Water and Wastewater Pipe Specifications

[Old Policy W-S-17.01]

12/18/2012
Winchester Utilities

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(not needed as policy – specifications document)

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WasteWater
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"Owner" refers to company of Winchester Utilities throughout this document.

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2.01 EXECUTION

A. The Contractor is responsible for having a thorough knowledge of all Drawings, Specifications, General and Supplementary Conditions, and other Contract Documents. Failure to acquaint himself with this knowledge does not relieve him of the responsibility for performing his work in a manner acceptable to the Owner. No additional compensation will be allowed because of conditions that occur due to failure by the Contractor to familiarize himself and all workers with this knowledge.

B. The Contractor shall be responsible for determining the existing conditions of the site and shall thoroughly examine all factors reasonably available to him, including but not limited to the Drawings, Specifications, site boundary and topography, site conditions, site history, local information, and seasonal weather conditions. Geotechnical report data is not available and it is the Contractor's responsibility to further investigate site conditions as he determines necessary. The Contractor shall be totally responsible for acceptance of the site and preparation of the site to the proper grade and compaction requirements as indicated by the Contract Documents including Construction Drawings and Specifications. Any construction performed by the Contractor on the project will constitute acceptance of the site.

C. The Material to be excavated is considered unclassified.

UNCLASSIFED EXCAVATION FOR UTILITIES

PART 1 GENERAL

The work called for by this section shall consist of clearing and grubbing, loosening, loading, removing, and disposing of, in the specified manner, all wet and dry materials (including rock) encountered that must be removed for construction purposes; furnishing, placing, and maintaining all sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work, the workmen, the public, and adjacent property and improvements; the dewatering of trenches and other excavations; the preparation of satisfactory pipe beds; the backfilling and tamping of trenches, foundations, and other structures; the perpetration of fills and embankments; the removal of unsuitable material from outside the normal limits of excavation and, where ordered by the A/E and/or owner, their replacement with suitable materials; and all other grading or excavation work incidental to or necessary for the work. This work shall be performed as specified below.

PART 2 EXECUTION

2.1 PREPARATION OF THE SITE

A. Before starting construction, remove from the work site all vegetable growth (except as hereinafter excluded), debris, and/or other objectable matter as well as any buildings and/or other structures that the drawings and/or the A/E and/or owner specifically indicate are to be removed. Dispose of this refuse material in a manner acceptable to the A/E and/or owner.

B. In certain areas it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the drawings, specifically listed in the specifications, marked on the site, or identified by the A/E and/or owner. In no case damage or remove such growth without written permission from the Owner.

C. If the area to be excavated is occupied by trees, brush, or other vegetable growth, clear such growth and grub the excavated area, and remove all large roots to a depth of not less than 2 feet below the bottom of the proposed construction. Dispose of the growth removed in a manner satisfactory to the A/E and/or owner. Fill all holes or cavities created during this work that extend below the subgrade elevation with suitable material, and compact to the same density as the surrounding material.

D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the A/E and/or owner. Take special precautions to protect and preserve such growth throughout all stages of the construction.

E. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

2.2 UNSUITABLE MATERIALS

Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed in the manner described below. Then refill the areas excavated for this reason with crushed stone. The top 6 inches of this refill shall be No. 67 (TDOT) crushed stone for bedding.

2.3 ROCKS AND BOULDERS

A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made thereof.

B. Should rock be encountered in the excavation, remove it by blasting or otherwise. Where blasts are made, cover the excavation with enough excavation material and/or timber or steel to prevent danger to life and property. The Contractor shall secure, at his own expense, all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable laws and ordinances pertaining to blasting operations.

C. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the bottom of pipe up to 30 inches in diameter and not less than 12 inches below the bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 67 (TDOT) crushed stone or other approved material, tamp to the proper grade, and make ready for construction. For brick or monolithic concrete sewers and for structures, excavate rock to the outside bottom of the structure or sewer.

2.4 DISPOSAL OF MATERIALS

A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the drawings or directed by the A/E and/or owner shall be used for these purposes. Any materials not so used shall be considered waste materials and disposed of by the Contractor as specified below.

B. Waste materials may be deposited in spoil areas at locations approved by the A/E and/or owner. Do not leave in unsightly piles but instead spread in uniform layers, neatly levels, shape to drain. Seed as specified in “Seeding” section starting on page 9 of this document.

C. Once any part of the work is completed, properly dispose of all surplus or used materials (including waste materials) let within the construction limits of that work. Leave the surface of the work in a neat and workmanlike condition, as described below.

D. The disposal of waste materials shall be considered an integral part of the excavation work and one for which no separate payment shall be allowed.

2.5 EXCAVATION FOR TRENCHES, MANHOLES, AND STRUCTURES

A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of water, sewer, and other pipes and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.

B. The Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connection.

C. Unless the construction of lines by tunneling, jacking, or boring is called for by the drawings or specifically authorized by the A/E and/or owner, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E and/or owner on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of this sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula: 4/3d + 15 inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by A/E and/or owner, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the A/E and/or owner to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

D. For rigid pipe, shape the bottom of all trenches to provide uniform bearing for the bottom of the pipe barrel. For plastic sewer lines, provide a minimum of 6 inches of No. 67 (TDOT) crushed stone for bedding.

E. Excavate bell holes for bell and spigot pipe at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than 2 joints ahead of pipe laying.

F. Excavation for manholes, inlets, and other incidental structures shall not be greater in horizontal area than that required to allow a 2-foot clearance between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings. No earth backfilling will be permitted under manholes, inlets, headwalls, or similar structures. Should the Contractor excavate below the elevation shown or specified, he shall, at his own expense, fill the void with either concrete or granular material approved by the A/E and/or owner.

G. Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and perform all work so as to cause the least possible inconvenience to the public.

Construct temporary bridges or crossings when and where the A/E and/or owner deems necessary to maintain vehicular or pedestrian traffic.

H. In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.

I. Excavation for manholes and other structures may be performed with nonvertical banks except beneath pavements or adjoining existing improvements. Do not permit the horizontal area of the excavation to exceed that required to allow a 2-foot clearance between the outer excavation or the sheeting used to protect the embankments. The bottom of the excavation shall be true to the required shape and elevation.

2.6 SHEETING, SHORING, AND BRACING

A. Take special care to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the part excavation work.

B. Whenever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5 feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than 5 feet deep when examination of the ground indicated hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.

C. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done. The sheeting, shoring, and bracing system shall be designed by a professional engineer licensed in the State of Tennessee and shall be subject to approval by the A/E and/or owner. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of sheeting, shoring, and bracing.

D. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the side of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the A/E and/or owner.

E. Do not leave sheeting, shoring, or bracing materials in place unless this is called for by the drawings, ordered by the A/E and/or owner, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are

avoided.

F. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.

G. The Contractor may use a trench box, which is a prefabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

2.7 THE DEWATERING OF EXCAVATION

Provide and keep in operation enough suitable pumping equipment whenever necessary or whenever directed to do so by the A/E and/or owner. Give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift.

2.8 BORROW EXCAVATION

A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, then obtain additional material from the other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and suitability of its material shall be approved by the A/E and/or owner.

B. Excavate borrow pits in such a way that the remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave the sides of borrow pit cuts at a maximum slope of 2:1 unless otherwise directed by the A/E and/or owner.

C. Properly clear and grub borrow pits, and remove all objectionable matter from the borrow pit material before placing it in the backfill.

D. The taking of materials from borrow pits for use in the construction of backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

2.9 BACKFILLING

A. Begin backfilling after the line construction is completed and then inspected and approved by the A/E and/or owner. On each side of the Line, from the bottom of barrel to 1 foot above the top of the pipe, the backfill material shall consist of either fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of no more than 2 inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than 6 inches deep. Thoroughly and

completely tamp each layer into place before placing additional layers. When shown on the drawings, this backfill shall, at locations beneath or closely adjacent to pavement, consist of No. 67 (TDOT) crushed stone.

B. If plastic sewer pipe is used, install No. 67 (TDOT) crushed stone in a 6-inch envelope in all sides of the pipe and over the pipe. Then add remaining backfill as described in the previous paragraph.

C. From 1 foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume. However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed 6 inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, tamp and thoroughly compact the backfill in other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.

D. If earth material for backfill is, in the opinion of the A/E and/or owner, too dry to allow thorough compaction, then add enough water so that the backfill can be properly compacted. Do not place earth that the A/E and/or owner considers too wet or otherwise unsuitable.

E. Wherever excavation has been made within easements across private property, the top 1 foot of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone, and/or other objectionable materials.

F. Wherever trenches have been cut across or along existing pavement or driveways, temporarily pave the backfill of such trenches by placing Class A, Grade D, crushed stone as the top 12 inches of the backfill. Maintain this temporary pavement either until the permanent pavement is restored or until the project is accepted by the Owner.

G. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.

H. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within 1 foot above the pipe.

I. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary, whenever directed to do so by the A/E and/or owner.

J. Backfilling and clean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the A/E's and/or owner requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.

K. Compaction Requirements: Under buildings and 2 times the depth of pipe beyond, and under roads and 2 times the depth beyond the shoulder, compact to 95% maximum density in accordance with ASTM D698, in all other locations, compact to 90% maximum density, or backfill the trench entirely with crushed stone.

2.10 MAINTENANCE

A. Seed and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Owner.

B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the A/E and/or owner. Continue such maintenance until final acceptance of the project, or until the A/E and/or owner issues a written release.

2.11 SLOPES

Neatly trim all open cut slopes, and finish to conform to either the slope lines shown on the drawings or the directions of the A/E and/or owner. Leave the finished surfaces of bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though the Contractor will not required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond slope.

SEEDING

PART I GENERAL

1.1 This work shall be performed in all existing grassed areas disturbed during construction, and shall include, but not necessarily be limited to, all seed bed preparation, the supplying and placing of fertilizer, seed, agricultural limestone, and mulch. Seeding shall not be required within the demolition area contained by the existing building.

1.2 Refer to other sections for items affecting seeding. Coordinate this work with that specified for timely execution.

PART 2 PRODUCTS

2.1 Grass Seed meeting the requirements of the State Department of Agriculture and furnished in new bags that are sound and not mended, no “below standards’ seed accepted. The seed shall be a uniform mixture of:

Planting Period	Seed Mixture
March 15 — May 15	Kentucky 31 Fescue at 120 pounds per acre or Bermuda grass at 80 pounds per acre.

May 15 — August 15	Mixture of Bermuda grass at 80 pounds per acre and Korean Lespedeza at 20 pounds per acre.
August 15 — March 15	Mixture of Kentucky Fescue at 120 pounds per acre and White Clover at 30 pounds per acre and annual Ryegrass at 50 pounds per acre.

2.2 Fertilizer: Commercially manufactured, Grade 10-10-10, furnished in standard containers that are clearly marked with the name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling, and in compliance with all state, and federal fertilizer laws.

2.3 Agricultural Limestone: Containing a minimum of 85% calcium carbonate and magnesium carbonate combined, 85% of which passes a No. 10 mesh sieve.

2.4 Mulch: Stalks of rye, oats, wheat, or other approved grain crops properly cured prior to baling, air dried, and reasonably free of noxious weeds and weed seeds or other material detrimental to plant growth.

PART 3 EXECUTION

3.1 Perform all seeding and related work as a continuous operation. Sow seeds as soon as the seed bed has been prepared, and perform subsequent work in a continuous manner.

3.2 Before beginning seeding operations in any area, complete the placing of topsoil and final grading, and have the work approved by the A/E and/or owner.

3.3 Scarify, disk, harrow, rake or otherwise work each area to be seeded until the soil has been loosened and pulverized to a depth of not less than 2". Perform this work only when the soil is in a tillable and workable condition.

3.4 Apply fertilizer and agricultural limestone uniformly over the seed bed, and lightly harrow, rake, or otherwise incorporate them into the soil for a depth of approximately 1" at the following rates:

Fertilizer: 20 pounds per 1,000 square feet
Agricultural Limestone: 100 pounds per 1,000 square feet

3.5 Sow seed uniformly with a rotary seeder, wheelbarrow seeder, or hydraulic equipment or by other satisfactory means.

3.6 Perform no seeding during windy weather or when the ground surface is frozen, wet, or otherwise untillable.

3.7 Spread mulch material evenly over the seeded area immediately following the seeding

operation. Mulch Rate: 150 pounds per 1,000 square feet.

3.8 The mulch rate may be varied by the A/E and/or owner, depending on the texture and condition of the mulch material and the characteristics of the area seeded. Cover all portions of the seeded areas with a uniform layer of mulch so that approximately 25% of the ground is visible.

3.9 No equipment, material storage, construction traffic, etc., will be permitted on newly seeded ground.

3.10 Dispose of all surplus materials as directed by the Owner.

3.11 The A/E and/or owner shall inspect the seeding within 60 days after planting and determine if it is acceptable.

3.12 Secure an acceptable growth of grass in all area designated for seeding.

3.13 An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representatives of the seed mixture. If an acceptable growth is not obtained on the first planting, reseeding and mulching will be required.

3.14 If the planting is less than 50% successful, rework the ground, refertilize, reseed, and remulch. Reworking the ground, refertilizing, reseeding, and remulching will not be a pay item.

PAVEMENT REPAIR

PART 1 GENERAL

1.1 The work specified by this section shall consist of repairing or replacing all damaged pavement, whether public or private. Dirt shoulders, roads, streets, drives, and walks are to be restored to their original condition as an incidental part of the installation of utilities. Repair damaged base on either side of a trench wherever necessary. Repair the entire area as specified below and as shown on the drawings or on the standard drawings. The entire street width shall be paved from the edge of the existing pavement to the edge of the existing pavement and from a point 2 feet before the damaged area to a point 2 feet past the damaged area. Where the pavement repair abuts the existing pavement, the existing pavement shall be cut in a straight line and excavated to a depth necessary to provide a smooth transition from the existing pavement surface to the new pavement surface while providing the new pavement to a thickness of 4 inches.

1.2 Both these specifications and the drawings make reference to the current edition of the standard specifications of the Tennessee Department of Transportation (TDOT). Even though the weather limitations, construction methods, and materials specifications contained in the TDOT specifications may not be explicitly repeated in these specifications, they shall, wherever applicable to the work called for by this sections, be considered as implied and therefore adhered to. However, the various subsections “Basis for Payment” contained in the TDOT specifications shall not be considered applicable.

1.3 Refer to other sections for items affecting paving.

PART 2 PRODUCTS

2.1 Mineral Aggregate Base: Class A, Grading D crushed stone (TDOT) specifications, (Section 303 Subsection 903.05).

2.2 Bituminous Prime Coats: Cutback asphalt, Grade RC-250, or emulsified asphalt, Grade AE-P (Section 402, Subsections 904.02 and 904.03).

2.3 Crushed Stone Chips: Size 6 or Size 7 (Subsection 903.14).

2.4 Double Bituminous Surface: for both course, either cutback asphalt, Grade RC-800 or RC-3000, or emulsified asphalt, Grade RS-2 (Subsections 904.02 and 904.03).

2.5 Asphalt Concrete Binder: Grading B (Section 307).

2.6 Bituminous Tack Coat: Grade AE-3 (Section 403, Subsection 904.03).

2.7 Asphaltic Concrete Surface: Grading E (Section 411)

2.8 Quick Dry Traffic Paint (White and Yellow): Subsection 910.05.

PART 3 EXECUTION

3.1 SUBGRADE

A. Before any base material is installed, compact the subgrade of the area to be paved to 95% of optimum density as determined by ASTM D698 (Standard Proctor).

B. The backfill material shall contain no topsoil or organic matter. For all areas where subgrade has been prepared, test for uniformity of support by driving a loaded dump truck at a speed of 2 to 3 mph over the entire surface. Make further improvements on all areas that show a deflection of 1" or more. When completed, the finished subgrade shall be hard, smooth, stable, and constructed in reasonably close conformance with the lines, grades, and typical cross sections shown on the drawings.

C. When a base course is compacted, cut back the surface course of the existing pavement a minimum of 1 foot beyond the limit of the joint between the old and new base course or as shown on the standard drawings. Take special care to ensure good compaction of the new base course at the joint. Apply and compact the surface to conform to the existing pavement so that it will have no surface irregularity.

