CITY OF
Saint Paul
ALASKA

CITY OF SAINT PAUL, ALASKA
STANDARD OPERATING PROCEDURE
EMERGENCY REPAIR OF WATER MAINS
MARCH 2023

1. SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Approved by

2. STAFF ACKNOWLEDGEMENT

I certify that the requirements of this SOP have been communicated to me and that I am trained in its use. A copy of this page will be distributed to the employee training record file.

Name	Date

3. APPROVAL SIGNATURES

Prepared by: Phillip A. Zavadil, City Manager Date: March 10, 2023

Approved by:_____ Date: _____

4. DEFINITIONS AND ACRONYMS

AWWA American Water Works Association

AE Asset Essentials

OSHA Occupational Safety and Health Administration PPEpersonal protective equipment

mg/L milligram per liter

5. KEY PERSONNEL AND RESPONSIBILITIES

5.1. Public Works Director of Designee

5.1.1. Oversee main repair and disinfection

5.1.2. Determine and implement any follow-up activities

5.1.3. Document the break, including the type, repair conditions and activities, process used for disinfection and all sampling results, in the enterprise asset management (EAM) system

5.2. Water/Wastewater Operators

5.2.1. Conduct repairs and field disinfection process

5.2.2. Collect and analyze samples for disinfectant residual and document results

5.2.3. Collect bacteriological samples and deliver to the water quality laboratory for analysis

5.3. Equipment Operators:

5.3.1. Operate equipment to assist with the repairs

6. SCOPE/PURPOSE

6.1. The purpose of this Standard Operating Procedure (SOP) is to outline the procedures for repairing a main break, including any necessary flushing, disinfection, and water quality testing to be conducted before a main is placed back into service. The procedures presented herein are based on the Water Research Foundation Report #4307 – Effective Microbial Control Strategies for Main Breaks and Depressurization (2014) and should be used in conjunction with AWWA Standard C651 – Disinfecting Water Mains. As not all breaks can be repaired in the same manner, crews should use their best judgment when implementing the procedures below.

7. HEALTH AND SAFETY

7.1. Main repair often involves several types of hazards, including:

7.1.1. Traffic Hazards: The field service team should use trucks, temporary signs, and traffic addition, a flag crew may be needed to direct traffic in some locations.

Trucks should be parked between oncoming traffic and the work area when possible to provide a barrier.

7.1.2. Heavy Equipment Hazards: Heavy equipment may be needed for excavation, trenching, grading, etc. Staff operating the equipment must have the proper training and licensure. Ensure proper distances from the equipment are maintained. Use hand signals / radios to communicate with the operator and spotters as needed when moving equipment. Make eye contact with the operator before coming in the vicinity of the equipment.

7.1.3. Trenching and Confined Space Entry: If trench work is required, consult the relevant excavation procedures for benching, sloping and shoring depending on depth and conduct work in accordance with the Occupational Safety and Health Administration (OSHA) standards for trenching and excavation. Where applicable, staff working in the trench must have the proper confined space entry training and certification.

7.1.4. Hazardous Chemicals: Disinfection procedures involve the use of chlorine, which can present various hazardous to staff and the public. Staff should be trained in the use of the specific chemicals to be used and how to address any emergencies that may arise. In addition, staff should follow all precautions when working with chlorine solutions.

7.2. Crews should be able to recognize and respond to the potential hazards, and must have the proper training, including knowledge of proper sanitary procedures during repair, and certifications to the complete the applicable tasks. In addition, proper PPE should be worn at all times and will vary depending on the specific repair activity. PPE may include:

7.2.1. Chemical resistance apron

7.2.2. Face Shield

7.2.3. Hard hat

7.2.4. High visibility safety vest

7.2.5. Knee pads

7.2.6. Safety glasses

7.2.7. Steel-toed boots

7.2.8. Work gloves and/or chemical resistant gloves

8. PROCEDURE

8.1. Equipment Required:

8.1.1. Traffic cones, barricades, and flashers

8.1.2. Temporary signs/arrow boards (warning lights, strobe lights, arrow boards, traffic maintenance signs)

8.1.3. Water system maps

8.1.4. Field tools for isolating and repairing the pipe section (e.g., pry bar, valve key or valve box keys for all saws, pipe wrenches, buckets, shovels, welding equipment, pickaxes, ladders, flashlights, pipe clamps, couplings, etc.)

