

DETAILED SPECIFICATIONS FOR WATER MAIN CONSTRUCTION

SITE PREPARATION

Scope

Site preparation includes all plant, labor, equipment, and appliances as required or necessary to clear and prepare the work site for further construction as shown and specified.

General Requirements

Site preparation shall be performed in such a manner as not to harm adjacent structures, utilities, and existing landscaping or natural vegetation. The Contractor shall assume full responsibility for such disturbances and all costs for such repair, rehabilitation, or modification shall be borne by the Contractor.

Construction

The Contractor shall perform all clearing and grubbing, and perform all demolition and removal work as required and shown for the proper construction and completion of the work.

Clearing and Grubbing

The site shall be cleared of all trees, stumps, logs, tree trimmings, roots, brush, heavy sod, vegetation, rocks in excess of 6 inches, debris, and other obstruction of whatever kind or character as required to perform the work. Do not remove or damage trees that do not interfere with the work, and properly treat any damaged trees that can be saved. Where trees are required to be removed, the trunk and branches shall be completely removed, with tree stumps and root systems left in place unless required to be removed because of interference in performing the work. All tree trunks and limbs greater than 2 inches in diameter shall be cut into 16 - inch lengths, and those 2 inches or less in diameter shall be chopped into wood chips. All material shall be removed from the site of the work and disposed of by the Contractor in a manner acceptable to the Engineer. Open burning on the site of the work will not be permitted.

After clearing and grubbing, the topsoil shall be stripped. The topsoil may be stockpiled as required for reuse, or it may be removed from the site of the work and replaced with acceptable imported topsoil. If the topsoil is stockpiled, care shall be taken to prevent mixing with the subsoil. Excess topsoil shall be removed from the site of the work and disposed of by the Contractor.

Demolition and Removal

- Structures - All structures including superstructures, foundation walls, footing, slabs, and other on-grade or below-grade construction shall be demolished and removed. Excavations caused by removal of existing structures shall be cleaned of all waste and debris.
- Pavements - The removal of pavement shall be made along sharp, clean, saw cut lines as shown or required. Curb and gutter shall be saw cut, on a neat line at right angles to the curb face. All concrete or asphalt shall be saw cut to a minimum depth of three (3) inches. If a saw cut in concrete pavement or curb and gutter falls within three feet of a construction joint, cold joint, expansion joint or edge the concrete shall be removed to the joint or edge.

A drop weight or other type of machinery for breaking pavement may be used when such usage does not become a nuisance or a source of damage to underground or adjacent utilities or structures. Before employing a drop weight, the Contractor shall verify that there are no nearby

underground or adjacent utilities or structures that could be injured by its use. The Owner reserves the right to order the discontinuance of the use of a drop weight at any time.

Basis of Payment

No separate payment will be made for site preparation work. All costs involved in site preparation shall be included in the unit price of the work that it is associated with.

EROSION CONTROL

Scope

Erosion control includes all labor, material, equipment, and services as required or necessary to furnish, install, and maintain control systems to minimize erosion as shown and specified until site restoration, landscaping, and paving are complete.

General Requirements

Submittals

The Contractor shall submit manufacturer's data for the silt fence and erosion mats.

Erosion Control Plan

Before construction is started, the Contractor shall submit a plan for accomplishing erosion control for all work that might create erosion. The plan shall identify the location and type of control measures to be used for the entire project.

Materials

Erosion Bales

Materials for erosion bales shall be tightly compacted bales of grain straw, hay or other suitable material, bound together with non-biodegradable materials.

Silt Fence

The silt fence shall be a two-component barrier system composed of a support fence and an attached filter fabric. The support fence shall be composed of minimum 14-gage woven wire or polypropylene netting.

Support Posts

The support fence shall be wood or steel construction with a minimum length of 5 feet. They shall be of sufficient strength to support the silt fence or erosion bales when either are required.

Mulching Material

Mulching Material shall consist of threshed straw of oats, wheat, or rye and be free from seed of noxious weeds.

Erosion Mat

The erosion mat may be constructed of jute fabric, wood fiber blanket, or paper mat. Jute fabric material shall be a woven fabric of a uniform open weave of single jute yarn. The jute yarn shall be made of loosely twisted construction having an average twist of not less than one and one-half turns per inch. The average size of the warp and weft yarns shall be approximately the same. The woven

fabric shall be furnished in rolled strips. The width of the strips shall be 48 inches, plus or minus one inch. The fabric shall have 41 weft yarns, plus or minus two inches, per linear yard of length. The weight of the fabric measured under average atmospheric conditions shall be 92 pounds per 100 square yards, plus or minus ten percent. The fabric shall be nontoxic to vegetation.