3.2 BASE

Install a mineral aggregate base of the type specified above in accordance with Section 303 of the TDOT specifications. The maximum compacted thickness of any one layer shall be 6".

3.3 SEAL COAT SURFACE

Uniformly apply a bituminous prime coat of either emulsified asphalt, Grade AE-P, or cutback asphalt, Grade RC-250, over the entire width of the area to be surfaced at a rate of 0.3 gallon per square yard. Immediately after application, uniformly cover the entire area size 7 crushed stone ships at a rate of 12 pounds per square yard.

3.4 DOUBLE BITUMINOUS SURFACE

A. Apply the first course at a rate of 0.38 to 0.42 gallon per square yard with either emulsified asphalt, Grade RS-2, or cutback asphalt, Grade RC-800 or RC-3000, and then immediately cover with Size 6 crushed stone chips at a rate of 33 to 37 pounds per square yard. After this is rolled, apply the second course at a rate of 0.30 to 0.35 gallon per square yard, and at once uniformly cover with Size 7 chips at a rate of 20 to 25 pounds per square yard. Then roll the entire area.

B. After the application of the cover aggregate, lightly broom or otherwise maintain the surface for a period of (4) days, or as directed by the A/E and/or owner. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free bitumen and cover any areas deficient in aggregate. Sweep excess material from the entire surface with rotary broom. Sweep the surface at the time determined by the A/E and/or owner.

3.5 ASPHALTIC CONCRETE BINDER

A. Apply a bituminous prime coat of emulsified asphalt, Grade AE-P, or cutback asphalt, Grade RC-250, at a rate of 0.38 to 0.42 gallon per square yard. Take care to prevent

the bituminous material's splashing on exposed faces of curbs and gutters, walls, walks, trees, etc. If such splashing does occur, remove it immediately. After the prime coat has been properly cured, apply and asphaltic concrete binder.

B. Carefully place the material to avoid segregation of the mix. Broadcasting of the material will not be permitted. Remove any lumps that do not readily break down.

3.6 ASPHALTIC CONCRETE SURFACE

If the asphaltic concrete surface course is to be placed directly on the mineral aggregate base, place a bituminous prime coat as described above. If, however, the surface course is to be placed on a binder course, then apply a bituminous tack coat of the sort specified above under PRODUCTS at a rate of 0.05 to 0.10 gallon per square yard. Take care to prevent the bituminous material's splashing on exposed faces of curbs, gutters, walls, walks, tress, etc., if such splashing does occur, remove it immediately. After the prime or tack coat has been properly cured, apply the asphaltic concrete to the thickness and width shown on the drawings. Apply the surface course as described above for the binder course.

3.7 SMOOTHNESS

The finished surface shall conform to the lines and grades shown on the drawings. No deviations, variations, or irregularities exceeding 1/4" in any direction when tested with a 12' straightedge will be permitted in the finished work, nor will any depression that will not drain. Correct all such defects.

3.8 SAMPLING AND TESTING

A. Submit to the A/E and/or owner test reports made by an independent testing laboratory on the crushed stone aggregate, bituminous materials, and asphaltic concrete design mixes, and obtain his approval of these reports before starting paving operations.

B. Tests shall be made on the completed elements of the pavement to ascertain the compacted thickness of the base and surface courses. If sections with deficient thicknesses are found, the full section for a reasonable distance on each side of the deficiency shall be refused. Remove and reinstall all such sections. Patch all test holes in connection with thickness tests.

C. When making surface tests, furnish one man to mark all surface defects for corrections.

MANHOLES

PART 1 GENERAL

1.1 Manholes shall be precast with eccentric cones unless otherwise approved by the A/E and/or owner.

1.2 Refer to other sections for items affecting manholes. Coordinate this work with that specified by other sections for timely execution

1.3 Shop drawings are required for casting, neoprene rubber gaskets, manhole steps, resilient pipe connection, and precast manholes specified in this section.

1.4 Manholes shall be watertight and of high quality.

PART 2 PRODUCTS

2.1 Concrete Masonry: Reinforced, meeting the applicable requirements of Section 03003, Concrete for Utility Lines.

2.2 Clay Brick (For Casting Adjustment): Clay brick shall be medium hard or better quality Grade MS sewer brick conforming to the requirements of ASTM C32-73. Brick shall be solid and not cored or frogged.

2.3 Mortar: Composed of one part portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use, mortar mixed for more than 30 minutes, retempered, or previously will not be allowed.

2.4 Gray Iron Castings: Cast iron conforming to requirements of Class 30, ASTM A48, made accurately to the required dimensions; sound. smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rests securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and, before rusting begins, painted with a bituminous coating so as to present a smooth finish, tough and tenacious when cold. but actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint.

2.5 STANDARD FRAME AND COVER

A. The standard frame and cover shall be traffic typed gray cast iron ASTM Designation A 48-Latest Revision, with a 24-inch diameter opening. The covers shall be the solid self-sealing type with no holes except watertight pick notches. The surface between the cover and frame shall fit smoothly without rocking and shall be thoroughly cleaned.

B. Covers shall be of the solid indented type with the words "Sanitary Sewer" cast in raised letters thereon. Manhole frames and covers shall be John Bouchard Number 1150 or

equal.

2.6 WATERTIGHT MANHOLES FRAMES AND COVERS

A. The manhole frames shall be set in the same manner prescribed for standard frames except special attention shall be paid to securing a watertight connection to the manhole barrel.

B. The watertight manhole frame and cover shall be a traffic type of grey cast iron ASTM Designation A 48-64 with a 24 inch diameter minimum clear opening weighing not less than 450 pounds and shall be of the two-cover design as shown on the Plans.

C. The surface cover shall be the solid type with no holes except watertight pick notches or a heavy lilting ring. The surface between this cover and frame shall fit without rocking. The inner cover shall be of the solid type with no holes, shall have not less than two lifting handles and shall have a neoprene sealing gasket at least 7/16 inch diameter cross-section with a hollow center. The inner cover shall be mechanically sealed by means of a removable metal bar located over the inner cover with a centrally-located bronze or stainless steel tightening bolt. This bolt shall have a tee-handle or bent-handle for turning. The bolt shall have Acme threads for durability. The inner cover shall have appropriate reinforcing ribs to prevent cracking or distortion when tightened. The inner cover shall have sufficient clearance to allow easy removal from the frame.

2.7 MANHOLE JOINT SEALANT FOR PRECAST MANHOLES

Flexible plastic sealant for joints in pre-cast manhole sections shall provide permanently flexible watertight joints, shall remain workable over wide temperature range and shall not shrink, harden or oxidize upon aging. Material shall be butyl resin sealant ConSeal CS-i 02 or CS-202 as manufactured by Concrete Sealants, Inc. of New Carlisle, Ohio, RUBR-NEK L-T-M manufactured by K.T. Snyder Co.. Inc. of Houston, Texas, or other approved equal.

2.8 MANHOLE STEPS

Manhole steps shall be made of copolymer polypropylene plastic meeting the latest revision of ASTM Designation D2i46-82, Type II Grade 16906 and shall have a 112-inch diameter Grade 60 reinforcing rod meeting the latest revision of ASTM Designation A 615 through its center. Each step shall be 12 inches in width and capable of carrying a load of 1,000 pounds in the center of the step when projected 6 inches from the wall. Each step shall be equipped with non-skid grooves.

2.9 MANHOLE INVERTS

A. The inverts shall be constructed when the manhole is being built by using prefabricated inverts for smooth flows.

B. The bench or top portion of the invert shall slope to the flow line to prevent standing water.

2.10 RESILIENT PIPE CONNECTIONS AT MANHOLES

A. Resilient pipe connectors shall be manufactured in accordance with ASTM C923 and shall provide a positive watertight joint and minimum of 10 degrees deflection in any direction. There shall be no water leakage through the connector when pipe is in its maximum deflected position. Connectors shall be manufactured of durable construction. Connectors shall be manufactured of durable rubber, which offers superior resistance to water, sewage, oils, acid, ozone, weathering and aging. Conical type flexible, which shall be clamped securely to the cut out in the manhole wall and to the pipe by means of stainless steel clamps or bands. The void area between the pipe and the connector shall be sealed with an approved flexible gasket material. Connectors shall be as manufactured by the KOR-N-SEAL Co. of Milford, N.H. or equal.

B. Compression-type connectors cast integrally into the manhole wall shall be equivalent to the A-Lok Manhole Pipe Connector as manufactured by A-Lok Products, Inc.

2.11 PRE-CAST CONCRETE MANHOLES

A. Precast manholes shall be constructed on a reinforced concrete foundation and shall be wet cast as modified herein. The bottom section of the manhole shall be precast integrally with the precast ring and shall be 4' – 0" in diameter. All concrete used in connection with the construction of manholes shall be 4,000 psi concrete. Wet cast precast manholes shall be Cloud or equal. Wet well manholes for lift stations shall be a minimum of 5' – 0" in diameter.

B. Precast concrete rings shall be constructed using standard forms and shall conform to ASTM Standard Specification C478 including steel reinforcement.

C. The precast sections shall be manufactured and installed in a manner so that there is no visible leakage in the manholes. The manhole section shall be manufactured in lengths such that a finished manhole will have the least possible number of joints. One section less than four feet in length will be allowed per manhole and that being the section required to bring the manhole to grade. The precast rings shall be of the tongue and groove design sealed watertight, and the joint shall be grouted smooth on the inside and outside of the manhole so that no crack is visible. A resilient pipe connection shall be utilized in the sewer line to manhole connection.

D. The outside surface of all precast manholes shall be coated with two layers of bitumastic coating applied at right angles to each other, unless xypex admixture is used in the casting process. Xypex admixture is recommended.

E. The manhole sidewall shall be of a length such that a maximum of one course of brick shall be placed on top of the unit to bring the casting to grade. Concrete adjustment rings are required.

F. Each manhole shall have a sewer trench check darn installed on the influent lines. The check dam shall be of 3,000 psi concrete. It shall extend a minimum of 6" under the sewer pipe and fill the entire trench and cut into the trench walls two feet into each wall. It shall be located not less than 10 feet from the face of the manhole and not more than 30 feet from the face of the manhole.

2.12 MATERIAL TESTING

A. All precast reinforced concrete manhole risers and tops specified herein shall be tested and inspected by a commercial testing laboratory approved by the A/E and/or owner prior to delivery to the site, and all materials that fail to conform to these specifications shall be rejected. After delivery to the site any materials that have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site. Supply certified copies in duplicate of the inspection and acceptance reports of the testing laboratory to A/E and/or owner before using the materials. The commercial testing laboratory shall be engaged and paid for by the Contractor. Submit a certificate from the manufacturer of the castings indicating that they meet all applicable requirements of these specifications.

PART 3 EXECUTION

3.1 Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.

3.2 Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected sewers or as directed by the A/E and/or owner. Wherever water is encountered at the site, place all cast in place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.

3.3 When the foundation subgrade has been prepared and is approved by the A/E and/or owner, carefully construct the concrete foundation for monolithic manholes to the line and grade required by the drawings. Construct the manholes after the concrete foundation has been allowed to set for a period of not less than 24 hours.

3.4 For precast manholes, carefully block the base section above the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipe can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. A base section with monolithic foundation (bottom) may be used when approved by the A/E and/or owner.

3.5 Thoroughly wet and then completely fill all holes with non-shrink grout.

3.6 Construct monolithic concrete manholes and bases of 4,000 psi concrete in accordance with the provisions of this section. The manhole steps shall be cast in place.

3.7 Carefully set the cast iron frame for the cover at the required elevation, and properly bond it to the masonry with cement grout and/or anchor bolts. Wherever manholes are constructed in paved areas, tilt the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the existing adjacent pavement (but raise slightly above existing grade (1/4" – 1/2").

3.8 Manhole inverts shall be constructed of concrete or mortared masonry fill and may, at the Contractor's option, be covered with cement mortar to the approximate cross section of the sewers connected to them. Make any necessary changes in cross sections gradually from side to side of the manhole. Make changes in direction of flow of the sewers to a true curve as large a radius as is permitted by the size of the manhole.

3.9 All rigid unreinforced pipe entering or leaving the manhole shall be provided with flexible joints within 12 inches of the manhole structure, or encase the full joint in particularly in the area of the manhole excavation, which is normally deeper than excavation for sewer trenches. Take special care to see that the openings through which pipes enter the structures are completely firmly rammed full of non-shrink grout or otherwise constructed to ensure a watertight connection.

3.10 Where the difference in the invert elevation of two or more sewers intersecting in one manhole is 24 inches or more, construct a drop manhole. Drop manholes shall be similar in connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 3,000 psi concrete.

3.11 Place backfill by hand around the manhole and to a distance of at least one pipe length into each trench, and tamp the selected material up to an elevation of 12 inches above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trench backfilling.

3.12 Vacuum testing of manholes

A. This test is only applicable to precast concrete manholes.

B. All lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar.

C. Manholes are to be tested immediately after assembly and before backfilling. No standing water shall be allowed in the manhole excavation, which may affect the accuracy of the test.

D. All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn.

E. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications and instructions provided by the manufacturer.

F. The test head may be placed in the cone section of the manhole. The rim-cone joint is not usually tested.

G. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

H. Acceptance for 4 ft. diameter manholes shall be defined as when the time to drop to 9 inches of mercury conforms to the table below. Contractor shall keep a log of all tests, which shall be submitted, to the Engineer and/or owner for approval.

Manholes Depth	Diameter	Time to Drop 1" Hg
10 ft. or less	4 ft.	60 seconds
10 ft. to 15 ft.	4ft.	75seconds
15 ft. to 25 ft.	4 ft.	90 seconds

I. For manholes 5 ft. in diameter, add an additional 15 seconds and for manholes 6 ft. in diameter, add an additional 30 seconds to the time requirements for four foot diameter manholes.

J. If the manhole fails to test, necessary repairs shall be made and vacuum test repeated until the manhole passes the test.

K. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled and the seal replaced.

GRAVITY SEWER

PART 1 GENERAL

A. Pipe material for sewer lines 18" and smaller shall be PVC unless otherwise directed.

B. Pipe material for sewer lines 24" and larger shall be reinforced concrete, PVC, or ductile iron. Ductile iron pipe shall be used only when indicated on the drawings.

C. Shop drawings are required for all products specified in this section.

D. Refer to other sections for items affecting gravity sewers. Coordinate this work with that specified by other sections for timely execution.

PART 2 PRODUCTS

2.1 PIPE

A. Reinforced Concrete: pipe with an internal diameter of 2411 and larger or more; are to be reinforced concrete pipe conforming to the requirements of ASTM C76, Class IV with Wall Thickness B, unless otherwise authorized by the A/E and/or owner in writing; circular concrete pipe with elliptical reinforcements not acceptable.

B. Polyvinyl Chloride (PVC): to meet and/or exceed the requirements of ASTM D-1785, which requires a minimum of schedule 40 pipe suitable for use as a gravity sewer conduit with provisions for contraction and expansion at each joint; with rubber ring and standard lengths of 20' and 12.5' plus or minus 1"; designed to pass all tests at 73°F (plus or minus 3°F); 6" long sections of pipe to be subjected to impact from a free falling tup (20 pounds, type A) in accordance with ASTM D2444 with no evident splitting or shattering (denting not considered a failure); and with a minimum envelope of 6" of granular material around and over the pipe, but with all other bedding and backfilling requirements remaining the same as for other pipe material.

C. Lateral Branches: to be wyes of the same material as the main sewer having a 6-inch inside diameter unless otherwise specified or noted; able to withstand all test pressure involved without leakage.

2.2 JOINTS AND JOINTING MATERIALS

A. Concrete Pipe Joint: 0-ring conforming to the requirements of ASTM 0443; shape and design submitted to the A/E and/or owner for his approval in writing; gaskets to meet the recommendations of the gasket manufacturer; joints designed to meet the infiltration requirements of these specifications.

B. Polyvinyl Chloride (PVC) Pipe Joints: joints for sewer plastic pipe shall meet all requirements of ASTM D2672 standard specifications. Joint design shall be tested and certified to result in no leakage under prescribed laboratory test conditions of joint alignment, load conditions, pressure and vacuum, and defection. Pipe and fittings shall have integral bell with elastometric seal joint.

C. Ductile Iron Pipe Joints: gasket type joints for bell and spigot ductile iron pipe designed to meet the infiltration requirements of these specifications; jointing to comply with the applicable provisions of ANSI A21.11.

