranteed arrangements to rent a portable generator during or after catastrophic events until power is restored.
7. Improve WTP alarm and system communications by installing cellular connections (if cellular service is added to the area) or secure web-based communications for remote access and control.
8. Install or add sensors and alarm indicators for James Creek water level, filter influent channel high level and raw water pump shutoff, low level alarm on storage tanks, and a rate-of-change limiter on the raw water pumps.

The following are longer-term recommendations for consideration:

1. Construct a permanent intake structure using the concept previously provided to Jamestown by ACE Engineering in combination with creek channel modifications.
2. Rehabilitate the existing and expand the WTP infiltration gallery to improve surface and subsurface water supply.
3. Construct evaporation ponds designed to handle the filter cleaning waste.
4. Add orthophosphate at the finished water pump to eliminate suspected pipe corrosion in the distribution system.
5. Consider the addition of a closed loop geothermal heating pipe system on the raw water piping.
6. Consider combining septic tank effluent from individual homes in areas of high flood risk (Lower Main Street) and pumping to a leach field higher in elevation.
7. Consider the addition of a well or multiple wells to provide a redundant water source for the community.

Engineering Evaluations and Recommendations

A site visit to Jamestown facilities was conducted on January 22, 2013 with the goals of assessing and evaluating the damage sustained to the water treatment plant, distribution system and private wastewater systems in order to develop recommendations to rebuild and optimize the system. The evaluations and recommendations are organized as follows:

- Water Treatment Plant
- Distribution System

- Backup and Alternative Source Waters
- Wastewater Management

On March 19, 2014, EPA hosted a webinar with Jamestown and community partners to review and discuss these proposed recommendations for integrating sustainability and resilience to future floods, while returning to serving the Town with the highest quality of water possible. The discussion was centered on updates from Jamestown and community partners (see **Attachment 2**).

Water Treatment Plant

Plant Structural Integrity

The WTP staff discovered that water had entered the office/control room and the pump room during the flooding event. No equipment was damaged in the office/control room and the water in the pump room was pumped out. Water may have entered the WTP through the main entry door or through penetrations in the walls. The staff also discovered that debris was deposited along the uphill side of the WTP and against the main door. Fortunately the debris did not damage the main entry door and enter the WTP with flood waters.

The contractor team recommends that flood proofing be installed on the main entry door to the WTP to prevent water from entering the WTP during a flood. This may be accomplished by installing a removable protection system on the exterior of the door. A more robust, long-term solution could be constructing a low wall along the uphill side of the WTP property to protect the WTP from debris carried by flood waters. Because the property owned by the Town ends at the edge of the utility building, a low wall for flood protection would have to be restricted to the vicinity of the WTP door or an easement would have to be obtained from the adjacent property owner.

Water Treatment Plant Intake

Jamestown withdraws water from James Creek at the water treatment plant. The intake structure is a 6-inch perforated PVC pipe that extends from the bank of the creek into the channel. The intake pipe was submerged before the flooding event. The flooding event changed the creek bed profile, deepening it at the intake pipe and leaving the intake pipe exposed above the creek's water surface. The intake pipe no longer withdraws water from the creek. The Jamestown stream restoration plan[2] is to restore the creek to the pre-flood condition along this reach. The intake would have to be repositioned following the restoration in order to restore service. The integrity of the intake and its operability during and after future flooding events is not sustainable in its present form.

The contractor team recommends extending the existing WTP intake into a deeper part of James Creek and, if needed, placing sand bags, rocks or a constructed J-bar in the channel to direct flow towards the intake as a temporary measure until a more permanent intake structure is constructed. During the last sanitary survey, it was recognized that the surface water intake should be separated from the infiltration gallery. This separation will occur during reconstruction and will require a new dedicated pump for the intake.

As a permanent measure, Jamestown would like to upgrade its intake structure as they frequently need to clear leaves and debris from the 6-inch perforated intake pipe. They would also like to protect the intake from debris in the creek during future storm events. Additional efforts may need to be taken if turbidity increases, relative to historical data, following moderate rainfall events. The source of high turbidity would need to be bet-

[2] Information on plan development, data and updates from presentations can be found at http://jamestownco.org/stream-corridor-master-plan/. Accessed February 11, 2014.

ter understood by the Town. Jamestown has recently tested and recorded the turbidity levels in James Creek: average of about 1 ntu, which is very similar to past winters. However, it is unclear what the conditions will be in the spring when snowpack melts.

ACE Engineering has proposed a draft concept to upgrade the existing intake system to better protect it against plugging and debris. This concept includes adding a concrete diversion, stop logs and an intake screen to protect the existing 6-inch perforated pipe. A pump will be needed for the new intake. Reference **Attachment 3** for the draft sketch produced by ACE.

Comments on the draft sketch and general recommendations for the intake are as follows:

1. The screen will add value by preventing the pipe from being clogged and is a good solution. However, there are many different types of screens. A self-cleaning screen, like a Coandă-effect screen, would be the best solution for Jamestown so that they do not have to install an air compressor system for cleaning or routinely perform manual cleans.
2. If a screen is added it will increase the head loss and deter flow from passing through the screen. During times of low flow in the creek the water surface elevation may not be high enough to push water through the screen. It would be helpful if the screen and downstream pit are dug deeper than the creek bed. Another solution would be to install either a temporary or permanent barrier in the creek, such as sand bags, during the low flow season to keep the water level higher than the screen.
3. The contractor team does not see a need to include stop logs in the design. If a self-cleaning screen is installed, there is no need to block debris or control the flow. In addition, most intakes designed by CH2M HILL do not include flow isolation. If the operational staff wants to have isolation capabilities, stop logs and other isolating mechanisms can be considered.
4. Installation of this intake would eliminate the need for the existing roughing filter which could then be removed.
5. The downstream pit, as conceptually designed, may have the ability to catch and trap fish. There needs to be a consideration in the design for the impacts of the intake design on the ecosystem. A more robust intake design will be extremely beneficial to Jamestown but also increases the impact on the surrounding ecosystem. The design should prove that this impact will be minimal.

Water Treatment Plant Infiltration Gallery

Jamestown currently uses surface water from James Creek and groundwater under the direct influence of surface water through an infiltration gallery located under the WTP. Jamestown plans to rebuild the existing gallery in a new location, close and parallel to the creek, to take advantage of the higher water quality in the infiltration gallery relative to the surface water quality. At this time there are no plans for a separate gallery. A greater reliance on the infiltration gallery will provide Jamestown with better raw water quality and make the intake system more robust with a more consistent water source than the creek.

The current infiltration gallery is approximately 15 feet deep and consists of a 40-foot long, 18–inch diameter. Perforated corrugated metal pipe for gallery and screens will be replaced to produce better water and result in less plugging. It has been reported that the yield of the infiltration gallery has decreased over time from approximately 20 gallons per minute (gpm) to approximately 7.3 gpm, according to a report performed by operational staff in May 2013. Based on the decrease in capacity over time, it is likely that the existing gallery is plugging over time from either fine grained sediments or biological fouling of the perforated pipe. Typical rehabilitation techniques consist of jetting from the inside of the perforated pipe out into the formation with air or water to clear the perforations or chemical dosing if biological fouling is suspected.

As Jamestown pursues expansion, it is expected that the expanded gallery will have a similar yield on a per-foot basis, but testing has not been done to confirm this. The contractor team recommends the following:

1. Acquire all permit modifications required to secure additional groundwater rights.
2. Consider installing the perforated pipe parallel to James Creek and as close to the creek thalweg, or as close to the deepest part of the creek channel, as possible or extend the perpendicular pipe below the invert of the creek. This will maximize pipe length in the area that likely has the highest infiltration capacity.
3. As part of the redesign of the infiltration gallery, EPA suggested a combination of a concrete wall perpendicular to the stream with a buried and anchored gallery at the bottom. This allows the creek to flow over the barrier to protect the new infiltration gallery.

