PIPE BURSTING TECHNICAL SPECIFICATIONS

1.0 GENERAL

This section specifies the system, method, or process to include all labor materials, tools, equipment and incidentals necessary to provide for the complete rehabilitation/replacement of deteriorated pipe by the Pipe Bursting System. Pipe bursting is the construction technique of replacing an existing, underground pipe system in situ by simultaneously "bursting" the existing pipe and installing a new pipe in its place. Essentially, the process involves the use of a static "moling" device, suitably sized to break out the old pipe with flared plug that bursts the existing pipe. Forward progress of the "mole" shall be aided by the use of hydraulic static pull method. The replacement pipe is either pulled or pushed into the bore. The method allows for the replacement pipe size on size from 2-inch through 36-inch and/or upsizing in varying increments up to 36 inches.

2.0 QUALITY ASSURANCE

2.1 Certification:
The Contractor shall provide qualifications to the representative upon request evidence of competency and authority to perform pipe bursting. The qualifications shall at a minimum include the following:

2.2 Pipe Bursting Experience:
The Contractor shall have a minimum of four (4) years of experience in the pipe bursting business and a record of at least eight (8) miles of pipe bursting using the hydraulic static pull method and pre-chlorination. The Contractor must be approved in pre-chlorination by the state of Wisconsin Department of Natural Resources, Florida DEP and certified by the Florida section of the AWWA in pre-chlorinated pipe bursting.

2.3 Pipe Bursting Certification:
The Contractor shall be trained by the pipe bursting equipment manufacturer in the use of the equipment for pipe bursting.

2.4 Pipe Bursting Patent:
The Contractor shall be licensed for the use of the pipe bursting technology patent.

2.5 Thermal Fusion Training:
The Contractor shall be trained by the thermal fusion equipment manufacturer in the use of the equipment for thermal butt-fusion/electrofusion of high-density polyethylene (HDPE) pipe.

2.6 Contractor License:
The Contractor shall be a licensed Contractor by the State of Wisconsin as a Certified Underground Utility Contractor or Master Plumber.

3.0 MATERIAL SPECIFICATIONS

3.1 Pipe

Polyethylene Plastic Pipe shall be AWWA C906 high-density polyethylene pipe (HDPE) characterized by ASTM F714 and NSF 61. HDPE resin shall be PE3408 resin characterized by ASTM D3350. All pipes shall be made of virgin material. No rework except that obtained from the manufacturers own production of the same formulation shall be used. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters or other deleterious faults. Prior to construction, Contractor shall submit for approval, the manufacturer's specific technical data with complete information on resin, physical properties of pipe and pipe dimensions pertinent to the job. A certificate of "Compliance with Specification" shall be furnished for all materials to be supplied. Dimension Ratios: The minimum wall thickness of the polyethylene pipe shall meet pipe manufacturers recommendations. Per ASTM specification F585, any abrasion, cuts or gouges less than 10% of the wall thickness of the pipe will be acceptable for use; any abrasion, cuts or gouges greater than 10% of the pipe will need to be cut out and repaired. The HDPE pipe shall be easily identifiable with a minimum of one stripe integrally extruded longitudinally in the exterior of the pipe wall or be of a solid color according to the County color applicable to the service. Mains for gravity sewer applications shall be gray color for ease of viewing when televising.

3.2 Fittings

Fittings for pressure systems shall be ductile iron with a minimum working pressure rating of 100 psi using HDPE MJ adapters to transition from the HDPE pipe to the fitting. At locations were bends are required pre-cast thrust blocks shall be installed.

3.3 Stiffeners Inserts

Stainless steel stiffener inserts, ASTM 240, shall be used for all fittings and connections to HDPE pipe. Stiffeners shall be of SS 304, wedge-type design.

3.4 Service Connections

Service connection fittings for pressure systems shall be HDPE electrofusion type fittings with a minimum working pressure rating of 100 psi. Service saddles shall be self-tapping and sealing. Double-strapped ductile iron body service saddles may be used in lieu of electrofusion type.

4.0 EXECUTION

4.1 Materials Handling

The Contractor is required to transport, handle and store pipe and fittings as recommended by the manufacturer. No materials shall be dumped, dropped, pushed or rolled into a trench. Pipe may be pulled longitudinally into the trench after fusion of the pipeline. Pulling of the main shall be accomplished by mechanical action during pipe bursting operations.

4.2 Pipe Bursting

Prior to commencement of the construction, the Contractor shall submit to the Contractor a pipe bursting plan which shall minimally include pit locations and schedule, service line replacement, bursting distances and directions, and service outage and reinstatement schedule.

Pipe bursting shall be accomplished using the hydraulic method. In general, the bursting operation shall be as follows:

- Post notices of service interruption and outages as indicated in the pipe-bursting plan.
- Isolate the existing system and excavate launch, bursting, and service pipes as indicated in the pipe-bursting plan.
- Construct placement service lines.
- Set up the bursting equipment in the bursting pit and insert the bursting rods or cable through the host pipe.
- Connect the bursting head to the main and the bursting rods or cable in the launch pit.
- Burst the existing main.
- Install new service connection fittings and connect new service lines.
- Flush the new main then connect the new main to the existing system; and
- Continue this series of operation to complete the full scope of burstings.

