Commonwealth of Massachusetts
Department of Environmental Protection
Bureau of Resource Protection
Drinking Water Program

Guidelines For

Pipe Bursting of Potable Water Mains

Using Pre- and Post-Chlorinated HDPE Pipe

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This Guide is adapted from
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Pipe Bursting of Potable Water Mains Using Pre- and *Post-Chlorinated Pipe*

Acronyms used in this chapter:

ANSI - American National Standards Institute
AWWA - American Water Works Association
DWP - Drinking Water Program
HDPE - high density polyethylene
MassDEP - MA Dept. of Environmental Protection
NPT- National Taper Thread
NSF - National Sanitation Foundation
OSHA - Occupational Safety and Health Act
ppm - parts per million
psi – pounds per square inch
PVC - polyvinyl chloride
PWS - public water system
SDR - standard dimension ratio

Pipe Bursting of Potable Water Mains Using Pre- and Post -Chlorinated Pipe

MassDEP strongly recommends that public water systems (PWS) intending to use this pipe replacement technique - pipe bursting of potable water mains using pre-chlorinated high density polyethylene (HDPE) pipe - develop and implement written project requirements based on this MassDEP guide; there are no state regulations specific to use of this technique. For purposes of this guidance, city, town, or private utility are terms used inter-changeably. They all refer to the owner of the system. The owner, based on a set of engineering drawings, selects a contractor, the party performing the work, to install the piping in accordance with designed plans and specifications of an engineer.

If you have any questions on this *Pipe Bursting of Potable Water Mains Using Pre- and Post-Chlorinated Pipe* please contact the Drinking Water Program at 617-292-5770 or by email at Program.Director-DWP@state.ma.us.

1.0 Method Outline for Pre- and Post-Chlorination of HDPE Pipe

Assuming all qualifications for skill and materials are met, the methods outlined in the operational guide *Pipe Bursting of Potable Water Mains Using Pre- and Post-Chlorinated Pipe* shall be applied to each pipe section. These processes may be performed in series or in parallel with other sections of pipe within the job.

a. Deliver notice of service outage to each affected property owner in advance of work

b. Chlorinate a length of product pipe that yields passing test results for potable water per AWWA, MassDEP, and city or town standards

c. Hydrostatic test of the product pipe section per city or town standards

d. Excavate a burst pit at one end of the section down to pipe grade for placement of the pipe bursting equipment

e. Excavate an insertion pit at the opposite end of the section down to pipe grade for entry of the product pipe

f. Excavate service connection pits

g. Isolate the section to be rehabilitated from the rest of the system so as to maintain pressure integrity of the system as well as preventing any backflow of chlorinated solution or non-potable water into the system

h. Excavate and remove hydrant tees and valve tees from the host pipe

i. Rod string to be assembled as it is thrust through the host pipe from the burst pit to insertion pit

j. Attach burst tooling and product pipe to rod end at the entry pit

k. Rod string pulled back and disassembled simultaneously while tooling and product pipe travels from insertion pit to burst pit

l. Service connections shall be made to the newly installed main.

m. Super-chlorinate main for 15 minutes to 300 ppm. A de-chlorination unit will be used to neutralize the residual chlorine when flushing. Flush the newly installed main with potable water.

n. Inspect for leaks at new connections

o. Final connection of the replaced section of pipe into the system

It should be noted that items “d” through “o” are to be accomplished within a single 10-hour day to eliminate the need for any temporary services. The length of pipe to be burst per run should be chosen to conform to this time frame. Items “d” though “f” (excavation items) may be performed one day prior to bursting operations to expedite process.

2.0 Work Prior to Pipe Bursting

2.1 Contractor Qualifications

In order to assure quality execution of the method, the contractor shall upon request of the PWS provide the following:

1. Experience – the contractor shall provide documented evidence of:

    a. Performing 30,000 feet or more of water main replacement using the process of pre-chlorinated pipe bursting in the United States over a minimum of a 48-month period;

    b. Performing chlorination of potable water mains per AWWA standards on at least two projects.