Water Treatment Plant Alarms/Communication

The Jamestown WTP alarm system functions over the telephone land lines. During the September flooding, the phone lines were lost during the beginning of the storm. The contractor team recommends implementing a more robust alarm system so that the operators can keep communication to the WTP during future storm events. Jamestown currently does not have a permanent cellular tower in the area.

The contractor team recommends changing the WTP alarm system to either a cellular or a web-based connection. It depends on the current controls system at the WTP and access to the community, but cellular connections are typically the easiest and cheapest to implement. Jamestown could have the ability to only receive alarms via a cellular network or they could also set up a remote access to the WTP which would allow them to make operational changes without being at the WTP. A web-based system would require either a satellite or a fiber connection which will likely be more expensive.

Given that Jamestown does not have a cellular tower, converting the alarm system to cellular would be an expensive option as it would require a tower. However, this would also provide significant value to the residents of Jamestown by providing a more resilient communications system, especially during extreme weather events.

The contractor team recommends evaluating the installation of a cellular tower as an improvement to the community that is outside the scope of this document.

Jamestown would also like to add preventative safety measures to the WTP control system so that the WTP can protect itself in future storm events. In addition to the alarms and interlocks that the WTP currently has, below is a list of items that could add value to the WTP operation.

1. High level alarm in the filter influent channel and corresponding raw water pump shutoff.
2. Direct level indicator in the potable water storage tank.
3. Rate of change limiter that limits the change in flow to the filters to a specific amount per rate of time (i.e. the flow rate can only change by 1 gpm per minute). This will only allow the filters to experience gradual changes rather than sudden changes that disturb the filter bed.
4. Stream level gauge to ensure that the WTP intake has sufficient water.
5. Due to the fluctuating quality of the stream source water, the addition of inline, continuous-reading water

turbidimeters at the WTP inlet and the individual filter effluent discharges would be useful instruments to have for this system. These sensors could be used to notify plant operators when turbidity limits were approached or exceeded so that action could be taken to switch water sources or change filter operation.

Water Treatment Plant Backup Power

The WTP lost power during the flooding event and has no backup power generation. All pumps, controls, alarms and communications shut down when the WTP lost power during the storm and will do so in the future during power outages. Operations cannot be restored until the power is restored to the power grid. There is very little space on the WTP property to install a backup generator. Due to the vulnerability of the WTP site to future flooding events, a backup generator installed on site would most likely be damaged or rendered inoperable in the event of another significant flood.

The installation of an Uninterruptable Power Supply (UPS) to power controls, alarms and communications would be a low-cost measure to ensure that WTP controls and alarms would continue to operate during brief power outages. This would also facilitate a safe shutdown of the WTP if power is lost.

A portable generator connected to the WTP during power outages would enable continued operations and fire protection. This would require the installation of external power connections. A portable generator that uses an alternative fuel with lower emissions is recommended if the fuel is readily available. Fuel storage for a portable generator should be identified and stocked outside of all flood zones yet still transportable to the WTP so that there is no reliance on a delivery source in case of future disasters. A portable generator could be purchased or rented. The advantage of purchasing a portable backup generator is that it may also be used for other community purposes. Alternatively, the community could make guaranteed arrangements to rent a portable generator during or after catastrophic events until power is restored if it would be readily accessible.
The contractor team recommends the following:

1. Install an Uninterruptable Power Supply (UPS) to power controls, alarms and communications.
2. Install external power connections for a portable generator to be connected to the WTP.
3. Either purchase a portable generator to power the WTP (and perhaps also use it for other community purposes) or secure the rights to rent one during or after catastrophic events.
4. Designate and stock a secure fuel storage location out of the flood zone but transportable to the WTP.

Water Treatment Plant Filter Operation

The water treatment plant consists of two slow sand filters that are typically operated at a loading rate between 0.01 and 0.04 gpm/sf. The WTP has periodically struggled to consistently meet the 1.0 ntu effluent turbidity requirement but there have been no turbidity violations in the past two years.

Jamestown has confirmed that work to remove and replace the sand in the filters has begun. The new filters should be operational in May or June. Jamestown will be installing a temporary intake in the creek to support sand filter ripening.

Jamestown is employing a more robust intake design and redeveloped infiltration gallery (previously discussed) to help address water quality and supply issues in the short-term. EPA suggested using a pressure filter to add a coagulant prior to the sand filter during high turbidity periods would increase capture of particulates in the filter.

The WTP operators have historically followed the scraping technique to clean the filters. This approach consists of completely removing the very top layer of sand after the schmutzdecke is fully developed. In the recent past they have switched to the harrowing technique in which they do not remove any sand but instead agitate the top layer and pump out as much of the turbid material that is lodged in the top layer of the filter as possible. This change in cleaning has facilitated a quicker recovery to normal operations but generates a significant volume of residuals. The quality of the residuals is insufficient to be allowed direct discharge to the creek and therefore it has to be disposed of at a cost.

The contractor team has the following recommendations for Jamestown:

1. The WTP operational staff has confirmed that the filters are typically operated with a constant flow rate each day. The first recommendation is to ensure that the filters always have a relatively constant loading rate throughout the day and that if a flow rate change is required, it should be a gradual change as opposed to a sudden change. A constant filter loading rate will help prevent particulates from dislodging from the filter bed and potentially causing turbidity breakthrough.
2. The filter design loading rate is 0.1 gpm/sf based on a capacity of 125 gpm operating through the two filters. Based on past WTP data, the filters typically operate at a maximum loading rate of 0.04 gpm/sf. The contractor team recommends maintaining a loading rate below 0.04 gpm/sf for optimal treatment performance. This would limit the treatment plant capacity to 50 gpm when both filters are in operation. Based on past data, this would not inhibit Jamestown's current supply but does constitute a change in operational strategy.
3. If Jamestown has future incidents of high effluent turbidity they should consider doing testing to identify the particles that are breaking through the filters. If there is breakthrough, identification of the particle size and characteristics will help define the necessary treatment improvements.
4. The WTP operational staff has reported that changing the filter cleaning method from scraping to harrowing has resulted in better filter performance. It is recommended that the staff continue with the current cleaning method that is working right now. However, it is worth noting that CH2M HILL has had the most long-term success using the scraping method as the harrowing method has resulted in shorter filter run times over time by driving smaller particles from the schmutzdecke deeper into the filter. This has decreased the available filter bed and should be considered by the WTP operational staff in the future.
5. If possible, the filters should not be cleaned in the winter. It is best to clean them in the fall a few weeks before the weather turns. This provides time for the schmutzdecke to form more rapidly with warmer water and will most likely prevent the need for another clean during the winter. In general, the town only cleans filters from April to October; cleaning is not done in colder months.
6. If the harrowing method is to be continued, Jamestown needs to identify a way to treat the residuals. The treatment solution for this waste should be considered separate to the community wastewater treatment system as they are two different types of waste (inorganic vs. organic) that require different treatment. It is recommended that an evaporation pond be used for the treatment of this waste. This is the recommended approach for a variety of reasons:
    a. A treatment system that completely removes the contaminants/metals from the system is preferred. After water has been evaporated, the particulate contaminants can be collected and disposed of. At this point, the dewatered solids should be analyzed and disposed of in a landfill. If deemed hazardous, they would need to be disposed of in a landfill that accepts hazardous waste, such as the Last Chance Landfill outside of Denver.
    b. Evaporation ponds have little to no maintenance requirements or operational costs and would save on power consumption compared to other treatment options.