4.3 Launching and Bursting Pit

Pits shall be strategically located along the alignment of the pipe to be burst to minimize the quantity of pits. The Contractor shall prepare a pit location schematic illustrating the planned pit locations and schedule for pit excavation, backfilling and restoration. The duration that pits are open shall be kept to a minimum. Pit locations shall consider locations of existing and proposed valves, hydrants, fittings, services, and isolating sections of the existing system to minimize service interruption to customers. Where it is necessary to excavate, the Contractor shall furnish and install trench shoring or bracing in compliance with OSHA standards.

4.4 Service Pits

Pits shall be required to install service connection fittings and reconnect services to the newly installed pipe.

4.5 Service Line Replacement

The pipe bursting plan shall include the schedule for replacing service lines and method for replacing lines (bursting existing service lines and /or moling new service lines).

4.6 Bursting Distance and Directions

The Contractor shall include in the pipe bursting plan distances and directions of the bursts to be performed.

4.7 Service Outage and Reinstatement

The Contractor shall minimize service interruption to customer. Service outage shall be strictly limited to the hours of 8:00 AM to 6:00 PM, Monday through Friday. No service interruption shall be allowed from 6:00 PM to 8:00 AM, Monday through Friday or at all on Saturdays, Sundays, or legal holidays. The pipe bursting plan shall include the days and hours planned for service outage and reinstatement to each customer.

NOTE: If off hours bursting is anticipated, special permission must be obtained. The Contractor shall coordinate with the Contractee and post notices to the customers with a one week notice if applicable and a minimum of 48 hours prior to service interruption.

4.8 Pit Contamination Prevention

Pits shall be kept as dry as possible and shall be excavated to at least one foot below the pipe invert to minimize the potential for contamination during connection of the new main valves, fittings, and services.

4.9 Pipe Jointing

Sections of polyethylene replacement pipe shall be assembled and joined on the job site above the ground. Jointing shall be accomplished by the heating and butt-fusion method to provide a leak proof joint in strict conformance with the manufacturer's printed instructions. Threaded or solvent-cement joints and connections are not permitted. The Butt-fusion method for pipe jointing shall be carried out in the field by certified operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer. These joints shall have a smooth, uniform; double rolled back bead made while applying the proper melt, pressure, and alignment. It shall be the sole responsibility of the Contractor to provide an acceptable butt-fusion joint. WHO shall make all joints available for inspection before the insertion. The replacement pipe shall be joined on the site in appropriate working lengths near the insertion pit.

4.10 Joining and Connections

Before joining and before any special surface preparation, surfaces must be clean and dry. General dust and light soil may be removed by wiping the surfaces with clean, dry, lint-free cloths. Heavier soil may be washed or scrubbed off with soap and water solutions, followed by thorough rinsing with clean water, and drying with dry, clean, lint-free cloths.

4.11 Cutting Pipe

Joining methods for plain end pipe require square-cut ends. Pipe cutting is accomplished with guillotine shears, run around cutters, and saws.

4.12 Cutting Branch Outlet Holes

Except for self-tapping saddle tees, hole cutting is required for field installed side outlet fittings. Polyethylene pipe hole saws shall be used.

4.13 Heat Fusion Joining

Heat fusion joining is the process where mating surfaces are prepared for joining, heated until molten, joined together, and cooled under pressure. All fusion procedures require appropriate surface preparation tools, alignment tools, and temperature controlled heating irons with properly shaped, non-stick heater faces. An open flame cannot be used for heating because it oxidizes the surface and prevents bonding. During joining, all heat fusion procedures require the mating components to be moved several inches apart to accommodate surface preparation and surface heating tools. All fusions shall be constructed in strict accordance with pipe and fitting manufacturers' recommendations.

4.14 Socket Fusion

Socket fusion shall be used with ½ inch through four-inch pipe and fittings.

4.15 Saddle Fusion

Saddle fusion outlets may be used for eight-inch and smaller outlets applied to twelve-inch and larger mains. Larger outlets for larger main sizes shall be factory fabricated.

4.16 Butt Fusion

Butt fusion joints shall be field constructed between pipe and fittings. Fusion may occur in the trench.

4.17 Electrofusion

Electrofusion is a heat fusion process where a coupling or saddle fitting contains an integral heating source. After surface preparations, the fitting is installed on the pipe, and the heating source is energized. During heating, the fitting and pipe materials melt, expand, and fuse together. Heating and cooling cycles are automatically controlled.

5.0 RECORD DRAWINGS

Services, fittings, fire hydrants and all other reconnections to the replaced pipes shall be identified and marked in the construction drawings by the Contractor. The Contractor shall be responsible for marking the construction drawings in reference to at least two fixed and easily found points. The Contractor shall submit to the Contractee record drawings within 15 calendar days from the date of completion of the job.

6.0 GRAVITY LINES PIPE BURSTING

6.1 Pre-Installation Video Inspection

It shall be the responsibility of the Contractor to video inspect the main prior to pipe bursting to assure that exiting pipe conditions are acceptable for pipe bursting, and to locate all active service line connections. This inspection as well as the video inspection after the installation shall be paid for as per bid item. Contractor shall provide one copy of each video inspection to the Contractee.