8.1.5. One percent chlorine solution in spray bottles

8.1.6. One of the following NSF/ANSI 60 certified disinfection chemicals:

8.1.6.1. Sodium hypochlorite solution

8.1.6.2. Calcium hypochlorite tablets

8.1.7. NSF/ANSI 60 certified dechlorination chemical, if needed

8.1.8. Sterile sample bottles treated with sodium thiosulfate, transport cooler, ice packs

8.1.9. Field chlorine test kit

8.1.10. Flashlights or headlamps

8.1.11. Portable dewatering pumps and accessories

8.1.12. Surface runoff diversionary equipment (sandbags, trench covers, etc.)

8.1.13. Backfill material or bedding (sand, crushed stone, etc.)

8.2. Procedure:

8.2.1. An overview of the procedure based on break type is summarized in Table 1. As not all breaks will fall into these categories and as site conditions (i.e., ability to locate and operate appropriate valves and hydrants) impact the ability to implement the procedures below, crews should use their best judgment when modifying the procedures below and ensure practices comply with AWWA Standard C651. Additional details are provided below:

Table 1: Categories of Main Break Types and Repair Response Procedures (Adapted from Kirmeyer et al., 2014 and AWWA Standard C651-15):

Water Main Break Type	Type 1	Type 2	Type 3	Type 4
Description				
Description	Controlled pipe repair without depressurization	Controlled pipe repair with depressurization after shutdown	Uncontrolled pipe break with possible water contamination or loss of sanitary conditions during repair	Uncontrolled pipe break with a likelihood of water contamination or loss of sanitary conditions during repair

Water Main Break Type	Type 1	Type 2	Type 3	Type 4
Description				
Pressure Conditions	Positive pressure maintained during break and repair	Pressure maintained during break and excavation, followed by controlled shutdown for repair	Loss of pressure at break site / possible local depressurization (less than 20 psi) adjacent to the break (e.g., severe erosion requires pressure to be reduced prior to exposing the pipe)	Loss of pressure at break site / widespread depressurization (less than 20 psi) in the system (e.g., pipe blowout and loss of pressure prior to shutdown)
Risk of Microbiological Contamination	No signs of contaminant intrusion	No signs of contaminant intrusion	Possible contaminant intrusion	Possible / actual contaminant intrusion
Procedures				
Assess Break	Excavate to at least 1' below the pipe invert No shutdown needed; maintain pit water level below break	Excavate to at least 1' below the pipe invert Perform controlled shutdown after pipe is exposed and secured from trench soil/water contamination and maintain pit water level below break	Uncontrolled shutdown Document possible contamination. Shut-off customer services in affected area	Immediate or uncontrolled shutdown Document likely contamination. Shut-off customer services in affected area
Repair	Repair pipe under positive pressure Disinfect repair parts Swab accessible components with 1% chlorine solution	Repair pipe following controlled shutdown Disinfect repair parts Swab accessible components with1% chlorine solution	Repair pipe following partial of uncontrolled shutdown Disinfect repair parts Swab accessible components with1% chlorine solution	Repair pipe following uncontrolled or immediate shutdown Disinfect repair parts Swab accessible components with1% chlorine solution
Disinfection	Not required	Not required	Conduct slug chlorination (CT of 100 mg/L-min)[1]	Conduct slug chlorination (CT of 100 mg/L-min)[1]
Flushing	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear. Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear. Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear. Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear. Dechlorinate if needed

Water Main Break Type	Type 1	Type 2	Type 3	Type 4
Procedures				
Disinfectant Residual Sampling	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels
Public Notification	No boil water advisory needed	No boil water advisory needed	Instruct customers to flush premise plumbing upon return to service Determine if boil water notice is needed based on depressurization extent and presence of contamination	Instruct customers to flush premise plumbing upon return to service Work with ADEC Drinking Water Program to issue a boil water notice
Bacteriological Sampling	No sampling needed	If a full pipe section is required during the repair, collect one set of samples; however, the pipeline may be returned to service prior to obtaining the results	Collect bacteriological samples; main may be returned to service prior to completion of the testing depending on the depressurization extent and presence of contamination	Collect bacteriological samples; await confirmation of sample results before boil water notice can be rescinded

8.2.2. In highly tuberculated pipes, a higher CT should be considered to compensate for possible lower flushing efficiency. If exposure of customers to high levels of chlorine cannot be controlled, a minimum free chlorine level of 0.5 mg/L must be maintained for at least 48 hours in conjunction with flushing, coliform sampling, and public notification.

8.2.3. If depressurization is limited to the pipe section, or area flushed or disinfected, then a boil water advisory is not needed and main can be returned to service prior to receiving the bacteriological sample results. However, if the area of depressurization is larger than the treated area, then a precautionary boil water notice should be considered.