c. The flow volume is small and intermittent. The ponds could be utilized only in the summer months when the sun is frequent and strong. Residual waste could be stored during the winter months.

d. If possible and within regulations, the existing tailing ponds could potentially be rehabilitated into evaporation ponds. The contractor team did not evaluate the existing ponds for this purpose and this analysis is essential if this option is considered in order to prevent potential cleanup liability and to comply with applicable regulatory requirements.

e. Ponds should be designed to be out of the flood zone and sized to handle precipitation without overflow. Based on the estimated cleaning frequency and volume, pond size could be conceptually estimated to be around 50 feet long by 50 feet wide with a water depth of 4 feet.

f. A different treatment system with effluent discharge would require capital and operational cost as well as new permitting and sampling requirements. Jamestown is currently working with the State on a potential strategy for combining on-site storage (20-30,000 gallon tank) and slow feed dilution (100:1) to discharge back to creek.

g. A different treatment system with discharge circulated back to the filters would require capital and operational cost and would likely not fully remove contaminants from the process stream.

h. Sending the residuals to the irrigation ditch could cause public health or perception problems and is not recommended.

Water Treatment Plant Raw Water Temperature

Raw water temperature in James Creek is typically very cold during the winter months (1-2°C water) and Jamestown believes that an increase in temperature of 2-3 degrees will improve WTP performance. The contractor team agrees that warmer water will help decrease the filter ripening period and could provide additional treatment improvements. Additional information on the benefits of increased influent temperature to filter performance would be needed to evaluate the benefit of any approach for warming source water.

Jamestown would like to consider the implementation of a closed loop geothermal heating system to achieve this temperature increase. Solar heating strategies were also considered, but are unlikely to be effective due to the limited sunlight exposure at the WTP site.

A geothermal heating system can simply consist of the raw water pipe going down into the ground a specified distance and then returning up to the surface. This piping would be between the raw water pump and the filter gallery and would only marginally change the pressure requirement on the raw water pump. Metallic pipe (non-insulating) should be used for the best heat transfer.

Prior to design and construction, an analysis should be performed to determine the groundwater temperatures at various depths. This information will allow Jamestown to determine how far into the ground the pipe needs to penetrate and how big the pipe should be in order to ensure that there is enough time for heat transfer to occur. Jamestown also plans to measure biological activity over a range of stream temperatures over the next year. With these details, a cost-benefit comparison of this concept would be prudent.

Distribution System

The distribution system provides potable drinking water to the Jamestown community and firefighting source water. The majority of the distribution piping in the community is currently out of service as a result of the September 2013 flooding. The two storage tanks were completely drained during the flood when the distribu-

tion system was compromised. The community still has no firefighting source water other than surface waters. Water pipes are planned to be reconstructed during road reconstruction and the replaced pipe needs to be more resilient to road scour and failures during similar events in the future. The following are evaluations and recommendations for distribution system piping.

Distribution System Corrosion

There have been high levels of lead and copper recorded in the distribution system piping suggesting that there is pipe corrosion. **Attachment 4** shows EPA guidance[3] on corrosion control strategies based on the treated water criteria. The treated water pH and alkalinity of Jamestown, as reported in the Preliminary Engi- neering Report for the WTP[4], results in a dissolved inorganic carbon (DIC) of greater than 25 mg/L. Therefore, from EPA's table, the recommended corrosion treatment for Jamestown is the installation of an orthophosphate storage and feed system. If this project moves forward, Jamestown should revisit this recommendation and implement a system that meets the community's needs and objectives.

Distribution System Piping

A Jamestown ordinance requires all future piping to be buried at least seven feet deep with either 4-inch (where fire protection is not provided) or 6-inch (where fire protection is required) ductile iron pipe. The pipe burial depth, the pipe material and the 6-inch piping for fire protection all align with best practices in pipeline design. However, the 4-inch piping for the rest of the distribution will result in very low flow velocities and increased water age.

Jamestown could save money and potentially improve distribution water quality by installing smaller pipes for these systems. The majority of the pipeline laterals could be reduced to 1-inch or 2-inch piping and still support future growth. Pipe sizing should be performed on a case by case basis. If pipe smaller than 3 inches is considered, PVC pipe is recommended instead of ductile iron.[5] The town is currently considering 2-inch HDPE for laterals, but the contractor team did not evaluate this choice as part of the recommendation development process.

Installation of flushing hydrants on these lines for the benefit of improved water age management may be reduced by the costs of additional maintenance for the system. The advantages of using these hydrants as sampling locations are also being considered by the town.

Concrete encased pipe buried 8 feet under James Creek was exposed due to the scouring during the flood. Jamestown has expressed interest in learning more about other options for replacing crossings. EPA plans to share recent experience from another community that is replacing lost river crossings by drilling and installing lines in deeper substrate (although Jamestown substrate differs from that under the other community).

Distribution System Isolation Valves

During the September 2013 flooding event the distribution piping isolation valves were not accessible. Thus, when the distribution pipe washed out, the storage tanks drained. Improvements should be made to conserve the potable water in the storage tanks for future storm events.

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[3] Based on Revised Guidance Manual for Selecting Lead and Copper Control Strategies, EPA-816-R-03-001, March 2003

[4] Prepared by ACE Engineering, LLC, for the Town of Jamestown, November 2012

[5] Preliminary Engineering Report for the Distribution System, prepared by ACE Engineering, LLC, for the Town of Jamestown, May 2013

The most common application would be to install actuated isolation valves throughout the distribution sys- tem. This would allow a central control system at the WTP to open or close valves in the distribution based on where damaged is sustained. However, this would require the installation of actuated valves, wire and conduit from each valve to the WTP, and additional control programming. This system would not provide enough value to justify the cost.

A “line break valve” uses a pilot valve to monitor the downstream pressure. If the downstream pressure decreases below a certain value, the isolation valve shuts and prevents flow from passing until pressure is restored. The line break valve should not be used as an isolation valve but as a disaster prevention valve. This valve would be a cost effective solution for Jamestown that would help avoid draining the system and would provide disaster relief for the distribution system.

The current distribution system has multiple buried valves that are used for maintenance. It is recommended that these remain isolation valves and that only one line break valve is installed at the storage tanks outlet. If a pipe break occurs in the future, the line break valve would close at the storage tanks until the isolation valves in the community can be closed to isolate the damaged pipe.

A potential issue raised by Jamestown regarding these valves is that a pressure drop from firefighting could activate the line break valve and prevent water use. Installing an additional bypass would provide a backup to allow firefighting to continue. EPA also suggested the use of another storage tank to preserve pressure in the system and provide redundancy.

Distribution System Metering

It is recommended that meters be installed throughout the distribution system at strategic locations in the distribution system, perhaps co-located with the existing isolation valves, in order to get a better understanding of flows through the system. This will enable the detection and identification of system leaks or unauthorized connections. Installing meters at each house would enable Jamestown to bill consumers based on usage instead of using a flat rate. The town has previously considered this approach and concluded that the expense of a new billing system with new staff to read and maintain meters would exceed any savings. This option should be revisited in the future, especially if irrigation ditch use were expanded.

Backup and Alternative Source Waters

Jamestown currently uses a mix of surface water from James Creek and groundwater underneath the WTP as its only source water. An irrigation ditch is located in the community and has historically provided non-potable irrigation water to the community, although the system has not been operational for a couple of years.