2.3 COMPRESSION COUPLING

When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM 0425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size.

2.4 METER BOX

Each service clean out shall be protected by a HDPE meter box, green, with a hinged HDPE cover, with "SEWER" printed on the cover. The clean out box shall be model 1419 as manufactured by Carson-Brooks Plastics, of Glendora California (1-800-735-5566) or approved equal.

2.5 SERVICE ASSEMBLY

2.5.1 The typical residential sewer service assembly will consist of the following:

a. Meter box.

b. Service line, 4" PVC, Schedule 40 or better.

c. Wye on sewer main.

d. 2" x 4" or 4" x 4" by 4'-0' long Creoste or Perma-Treated sewer marker set flush with the ground surface marking the end of any stubbed service lines.

e. Plug the end of any unconnected service line and cleanout.

f. Grade of service line to be 1/8" per foot, minimum.

PART 3 EXECUTION

3.1 PIPE LAYING

For new sections of sanitary sewer from manhole (new or existing) to manhole (new or existing).

A. Lay no pipe except in the presence of an inspector representing the A/E and/or owner.

B. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trenches, and install any necessary bracing and sheeting as provided in "Unclassified Excavation for Utilities" section starting on page 2 of this document.

C. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the A/E and/or owner. Cradles shall be of concrete.

D. Tightly stretch a mason's line or wire above ground level, parallel to and directly above the axis of the pipe to be installed, supporting this line at intervals of no more than 50' for sewers being laid on a grade of 2% or more and of no more than 25' for grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place, and accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batterboards.

E. Laser may be used after the type and procedures are approved by the A/E and/or owner. When lasers are used, set reference points for both line and grade at each manhole. Where grades are 0.6% or less, check the elevation of the beam each 100' with an offset point or engineer's level.

F. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.

G. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with crushed stone as necessary per "Unclassified Excavation for Utilities" section starting on page 2 of this document.

H. Carefully inspect each piece and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.

I. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out bell holes no more than 2 joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concretic joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

J. Before constructing or placing any joints, demonstrate to the A/E and/or owner, by completing at least one sample joint, that the methods to be used conform to the specifications and will provide a watertight joint and further that the workmen to be involved in this phase of work are thoroughly familiar and experienced with the type of joint proposed.

K. No other type of joint may be used unless authorized in writing by the A/E and/or owner.

L. Install tee branches in sewer lines to serve properly each lot facing or abutting on the street or alley in which sewer is being laid and at such other locations as may be designated by the A/E and/or owner. If tee branches are not to be used immediately, close them with approved stoppers that are held in place to prevent infiltration and withstand alt test requirements.

M. For all tees that are plugged and laid in rock, blast a minimum of 6 LF of ditch line in the direction and to the approximate grade of the future lateral as directed by the A/E and/or owner, but do not excavate the material. This shall be done at no extra cost to the Owner. Furnish the A/E and/or owner with a record of the exact location of each tee installed.

N. If the work consists of constructing a new sewer to replace an existing one, connect existing service lines to the new line.

O. New service laterals shall conform to the standard drawings.

P. As the work progresses, thoroughly clean the interior of the pipe in place. After line of pipe has been laid, carefully inspect it, and remove alt earth, trash, rags, and other foreign matter from its interior.

Q. After the joints have been completed, they shall be inspected, tested, and accepted by the A/E and/or owner before being covered. The pipe shall meet the test requirements for water tightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe re-laid at the Contractor's expense. Carefully protect all pipe in place from damage until backfilling operations are completed.

R. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the A/E and/or owner.

S. Lay sewers at least 10' horizontally from any existing or proposed water main. If this is not practical, the sewer may be laid closer than 10' to a water main provided it is laid in a separate trench and the elevation of the of the sewer is at least 18" below the bottom of the water main.

T. Where a sewer crosses under water mains, the top of the sewer shall be at least 18" below the bottom of the water main, If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of 10' on each side of the sewer with a full joint of water main centered over the sewer.

U. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.

V. Perform boring by means of augering to the size, line, and grade shown on the drawings. Jack the steel casing pipe into place as the boring proceeds. Weld sections of casing pipe together to provide a watertight joint.

W. Make connections to all existing sewer lines as shown on the drawings or as directed by the A/E and/or owner. Make connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or by constructing a manhole, junction box or regulator chamber.

X. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing concrete structure by core drilling and inserting a length of sewer pipe into the hole with a permanent watertight connection. Connection material shall be of natural or synthetic rubber. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.

Y. Joint dissimilar pipe by using suitable compression couplings. If compression couplings are not available, make jointing with a special fabricated coupling approved by the A/E and/or owner.

Z. Provide concrete protection or concrete cap as shown on the drawings for pipe sewers that, when completed, have less than 2.5' of covering in nontraffic areas and 4' of cover in traffic areas.

AA. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, so in compliance with the provisions set forth in other sections of these specifications. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed thereof.

BB. Water service connections will be repaired or replaced by the Contractor at his expense as an incidental part of the work.

CC. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.

DD. All testing of concrete pipe and materials will be made by a commercial testing laboratory. Before beginning work, furnish the A/E and/or owner with the name of the pipe materials supplier. No pipe shall be delivered to the job site which does not bear the testing laboratory's stenciled or other marked sign of acceptance. Furnish the A/E and/or owner with 2 certified copies of the testing laboratory's report of inspection, testing, and acceptance on all pipe and specials.

EE. For PVC and ductile iron, furnish a certificate from the pipe manufacturer indicating that the pipe meets alt applicable requirements of these specifications.

FF. Reinforced concrete pipe, furnish a certificate by and meet the requirements of the Permeability Test and Hydrostatic Test of ASTM C14.

GG. The minimum pipe stiffness for PVC pipe at 5% defection shall be 46 for all sizes when tested in accordance with ASTM D2412; external loading properties of plastic pipe shall

be by parallel plate loading.

HH. A specimen of PVC pipe 6” long shall be flattened between parallel plates in a suitable press until the distance between the plates is 40% of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is complete in 2 to 5 minutes.

II. After being immersed for 2 hours in a sealed container of anhydrous acetone (99.5% pure), a sample ring of PVC pipe shall show no visible spalling or cracking when tested in accordance with ASTM D2152 (swelling or softening is not considered a failure).

JJ. A number I2TN copper wire shall be buried 18” below the surface and directly above all non-metallic pipe used for force main.

3.2 PARTIAL SEWER LINE REPLACEMENT AND/OR POINT REPAIRS

A. Locate alt existing underground utilities before beginning excavation.

B. Unless the construction of lines by tunneling, jacking, or boring is called for, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E and/or owner on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula 4/3d + 15 inches, where “d” represents the internal diameter of the pipe in inches. When approved in writing by the NE, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to nonvertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula 4/3d + 15 inches shall be at the expense of the Contractor and may be cause for the A/E and/or owner to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.

C. Take reasonable care during the initial excavation of the defective pipe so as not to disturb existing pipe that is still acceptable. Where the specifications require the material from excavation to be wasted and the trench backfilled with crushed stone; load this material directly into trucks during excavation; do not pile on the street. After defective pipe has been exposed, uncover as much additional pipe as is necessary to allow space for workmen and the installation of the new pipe. Cut out the defective pipe in such a way that the ends are straight and smooth and free of chips or cracks. Remove the defective pipe from the trench, and excavate the former bedding material of any nature of that pipe to 6 inches below the pipe grade. All excavation is to be done in accordance with applicable portions per “Unclassified Excavation for Utilities” section starting on page 2 of this document. Then fill the bottom of the trench with 6 inches of 1/2 inch to 3/4 inch crushed stone.

D. Lay no pipe except in the presence of an inspector.

E. Before placing sewer pipe in position in the trench, carefully prepare the bottom and side of the trench, and install any necessary bracing and sheeting as specified per “Unclassified Excavation for Utilities” section starting on page 2 of this document.

F. Wherever necessary to provide a satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by A/E and/or owner.

G. Tightly stretch a mason’s line or wire above the ground level, parallel to and directly above the axis of the pipe to be installed. This line is to be supported at intervals not exceeding 50 feet on sewers being laid on a grade of 2% or more ant not exceeding 25 feet on grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down this line to the invert of the pipe in place. Accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batter boards.

H. Laser may be used after the type and procedures are approved by the A/E and/or owner. When lasers are used, set reference points for both line and grade at each manhole. Where grades are 0.6% or less, check the elevation of the beam 100 feet with an off site point or Engineer’s level.

I. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than available pumping facilities are able to dewater.

J. If trench bottoms are found to be unsuitable for foundations after pipe laying operations have started, correct and bring them to exact line and grade as required per “Unclassified Excavation for Utilities” section starting on page 2 of this document.

K. Carefully inspect each piece of pipe special fitting before it is placed, and lay no defective pipe and in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with a temporary plug approved by the A/E and/or owner.

L. Bell holes shall be large enough to allow ample room for pipe joints to be properly made. Cut out belt holes not more than 2 joints ahead of pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel will rest on a solid foundation for its entire length. Lay each pipe joint to form a close concretic joint with adjoining pipe and so as to avoid sudden offsets or inequalities in the flow line.

M. Before constructing or placing any joints, complete at least one sample joint in order to demonstrate to the A/E and/or owner that the methods employed conform to the specifications and will provide a watertight joint, and further that the workmen intended for use on this phase of the work are thoroughly familiar and experienced with type of joint proposed.

N. Wherever pipe materials are joined, cut the replacement pipe to a length 1 inch less than the overall length of the section being replaced. Then place the pipe in the trench, thoroughly clean the ends of existing and replacement pipe, and install the compression

couplings. After installation, check the work to ensure that the replacement pipe is vertically and horizontally aligned with the existing pipe and that the compression couplings area tight and evenly fitted.

O. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect and remove all earth, trash, rags, and other foreign matter from the interior.

P. After the joints have been completed, they shall be inspected before they are covered. The pipe shall meet the test requirements for water tightness; immediately repair any leak or defect discovered at any time after completion of the work. Take up any pipe that has been disturbed after joints were formed, clean and remake the joints, and relay the pipe this shall be done at the Contractor's expense. Carefully protect all pipe in place from damage until backfill operations have been completed.

Q. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved.

3.3 SERVICE LINE

A. If the work consists of constructing a new sewer to replace an existing sewer, connect all existing service lines to the new line.

B. Replace service lines from the sewer line to the property line being served by the lines as shown in the drawings. Replace the entire service line with 4" PVC or 6" PVC service line next to the existing line.

C. When replacing service line and/or service connections to the main line, install a 4" clean out at the property line and backfill the entire area with crushed stone if it is in a paved area.

D. Install tee branches in any sanitary sewer lines designated by the A/E and/or owner. If such branches are not to be used immediately, close them with stoppers approved by the A/E and/or owner that are held in place to prevent infiltration and meet all test requirements.

E. To repair or replace a service connection, which, in the judgment of the A/E and/or owner, is the source of the leak, properly connect the service in conformance with the pipe manufacturer's recommendations and specifications and applicable ASTM specifications for the service connection and the installation of same. The material of the connection shall be similar to the sewer pipe it will connect to.

3.4 CROSSING ABOVE WATER LINES

Where sewers cross above water lines, encase the sewer pipe with concrete for distance of 10 feet on each side of the crossing.

3.5 CONNECTIONS

A. Make connections to all existing sewer lines as shown on the drawings or as directed by

the A/E and/or owner. Make connections by removing a section of the sewer from the existing lines and inserting a tee branch of proper size into space; adding a saddle; or by construction a manhole, junction box, regulator chamber, or other structure as shown on the drawings.

B. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing concrete structure by core drilling and inserting a length of sewer pipe into the hole. Place a manhole coupling or gasket on the pipe before inserting the pipe to insure a permanent watertight connection. Connection material shall be of natural or synthetic rubber. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.

3.6 VISUAL TESTING OF ALL NEW GRAVITY SEWERS

A. Upon completion of the construction or earlier if the A/E and/or owner deems advisable, the A/E and/or owner will make a visual inspection of the sewer and construction site. Immediately repair all leaks and defects found by such inspection.

B. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.

C. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2” on pipe 36” internal diameter or smaller and 3/4” in pipe larger than 36” internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the Contractor’s expense.

D. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100” develop in the pipe within one year from the date of final acceptance of the work, the Contractor wilt be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the drawings, specifications, and local conditions at the site of the work.

3.7 AIR TESTING FOR SEWERS LINES THAT HAVE BEEN REPLACED FROM MANHOLE TO MANHOLE

A. Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by a representative of the Owner.

B. Make the air test before backfilling.

C. Conduct the air test on sections of line replaced from manhole to manhole. Point repairs consisting of replacing a portion of the sewer line are to be smoke tested.

D. Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed

lateral connection or extension.

E. Prior to testing, check the pipe to see that it is clean. If not, clean it by passing a full-gauge squeegee through the pipe. It shall be the Contractor's responsibility to have the pipe cleaned.

F. Immediately following this check or cleaning, test the pipe installation with low pressure air. Supply the air slowly to the plugged pipe installation until the internal air pressure reaches 4.0 psi more than the average backpressure of any ground water that may submerge the pipe. Allow at least 2 minutes for temperature stabilization.

G. The pipeline shall be considered acceptable when tested at an average pressure of 3.0 psi more than the average back pressure of any ground water that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.00 15 cfm per square foot of internal pipe surface area. Calculate the pressure drop as the number of seconds for the air pressure to drop from a stabilized pressure of 3.5 to 2.5 psi more than the average backpressure any ground water that may submerge the pipe. Calculate time as described in ASTM C828.

H. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 psi more than the average back pressure of any ground water that may submerge the pipe is not less than that shown in the following table:

ALLOWABLE AIR LOSS VALUES PER 100 LF

Pipe Size	Time in Seconds
6"	42
8"	72
10"	90
12"	108
15"	126
18"	144
21"	180

I. If the pipe installation fails to meet these requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.

J. The recommended procedures for conducting acceptance tests are as follows:

1. Clean pipe that is to be tested.

2. Plug all pipe outlets with suitable test plugs, and brace each plug securely.

3. Increase gauge pressure in the test by the amount of ground water pressure at the crown of the pipe.

4. Add air slowly to the portion of the pipe installation being tested until the internal

air pressure is raised to 4.0 psi more than the average backpressure above the crown of the pipe.

5. After the above internal pressure is obtained, allow at least 2 minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

6. After 2 minutes, disconnect the air supply.

7. When pressure decreases to 3.5 psig either by leaking down or by bleeding down with a release valve, start the stopwatch, and determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Compare this time interval as calculated above. If the time is more than that calculated, the test shall be assumed to be acceptable.

K. Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Locate gauges, air piping manifolds, and valves at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. Four pounds air pressure (gauge) develops a force against the plug in a 12" pipe of approximately 450 pounds. Pipes more than 30" in diameter shall not be air tested because of the difficulty of adequately blocking the plugs. Provide a safety release device set to release at 10 psi between the air supply and the sewer under test.

L. Regardless of the outcome of the tests, repair any noticeable leak.

3.8 TESTING OF POINT REPAIRS

Plug the flow from the upstream manhole. Blow smoke into the downstream manhole for a minimum of 2 minutes. Check the point repair, connections to the existing sewer, and any new service for leaks. Repair any leaks detected.

3.9 VISUAL INSPECTION OF MISCELLANEOUS MATERIALS

All material used in this project will be visually inspected by the A/E and/or owner at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the A/E and/or owner may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

3.10 DEFLECTION TESTING FOR PVC PIPE

Test deflection of the pipe by passing a 9-arm pin go no-go mandrel sized to 95% of the pipe diameter of the actual pipe used with the pipe in place and covered. Make this acceptance test after backfill consolidation has occurred.

3.11 CLEANUP

After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site of the work, grade and smooth over the surface on both sides of the

line, and leave the entire right-of-way in a clean, neat, and serviceable condition.

BORING & CASING FOR WATER LINES AND SANITARY SEWERS

PART I GENERAL

1.01 GENERAL

The work to be performed hereunder shall consist of the installation of a casing pipe for the purpose of installing a sanitary sewer or water line as shown on the Drawings or as called for in these specifications. It shall include the excavation of a boring pit, auger boring between the points specified on the Drawings, furnishing and installing of the carrier pipe, and disposing of the excavated materials in the manner herein provided.