6.2 Post-Installation Video of Completed Sections

The Contractor shall provide the Contractee a color video tape taken by a pan and tilt camera that pans 275 degrees and rotates 360 degrees for close up view showing the completed work, including the condition of the restored service connections. This shall be paid for as per bid item.

6.3 Bypassing Sewage

In wastewater applications, when required for acceptable completion of the pipe bursting, the Contractor shall provide for continuous sewage flow around the section(s) of pipe designated for pipe replacement. The pump bypass discharge lines shall be rigid of adequate capacity and size to handle flow, solid PVC with socket welds or HDPE butt-fused. Lay flat piping may be used when permitted by the Contractee. Prior to disassembling the discharge piping, the piping shall be flushed with clean water in its entirety. The cost for flushing operations and water shall be incidental to the bypass piping.

When bypassing conditions require overnight or non-working days operation, a standby bypass pump of the same size as the primary pump shall be on-site ready for emergency use in the event that the primary pump fails. Payment for the standby pump shall be in accordance with the pay item for bypass system.

6.4 Sags in Line

If pre-installation video inspection reveals a sag in the existing sewer that is greater than one-half the diameter of the existing pipe, it shall be the Contractor's responsibility to install the replacement pipe to the result in an acceptable grade without the sag. The Contractor shall take in necessary measures to eliminate these sags, as directed by the Contractee. Pipe replacement, digging a sag elimination pit, and bringing the bottom of the pipe trench to a uniform grade in line with existing pipe invert or by other measures that shall be acceptable to the Contractee. Payment shall be as per bid item.

6.5 Sealing and Benches in Manhole

The replacement pipe shall be installed with a tight fitting seal with the existing or mew manhole. A Fernco CMA Water Stop Gasket or approved equal shall be placed circumferentially on the replacement pipe and encased with cementitious non-shrink grout to prevent inflow at the manhole. The top half of the pipe within the manhole shall be neatly cutoff and not broken or sheared off, at least four inches away from the manhole walls. The channel in the manhole shall be a smooth continuation of the pipe(s) and shall be merged with other lines or channels, if any. Channel cross-section shall be U-shaped with a minimum height of half pipe diameter to three-fourths of the pipe diameter for fifteen inches and larger. The side of the channels shall be built up with mortar/concrete, as specified, to provide benches at a maximum of one in 12 pitch towards the channel.

The replacement pipe in the manhole shall be sealed as specified above before proceeding on to the next manhole section and all manholes shall be individually inspected for replacement pipe outfalls, benches and sealing.

Where excavations for the insertion of the replacement pipe are made between two manholes, the ends of the pipe will be cut smooth and square to the axis so that it can by joined in a workman like manner such that both ends meet and touch uniformly and continuously. A full circle repair clamp (Smith-Blair or approved equal) shall be used. Minimum clamp length shall be 24 inches.

6.6 Sewer Service Laterals and Connections

Existing service connections shall be located before initiating sewer main replacement operations. Service laterals shall be reconnected to the new sewer line after replacement and before video inspection is completed. Any services remaining off line for an extended period of time, or any connections as deemed necessary by the Contractee to protect the customer, shall be bypass pumped until such time that they can be reconnected.

Connection of the new service lateral, green color (ASTM D-3034 SDR 35 PVC Pipe) to the new sewer main shall be accomplished by use of the watertight compression-fit service connection. The service connection shall be specifically designed for connection to the HDPE sewer main being installed, and shall be INSERTA TEE, as manufactured by Insert Tee Fittings, Inc., Hillsboro, Oregon, or an approved equal.

Surface materials to be removed for excavation purposes shall be replaced to the condition they were prior to excavation. Affected grassed area shall be sodded.

7.0 PIPE BURSTING OF PRESSURE MAINS

Sewer Service Laterals and Connections

Existing service connections shall be located before initiating main replacement operations. Service laterals shall be reconnected to the new line after replacement, flushing and pressure testing is completed. For wastewater applications, any tie-ins remaining offline for an extended period of time, or any connections as deemed necessary by the Contractee to protect the customer, shall be bypass pumped until such time that they can be reconnected. For bypassing requirements refer to Section 6.0 above.

Connection of the new services to the new main shall be accomplished by use of electrofused HDPE self-tapping saddles. All piping, fittings and accessories shall have a 100-psi minimum working pressure.

Surface materials to be removed for excavation purposes shall be replaced to the condition they were prior to excavation. Affected grassed area shall be sodded.

8.0 PIPE BURSTING OF POTABLE MAINS WITH PRE-CHLORINATED PIPE

8.1 Pipe Pre-chlorination

Pipe shall be pre-chlorinated and cleared for use in accordance with requirements specified herein. Given the essence of time for using a cleared pipe and placing it into service, the bursting plan shall include a schedule for testing, clearing, and installation of the mains. As part of the pipe bursting plan, the Contractor shall include which pipes will be provided on reels and sticks. Lengths and diameters of pipes on reels and sticks shall be included.

Pre-chlorination is the quality assurance technique required when replacing an existing potable water system in-situ by pipe bursting without a temporary bypass main. Pre-chlorination minimally includes pressure testing, chlorination, swabbing, and bacteriologically clearing a pipe for potable use prior to installation of new pipe. AWWA standard C651-99, Section 4.6.2, applies to "pre-disinfected" pipe.