8.2.4. Residual levels should be at least 90% of ambient or pre-break levels and not more than 1.0 mg/L.

8.2.5. Upon arrival at the site, evaluate the site for safety (including the appropriate PPE) and set up the appropriate traffic control measures. This may include: warning lights, strobe lights, arrow boards, traffic maintenance signs, cones, flagmen (if necessary), safety vests and/or other PPE. Locate and mark buried utility lines and valves in the vicinity. Check for potential contamination sources, such as septic systems, underground storage tanks, service connections without proper backflow prevention devices, and presence of multistory buildings.

8.2.6. If necessary, isolate the pipe section by slowly adjusting valve settings, maintaining positive pressure to reduce backflow or runoff contamination. Where possible, service disruptions should be minimized; however, it may be necessary to isolate certain areas to minimize the potential for contamination. Close or throttle valves, particularly service connections that do not have proper backflow prevention, as needed, to isolate the repair area. If possible, notify impacted customer of the potential disruption. Use caps or covers to protect existing mains or service connections.

8.2.7. Excavate the break. Provide the necessary benching, sloping and/or shoring depending on depth and conduct work in accordance with the Occupational Safety and Health Administration (OSHA) standards for trenching and excavation. Install temporary devices to divert surface water runoff around the repair site. Use portable dewatering pumps to maintain water levels at least one foot below the pipe invert during repair.

8.2.8. Repair the pipe using the appropriate materials (i.e., fittings, joints, gaskets, clamps), sizes and other necessary repair equipment. During the repair:

8.2.8.1. Maintain positive pressure, where possible, to prevent contamination from backflow into the pipe. At the start of, at least once during and at the end of the repair, confirm and document if positive pressure is maintained in the immediately vicinity of the break site by visually observing a steady flow or spray of water coming from the pipe, or observation of a hose bib or hydrant located near and at a higher elevation than the break site. Pressure above 20 psi should be maintained outside the immediate repair area. If pipe cannot be repaired

under pressure, do no depressurize the pipe until the pipe is exposed.

8.2.8.2. Maintaining a dewatered trench to at least 1' below the pipe invert.

8.2.8.3. Visually inspect the interior and exterior of all new materials (pipes, fittings, valves, etc.) to ensure there is no visible damage, debris, or contamination.

8.2.8.4. Remove any visible debris from exposed areas of the existing pipe.

8.2.8.5. Keeping all parts, tools and materials used in the repair in a clean and sanitary condition. Clean and disinfect prior to use or installation with a 1 percent chlorine solution. If any interior areas of the pipe were exposed to the environment during the repair, spray or swab any accessible upstream and downstream interior of the existing pipe areas with a 1 percent chlorine solution. If the repair requires new piping to be installed in any section, the new pipe must be inspected, cleaned and disinfected from both ends by swabbing with 1 percent chlorine solution.

8.2.8.6. Maintain pipe caps, plugs or other protective coatings until materials are ready to be installed.

8.2.8.7. Complete all pipe and fitting joints in the trench before stopping work. If work requires more than one day, store materials on-site in a secure area.

8.2.9. If needed, disinfect the pipe in accordance with the described outlined in AWWA Standard C651. For disinfection of repaired mains, the following methods can be used:

8.2.9.1. Tablet method: involves the use of calcium hypochlorite tables in the repaired or replaced pipe section and contact time with an initial free chlorine concentration of 25 milligrams per liter (mg/L). Note that pipe materials must be evaluated for compatibility and that this method may only be used when pipes and appurtenances are kept clean and dry during construction. Cleaning and flushing of the main prior to disinfection cannot be performed with this method.

8.2.9.2. Continuous feed method: involves filling the main with potable water to remove air pockets, then flushing to remove particulates, and refilling the main with chlorinated water at a dose of 25 mg/L until stable concentrations are reached within the pipe (i.e., a free chlorine residual of not less than 10 mg/L after a holding period of 24 hours).

8.2.9.3. Slug method: involves filling the main with potable water to remove air pockets, flushing to remove particulates, followed by slow flush with a high concentration of chlorine – 100 mg/L – for at least 3 hours. The use of cross connection control and backflow prevention must be used to ensure the high chlorine concentration does not affect the distribution system.

8.2.9.4. Spray method: involves a 30-minute exposure to free chlorine at not less

than 200 mg/L. Refer to chlorination method 2 in AWWA Standard C652 – Disinfection of Water Storage Facilities.

8.2.10. The slug method may be preferable as it requires reduced contact time. However, alternative methods (tablet method, continuous feed method, or spray disinfection) are available. Evaluate the scene and select the best method for disinfection based on site conditions, length and diameter of the main, type of joints present, available materials and equipment, type of break and associated risk for microbiological contamination. If highly chlorinated water is likely to impact fish or plant life or other downstream users), dechlorination must be performed to neutralize the remaining chlorine residual prior to discharge. If dechlorination is necessary, follow the procedures outlined in AWWA Standard C655 – Field Dechlorination.