Wood fiber blanket material shall be a uniform web of interlocking wood excelsior fibers, with a net backing on one side. The wood from which the blanket is produced shall have been properly cured to achieve adequately curled and barbed fibers. The blanket shall be of uniform thickness with the wood fibers evenly distributed over the entire area of the blanket. The blanket shall be furnished in rolled strips. The width of the strips shall be either 48 or 60 inches, each plus or minus one inch. The weight of the blanket, measured under average atmospheric conditions, shall be 80 pounds per 100 square yards, plus or minus ten percent. The net backing shall have a mesh size not exceeding 1-1/2 by 3 inches and may be woven from twisted paper, cotton cord, an approved plastic or other approved material. The blanket shall be non-toxic to vegetation.

Paper mat material shall consist of a knitted construction of polypropylene yarn with uniform openings interwoven with strips of biodegradable paper designed to degrade over selected periods of time recommended by the manufacturer and approved by the Engineer for each installation. The paper mat shall be furnished in rolls that can be easily handled. The rolls shall be packaged with suitable protection for outdoor storage at a construction site in a manner that protects them from biodegradation prior to use. The weight of the paper mat shall be approximately 0.2 pounds per square yard. Roll sizes shall be approximately 5 feet wide x 360 feet long and as specified on the plans.

Erosion Mat Staples

Material for erosion mat staples anchoring the erosion mat in place shall be U-shaped, made of No. 11 gage or larger diameter steel wire, or other approved material, have a width of one to two inches, and a length of not less than six inches for use in firm soils and not less than 12 inches for use in loose soils.

Sandbags

Sandbags shall have a minimum unfilled size of 16 inches by 26 inches, and shall be completely filled with a sandy soil.

Construction

General Requirements

Prior to construction, the Contractor shall install erosion and sedimentation measures where shown on the plans or any place the Contractor, Engineer, or Owner feel it is necessary. The Contractor shall minimize disturbed areas and soil stockpiles. Disturbed areas shall be protected from erosion the same day it was exposed. If during construction other areas have become a problem with erosion and sedimentation, the Contractor shall construct whatever control measure is necessary. Top soil or any other soils shall be stored in such a manner as not to cause any erosion or sedimentation.

Erosion Control Measures

- Erosion bales shall be placed end to end across ditches or at other areas requiring erosion control. The bales shall be placed immediately after shaping of the ditches or slopes is

completed. Bales shall be placed at right angles to the direction of flow and shall be embedded and securely anchored with stakes. Sumps shall be excavated upstream from the bales.

- Silt fences shall be placed at the toe of fill to retain sediment washed from the slope by rainfall runoff. Where an unvegetated slope is exceptionally steep or long, a series of silt fences shall be installed along contours down the slope. Silt fences shall also be installed perpendicular to the flow path in roadside ditches to reduce runoff velocity and cause deposition of suspended solids. Other locations are along the bank of a natural waterway, around a drop inlet, along the toe of an embankment, along the contour of an unvegetated slope, in a ditch or median drainage, or in conjunction with a sediment pond. When a series of fences is required, a fence shall be installed at every 1.5 feet in elevation in the median or ditch flow line. The silt fence shall be anchored to the ground by excavating a shallow trench approximately 6 inches deep by 6 inches wide along the perimeter of the area to be fenced, and installing the silt in the trench bottom to a minimum depth of 6 inches. The support post shall be installed on the down stream side of the silt fence to a depth that will adequately insure stability of the fence. Soil shall be then backfilled over the silt in the trench and compacted. The fabric shall not extend to a height greater than 36 inches. Water must not be allowed to flow under, around or over the structure unless proper control is provided.
- Mulch shall be used on bare soil surfaces for protection from the impact of raindrops and runoff on surfaces with a slope of three horizontal to one vertical (3:1) or less. Mulch shall be uniformly placed to a loose depth of 1 to 1-1/2 inches beginning at the top of slopes and proceeding downward. Mulch shall be secured with heavy twine or netting. The twine shall be fastened with pegs or staples to form a grid spacing of six to ten feet.
- The jute material or wood fiber blanket erosion mat shall be placed, surfaces of slopes of greater than three horizontal to one vertical (3:1), immediately after the temporary or permanent seeding, or sodding operations have been completed. All stone or clods over 1-1/2 inches in diameter and all roots, sticks or other foreign material which would interfere with the mat bearing completely on the soil or sod, shall be removed prior to placing the mat. The matting strips shall be rolled on or laid in the direction of the flow. The mat shall be spread evenly, smoothly, in a natural position without stretching and with all parts bearing on the soil. When wood fiber blanket is used the blanket shall be placed with the netting on top. Adjacent strips shall overlap at least four inches. Strip ends shall overlap at least ten inches. All overlaps shall be made with the up-grade section on top. The up-grade end of each strip of fabric or blanket shall be buried at least six inches in a vertical slot cut in the soil and the soil pressed firmly against the embedded fabric or blanket. When jute fabric is placed over sod, at least six inches of the up-grade end of the fabric shall be buried under the downgrade sod at junction slots. The mat shall be anchored in place with vertically driven staples driven until their tops are flush with the soil. Staples shall be spaced at three-foot centers along mat edges and be alternately spaced at three-foot centers through the center. Staples shall be at ten-inch centers at end or junction slots. Any small stones or clods, which prevent contact of the mats with the soil, shall be pressed in the soil with a small lawn-type roller or by other effective means. The mat shall have its lateral edges so impressed in the soil as