1.02 RELATED SECTIONS

A. Unclassified Excavation for Utilites

B. Local Governing Authority and Code Requirements

C. Construction Drawings

PART 2 PRODUCTS

2.01 CASING PIPE

A. The casing pipe shall be of steel meeting the latest approved American Railway Engineering Association “Specifications for Pipelines for Carrying Flammable and Nonflammable Substances.” The steel casing pipe shall have the minimum yield of 35,000 psi and shall have the minimum wall thickness in the following table:

TABLE OF MINIMUM THICKNESS FOR STEEL CASING PIPE FOR E72 LOADING

Carrier Pipe	Casing Pipe	Nominal Thickness
4	8	0.250 inch
6	12	0.250 inch
8	16	0.312 inch
10	20	0.312 inch
12	22	0.312 inch
14	24	0.344 inch
16	26	0.375 inch
18	28	0.406 inch

B. When the casing pipe is installed without benefit of a protective coating inside and outside, the wall thickness shown above shall be increased to the nearest standard size, which is a minimum of 0.063 inch greater than the thickness shown.

2.02 CARRIER PIPE

A. The carrier pipe shall be ductile iron pipe or PVC as shown on the Drawings.

B. Joints shall be butt-welded. Coatings shall be continuous at the joints.

PART 3 EXECUTION

3.01 BORING

The boring shall be accomplished by means of augering to the size, line, and grade shown on the Drawings.

3.02 INSTALLATION OF CASING PIPE

A. Jack the steel casing pipe into place as the boring proceeds. Weld section of casing pipe together to provide watertight joints.

B. Do not remove unacceptable casing without prior approval from the Engineer and/or owner. If the removal of casing pipe is permitted, make proper provisions to prevent caving in of the earth surrounding the casing.

3.03 OPEN CUT

If the Contractor receives permission from the Owner of the road right-of-way, or if the casing is to be installed across a road that is not yet built, the casing may be installed by open cut trenching, in accordance with specification per “Unclassified Excavation for Utilities” section starting on page 2 of this document.

3.04 INSURANCE

If the boring or open cut requires permission from a third party, such as a railroad, a county or state highway or road department, etc., the Contractor shall be responsible for complying with all requirements of such permits, including providing signs, flagmen, fees, and insurance policies.

Water Mains and Appurtenances

MATERIALS

1. GENERAL

All materials to be incorporated in the project shall be first quality, new and undamaged material conforming to all applicable portions of these Specifications.

2. CONCRETE

Cement - Cement shall be Portland cement of a brand approved by the Engineer and shall conform to "Standard Specifications for Portland Cement," Type 1, ASTM Designation C-150, latest revision. Cement shall be furnished in undamaged 94 pound, one cubic foot sacks, and shall show no evidence of lumping.

Concrete Fine Aggregate - Fine aggregate shall be clean, hard uncoated natural sand conforming to ASTM Designation C-33, latest revision, "Standard Specifications for Concrete Aggregate."

Concrete Coarse Aggregate - Coarse aggregate shall consist of clean, hard, dense particles of stone or gravel conforming to ASTM Designation C-33, latest revision, "Standard Specifications for Concrete Aggregate." Aggregate shall be well graded between 1-1/2-inch and #4 sieve sizes.

Water - Water used in mixing concrete shall be clean and free from organic matter, pollutants and other foreign materials.

Ready-Mix Concrete - Ready-mix concrete shall be secured only from a source approved by the Engineer, and shall conform to ASTM Designation C-94, latest revision, "Specifications for Ready-Mix Concrete". Before any concrete is delivered to the job site, the supplier must furnish a statement of the proportions of cement, fine aggregate and coarse aggregate to be used for each mix ordered, and must receive the Engineer's approval of such proportions.

Class "A" Concrete - Class "A" concrete shall have a minimum compressive strength of 4,000 pounds per square inch in 28 days and shall contain not less than 5.5 sacks of cement per cubic yard.

Class "C" Concrete - Class "C" concrete shall have a minimum compressive strength of 2,000 pounds per square inch in 28 days and shall contain no less than 4.5 sacks of cement per cubic yard.

Metal Reinforcing - Reinforcing bars shall be intermediate grade steel conforming to ASTM Designation A-615, latest revision, "Standard Specifications for Billet Steel Bars for Concrete Reinforcement." Bars shall be deformed with a cross-sectional area at all points equal to that of plain bars of equal nominal size.

3. CRUSHED STONE

Crushed stone for pipe bedding shall meet the quality requirements of ASTM D-692 and the grading requirements of AASHTO M-43 for Size 67.

Crushed stone for backfill shall meet the quality requirements of ASTM D-692 and the grading requirements of AASHTO M-43, size 67.

4. DUCTILE IRON PIPE

Ductile iron pipe for water shall be manufactured in accordance with USA Standard A21.51 for centrifugally case ductile iron pipe. The pipe shall be manufactured of iron having acceptance values of 60-42-10. Minimum allowable wall thickness shall be in accordance with the following table. Heavier pipe will be required where designated on the Drawings or required by Section 3 of these Specifications.

Nominal Dia., In.	Minimum Wall Thickness. In.	Minimum Thickness Class
4	0.29	52
6	0.31	52
8	0.33	52
10	0.35	52
12	0.34	51
16	0.37	51
18	0.38	51
20	0.39	51
24	0.41	51
30	0.43	51

Pipe shall be furnished in lengths of 18 feet to 20 feet and, unless otherwise indicated, shall be provided with a compression type slip joint equal to the Fastite joint as manufactured by American. Gaskets and lubricants shall be furnished with the pipe.

Pipe shall be furnished with standard thickness cement lining on the inside with a bituminous steel coat and a bituminous coating on the outside. Cement lining shall conform to USA Standard A21.4. The exterior of the pipe shall be clearly marked to indicate the manufacturer, date of manufacture, the pipe class and weight. Exterior markings shall also positively identify the pipe as being Ductile Iron.

5. PVC WATER PIPE

PVC pipe for water shall be manufactured in accordance with ASTM D-2241 and have NSF approval. The pipe shall be Class 200 polyvinyl chloride plastic (PVC 1120) SDR-21. The following tests shall be run for each machine on each size and type of pipe being produced, as specified below:

Flattening Test: Once per shift in accordance with ASTM D-2412. Upon completion of the test, the specimen shall not be split, cracked or broken.

Acetone Test (Extrusion Quality Test): Once per shift in accordance with ASTM D-2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.
Quick Burst Test: Once per 24 hours in accordance with ASTM 5199.

SDR	Pressure Rating	Minimum Bursting Pressure, psi
21	200	800

Impact Tests: 6-inch and smaller, once each 2 hours in accordance with ASTM D-2444.

Wall Thickness and Outside Dimensions Test: Once per hour in accordance with ASTM D-2122.

Bell Dimensions Test: Once per hour in accordance with ASTM D-3139.

If any specimen fails to meet any of the above mentioned tests, all pipe of that size and type manufactured between the test period must be scrapped and a full set of tests rerun.

Furnish a certificate from the pipe manufacturer stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer's equipment and quality control facilities must be adequate to ensure that each extrusion of pipe is uniform in texture, dimensions, and strength. Also furnish a certificate from the manufacturer certifying that the pipe furnished for this project meets the requirements of these Specifications.

All pipe shall be manufactured in the United States of America. All pipe for any one project shall be made by the same manufacturer.

The pipe may be furnished in the manufacturer's standard laying lengths of 20 feet. The Contractor's methods of storing and handling the pipe shall be approved by the Engineer. All pipe shall be supported within 5 feet of each end; in between the end supports, there shall be additional supports at least every 5 feet. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed water line routes will not be allowed.

Certain information shall be applied to each piece of pipe. At the least, this shall consist of:

Nominal size
Type of material
SDR or class
Manufacturer
NSF Seal of Approval

Pipe that fails to comply with the requirements set forth in these Specifications shall be rejected.

Detectable tape shall be 3 inches wide and shall be an inert, bonded layer plastic with a metalized foil core and shall be highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. The tape shall be brightly colored to contrast with soil and shall bear the imprint "CAUTION - WATER LINE BURIED BELOW". This detection tape shall be placed over the water main at a level of 15 inches below the finished ground surface.

Prior to ordering water pipe or detectable tape the Contractor shall submit proposed materials to the Engineer for approval.

6. POLYVINYL CHLORIDE (PVC) WATER MAIN

C-900 PVC water main pipe, where designated on the Contract Drawings and in the Bid Proposal shall conform to ANSI / AWWA C-900 manufactured in accordance with ASTM D2241, latest revision. All pipe shall be manufactured from Class 12454-B Polyvinyl chloride plastic (PVC 1120) as defined in ASTM D-1784. The pipe shall have NSF approval. The following test shall be performed for each machine and on each size and type of pipe being produced with test results furnished to the Engineer prior to any pipe being installed.

Flattening Test - Once per shift in accordance with ASTM D-2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.

Acetone Test (Extrusion Quality Test) - Once per shift in accordance with ASTM D-2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.

Quick Burst Test - Once per 24 hours in accordance with ASTM 1599.

SDR	Pressure Rating	Minimum Bursting Pressure, psi
14	200	985

Wall Thickness and Outside Dimensions Tests - Once per hour in accordance with ASTM D2122.

Bell Dimension Test - Once per hour in accordance with ASTM D-3139.

In addition to the above, the pipe manufacturer shall furnish a certificate stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these Specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer's equipment and quality control facilities must be adequate to ensure that each extrusion of pipe is uniform in texture, dimensions, and strength. Also furnish a certificate from the manufacturer certifying that the pipe furnished for this project meets the requirements of these Specifications.

All pipe shall be manufactured in the United States of America. All pipe for any one project shall be made by the same manufacturer.

The pipe may be furnished in the manufacturer's standard laying lengths of 20 feet. The contractor's methods of storing and handling the pipe shall be approved by the Engineer. All pipe shall be supported within 5 feet of each end; in between the end supports, there shall be additional supports at least every 15 feet. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed water line routes will not be allowed.

Certain information shall be applied to each piece of pipe. At the least, this shall consist of:

Normal Size
Type of material
NSF Seal of Approval
SDR or class
Manufacturer
AWWA C-900

Pipe that fails to comply with the requirements set forth in these Specifications shall be rejected.

Pressure Class at 73.4º shall be 200 PSI (DR 14), (working pressure 200 PSI). Joints shall be compression type conforming to ASTM D-3139 and F-477 shall be used for 4-inch or larger. All joints shall be designed to withstand the same pressure as required for the pipe.

Furnish detection tape and trace wire as per specifications in this Section.

Fittings for C-900 water main pipe 4-inch through 12-inch shall be cast iron or ductile iron conforming to USA Std. A21.10 or compact ductile iron conforming to USA Std. A21.53-84, latest revision. Fittings shall have interior lining and exterior coating as specified for ductile iron pipe. Fittings for 12-inch and

smaller pipe may be either cast iron or ductile iron.

7. FITTINGS

All fittings shall be cast gray iron or ductile iron, cement lined, bituminous coated, manufactured in accordance with USA Standards A21.10 and A21.11, latest revision, unless otherwise indicated or directed. Minimum pressure rating shall be 250 psi. Unless indicated otherwise on the Drawings, mechanical joint fittings shall be used.

Fitting manufacturer shall furnish certificates that fittings were manufactured in compliance with ANSI A21.10 and A21.11, latest revision.

All fittings and valves, etc. shall be assembled to the ductile iron pipe by the use of pipe retainer glands, similar to Series 1200 EBAA iron or approved equal. This is in addition to standard concrete thrust blocking.

8. RESILIENT SEAT GATE VALVES

Resilient seat gate valves shall be iron body, machined surface, modified wedge disc, resilient rubber seat ring type valves with non-rising stems (NRS). Resilient seat gate valves shall have the bronze stem nut cast integrally with the cast iron valve disc. The valve shall have machined seating surface and capable of being installed and operated in either direction. Valves shall be furnished with mechanical joint ends in accordance with USA Standard A21.11 unless otherwise shown or directed. Valves shall be suitable for installation in approximately vertical position in buried pipe lines. Stem seal shall consist of O-ring seals. All valves shall open to the left (counterclockwise), and shall be provided with 2-inch square operating nut. All underground gate valves which have nuts deeper than 30 inches below the valve box top shall have extended stems with nuts located within one foot of the valve box cap.

Valves shall be for working pressures up to 200 psi and shall be equal to latest specifications of AWWA C509 in all respects. Valves shall be equal to Mueller A-2370-20, unless shown otherwise on Project Drawings.

Iron body resilient seat gate valves shall be as manufactured by Mueller, or equal.

9. TAPPING SLEEVES AND VALVES

Tapping sleeves shall consist of a mechanical joint tapping sleeve Mueller H-615, or approved equal, and a valve with mechanical joint outlet Mueller H-667 or approved equal. The valve shall conform to all applicable specifications for gate valves.

10. AIR RELEASE VALVE

Automatic air release valves shall be designed to allow a quantity of air to escape out of the orifice when air accumulates at high points in the water line. Valves shall be tested for service to pressures of 300 psi and can be made of cast iron housings. Valves shall be of similar construction to APCO 200A or approved equal. Inlet size shall be 1 inch in diameter.

11. VALVE BOX FRAMES AND COVERS

Valve box frames and covers shall be made of heavy cast iron and shall meet the requirements of

ASTM A-48, Class 30.

All casting shall be made accurately to the required dimensions and shall be sound, smooth, clear and free of blemished or other defects. Defective castings which have been plugged or otherwise treated to remedy defects shall be rejected. Contact surfaces of frames and covers shall be machined so that the covers rest securely in the frames with no rocking or movement. The cover shall be in contact with the frame for the entire perimeter of the contact surface.

The valve box frames and covers shall be as manufactured by John Bouchard and Sons Company, Nashville, Tennessee, No. 8004 Roadway Type, or approved equal. The cover shall be marked "WATER".

A minimum 2-foot diameter concrete collar shall be placed around the top of the valve box in non-paved areas to provide support of the box. The collar shall be a minimum of 4 inches thick and sloped to drain away from the box (see the Standard Detail for Gate Valve on Drawings).

12. SERVICE CLAMPS

Where designated on the Drawings or required by the Engineer, service clamps shall be used for all taps made to the water line. Service clamps shall be all bronze construction with neoprene gasket.

13. CASING PIPE

Where noted on the Drawings or required by these Specifications, roadway, railroad or other crossings shall be made utilizing carrier pipe within a casing pipe. Sizes of carrier pipe and casing pipe shall be as noted on the Drawings or described in these Specifications.

Casing pipe and joints shall be of leakproof construction. The steel casing pipe shall have a minimum yield strength of 35,000 psi and shall have the minimum wall thickness shown in the following table or as shown on the Drawings.

TABLE OF MINIMUM WALL THICKNESS
FOR STEEL CASING PIPE
(COOPER E-80 LOADING)

Casing Diameter, Inches	Wall Thickness with approved protective coating, inches	Wall Thickness without approved protective Coating, inches
Under 14	0.188	0.251
14 & 16	0.219	0.282
18	0.250	0.313

20	0.281	0.344
22	0.312	0.375
24	0.344	0.407
30	0.406	0.469
36	0.469	0.532
42	0.500	0.563

The casing pipe shall extend to the points indicated on the Drawings. The ends of the casing shall be protected against the entrance of foreign material but not tightly sealed, in a manner approved by the Engineer.

14. PIPELINE DETECTION TAPE AND TRACER WIRE

Detectable pipeline location tape shall be plastic composition film containing one layer of metalized foil laminated between two layers of inert plastic film specifically formulated for prolonged use underground. Tape shall be minimum 5.5 mils thickness, blue in color, and continuously printed in permanent ink to indicate caution for a buried water line below. Tape shall be placed 15 inches below the finished ground surface.

Tape shall be a minimum of 3 inches in width with a minimum tensile strength of 5,000 psi. Tape shall be Terra-Tape as manufactured by Reef Industries, Inc., or approved equal.

In addition to detectable tape described above, a tracer wire shall also be installed by taping to the top of the water main. This tracer wire shall be 14-gauge insulated copper wire. All splices shall be by the solder or compression fitting methods. Wire nuts are not permitted.