Redundant Source Water

Jamestown has been advised by the Colorado Department of Public Health and Environment (CDPHE) that a redundant water source should be added to their system. Due to the location and size of Jamestown, the most feasible source for a redundant water supply is groundwater. This new source could provide redundancy in one of two different ways: (1) providing an alternate source to the creek that still requires treatment or (2) providing a new source that does not rely on the water treatment plant. Additional groundwater could help address potential turbidity issues during spring runoff due to the increased snowpack this winter and stream channel changes upstream.

Jamestown recognizes that, in addition to an expanded infiltration gallery, it would be beneficial to dig a new well that is not under the influence of the surface water in case the surface water supply was impacted by a future event; however, the use of additional wells will be a project for future consideration.

Three additional groundwater supply alternatives have been identified and the feasibility of each alternative is discussed below. To develop these alternatives, all existing wells in the vicinity of Jamestown permitted and on file with the Colorado Division of Water Resources, State Engineer's Office (SEO) are identified on **Attachment 6** with pertinent information for each well.

Alternative 1: Shallow Wells

The first alternative consists of drilling a shallow well or multiple shallow wells along James Creek near the WTP. Seven existing shallow wells in the Jamestown area (less than 100 feet deep) are permitted for 3 to 100 gpm with five of the seven permitted for less than 15 gpm. It is likely that multiple shallow wells would be required to obtain full redundancy for the WTP; however, further field investigation would be required to determine the estimated yield and recommended well configuration (horizontal well, vertical well or collector well) for a shallow well in this area.

New shallow wells permitted by the SEO would be considered tributary to James Creek and require an augmentation plan to replace the water pumped from the new wells. Based on preliminary discussions with the SEO[6], Jamestown would need to amend their current water rights and augmentation plan through Water Court to add new underground water rights for the new wells.
In addition, a shallow well will be under the direct influence of surface water and the water produced would require treatment. The new wells would provide a redundant water source for times when the creek is unavailable as source water; however, it would not provide redundancy for when the WTP is offline.

Alternative 2: Deep Wells

The second alternative consists of drilling a deep vertical well or multiple wells. Fifteen existing deep wells (greater than 100 feet) in the Jamestown area are permitted for 0.25 to 15 gpm with well total depths ranging from 180 to 600 feet. Similar to the first alternative, it is likely that multiple deep wells would be required to obtain full redundancy for the WTP; however further field investigation would be required to determine the estimated yield for a deep well in this area.

Based on preliminary discussion with the SEO, it is likely that deep wells in this area would also be considered tributary to James Creek and would require Jamestown to amend their current water rights and augmentation plan through Water Court to add new underground water rights for the wells.

At this time, it is uncertain whether a new deep well would be under the direct influence of surface water and thus whether or not it would require treatment. To determine this, it is recommended that a particulate test be performed on an existing well of similar depth. If a deep well of similar depth is determined to not be under the direct influence of surface water, new deep wells could ideally be co-located by the storage tanks in order to minimize piping. As this system would be considered groundwater, the only treatment required would be chemical storage and feed systems for chlorine and potentially orthophosphate. If this system had been installed prior to the flood event, the majority of the community could have stayed in service through the flooding event.

[6] Personal communication with Jeff Deatherage, PE, on February 18, 2014.

Alternative 3: Use Existing Wells

A third alternative, purchasing and using an existing groundwater supply well, was also developed, but determined unfeasible for the following reasons:

- The conditions of the existing wells are unknown. Jamestown has not investigated private wells to date. Based on the Colorado Division of Water Resources, Water Well Construction Rules, abandoned wells are required to be backfilled with sand, gravel and cement depending on the type of aquifer(s) the well is completed into.
- If the existing well has not been backfilled, it is recommended that the condition and capacity of the existing well be determined by running a down-hole video survey of the well casing and setting a temporary pump to perform an aquifer test.
- In addition, the existing wells are permitted by SEO for domestic, stock and household use. In order for Jamestown to use an existing well, they would be required to re-permit the well for municipal use and amend their current water rights and augmentation plan through Water Court.

It is recommended that further field investigation steps be conducted to confirm the estimated yield from a new shallow or deep well, confirm whether a deep well would be under the direct influence of surface water and confirm the condition of existing wells which might be candidates for use. These steps should all be conducted prior to design and construction of any new wells.

Irrigation Ditch

The irrigation ditch provides a good service to the community and reduces the WTP demand. It is recommended to continue use by the community and to expand the system. Increased use of the irrigation ditch for the community's non-potable water demands will decrease the required load on the WTP and will result in lower WTP operating costs and power consumption.

Wastewater Management

Jamestown does not currently have a community wastewater treatment system as its residents all have their own septic tanks and leach fields. The September 2013 flooding damaged or removed a significant number of the individual septic systems. Jamestown would like to rebuild the system so that it is more resilient to disaster in the future.

Jamestown currently considers wastewater management a moving target since it is unclear which lots will be reconstructed and residents might consider rebuilding their systems on their own. At this point, this issue is not a high priority for residents. Recent discussions amongst Jamestown residents have centered on using vacant lots for community septic fields (e.g., lost homes on Lower Main Street). Jamestown would also like to evaluate the potential for developing a combined treatment system. Three different strategies for wastewater management have been identified and each alternative is discussed below.

Alternative 1: Rebuild Former System

Rebuilding the former system so that individual houses continue to have individual septic tanks and leach fields will be the cheapest option for Jamestown, but it does not provide additional resilience against future catastrophic events. Each home can be advised to place the septic tank and leach field in a flood protected area, but there will still be potential for future damage. State regulations limit how deep into the ground a leach field can be which limits the resultant flood resilience. It is also possible that some of the leach fields and septic tanks that were damaged may not have been in compliance with current standards and changes to their size or location may be needed.

Alternative 2: Use STEP Tanks and Combined Leach Fields

A second alternative is to install individual specialized septic tank effluent pumping (STEP) tanks at each house that pump to a community leach field. STEP tanks include a small (1-1.5 HP) pump inherent to the tank that pumps to a pressurized pipe system. STEP tanks are more watertight than septic tanks which would reduce the total volume of waste and would allow the installation to be deeper in the ground at a more resilient depth. This would reduce the potential for future damage. The STEP tank effluent would be pumped to a new leach field at a higher elevation in the community that is not susceptible to flood damage. There are many advantages to this alternative:

1. It protects the septic tanks and leach field against future catastrophic events.
2. STEP tanks are more resilient and water tight than septic tanks, reducing total waste volume.
3. The strategy would require new STEP tanks which are moderately more expensive than standard septic tanks. The cost would also require piping to the community leach field location. Although more expensive than rebuilding the former system, it would still be less expensive than a package treatment system.
4. Additional treatment is not required as the wastewater is all septic tank effluent; therefore no additional operating or maintenance costs are incurred for treatment.
5. If the system handles less than 2,000 gallons per day (approximately 25 people), a state permit is not required and the Boulder County permit required is the same as for an individual permit. Each resident that currently has a damaged septic system will have to fill out a permit to reconstruct the system if each rebuilds an individual leach field. A combined leach field only requires one permit.
6. Separate leach field systems could be constructed for clusters of homes in order to stay under the 2,000 gallons per day limit if the total community capacity exceeds 2,000 gallons per day.
7. The location of the combined leach field is flexible and can be placed according to proximity, drainage characteristics, land rights, land slope, and elevation.

This alternative does have some disadvantages, including the additional cost, the operating cost and power consumption for the STEP tanks, and the difficulty in siting and maintaining the community leach fields. The community leach field would need to be on level terrain which may be difficult to find around the Jamestown community. Combined leach fields may not provide more resilience during another flooding event, as they could still be damaged depending on scour depth.