2. Certification

    a. Certificate of training endorsed by the manufacturer of the pipe bursting equipment

    b. Certificate of training endorsed by the manufacturer of thermal fusion equipment in butt fusing of high density polyethylene pipe (HDPE) pipe; in lieu of certificate, evidence of training may be substituted.

    c. Certificate of training endorsed by the supplier or manufacturer of HDPE electrofusion couplers to be used in the method. In lieu of certificate, evidence of training may be substituted.

3. A competency statement by contractor that all employees are medically cleared to work on restricted operations and have been trained in hygienic procedures.

4. Personnel overseeing pre-chlorination process shall be trained and qualified in process.

2.2 Pipe Specifications

1. High Density Polyethylene Pipe shall be AWWA C906 (HDPE) and per city or town specifications.

2. Pipe must conform to ASTM F714 and NSF 61.

3. HDPE resin shall be PE3408 characterized by ASTM D3350.

4. All pipes shall be made of virgin material, not reworked except that obtained from manufacturer's own production.

5. Pipe shall be, at minimum, a Standard Dimension Ratio of 17 (SDR =17). The Standard Dimension Ratio is the ratio of pipe thickness compared to the outer diameter of the pipe, or as directed by the design engineer.

6. Cuts or gouges, per ASTM F585 are acceptable up to 10% of wall thickness. Beyond 10% of wall, damage must be removed by cutting the damaged section from the pipe string and butt fusing the ends.

7. Stripe along the length of the pipe shall be blue in color to identify the pipe as potable water.

2.3 Other Product Specifications

1. Fittings for pressure systems shall be ductile iron and comply with AWWA C110. The minimum pressure rating shall be 200 PSI and meet all city or town standard specifications.

2. Stiffener inserts per ASTM 240 shall be used for all fittings and connections to HDPE pipe. Stiffeners shall be 304 stainless steel and be of wedge type design.

3. Service connection fittings shall be HDPE electrofusion type and/or mechanical saddles with a minimum working pressure of 100 PSI and per city or town specifications.

4. Pipe connection fittings shall meet AWWA C906 and meet or exceed the pressure requirements of the HDPE pipe.

2.4 Product Compliance

1. Certificate of compliance that the product pipe is per specifications in section 2.2 shall be supplied to the city or town.

2. All materials (in excess of those specified above in 2.4.1.) used with the coupling or connecting HDPE water main must be submitted and approved by the city or town.

2.5 Product Handling

1. Pipe transport and handling shall be per manufacturer's recommendation.

2. Product other than pipe must be stored and handled per manufacturer's recommendations.

2.6 Documentation and Planning

1. Contractor shall submit a plan to the city or town on a marked-up copy of the project drawings showing the contractor's construction phasing and plans at the pre-construction meeting. Plan details should include:

    a. Pit locations for pipe insertion and burst machine location;

    b. Pit locations for service reconnects;

    c. Schedule of when various sections are to be rehabilitated;

    d. Distances of each pull;

    e. Isolating points used to seal the system during the pipe burst;

    f. Chlorination/de-chlorination logs for each pipe section.

2. The project construction drawings provided by PWS shall be marked by the contractor to show actual locations of services, fittings, fire hydrants and other reconnects. These markups shall be done the day of the actual placement. A set of marked-up plans shall be returned to the PWS within 15 days of substantial completion of job.

3. Chlorination submission documents: At the start of the pipe pre-chlorination, the contractor must attach a log sheet, placed in a sealed waterproof envelope, to the pipe. This sheet makes up the chlorination submission documents and shall be delivered to the PWS at the same time as the marked-up construction drawing. Information on the log sheet shall at a minimum include:

    a. Date of swabbing

    b. Date of chlorinating and amount of chlorine used

    c. Date of samplings

    d. Results of sample tests

    e. Date of pipe installation

    f. Date of pressure test

    g. Makeup water details (if any)

    h. End test pressure

    i. Final pressure test results

j. Location of installation

2.7 Notification of Regulatory Authority

Prior to commencement of construction, the PWS and the contractor shall notify the MassDEP Regional Office. If all construction is performed in accordance with this operational guideline, and required state and local regulations has been followed, then no review is required by MassDEP; however, all construction specifications and drawings must be maintained on file for state review upon request.

2.8 Interruption of Service to End Users

1. Interruption of service to end-users shall be minimized. Outages shall be limited to 8:00 AM to 6:00 PM Monday through Friday. No interruption shall be permitted between 6:00 PM and 8:00 AM or on Saturday, Sunday or legal holidays without the approval of the city or town or owner.