15. SERVICE LINE ITEMS

Service lines shall consist of a corporation cock, bronze service clamp as per Contract Drawings, curb stop, meter box, and line setter as described herein or as shown on the Contract Drawings. Service line shall be copper conforming to ASTM-B-88-62, Type K, with size as designated on the Drawings or as directed by the Engineer (3/4-inch minimum)

Bronze fittings shall be as follows:

Corporation cock - Ford F-1000 CTS/CC or approved equal.

16. WATER LINE / VALVE MARKERS

Where indicated on the Contract Drawings, markers for valves and/or water lines shall be one piece for driving or settling in the ground. Marker units shall be weather resistant with identifying color and permanently affixed marker identifying water main and/or water valve and shall be a minimum of 62 inches in length. Units shall be flexible and resistant to damage by vehicles, animals, or vandals. Marker units shall be Carsonite Utility Marker, manufactured by Carsonite International, Carson City, Nevada or approved equal.

17. FIRE HYDRANTS

Fire hydrants shall be iron bodies, fully bronze mounted hydrants manufactured to equal or exceed AWWA Specification C502 latest revision. Hydrants shall be suitable for 150 psi working pressure and shall be subjected to a test pressure of 300 psi. Inlet connection shall be 6-inch mechanical joint unless

noted otherwise on Drawings. Main hydrant valve shall be compression type, closing with the pressure, with 5¼-inch valve opening.

All hydrants shall be equipped with two 2½-inch hose nozzles, one 4½-inch pumper nozzle, breakable safety flange and safety stem coupling. Bronze nozzles shall be securely locked to prevent them from blowing off. Hose threads and pumper nozzle threads shall be National Standard. Nozzle caps shall be equipped with non-kink chains.

Hydrants shall be of the "dry head" type with an oil reservoir and provision for automatic lubrication of stem threads and bearing surfaces each time the hydrant is operated. Double O-ring seals shall be provided to keep water out of the hydrant top. Operating nut shall be 1½-inch pentagon, opening to left, and shall be equipped with a weather cap.

Hydrants shall be provided with automatic multiport drain ports arranged to momentarily flush water pressure each time hydrant is operated. A positive stop shall be provided on the operating stem to prevent over travel when operating valve.

Fire hydrant shall be supplied with a bituminous coating for buried portion of hydrant and a red enamel finish for above ground portions of the hydrant. Hydrants shall be equal to M & H 129 unless shown otherwise on the Drawings.

Minimum bury shall be 36 inches.

Fire hydrant manufacturer shall furnish certificates that all fire hydrants were tested and manufactured in compliance with AWWA C502 in all respects.

Locking tees shall be used at all locations where possible. At all other locations restrained joints shall be used.

18. RIP-RAP

Rip-Rap stone material shall be sound, durable, free from cracks, pyrite intrusion and other structural defects. Wear shall not exceed sixty by the Los Angeles Method. When crushed aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not be more than fifteen. Al least 90 percent of the stone shall not be less than 8 inches wide by 12 inches long by 12 inches deep and shall be approximately rectangular in shape.

19. CORPORATION STOPS

Where designated on the Drawings or required by the Engineer, corporation stops shall be Mueller H-1500 or approved equal with compression type connections for flared copper tubing.

20. COPPER PIPE

Small piping in the ground shall be of standard soft water pipe (tubing) for water service, ASTM B-88, Type "K" with bronze fittings, corporation stops and valves having compression type connections for flared copper pipe (tubing).

CONSTRUCTION

1. PRELIMINARY WORK

1.1 Location of Lines - The streets, roads and easements in which lines shall be placed have been indicated on the Drawings. Actual alignment and layout shall be performed by the Contractor. Final location of the pipe lines within these locations shall be approved by the Engineer at the time of construction.

1.2 Location and Protection of Underground Utilities - Prior to trenching the Contractor shall determine, insofar as possible, the actual location of all under ground utilities in the vicinity of this operation and shall clearly mark their locations so that they may be avoided by equipment operators. Where such utility lines or services appear to lie in the path of construction they shall be uncovered in advance to determine the exact location and depth and to avoid damage due to trenching operations. Existing facilities shall be protected during construction or removed and replaced in equal condition, as necessary.

The Contractor shall call “TENNESSEE ONE CALL” at 1-800-351-1111 for location of existing utilities prior to any underground utility work.

Should any existing utility line or service be damaged during, or as a result of the Contractor's operations, the Contractor shall take such emergency measures as may be necessary to minimize damage and shall immediately notify the utility involved. The Contractor shall then repair the damage to the satisfaction of the utility or shall pay the utility for making the repairs. In all cases, the restoration and/or repair shall be such that the damaged structure will be in as good or better condition as before the damage occurred.

1.3 Removal of Obstructions - The Contractor shall be responsible for the removal, safeguarding and replacement of fences, walls, structures, culverts, street signs, billboards, shrubs, mailboxes, or other obstructions which must be moved to facilitate construction. Such obstructions must be restored to at least their original condition.

1.4 Clearing and Grubbing - The Contractor shall be responsible for cutting, removing and disposing of all trees, brush, stumps, roots and weeds within the construction area. Disposal shall be by means of chippers, landfills, or other approved method and not in conflict with state or local ordinances.

Care shall be taken to avoid unnecessary cutting or damage to trees not in the construction area. The Contractor will be responsible for loss or damage to trees outside the permanent easement or rights-of-way.

2. EXCAVATION

2.1 General - The Contractor shall perform all required excavation and backfilling incidental to the installation of the water lines, air release valve installations, and other appurtenances under this Contract. Excavation shall be carried to the depths indicated on the Drawings or as necessary to permit the installation of pipe, bedding, structures or appurtenances. Care shall be taken to provide a firm, undisturbed, uniform surface in the bottoms of trenches and excavations for structures. Where the excavation exceeds the required depth, the Contractor shall bring the excavation to proper grade through the use of an approved incompressible backfill material (generally crushed stone or fill concrete, depending upon the nature of the facility to be placed thereon). In the event unstable soil conditions are encountered at the bottom of the excavation, the Engineer may direct the Contractor to continue the excavation to firm soil or to provide pilings or other suitable special foundations.

The Contractor shall take such precautions as may be necessary to avoid endangering personnel, pavement, adjacent utilities or structures through cave-ins, slides, settlement or other soil disturbance resulting from his operations.

The Contractor shall saw cut pavements prior to excavation procedures.

The Contractor shall be responsible for storage of excavated material, disposal of surplus excavated material, trench dewatering and other operations incidental to excavation and backfilling operations.

2.2 Pavement Removal - Where existing paved streets, roads, parking lots, drives or sidewalks must be disturbed during construction of the project the Contractor shall take the necessary steps to minimize damage. Permanent type pavement shall be cut or sawed in a straight line before removal and care shall be taken during excavation to avoid damage to adjacent pavement. Where trucks or other heavy equipment must cross curbs or sidewalks, such areas shall be suitably protected.

2.3 Trench Excavation - Trenches shall be excavated in a neat and workmanlike manner, maintaining proper alignment except where necessary to make deviations to miss obstructions. Trenching for installation of water distribution piping shall be such that the pipe will have a minimum cover of 48 inches for 12-inch to 16-inch water mains and 30 inches for 10-inch and smaller water mains except as noted on Drawings. The bottom of trenches must be shaped by hand and bell holes must be dug so that full length of pipe is resting on trench bottom. Blocking shall not be used.

Note: In many cases the water main shall be required to have more than 48 or 30 inches of cover to get under existing utilities or to satisfy other requirements. This additional depth, when required, shall be merged into the unit price bid per foot of water main.

Trenches shall be opened up far enough ahead of pipe laying to reveal obstructions, but in general shall not include more than 300 feet of continuous open trench at any time. The Contractor will be required to follow up trenching operations promptly with pipe laying, backfill and clean-up, and in event of failure to do so, may be prohibited from opening additional trench until such work is completed.

The Contractor shall plan his operations so as to cause a minimum of inconvenience to property owners and to traffic. No road, street or alley may be closed unless absolutely necessary, and then only if the following conditions are met:

1. Permit is secured from appropriate, State, County or Municipal authorities having jurisdiction.

2. Fire and Police Departments are notified before road is closed.

3. Suitable detours are provided and are clearly marked.

No driveways shall be cut or blocked without first notifying the occupants of the property. Every effort shall be made to schedule the blocking of drives to suit to occupants convenience, and except in case of emergency, drives shall not be blocked for a period of more than 8 hours.

The Contractor shall furnish and maintain barricades, signs, flashing lights, and other warning devices as necessary for the protection of public safety. Flagman shall be provided as required on heavily traveled streets to avoid traffic jams or accidents.

Trench width shall be held to a minimum consistent with proper working space for assembly of pipe. Maximum trench width up to a point one foot above top of pipe shall be limited to the outside pipe diameter plus 16 inches. Boulders, large stone, shale and rock shall be removed to provide clearance of 6 inches below and on each side of the pipe. Trench walls shall be kept as nearly vertical as possible with due consideration to soil conditions encountered and when necessary, sheeting or bracing shall be provided to protect life and property.

Where unstable soil conditions are encountered at the trench bottom, the Contractor shall remove such additional material as may be directed by the Engineer and replace the excavated material with approved backfill.

The Contractor shall excavate by hand wherever necessary to protect existing structures or utilities from damage or to prevent overdepth excavation in the trench subgrade.

Excavated material shall be stored safely away from the edge of trench and in such a way as to avoid encroachment of private property.

2.4 Excavation for Structures - Excavation for air release valve installations, metering pits or other appurtenance shall be only as large as may be required for the structure of appurtenance and for working room around the same. In earth, excavation shall generally extend to the outer limits of the structure at the bottom, and shall slope outward at such angle as may be required for stability of excavated face. In rock, excavation shall be carried to a point 6 inches outside the structure so that no rock is left within 6 inches of the finished structure or appurtenance.

Care shall be taken as the excavation approaches the desired grade to avoid overdepth excavation and provide a firm and undisturbed soil surface on which footings, slabs or foundations are to be placed. Should the Contractor excavate below the desired grade level, the excavation shall be brought to grade by the use of Class C concrete at the expense of the Contractor. The use of tamped earth backfill under foundations, footings or slabs will not be acceptable.

Where structures rest partially upon rock, the rock shall be excavated to a point 6 inches below bottom of structure and compacted crushed stone shall be used to bring the excavation back to grade. Where the structure will rest completely on sound solid rock, the rock shall be excavated to a point 4 inches below bottom of structure and compacted crushed stone shall be used to bring the excavation back to grade.

Should the material found at the desired subgrade appear to be unstable or otherwise unsuitable for support of the structure, such condition shall be immediately called to the attention of the Engineer. The Engineer may direct that such unsuitable material be removed and replaced with concrete, he may modify the foundation design to suit the condition, or he may determine that the bearing capacity of the material for the load to be supported; but in any case shall provide written instructions to the Contractor as to the procedure to be followed.

2.5 Rock Excavation - Rock excavation shall consist of loosening, removing and disposing of all rock larger than 9 cubic feet in volume, which in the opinion of the Engineer can only be removed by blasting or other equivalent methods. Such materials to be classified as solid rock shall include boulders, bed rock, or solid concrete but shall not include pavement or shaley materials that can be loosened by other methods.

Where rock excavation is encountered in trenches the excavation shall be carried to a depth of 6 inches below the bottom of the pipe. The rock shall also be removed to a width of at least 6 inches beyond the outside of the pipe on each side so that no rock is left within 6 inches of the outside wall of the pipe. Where rock is excavated in the bottom of the trench, the trench shall be brought back to grade by the use of crushed stone which shall be compacted to form a stable base for the pipe laying operation.

The Contractor shall exercise all necessary precautions in blasting operations. Suitable blasting mats shall be provided and utilized as required. Blasting shall be done only by experienced men. Careless shooting, resulting in the ejection of stones or other debris during blasting, shall be corrected immediately by the Contractor's representative.

No blasting shall be done unless the Contractor shall have taken out the necessary insurance to fully protect the Owner from all possible damages resulting from the blasting operations. The blasting shall be done in accordance with all recognized safety precautions and in accordance with regulations of authorities having jurisdiction. In addition the Contractor shall exercise the necessary care to safeguard the stores of blasting materials on the property.

Where rock is encountered in the immediate vicinity of gas mains, telephone cables, building footings, gasoline tanks, or other hazardous areas the Contractor shall remove the rock in a manner that will insure protection of these structures. Care shall be taken in blasting operations to see that pipe or other structures previously installed are not damaged by blasting. In general, blasting shall not be done within 25 feet of the completed pipeline or any existing structure.

2.6 Disposal of Surplus Excavated Material - Excavated material that is unsuitable or unnecessary for backfilling shall be hauled to sites as directed by the Engineer for use as fill on the project. No surplus excavated material may be disposed of except as provided herein unless specifically authorized by the Engineer. Any material which is not suitable or not required for the fill on the project shall be disposed of by the Contractor.

Prior to the Contractor disposing surplus excavated material on private property, the Contractor shall provide a “surplus excavated material” release / dumping agreement between the Contractor and the property owner. This release / dumping agreement shall be submitted to Winchester Utilities for review and approval prior to placing any surplus excavated material on private property.

2.7 Subsurface Obstructions - In excavating, backfilling, and laying pipe, care must be taken not to remove, disturb or injure other pipes, conduits, or structures, without the approval of the Engineer. If necessary, the Contractor, at his own expense, shall sling, shore up and maintain such structures in operation, and within a reasonable time shall repair any damage done thereto. Repairs to these facilities shall be made to the satisfaction of the Engineer.

The Contractor shall give sufficient notice to the interested utility of his intention to remove or disturb any other pipe, conduit, etc., and shall abide by their regulations governing such work. In the event subsurface structures are broken or damaged in the prosecution of the work, the Contractor shall immediately notify the proper authorities and shall be responsible for any damage to persons or property caused by such breaks.

When pipes or conduits providing service to adjoining buildings are broken during the progress of the work. the Contractor shall have them repaired at once. Delays, such as would result in buildings being without service overnight or for needlessly long periods during the day, will not be tolerated, and the Owner reserves the right to make repairs at the Contractor's expense without prior notification. Should it become necessary to move the position of a pipe, conduit, or structure, it shall be done by the Contractor in strict accordance with instructions given by the Engineer or the utility involved.

The Owner or Engineer will not be liable for any claim made by the Contractor based on underground obstructions being different than that indicated on the Drawings. Where ordered by the Engineer, the Contractor shall uncover subsurface obstructions in advance of construction so that the method of avoiding same may be deter mined before pipe laying reaches the obstructions.

The Contractor shall be governed by instructions of the Engineer regarding the laying of pipe along State Highways and the latter will determine whether the pipe shall be laid over, under, or along the end of various drainage structures encountered.

2.8 Special Conditions - Special care must be exercised in excavation under or near State Highways, railroads, or other areas as designated on the Drawings in order to avoid or minimize delays or injuries resulting there from. Where it is necessary to cross beneath state highways, railroads, or other designated areas, the Contractor shall make such installations as shown on the Drawings and/or as directed in Section 6 - Special Construction Items.

3. INSTALLATION OF WATER LINE AND APPURTENANCES

3.1 General - The Contractor shall use only experienced men in the final assembly of pipe in the trench, and all pipe shall be layed in accordance with these Specifications and the recommended practice of the pipe manufacturer. Trench bottoms shall be carefully prepared and shall be free of water.

Care shall be exercised to insure that pipe of the proper strength or classification meeting the specifications in every respect is provided at the site of pipe laying operations. Recommended tools, equipment, lubricant and other accessories needed for proper assembly or installation of the pipe shall be provided at the site of the work. Any damaged or defective pipe discovered during the pipe laying operations shall be discarded and removed from the site of the pipe laying operations.

The Contractor shall exercise care in the storage and handling of pipe, both on the storage yard and at the site of laying operations. Suitable clamps, slings, or other lifting devices shall be provided for handling pipe and fittings. Pipe and fittings shall be carefully lowered into the trench piece by piece. Pipe and fittings shall be carefully inspected for defects and for dirt or other foreign material immediately before placing them in the trench. Suitable swabs shall be available at the site of laying operations, and any dirt or foreign material shall be removed from the pipe before it is lowered into the trench.