Alternative 3: Community Treatment System

If land is not available and acceptable for a community leach field or if the effluent water quality needs to be improved, a third alternative would include individual STEP tanks that pump to a new community package treatment plant that disperses the effluent with a sub-surface drip system. Systems similar to recirculating gravel filters could be considered. This alternative provides a robust treatment option that would work well for the terrain and climate of Jamestown. The plant location is flexible because the efflu- ent waste would be pressurized from the STEP tanks. However, this option would clearly be the most expen-

sive (both capital and operating cost) of the three strategies considered and is only recommended if Alternative 2 is not suitable for the community.

Summary

Following the webinar discussion and review of this report , Jamestown will be able to consider these recommendations and may use the information to put together cost estimated, phased project designs, which will benefit the Town. Ideally, this information will be available as the State makes announcements with respect to funding opportunities that could support recovery.

Changes to the stream from the September flooding event will likely impact water quality (e.g., increased turbidity) for some time and these impacts will need to be considered as the town moves forward with implementing and addressing the recommendations. It is recommended that Jamestown work closely with the State on any regulatory issues that may arise while rebuilding the system. The partnership between the Town of Jamestown and CDPHE has been very beneficial, as the open lines of communication have been extremely helpful to answer questions about permitting issues and other regulatory concerns while addressing the recovery effort.

Citations and Resource Inventory

The list below captures all source materials cited in this document and those documents and datasets provided by the Town of Jamestown, EPA and community partners in support of the recommendation development process.

Cited in this document

Odell, LH (2010) Treatment Technologies for Groundwater. AWWA

Preliminary Engineering Report for the WTP, Prepared by ACE Engineering, LLC, for the Town of Jamestown, November 2012

Preliminary Engineering Report for the Distribution System, prepared by ACE Engineering, LLC, for the Town of Jamestown, May 2013

Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Hole/Well Construction, http://water.state.co.us/DWRIPub/Documents/constructionrules05.pdf. Accessed February 18, 2014.

Information on plan development, data and updates from presentations can be found at http://jamestownco.org/stream-corridor-master-plan/. Accessed February 11, 2014.

USDA NRCS Colorado State Office report titled “Colorado Front Range Flood of 2013: Peak Flow Estimates at Selected Mountain Stream Locations,” December 2013. http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1240980&ext=pdf. Accessed February 19, 2014.

Designs/Schematics

Jamestown WTP Designs

Diagram of Town of Jamestown Distribution System (with current irrigation ditch and potential ditch expansion information).

Infiltration Gallery Plans (with total area of gallery)

Water System Improvements Schematics

Monitoring Data

Monthly MOR (monitoring data) for 2010-2013

Laminar and Turbulent Regime Changes in Drinking Water Contact Tanks

Conceptual Plans/Utility Reports

Nine Guiding Principles for Jamestown

Water Supply Report for Jamestown, Colorado (Well yield)

Permits/Regulatory Compliance

Sanitary Survey of Town of Jamestown

Analytical results for sample related to discharge permit for irrigation water

Failure to Monitor Violation Total Coliform Bacteria (Camp Buffalo Bill)

Water Quality data for James Creek for metals and nutrients

September 2013 Flood Response

Jamestown Aerial photos (comparison of pre- and post-flood inundation boundary comparison)

Activity log for 2013 CO Flood damage

Jamestown Water System Damage Assessment Photos

Jamestown Water System Damage Assessment Pictures

Jamestown Water System Drinking Water Evaluation Data Sheet

Key with details on identified damaged OWS with HGMP eligibility information

Map of Flood Damaged Onsite Wastewater Systems (OWS) - Upper Main Street and Anderson Hill

Map of Flood Damaged OWS - Lower Main Street

Streambed/System Restoration

Diagram of Town of Jamestown Distribution System (with current irrigation ditch and potential ditch expansion information).

Jamestown OWS Status Map

Key with details on identified damaged OWS with HGMP eligibility information

Map of Flood Damaged Onsite Wastewater Systems (OWS) - Upper Main Street and Anderson Hill

Map of Flood Damaged OWS - Lower Main Street

Photos from on-site visit

Town of Jamestown Stream Corridor Master Plan Community - Meeting #4

Unapproved OWS Key_Jamestown

FEMA Flood Insurance Rate Maps (FIRMs) from FEMA’s Map Service Center

Manuals/SOPS

SOP for Chlorine and Flow Volumes

SOP for Chlorine and Flow Volumes (revised)

SOP for Flow Rates across Slow Sand Filter Beds

SOP for Sand Filter Data Collection

SOP for Slow Sand Filter Cleaning

SOP for Stream/Well Water Mixing

Climate and Resilience Information

Climate Data Report from EPA’s Climate Resilience Evaluation and Awareness Tool (CREAT)

EPA Report (Draft): Becoming More Resilient to Flooding: A Basic Guide for Water and Wastewater Utilities

Attachment 1 – Contributors

Subject Matter Experts Contributing to Recommendations

Contributor	Specialty
Bill McMillin	Project Manager
Tyler Nading	Project Engineer
Paul Swaim	Water Treatment, QA/QC
Bill Bellamy	Slow Sand Filters
Kerry Meyer	Slow Sand Filters
Bob Gatton	Intake Structures
Lindsay Atkinson	Groundwater Systems
Doug Simon	Distribution Systems
Gary Davis	Instrumentation and Controls
Doug Berschauer	Wastewater Treatment
Jose Velazquez	Wastewater Treatment

Attachment 2 – Materials from Jamestown Webinar

Meeting Summary

Subject: Flood Recovery/Resilience – Jamestown, CO Recommendations Webinar
Date and Time: Wednesday, March 19, 2014. 9:00 AM – 11:00 AM Mountain
Location: Conference Call and Webinar

Participants:

- Town of Jamestown: Jennifer Aieta (with ACE Engineering), Jon Ashton
- EPA Region 8 (R8): Bob Clement, Michael Copeland, Lisa Kahn, Nat Miullo, Kendra Morrison
- EPA Headquarters (HQ): Brian Pickard
- FEMA: Thomas Rounds
- CDHPE: Jeff Hlad
- CSC: Steve Fries, Amy Posner
- CH2M HILL: Bill McMillin, Tyler Nading

Purpose: The purpose of this meeting was to review and discuss proposed recommendations for recovery of the water system in Jamestown, CO. This webinar provided a review of the recommendations for integrating sustainability and resilience to future floods, while returning to serving the Town with the highest quality of water possible. The discussion was centered on updates from Jamestown and community partners; these updates are captured in the Summary below.

Next steps and action items

- Bob Clement (EPA R8) will provide additional detail, as needed, on suggestions related to installation of buried pipes for stream crossings and isolation valve function.
- CSC will make revisions, as needed, to the recommendations report based on this discussion.

Summary of Discussion / Updates:

Project History and Overview

Lisa Kahn (EPA R8) provided an overview of the impacts of the September 2013 flooding event on the Town of Jamestown and the mission assignment under FEMA and the National Disaster Recovery Framework. EPA R8 established a team to assess the damage to Jamestown and develop recommendations of how best to recover from flooding impacts in a sustainable way that is consistent with Jamestown's Guiding Principles.

Lisa also noted that the flood will likely impact water quality (e.g., increased turbidity) for some time and these impacts will need to be considered as the town moves forward with implementing and addressing the recommendations. It is recommended that Jamestown work closely with the State on any regulatory issues that may arise while rebuilding the system. Additional comments provided by EPA R8 are provided at the end of this meeting summary.