2. Only one (1) line segment may be shut down for rehabilitation at any one moment.

3. End users shall be notified in writing (door hanger, flier, etc.) by the contractor in a manner approved by the MassDEP. General notice shall be provided seven (7) days in advance if possible. Detailed notice shall be provided at minimum permissible advance of 48 hours prior to service interruption.

2.9 Joining of Pipe

1. Fusing per butt fusion methods in strict conformance to the pipe and/or fusing equipment manufacturer's recommendations shall be used to join sections of HDPE pipe.

2. Fusing of 'sticks' of pipe shall be performed in the general vicinity of the pipe insertion pit or lay-down yard (staging area).

3. Pipe supplied by the pipe manufacturer in a coil may be fused remote from the pipe insertion pit.

4. Solvent cement joints performed by anyone other than the manufacturer are unacceptable for any HDPE pipe or fitting.

2.10 Pre-Chlorination of Product Pipe

Chlorination of pipes prior to bursting shall be carried out per ANSI/AWWA C651-99 standard for disinfecting water mains and in cooperation with the city or town's water maintenance department. Any information here shall facilitate that method when performed on pipes not yet placed on grade. In general, the method includes the following:

1. Disinfect all equipment, tools, end caps, pipe fittings or product that may contact pipe.

2. Disinfection shall be carried out by immersing or rinsing items in a sodium hypochlorous acid solution containing one to five percent chlorine measured by weight. See details of chlorination solution in section 2.11.

3. Product pipe shall be fused into a string of sufficient length to complete the designated section or be coiled in a manner suitable for delivery on a pipe reel. Maximum allowable length is 800 feet.

4. The surface upon which the product pipe rests during chlorination shall be relatively impervious, such as asphalt, concrete or stone, and free from visible contamination. Coiled pipe must be laid horizontally to allow all air to be expelled.

5. Swabbing, chlorination and testing of the inside diameter of the pipe shall be accomplished by:

    a. Swab being inserted at the lowest end of the pipe

    b. Calcium hypochlorite tablets or granules as described in section 2.11 shall be placed behind the swab.

    c. Pressure tight end cap shall be mounted to the low end of the pipe either by fusing or mechanically assembled to the pipe.

    d. Potable water shall be introduced through this end cap at a controlled rate such that the swab is propelled at a velocity less than or equal to one foot per second. All air is to be dispelled from the pipe.

    e. Upon discharge of the swab from the elevated end of the pipe, the elevated end shall be capped with a pressure tight seal. This seal having a tapped access hole at least 1.25 inches, in accordance with the American National Taper Thread (NPT) Standard, or incorporating the ability to leak (purge) air or water at will by adjustment of clamping bolts. Additional potable water should be added after capping to ensure that no air remains between the caps.

    f. Pressure testing of the pipe section should be performed per details in section 2.12 upon replacement of the second end cap.

    g. Chlorinated solution should be maintained in the pipe for a minimum of 24 hours prior to flushing when water temperature is above 41º F (5º C), 48 hours when water temperature is 41ºF (5º C) or less. Time for retention of the chlorinated solution shall not be significantly over designated holding time so as to prevent damage to the pipe or end caps.

    h. After designated holding time, the pipe shall be drained, flushed and filled with potable water so as to expel the highly chlorinated solution. The spent chlorinated solution shall not be allowed to enter any watershed, a sanitary sewer or any other area where environmental damage may occur without neutralizing it in accordance with local sewer ordinances. Flushing water shall be from a known drinking water source.

    i. Test samples shall be taken from each end of the pipe on consecutive days, 24 hours apart. Samples shall be tested by a state-certified lab within 30 hours of being taken.

    j. Failure of any sample to pass a bacteriological test should result in the related section of pipe being re-flushed and retested. Should any sample again fail, the section must be chlorinated before retest.

    k. Time before re-connection of a passing pipe section shall be limited to 14 days from the last sampling. After this time the pipe must be retested to be acceptable for use.

l. Drain the section of pipe prior to pipe bursting. The pipe shall be drained on the day of the pipe bursting, and sealed after draining and for the pipe bursting process.

m. Swabs should be designated by the manufacturer as suitable for potable water system use. Swabs are to be manufactured by Knapp Industries or be of equivalent design.

