

**DIVISION IV
UTILITY INSTALLATION, CONSTRUCTION AND REPAIR**

1. General

1A.	Scope	IV-1
1B.	Material Handling	IV-1
1C.	Pavement Removal.....	IV-2
1D.	Excavation.....	IV-2
1E.	Laying Pipe	IV-6
1F.	Making Joints.....	IV-7
1G.	Backfilling.....	IV-10
1H.	Manholes, Inlets, Gate Wells and Structures	IV-13
1I.	Backfilling Around Manholes, Inlets, Fire Hydrants Gate Wells and Structures.....	IV-15
1J.	Bores	IV-15
1K.	River and Stream Crossings	IV-18
1L.	Restoration of Damaged Surfaces and Property	IV-21
1M.	Replacement of Pavement and Road Surfaces	IV-21
1N.	Turf Restoration and Clean-Up	IV-22

2. Sewer Construction

2A.	Drop Connections	IV-22
2B.	Concrete Cradle and Encasement for Sewers.....	IV-22
2C.	Cutting Pipe	IV-23
2D.	Service Lead Connections and Fittings	IV-23
2E.	Riser Pipe for Service Leads	IV-24
2F.	Abandonment of Sewer.....	IV-24
2G.	Cured-In-Place Pipe (CIPP) for Existing Sewers	IV-24
2H.	Sewer Testing.....	IV-26
2I.	Sewer Repairs	IV-30

3. Water Main Construction

3A.	Connection to Existing Water Mains	IV-31
3B.	Oversized Water Mains.....	IV-32
3C.	Permissible Deflection at Joints	IV-33
3D.	Cutting Pipe	IV-33
3E.	Setting Water Main Fittings and Accessories	IV-33
3F.	Anchorage for Water Main Fittings and Accessories.....	IV-34
3G.	Abandonment of Water Main.....	IV-34
3H.	Water Main Testing	IV-34

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I. GENERAL

IA. Scope

The Contractor shall furnish all materials, equipment, tools, and labor necessary to do the work required by this section and unload, haul, distribute, store, and install all pipe, castings, fittings, valves, manholes, hydrants, and accessories. The Contractor shall also excavate the trenches and pits to the required dimensions; excavate the bell holes; provide and maintain traffic control including, but not limited to, barricades, warning lights, flag people, and warning and detour signs; sheet, brace, and support the adjoining ground or structures where necessary; properly handle all drainage or ground water; lay and test the pipe, castings, fittings, valves, manholes, hydrants, and accessories; backfill and consolidate the trenches and pits; restore the surface; remove and dispose of surplus excavated material; clean the site of the work; and maintain the street or other surface over the trenches as specified.

The Contractor shall also furnish all materials, equipment, tools, and labor required to rearrange branch connections to main sewers, or to rearrange sewers, water lines, conduits, ducts, pipes, or other structures in accordance with the Plans and Specifications.

IB. Material Handling

Pipe, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such material be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

In distributing the material at the site of the work, each piece shall be stored off of the ground surface by means of skids or bunks, and stacked neatly. All water main pipe shall have each end plugged or bagged so as to keep the pipe interior clean until final installation. Pipe may be "strung-out" for only the length which in the opinion of the Public Services Director will be installed within 24 hours, if maintained such that the pipe interior will remain free of dirt, mud, and debris.

Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be by the

Contractor at the Contractor's expense in a manner satisfactory to the Public Services Director.

IC. **Pavement Removal**

The Contractor should, before commencement of excavating operations, cut and remove from the work, all pavement, curb and gutter, or sidewalk that would be damaged by his/her operations as a part of the trench excavation. Cutting of concrete pavement, where permitted, shall be done with a concrete saw, in a manner meeting the approval of the Public Services Director. Asphalt pavements shall be cut by a tool leaving a square, neat cut. Pavement shall be cut back so that the pavement opening is twelve inches wider on each side than the width of the trench, and care shall be taken during construction operations so as not to cave the banks or undermine the remaining pavement. If any existing pavement is undermined during the construction operations, this pavement shall be removed a minimum of 12 inches from the trench edge. Any reinforcement encountered shall not be cut out, but shall be left protruding at least two feet from the face of the cut and shall be bent out of the way to be replaced later and spliced to new reinforcement. If any existing reinforcement is cut, the new pavement, curb and gutter, etc., shall be tied into the existing by the use of hook bolts or other methods approved by the Public Services Director. Any existing brick pavers removed by the Contractor shall be salvaged and returned to the Transportation Division.

In cutting through sidewalks, driveways, or curb and gutter, the Contractor shall remove full slabs of sidewalk or driveway, or full lengths of curb and gutter, to the nearest joint on each side of the excavation. Broken pieces of pavement, sidewalk, or curb and gutter shall be removed from the work and disposed of by the Contractor, at the Contractor's expense.

All trenches across paved traffic lanes shall be provided with temporary or permanent trench cover, after proper compaction. Minimum requirements for temporary trench cover shall be a bituminous patching mixture conforming to MDOT Specification Section 7.11 for mixtures CP-3 or CP-5 as directed by the Public Services Director. Temporary trench cover shall be properly maintained by the Contractor until permanent trench cover is placed. The final surfacing shall take place within two weeks of the completion of the utility construction, and the final surfacing for all cuts made in the off season, November 15th to April 15th, shall be completed before June 15th of the following construction season (see **Division I, Section 1H. Work in Right-of-Way**).

ID. **Excavation**

Excavation shall include the clearing of the site, and the removal and disposal of all materials of every kind, including rock, boulders, or buried obstructions necessary to be removed in the construction work.

The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and the Contractor shall be held responsible for the repair of such structures when broken or otherwise damaged.

Excavation normally shall be by open cut from the surface, except as otherwise specified, or in special cases where crossing under trees, pavements, or structures. The Contractor may use tunnel methods if permitted in writing by the Public Services Director, provided his method of backfill is such, in the judgment of the Public Services Director, as to avoid any present or future injury to the tree, pavement, or structure. All excavation shall be in such manner as will provide adequate room for the construction and installation of the work to the lines, grades and dimensions shown on the Plans.

The trench shall be excavated to a minimum of four inches below the final location of the pipe. For reinforced concrete pipe 66" in diameter or larger, the trench will be excavated to a minimum of six inches below the pipe. This cut shall be filled to the level of the bottom quadrant of the pipe with Class II granular material as specified herein, shaped and compacted to the pipe barrel.

Bell holes shall be provided in the trench bottom at each joint to permit the joints to be made properly.

Whenever, in the opinion of the Public Services Director, it is necessary to explore and excavate to determine the location of existing underground structures, the Contractor shall make explorations and excavations for such purposes.

All excavated material approved by the Public Services Director as backfill material and imported backfill material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. All excavated material which is unsuitable for backfill shall be immediately removed from the site by the Contractor. Hydrants under pressure, manholes of any kind, valve boxes, curb stop boxes, fire and police call boxes, and other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clear, or other satisfactory provisions made, for street drainage, and natural water courses shall not be obstructed. Disposal of excavated material, if required, shall be the Contractor's responsibility.

Hand methods for excavation shall be employed in locations shown on the Plans. In

other locations the Contractor may use trench-digging machinery or employ hand methods.

All surface material which, in the opinion of the Public Services Director, is suitable for reuse in restoring the surface shall be kept separate from the general excavation material, as directed by the Public Services Director.

Pipe Undercut

In locations where in the opinion of the Public Services Director, the soil at the bottom of the trench is unstable, the Contractor shall excavate below the trench bottom to such depth as directed by the Public Services Director and refill with compacted 6A dense-graded aggregate, or compacted Class II granular material, as directed by the Public Services Director, to the level of the bottom quadrant of the pipe. If refill with compacted dense-graded aggregate is required during sewer construction, it shall be placed for the entire sewer run, from manhole to manhole.

Trench Opening

The width of the trench shall be ample to permit the pipe to be laid and jointed properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, to permit the convenient placing of timber supports, sheeting and bracing, and handling of special fittings. For each size of pipe, the minimum trench width shall provide clearance of four inches on each side of the bell of the pipe or fitting or six inches on each side of the pipe barrel, whichever is greater. The maximum trench width shall be in keeping with good construction practice, such that existing structures are not undermined.

In excavating for pipe lines, the excavation shall at all times be finished to the required grade in advance of the pipe line, but unless otherwise permitted in writing by the Public Services Director, not more than 50 feet of trench shall be open at one time in advance of the pipe. At no time shall more than 200 feet of trench be opened and incompletely backfilled. At the end of each day, no more than 25 feet of trench may be left open, and access to all drives shall be restored. This opening shall be surrounded by fencing and lighted barricades, or plated. The remainder of the trenching operation shall be available for safe vehicular and pedestrian traffic at all times.

The trench shall be so braced and drained that the workers may work therein safely and efficiently. It is essential that the discharge of the trench dewatering pumps be conducted to natural drainage channels, drains, or storm sewers. If trench water is pumped to natural drainage channels or drains, approved soil erosion and

sedimentation controls shall be installed and maintained at the point of discharge. If trench water is pumped into storm sewers, filters shall be provided to prevent the flow of rocks, mud and other debris into the storm sewer line.

The length of street which may be occupied by the construction work at any one time shall be subject to the approval of the Public Services Director and will be based on the requirements of use of the street by the public.