The pre-chlorination method described below is consistent with the requirements of AWWA Standard C651, Section 4.6.

8.2 Chlorination

Chlorination solutions used for disinfecting equipment and pipe shall contain one percent to five percent chlorine, as measured by weight. Acceptable solutions my be prepared from liquid chlorine (100% available chlorine by weight), sodium hypo chlorite conforming to ANSI/AWWA B300 (5% to 15% available chlorine by weight), or calcium hypo chlorite conforming to ANSI/AWWA B300, available in granular or five-gram tables (65% available chlorine by weight). Calcium hypo chlorite intended for swimming pool disinfections is strictly prohibited.

8.3 Disinfection of Equipment and Tools

All tools and equipment used for pre-chlorination and pipe bursting that may contact pipe, service lines, or fittings shall be disinfected with a hypochlorous solution containing one percent to five percent chlorine, as measured by weight.

8.4 Preparing the Pipe (Coil or Sticks)

An area to prepare the new pipe for pre-chlorination shall be of relatively impervious surface (asphalt, concrete, or stone) and free from visible contamination. When using coiled pipe, the coil shall be laid on its side to ensure expelling of all air within the coil.

8.5 Swabbing, Pressure Testing and Chlorinating

The pipe shall be assembled and tested in lengths not to exceed 1,200 lineal feet. A poly swab shall be inserted into the low end of the pipe. Instant-dissolve tablets, or equivalent, shall be inserted behind the poly swab. The quality of tablets shall be sufficient to develop a minimum available chlorine concentration of 25 mg/L. The pipe shall then be filled slowly with potable water to dissolve the chlorine tablets, propel the swab through the pipe and ensure all air is expelled from the pipe. The introduction of water into the pipe shall generate less than one foot per second velocity. Once the pipe swab is discharged from the high end of the pipe, a tapped watertight cap shall be placed on the high end of the pipe. Additional water shall be introduced into the pipe to ensure the pipe is completely full of water and all air is expelled. The pipe shall then be

pressure tested as per the recommendations for testing HDPE pipe. The highly chlorinated solution shall be maintained in the pipe for at least 24 hours. After 24 hours, the pipe shall be drained, flushed and filled with potable water to expel the highly chlorinated solution.

At least one sample shall then be taken each day for two consecutive days from each end of the pipe. All samples shall be bacteriologically tested by a State certified laboratory. Consecutive samples shall be taken at least 24 hours apart. The maximum holding time of a sample prior to analysis shall be 30 hours.

8.6 Poly Swab

Poly swabs used for swabbing pipe shall be suitable for use in potable water systems and shall be as manufactured by Knapp Industries or equal.

8.7 Manifest

Once the required samples have been tested and found to be satisfactory, the pipe shall be stored hygienically with both ends sealed watertight. A manifest shall be affixed to the pipe stating the dates of swabbing, chlorinating, sampling and test results of the samples.

8.8 Timely Use of Pipe

The pipe shall be installed within 14 days of the first day of sampling. If it is not, then the pipe shall be re-sampled and tested for bacteriological purposes in accordance with the preceding procedures. On the day of intended use of the pipe, water shall be drained from the pipe. The pipe shall be connected to the bursting head and installed by pipe bursting.

8.9 Method Two: Pre-chlorination Procedure for Rehabilitation of Existing Water Lines

This procedure outlines the steps to be followed when pre-chlorination of the new water line is used to enable the process of pipe bursting to replace an existing water supply line. All work shall be carried out as hygienically as practicable in accordance with applicable specifications, procedures, codes, regulations and laws of governing Wisconsin regulatory authorities, as applicable and the American Water Works Association with all reasonable steps being taken to avoid contamination of water supplies. It is essential that all precautions be taken in order that water quality is maintained and standards are not compromised.

Ensure all persons are fully qualified, medically cleared to work on restricted operations and are fully competent in company procedure of hygiene.

Throughout this section, the ANSI/AWWA C651-99, AWWA Standard for Disinfecting Water Mains is referenced in detail to provide as a guide for the process of chlorination of replacement water mains.

As referenced in Section 4.2 Basic Disinfection Procedures, the basic disinfection procedure consists of:

1. Inspecting all materials to be used to ensure the integrity of the materials.
2. Preventing contaminating material from entering the water main during storage, construction, or repair and noting potential contamination at the construction site.
3. Removing, by flushing or other means, those materials that may have entered the water main.

4. Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
5. Protecting the existing distribution system from backflow caused by hydrostatic pressure test and disinfection procedures.
6. Documenting that an adequate level of chlorine contacted each pipe to provide disinfection.
7. Determining the bacteriological quality by laboratory test after disinfection.
8. Final connection of the approved new water main to the active distribution system.

Check with the water supplier's system operations team for potential problems that may occur to the flow patterns during the work.

Sample incoming water upstream of the pipe bursting project at the customer's tap to determine that existing water quality is satisfactory. As a guide, it is recommended to take samples at least 10 working days before the project is started. This will allow 3 days for the bacteriological sample to pass and 7-day card warning notice to be sent to the affected customers. A 48-hour warning card will also be delivered to notify the customers of the actual time water supplies will be interrupted.

Disinfecting

An appropriate solution for disinfecting of tools, equipment, fittings and materials to be used in pipe bursting is made of a minimum 1-5% of available chlorine, as referenced below.