Bell holes for bell and spigot and mechanical joint pipe shall be dug in trench to allow entire length of pipe barrel to be bedded and to allow proper jointing of pipe. Alignment of pipe shall be as true as possible in order to avoid air pockets. When work is suspended either for the night or for any other reason, open ends of the pipe shall be securely plugged to prevent the entrance of foreign materials. Dead ends of the pipe and unused branches of crosses, tees, valves, etc. shall be closed with plugs suitable to the type of pipe in use.

Dead ends of the pipe and unused branches of crosses, tees, valves, etc., shall be closed with plugs suitable to the type of pipe in use.

Cutting of pipe shall be done in a neat, workmanlike manner without damage to pipe, coatings and linings and so that a smooth end remains at right angles to axis of pipe.

3.2 Removal of Water - The Contractor shall be responsible for handling run-off, ground water, and sewage in such a way as to maintain trenches and excavations in a dry condition until the work is completed. Pumps, piping, well points, labor, fuel, and other facilities necessary to control, intercept, remove and/or dispose of water shall be provided by the Contractor at his own expense. Water removed from trenches or holes shall be discharged to natural drains in such a way as to avoid danger or damage to adjacent property owners or sewers. No pipe shall be laid with water in the bells.

Where the Contractor fails, refuses, or neglects to control water in trenches or other excavations, and corrective work is deemed by the Engineer to be necessary as a consequence thereof, such work shall be at the Contractor's expense.

3.3 Ductile Iron Pipe - Provision of AWWA Specifications C600, latest revision, “AWWA Standard for Installation of Gray and Ductile Cast Iron Water Mains” shall apply. Laying conditions shall be Type 2 (flat bottom trench without blocks) with tamped backfill.

Joints shall be an approved slip-on type or mechanical joint. Unless otherwise indicated on Drawings, lines laid below ground shall have approved slip-on joints, lines laid above ground shall have mechanical joints. Flanged joints shall be used only where designated on Drawings. Cement joints will not be permitted.

Mechanical joint and slip-on type or mechanical joint. Unless otherwise indicated on Drawings, lines laid below ground shall have approved slip-on joints; lines laid above ground shall have mechanical joints. Flanged joints shall be used only where designated on Drawings. Cement joints will not be permitted.

Mechanical joint and slip-on type water line shall be jointed together in trench according to recommendations of pipe manufacturer. Inside of bell and outside of spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter. Circular rubber gasket shall be flexed inward and inserted in gasket recess of bell socket. Thin film of gasket lubricant shall be applied to inside surface of gasket or spigot end of pipe or both. Gasket lubricant shall be as supplied by pipe manufacturer and approved by Engineer. Spigot end of pipe shall be inserted into socket, with care used to keep joint end to bottom of socket with forked tool, jack-type tool, or other device approved by Engineer. Pipe not furnished with depth mark shall be marked before assembly to assure that spigot and is inserted to full depth of joint. Field cut pipe lengths shall be filled or ground to resemble spigot end as manufactured.

Whenever it is desirable to deflect slip-on joint pipe in order to form long-radius curve, amount of deflection shall not to exceed maximum limits as follows:

Diameter	Joint Length	Deflection
4” thru 12”	18 feet	18 inches
14” thru 30”	18 feet	10 inches

3.4 Polyvinyl Chloride Pipe (Class 200 PVC) - Installation of polyvinyl chloride pipe shall conform to ASTM 2321 and AWWA C900, latest revision. Pipe shall be bedded in compacted granular material to centerline of pipe and compacted granular material to a point 6 inches over pipe. Type 5 Trench Condition as set forth in AWWA-C-600-87. The bedding material shall be shaped to provide continuous support for the PVC pipe throughout its length except at bells. Blocking shall not be used to bring the pipe to grade.

Whenever it is necessary to cut a joint of pipe in order to fit the trench conditions, the cutting may be made with either hand or mechanical saws or plastic pipe cutters. The cut shall be square and perpendicular to the pipe axis. The cut end shall be beveled as specified by the pipe manufacturer.

Assemble all joints in accordance with recommendations of the manufacturer.

Note: For installation of PVC water main materials, the Contractor shall provide and install 3-inch detection tape as per specifications. This detection tape shall be placed over the newly installed water main at a level of 15 inches below the finish ground surface.

Additionally, the Contractor shall provide and install a 14-gauge insulated copper wire directly on top of the newly installed water main. This copper wire shall be stubbed up into each valve box along the water main alignment. This stub-up shall be suitably secured in the valve box to be readily attached to pipe-locating equipment. Any splices of this wire shall be performed in a manner approved by the Engineer.

3.5 Installation of Fittings - Fittings in pipe lines shall be firmly secured to prevent the fitting from being blown off the line when under pressure. When connections are made between the new work and existing mains, the connections shall be made using specials and fittings to suit the actual conditions.

All tees, caps, plugs, bends or other fittings subjected to unbalanced forces tending to pull the joints apart shall be protected with concrete thrust blocks. Thrust blocks shall be provided in accordance with details shown on Drawings and must bear against an undisturbed trench face. Thrust blocks must be used unless written permission is obtained from the Engineer to use special locked-joint fittings, anchoring fittings, or pipe clamps with tie rods.

Fittings shall be placed in locations indicated on Drawings or designated by Engineer and shall be in stalled in accordance with provisions of these Specifications dealing with laying of Ductile Iron Pipe. Joints shall be as designated under Section 2, Materials.

All fittings, valves, etc. shall be assembled to the Ductile Iron Pipe by the use of pipe retainer glands similar or equal to Series 1200 EBAA iron, or approved equal. This is in addition to the standard concrete thrust blocking.

Before being placed in trench, all fittings shall be subjected to inspection by Engineer; and any defective, unsound or damaged fittings shall be rejected and Contractor shall remove at once from work area.

3.6 Installation of Valves, Valve Boxes - Valves shall be placed in the locations indicated on the Plans or at locations designated by the Engineer. All valves shall be set vertically. Before being placed in the trench, all valves shall be carefully examined by the Contractor and Engineer to see that they are in good working order.

All valves must be assembled to the Ductile Iron Pipe by the use of retainer glands.

Over each valve shall be placed a valve box. All valves which, when properly set, have operating nuts deeper than 30 inches below the top of the valve box shall have extension stems with operating nuts located within one foot of the valve box cap.

See Special Detail on Contract Drawings concerning the pipeline trace wire stub-ups at all valve boxes.

The valve box shall not come in contact with valve, valve stem, extension, or operating nut at any point. Backfill around boxes shall be tamped to maintain centered and plumbed alignment of box.

Box shall be installed with top set flush with finished surface in paved areas and to 2 inches above natural ground level in unpaved areas.

Upon completion of project, the Contractor shall operate all buried valves in the presence of the Engineer to verify proper operation.

3.7 Installation of Fire Hydrants - Hydrants shall be located generally as shown on the Drawings subject to review and approval by the Fire Department. Location shall provide complete accessibility and minimize possibility of damage from vehicles or injury to pedestrians.

Hydrants shall stand plumb (vertically) with pump nozzle facing street or public rights-of-way. Hydrants shall be set so that groundline, as indicated on hydrant barrel, is within 4 inches of finished grade. Hydrants without ground lines marked on barrel shall be set so that barrel flange is no more than 2 inches below finished grade. Hydrant barrels shall be minimum bury of 36 inches. Greater bury depths might be required to accomplish the above described grade setting. It is desired to accomplish the proper grade setting without the use of barrel extensions. All cost for barrel extensions and greater depth of bury shall be included in the unit price bid for the fire hydrant assemblies.

A hydrant drain consisting of at least 7 cubic feet of clean, washed gravel or crushed stone shall be placed around base of hydrant. After installation is complete, hydrant will be tested for drainage and Contractor must correct situation if hydrant does not drain satisfactorily.

Concrete thrust block shall be poured at base of hydrant with care taken not to plug hydrant drains. Blocks must be poured in addition to retainer glands, locked joint base fittings, anchoring fittings, or pipe clamps and tie rods.

Painting of hydrants after installation shall be required if factory finish is not satisfactory or has been damaged. All hydrants shall be red unless otherwise directed by the Engineer.

In case of damaged or otherwise unsatisfactory paint, Contractor shall apply two (2) coats of approved enamel.

Hydrant installation shall conform to details in Project Drawings.

4. BACKFILL

4.1 General - Backfilling shall be carried out as expeditiously as possible, but shall not be undertaken until the Engineer has been given the opportunity to inspect the work. The Contractor must carry out all backfilling operations with due regard to: the protection of pipes, structures and appurtenances; the use of prescribed backfill materials; and procedures to obtain the desired degree of compaction. No equipment may be used which will result in damage to or misalignment of the pipe.

4.2 Acceptable Backfill Material - All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones, or other material that in the opinion of the Engineer is unsuitable. From one foot above top of pipe to within twelve inches of finished grade in unpaved areas, back fill may contain stones up to six inches in their greatest dimension, unless otherwise specified. Back fill containing rock must contain enough dirt to fill voids between rock.

When backfill material is not specified on Project Drawings or elsewhere in these Specifications, Contractor may backfill with the excavated material provided material consists of loam, clay, sand, gravel, or other materials than, in opinion of Engineer, are suitable for backfilling.

Backfilling shall not be done in freezing weather and it shall not be made with frozen material. No fill shall be made where material already in trench is frozen. Backfill shall not be made with material which, in Engineer's opinion, is too wet.

Where crushed stone backfill is required the crushed stone shall be No. 67 size as designated by the State Department of Transportation Standards for crushed stone used in road surfacing.

4.3 Backfilling Under Pipe - All trenches shall be backfilled by hand from bottom of trench to centerline of pipe. Approved backfill material (Crushed Stone No. 67) shall be placed in 6-inch layers and thoroughly compacted by hand tamping. Backfill material shall be deposited in trench for its full width on each side of pipe, fittings and appurtenances simultaneously. Care must be taken to compact fill along sides of pipe and appurtenances adjacent to pipe wall.

4.4 Backfilling Under Pipe in Rock - Where trench is excavated in rock or shale, 6-inch space below pipe shall be backfilled with approved bedding (Crushed Stone No. 67) material firmly compacted to form a cushion for pipe and appurtenances.

4.5 Backfilling Over Pipe - From centerline of pipe, fittings and appurtenances to a depth of 1 foot above top of pipe, trench shall be backfilled by hand or by approved mechanical methods of 6-inch layers and thoroughly compacted by hand tamping or by approved mechanical methods. Contractor shall use special care in placing this portion of backfill in order to avoid injuring or moving pipe.

After the backfill has been placed to a depth of at least 12 inches above top of pipe, additional backfill may be placed by means of front end loaders, bulldozers or other suitable mechanical equipment subject to a 9-inch limitation of maximum thickness of layers placed before compaction.

4.6 In Areas Subject to Vehicular Traffic or Under Sidewalks - Where excavation is made through pavement, curbs, driveways, sidewalks, road shoulders, or other areas subject to vehicular traffic or supporting permanent structures, or where such areas, items or structures are undercut by excavation, entire backfill shall be crushed stone (No. 67) which shall be placed in layers or lifts not exceeding 9 inches in thickness.

After placing in layers, crushed stone shall be carefully compacted to maximum density or minimum volume. Such backfill, placed where called for on the Drawings or as directed by the Engineer, shall be designated as Crushed Stone Backfill.

Where excavation is made through permanent pavements, backfill shall be placed as described above to subgrade elevation only. Remainder of backfill shall be crushed stone placed as directed to finished pavement grade to serve as temporary pavement.

The last 8 to 10 inches of backfill shall be compacted pug mix to stabilize trench cut.

From time that backfilling is complete until time permanent pavement surface is replaced or, in absence of pavement replacement, until job is accepted, Contractor shall, at direction of Engineer, water streets, roads, etc. to settle dust where excessive dust has, in opinion of Engineer, been caused by Contractor's operations. If Contractor refuses or delays unnecessarily to obey direction of Engineer, the Owner shall, after 24 hours written notice through Engineer, be permitted to proceed with such work with cost to be billed to Contractor.

The Contractor's attention is directed to the fact that water main items on this project are established as "under" and "outside" of roadway. Therefore, crushed stone backfill for pipe indicated to be under roadway shall not be a separate pay item.

In Areas Not Subject to Vehicular Traffic - Where excavation is made in areas not subject to vehicular traffic or supporting permanent structures and where settlement is not as critical, Contractor may backfill trench from 1 foot above top of pipe to top of trench with approved excavated material using hand or approved methods. Backfill material shall be brought up to the original ground level in layers and walked in with suitable equipment. More restrictive compaction of this backfill material will not be required, however, the Contractor shall be responsible for bringing in such additional fill material as may be required from time to time during the one year warranty period to fill in areas where excessive settlement has occurred.

5. COMPLETING INSTALLATION OF LINES, STRUCTURES, ETC.

5.1 General - The Contractor shall not, without the permission of the Engineer, remove from the line of work any earth excavated therefrom which may be suitable for backfilling or surfacing until the excavation has been refilled and surfaced.

As soon as the backfilling of any excavation is completed and when in areas of existing development, the Contractor must at once begin the removal of all surplus dirt except that actually necessary to provide for the settlement of the fill. He shall also remove all the pipe and other material placed or left on the street by him except material needed for the replacement of paving, and the street shall be opened up and made passable for traffic. Following the above work, the repairing and complete restoration of the street surfaces, bridges, crossings, and all places affected by the work shall be done as promptly as possible.

All excavated material shall be cleared from adjacent street surfaces, gutters, sidewalks, parkways, railroads, grass plots, yards, etc., and the whole work shall be left in tidy and acceptable condition. Contractor will be required to regrass lawns or neutral grounds where trenches are excavated in these locations or where Contractor has damaged lawns or neutral grounds by his operations.

The Engineer shall be sole authority in determining time in which rough and final clean-up shall be prosecuted. Rough clean-up shall consist of removal of large rocks, grading of excess backfill material over pipe line or removal of said material, opening of any drainage device, restoration of any street or roadway to condition so that traffic may safely and conveniently use street or roadway, restoration of pedestrian ways to condition where pedestrians may safely and conveniently use same. Rough clean-up shall, in general, be prosecuted no later than 1 day after pipe laying and backfilling or nor farther behind pipe laying operations than 1,000 feet; whichever time limit is shortest shall govern. Final clean-up consisting of pavement replacement, sidewalk replacement, removal of rocks, handraking with seeding, strawing, etc., of lawns and neutral grounds, adjusting grade of ground over pipeline, property repairs, and other items shall be prosecuted as soon as is practical after pipe has been laid and backfilled. In general, this would be no later than 2 to 3 weeks after completion of backfilling.

5.2 Final Grading and Seeding - Final clean-up shall consist of, among other items, final grading of disturbed areas and seeding of areas where grass growth was damaged or destroyed by the Contractor's operation. In areas of established lawns no rock shall be left in the top 6 inches of soil and the finished grade shall be that which existed before construction began. In all cases, lawn areas shall be left neat and in a condition so that hand mowing is as easy and convenient as before construction began. The lawn areas and other areas disturbed by the Contractor's activities shall have ground cover restored at least equal to the condition which existed before construction began. In established lawn areas new grass shall be of the same type as originally present. Grass and other ground cover shall be properly applied, fertilized, strawed, and watered as necessary and required to establish a good stand of grass.

5.3 Pavement Replacement - Where existing paved streets, roads, parking lots, drives or sidewalks must be disturbed during construction of the project, the Contractor shall take the necessary steps to

minimize damage. Permanent type pavement shall be cut or sawed in a straight line before removal and care shall be taken during excavation to avoid damage to adjacent pavement. Where trucks or other heavy equipment must cross curbs or sidewalks, such areas shall be suitably protected.

In roadway areas as soon as the pipe has been installed, the trench shall be backfilled as specified and, where directed by Engineer, a temporary pavement patch shall be provided in areas which have permanent paving. "Permanent paving" shall mean asphaltic concrete ("hot mix") or Portland cement concrete. Cold mix, surface treatments, crushed stone are excluded from the "permanent pavement" classification. The temporary pavement patch shall consist of at least 6 inches of compacted stone base brought to within 2 inches of the surface of the existing permanent pavement. A 1-inch layer of cold mix asphaltic concrete shall then be applied to protect the base, prevent "pot holes" or "chuck holes", and provide a reasonably smooth pavement surface until the permanent patch is made. The temporary pavement patch shall be placed within 48 hours of receipt of written instruction of the Engineer.