- The paper mat shall be placed such that it rests loosely (not stretched tightly), and smoothly on surfaces of slopes of greater than three horizontal to one vertical (3:1), immediately after the temporary or permanent seeding or sodding operations have been completed. Paper mat used as a ditch lining shall be applied with the lengths running parallel to direction of flow of water. The upslope end of each strip of paper mat and end of roll shall be folded and buried in a narrow trench 6 inches deep and stapled in the trench on approximately 9-inch centers. The trench shall be backfilled with soil and tamped firmly after stapling. In cases where one roll of matting ends and second roll starts, the upslope piece shall be brought over the buried end of the second roll so that there is a 12-inch overlap to form a junction slot. Where two or more widths of matting are applied side by side, an overlap of at least 4 inches shall be made. Each length of matting shall be stapled along each edge and down the center with staples, not to exceed 3 feet on centers. Transverse laps shall be stapled on approximately 9-inch centers across the lap in the trench.
- In paved areas, a temporary 2-inch thick bituminous (cold mix) concrete pavement shall be placed and maintained over the finished aggregate base course until final surface replacement is made. The temporary pavement covering shall be placed within three days of placing the finished aggregate base course.

Maintenance

All erosion control measures shall be maintained until vegetation is reestablished or permanent structures are installed. Sediment shall be removed on a regular basis, lost structures shall be replaced, damaged structures shall be repaired, and eroded areas shall be refilled as required.

Basis of Payment

No separate payment will be made for erosion control work. All costs involved in erosion control shall be included in the unit price of the work it is associated with.

TRENCHING

Scope

Trenching includes all plant, labor, equipment, appliances, and materials as required or necessary to excavate, bed, and backfill, for the construction of pipelines and appurtenances as shown and specified.

General Requirements

Submittals

The Contractor shall submit test reports which include moisture density relationship, and gradation results prepared by a certified testing laboratory acceptable to the Engineer for Type "A," "B," "C," "D," "E," and "F" material. A labeled jar containing a sample of each material shall be submitted with the results. No material shall be used unless it has been accepted by the Engineer.

Testing

The standard test to define maximum densities of all compaction work shall be ASTM D1557. All densities shall be expressed as a percentage of the maximum density obtained in the laboratory by the foregoing standard procedure. Periodically throughout the job the Engineer will perform density tests on fills and backfills as placed by the Contractor. The Contractor shall permit the

Engineer to sample, test, and inspect in-place materials at times selected by the Engineer and without additional compensation or additional time.

Materials

Fill and Backfill

- Type "A"
Type "A" material shall be a clean gravel-sand mixture free from organic matter and, when tested in accordance with ASTM C117 and C136, shall conform to the following gradation requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4 inch	100
3/8 inch	70-90
#4	55-85
#10	45-75
#40	20-50
#100	0-10
#200	0-5

- Type "B"
Type "B" material shall be a select granular material free from organic matter and of such size and gradation that the desired compaction can be readily attained. When tested in accordance with ASTM C117 and C136, it shall conform to the following requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
3 inch	100
1-1 ½ inch	95-100
#4	35-100
#10	10-100
#40	0-60
#100	0-30
#200	0-10

The coefficient of uniformity shall be 3 or greater. The material may be clean natural sand or gravel, select excavation or mixture thereof.

- Type "C"
Type "C" material shall be unclassified material obtained from excavation or from any other source. The material shall be free from peat, wood, roots, bark, debris, garbage, rubbish or

other extraneous material. The maximum size of stone shall not exceed 6 inches. Not less than 95 percent of the particles shall pass a 2-inch U.S. Standard Sieve size.