Water Treatment Plant Recommendations

- Structural Integrity
  - o The property owned by the Town ends at the edge of the utility building. A low wall for flood protection would have to be restricted to the vicinity of the WTP door or an easement would have to be obtained from the adjacent property owner.

- Source Water Intake
  - Jamestown will be installing a temporary intake in the creek to support sand filter ripening.
  - Jamestown has recently tested and recorded the turbidity levels in James Creek: average of about 1 ntu, which is very similar to past winters. However, it is unclear what the conditions will be in the spring when snowpack melts.
  - EPA R8 mentioned that the turbidity could change even with smaller flooding/rain events. The source of high turbidity needs to be better understood by the Town.
- Infiltration Gallery
  - During the last sanitary survey, it was recognized that the gallery should be separated from the surface water intake. This separation will occur during reconstruction.
  - Jamestown plans to rebuild the existing gallery in a new location. At this time there are no plans for a separate gallery.
  - Perforated corrugated metal pipe for gallery and screens will be replaced to produce better water and result in less plugging.
  - As part of the redesign of the infiltration gallery, EPA R8 suggested a combination of a concrete wall perpendicular to the stream with a buried and anchored gallery at the bottom. This allows the creek to flow over the barrier to protect the new infiltration gallery.
- Filter Operation and Raw Water Temperature
  - Jamestown confirmed that a contractor began work to remove and replace the sand in the filters. The new filters should be operational in May or June.
  - Jamestown explained that in general, the town only cleans filters from April – October; cleaning is not done in colder months. In Jamestown's experience, harrowing performs better.
  - Jamestown is considering a geothermal well to increase raw water temperature; more data are needed to understand design to provide this heat transfer, especially in winter (1-2°C water). Jamestown would like to measure biological activity over the next year.
  - EPA R8 suggested a cartridge filter could be used after the slow sand filter to protect public health in the winter.

Distribution System

- System Piping
  - Part of the distribution system is being replaced now; design includes 6-inch ductile iron and 4-inch (and smaller) HDPE pipes.
  - EPA R8 provided experience from another community that is replacing lost river crossings by drilling and installing lines not within granite, like that found in the Jamestown substrate, but it should be possible to do that, in deeper substrate in the Jamestown setting. Concrete encased pipe that ran under James Creek (buried at 8ft) was exposed due to the scouring during the flood. Jamestown expressed interest in learning more about other options for replacing crossings.
- Isolation Valves
  - Jamestown was concerned that pressure drop from firefighting could activate the line break valve and prevent water use. Installing an additional bypass would provide a backup to allow firefighting to continue.
  - EPA R8 suggested the use of another storage tank to preserve pressure in the system and provide redundancy.

Backup & Alternative Source

- Two different ways to look at redundancy: providing an alternate source to the creek that still requires treatment or providing a new source that does not rely on the water treatment plant.
- EPA R8 suggested that potential turbidity issues could be a driving reason to move to groundwater. The runoff that is expected due to the increased snowpack (about 145% of average) could bring a great deal of challenges in the spring.
- After the emergency watershed protection project is complete, the entire stream corridor will be realigned in certain areas, which will allow it to be more stable and will be further protected from spring runoff. It was noted that the project extends upstream of Jamestown where there could be some significant deposition of materials that could break loose and cause damage as they flow downstream.
- Jamestown is employing a more robust intake design and redeveloped infiltration gallery (previously discussed) to help address water quality and supply issues in the short-term. EPA R8 suggested using a pressure filter to add a coagulant prior to the sand filter during high turbidity periods would increase capture of particulates in the filter.
- Previous fires upstream threatened water quality and has been the driver for plans to upgrade the infiltration gallery to provide water when the plant could not process the surface water.
- Jamestown recognized it would be beneficial to dig a new well that is not under the influence of the surface water in case the surface water supply was impacted by a future event. Use of additional wells will be a project for future consideration.
- EPA R8 also noted that a deep well can be installed to provide enough production for the entire town and would not need to go through the slow sand filter. Well water could bypass the water treatment plant, and could be a more secure supply than the surface water.
- Jamestown should speak with residents that have private wells to determine how deep their wells are and their production. The Town has not investigated private wells to date.

Wastewater Management

- Wastewater management is currently a moving target, since it is unclear which lots will be reconstructed. Residents might consider rebuilding their systems on their own. At this point, this issue is not a high priority for residents.
- Recent discussions among Jamestown residents have centered on using vacant lots for community septic fields (e.g., lost homes on Lower Main Street). A benefit of combined leach fields is that the strategy is scalable and there is a great deal of flexibility on where and when they are installed. Combined leach fields may not provide more resilience during another flooding event, as they could still be damaged depending on scour depth.
- EPA R8 noted that metal loading is a potential source of contamination in mountain towns, like Jamestown, that is not often discussed, but should be considered.

Wrap Up and Next Steps

- Jamestown will consider the recommendations in this report and may use the information to put together cost estimated, phased project designs, which will benefit the Town as the State begins making announcement with respect to funding opportunities.
- The partnership between the Town of Jamestown and CDPHE has been very beneficial, as the open lines of communication have been extremely helpful to answer questions about permitting issues and other regulatory concerns while addressing the recovery effort. CHPHE offered to continue to provide assistance as needed to Jamestown.

Comments to the Draft Jamestown Restoration Recommendations

By Bob Clement, Environmental Engineer/Microbiologist, U.S. EPA, Region 8

One of the important issues that need to be acknowledged relative to the long term resiliency of Jamestown's drinking water system is that, the slow sand filtration was not the correct treatment technology for a raw water source that has spring runoff turbidity of greater than 10 NTU. For slow sand filtration to be successful the turbidity of the raw water should be in the range of 5 to 10 NTU. The majority of slow sand filtration plants in the US have raw water with less than 10 NTU. Even before the floods, Jamestown's slow sand filter needed to be augmented with an infiltration gallery. The floods have severely scoured the stream bed which will only increase the duration of time the stream is over 10 NTU. Considering this long term impact of increased turbidity in the raw water may last decades, slow sand filtration needs an even more robust level of augmentation to be successful.

The turbidity standard for slow sand filtration is higher (1 NTU) than for conventional or direct filtration (0.3 NTU) because slow sand filtration uses a biological process called a schmutzdecke. The sand particles are smaller for a slow sand filter which allows bacteria to be captured in the pore spaces and enables a biological mat to develop that is effective at protozoan pathogen removal. The expectation is that, even slow sand filtration will operate well below the 1 NTU standard but a larger buffer is allowed due to the effectiveness of the schmutzdecke. Turbidities over 1 NTU are a concern because it gives bacteria and viruses particles to attach to. Bacteria and viruses attached to particles are hundreds of times more resistant to chlorine than free floating bacteria. Other factors that increases the survival of bacteria are encapsulation, aggregation, low nutrient growth considerations and strain variation; these factors are multiplicative. Therefore, compliance with the turbidity standards is very important. Compliance with the turbidity standard and all other DW standards needs to be incorporated into any legitimate plan for resiliency.

The slow sand filtration augmentation options should be prioritized in order of likely success with the resiliency objective of compliance.

1) Replacement of existing wells: This is alternative three in the report, and involves re-drilling the two existing wells currently owned by Jamestown. The history of why these wells fell into disuse is very important. If Jamestown stopped using these wells to reduce power costs then perhaps a long term resiliency option would be to develop a small hydroelectric facility that would offset the power costs for these wells. The wells should be re-drilled as far away from the flood area as possible. At Sylvan Dale Guest Ranch for example, the floods gouged out the valley floor which washed out their distribution pipes and leach fields, their wells were above the flood plain and suffered no damage. If moving the wells the 200 feet allowed to maintain the water rights provides ground water then the water would not need to be filtered. Ground water would provide the best long term resiliency for Jamestown due to its simplicity. If the re-drilled wells were under the direct influence of surface water they would need to go through the slow sand filter. These wells have the greatest potential to produce the best and most consistent raw water quality for the slow sand filters and best opportunity for meeting turbidity and other standards. Also the wells may circumvent the need for a more robust level of augmentation discussed below.