The Contractor shall fully comply with all laws and regulations governing construction methods and the furnishing and use of all safeguards, safety devices, protective equipment, and pollution controls. Particular care shall be taken to conform to all applicable rules of the Michigan Department of Labor, Construction Safety Standards Commission, "Safety Standards". Part 9 of the above document should be particularly noted.

Where required to support the surfaces of adjacent thoroughfares, structures, or excavations, or to protect the construction work, adjacent work, or workmen; sheeting, bracing, and shoring shall be provided. The placing of such supports shall not release the Contractor of the responsibility for the sufficiency and integrity of the trench opening. In the removing of sheeting and bracing after the construction has been completed, special care shall be taken to prevent any caving of the sides of the excavation and injury to the completed work or to adjacent property.

Sheeting, bracing, and shoring shall not be left in place after completion of the work except as required by the Public Services Director. Where the Public Services Director requires the sheeting, bracing, or shoring to be left in place it shall be cut off below the established surface grade as required by the Public Services Director.

Disposal of Water and Sewage

The Contractor shall remove by well points, pumping, bailing, or other acceptable method any water which may accumulate or be found in the trenches or other excavations to be made. The Contractor shall take all necessary precautions to keep the trenches and other excavations entirely clear of water and sewage during construction of pipe lines and structures. Newly placed concrete shall be adequately protected from injury resulting from ground water or sewage. No drainage ditches shall be placed within the area to be occupied by any structure except as permitted in writing by the Public Services Director.

The Contractor shall at all times have upon the work sufficient pumping equipment ready for immediate use to carry out the intent of this section.

Where existing sewers, drains, or ditches are encountered in this work, adequate provisions shall be made for diverting their flow, so that the excavation will be kept dry. Upon completion of the construction work, the existing sewers, drains, or ditches shall be restored as directed by the Public Services Director.

Crossing Existing Structures & Facilities

During the construction it may be necessary to cross under or over certain sewers, drains, culverts, water lines, gas lines, electric lines, and other underground structures or facilities, known or unknown. The Contractor shall make every effort to prevent damage to such underground structures and facilities. Wherever such structures or facilities are disturbed or broken, they shall be restored to good condition, acceptable to the owner and the City, at the Contractor's expense. These crossings shall be made with a minimum of twelve inches of vertical clearance between facilities.

1E. Laying Pipe

Each pipe shall be inspected for defects prior to being lowered into the trench. Inside of pipe and outside of spigot shall be cleaned of any earth or foreign matter.

Proper implements, tools, and facilities satisfactory to the Public Services Director shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment as recommended by the manufacturer, in such a manner as to prevent damage to them and their protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.

New sewer construction shall be plugged at the outlet, so as to not be connected into the existing system until it has been tested and accepted. Construction of sewers shall begin at the outlet end and proceed upgrade. New water main construction shall not be connected into the existing system until it has been tested and accepted by the Public Services Director. Pipe shall be laid on the prepared subgrade with the bell ends facing the direction of laying, unless otherwise directed by the Public Services Director.

The Contractor shall take every precaution to prevent foreign material from entering the pipe while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a **watertight** plug. This provision shall apply during the noon hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

Pipe shall be jointed as specified elsewhere herein. The pipe shall be secured in place with approved backfill material tamped under it except at the bells. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed

and replaced with pipe and fittings of proper dimensions to insure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space. All pipe shall be laid at the correct line and grade as indicated by the grade stakes and offset line. For sewer construction the correct line and grade shall be maintained by the use of a laser alignment system. The staking shall be provided by the Engineer, as specified in **Division I, Section 1Q. Elevations, Lines, and Grades** of these Specifications. No pipe shall be laid until a cut sheet for that pipe has been approved by the Public Services Director. Each pipe, as laid, shall be checked by the Contractor to insure that this result is obtained. The grade as shown on the Plans is that of the pipe invert for sewers, and top-of-pipe for water main; and the work must conform to this profile. For sewer construction, a variation of 1/4 inch from this profile grade will be deemed sufficient reason to cause the work to be rejected and relaid. For water main construction, a variation from the profile grade of two inches with ductile iron pipe, and three inches with reinforced concrete pipe, will be deemed sufficient reason to cause the work to be rejected and relaid. Sewer pipe alignment shall be maintained so as to not vary more than one-half inch from the correct line on pipes up to 36 inches in diameter nor more than one inch on pipes 42 inches in diameter and larger. Water main pipe alignment shall be maintained so as not to vary more than three inches from the correct line. Any pipe found out of line shall be relaid properly by the Contractor.

Due to conditions in the field, changes to the proposed vertical and horizontal alignment of the proposed water main may become necessary. The Contractor shall, where directed by the Public Services Director, excavate up to 60 feet in advance of the pipe laying operation to expose existing underground facilities thereby enabling the Public Services Director to make alignment decisions. The Contractor is required to realign (re-lay) the water main up to 2 feet vertically and/or horizontally as directed by the Public Services Director at no extra cost to a City project. The excavation in advance of the pipe laying is intended to help eliminate the need for re-laying pipe.

1F. **Making Joints**

General

Mechanical means shall be used for pulling home all rubber-gasketed pipe regardless of trench condition where manual means will not result in pushing and holding the pipe home. When a trench box or liner is used, a cable shall be used to pull the joints home and hold them in position.

Where work is performed in wet trenches or trenches with running sand, the Contractor shall provide and use mechanical means for pulling the pipe home in

making up the joint and for holding the pipe joints tight until completion of the line. Mechanical means shall consist of a cable placed inside or outside of the pipe with a suitable winch, jack, or come-along for pulling the pipe home and holding the pipe in position.

Where not required by these Specifications, manual means will be acceptable only if the joints can be pushed home and held.

Vitrified Clay Pipe

Compression-type joints shall be made in accordance with manufacturer's standards and ASTM C 425. The jointing surfaces of the pipe shall be wiped clean, and lubricated using lubricants supplied by the pipe manufacturer. The socket and spigot shall be lined up and joined together with a steady, uniformly applied force.

Reinforced Concrete Pipe

Rubber gasket-type joints shall be made in accordance with manufacturer's standards. The jointing surfaces of the pipe shall be wiped clean, and lubricated using lubricant supplied by the pipe manufacturer.

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Outside joints to receive cement mortar collars shall be cleaned of all dirt and covered with cloth bands to receive the mortar grout. Bands shall be fastened in place with the strapping stitched into their edges. The joint recesses beneath the cloth band shall then be filled with cement mortar of sufficient liquid consistency to flow easily into the recess. To assist the flow, and to assure complete filling of the entire recess, rodding with a stiff wire, curved to the radius of the pipe, will be required.

Ductile Iron Pipe

In making up push-on joints, the gasket seat in the socket and the gasket shall be wiped clean with a cloth. The gasket shall then be placed in the socket with the large round end entering first and sprung into the gasket seat so that the groove fits over the bead in the seat. A thin film of lubricant shall then be applied to the inside surface of the gasket that will come in contact with the entering pipe. The plain end of the pipe to be entered shall be wiped clean and placed in approximate alignment with the bell of the pipe to which it is to be joined. The plain end of the pipe shall then be lifted and started into the socket so that it is in contact with the gasket. The joint shall then be made by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket. This force must be applied slowly, uniformly, and without impact.

In making up mechanical joints (for solid sleeves or fire hydrants), the sockets, spigot ends, and gaskets shall be thoroughly cleaned and washed with soapy water.

The joint shall be assembled while the surfaces are still wet. The Mega-Lug gland and gasket shall be slipped on the pipe and pushed back from the end. The plain end shall be entered into the socket and, after the two adjoining pipe are substantially in alignment, shall be inserted to the full depth of the socket. The gasket shall then be slipped along the pipe into the socket until it is confined to the full height of the gasket uniformly around the joint. The bolts shall be inserted with the heads bearing on the pipe flange and the nuts against the Mega-Lug gland. The bolts shall be tightened alternately and uniformly. The torque limiting twist-off nuts on the Mega-Lug gland shall be tightened in a clockwise direction until all the wedges are in firm contact with the pipe surface. Tightening shall continue in an alternate manner until all of the nuts have been twisted off.

Flanged pipe and fittings shall be connected by standard A-307 or A-325 bolts, heavy hex nuts, and full face rubber or composition gaskets.

Restrained-type joints shall be in accordance with manufacturer's standards and shall meet all of the applicable requirements of ANSI/AWWA C111/A21.11. Bolts and nuts for the retainer assembly shall be stainless steel. Restrained, push-on joints shall be made in accordance with the manufacturer's standards.

Lead joints, where necessary, shall be performed in accordance with the Specifications for Installation of Cast-Iron Water Mains adopted by the American Water Works Association on June 3, 1949, Section 9, and the Addendum attached thereto.

Polyvinyl Chloride (PVC) Pipe

Elastomeric gasketed push-on joints shall be made in accordance with manufacturer's standards, and ASTM D2321 and D3212. The jointing surfaces of the pipe shall be wiped clean, and lubricated using lubricant supplied by the pipe manufacturer. The spigot end is to be inserted into the bell so that it is in contact with the gasket. The bell is to be braced while the spigot end is pushed in under the gasket, so that previously completed joints will not be altered. The spigot shall be pushed into the bell until the reference mark on the pipe barrel is flush with the end of the bell.

High Density Polyethylene (HDP) Pipe

Rubber gasket-type joints shall be made in accordance with manufacturer's

standards. The jointing surfaces of the pipe shall be wiped clean, and lubricated using lubricant supplied by the pipe manufacturer.