- Type "D"
Type "D" material shall be a clean, washed, sound and durable well graded crushed rock or crushed gravel. When tested in accordance with ASTM C136 this material shall conform to the following ASTM C33 gradation requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
#4	0-10
#8	0-5

- Type "E"
Type "E" material shall be clay with at least 90 percent of the particles passing a No. 200 sieve and a plasticity index greater than 15.
- Type "F"
Type "F" material shall be a select, granular material free from organic matter, and when tested in accordance with ASTM C117 and C136, shall conform to the following requirements:

U.S. Standard Sieve Size	Percent by Weight Passing
1 inch	100
3/8 inch	40-75
#4	25-60
#10	15-45
#200	3-10

Bedding Concrete

Bedding concrete shall have a minimum 28-day compressive strength of 3000 psi. The minimum cement content shall be 5-1/2 bags per cubic yard. The slump shall not exceed 4 inches. Cement shall be of one brand unless otherwise permitted and shall conform to ASTM C150 Type I or IA. Aggregate used in the manufacture of concrete shall conform to the quality and grading requirements of ASTM C33. For bedding concrete the maximum size of aggregate shall be 1 inch. Water for bedding concrete shall be clean and free from injurious amounts of acid, oil, alkali, organic

matter or other deleterious substances. Reinforcing steel, when required, shall consist of grade 60 deformed bars conforming to the requirements of ASTM A615.

Construction

General Requirements

- **Work Limits** - Length of trench excavated in advance of the pipe laying shall be kept to a minimum, and in no case shall it exceed fifty (50) feet unless otherwise authorized. The total length of open trench shall not exceed one hundred (100) feet for each main pipe laying operation unless otherwise authorized. Not more than one street crossing may be obstructed by the same trench at any one time unless otherwise authorized. The length of unrestored work area and total unfinished trench construction shall not exceed a length of eight hundred (800) feet, for each main pipe laying operation unless otherwise authorized. Trench construction will not be considered completed until all restoration is completed. A section of trench shall not be considered as finished until excavation, construction, backfilling, compaction, surface restoration and replacement, and cleanup operations have been completed.
- **Control of Water** - The Contractor shall provide all necessary machinery, appliances, and equipment to keep excavation free from water during construction, and shall dewater and dispose of the water so as to minimize discharge of turbid water to surface water and not to cause injury to public or private property, or to cause a nuisance or a menace to the public. Before dewatering is started, the Contractor shall obtain acceptance from the Engineer for the method, installation and details of the dewatering system he proposed to use. The Contractor shall at all times have on hand sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outage, and shall have available at all times competent workmen for the operation of the pumping equipment. The dewatering system shall not be shut down between shifts, on holidays or weekends, or during the work stoppages without written permission from the Engineer. The control of groundwater shall be such that softening of the bottom of excavations or formation of "quick" conditions or "boils" shall be prevented. Dewatering systems shall be designed and operated so as to prevent the removal of the natural soils. During excavating, construction of pipelines and appurtenances, and backfilling, excavations shall be kept free of water. The static water level shall be drawn down a minimum of one foot below the bottom of the excavation so as to maintain the undisturbed state of the natural soils and allow the placement of any fill or backfill to the required density. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill and prevent flotation or movement of all pipelines and appurtenances.
- **Removal of Obstructions** - The Contractor shall remove all rock, stones, debris and all obstructions of whatsoever kind or character, whether natural or artificial, encountered in the work. Material shall be removed from the site of the work and disposed of in a manner acceptable to the Engineer.
- **Sheathing, Shoring, and Bracing** - The Contractor shall provide all necessary sheathing and shoring including all labor, material, equipment and tools required or as necessary to maintain

the excavation in a condition to furnish safe working conditions, to permit the safe and efficient installation of all items of contract work, and to protect adjacent property. The Contractor shall be held liable for any damage, which may result, to neighboring property from excavation or construction operations. When sheetpiling and timbers in excavations are removed, they shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe. Nothing in this specification shall be deemed to allow the use of protective systems less effective than those required by the Occupational Safety and Health Administration (OSHA) and the Department of Industry, Labor and Human Relations (DILHR).