4.7.2 *Swabbing with hypochlorite solution*. The interior of all pipe and fittings (particularly couplings and sleeves) used in making the repair (or in this method) shall be swabbed or sprayed with a 1% hypochlorite solution before they are installed.

Fresh solution should be made regularly as dilute chloros solutions deteriorate after 7 days. Old solutions should be disposed of after de-chlorination. No chlorinated water shall be discharged to a water course or surface drain.

Disinfecting should be carried out using hand held spray equipment and care taken to ensure the whole surface is treated.

All tools and equipment to be used in contact with water shall be disinfected using the appropriate strength chlorine solution detailed above with hand held spray equipment. Special care needs to be taken with hired in equipment to ensure that no contamination risk is present and off site washing may be necessary before disinfecting prior to use. All fittings and materials used in pipe bursting shall be stored hygienically and reasonable measures taken to exclude vermin, debris or dirty water. Ensure all fittings and materials are disinfected before installation with hand held spray equipment using the appropriate strength chlorine solution detailed above.

Preparation of the Coil

An area to prepare the new pipe for pre-chlorination shall preferably be of hard standing (asphalt, concrete or stone) which is free from any visible contamination.

When using coiled pipe it should be laid on its side rather than in a vertical position, making sure that air can escape.

One end of the coil shall be capped, then at the other end insert a clean swab. Next, install the correct amount of tablets for the size of pipe to be pre-chlorinated (tablets should be the instant dissolve type).

The forms of chlorine that may be used in the disinfection operations are liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets as referenced in Section 4.1 Forms of Chlorine for Disinfection, and is detailed as follows.

4.1.1 *Liquid chlorine*. Liquid chlorine conforming to ANSI/AWWA B301 contains 100% available chlorine and is packaged in steel containers usually of 100-lb, 150-lb, or 1-ton (45.4-kg, 68.0-kg, or 907.2-kg) net chlorine weight. Liquid chlorine shall be used only (1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water to be chlorinated; (2) under the direct supervision of someone familiar with the physiological, chemical, and physical properties of liquid chlorine who is trained and equipped to handle any emergency that may arise; and (3) when appropriate safety practices are observed to protect working personnel and the public.

4.1.2 *Sodium hypochlorite.* Sodium hypochlorite conforming to ANSI/AWWA B300 is available in liquid form in glass, rubber-lined, or plastic containers typically ranging in size from 1-qt (0.95 L) to 5-gal (18.92 L). Containers of 30 gal (113.6 L) or larger may be available in some areas. Sodium hypochlorite contains approximately 5% to 15% available chlorine and the storage conditions and time must be controlled to minimize its deterioration. (Available chlorine is expressed as a percent of weight when the concentration is 5% or less, and usually as a percent of volume for higher concentrations. Percent x 10 = grams of available chlorine per litter of hypochlorite.)

4.1.3 *Calcium hypochlorite.* Calcium hypochlorite conforming to ANSI/AWWA B300 is available in granular form or in 5-g tablets, and must contain approximately 65% available chlorine by weight. The material should be stored in a cool, dry, and dark environment to minimize its deterioration.

CAUTION: Tablets dissolve in approximately 7 hours and must be given adequate CT. Also, don not use calcium hypochlorite intended for swimming pool disinfection, as this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired CT has been achieved.

Finally, cap the other end (ensure the caps and pipe ends are disinfected using the appropriate strength chlorine).

Slowly charge the new pipe allowing the tablets to be distributed evenly. A free chlorine residual of 25 mg/L should be maintained for a minimum contact time of 24 hours, as referenced below.

4.4.2 Tablet method. The tablet method consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed (or before installation with this method) and then filling the main with potable water when installation is completed.

This method may be used only if the pipes and appurtenances are kept clean and dry during construction.

4.4.2.1 Placing of calcium hypochlorite granules. During construction (or before construction with this method), calcium hypochlorite granules shall be placed at the upstream end of the first section of pipe, at the upstream end of each branch main, and at 500-ft intervals. The quantity of granules shall be as shown in Table 1 detailed in the ANSI/AWWA C651-99 AWWA Standard For Disinfecting Water Mains.

WARNING: This procedure must not be used on solvent-welded plastic or on screwed-joint steel pipe because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite.

4.4.2.2 Placing of calcium hypochlorite tablets. During construction (or before construction with this method), 5-g calcium hypochlorite tablets shall be placed in each section of pipe. Also, one table shall be placed in each hydrant, hydrant branch, and other appurtenance. The number of 5-g tablets required for each pipe section shall be 0.0012 d L rounded to the next higher integer, where d is the inside pipe diameter, in inches, and L is the length of the pipe section, in feet. Table 2, detailed in the ANSI/AWWA C651-99, shows the number of tablets required for commonly used sizes of pipe. The tablets shall be attached by a food-grade adhesive (Please see footnote detailed in the ANSI/AWWA C651-99). There shall be adhesive only on the broadside of the tablet attached to the surface of the pipe. Attach all the tablets inside and at the tip of the main, with approximately equal numbers of tablets at each end of a given pipe length. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section to indicate that the pipe has been installed with the tablets at the top.