2.11 Chlorination Solutions

1. Acceptable forms of chlorine include calcium hypochlorite conforming to ANSI/AWWA B300, preferably in five-gram tablets, alternately in granular form. Material must be stored per manufacturer's recommendations.

2. Unacceptable forms of chlorine include calcium hypochlorite intended for swimming pool use.

3. Calcium hypochlorite tablets shall be placed behind the swab in quantity based on pipe size and length per ANSI/AWWA C651-99, *AWWA Standard for Disinfecting Water Mains.*

4. Calcium hypochlorite in granular form shall be placed behind the swab in quantity based on pipe size and length per ANSI/AWWA C651-99 *AWWA Standard for Disinfecting Water Mains.*

5. Solutions acceptable for pipe chlorination shall be acceptable for disinfection of equipment, tools, and caps, pipe fitting or product that may contact pipe.

6. Dilute chlorinated solutions over seven days old shall be disposed of properly and not used as a disinfection agent. See section 2.10(5.h.) for appropriate disposal.

2.12 Hydrostatic Pressure Testing

1. Maximum allowable test pressure, per AWWA Standards, shall be 1.5 times the pipe rated operating pressure (minimum test pressure 125 psi) at the lowest point in the section under test or that of the lowest rated pressure component such as flanges, valves, fittings, etc.

2. Air trapped in the product pipe must be purged before test.

3. At the discretion of the PWS, the test method used may be either a Monitored Make-up Water Test or a Non-monitored Make-up Water Test. Either test shall be performed above ground without fittings prior to pipe bursting. If damage to the product pipe occurs during bursting that requires a fused joint repair, the PWS may require re-test, with or without fittings after bursting.

4. Monitored Make-up Water Test shall be comprised of two stages.

   a. Initial expansion and stabilization stage: The initial test pressure is applied and the system is allowed to stand without make-up water during a two to three hour period. During this time the pipe is allowed to expand and stabilize.

   b. Test stage: After the stabilization is complete, the system is pumped back to test pressure and allowed to sit for two additional hours. Water is then added until the test pressure is attained. Water added shall not exceed that of Table 6.1.

5. Non-monitored Make-up Water Test shall be comprised of two stages.

a. Initial expansion and stabilization stage: The initial test pressure is applied and the system is allowed to stand without make-up water during a two- to three-hour period. During this time the pipe is allowed to expand and stabilize.

b. Test stage: After the stabilization is complete, the system is pumped back to test pressure and then reduced by 10 psi. The pressure shall remain steady, not falling more than five percent from reduced pressure during a one-hour test period.

c. Total time allotted for test shall not exceed eight hours. If successful test cannot be completed in this period, then the test section must be depressurized and allowed to relax for a minimum of eight hours before retest.

6. Re-test after repair. Should the PWS require re- test after repair, refer to Equation 6.2 for Leakage Allowance due to fittings for the Monitored Make-up Water Test.

7. Manifest shall be filled out with all pressure test results.

2.13 Replacing Asbestos Pipe

The Massachusetts Department of Environmental Protection, Drinking Water Program, prohibits the use of the pipe bursting technique on asbestos pipe.

3.0 Pipe Bursting Operation

The pipe bursting operation described within provides guidance on the basic process. It is to be understood that the need to make exceptions or additions to this process is common. These changes are made to accommodate non-standard conditions. The contractor experience requirements make it reasonable to put the responsibility of devising these exceptions upon the contractor.

3.1 Pit Location and Excavation

1. Burst pit and insertion pit locations shall be placed such that excavations are minimized. This may be accomplished by placing either or both of these pits at the point of a service connection.

2. Burst length shall be 400’ (+/-) 50’ in length for first two bursts. After soil pipe friction is evaluated longer burst runs may be performed.

3. All pits shall be shored to ensure worker safety per OSHA or other local regulations.

4. All pits shall be roped off and or covered when not active per OSHA or local regulations to ensure public safety.

5. Traffic control shall be accommodated by the contractor as per the contract specifications. Safe traffic passage around pit excavations that are located in or adjacent to streets or highways shall meet requirements of the city or town Right-of-way Department. Parking of related employee vehicles, trucks and auxiliary equipment shall be such that congestion and traffic delays are minimized.