- **Portable Trench Box and Sliding Trench Shield** - Portable trench boxes and sliding trench shields approved by the Wisconsin Department of Industry, Labor, and Human Relations may be used as long as in the judgment of the Contractor, job conditions warrant such use. Use of the shield shall not relieve the Contractor of any liability for damages to persons or property occurring from or upon the work of constructing the pipeline, or appurtenances occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place in the trench sufficient sheathing and bracing to prevent the caving or moving of the ground, or disturbance of the completed work or any of the surface or subsurface structures. Care shall be taken when a trench box or shield is moved ahead so as not to pull the already jointed pipe apart or leave voids around the pipe wall. When required by the Engineer, the Contractor shall provide an acceptable method of rechecking line, grade and horizontal location of the pipe after the shield has been moved ahead. If the pipe has moved, it shall be reset to the proper line and grade. Where a concrete cradle or envelope is required, a suitable spacer between the concrete and the shield shall be provided. Tar paper or other suitable material shall be used to prevent a bond between the spacer and the concrete, so as to permit moving of the shield without disturbing the pipe, cradle or envelope. The width of the trench shield or box shall be such that a minimum six (6) inch horizontal clearance is maintained between the pipe and shield at all times. Any voids between the trench box or shield and the undisturbed trench wall within the bedding section (bottom of trench to top of initial backfill) shall be filled with bedding material, immediately after the box or shield is positioned.
- **Unstable Foundations** - When the trench bottom is wet, soft, or spongy so that, in the opinion of the Engineer, it will not provide a proper foundation for the pipe, the trench shall be over excavated until a firm foundation is obtained. The over excavated portion of the trench shall be backfilled with such material and in such a manner as may be required by the Engineer. All over excavation and associated backfilling shall be paid for as extra work, except when the unstable foundation is a result of the Contractor's operations in which case it shall be provided for at the Contractor's expense. Where the distance to stable ground is excessive the Owner reserves the right to order, in writing, as extra work such other types of foundation as the Engineer shall deem necessary.
- **Over Excavation** - Whenever the excavation is carried beyond the lines and grades shown on the contract drawings, or as determined by the Engineer, the Contractor shall at his own expense, backfill all such excavated space with such material and in such a manner as may be required by the Engineer. The space beneath and around concrete structures, which was over excavated shall be thoroughly compacted when backfilling or, if deemed necessary by the Engineer, shall be backfilled with concrete at the Contractor's expense.

Excavation

- General - Unless otherwise indicated, excavation for pipelines and appurtenances shall be open cut using an unrestricted trench. When a restricted trench is specified or indicated, sheeting, shoring, and bracing shall be provided to limit the width of the trench to the width of the bedding section. The Contractor may use any method of excavation that will not damage or endanger adjacent structures, utilities, or property, or disturb the natural soils at or below the bottom of the excavation.
- Trench Width - The maximum allowable width of trench measured at the top of the pipe shall be the outside diameter of the pipe exclusive of bells and collars, plus 24 inches, and such maximum width shall be inclusive of all trench timbers unless otherwise indicated. A minimum of 6 inches shall be maintained between the pipe and the trench wall. The trench walls shall be kept vertical from the bottom of the trench to the top of the pipe, wherever possible. Where the normal trench width below the top of the pipe is exceeded for any reason, the Contractor, at his own expense, shall furnish an adequate section for the actual trench width. This may be accomplished by furnishing a stronger pipe, a better bedding section, or providing concrete encasement, whichever is an adequate section as determined by the Engineer. When the pipe specified is strong enough for the actual trench width, as determined by the Engineer, no further provisions need be made for this greater trench width. Where wide trench construction is specified, the width of the trench at the top of the pipe is not limited. The bedding section width for wide trench construction shall be extended two and one-half diameters on either side of the pipe or to the trench wall, whichever is less.
- Excavated Materials - All excavated material to be used as backfill shall be stockpiled in a manner that will not endanger the work, cause an obstruction, or block drainage. Excavated material not to be used for backfill shall be removed from the site of the work. The Owner shall have prior claim to all surplus excavated material. If the Owner exercises such claim, the material shall be deposited by the Contractor, at such points as designated by the Engineer up to 3 miles from the site of the work. If the Owner wishes to use a site greater than 3 miles from the site of the work an adjustment to the Contract price will be made with a change order. After delivery to such designated location the material shall be spread and leveled. If the Owner does not wish to claim any or all excavated material, the Contractor shall be responsible for obtaining a site for disposal of the material.

Bedding

All pipelines shall be uniformly supported at every point between joints using one of the bedding sections described herein. A small depression shall be provided, as needed, at each joint to insure the barrel of the pipe is properly supported. The depression shall be no larger than necessary to accomplish proper joint assembly. In wet, but otherwise stable trenches, the contractor may, if acceptable to the engineer, over excavate the bottom of the trench and install not less than 6 inches of Type "D" material. The Type "D" material shall be compacted by a power operated tamper. In rock excavation the minimum depth of the bedding section below the pipe shall be increased 6 inches and filled with Type "A" material compacted to 95 percent of the maximum dry density.

- Class "E" Bedding - The pipeline shall be bedded on Type "A" material compacted to 95 percent of the maximum dry density and placed on a flat trench bottom. The Type "A" material shall have a minimum thickness of 4 inches under the barrel. The remainder of the bedding section

shall be filled to a minimum depth of 12 inches over the top of the pipe with Type "A" material compacted to 90 percent density.