4.4.2.3 Filling and contact. When installation has been completed (or before installation with this method), the main shall be filled with water at a rate to ensure that the water within the main will flow at a velocity no greater than 1 ft/s (0.3 m/s). Precautions shall be taken to ensure that air pockets are eliminated. This water shall remain in the pipe for at least 24-h. If the water temperature is less than 41ºF (5ºC), the water shall remain in the pipe for at least 48 h. As an optional procedure (if specified by the purchaser), water used to fill the new main shall be supplied through a temporary connection that shall include an appropriate cross-connection control device, consistent with the degree of hazard, for backflow protection of the active distribution system (see Figure 1 in the ANSI/AWWA C651-99). A detectable chlorine residual should be found at each sampling point after the 24-h period. The results must be reported.

After thorough flushing the new pipe shall be sampled at each end at intervals of 1200 feet, only by fully qualified rehabilitation staff, who will then fill in a log book/passport form detailing the date, coil number and time the sample was taken. A copy of this form will also be taped to the coil to ensure the correct pipe is referred to.

As referenced in Section 5.1 Bacteriological Tests and Section 5.2 Redisinfection.

5.1.1 *Standard conditions*. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 h apart, shall be collected from the new main. (NOTE: The pipe, the water loaded into the pipe, and any debris all exert a chlorine demand that can interfere with disinfection.) At least one set of samples shall be collected from every 1,200-ft (366 m) of the new water main, plus one set from the end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality I accordance with *Standard Methods for the Examination of Water and Wastewater*; and shall show the absence of coliform organisms and, if required, the presence of a chlorine residual. Turbidity, pH, and a standard heterotrophic plate count or test may be required at the option of the purchaser, because new material does not typically contain coliform but does typically contain HPC bacteria.

5.1.2 *Special conditions*. If trench water has entered the new main during construction of if, in the opinion of the purchaser, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200-ft (61m), and the location shall be identified. Samples shall be taken of water that has stood in the new main for at least 16-h after final flushing has been completed.

5.1.3 *Sampling procedure*. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate as required by *Standard Methods for the Examination of Water and Wastewater*. No hose or fire hydrant shall be sued in the collection of samples. (NOTE: For pipe repairs, if no other sampling port is available, well-flushed fire hydrants may be used with the

understanding that they don not represent optimum sampling conditions.) A suggested combination blowoff and sampling tap used for mains up to and including 89-in. (200-mm) diameter is shown in Figure 2 of the ANSI/AWWA C651-99 Standard for Disinfecting Water Mains. There should be no water in the trench up to the connection for sampling. The sampling pipe must be dedicated and clean, and disinfected and flushed prior to sampling. A corporation cock may be installed in the main with a copper-tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

5.1.4 *Record of compliance*. The record of compliance shall be the bacteriological test results certifying that the water sampled from the new water main is free of coliform bacteria contamination and is equal to or better than the bacteriologic water quality in the distribution system.

5.2 Redisinfection. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained.

NOTE: High velocities in the existing system, resulting from flushing the new main, may disturb sediment that has accumulated in the existing mains. When check samples are taken, it is advisable to sample water entering the new main to determine the source of turbidity.

As referenced in Section 4.5 Final Flushing.

4.5.1 *Clearing the main of heavily chlorinated water*. After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with pipe. In order to prevent damage to the pipe lining or to prevent corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or that is acceptable for domestic use.

4.5.2 *Disposing of heavily chlorinated water*. The environment to which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the residual chlorine. Where necessary, federal, state provincial and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

Once two consecutive sets of acceptable bacteriological samples, taken at least 24 hours apart, have been obtained the coil must be stored hygienically with the ends sealed and secured to prevent tampering. The date and time of the cleared samples must be entered into the relevant logbook/passport sheet for that coil. The coil must be used within 14 days of clearance or it will need to be flushed and re-sampled.

Pre-Chlorinated Coil

When required for use, cleared coils will be drained and sealed at both ends using two-pressure test ends. Care must be taken to avoid contamination, and all fittings must be disinfected by spraying, using the chloros solution. The coil will be transported to site and used the same day.

Only coils with a valid log book/passport attached and which remain hygienically secure will be used for pipe bursting. Others will be returned for re-sampling.

It is vital during the on site construction to adhere to Section 4.3 Preventive and Corrective Measures During Construction.

4.3.1 *General*. Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing these organisms. Therefore, the procedures of this section must be observed to assure that a water main and its appurtenances have been thoroughly cleaning for the final disinfection by chlorination. Also, any connection of a new water main to the active distribution system prior to the receipt of satisfactory bacteriological samples may constitute a cross-connection. Therefore, the new main must be isolated until bacteriological tests described in Sec. 5 of this standard are satisfactorily completed.

4.3.2 *Keeping pipe clean and dry*. The interiors of pipes, fittings, and valves shall be protected from contamination. Pipe delivered for construction shall be strung to minimize the entrance of foreign material. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Rodent-proof plugs may be used when watertight plugs are not practicable and when thorough cleaning well be performed by flushing or other means.

4.3.2.1 Delay in placement of delivered pipe invites contamination. The more closely the rate of delivery is correlated to the rate of pipe laying the lower the risk of contamination.