Split coupling joints shall be made in accordance with manufacturer's standards. The band shall engage a minimum of four corrugations, two on each side of the pipe joint. A continuous geotextile fabric sock shall be placed over the coupling band, extending a minimum of one foot past each end of the coupling band. The ends of this filter fabric sock shall be secured with coupling band tie straps placed in the bottom of the corrugations.

1G. Backfilling

Vitrified Clay, Reinforced Concrete, HDP, and Cast Iron Pipes

All pipes shall be bed on a four inch or thicker layer of compacted Class II granular or compacted dense-graded aggregate material as specified in **Section 1D. Excavation**.

From the bedding to the pipe centerline backfill shall be carefully placed Class II granular material, placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. Each lift shall extend the full width of the space between the pipe and trench, and the fill shall be brought up evenly on both sides of the pipe. The backfill under the haunches of the pipe shall be consolidated by the use of a tee-bar.

When the pipe is greater than 48 inch diameter, or when permitted in writing by the Public Services Director, the Class II granular fill from the bedding to the centerline may be replaced by modified dense graded aggregate as specified. A suitable granular filter, designed by the Contractor and approved by the Public Services Director, shall be provided above the coarse aggregate to prevent intrusion of succeeding backfill materials.

From the pipe centerline to the top of the pipe, backfill shall be Class II granular material placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557 Method C, or AASHTO T-180.

From the top of the pipe to two feet above the top of the pipe backfill shall be Class II granular material uniformly spread and machine tamped. Machine tamping shall include manually operated vibrating plate compactors. The backfill material shall be

compacted in lifts of twelve inches, loose measure.

From two feet above the top of the pipe to the grade shown on the Plans and Details, or to the subgrade of surface materials, or to the subgrade of surface structures, backfill shall be Class II granular material uniformly spread and machine tamped. If machine tamping includes manually operated vibrating plate compactors or self propelled vibrating rollers the backfill material shall be compacted in lifts not exceeding twelve inches, loose measure. If a backhoe mounted compactor is employed, the backfill material shall be compacted in lifts of thirty-six inches, loose measure. Approval to use a particular machine tamping method will be withdrawn by the Public Services Director if the method causes injury to the pipe or adjacent structures or movement of the pipe. Each lift shall be thoroughly compacted to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. The Public Services Director may give consideration to giving written permission to increase the thickness of the lifts specified in this paragraph if satisfactory compaction is achieved and no undesirable side effects occur.

Ductile Iron Pipe

All pipes shall be bed on a four inch or thicker layer of compacted Class II granular material or compacted dense-graded material as specified in **Section 1D. Excavation** of these Specifications.

From the bedding to the pipe centerline, backfill shall be carefully placed Class II granular material, placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. Each lift shall extend the full width of the space between the pipe and trench, and the fill shall be brought up evenly on both sides of the pipe. The backfill under the haunches of the pipe shall be consolidated by the use of a tee-bar or other approved methods.

From the pipe centerline to the top of the pipe, backfill shall be Class II granular material placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180.

From the top of the pipe to one foot above the top of the pipe, unless otherwise specified, backfill shall be Class II granular material placed in a maximum lift

thickness of twelve inches, loose measure. Each lift shall be thoroughly compacted by a vibrating plate compactor, or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180.

From one foot above the top of the pipe, to the grade shown on the Plans and Details, or to the subgrade of surface materials or to the subgrade of surface structures, backfill shall be Class II granular material uniformly spread and machine tamped. If machine tamping includes manually operated vibrating plate compactors or self propelled vibrating rollers the backfill material shall be compacted in lifts of twelve inches, loose measure. If a backhoe mounted compactor is employed, the backfill material shall be compacted in lifts of thirty-six inches, loose measure. Approval to use a particular machine tamping method will be withdrawn by the Public Services Director if the method causes injury to the pipe or adjacent structures or movement of the pipe. Each lift shall be thoroughly compacted to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180.

PVC Pipe

All pipes shall be bed on a four inch or thicker layer of compacted 6A dense-graded aggregate material as specified in **Section 1D. Excavation**.

From the bedding to the pipe centerline backfill shall be carefully placed 6A dense-graded aggregate material, placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. Each lift shall extend the full width of the space between the pipe and trench, and the fill shall be brought up evenly on both sides of the pipe. The backfill under the haunches of the pipe shall be consolidated by the use of a tee-bar.

From the pipe centerline to the top of the pipe, backfill shall be 6A dense-graded aggregate material placed in maximum lift thicknesses of six inches, loose measure. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks", or other approved methods, to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557 Method C, or AASHTO T-180.

From the top of the pipe to two feet above the top of the pipe, unless otherwise specified, backfill shall be Class II granular material placed in a maximum lift thickness of twelve inches, loose measure. These lifts shall be thoroughly compacted by manually operated vibrating plate compactors, to at least 95% of maximum unit weight at optimum moisture content, as determined by ASTM D 1557,

Method C, or AASHTO T-180.

From two feet above the top of pvc pipe to the grade shown on the Plans and Details, or to the subgrade of surface materials, or to the subgrade of surface structures, backfill shall be Class II granular material uniformly spread and machine tamped. If machine tamping includes manually operated vibrating plate compactors or self propelled vibrating rollers the backfill material shall be compacted in lifts not exceeding twelve inches, loose measure. If a backhoe mounted compactor is employed, the backfill material shall be compacted in lifts of thirty-six inches, loose measure. Approval to use a particular machine tamping method will be withdrawn by the Public Services Director if the method causes injury to the pipe or adjacent structures or movement of the pipe. Each lift shall be thoroughly compacted to at least 95% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. The Public Services Director may give consideration to giving written permission to increase the thickness of the lifts specified in this paragraph if satisfactory compaction is achieved and no undesirable side effects occur.

General

In undeveloped property (other than existing or future rights-of-way), or outside of the one-on-one influence line of existing or future roadway, pavements, shoulders, driveways, and sidewalks, or where specifically shown on the Plans or in the specifications, the Contractor may backfill the trench from one foot above the pipe to the top of the trench with excavated material compacted to 90% of maximum unit weight at optimum moisture content as determined by ASTM D 1557, Method C, or AASHTO T-180. The backfill shall be neatly rounded over the trench to a sufficient height to allow for settlement to grade after consolidation. All such trenches and excavations are to be consolidated by methods approved by the Public Services Director including running the tires or tracks of heavy equipment on granular material and a sheepsfoot type roller on cohesive soils until satisfactory compaction is accomplished.

It is strongly recommended that all trenches under or within the one-on-one influence of all private drives and parking areas be backfilled from one foot above the pipe to the pavement subgrade with Class II granular material. This will be required by the Public Services Director unless a written waiver from this requirement is received from the Owner or Developer accepting responsibility for any future settlement in the trench areas.

Backfilling shall not be done in freezing weather except by written permission of the Public Services Director, and it shall not be made with frozen material. No fill shall be made where the material already in the trench is frozen.

1H. **Manholes, Inlets, Gate Wells and Structures**

Excavation shall be carried to the depth and width required to permit the construction of the required base. The excavation width shall be greater than the base. The bottom of the excavation shall be trimmed to a uniform horizontal bed and be completely dewatered before any concrete is placed therein. Concrete shall be Class A. Precast manhole bases and precast bottom sections are allowed.

Precast concrete manholes, inlets, gate wells and concrete special structures shall be constructed of Class A concrete in accordance with the Standard Detail Drawings and conform to the requirements of these Specifications.

Concrete block construction shall only be allowed for storm sewer manholes and inlets and shall be built of the size and dimensions shown on the Plans. The block shall be clean, laid in a full bed of mortar, and thoroughly bonded by completely filling the vertical end grooves with mortar so as to interlock with the adjacent block.

The mortar beds and joints shall not exceed 3/4 inch thickness. The vertical joints are to be completely filled with the joints on the inside face rubbed full of mortar and struck smooth as the manhole, inlet or structure is built up. The entire outside face of the structure shall receive a 1/2" thick mortar coat and struck smooth. All masonry materials, sand, and water shall be heated to over 50° F during freezing weather, and the completed work shall be covered and protected from damage by freezing.

Circular precast manhole sections shall be constructed in accordance with the Standard Detail Drawings. Manhole stack units shall be constructed on level poured-in-place bases, precast concrete bases, or precast concrete bottom sections.

Precast cone sections shall be constructed in accordance with the Standard Details. These units shall be eccentric for all manholes, precast or block. All structures shall be topped with a minimum of one and a maximum of three brick or precast adjustment ring courses.

Manholes, inlets, gate wells and structures shall be constructed within 2-1/2 inches of plumb.

Frames and cover castings shall be set in full mortar beds and pointed on the structure interior to a smooth, brushed finish. The covers shall be set flush with sidewalk, roadway pavement, or ground surfaces. Engineering shall be notified prior to the final paving of all private roads and parking lots so as to allow inspection of the final casting adjustments for all City utility structures. In gravel streets, covers

shall be set six to eight inches below finished gravel surface.

Sewer pipes shall extend into structures a minimum of 1/2 inch and a maximum of 3 inches.

Flow channels for sewer structures shall be finished in accordance with the Standard Details. All flow channels shall be screeded and floated to a smooth, uniform surface and troweled to a hard surface finish. In vitrified clay sewers, the manhole may be constructed around the pipe, then the top half of the pipe broken out with concrete fillets provided to fill in between the pipe and manhole.