- Class "D" Bedding - The pipeline shall be bedded on solid undisturbed earth in a flat bottom trench. The finished subgrade shall be accurately prepared by means of hand tools so that the subgrade beneath the centerline of the pipe shall be within 0.03 feet of a straight line between joints. After the pipe is laid the remainder of the bedding section shall be filled to a minimum depth of 6 inches over the pipe with Type "B" or "C" material compacted to 85 percent of the maximum dry density.
- Class "C" Bedding - The pipeline shall be bedded on Type "D" material compacted to 95 percent of the maximum dry density placed on a flat bottom trench. The Type "D" material shall have a minimum thickness of 4 inches under the barrel and shall extend up one-sixth the outside diameter of the pipe barrel at the sides. The remainder of the bedding section shall be filled to a minimum depth of 6 inches over the pipe with Type "B" or "C" material compacted to 90 percent of the maximum dry density.
- Class "B" Bedding - The pipeline shall be bedded on Type "D" material compacted to 95 percent of the maximum dry density and placed on a flat trench bottom. The Type "D" material shall have a minimum thickness of 4 inches under the barrel and shall extend up to a minimum depth of 6 inches over the top of the pipe and compacted to 90 percent density.
- Class "A" Bedding - The pipeline shall be bedded with a concrete cradle, unless otherwise indicated. The arch section may be substituted for the concrete cradle when sheathing and shoring is not below the spring line of the pipe or when it is left in place. The concrete cradle or arch shall, in all cases, start and stop at pipe joints.
 - Concrete Cradle - The pipeline shall be set in bedding concrete placed in a flat bottom trench. The bedding concrete shall have a minimum thickness under the pipe of 4 inches or one-fourth the pipe diameter, which ever is greater, and shall extend up one-fourth the outside diameter of the pipe barrel at the sides. The minimum width of the cradle shall be equal to the outside diameter of the pipe plus 8 inches. Solid concrete masonry units shall be used to support the pipe at the correct grade. After the concrete has set the remaining portion of the bedding section shall be filled to a depth of 12 inches over the pipe with Type "B" or "C" material compacted to 90 percent of the maximum dry density.
 - Concrete Arch - The pipeline shall be bedded in Type "D" material compacted to 95 percent of the maximum dry density placed on a flat trench bottom. The Type "D" material shall have a minimum thickness under the pipe of 4 inches, and shall extend up one-half the outside diameter of the pipe barrel at the sides. The top half of the pipe shall be covered with a concrete arch having a minimum thickness at the crown of 4 inches or one-fourth the pipe diameter, which ever is greater. The minimum width of the arch shall be equal to the outside diameter of the pipe plus 8 inches. The remainder of the bedding section shall be filled with Type "B" material compacted to 90 percent of the maximum dry density.
 - Concrete Encasement - The pipeline shall be set in bedding concrete placed in a flat bottom trench. The bedding concrete shall have a minimum thickness of 6 inches. Concrete shall extend to undisturbed earth at the walls of the trench. The pipe shall be supported on solid concrete masonry units. Multiple pours of concrete shall be used to prevent flotation of the pipeline. Concrete encasement shall start and stop at pipe joints.

Backfill

Backfill shall be constructed at the locations and to the lines and grades indicated. Unless otherwise indicated, an engineered backfill system shall be used. Dewatering must be maintained during the placement of backfill. After completion of all construction below the elevation of final grade, and

prior to backfilling, the excavation shall be cleaned of all debris. The required degree of compaction shall be obtained by using power-operated tampers, rollers, vibrators or other suitable equipment. Compaction shall be done in such a manner that will not damage adjacent or buried facilities. Each layer shall be compacted to the specified density prior to placing subsequent layers. The thickness of the loose layer may be increased when in-place density tests, acceptable to the Engineer, show that the specified density can be obtained.