4.3.3 *Joints.* Joints of all pipes in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

4.3.4 *Packing materials*. Yarning or packing material shall consist of molded or tubular rubber rings, rope of treated paper, or other approved materials. Materials such as jute or hemp shall not be used. Packing material shall be handled in a manner that avoids contamination. If asbestos rope is used, asbestos shall be prevented from entering into the water-carrying portion of the pipe.

4.3.5 *Sealing materials.* No contaminated material or any material capable of supporting prolific growth of microorganisms shall be used for sealing joints. Sealing material or gaskets shall be handled in a manner that avoids contamination. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water and shall not contribute odors. It shall be delivered to the job in closed containers and shall be kept clean and applied with dedicated, clean applicator brushes.

4.3.6 *Cleaning and swabbing*. If dirt enters the pipe, it shall be removed and the interior pipe surface swabbed with a 1 to 5% hypochlorite disinfecting solution. If, in the opinion of the purchaser, the dirt remaining tin the pipe will not be removed using the flushing operation, then the interior of the pipe shall be cleaned using mechanical means, such as a hydraulically propelled foam pig (or other suitable device acceptable to the purchaser) in conjunction with the application of a 1% hypochlorite disinfecting solution. The cleaning method used shall not force mud or debris into the interior pipe-joint spaces and shall be acceptable to the purchaser.

4.3.7 *Wet-trench construction*. If it is not possible to keep the pipe and fittings dry during installation, the water that may enter the pipe-joint spaces shall contain an available chlorine concentration of approximately 25 mg/L. This may be accomplished by adding calcium hypochlorite granules or tablets to each length of pipe before it is lowered into a wet trench or by treating the trench water with y hypochlorite tablets.

4.3.8 *Flooding by storm or accident during construction.* If the main is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the main is clean. The section exposed to the floodwater shall then be filled with chlorinated potable water that, at the end of a 24-h holding period, will have a free chlorine residual of not less than 25 mg/L. The chlorinated water may then be drained or flushed from the main. After construction is completed, the main shall be disinfected using the continuous-feed or slug method.

4.3.9 *Backflow protection (optional)*. As an optional procedure (if specified by the purchaser), the new water main shall be kept isolated from the active distribution system using a physical

separation until satisfactory bacteriological testing has been completed and the disinfectant water flushed out. Water required to fill the new main for hydrostatic pressure testing, disinfection, and flushing shall be supplied through a temporary connection between the distribution system and the new main. The temporary connection shall include an appropriate cross-connection control device consistent with the degree of hazard (a double check valve assembly or a reduced pressure zone assembly) and shall be disconnected (physically separated) from the new main during the hydrostatic pressure test. It will be necessary to reestablish the temporary connection after completion of the hydrostatic pressure test to flush out the disinfectant water prior rot final connection of the new main to the distribution system. NOTE: Exposure to high levels of chlorine of high pH can cause severe irritation to customers. Also, the chlorinated water can be high in disinfection by-products.

Access holes should be kept as dry as possible, the excavation being taken 12" below the pipe invert to prevent ingress of contamination. The existing main shall be cut and capped at the access holes and the services disconnected. All fittings, including the internal surfaces of the existing main, shall be sprayed using the dilute solution of freshly prepared chloros of 1-5% of available chlorine.

A clean chloros soaked swab shall be inserted behind the pulling eye attached to the coil.

Pipe burst the dead section of main.

Cut away the pulling eye and swab and install a blank flange with a sample tap.

Re-chlorinate the new section of main to 50-100mg/L and stood for 3 hours or 300mg/L and stood for 15 minutes before being flushed and commissioned.

During the final chlorination step, the slug method will be used.

4.4.4 *Slug method*. The slug method consists of placing calcium hypochlorite granules in the main during construction; completely filling the main to eliminate all air pockets; flushing the main to remove particulates; and slowly flowing through the rate of flow ensures that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 h, (unless super-chlorination is utilized to 300 mg/L in which a period of not less than 15 minutes for exposure).

4.4.4.1 Placing calcium hypochlorite granules. Same as Section 4.4.3.1.

4.4.4.2 Preliminary flushing. Same as Section 4.4.3.2.

4.4.4.3 Chlorinating the main.

1. Same as Section 4.4.3.3(1)
2. At a point not more than 10 ft (3 m) downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine. To ensure that this concentration is achieved, the chlorine concentration should be measured at regular intervals. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L for at least 3 h.
3. The free chlorine residual shall be measured in the slug as it moves through the main. If at any time it drops below 50 mg/L, the flow shall be stopped; chlorination equipment shall be relocated at the head of the slug; and as flow resumes, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L.

4. As the chlorinated water flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches.

Note: If there is a possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the residual chlorine. The discharge of large quantities of water from a main must be planned to avoid flooding or causing dangerous road conditions, as previously referenced in Section 4.5 Final Flushing.

Samples should be taken downstream by fully qualified rehabilitation staffs who are involved in the valving operations. Where no pollution hazard has been present the main can be returned to service.

Only fully trained and certified personnel shall be allowed to undertake disinfecting and piece-up operations involving mainlaying, fitting installations and all reconnections.

All samples, when taken, must have a maximum holding time of 30 hours.

8.10 Service Connections

Existing service connections shall be located before initiating sewer main replacement operations. Replacement service lines shall be ¾", 1", 1-1/2", or 2" Endopure ENDOT polyethylene tubing conforming to specifications in AWWA C800 and AWWA C901. Existing services shall be reconnected to the new line after testing and replacement are completed.