2) Gravity flow to the slow sand filter. If the intake and infiltration gallery were able to be moved upstream enough to allow gravity flow to the slow sand filter then Jamestown could reduce its complexity and increase its resiliency by eliminating the need for raw water pumps to the slow sand filter.

3) Infiltration gallery options: A literature search and review of PWSs with infiltration galleries should be researched to provide a broad array of options on design. Innovative ideas should be considered, for example designs that take into account the best concepts of river crossings and infiltration galleries. Typically, a good design for a river crossing is a concrete wall running perpendicular to the stream. The pipe is laid upstream and filled in to the top of the concrete wall. Stream flow pushes sand flush with the top of the wall keeping the pipe fully buried. Explore concepts of two concrete walls with an infiltration gallery between them. Engineer the distance between these concrete walls such that high flows and floods do not scour out the gravel in the infiltration gallery. The concrete walls need to be formed well into the banks on either side to prevent floods from washing around them. To prevent the stream from undercutting the walls large boulders could be cemented in place on both the upstream and the downstream sides. The area in between the walls would be filled with gravel designed for an infiltration gallery. The stream flow would always be over the infiltration gallery and flow would scour the top layer not allowing a deep silt layer to build up. During low flows the gravel could be replaced or maintained as needed.

4) Buried intake. Create a raw water intake with one concrete wall across the stream with the intake pipe buried (as in #3 above) upstream but have larger pipe openings surrounded by larger rock. The purpose of such an intake would be to protect it from flooding and prevent it from clogging and increasing the reliability of the intake to transport raw water to the infiltration gallery.

5) Create an off stream infiltration pond. This option may be available if water laws allow the creation of a stream diversion to an infiltration pond. This would allow Jamestown to take advantage of a more complex biological mat as a silt layer builds up in the surface water pond. The design and number of the infiltration pipes should account for lower flows of water through the silt layer. Two redundant ponds would allow for repairs/maintenance to one side while providing water to the slow sand filter with the other pond.

6) Seasonal cartridge filtration after the slow sand filter. To compensate for concerns regarding lower temperatures and decreased biological activity in the slow sand filter, cartridge filters could be added after the slow sand filter. These filters would be used during the winter months. Cartridge filters could also be used for a period of time after cleaning either harrowing or removing the top layer of sand as an added measure of safety until the filter ripens. This would provide Jamestown with the resiliency to ensure pathogen removal is maintained during cold weather and after cleaning. It would also provide another barrier during spring runoff (see 7 below) if needed.

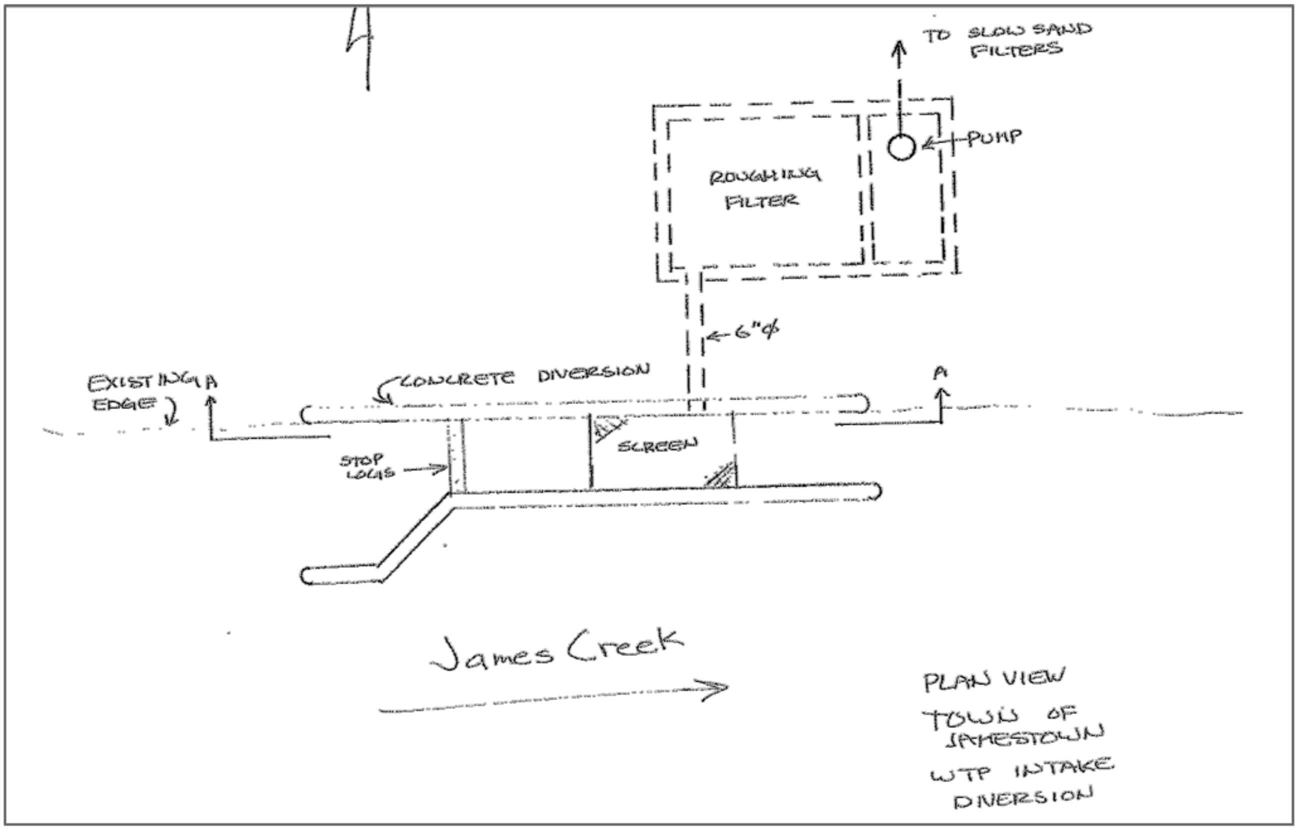
7) Pressure filters with coagulant prior to the slow sand filter. To ensure compliance with turbidity during spring runoff with the scoured streambed, simple pressure filters with coagulant addition could be added prior to the slow sand filters. The coagulant addition would be used in the charge neutralization range which uses lower dosages to neutralize the charge on the particles and allow the turbidity to be filter out. This would provide Jamestown the resiliency to meet the turbidity standards in the severely scoured out stream bed during spring runoff and storm events.