- Backfilling Trenches - After the pipe bedding section has been accepted the trench shall be backfilled within 24 hours. During backfilling the contractor shall protect the pipeline from damage or shifting. Portable hand held equipment shall be used for compacting the initial backfill. The initial backfill shall not be less than 3 feet thick. After the initial backfill is placed the subsequent backfill may be compacted using wheeled type or vehicle mounted compaction equipment.
- Backfill Systems
 - Structural Backfill - Structural backfill shall be Type "B" material placed in horizontal layers not exceeding 8 inches in loose depth. The material shall be moisture conditioned to within 3 percent of the optimum moisture content so the required degree of compaction may be obtained. Each layer shall be compacted to 90 percent of the maximum dry density, except when the backfill is subgrade for walks, roadways, foundations, or slabs the upper three feet shall be compacted to 95 percent of the maximum dry density.
 - Engineered Backfill - Engineered backfill shall be Type "C" material placed in horizontal layers not exceeding 8 inches in loose depth. The material shall be moisture conditioned to within 3 percent of the optimum moisture content so the required degree of compaction may be obtained. Each layer shall be compacted to 90 percent of the maximum dry density, except when the backfill is subgrade for walks, roadways, foundations or slabs the upper three feet shall be compacted to 95 percent of the maximum dry density.
 - Common Backfill - Common backfill shall be Type "C" material placed in horizontal layers not exceeding 12 inches in loose depth. Each layer shall be compacted to 85 percent of the maximum dry density.
 - Drain Rock - Drain rock shall be Type "D" material placed in horizontal layers not exceeding 6 inches in loose depth. Each layer shall be compacted with a power-operated tamper.
 - Impervious Backfill - Impervious backfill shall be Type "E" material placed in horizontal layers not exceeding 6 inches in loose depth. The material shall be moisture conditioned to 1-2 percent over optimum moisture content so the required degree of compaction may be obtained. Each layer shall be compacted to 95 percent of the maximum dry density.
 - Gravel Backfill – Gravel backfill shall be Type "F" material placed in horizontal layers not exceeding 8 inches in loose depth. The material shall be moisture conditioned to within 3 percent of optimum moisture content so the required degree of compaction may be obtained. Each layer shall be compacted to 90 percent of the maximum dry density, except when the backfill is subgrade for walks, roadways, foundations, or slabs, the upper three feet shall be compacted to 95 percent of the maximum dry density.
 - Aggregate Slurry Backfill – Aggregate slurry backfill shall consist of a concrete mix with the cement deleted. Aggregate slurry backfill material shall be mixed in the following quantities:

1360 lbs. Sand (ASTM C33 fine aggregate)
 750 lbs. No. 1 stone (ASTM C33 size number 67)
 1150 lbs. No. 2 stone (ASTM C33 size number 4)
 25 gals. (+0 to -0.5 gal.) water per cubic yard

The material shall be placed in a clean concrete mix truck and thoroughly mixed with sufficient water to produce a slump of approximately 3 inches. The mixture shall be deposited directly into the trench from concrete mix trucks. Just prior to placing the slurry, the mixed shall be run at mixing speed to insure a uniform mixture.

- Finish - All areas covered by the work shall be graded uniformly to the elevations shown on the drawings or as required for restoring the surface to its original condition. The degree of finish shall be that ordinarily obtainable from a blade grader.

Basis of Payment

No separate payment will be made for work specified in this section. All costs involved with trenching work for the pipeline installation shall be included in the unit price for the work it is associated with.

BORING AND JACKING

Scope

Boring and jacking includes all plant, labor, equipment, and materials as required or necessary to furnish, install, and test steel casing and carrier pipes as shown and specified.

General Requirements

Submittals

The Contractor shall submit manufacturer's data for the casing, casing spacers, and carrier pipe. Information shall include the name of the pipe manufacturer, the dimensions of the pipe, and details on the materials and method of pipe manufacture or fabrication.

Jacking Plan

The Contractor shall submit a jacking plan for each installation. The plan shall identify the method and equipment to be used, the location and size of the jacking pits, and the limits of the proposed jacking.

Materials

Carrier Pipe

The carrier pipe to be installed within casing pipe shall conform to the same requirements as pipe to be installed by open cut excavation unless noted otherwise. Carrier pipe shall have restrained joints or a joint restraint system shall be provided to prevent any joint from opening or being over inserted during installation in the casing.

Casing Pipe

Casing shall be steel pipe conforming to ASTM A53 Grade B, ASTM A139 Grade B, or pipe fabricated in accordance with AWWA C200 using ASTM A36 steel. The minimum inside diameter of the casing shall not be less than 4 inches larger than the maximum diameter of the carrier pipe. The minimum wall thickness shall be as required by permit requirements or the Contractor's method of construction, whichever is greater, but in no case shall it be less than the following values.

Minimum Casing Size	Minimum Wall Thickness, Highway Crossing (inches)	Minimum Wall Thickness, Railway Crossing (inches)
18" OD	0.1875 (3/16)	0.3125 (5/16)
20" OD	0.1875 (3/16)	0.344 (11/32)
22" OD	0.1875 (3/16)	0.3750 (3/8)
24" OD	0.2500 (1/4)	0.406 (13/32)
26" OD	0.2500 (1/4)	0.438 (7/16)
28" OD	0.2500 (1/4)	0.469 (15/32)
30" OD	0.3125 (5/16)	0.469 (15/32)
34" OD	0.3125 (5/16)	0.531 (17/32)
40" OD	0.3750 (3/8)	0.563 (9/16)
48" OD	0.5000 (1/2)	0.625 (5/8)

Lumber

All lumber permanently incorporated in the work shall be treated Douglas fir or Southern pine. Treatment shall be with a chromated copper arsenate (CCA) salt solution, which meets or exceeds Federal Specification TTW-550. Salt retention shall not be less than 0.35 pounds per cubic foot of wood.