Pavement types shall be designated by Engineer for installation in specific location where such designation is not shown on Drawings. All street pavements, unless otherwise noted herein, or directed by the Engineer, which have sewers installed parallel with the road, across streets, driveways or parking lots, shall be restored by the following:

Prior to placement of the pavement restoration, the Contractor shall reshape the street or roadway surface. Street preparation shall include all required scarifying, shaping, and rolling in pug mix of areas to be paved. This item will also include the removal of all pavement which is heaved by the Contractor's blasting operations. This street preparation shall return the streets to the template which existed prior to construction. This street preparation shall be satisfactory to the local street department or authority before the street is accepted for paving operations.

Contractor shall be responsible for replacing all crushed stone surfacing damaged by his operation with measurement and payment to be described in these Specifications. The Contractor shall be responsible for maintaining temporary patches during construction and shall promptly repair any defects. Upon completion of the work the paved surfaces shall be left in as good or better condition than before the start of construction.

In paved or improved roads, or where sidewalks, curbs, gutters or driveways have been damaged by Contractor, and where replacement of surfaces or damaged items is required, items shall be repaired or replaced without any needless delay and in the best workmanlike manner with same kind of materials as were removed or damaged in construction operation. Underlying foundation courses for roads, etc., finished surfaces, etc. shall conform to undisturbed item. Decision of Engineer shall be final as to classification of any form of pavement or surfacing not specified on Project Drawings or of any forms of pavement or surfacing where classification is at all doubtful. Should Contractor fail or refuse to repair any damage after receiving directions of Engineer, Owner may, after 24 hours written notice, employ such force and furnish such materials as may be necessary to do the work with cost to be billed to Contractor.

All gas valves, water valves, and manholes will be adjusted to the final surface elevations by the Contractor.

1. Asphalt Pavement Replacement Type A

   This item of pavement restoration shall conform to the details included in the Contract Drawings. The leveling binder course and the surface course shall be furnished and placed in accordance with the Tennessee Department of Transportation.

2. 4 Inches or 2 Inches of Leveling Course Binder in Trenches

Place 4 or 2 inches of leveling course binder in trenches. Furnish and place in accordance with the Tennessee Department of Transportation Standard Specifications, conforming to the details included in the Contract Drawings. This item is intended for use and placement prior to full-width overlay with asphaltic surface course.

3. Asphalt Surface Course

Place 2 inches of asphalt surface course over the trench cut patch pavement and place 1-1/2 inches of asphalt surface course over parking lots, entire roadway or traffic lanes of streets. Furnish and place in accordance with Tennessee Department of Transportation Standard Specifications. Prior to placing the surface course, a tack coat shall be applied in accordance with the Standard Specifications.

The above asphalt pavement replacements will be measured for payment as indicated in the Unit Price Items. These payments shall also include full compensation for applying all necessary prime or tack coats required by the Tennessee Department of Transportation Standard Specifications prior to the placement of base or surface courses.

4. Asphalt Driveway and Parking Lot Patch Replacement

Asphalt Driveways and Parking Lots shall be replaced equal to that existing prior to construction and shall consist of no less than 2 inches of surface course conforming to the Tennessee Department of Transportation Standard Specifications.

5. Crushed Stone Roadway Replacement or Driveway Replacement

Crushed Stone Roadways and Pavement shall be replaced to that existing prior to construction but in no case less than 6 inches in depth.

6. Concrete Driveway or Ramp Replacement

Concrete driveway shall be replaced equal to that existing prior to construction but in no case less than 6 inches in depth with 4" x 4" reinforcing wire mesh.

5.4 Dust Control - From time that backfilling is complete until time permanent pavement surface is replaced or, in absence of pavement replacement, until job is accepted, Contractor shall, at direction of Engineer, water or apply calcium chloride to streets, roads, etc. to settle dust where excessive dust has, in opinion of Engineer, been caused by Contractor's operations. If Contractor refuses or delays unnecessarily to obey direction of Engineer, the Owner shall, after 24 hours written notice through Engineer, be permitted to proceed with such work with cost to be billed to Contractor.

5.5 Sodding or Sprigging - Where shown on the Drawings or directed by Engineer, Contractor shall install sodding or sprigging in lieu of seeding in order to establish ground cover. Normally this would be done in areas subject to erosion in soils that are difficult to hold.

Prior to sodding or sprigging, soil shall be properly prepared and fertilized. The top 3± inches of soil shall be pulverized to remove roots, sticks, etc. and smooth the surface. Area shall be fertilized at a minimum rate of 500 pounds per acre. Fertilizer shall be mixed into the top 3 inches of soil by raking, disking, or other acceptable method. Do not overfertilize areas in order to avoid damaging growth. Fertilizer shall be "Vertigreen", "Vigaro", or approved equal. It shall contain not less than 5% nitrogen,

10% phosphorus, and 4% potash. If the area soil requires, by test, adjustment of the pH for proper growth of ground cover, ground limestone shall be applied to bring the pH into the proper range.

Sod shall be at least 8 inches wide and 12 inches long with at least 3 inches of dirt on the roots. It shall be placed on the prepared surfaces with edges in close contact and, as just as is practicable, in a position to break joints. Each section shall be pounded into place with wooden tamps or other approved implements. Sod shall be maintained moist from the time of its removal until reset and shall be reset as soon as practicable after removal. Immediately after placing, it shall be rolled or hand tamped to the satisfaction of the Engineer. On steep slopes, pinning or pegging will be required to hold the sod in place.

Sprigs shall be placed in a random manner at spacing suitable for optimum growth and cover as recommended by the supplier.

Immediately prior to sodding or sprigging, the area shall be sprinkled until saturated to at least a 1inch depth and kept moist until sodding or sprigging is completed. Sprigs or sod shall be watered as required after setting (normally through a 14-day period). Contractor shall not allow any equipment or material on any planted area and shall erect barricades and guards if necessary to prevent his equipment, labor or the public from traveling on any planted area until satisfactory growth is established.

6. SPECIAL CONSTRUCTION ITEMS

6.1 Roadway Crossings - Roads, streets or highways will be crossed at locations and in the manner as designated by the Drawings. State Highway crossings will be subject to the requirements of the crossing permit obtained from the Tennessee Department of Transportation.

When working in or near lines of traffic, the Contractor shall provide warning signals or flagmen as required by the Tennessee Department of Transportation.

6.2 Water Main In Tunnel/Bore - The carrier pipe in the tunnel/bore shall be as specified in the Materials section of this specification. All work performed beneath existing structures, across railroad rights-of-way, and under pavements shall be performed in accordance with the requirements of the parties or agencies having jurisdiction over these locations. The Contractor shall contact the parties or agencies prior to starting work and shall meet all requirements of the parties or agencies in regard to methods of construction and the safety precautions to be taken in performing the tunnel work. All costs involved in meeting these requirements shall be paid for by the Contractor and no additional compensation allowed.

At the Contractor's option and with consent of the parties or agencies having jurisdiction, steel pipe may be jacked or bored into place in lieu of a liner plate tunnel provided the Contractor be responsible for all approvals from the parties and/or agencies having jurisdiction including, but not limited to, furnishing complete details of the methods to be employed for approval.

The water main pipe shall be adequately secured in the tunnel/bore casing by a method approved by the Engineer. At a minimum, the carrier pipe must be secured and new compressible sand or pea gravel shall be placed in the space between the liner/casing and the carrier pipe by a method approved by the Engineer. Concrete bulkheads will be placed at the end of the tunnel, thickness and placement of which shall be subject to the Engineer's approval.

Note: In situations where the bore method is utilized with a steel casing pipe, the carrier pipe shall be secured inside the steel casing pipe with casing chocks (minimum three per joint) as manufactured by Powerseal Pipeline Products Corporation of Wichita Falls, Texas, or Engineer-approved equal. Where

casing chocks are used inside steel casing pipes, the requirement for sand or pea gravel backfill can be eliminated. Additionally, the ends of the steel casing pipe shall be sealed with casing pipe “End Seals”, “Link-seal”, or Engineer-approved equal.

Construction of the tunnel/bore shall be carried on in such a manner that settlement of the ground surface above the tunnel/bore shall be held to an absolute minimum. Where ground conditions are unstable, poling plates or poling boards shall be used to prevent caving of material above the tunnel before the liner plates can be installed. Steel liner plates shall be installed as soon after the excavation is removed as possible and excavation shall not be removed more than 24 inches ahead of the installed liner plates.

Excavation shall be carried on in such a manner that voids behind the liner plates will be held to a minimum. However, should any boulders larger than one foot in diameter be encountered, they shall be removed so that none are closer than 6 inches to the outer face of the liner plates. Should piling be encountered, each pile shall be cut out so that no portion remaining shall be closer than one foot to the outer face of the liner. Where boulders or piling are excavated, the holes shall be backfilled by tamped material.

The steel lining shall consist of plates not to exceed 18 inches wide. Each circumferential ring shall be composed of the number and length of plates to complete the required diameter. The Contractor shall submit details of the lining for approval.

The strength of the casing or tunnel lining will be determined by its section modulus. Thickness of the metal for these steel plates shall not be less than 8 gauge allowing for standard mill tolerance.

All plates shall be punched for bolting on both longitudinal and circumferential seams and shall be so fabricated as to permit complete erection from the inside of the tunnel. The longitudinal seam shall be of the lap type with offset equal to gauge of metal for full width of plates including flanges and shall have staggered bolt construction so fabricated as to allow the cross-section of the plate to be continuous through the seam. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

The material used for the construction of these plates shall be new and unused and suitable for the purpose intended. Workmanship shall be first-class in every respect.

After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter, or equal, shall be applied at the rate of not less than three ounces per foot of double exposed surface. If the average spelter coating as determined from the required samples is less than the amount specified above, or if any one specimen shows a deficiency of 0.2 ounce, the lot shall be rejected. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots.

All nuts and bolts shall be galvanized.

Plates shall be fabricated with grout holes to facilitate grouting above and around the tunnel liner. These grout openings shall be 2-inch I.P.T. half couplings welded into a hole in the center corrugation couplings welded into a hole in the center corrugation of a plate and a galvanized C.I. plug shall be provided for each opening to permit tight closure after grout holes so that the spacing of 18-inch centers at the top of the tunnel and at the top quarter points, staggered with the holes at the top.

Field coating material shall be asphaltic mastic, Trumbull 5X, or approved equal, and shall be applied with hydraulic spray equipment using a minimum of 2,400 pounds pressure at the nozzle tip. The

material shall be supplied at spraying consistency and shall be applied both the outside and inside of the liner plates. Plates may be hot-dipped to produce a similar coating.

When installing liner plate by the tunneling method, the excavation shall be performed in such a manner that voids between the undisturbed earth and the liner plate shall be maintained at a minimum. Any void occurring shall be filled with a Portland cement and sand grout pumped under pressure through grouting openings in the liner plate.

The minimum provision for grouting openings shall be one opening in a top plate of the tunnel or conduit at locations not to exceed 54 inches apart. Additional plates with grouting openings are to be installed at the top quarter points on each side between the top openings. The opening shall be staggered but shall not exceed 54 inches in any one line. Grout vent pipes will be required at a minimum of one per monolithic pour.

The grout shall consist of Portland cement, water, sand and 2% approved additive (Bentorite, Septamine Seax, Hydrocide liquid, etc.). One part Portland cement with additive shall be combined to four parts clean sand and sufficient water added to provide a grout having the consistency of thick cream when well mixed.

A pump shall be provided for placing the grout which shall be capable of exerting sufficient pressure to assure the filling of all voids between the liner plate/ casing and the undisturbed ground. Minimum acceptable pressure will be five pounds per square inch.

Pumping of grout shall be done (1) at the completion of the installation of approximately each 9 feet of liner plate, (2) at more frequent intervals than 9 feet if conditions indicate the necessity, and (3) at the end of a work day or when there is work stoppage for any reason.

The carrier pipe shall be furnished by the Contractor. Upon acceptance of the liner/casing, install the carrier pipe in the casing by jacking it through the casing. A concrete invert may be poured if necessary to achieve proper line and grade on the carrier pipe to offset any minor variations in the alignment of the casing.

6.3 Maintaining Traffic while Crossing Streets and Highways - At various locations on this project (in addition to what might be specifically shown on the Contract Drawings) the nature of construction and traffic conditions will require that the Contractor utilize and maintain heavy steel plates to facilitate traffic. These steel plates shall be of sufficient size and thickness to be utilized for varying trenching conditions.

7. SLOPE PROTECTION AND EROSION CONTROL

This section shall consist of temporary control measures as shown in the Drawings or directed by the Engineer or as required by the State of Tennessee, Water Pollution Control Division during the life of the Contract to control erosion and water pollution through the use of hay bales and other control devices.

The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.

a. Baled hay or straw erosion checks are temporary measures to control erosion and prevent siltation. Bales shall be either hay or straw containing five cubic feet or more of material.

Baled hay or straw checks shall be used where the existing ground slopes in ditches or other areas where siltation erosion or water run-off is a problem.

b. Baled hay or straw erosion checks - Hay or straw erosion checks shall be embedded in the ground 4 to 6 inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the Engineer. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.

c. Temporary silt fences - Silt fences utilizing posts, filter cloth (burlap or plastic filter fabric, etc.) or other approved materials are temporary measures for erosion control. These fences shall be installed to retain suspended silt particles in the run-off water.

d. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.

In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of work as scheduled, and are ordered by the Engineer, such work shall be performed by the Contractor at his own expense.

e. Erosion control outside project area - Temporary pollution control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads and equipment storage sites. Bid price in such cases shall include all necessary clearing and grubbing, construction incidentals, maintenance, and site restoration when no longer needed.

TESTING AND ACCEPTANCE - SMALL PROJECTS

1. GENERAL

Upon completion of the construction work the Contractor shall conduct the necessary pressure and leakage tests, and shall disinfect the completed water mains and appurtenances. The Contractor shall furnish all labor, tools, equipment and materials for making the tests. In the event that the pressure or leakage test is unsatisfactory, or bacteriological tests indicate that disinfection is in complete, the Contractor shall take corrective measures and shall repeat the tests until satisfactory results are obtained. Tests shall be made in the presence of an authorized representative of the Engineer.

2. PRESSURE AND LEAKAGE TESTS

Each section of the completed water line shall be subjected to a pressure test. The section to be tested shall be valved off after having been filled with water, and a positive displacement test pump shall be used to pump clean water into the section to build up a test pressure of 200 psi at the point of maximum pressure in the test section. Each valved section of pipe shall be slowly filled with water, and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. The system shall be allowed to stabilize at the test pressure before conducting any leakage test. The test pump shall then be valved off from the system and the pressure shall be observed over a period of at least 2 hours.

Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place at the discretion of the Owner.

Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until it is satisfactory to the Owner.

No pipe installation will be accepted if the leakage is greater than that established in AWWA C600. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
A drop in pressure of 5 psi or more during the one hour test shall be taken as an indication of leakage. In the event leaks are found and corrected, the Contractor shall repeat the pressure test using the same procedure described above. Should the Contractor be unable to obtain a satisfactory pressure test over a duration of at least 2 hours, he shall then be required to perform a leakage test using a water tap and standard water meter to measure the leakage in the test section at system pressure over a period of 24 hours. Leakage during the 24-hour period must not exceed the allowable leakage for mechanical or push-on joints as shown in Table 7 of AWWA C600, latest revision, and reproduced on the following page. Should the system fail to pass the leakage test, the Contractor will be required to locate and correct the leaks and to retest the system until satisfactory results can be obtained.

The Contractor shall provide suitable first quality pressure gauges with 5 lb. or smaller graduations and a standard 5/8" x 3/4" water meter in the event the meter is required for the leakage test. Pressure gauges and water meter shall be in good condition and shall be subject to such tests for proof of accuracy as the Engineer may require.

Allowable Leakage per 1,000 feet (305 m) of Pipeline* - gph+

Avg. Test Pressure psi (Bar)	Nominal Pipe Diameter - in.															
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

*** If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.**

+ To obtain leakage in liters/hour, multiply the values in the table by 3.785

Copied from AWWA C600.

3. DISINFECTION

All water line extensions and appurtenances shall be disinfected upon completion. After the lines have been flushed or otherwise suitably cleaned to remove dirt or debris which may have been introduced into the lines during construction, disinfection shall be accomplished in accordance with the provisions of AWWA Standard for Disinfecting Water Mains: AWWA C651, latest revision.