Stubs for future sewer connections shall be furnished and placed by the Contractor as shown on the Plans and as directed by the Public Services Director. Connections shall be properly supported and braced when not resting on original ground so that any settlement will not disturb the connection. Stubs shall consist of one length of sewer pipe, of the size indicated on the Plans, with a **watertight plug**.

See **Division IV, Section 2H. Sewer Testing** of these Specifications for the requirement of the installation of a pipe nipple through the sewer manhole wall.

1I. Backfilling Around Manholes, Inlets, Fire Hydrants, Gate Wells and Structures

As soon as practicable after a precast structure has been set or a cast-in-place structure has been poured, forms and debris have been removed, the surfaces of the concrete have been pointed up, and the structure has been inspected and approved, the excavated area around the structure shall be backfilled up to the specified grade with Class II granular material. No boulders, rocks, stones, masonry, lumber, or debris shall be placed as backfill. No backfilling may be performed around cast-in-place concrete structures until the concrete has attained at least 75% of its design strength and written approval of the Public Services Director has been obtained. No backfilling may be performed around concrete block manholes, inlets and structures until the mortar has, in the opinion of the Public Services Director, satisfactorily set, this being at least one working day.

IJ. Bores

General

Pipe lines shall be bored under City streets, highways and railroad tracks in the locations shown and at lines and grades according to details shown on the Plans. The requirements of the governmental body or railroad having jurisdiction at the crossing location shall supplement these Specifications, and if more stringent shall supersede these Specifications. Pipes shall be placed in casing pipes of length, size, and class (or wall thickness) shown on the Plans or in the Specifications. The methods of installation shall be as noted on the Plans and Specifications herein.

Bore depths shall provide a minimum of 4.5 feet of cover between the top of the pavement and the top of the casing or conduit.

For crossing of highway or railroad rights-of-way, the Contractor shall furnish deposits, special insurance, bore pit design calculations, permanent location signs, or other items required by the highway or railroad agency, including bearing all costs for their flagging personnel and inspectors.

Bore and Receiving Pits

The face of the bore and receiving pits shall be located a minimum of 5 feet from the back of the curb on curbed streets and 10 feet from the edge of the pavement on uncurbed streets. This horizontal clearance shall be an absolute minimum. A

greater horizontal clearance will be required by the Public Services Director on major arterial

and major streets as listed in **Division I, Section 1H. Work in Right-of-Way** of these Standards. For highway or railroad bores, the boring pit shall be no closer than the highway or railroad right-of-way line unless otherwise shown on the Plans or required by the agency.

Sheeting and bracking will be required in bore and receiving pits when any portion of the excavation is located within the one-on-one influence of the back of the curb or shoulder edge. Support will be required at the front face of all bore pits for bores 4" in diameter or larger to prevent loss of material during construction. For highway and railroad bores, adequate sheeting, bracing, and shoring shall be used to support the highway or railroad if required by the agency.

All bore and receiving pits shall be protected with construction fencing and lighted Type II barricades for the duration of the work. The use of equipment in lieu of fencing and barricades will not be allowed.

Boring (4" and Larger)

The boring method for bores 4" in diameter or larger shall consist of augering a hole not exceeding the diameter of the casing pipe, or carrying pipe as applicable, and jacking the casing pipe through the hole either in advance of, or simultaneously with, the auger. The bore pit shall be large enough to accommodate at least one section of pipe and to provide adequate space for the jacking equipment and blocking. Two or more guide rails shall be provided to support the pipe at the established line and grade during the jacking operations. These guides shall be kept coated with suitable lubricant.

Jacks of sufficient capacity shall be provided and used in jacking the pipe. A backstop of cribbing, or other approved means, shall be provided at the rear of the bore pit which is substantial enough to withstand the thrust which will be developed during jacking. A jacking head consisting of bearing blocks shall be used to transfer the pressure uniformly from the jacks to the perimeter of the pipe. Jacking forces shall be distributed in a manner that average compressive stresses developed will not exceed design compressive strength of the pipe used.

The Contractor shall provide mechanical auger guards on the leading edge of the casing pipe such that the auger cannot precede the casing pipe.

Prior to the jacking of the individual pipe sections, the outside surface may be coated with bentonite or other suitable lubricant. Bentonite or other suitable lubricant may be applied at the front face of the lead pipe simultaneously with the jacking operation. A lubricant sill plank may be required in the heading to maintain vertical alignment.

Sufficient quantities of auger lengths and casing lengths shall be provided to allow for adjustment in the position of the auger head. Adjustment in the position of the auger head shall not be made unless authorized by the Public Services Director. In borings over 50 feet in length and over 24 inches in diameter, the Contractor will be required to withdraw the auger every 40 feet from the beginning and check grade and alignment at the inside leading end of the bore.

Delays between jacking operations may result in soil settling around the jacked pipe, thus making it difficult, and sometimes impossible, to resume movement. Should conditions arise making it impossible to further jack the pipes without damage, the balance of the pipe shall be constructed by methods approved by the Public Services Director.

When a casing pipe is used, after the placing of the casing pipe has been completed, the sewer pipe shall be strung through the casing using wooden blocks and straps or other approved means for support and grade control, as shown on the Plans. The interior of the casing pipe shall have the invert elevation checked at sufficient intervals that the support blocks can be individually sized to obtain a uniform grade on the sewer pipe. The sewer must pass a television inspection before and after the grouting operation. The void between casing pipe and a sewer pipe shall be filled with flowable fill placed under pressure so as to prevent voids. The flowable fill shall be placed through a 6 inch tube at the low end of the casing pipe, until it appears out of a 6 inch tube placed at the high end of the casing pipe. The sewer shall be plugged and filled with water to avoid floating the pipe. Ductile iron pipes may rest on the pipe bells. The area between the casing pipe and a water main shall be left open except for a solid brick masonry bulkhead at each end.

Boring (under 4")

The boring method for bores under 4" in diameter shall be either compaction auger ("packer" or "expander") or hydraulic push rods or stem ("pipe puller" or "packer"). The compaction auger method shall consist of augering a rotating stem then pulling back a series of graduated cones which squeeze the soil to obtain the desired diameter. The hydraulic push rod/stem method shall consist of pushing rods or stems by means of a hydraulic ram then pulling a series of graduated cones which squeeze the soil to obtain the required diameter. Boring by jetting or air ramming will not be allowed.

A starter alignment trench shall be excavated to the elevation of the proposed utility conduit. The length of level trench shall be a minimum of 15' for trench depths to 4.5' and increase 5' for each additional 1' increment of depth.

Guide rails, sills, or other positive alignment devices shall be used to start the crossing. Drive rods, if used, shall be securely restrained against side to side or up and down movement.

Where "Heads" are used to develop the conduit opening, holes over 2" in size shall be developed by increasing the head size in 1" increments.

Where the road is super-elevated, the bore shall be started from the lower side of the pavement.

IK. River and Stream Crossings

A City Wetland and Watercourse Use Permit is required for all construction activities associated with a river or stream crossing. (See **Division I, Section 1D. Permits** for information on this permit). An Act 346 (Inland Lakes and Streams Act) permit is required to construct a water main across a stream, but is not required to construct a sanitary sewer across a stream. However, for work under these Specifications, applicable requirements of Act 346 will be required in either case. Rules 22 through 29 of Act 346 are summarized in this section.

The Contractor shall take all necessary steps to prevent damage to fish and game habitat and to preserve the natural resources of the streams. Excavation shall be performed without discharging materials into any stream, lake or reservoir.

The work of clearing, scalping, grading, slope erosion protection, ditching, backfilling and final clean-up within 50 feet of streams, lakes and reservoirs shall be completed within as short a period of time as reasonably possible in order to minimize erosion occurring from wind and precipitation.

Sedimentation Basins and Cofferdams

Sedimentation basins or cofferdams, where required, shall be constructed prior to any other work at the crossing site.

Weirs shall be constructed of continuous interlocking steel sheeting except where other substitute materials are authorized in writing by the Public Services Director. When specified or requested by the Public Services Director, a detail drawing of the weir installation shall be furnished by the Contractor.

Temporary weirs or cofferdams are to be removed, including any materials trapped by them in the control of siltation, within 2 weeks of final clean-up. Intermittent removal of silt or sand during construction may be required for proper operation of sedimentation basins. In any event, the sedimentation basins shall be cleaned before removal.

The Developer (or the Public Services Director if a City Project) is responsible for

securing the necessary approval of private land owners where temporary additional right-of-way or easement is necessary to construct and/or operate a settling basin. An easement is not required in locations where the crossing is made on State owned lands.

Haul Roads

Temporary haul roads crossing streams shall be constructed of clean coarse aggregate with culverts laid parallel to the stream. The side slopes shall be protected with permanent riprap up to a level one foot above the normal water level and over the ends of the culverts.

Permanent haul roads crossing streams (roads that are to be left in place at the request of the property owner) will require a permit under Act No. 245 of the Public Acts of 1929, as amended.

Both temporary and permanent haul roads shall have adequate top width to permit passage of all construction equipment without sloughing of sides slopes.

Culverts of adequate size and length, approved by the Michigan Department of Natural Resources, are required in both temporary and permanent haul roads.

Fording of streams is permitted only where it will not cause either erosion or siltation.