6. Utilities intersecting the hosepipe shall be exposed using an excavation technique appropriate for the utility. This utility crossing pit shall exist prior to commencement of bursting. Man entry shoring is not required; however, appropriate safety precautions should be made.

3.2 Bursting Machine Location and Shoring

Bursting machines of the static pull style require preparation and planning for the bursting pit that they are to operate from.

1. Burst pit shall be shored in accordance to 3.1 (c).

2. Forward face of the burst pit or the surface that the machine bears against while pulling back, shall be shored in workmanlike manner. This shoring shall maintain perpendicular burst machine alignment to the pipe during pullback. Any loss of perpendicular alignment during pull shall result in stopping of the bursting process and improvement of the forward face shoring must occur.

3. Rearward shoring shall be provided to react to rod thrust forces during payout. While these forces are substantially lower than pullback forces, shoring must be used to stabilize the bursting machine so as to maintain perpendicular alignment of the machine during payout. The weight of the machine cannot be depended on to react to thrust forces. Hosepipe at rear face of pit may only be utilized for rearward shoring if scheduled for replacement.

4. Pipe face for cast iron, ductile iron or PVC shall be cut off using a saw or similar device to produce a square face for the bursting machine forward face to bear against. Final separation of cast iron pipe with a wedge may provide a clean face. Host pipe shall be removed in sufficient length to accommodate burst machine.

5. Burst machine must be positioned so as to have rod centerline at approximate centerline of host pipe.

6. Rod box delivery and removal between temporary rod storage location and burst pit must be accommodated with appropriate lifting equipment and techniques. Additionally, movement and/or placement of lifting machine must be included in traffic control plans.

3.3 Rod Payout Operation

1. Rod payout is the process of assembling a string of rods and pushing them in a step-wise manner from the burst pit, through the interior of the host pipe to insertion pit.

2. Lifting of rod boxes into or out of the burst pit shall be performed per OSHA or other applicable requirements with respect to equipment and method.

3. Threads shall be cleaned of foreign matter before assembly.

4. Counting of rods during payout or quantity of rods per box shall be monitored such that the operator is aware of the distance between the burst machine and the lead end of the rod string.

5. Thrust force should be monitored by the contractor of the pipe-bursting machine. Should an unexpected sudden and significant increase in thrust force be experienced, the process shall be halted. The operator or contractor shall review the results of 3.3 (e.1) with the PWS to remedy per 3.3 (e.2) in an attempt to determine if offsets, valves or other features or obstruction exist that may cause the rod string to leave the pipe.

    a. Front end of the rod string should be located by distance from the burst pit. Location should be painted and compared to as-built plans.

    b. Appropriate action should be taken to remedy the cause. This action may include an additional pit at the obstruction to determine the cause, and removal of or accommodation for the obstruction. The decision may be to continue thrusting if the obstruction is believed to be encrustation.

6. Host pipe in the insertion pit shall be cut or broken prior to arrival of the rod string. Sufficient length shall be removed so as to allow the burst tooling to enter the host pipe and bend the product within the allowable radius specified by the pipe manufacturer. The second end of the pipe in the insertion pit shall be positioned or worked so as not to damage the product pipe as it travels through the insertion pit.

7. Workmen shall not enter the insertion pit when the rod string is nearing the pit. A workman shall be in visual or radio contact with the burst machine operator so as to have the payout halted in a position that allows attachment of the burst tooling. Style shall be chosen based on anticipated properties of pipe and pipe repairs.

    a. Cast iron host pipe anticipated to be free of either ductile iron repair sections or dresser style couplings may use a simple conical burst head with a single or double longitudinal blade.

    b. Ductile iron, PVC or host pipe with ductile iron repair sections or dresser style couplings require use of a rolling blade cutter (slitter) ahead of the conical expander.

3.4 Tooling and Attachment

1. The product pipe shall be moved into position for attachment to the rod string. Appropriate traffic or pedestrian control will be exercised along the path of the product pipe.

2. The lead and second rod shall be painted orange or yellow so as to give notice to the burst machine operator position of the burst tooling.