Surface materials to be removed for excavation purposes shall be replaced to the condition they were prior to excavation. Affected grassed area shall be sodded.

Payment for replacement/reconnection of service laterals shall be at the unit price for each as outlined in the Bid Proposal and shall include all labor and materials, excavation, location of service, backfill, compaction, pavement removal and replacement, and sodding.

8.11 Post-Installation Flushing

After installation of the pipe-by-pipe bursting, the pipe shall be flushed using potable water. Following, the pipe shall be connected to the existing system and service may be reinstated.

8.12 Post-Installation Sampling

After activation of the pipe, at least one sample at each end of the new pipe shall be taken and bacteriologically tested for post-installation assurance of sanitary conditions of the pipe. Should a problem be realized, the new pipe shall be deactivated, re-swabbed and chlorinated. The maximum holding time of a sample prior to analysis shall be 30 hours.

8.13 Notice

Prior to the commencement of construction, the water provider and Contractor shall notify the local regulatory authority (Department of Natural Resources, Approved County Health Department, etc.) having jurisdiction over potable water systems of the planned construction and submit copies of all satisfactory bacteriological test results to the local regulatory authority.

9.0 HYDROSTATIC TESTING OF POLYETHYLENE PIPELINES

The maximum allowable test pressure shall 1.5 times the pipe rated operating pressure at the lowest point in the section under test or that of the lowest rated pressure component such as flanges, valves, fittings, etc. (i.e.: for a SDR 12 pipe rated at 100 psi the maximum test pressure shall be 150 psi). The test section shall be completely filled with clean water. The venting of trapped air at high points may be necessary to purge air pockets. Concurrent with the pressure test, a visual inspection of the entire system being tested shall be conducted to insure complete integrity of the system.

Monitored Make-up Water Test: The hydrostatic test shall be comprised of two stages:

1) Initial expansion and stabilization stage, where the initial test pressure is applied and the system is allowed to stand without makeup water during a 2 to 3 hour period, to allow for the diametric expansion or pipe stretching to stabilize.
2) Test stage, after the stabilization period is completed, the system is pumped back to the test pressure and at the end of a two hour period, water is pumped back to return to the test pressure and the amount of pumped water measured. The amount of water added shall not exceed the values listed in the following table.

TWO HOUR TEST PRESSURE

Nominal Pipe Size in inches													
2	4	6	8	10	12	14	16	18	20	22	24	30	36
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	18

Make-up Water Allowance (Gallon/100 ft)

Allowance for Leakage due to Fittings: This leakage is defined as the quantity of water lost through pipe connections, valves and other fittings and that has to be made-up to return the tested system to the test pressure after the two hour test.

Allowable leakage in gallons per hour shall not be grater than that determined by the formula:

$$L = \frac{ND\,(P)\,\frac{1}{2}}{7{,}400}$$

L = Maximum allowable leakage, gallons per hour.
N = Number of joints (connections for pipes or fittings) in the tested section of pipe.
D = Nominal inside diameter of the pipe, inches.
P = Test pressure, pound per square inch (psi)

Alternate Non-monitored Make-up Water Test: This hydrostatic test shall be comprised of two stages:

1) Initial expansion and stabilization stage, where the initial test pressure is applied and the system is allowed to stand without makeup water during a 3 hour period, to allow for the diametric expansion or pipe stretching to stabilize. Make-up water may be added each hour to bring the pressure to the test pressure.
2) Test stage, after the stabilization period is completed, the system is pumped back to the test pressure, and then the test pressure is reduced by 10 psi. The pressure shall then remain steady, not falling more than 5% during one-hour test. (i.e.: 150 psi test pressure, 140 psi reduced pressure, minimum lowest pressure 133 psi).

Test Duration: The total test time including expansion and actual test must not exceed a total of 8 hours. If the test can not be completed within this allotted time, the system must be depressurized and then allowed to "relax" for at least 8 hour before initiating the system retest.

10.0 EMERGENCY REPAIRS TO DAMAGED UTILITIES

10.1 Known or Field Located Utilities

In the event that the Contractor or his Subcontractor during the execution of the work breaks any know or field located pressure or gravity main causing the disruption of service and/or an eminent hazard, it shall be the responsibility of the Contractor/Subcontractor to immediately notify DPW Operations at the designated emergency telephone number and immediately undertake measure to repair the damaged utility. To that effect the Contractor/Subcontractor shall ascertain prior to initiating the work that the necessary repair parts, tools, equipment, and labor are on ready and available onsite to complete the repair work without delays. DPW personnel shall witness the repair work.

If the Contractor/Subcontractor estimates or determines that he is not going to be able to restore service within a less than two-hour period, the Contractor shall immediately contact the DPW Operation's Regional Manager to initiate repair. DPW Operations will undertake the repair work and will back charge the Contractor. DPW will submit an itemized bill within 30 calendar days from the occurrence of the event.

10.2 Unknown or Inaccurately Located Utilities

If the utility was not field located or it was inaccurately located in accordance with the prescribed procedures under the Diggers Hotline guidelines and the Contractor/Subcontractor cause a line break during the execution of the work, the same notification procedure as above must be followed. DPW Operations will undertake the repair work at no cost to the Contractor.