Trench Excavation

Appropriate trench excavation methods shall be employed to minimize material from the pipe trench flowing into the stream, giving due consideration to the soil, terrain, cover, side slopes and weather conditions involved.

All pipe trenches shall be excavated to a depth which will provide a minimum cover of 30 inches from the bed of the stream to the top of the pipe unless specified otherwise.

The width of the trench shall be the O.D. of the bell plus a minimum of 12 inches on each side. All excavated material shall be removed from the river and used as backfill, if suitable in the opinion of the Public Services Director, or disposed of by the Contractor at the Contractor's expense.

Pumping or draining water from trench excavations shall be made on either side of the pipeline and not into the waters of the State. Approval of private land owners shall be obtained in writing by the Contractor before discharging water from the

trench excavation onto private lands.

Pipe Installation

In using river crossing pipe, assembly and installation procedures shall conform to the manufacturer's recommendations. The pipe shall be installed in the trench either by pulling into position or floating into position. If the pipe is to be pulled, a closed end assembly with a pulling eye manufactured by the pipe manufacturer, shall be installed and used in pulling the pipe. For either method the river crossing pipe joints shall be assembled on shore.

The pipe shall be laid on a foundation of granular material placed on the trench bottom to a depth of not less than 6 inches. After the pipe has been properly placed in position, the Contractor shall backfill the trench with granular material. Joining land pipe shall be as specified in **Section 1F. Making Joints**.

The trench in the stream bed may be backfilled with existing river bottom material if the material used does not, in the opinion of the Public Services Director, cause excessive siltation. Clean crushed stone, clean coarse aggregate, or washed gravel shall be used as backfill where, in the opinion of the Public Services Director, use of existing material will cause excessive siltation.

Bank restoration disturbed by the Contractor for slopes steeper than 1:3 (1 vertical to 3 horizontal) shall be 18 inches of heavy riprap as specified elsewhere or shown on the Plans.

All work on the crossing and restoration shall be completed as specified in the Act 346 Permit and as required in these Specifications.

Stream Bank Protection

Following the installation of the pipeline, all work areas along or across streams or lakes shall be restored immediately and the exposed beds and banks shall not remain unprotected for more than 7 days, except where subsequent permission is provided for a pumping and testing operation.

All disturbed stream banks shall have a finished slope no steeper than 1:2 (1 vertical to 2 horizontal) to prevent sloughing until stabilized by vegetative cover or riprap. The 1 on 2 slope shall be graded up and back to the high-water line.

All raw soil exposed above the permanent riprap protection line shall be sodded or rippapped, or shall be seeded, fertilized, and mulched. Sandbags may be used for temporary riprap.

Mulch shall consist of 3 inches of straw or other approved material. Mulch on slopes greater than 10% shall be held in place by a spray of asphalt type SS-1s emulsion mixed with an equal amount of water.

Seeding and fertilizing rates shall be as follows:

- a) Seed per acre: 10 pounds Kentucky 31 fescue, 3 pounds Birdsfoot trefoil, and 3 pounds white clover.
- b) Fertilizer per acre: 200 pounds of 6-24-24.

Permanent stone riprap shall be placed from the bed of the channel to 3 feet above the normal high-water line or to the top of the bank.

Final Clean-up

Final clean-up shall consist of removing the temporary haul road across the stream; reshaping the stream as nearly as possible to its original configuration, width, depth and bottom material; permanent protection of the stream banks; and removing all construction material and debris from the crossing site, including any material and debris up or down-stream from the site left as a result of this construction.

Use of Water for Cleaning and Testing Pipeline

The cleaning and testing procedure shall be conducted in a manner that will minimize potential problems which might affect fish and game habitat or other natural resources of the State.

II. Restoration of Damaged Surfaces and Property

Where any pavement, sidewalks, curbing, gutters, drives, trees, shrubbery, fences, poles, or other property or structures have been damaged, removed, or disturbed by the Contractor, whether through failure to carry out the requirements of state laws, municipal ordinances, or the specific direction of the Public Services Director, or through failure to employ usual and reasonable safeguards, such property and structures shall be replaced or repaired at the expense of the Contractor to a condition at least equal, in the opinion of the Public Services Director, to that before the work began.

III. Replacement of Pavement and Road Surfaces

The Contractor shall cold patch the top 2" of all hard surface excavations immediately following backfilling and shall continuously maintain all excavated trenches and shall refill to finished grade all settlement which occurs in the trenches for a period of not more than fourteen days. After a period of fourteen days (or less, if required by the Public Services Director), the Contractor shall neatly retrim any broken edges of pavement, sidewalk, driveways, or curb and gutter removed or disturbed by the Contractor, remove the cold patch and where necessary the top surface of the backfill, and perform permanent repair. All work of replacing pavement, sidewalks, driveways, and curb and gutter shall be performed in accordance with these Standards. No pavement, sidewalk, driveway, or curb and gutter replacement is to be performed during the period between November 15 and April 15, unless with the written permission of the Public Services Director. In the event that this replacement cannot be accomplished satisfactorily before November 15, the Contractor shall be responsible for the maintenance, and cost of maintenance, of the disturbed area until such time as a permanent repair can be made. The final surfacing for all cuts made in the off season, November 15 and April 15, shall be completed before June 15 of the following construction season. (See **Division I, Section 1H. Work in Right-of-Way**).

All gravel road surfaces disturbed by the Contractor shall be restored as called for on the Plans within three days of the completion of the utility construction. This shall include a minimum of one application of calcium chloride over all restored gravel surfaces.

IN. **Turf Restoration and Clean-Up**

The Contractor shall permanently prepare, fertilize and seed or sod, the areas specified on the Plans and all areas disturbed by the Contractor, and remove all surplus materials as required by **Division VIII, Landscaping and Restoration** of these Specifications.

2. **SEWER CONSTRUCTION**

2A. **Drop Connections**

Where shown on the Plans or directed by the Public Services Director where a branch sanitary sewer is brought into a manhole more than 24 inches above the invert elevation in the manhole, a drop connection shall be provided in accordance with the Standard Detail Drawings.

2B. **Concrete Cradle and Encasement for Sewers**

Where shown on the Plans, pipe shall be installed with a concrete cradle or encasement of Class X concrete as shown in the Standard Detail Drawings. Cradle or encasement shall be for the full run of the sewer, from manhole to manhole. Each pipe shall rest on a bed of Class X concrete, shaped to fit the bottom of the pipe. After setting the pipe, the space between the outside of the pipe and the undisturbed trench bank shall be completely filled with Class X concrete. Class X concrete used for this purpose shall have a slump not exceeding two inches.

2C. **Cutting Pipe**

Sewer pipe may not be cut when the cut end will be used in making a pipe joint. Cut ends may only occur in situations such as a manhole or headwall. Cut ends shall be carefully and neatly made with a saw, pipe cutter, or other approved means.

2D. **Service Lead Connections and Fittings**

Service lead connections shall be provided at such points as shown on the Plans or as directed by the Public Services Director. These shall be of the size and character indicated on the Plans. House service leads shall be a minimum of four inches in diameter. Service lead connections shall be formed by the use of standard wye or tee fittings of the same material called for use on the main sewer being constructed.

Wye fittings are not to be used for connections with riser pipes. All wye and tee fittings shall be encased in Class "X" concrete. All leads which will not have pipe connected to them immediately shall be closed by the use of a watertight plug manufactured specifically for that purpose and approved by the Public Services Director.

Branch connections to existing sewers shall be made by the Utilities Department. Scheduling of these taps shall be made with Utilities by the Contractor. All applicable tap fees must be paid in full prior to this scheduling. (See **Division I, Sections 1D. Permits** and **1E. Inspections and City Departments Involvement**)

Connections for sewer service leads connecting to existing sewer mains or sewer mains of a different pipe material shall be at a core-drilled tap into the sewer pipe. The joint at this tapped connection shall be made using a Romac Industries, Inc. style "CB" gasketed sewer saddle or approved equal, or a flexible neoprene rubber boot securely clamped into the core-drilled tap. The end of the sewer service lead pipe shall be flush with the inside wall of the concrete sewer main.

In order to properly mark the location of every branch connection, the Contractor shall take accurate measurement of all branches before the sewer trench is backfilled. The measurements shall indicate the distance from each branch to the center of the nearest downstream and upstream manhole. When leads are run to

the property line, they shall be perpendicular to the main sewer. The Contractor shall also report the location of the point where the lead ends, relative to the nearest property corners. The Contractor shall furnish the Public Services Director with a copy of these measurements immediately upon the completion of each section of sewer.

In addition to measurements, the Contractor shall furnish and place a minimum two inch by two inch cedar or treated lumber marking stick at the end of each lateral extension or service lead connection of such length that it will reach from the end of the pipe vertically up to a minimum of two inches above the proposed finished grade. Each marker shall be set in a vertical position. Markers will not be required on the main run of sewer at fittings. The visible end of each marker stake must be plainly painted red if sanitary or white if storm.

The service lead pipes shall also be marked for identification in order to prevent cross connection of the leads: sanitary leads - red, storm leads - white. The last two lengths of pipe shall be marked by wrapping the appropriate colored tape twice around the barrel. This wrapping shall take place at any point in the lead whenever the lead is terminated. This taping (wrapping) must be performed under the inspection of the Inspector.