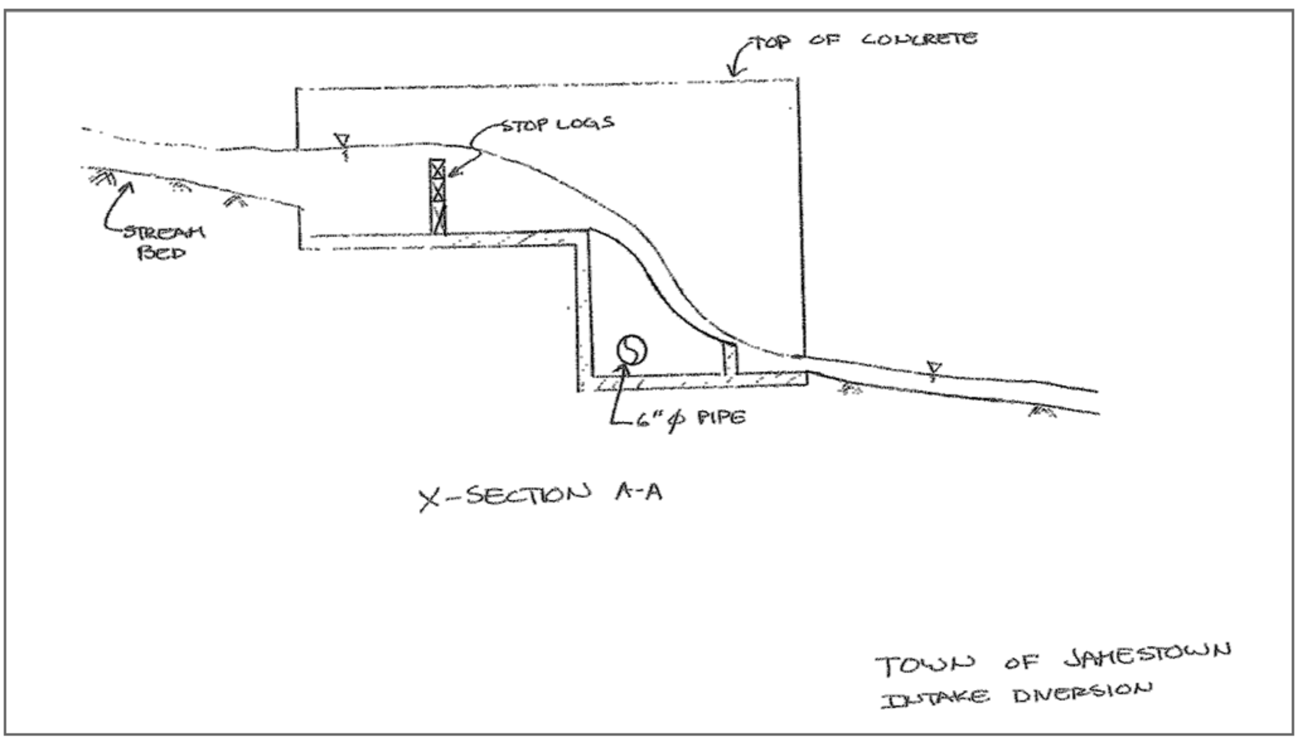
8) Bore the finished water line under the stream. The finished water line can be bored 40 to 50 feet under the stream to eliminate being washed out during floods. Morgan County Water System decided to bore their drinking water lines under the Platte after three river crossings were washed out. With storage tanks on either side of the river and properly placed valves above the flood plain, breaks can be isolated and avoid draining the water out of the storage tank. Pressure can be maintained on both sides of the river.

9) Locate the generator/fuel above the 1000 year flood plain.   A separate building or shed could be located above the 1000 year flood plain that houses a generator and fuel to power the system during emergencies. A designated electrical line from the generator to the plant could be routed along telephone poles above the flood plain. Enough fuel needs to be located at the site to power the generator for at least as long as Jamestown was isolated during the 2013 floods.

Attachment 3 – Intake Concept Drawings

Concept drawings below provided by ACE Engineering





Attachment 4 – Corrosion Control Strategies

Possible corrosion control strategies for conditions similar to those reported for Jamestown source waters from a table of USEPA Recommended Corrosion Control Treatment Strategies summarized in Odell (2010).

Exceeded Lead AL	Exceeded Copper AL	Raw Water pH	Iron and Manganese Removal?	DIC	Recommended Corrosion Control Strategies
Yes	Yes	<7.2	No	>15	Raise pH in 0.25 increments using Soda Ash, Potassium Carbonate, Caustic or Aeration, or Orthophosphate addition
Yes	No	<7.2	No	>12	Raise pH in 0.25 increments using, Potassium Carbonate, Caustic or Aeration, or Orthophosphate addition
No	Yes	<7.2	No	>35	Raise pH to 7.2-7.8 using Aeration and Orthophosphate addition
Either	Either	<7.2	Yes	>12	Raise pH in 0.25 increments using, Potassium Carbonate, Caustic or Aeration, or Orthophosphate addition
Either	Either	<7.3	Have but no removal	>25	Add Orthophosphate

Attachment 5 – Line Break Valve Specifications
(REMOVED SPECIFIC MANUFACTURER INFORMATION)

Attachment 6 – Existing Wells List

PERMIT_NO	USE1	DAT_ISSUED	DAT_CONSTR	DEPTH	PUMP_RATE	OWNER (REMOVED PII)
128863	HOUSEHOLD USE ONLY	1/26/1983	9/18/1984	400	1	
46190	MUNICIPAL	3/5/1996		21	100	
46189	MUNICIPAL	3/5/1996		28	50	
124112	HOUSEHOLD USE ONLY	2/26/1983		0	0	
65583	HOUSEHOLD USE ONLY	4/18/1983	8/18/1983	0	0	
133102	HOUSEHOLD USE ONLY	10/12/1983		0	0	
133103	HOUSEHOLD USE ONLY	10/12/1983	3/1/1985	60	10	
136665	HOUSEHOLD USE ONLY	8/24/1984		0	0	
141123	HOUSEHOLD USE ONLY	9/5/1985	10/8/1985	305	1.73	
142364	HOUSEHOLD USE ONLY	12/20/1985		0	0	
145277	HOUSEHOLD USE ONLY	9/4/1986	10/13/1986	200	4	
145659	HOUSEHOLD USE ONLY	10/14/1986	10/19/1986	180	2	
146802	HOUSEHOLD USE ONLY	2/6/1987		0	0	
147382	HOUSEHOLD USE ONLY	4/7/1987	5/23/1987	600	1.67	
148327	HOUSEHOLD USE ONLY	6/18/1988		0	0	
148032	HOUSEHOLD USE ONLY	5/22/1987	3/24/1989	360	0.25	
158478	HOUSEHOLD USE ONLY	10/18/1990	11/28/1990	440	2	
158478	HOUSEHOLD USE ONLY	10/15/1991	9/23/1991	340	2	
91364	HOUSEHOLD USE ONLY	9/11/1991		0	0	
164767	HOUSEHOLD USE ONLY	6/18/1992		0	0	
165164	HOUSEHOLD USE ONLY	7/14/1992	9/9/1992	340	5	
168263	HOUSEHOLD USE ONLY	1/26/1993		0	0	
13257	HOUSEHOLD USE ONLY	3/16/1994		0	0	
190770	HOUSEHOLD USE ONLY	10/20/1995	12/7/1995	300	1.9	
14257	DOMESTIC	9/3/1998		0	0	
214217	DOMESTIC	12/1/1998		6	10	
257306	HOUSEHOLD USE ONLY	6/3/2004	4/14/2006	0	15	
39459	DOMESTIC			0	0	
69790	HOUSEHOLD USE ONLY	7/3/1973		0	0	
75927	DOMESTIC			0	0	
78663	HOUSEHOLD USE ONLY			0	0	
621	DOMESTIC		12/30/1932	5	6	
46679	DOMESTIC			46	15	
65583	HOUSEHOLD USE ONLY	10/16/1972	12/5/1972	215	1	
79637	DOMESTIC			14	12	
88420	HOUSEHOLD USE ONLY		1/31/1977	290	3.5	
88913	HOUSEHOLD USE ONLY			375	15	
90472	HOUSEHOLD USE ONLY			515	0.3	
108732	HOUSEHOLD USE ONLY			225	12	
144686	HOUSEHOLD USE ONLY			80	4