3. Attachment of the burst tooling to the rod shall be through the use of removable pin joint allowing the tooling to pivot at least 46 degrees to the rod axis.

4. Burst head diameter must be a minimum of 15% over-size to the outside diameter of the product pipe. Actual size is left to the discretion of the contractor. A greater outside diameter allows for reduced pipe friction and increases bursting forces pushed and increases solid pipe placement.

5. Attachment of the product pipe to the burst tooling shall be with a swivel that permits rotation to relieve torsional (twist) stress on the product pipe.

6. Burst head shall slide on the rod string such that the rear of the burst head overlaps the forward end of the product pipe to eliminate the chance of damage to the product pipe.

3.5 Pullback Operation

1. Prior to commencement of pullback, there will be visual or radio contact between observers stationed adjacent to the insertion pit, the burst machine operator and a product pipe observer stationed strategically along the length of the product pipe to watch for product pipe entanglement with above-ground obstructions.

2. The burst machine operator will begin the pullback with the approval of the insertion pit observer. Progress will be made at a slow rate until the observer sees the burst tooling has completely entered the host pipe.

3. Pipe progress will be monitored for the first 20 feet of pullback by the insertion pit observer and the product pipe observer.

4. As the burst tooling nears any utility crossing pit, an observer in radio or visual contact with the burst machine operator will monitor and control movement of the burst tooling past the utility.

5. Should the forward shoring upon which the bursting machine bears yield sufficiently to bring the bursting machine out of square to the host pipe, the shoring will be reworked according to 3.2 (b).

3.6 Tooling Removal

1. Burst machine operator shall note rod count and anticipate entry of painted rods into the burst pit. As the pin joint connection nears the burst machine forward face, the burst is to be halted. Load on the forward face is relieved by reversing the rod direction slightly.

2. The burst machine shore plate is to be removed, allowing the tooling to enter a cage or the hull of the burst machine. The tooling string will be disassembled and removed, in sections if necessary, until the product pipe face has been pulled beyond the face of the burst pit. The distance past the face of the burst pit shall be at the discretion of the contractor anticipating the length required for connection/fusing.

4.0 After Pipe Bursting

Upon completion of the pipe bursting, certain tasks must be followed through in order to complete the overall process.

4.1 Pit Condition Prior to Taps or Joining System

1. Maintaining sanitary conditions within the product pipe after pipe bursting must take high priority. Should any foreign matter, including groundwater, be allowed to enter the pipe interior, the condition of the pipe is no longer suitable for connection to the system. For this reason connections may not be made in standing water. Such water must be pumped or bailed prior to making the connection or unsealing the pipe. Areas under connections should be excavated below the pipe invert.

2. Before joining a surface and before any special surface preparation to accommodate that joining, external surfaces should be clean and dry. Dust may be removed by wiping with clean, lint-free cloth. Heavier deposits must be washed from the surface with soap and water and dried with a clean, lint-free cloth.

3. Incidental exposure of the interior of the pipe to any foreign matter shall require that one of the two following remedies be carried out:

    a. Complete chlorination per AWWA specifications for buried pipe.

    b. Localized contamination at the end of the pipe may be removed and the contaminated interior surface of the pipe wiped with a solution of 1-to-5% hypochlorite disinfecting solution. However, disinfection of the entire main must be performed upon complete installation of the pipes.

4.2 Service Taps and Service Lines

1. Service taps shall be of a type approved by the PWS and must meet AWWA standard C906. Construction of taps shall be per the manufacturer's recommendation. Acceptable choices include:

    a. Electrofusion type and/or mechanical saddles with a minimum working pressure of 100psi;

    b. Socket fusion.

2. Replacement or rehabilitation of service lines, if required, shall be according to the contract. Note: HDPE pipe is the preferred material for service line replacements to curb stops.

4.3 Post Chlorination

The section of main will be super-chlorinated to 300 ppm by inserting a swab at one end. The swab shall travel the entire length of the pipe section.

4.4 Service Reinstatement

Prior to connection of the newly installed pipe, the section of pipe shall be fully flushed with the use of a de-chlorination unit and ascorbic acid to neutralize the residual chlorine. Following flushing, the newly installed section may be connected to the main at both ends and service reinstated.