2E. Riser Pipe for Service Leads

Where shown on the Plans or directed by the Public Services Director, the Contractor shall furnish and place risers extending from the branch opening of the sewer up to within eight to ten feet of the proposed finished grade. These pipes shall be laid with joints as specified above. These risers shall be laid up and held in place as required by the Standard Details. The connection fitting when a riser is to be used shall be a tee fitting. Openings in the top of the riser pipe shall be closed, marked, and staked as specified above.

2F. Abandonment of Sewer

The Contractor shall abandon sewers where shown on the Plans. This shall include either removing a minimum of five feet of the main at each manhole and placing flow fill grouting the full length and volume of the abandoned sewer, or removing the entire run of sewer. Abandonment shall also include breaking down any manholes (remove manhole ring and cover and the top 4' of manhole structure, breaking of the manhole base, and backfill as specified in **Division IV, Section 1G. Backfilling** of these Standards) in the abandoned line, salvaging any removed manhole ring and cover and returning them to the Utilities Department, and bulkheading the abandoned pipe in manholes to remain with brick and mortar.

2G. Cured-In-Place Pipe (CIPP) for Existing Sewers

The Contractor shall remove all debris from the existing sewer line by jetting and vactoring of the line. The Contractor shall also, when required by the Public Services Director, provide bypass pumping of the flow of sewage around the section or sections of pipe designated for lining. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole. The pump and bypass lines shall be of adequate size and capacity to handle the flow.

The existing sewer designated for lining shall be television inspected by the Contractor to determine the location of any conditions which may prevent proper installation of the CIPP tubes, and these locations shall be noted so that these conditions can be corrected. A video tape and log of these locations shall be submitted to the Public Services Director for review. The Contractor shall clear the line of obstructions such as solids and roots which will prevent the insertion of the CIPP tube. If the television inspection reveals an obstruction that will prevent the insertion of the CIPP but which cannot be removed by conventional sewer cleaning equipment, such as a protruding service connection, dropped joint, or a collapse, the Contractor shall excavate the sewer line and remove or repair the obstruction. Such excavation shall be approved in writing by the Public Services Director prior to the commencement of the work and in a City Project shall be paid for as a separate pay item.

The Contractor shall designate a location, approved by the Public Services Director, where the CIPP tube shall be vacuum impregnated prior to installation, in order to allow the Public Services Director to inspect the materials and "wet-out" procedure. A resin and catalyst system compatible with requirements of this method shall be used. The quantity of resin used shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A roller system shall be used to uniformly distribute the resin throughout the tube. The CIPP tube dimensions and quantities of the liquid thermosetting materials shall be per INA manufacturer's standards to provide the wall thickness specified.

The impregnated tube shall be inserted into a vertical inversion standpipe with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the resin impregnated tube shall be turned inside out and attached to the standpipe so that a leak proof seal is created. Water shall be added to the standpipe, and will be adjusted so as to be of a sufficient height to cause the tube to invert to the termination point, hold the tube tight to the pipe wall, produce dimples at service connections and flared ends at the manholes. The use of a lubricant is recommended, and if used it shall meet the INA manufacturer's standards.

After the inversion is completed, the Contractor shall cure the CIPP by using a suitable heat source and water recirculation equipment to uniformly raise the water temperature above the temperature required to effect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed. The INA manufacturer's standards shall be closely followed during the elevated curing temperature so as not to over stress the felt fiber and cause damage or failure prior to cure. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such gauge shall be placed at the remote manhole to determine the temperatures at that location during cure. Initial cure shall be deemed to be completed when inspection of the exposed portions of the pipe material appear to be hard and sound. The cure period shall continue for a duration recommended by the resin manufacturer, during which time the recirculation of the water at the prescribed temperature shall continue.

The Contractor shall cool the CIPP to a temperature below 100°F before relieving the static head in the inversion standpipe. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Care shall be taken in the release of the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

The finished CIPP shall be continuous over the entire length of an inversion run between two manholes and be free from visual defects such as foreign inclusions, dry spots, pinholes and delamination. The Contractor shall conduct a hydrostatic test on the CIPP to determine its water tightness. The test shall be conducted by using the existing hydrostatic head of 4 to 6 psi provided by the inversion standpipe. The test time shall be five minutes, during which time no makeup water shall be added to the standpipe. If at the end of the test period no water loss is observed in the standpipe, the water tightness of the CIPP will be considered satisfactory.

If due to broken or misaligned pipe at the manhole wall, the CIPP fails to make a tight seal, the Contractor shall apply a seal at that point with a material compatible with the CIPP material.

After the CIPP has cured, the Contractor shall reopen/restore all existing active service connections and branch connections. This shall be done from the interior of the pipeline by means of a remotely controlled cutting device, monitored by a close circuit television camera, re-establishing these service connections to their operational capacity.

Following the completion of the work, the Contractor shall provide to the Public Services Director a video tape and report log showing the lined sewer, including the restored connections. This television inspection shall meet the requirements of

Division IV, Section 2H. Sewer Testing of these Standards.

2H. Sewer Testing

All sanitary sewers, including leads, 36 inches and smaller shall be air tested by the Contractor. All sanitary sewers greater than 36 inches shall be infiltration or exfiltration tested by the Contractor. The Public Services Director will decide whether infiltration or exfiltration testing is performed based upon ground water conditions. All sewers, both sanitary and storm, except 4 inch and 6 inch leads, shall be television inspected by the

Contractor. All PVC sanitary sewer mains and all high density polyethylene (HDP) storm sewers shall be mandrel tested. All sewer must meet each test, in order (mandrel testing, air or infiltration/exfiltration, television inspection), before the next test is performed. The Contractor shall furnish all labor, equipment and materials necessary for testing. Only after all tests have been successfully completed, and acknowledged by the Public Services Director in writing, may the sewer be placed in service.

Mandrel Testing

All PVC sanitary sewer mains and HDP storm sewers shall be mandrel tested for deflection by the Contractor. The mandrel shall be a commercially produced, nine fin mandrel, with the pipe diameter, percent deflection and applicable ASTM or AASHTO standard stamped on the fins. The testing is to take place after the sewers have been in place for a minimum of 30 days. The mandrel shall be pulled from structure to structure. Any portion of the pipe through which the mandrel passes freely shall be deemed to have passed the mandrel test. Sections of pipe through which the mandrel does not pass freely shall be exposed and examined. Based on this examination either the pipe zone bedding and backfill shall be improved or the pipe replaced. The pipe shall then be retested before approval is granted.

The mandrel is to be constructed in accordance with the following table:

<u>Pipe I.D.</u>	<u>HDPE Mandrel O.D.</u>	<u>SDR 35 PVC Mandrel O.D.</u>
8"	7.54"	7.28"
10"	9.41"	9.08"
12"	11.54"	10.79"
15"	14.27"	13.20"
18"	17.24"	N/A
24"	23.18"	N/A

Air Test

The air test can be dangerous. Lack of understanding, carelessness, or an improperly prepared line must be avoided. It is extremely important that the plugs be installed in such a way as to prevent blowouts. Sudden expulsion of a poorly installed or partially deflated plug can cause serious injury or damage. As a safety precaution, pressurizing equipment must include a relief valve set at not more than 10 psig. No one will be allowed in the manholes during testing.

In areas where ground water is known to exist and the sewer is to be air tested, the Contractor shall install a 1/2-inch diameter by approximately 10 inch long pipe nipple, through the manhole wall above one of the sewer lines entering the manhole. The pipe nipple shall be capped on the inside of the manhole at the time the sewer line is installed. Immediately prior to the performance of the air test, the ground water level shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the pipe nipple. The tube shall be held vertically and a measurement of the height in feet of water above pipe centerline shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.31 to establish the pressure (in psig) that will be considered to be the average ground water back pressure.

The normal sequence and time requirements for air testing are:

1. After a manhole-to-manhole section of line has been backfilled and cleaned, it shall be plugged at each manhole with pneumatic plugs. The design of the pneumatic plugs shall be such that they will hold against the line test pressure without requiring external blocking or bracing. There shall be three hose connections to the pneumatic plug. One hose shall be used only for inflation of the pneumatic plug. The second hose shall be used for continuously reading the air pressure rise in the sealed line. The third hose shall be used only for introducing low pressure air into the sealed line.
2. Low pressure air shall be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any ground water pressure that may be over the pipe. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period, the pressurization hose shall be disconnected to prevent air from entering or escaping from the line.

There shall be a pressure gauge for reading the internal pressure of the line being tested. The gauge shall be capable of showing pressure as low as 0 psig up to no greater than 20 psig. In the 0-10 psig range the gauge shall be both calibrated and accurate to one-tenth of one pound. The 0-10 psig portion of the gauge dial shall cover at least one-half of the complete dial range. This gauge shall have a tee fitting to allow simultaneous pressure reading by a City gauge.

3. The time requirement for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time given in the following table:

Pipe	VCP & RCP SEWERS	PVC & DIP SEWERS	
	Minimum Holding Time Seconds/100 ft. Pipe	Holding Time (Seconds)	Minimum Holding Time (Min:Sec)
4-	18	0.380 x	3:46
6-	42	Length	5:40
8-	72	0.854 x L	7:34
10-	90	1.520 x L	9:26
12-	108	2.374 x L	11:20
15-	126	3.418 x L	14:10
18-	144	5.342 x L	17:00
21-	180	7.692 x L	19:50
24-	216	10.470 x L	22:40
30-	288	13.674 x L	28:20
36-	360	21.366 x L	34:00
		30.768 x L	

Infiltration Test

The Contractor shall place temporary weirs for testing purposes in such manholes as necessary to measure the amount of infiltration. Test sections shall be no longer than 1,200 feet.