8.2.11. Target a unidirectional flush towards the water main break. Open the necessary hydrants to complete the flush. Flush with potable water at a velocity of 3.0 feet per second (fps) in the pipe for a minimum of three pipe volumes to remove debris and verify that the discharge is visually clear.

8.2.12. Check for typical system chlorine residual in the main using a field chlorine test kit and flush the pipe section until typical system residuals are detected (i.e., to at least 90% of ambient or pre-break levels and not more than 1.0 mg/L). Collect samples from the immediate and surrounding areas around the repair site.

8.2.13. For high-risk breaks (Types 3 and 4), notify affected customers about the break, schedule, and concerns. Instruct customers to flush their home plumbing after repairs are completed. If contamination was likely to occur, perform issue a precautionary boil water notice. If a boil water notice is needed, the Water/Wastewater Operator should immediately contact the following staff with the Alaska Department of Environmental Conservation to notify them of the situation and to coordinate the public notification:

Leah A. Van Sandt, Environmental Program Specialist III
Alaska DEC-EH - Drinking Water Program
907.269.7653
leah.vansandt@alaska.gov

Cindy Christian, Drinking Water Program Manager
Alaska DEC-EH - Drinking Water Program
907.451.2138
cindy.christian@alaska.gov

8.2.14. For medium risk breaks (Type 2) where a full pipe section was required and high-risk breaks (Types 3 and 4), conduct coliform sampling in accordance with AWWA Standard C651. For Type 2 and some Type 3 breaks, the main may be returned to service prior to the completion of the bacteriological results. For Type 4 results, await until sample results are received and show the absence of coliforms. If coliforms organisms are detected, repeat the flushing, and resample for coliforms. If the confirmation coliform sample also shows the presence of coliforms, repeat disinfection using the continuous- feed or slug method until no coliform organisms

are present. For any positive coliform results, the Water/Wastewater Operator shall immediately notify the following staff with the Alaska Department of Environmental Conservation and follow any required procedures:

Leah A. Van Sandt, Environmental Program Specialist III
Alaska DEC-EH - Drinking Water Program
907.269.7653
leah.vansandt@alaska.gov

Cindy Christian, Drinking Water Program Manager
Alaska DEC-EH - Drinking Water Program
907.451.2138
cindy.christian@alaska.gov

8.2.15. Flush hydrants, if needed, to remove any debris.

8.2.16. Return the main to service by opening any closed valves, using a sequence that avoids low or negative pressures.

8.2.17. Backfill and compact pipe bedding per applicable AWWA pipe installation standard.

8.2.18. Repair ground surface to at least original conditions.

9. DATA RECORDING AND MANAGEMENT

9.1. Following a main break, enter all necessary information into the Asset Essentials (AE). This includes:

9.1.1. Date and approximate type of break

9.1.2. Nature of break (i.e., circumferential, longitudinal, both, shear, hole, split, blowout, joint, sleeve, other)

9.1.3. Apparent cause of break (i.e., water hammer, defective pipe, corrosion, deterioration, improper bedding, operating pressure, temperature, differential settlement, improper installation, other)

9.1.4. Type of break (based on Table 1 above)

9.1.5. Location and field conditions (paved/unpaved, traffic conditions, type of soil, side of street, weather conditions,)

9.1.6. Pipe data (type of main, class, length, diameter, bedding, backfill, compaction)

9.1.7. Type of repair (clamp, sleeve, etc.)

9.1.8. Repair materials used

9.1.9. Potential contamination issues (e.g., muddy trench water flowing into broken pipe, leaking sewer pipe in trench, catastrophic pipe failure where pipe is open)

9.1.10. Problems encountered

9.1.11. Water quality test results

9.1.12. Field observations, including inoperable valves or hydrants or incorrect locations of mains, valves, hydrants, underground utility locations, service connections, etc.

9.1.13. Estimate the cost associated with the repair (materials, manpower, time, overtime, etc.)

9.2. The Public Works Director or designee shall assign work orders for any follow-up items, such as valve replacements.

10. REFERENCES

AWWA. (2015). *C651-14 Disinfecting Water Mains.* AWWA

AWWA. (2011). *C652-11 Disinfection of Water Storage Facilities.* AWWA

Kirmeyer, G. J., Thomure, T. M., Rahman, R., Marie, J. L., LeChevallier, M. W., Yang, J., … & Schneider, O. (2014). Effective Microbial Control Strategies for Main Breaks and Depressurization. Denver, CO: Water Research Foundation.