4.5 Backfill and Surface Reinstatement

1. Backfill used to restore pits shall be per sewer and water construction standards applicable in the municipality.

2. Lawn restoration shall be per applicable sewer and water construction standards applicable in the city or town.

3. Asphalt, concrete or other roadway surface restoration shall be per applicable sewer and water construction standards in the city or town.

4.6 Documentation Finalization

Within (15) days of completion of the job, all records including manifests, marked up construction plans or documents pertinent to describing the system as installed shall be provided to the PWS.

4.7 Recommendations

1. The contractor must be prepared to work with the PWS to resolve any owner concerns during construction.

2. Any contractor proposing to perform these methods on the project must meet the experience requirements listed, provide detailed references, and meet any other requirement requested by the public utility.

3. All replacement projects must obtain all necessary construction permits before the project is started.

4. Before installing the new pipe, the pipe will be disinfected in accordance with AWWA Standard C651-99. If the pipe passes the manufacturer's pressure test requirements and the two consecutive bacteriological samples (collected 24 hours apart) are reported as non-detected from a certified lab, the pipe may be installed via the pipe bursting procedure.

5. After the new pipe has been installed, the pipe will be re-chlorinated using a slug method where a 300 mg/L of chlorine solution will be slowly moved through the new pipe. After the chlorine solution has been removed from the pipe, another bacteriological sample must be collected.

6. After re-chlorination in accordance to AWWA Standard C651-99, flush the mains. After flushing mains, it is important to maintain the proper disinfectant residual concentration for safety.

5.0 Definitions

Authority: City, town, private utility, or its utility engineer representative, that is the owner of the project.
AWWA: American Water Works Association, see www.awwa.org
ASTM: American Society for Testing and Materials, see www.astm.org

Burst head: Conical-shaped portion of burst tooling used to expand fractured pipe and surrounding soil to accommodate product pipe.
Burst pit: Excavation where static pull pipe bursting machine is located. The product pipe is pulled toward this pit.
Burst tooling: Tooling designed to crack the host pipe, expand the remains of the host pipe and surrounding soil so as to allow passage of the product pipe.

Chlorination submission documents: Written log attached to section of pipe detailing processes related to Pre-Chlorination and Hydrostatic Testing.

Dresser coupling: Commonly used repair coupling, see www.dressercouplings.com
Ductile Iron Pipe: Centrifugally cast pipe with superior tensile and yield strength, high ductility (malleability) and impact resistant properties.

Electrofusion: Joint or saddle that connects two sections of HDPE pipe. These joints contain internal heating elements to facilitate a heat-fused joint.

HDPE: High Density Poly-Ethylene, plastic material from which product pipe is manufactured.
Host pipe: Existing pipe buried in the ground that will be rehabilitated by bursting (cracking) and pulling in a new replacement pipe (product pipe).

Insertion pit: Excavation where product pipe enters the host pipe and bursting begins. Product pipe is pulled through the insertion pit towards the burst pit. Nominal depth of insertion it is 2.5 to 3.0 times depth of host pipe.

Manifest: Written log attached to section of pipe detailing processes related to Pre-Chlorination and Hydrostatic Testing.

Product pipe: Newly installed pressure pipe made from HDPE.
PPI: Plastic Pipe Institute, see www.plasticpipe.org.

Rod string: Assembled string of rods that extend from burst pit to insertion pit and serve to transmit tensile pullback forces to burst tooling.

Utility crossing pit: An excavation created at any point where another buried utility crosses the burst path.

6.0 Tables and Equations

6.1 Makeup Water Allowance Table

Nominal Pipe Size in Inches	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**30**
Makeup Water Allowance (gallon/100 ft)	**0.1**	**0.2**	**0.6**	**1.0**	**1.3**	**2.3**	**2.8**	**3.3**	**4.3**	**5.5**	**7.0**	**8.9**	**12**

6.2 Leakage Allowance Due to Fittings for the Monitored Make-up Water Test-Equation

$$L = [(N)(D)(P^{0.50})]/[(7400)]$$

Where:
L = Maximum allowable leakage, gallons/hour
N = Number of joints in the tested pipe (connections for pipes or fitting, not fuse joints)
D = Nominal inside diameter of pipe; Inches
P = Test Pressure, PSI