The allowable amount of infiltration shall not be more than 200 gallons per inch of pipe diameter per mile of sewer per 24 hours, including manholes. The Contractor shall repair all visible leaks regardless of the results of the infiltration test.

If the allowable limit of infiltration is exceeded on any test section, the Contractor shall reconstruct or repair the defective portion of the sewer, and re-test.

Exfiltration Test

The standpipe method will be used from manhole to manhole for the length of pipe to be tested. A hydrostatic head of 10 ft. to the sewer's average centerline elevation will be required, with adjustments for external submergence due to water in the trench. The Public Services Director will establish time durations and procedures for each test. The maximum allowable exfiltration rate will be 200 gallons per inch of pipe diameter per mile of sewer per 24 hours including manholes. Upon completion of this test on a sanitary sewer, the Contractor shall pump all water out of the downstream manhole to a storm sewer.

Television Inspection

A preliminary television inspection must be approved prior to the preliminary acceptance of the sewers, and prior to any building connections being made. A final television inspection will be performed by the Utilities Department within a year of the completion of sewer construction and after the completion of all paving and/or site work. This final television inspection must be approved prior to final release of the Contractor's one-year guarantee for sewer construction. The Public Services Director shall be given 24 hours notice so that an Inspector may witness the preliminary television inspection. All sewer lines are to be thoroughly cleaned prior to television inspection, by jetting of the lines or other approved methods. Television inspection shall consist of wetting the invert of the section by pouring clean water in the upstream manhole until it appears in the downstream manhole, and then, after the water has stopped flowing, passing a television camera through the section. The camera shall be connected to a monitor and video tape recorder. The tape shall indicate the date, the section tested, and the actual distance from the beginning manhole to each tee or wye, and each visible defect. The tape shall be furnished to the Public Services Director for further review.

The television inspection will be deemed satisfactory if no visible defects, including, but not limited to, dips or low spots, high spots, errors in horizontal or vertical alignment, joint offsets, leaks, cracks, or debris, are present.

2I. Sewer Repairs

If a sewer repair is required as a result of damage during construction operations, air test failure, or television inspection failure, the Contractor shall expose the sewer pipe and perform the required correction(s), as specified herein and as directed by the Public Services Director.

If the repair is required due to the pipe being out of alignment or off grade, the pipe shall be adjusted so as to be placed in proper alignment and grade. Dense-graded aggregate material shall be carefully placed under the haunches of the realigned pipe and compacted by the use of a tee-bar. From the haunches of the pipe, backfilling shall be performed in accordance with **Section 1G. Backfilling**.

If the pipe cannot be satisfactorily realigned or an open joint reset; or if the pipe is cracked, broken, or permanently deflected, the affected pipe shall be removed and

replaced with the same pipe material. The pipe to be removed is to be sawed on each side of the damaged section in a neat and workmanlike manner without damage to the adjacent pipe. The replacement pipe section shall fit flush to the remaining pipe at each end. These sawed joints shall be coupled using a Fernco flexible coupling and stainless steel shear ring. These joints shall be encased to the pipe centerline with Class X concrete one foot on either side of the flexible coupling. The remaining pipe backfill shall be performed in accordance with **Section 1G. Backfilling.**

3. **WATER MAIN CONSTRUCTION**

3A. **Connection to Existing Water Mains**

Dry Tap

When a connection to an existing water main is to be made in the dry, the existing main to which a connection is to be made shall be isolated by the closing of the necessary existing valves, and the water from the existing main shall then be pumped out or removed by other means so that the connection may be made in the dry. All pipe materials and appurtenances which will come into contact with potable City water after the restoration of water service following the connections shall be disinfected with a strong chlorine solution prior to installation.

It shall be the responsibility of the Contractor to assist the City in notifying all persons affected by any City utility shut-off prior to the shut-off. No shut-off will be permitted without 24 hour prior notice to the persons affected in residential property, and two full working days notice to persons affected in commercial property.

It is possible that the valves which need to be operated to facilitate a shutdown will not close entirely, thereby allowing water to leak past the valve into the area of the shut-down. The Contractor shall provide the necessary equipment and labor to enable work to be completed with a poor shut-down. It is the intent of the City to provide the best possible shut-down of water mains. However, in the event that water leaks past valves into the shut-down area, the Contractor on a City project will not be entitled to any additional compensation due to damages and/or delays other than an extension of the Contract completion date equal to the time of delay.

City personnel shall locate and operate, or direct the operation of, all necessary valves for the shutdown. The Contractor shall provide the necessary personnel to assist in valve operations if requested by City Personnel. The Contractor shall not operate valves without the direction of the City; any unauthorized valve operations is a violation of Title II, Chapter of the City Code, and violators will be subject to citation.

Due to the size and length of pipe being shut down, and the quality of shut-down attained, large amounts of water may need to be removed from the excavation. Where possible, the water shall be run directly into nearby storm sewer inlets via pumps and hose.

The Contractor shall have all pipe, fittings and appurtenances required to complete the water main connection prior to the excavation for the connection, or the work will not be allowed to commence.

No water main shutdown shall take place after 12:00 noon, unless written permission has been granted by the Public Services Director and that the Contractor has sufficient lighting equipment to provide a safe and efficient work area for working after dark. No No water main will be shut down until the main has been exposed and cleaned, and is ready to be cut.

There shall be no gap larger than 1/4 inch left in the existing water main as a result of the tie-in. If needed, a closure piece ("thrust ring") of such size so as to meet this requirement shall be installed.

Wet Tap

Prior to the installation of a tapping sleeve, the section of pipe to be tapped shall be cleaned of all foreign material and wire brushed to a smooth surface. The two halves of the sleeve shall be placed around the pipe with the gaskets installed per the manufacturer's instructions. The bolts shall be tightened evenly from the center toward the ends. The bolts shall be torqued to the manufacturer's specification.

When performing a wet tap in a prestressed concrete steel cylinder water main, grout is to be placed under the tapping saddle whether or not the saddle is epoxy coated.

All pipe materials and appurtenances which may come into contact with potable City water shall be disinfected with a strong chlorine solution prior to installation. This includes the pipe section to be tapped, the two halves of the sleeve, gaskets and the gate valve.

Prior to installation of the end gaskets, the sleeve shall be blocked with cement bricks such that the outlet is in proper position. The end gaskets shall be installed with an overlap as specified by the manufacturer.

The glands shall be assembled on the pipe. The bolts around the gland shall be tightened evenly, causing the gaskets to uniformly compress.

The valve shall be installed on the sleeve following the manufacturer's instructions.

Prior to tapping, the assembly shall be tested using the test plug tap in the sleeve with the valve closed, or by placing a tapped plug on the outlet of the valve with the valve open. The assembly shall be pressurized to 150 psi and hold the pressure fifteen minutes.

After the pressure test is complete, the pipe shall be tapped.

3B. Oversized Water Mains

Portions of the proposed water mains or fittings may connect with existing water

mains or fittings. The possibility exists that some of the existing water mains may have been constructed using oversized pipe. Where tie-ins or interconnections are specified and the existing main is found to be oversized, the Contractor shall furnish and install CLOW 350IB SLEEVES, TYLER DUAL SLEEVE 5-146L, or ROCKWELL 44I SLEEVES. These sleeves are to be present on the jobsite prior to the excavation for the water main connection, or the work will not be allowed to commence.

3C. Permissible Deflection at Joints

Wherever it is necessary to deflect ductile iron pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions, to plum valve stems, or where long-radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory making of the joint, and shall be approved by the Public Services Director. The deflection shall not exceed the following amounts:

<u>Size of Pipe (Inches)</u>	<u>Joint Angle (Degrees)</u>	<u>Deflection in 18 ft. (Inches)</u>	<u>Approx. Radius of Curve Pro- duced by Succession of 18 ft. Lengths (feet)</u>
4	5	19	205
6	5	19	205
8	5	19	205
10	5	19	205
12	5	19	205
16	3	11	340
20	3	11	340
24	3	11	340

The above joint deflection angles apply to fittings as well as pipe joints.

3D. Cutting Pipe

Cutting cast iron or ductile iron pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the longitudinal axis. Where the type of pipe joint in use is such that it employs push-on assembly to effect the joint seal, the outside of the cut end shall be tapered back 1/8 inch with a coarse file or a portable grinder at an angle of about 30 degrees. The tapering must remove all sharp and/or rough edges which might injure the gasket.

The flame cutting of pipe will not be allowed.

Reinforced concrete water main pipe shall not be cut.

3E. Setting Water Main Fittings and Accessories

Valves, fittings, plugs, hydrants, etc. shall be set and joined to pipe in the manner specified in **Section 1F. Making Joints.**

Hydrants shall be located as shown on the Plans or as directed by the Public Services Director in such a manner as to provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians.

Hydrants shall be set to stand plumb with their nozzles either parallel or at right angles to the street, with the pumper nozzle facing the street. Plumb shall mean within one inch in six feet. Hydrants shall be set with pumper nozzles between 18 inches and 24 inches above finished grade, or as directed in writing by the Public Services Director.

3F. **Anchorage for Water Main Fittings and Accessories**

All plugs, caps, tees, hydrants, and bends shall be provided with a Class A concrete reaction backing (thrust block) as shown on the Plans or specified herein. Valves shall be restrained from movement at adjacent sleeves by the use of a closure piece, or "thrust ring" (full size pipe section cut to fill the gap inside the sleeve to within 1/4") as specified herein.