The basic disinfection procedure consists of: (1) Preventing contaminating materials from entering water lines and appurtenances during storage, construction or repair; (2) Removing, by flushing or other means, those materials that may have entered the water lines and appurtenances; (3) Chlorinating any residual contamination that may remain and flushing the chlorinated water from the lines; and (4) Determining the bacteriological quality by laboratory testing after disinfection.

3.1 Preventing Contamination During Construction

Heavy particulate matter and debris generally contain bacteria and can prevent even very high chlorine concentrations from contacting and killing such organisms. It is, therefore, essential that the Contractor utilize procedures to assure that the water lines and appurtenances are thoroughly clean for the final

disinfection by chlorination. Toward that end, it is important for the Contractor to prevent contamination of water lines and appurtenances during storage and installation.

All openings in the pipelines shall be closed with watertight plugs when pipe laying is stopped for any reason. Rodent proof plugs may be used when it is determined that watertight plugs are not practicable, where their use could result in pipe flotation if water enters the trench, or where thorough cleaning will be performed by flushing or other means. Workmen need to routinely check the pipeline for contaminating material and keep the pipeline as clean as practicable.

Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry enough to prevent trench water from entering the pipeline. All jointing material and lubricates shall be as recommended by the pipe manufacturer and shall be suitable for use in potable water lines. Trench water shall be kept out of the pipelines, if possible, by the use of plugs or other suitable means. Protect the jointing material and lubricates from contamination. Lubricates shall be delivered to the Project site in closed containers and shall be kept clean.

3.2 Flushing or Cleaning by Other Means

If dirt or debris does find its way into the pipeline and it is likely that it will not be removed by flushing, the interior of the pipe shall be cleaned by mechanical means and then shall be swabbed with one (1) percent hypochlorite disinfecting solution. Cleaning with a swab, pig or similar device should be undertaken only when it has been determined that such operation will not force mud or debris into pipe joint spaces where removal is difficult or impossible.

Velocities of about 2.5 feet per second (fps) or higher are generally required to adequately flush a pipeline. The Contractor is cautioned that the flow rate necessary to reach these velocities is not always practical or even possible. Other methods of cleaning must be employed, and it is even more important to take extra precautions to keep the pipeline clean during the pipe laying operation. This is especially true of large diameter pipes. The following tabulation shows the approximate gallons per minute required to reach a velocity of 2.5 fps for various pipe diameters.

Pipe Diameter, Inches	Gallons per Minute Required
4	100
6	200
8	400
10	600
12	900
16	1,600
20	2,500
24	3,500
30	5,500
36	7,900
42	10,800
48	14,100
54	17,900

When flushing is used to clean pipelines, the Contractor must use care and caution concerning the disposal of water flushed from the lines.

3.3 Chlorination for Disinfection

The forms of chlorine that may be used for disinfection are: (1) liquid chlorine; (2) sodium hypochlorite solution; and (3) calcium hypochlorite granules or tablets. Liquid chlorine must meet the requirements of AWWA B301 and sodium and calcium hypochlorites must meet the requirements of AWWA B300.

Three methods are approved for use under the AWWA standard: (1) the tablet method; (2) the continuous feed method; and (3) the slug method. Each has its advantages under certain situations. The method to be used on this project must be approved by the Engineer before implementation by the Contractor. The continuous feed method is suitable for general application. The slug feed method is suitable for use in large diameter lines where the volume of chlorinated water which must be flushed to waste is of concern and where chemical costs are a consideration. The tablet method is generally more suitable for small diameter pipelines; but the line must be kept dry during installation, preliminary flushing for cleaning is not possible, and the chlorine concentration tends to be less uniform.

(a) The Tablet Method - This method consists of placing granules or tablets in the pipeline as it is being installed and filling the pipeline with potable water when the installation is completed. Only use this method if the pipes and appurtenances are kept clean and dry during construction.

Granules - during construction, granules are placed at the upstream end of the first section of pipe, then at the upstream end of each branch pipeline, and along the pipeline at intervals of 500 feet. The quantity shall be as shown in AWWA C651 and as approved by the Engineer. Do not use this method on solvent-weld plastic or on screwed-joint steel pipe because of the danger of fire or explosion from a reaction of the joint compounds with the calcium hypochlorite.

Tablets - During construction, 5 gram calcium hypochlorite tablets shall be placed in each section of pipe and also one such tablet in each fire hydrant, fire hydrant branch and other appurtenances. The number of tablets shall be as required in AWWA C651 and as approved by the Engineer. The tablets shall be attached by an adhesive such as Permatex No. 1, or approved equal. there shall be no adhesive on the tablet except on the broad side attached to the surface of the pipe. Attach all tablets to the inside of the pipe at the top with approximately an equal number of tablets at each end of a given pipe length. Make sure the tablets end up at the top of the pipe as installed in the trench.

Filling and Contact - when pipe installation is complete, the pipeline shall be filled with potable water at such a rate that the water within the pipeline will flow at a velocity no greater than one foot per second (1 fps). Precautions shall be taken to assure that air pockets are eliminated. This water shall remain in the pipeline for at least 24 hours. If the temperature is less than 41 degrees F (5 degrees C), the water shall remain in the pipeline at least 48 hours. During this period of contact, all valves and hydrants in the treated section shall be operated to ensure disinfection of these appurtenances. Valves shall be positioned so that the strong chlorine solution in the treated pipeline willm not flow into pipelines in active service

(b) Continuous Feed Method - This method consists of placing calcium hypochlorite granules in the pipeline during construction (Contractor's option), completely filling the pipeline with potable water in order to remove all air pockets, flushing the completed pipeline if necessary to remove particulates, then filling the pipeline with potable water chlorinated so that after 24 hour holding period in the pipeline there will be free chlorine residual of not less than 10 milligrams per liter (mg/l).

Placing Hypochlorite Granules - This procedure shall be as outlined under "Tablet Method" above and is at the Contractor's option. Its purpose is to provide a strong chlorine concentration in the first flow of flushing water passing through the pipeline.

Preliminary Flushing - Before being chlorinated, the pipeline shall be filled to eliminate air pockets and shall be flushed to remove particulates. The flushing velocity shall not be less than 2.5 fps. Part 3.2 above contains a table showing the rates of flow required to produce this velocity in pipelines of various sizes. Flushing is no substitute for keeping the pipeline clean during construction because some contaminants resist removal by flushing at any feasible velocity. For pipelines of 24-inch diameter and larger, broom sweeping and careful removal of all debris, silt and other contaminants is an acceptable alternative to flushing.

Chlorinating the Pipeline and Appurtenances - Water from existing distribution system or other approved source shall be made to flow at a constant, measures rate of flow into the newly laid pipeline. The regulation of this rate of flow is important and shall be as approved by the Engineer.

At a point not more than 10 feet downstream from the beginning of the new pipeline, water entering this line shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 25 mg/l free chlorine. To assure that this concentration is provided, the concentration shall be measured at regular intervals in accordance with procedures established in AWWA C651.

The devices and methods used to measure rates of flow, apply the chlorine solution and test the concentration shall be as approved by the Engineer and in accordance with AWWA C651.

during the application of chlorine, valves shall be positioned so that the strong chlorine solution in the pipeline being treated will not flow into water lines in active service. Chlorine application shall not cease until the entire pipeline is filled with heavily chlorinated water. The chlorinated water shall be retained in the pipeline for at least 24 hours, during which time all valves and hydrants in the treated section shall be operated to ensure disinfection of the appurtenances. At the end of this 24-hour period, the treated water in all portions of the pipeline shall have a residual of not less than 10 mg/l free chlorine.

(c) Slug Method - This method differs from the Continuous Feed Method described above in that the disinfection is accomplished by a slug of water containing highly concentrated chlorine (100 mg/l) flowing slowly through the length of the pipeline. The slow flow ensures that all parts of the pipeline and the appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours.

For the execution of this method, refer to Part 3.3(b) above for all procedures except as described below.

Chlorinating the Pipeline and Appurtenances - At a point not more than 10 feet downstream from the beginning of the new pipeline, water entering the new pipeline shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 100 mg/l free chlorine. To ensure that this concentration is provided, the chlorine concentration should be measured at various intervals. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or "slug", of chlorinated water that will, as it moves through the pipeline, expose all surfaces to a concentration of approximately 100 mg/l for at least 3 hours.

The free chlorine residual shall be measured in the slug as it moves through the pipeline. If at any time it drops below 50 mg/l, the flow shall be stopped, chlorination equipment shall be

located to the head of the slug; and, as flow is resumed, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/l.

As the chlorinated water flows past fittings and valves, these valves, hydrants and other appurtenances shall be operated so as to disinfect these items.

(d) Final Flushing - After the applicable retention period (contact time), heavily chlorinated water should not remain in prolonged contact with the pipeline or appurtenances. To prevent damage to the pipe lining, the pipe itself or to appurtenances, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the water system or is acceptable for domestic water use.

Disposal of Heavily Chlorinated Water - The environment to which the chlorinated water will be discharged shall be inspected. If there is any question that discharge of the water flushed from the pipeline will cause damage to the environment, then a reducing agent shall be applied to the water to be wasted in order to neutralize the chlorine residual remaining in the water. Where necessary, federal, state or local regulatory agencies should be contacted to determine specific provisions for the disposal of heavily chlorinated water. The procedure used for disposal shall be subject to review and approval by the Engineer prior to initiating any disposal.

3.4 Bacteriological Testing

Upon completion of the disinfection and flushing procedures, samples of the water from the treated pipeline shall be taken using methods in accordance with AWWA C651 and as approved by the Engineer. Samples shall show the absence of coliform organisms before the testing is considered complete and the new pipeline put in service.

In the event that the samples show the presence of coliform bacteria or an excessive total count, the disinfection procedure shall be repeated by the Contractor until samples of satisfactory bacteriological quality are obtained.

The Contractor shall furnish all equipment, material (except for the sample bottles which will be furnished to the Contractor by the Owner at no cost to the Contractor) and labor necessary for this testing procedure and shall perform the sampling. The samples shall be turned over to the Owner for testing at a laboratory designated by the Owner.

(a) Procedures - All sampling and testing shall be done in accordance with AWWA C651 and Standard Methods for the Examination of Water and Wastewater.

At least one sample shall be collected from the new pipeline and one from the branch. In the case of long pipelines, samples shall be taken along its length as well as at its end. Sample spacing shall generally not exceed 2,500 feet.

If, during construction, trench water has entered the pipeline or excessive quantities of dirt or debris have entered the pipeline, bacteriological samples shall be taken at intervals of approximately 200 feet and shall be identified by location. In these cases, samples shall not be taken until water has stood in the pipeline for at least 16 hours after completion of the flushing.

Samples shall be collected in sterile bottles furnished by the Owner for the purpose of bacteriological sampling (treated with sodium thiosulfate).

No hose or fire hydrant shall be used in the collection of the samples. A corporation cock installed in the pipeline with a copper tube gooseneck assemble, or other arrangement as approved by the Engineer, may be used.

(b) Redisinfection - If the initial disinfection fails to produce satisfactory bacteriological samples, the pipeline may be reflushed and shall be resampled. If check samples show the presence of coliform organisms, the pipeline shall be rechlorinated by the continuous feed method or by the slug feed method until satisfactory results are obtained.

3.5 Acceptance

When testing of the samples shows that there is no presence of coliform organisms or, in the case of the standard plate count, there is not an excessive total count, the disinfection procedure is considered successful and the pipeline and appurtenances may be put in service provided all other Contract provisions, necessary or required for putting the pipeline in service, have been met.

4. TESTING OF VALVES and OTHER APPURTENANCES

Upon completion of installation, all valves, fire hydrants, service connections, meters, and other appurtenances shall be operated in the presence of the Engineer to verify proper operation.

5. TESTING OF WATER SERVICES

The Contractor shall test all new water services at the same time that the water main is tested or the Contractor shall expose all connections, taps, curb cocks, unions, and any other fittings when the system water pressure is restored to the meter. These fittings shall be inspected by the Contractor in the presence of the Engineer. If any leaks are found, these leaks shall be repaired in a manner approved by the Engineer.

TESTING AND ACCEPTANCE - LARGE PROJECTS

1. GENERAL

Upon completion of the construction work the Contractor shall conduct the necessary pressure and leakage tests, and shall disinfect the completed water mains and appurtenances. The Contractor shall furnish all labor, tools, equipment and materials for making the tests. In the event that the pressure or leakage test is unsatisfactory, or bacteriological tests indicate that disinfection is in complete, the Contractor shall take corrective measures and shall repeat the tests until satisfactory results are obtained. Tests shall be made in the presence of an authorized representative of the Engineer.

2. PRESSURE AND LEAKAGE TESTS

Each section of the completed water main extension shall be subjected to a pressure test. The section to be tested shall be valved off after having been filled with water, and a positive displacement test pump shall be used to pump clean water into the section to build up a test pressure of 200 psi. The test pump shall then be valved off from the system and the pressure shall be observed over a period of one hour. A drop in pressure of 5 psi or more during the one hour test shall be taken as an indication of leakage. In the event leaks are found and corrected, the Contractor shall repeat the pressure test using the same procedure described above. Should the Con tractor be unable to obtain a satisfactory pressure test over a duration of one hour, he shall then be required to perform a leakage test using a water tap and standard water meter to measure the leakage in the test section at system pressure over a period of 24 hours. Leakage during the 24 hour period must not exceed the allowable leakage for mechanical or push-on joints as shown in Table 7 of ANSI/AWWA C600, latest revision, and reproduced on the following page. Should the system fail to pass the leakage test, the Contractor will be required to locate and correct the leaks and to retest the system until satisfactory results can be obtained.

The Contractor shall provide suitable first quality pressure gauges with 5 lb. or smaller graduations and a standard 5/8" x 3/4" water meter in the event the meter is required for the leakage test. Pressure gauges and water meter shall be in good condition and shall be subject to such tests for proof of accuracy as the Engineer may require.

	Allowable Leakage per 1,000 feet (305 m) of Pipeline* - gph+
Avg. Test Pressure	Nominal Pipe Diameter - in.

psi (Bar)	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

*** If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.**

+ To obtain leakage in liters/hour, multiply the values in the table by 3.785

Copied from AWWA C600.

3. DISINFECTION

All water main extensions and appurtenances shall be disinfected upon completion, and after the system has been flushed to remove dirt or foreign objects which may have been accidentally introduced into the line, disinfection shall be accomplished by use of a main sterilizer of applying chlorine gas or a hypochlorinator for application of a hypochlorite solution.

The chlorine shall be introduced into the main as water is being added so that adequate mixing will occur. Chlorine shall be added until a concentration of not less than 50 parts per million of available chlorine is observed at check points throughout the section being disinfected. The chlorine solution shall be left in the mains for a period of 24 hours after which the mains shall be flushed until only the normal residual chlorine found in tap water is present. Samples of water shall then be taken by methods and personnel approved by the Engineer and the Owner and shall be submitted to the bacteriological laboratory of the State Division of Water or the Owner as the Owner may direct. In the event any of the bacteriological samples show the presence of coliform organisms or an excessive total count, the disinfection procedure shall be repeated until samples of satisfactory bacteriological quality can be obtained.
The Contractor shall furnish the chlorine for main disinfection and shall furnish all labor, tools and equipment for the disinfection and sampling, but the sample bottles will be furnished at no cost by the Water Utility.

Disinfection procedures shall generally be in accordance with the AWWA Standard for Disinfecting Water Mains, AWWA C651, latest revision.

Chlorine Required to Produce 50 mg/l Concentration
in 100 Feet of Pipe by Diameter

Pipe Size in.	100% Chlorine Lb.
4	0.027
6	0.061
8	0.109
10	0.170
12	0.245
16	0.435
18	0.551
20	0.681
24	0.98
30	1.53

4. TESTING OF VALVES

Upon completion of this project, the Contractor shall operate all buried valves in the presence of the Engineer to verify proper operation of each valve.

5. TESTING OF WATER SERVICES

The Contractor shall test all new water services at the same time that the water main is tested or the Contractor shall expose all connections, taps, curb cocks, unions, and any other fittings at the instant water pressure is restored to the meter. These fittings shall be inspected by the Contractor in the presence of the Engineer. If any leaks are found, these leaks shall be repaired in a manner approved by the Engineer.