Reaction backing shall be placed between unexcavated solid ground and the fitting to be anchored. The area of bearing on the pipe and on the ground in each instance shall be that shown on the Details or directed by the Public Services Director. The reaction backing shall, unless otherwise shown or directed, be so placed that the pipe and fitting joints will be accessible for repairs. This shall include adequate protection of any bolts from direct contact with the concrete.

Metal harnesses of tie rods or clamps may not be used instead of concrete reaction backing. Megalug joint restraint systems and restrained push-on joint pipe shall be used where connections to existing lines require immediate pressurization, as specified herein.

In the event that the Public Services Director determines a change in the anchorage or design is required due to unsuitable earth conditions, changes may be ordered by the Public Services Director.

The use of friction clamps or set-screw type retainer glands for thrust restraint will not be allowed.

3G. **Abandonment of Water Main**

The Contractor shall abandon water mains where shown on the Plans. This includes, but is not limited to, cutting the main at each end, plugging the live main at the end(s) with mechanical joint plug(s) and thrust block(s), plugging the abandoned main at end(s) with brick and mortar, concrete, or mechanical joint plug, breaking down any manholes (remove manhole ring and cover and the top 4' of manhole structure, breaking out the manhole base, and backfill as specified in **Division IV, Section 3F. Backfilling** of these Standards) in the abandoned line, removing and salvaging any valves and fittings and returning them to the City and plugging the pipe in manholes with brick and mortar, concrete, or mechanical joint plugs.

3H. **Water Main Testing**

The water main shall be disinfected and tested by the Contractor in the presence of the Public Services Director in accordance with the requirements below. The

Contractor shall furnish all piping, pumps, gauges and other materials and equipment required to carry out the tests using water from the City's water mains. Any hoses which are needed to direct water from blow-offs and/or hydrants during water main testing and flushing shall be supplied by the Contractor. The City shall furnish and install one inch corporation stops at all necessary locations, at the expense of the Contractor. The tapping of water mains, the installation of all corporation stops, and the operation of valves and hydrants is reserved for City personnel. The Contractor is required to assist in valve and hydrant operation, however. The Contractor shall give the City forty-eight hours prior written notice of intent and desire to test water mains. If the Contractor so desires, the Public Services Department-Engineering Division will (when personnel and equipment are available) perform disinfecting and pressure testing for the Contractor at the Contractor's expense.

Sequence

In the case of all water mains connected to existing facilities, flushing, chlorination and bacteriological testing must precede pressure testing. Where mains can be totally isolated from existing facilities with air gaps or double valves, pressure testing may precede chlorination and bacteriological testing. The normal sequence and time requirements for testing are:

<u>Isolated (Gapped) Water Main</u>	<u>Connected Water Main</u>
1) Fill Main	1) Flush and Swab*
2) Pressure Test	2) Chlorinate
3) Connect One End of Main	3) Wait; 24 hours
4) Flush and Swab*	4) Flush**
5) Chlorinate	5) Wait; 24 hours
6) Wait; 24 hours	6) Bacteriological
Samples	
7) Flush**	7) Wait; 24 hours
8) Wait; 24 hours	8) Bacteriological
Samples	
9) Bacteriological Samples	9) Wait; 48 hours
10) Wait; 24 hours	10) Pressure Test (If both
11) Bacteriological Samples	sets of
bacteriological	
12) Wait; 48 hours	samples pass)
13) Make Final Connection(s) - Place in	11) Flush*
Service (If both sets of	12) Wait; 24 hours
bacteriological samples pass)	13) Bacteriological
Samples	
*Collect flush water in operable storm water	14) Wait; 24 hours
Samples	15) Bacteriological
retention/detention facility.	
both	16) Wait; 48 hours
**Discharge flush water into approved sanitary	17) Place in Service (If
	sets of bacteriological

sewer.

samples pass)

The Contractor shall not connect any end of a newly constructed water main until after the passing of the hydrostatic test, unless approved in writing by the Public Services Director.

Hydrostatic (Pressure Test)

Insofar as is practical, mains shall be pressure tested between valves. The maximum length of water main to be tested in any one test shall be 1500 feet. The section of main to be tested shall be slowly filled with potable water and the entrained air within the pipe removed or absorbed and pumped up to a pressure of 150 psi (or other pressure if specified) and the test period shall start immediately thereafter. The lines shall then be maintained under a test pressure of 145-155 psi for a continuous period of three hours by pumping chlorinated (25 ppm) water into the line at frequent intervals. The volume of water so added shall be measured and considered to represent the leakage from the line under test during the interval. Visible leaks shall be repaired regardless of test results. The leakage under the conditions of the test shall not exceed the values shown in the table below. If one side of a double disc gate valve is under test pressure, that seat shall count as four joints.

Maximum Allowable Leakage per 100 Joints at 150 psi Avg. Test Pressure

Pipe Diameter (inches)	4	6	8	10	12	16	20	24	30	36
Leakage (gallons/hr.)	0.66	0.99	1.32	1.66	1.99	2.65	3.31	3.97	4.97	5.96

In the event that the leakage exceeds the maximum allowable leakage as specified above, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or fittings found to be leaking shall be removed and replaced with new pieces by the Contractor. After this work has been performed, all tests shall be repeated.

Flushing and Swabbing

The Contractor shall flush the water main after making a connection to the existing City water main where a valve separates the new water main from the existing main. As a result, flushing will be accomplished using flow through the full size of the new water main. If a storm water retention/detention facility is to be constructed as part of the project, this facility is to be completed, stabilized, operable, and utilized for the collection of the flushing water. All pipe materials and appurtenances which will come into contact with potable City water after the restoration of water service following the connection shall be disinfected with a strong chlorine solution prior to installation.

At the time of the first water main flush, the new main shall be swabbed using a Girard Aqua Swab (AS) 2 lbs./cf density swab polly-pig or approved equal. If there are no branch connections to be swabbed, the polly-pig shall be inserted in the new water main at the time of connection described above. The polly-pig shall be located on the "downstream" or new side of the separation valve. The polly-pig shall then be forced through the new water main during the first flush and discharged through a construction blow-off of sufficient size to allow passage of the polly-pig. An alternative discharge point is an East Jordan 6-BR fire hydrant with its head and inner parts having been removed. For water mains with branch connections, a launching tee or wye shall be installed as shown in the Details, for launching multiple polly-pigs. The main line and each branch main shall be flushed and swabbed individually. Following the successful final bacteriological testing of the water main, the launching tee/wye shall be permanently capped at its branch.

During the flushing and swabbing of a water main, the discharge point for the main shall be left open, with all other discharge points closed, to direct the polly-pig completely through the main being swabbed to its point of termination. Following the initial swabbing of water main, the separation valve shall be closed, then the discharge point closed. If a branch water main is to be swabbed, the polly-pig is then to be placed in the launcher; the discharge point for the branch water main is to be opened; the polly-pig is to be inserted into the water main; the separation valve partially opened and the branch water main flushed and swabbed.

Following the swabbing of the water main(s), they are to be flushed as required. If approved or directed by the Public Services Director, the water main(s) may be flushed overnight, provided that proper controls (i.e. hoses directed into storm structures, etc.) are installed to direct and control the flushing water.

Chlorination

After the water mains to be tested have been acceptably flushed, they shall be disinfected in accordance with AWWA C651 "Disinfecting Water Mains" and these Specifications. All new mains and fittings, and any existing mains contaminated by the Contractor, shall be chlorinated to a minimum residual of fifty (50) parts per million (ppm) with commercial liquid chlorine solution (sodium hypochlorite) (pool type). Other forms of chlorination and disinfection methods of water mains may be presented by the Contractor and shall receive prior approval in writing by the Public Services Director before being

used. The minimum recommended dosage of sodium hypochlorite is as follows (based on 10% available chlorine):

Recommended Minimum Chlorine Dosage to Disinfect 100 L.F. of Pipe

<u>Pipe Diameter (inches)</u>	<u>10% Chlorine Solution (gal.)</u>
6	0.153
8	0.272
10	0.426
12	0.613
16	1.090
20	1.703
24	2.452

The chlorinated water shall remain in the mains for a minimum of 24 hours, at the end of which period the chlorinated water at all parts of the main must show a free available chlorine residual of at least twenty-five (25) ppm. If less than 25 ppm residual is shown at the end of the first 24 hour period, additional chlorine shall be added until a residual of not less than 25 ppm at all parts of the system is shown after a subsequent 24 hour period. The chlorinated water shall then be removed from the mains and disposed of into an existing, approved City sanitary sewer main, or other location approved in writing by the Public Services Director. The mains shall then be left full of water ready for bacteriological testing.

Bacteriological Testing

The City will take bacteriological samples of the water in the mains for analysis. Samples will be taken after the mains have been satisfactorily chlorinated in accordance with these Specifications, the chlorinated water flushed out, and the mains filled with potable water. If the water main is connected at one end and the chlorination precedes pressure testing, the City will also take samples after satisfactory pressure testing. In each case, two sets of samples shall be taken; a period of 24 hours must elapse between flushing of the main and drawing of the first samples, with the second samples being drawn 24 hours after the first samples were drawn. For each sample, a minimum of 48 hours is required to obtain test results. All samples must pass the bacteriological test.