Sand Slurry

Sand slurry shall be composed of fly ash, sand, and water proportioned as specified. Fly ash shall be Class "C" or "F" conforming to the requirements of ASTM C618. Sand shall conform to ASTM C33 and shall be graded so that 100 percent by weight will pass a standard No. 8 mesh sieve, and at least 45 percent by weight will pass a standard No. 40 mesh sieve. Air-entraining admixture shall be Darex AEA by W.R. Grace & Company or equal and shall conform to ASTM C260. Slurry shall be used for filling the space between the casing and carrier pipes.

- Design Mix - S Sand slurry shall be a mixture of five parts sand, one part fly ash, air entrainment (one ounce per 430 pounds of sand), and water (one gallon per 37.5 pounds of sand).

Casing Spacers

Casing spacers shall be designed to guide and support the carrier pipe in the casing.

- Standard casing spacers shall consist of a 14 gauge AISI type 304 stainless steel attachment band with a PVC liner and not less than four 10 gauge AISI Type 304 stainless steel risers. Each riser shall be equipped with a removable ultra-high molecular weight polymer or glass reinforced plastic runner. Attachment hardware shall be AISI Type 304 stainless steel. Spacer shall have a minimum width of 8 inches. Standard casing spacers shall be Cascade Waterworks Manufacturing Model CCS or Pipeline Seal and Insulator, Inc. Model S8G.
- Restrained joint casing spacers shall consist of two ASTM A536 ductile iron clamping rings, ASTM A242 high strength low alloy restraining rods and nuts, and not less than four ductile iron runner supports. Each runner support shall be equipped with an ultra-high molecular weight polymer runner. Restrained casing spacers shall be Uniflange Series UFRCS 1300 for pipe and UFRCS 1390 for pipe joints.

Construction

General

The Contractor shall construct a jacking pit of sufficient size to accommodate the backstop, jacks, pushing frame and pipe to be jacked. The pit shall have guide rails or timbers to keep the pipe in alignment and on grade. A push frame shall be provided to evenly distribute the jacking pressure to protect the ends of the pipe being jacked. A minimum of two hydraulic jacks shall be used. The casing pipe shall be fitted with a hardened steel cutting edge. The casing shall be jacked up grade, if possible, to facilitate drainage. All pipe shall be on site before starting jacking.

Casing Installation

The casing shall be pushed into place as the soil is excavated from the inside of the pipe. The excavation shall not precede the leading edge of the casing unless it is necessary to remove a large obstruction. Excavation for small diameter casing shall be accomplished by a boring auger. Excavation for large diameter casings shall be accomplished by hand or mechanical means. Once the jacking operation is started it shall be continued without interruption until completion. Casing pipes shall be jointed with a continuous weld for the full circumference. The welded joints shall be capable of resisting all jacking stresses. The casing pipe in its final position shall be straight and true in alignment and grade. There shall be no space between the earth and the outside of the casing. If it is necessary to over excavate, the location shall be identified and pressure grouted after the casing is in place.

Carrier Pipe Installation

After the casing has been installed and accepted by the Engineer, the carrier pipe shall be installed. The positioning of spacers shall adequately support the carrier pipe throughout the casing. A casing spacer shall be installed within one foot of each end of the casing, on each side of each pipe joint, and at a maximum spacing of 10 feet for ductile iron and 6 feet for PVC carrier pipe, as a minimum. Assembly and location of casing spacers shall be in strict accordance with manufacturer's recommendations. The casing spacers shall be sized such that the carrier the carrier pipe will meet the line and grade as indicated on the drawings and be centered as close as possible in the casing.

The carrier pipe shall be pushed and pulled into place in such a manner that there is no opportunity for a joint to be opened or over inserted. The carrier pipe length shall be adjusted so that the end extends past the end of the casing 12 to 18 inches. After the carrier pipe is installed the end of the casing shall be sealed with 2-inch thick planks and the space between the casing and carrier shall be filled with a sand slurry.

Sand Slurry Application

Sand slurry shall be pumped or poured into the void between the casing and carrier pipe by means of a filler pipe. The filler pipe shall be installed at the top of the seal at the low end of the casing and a vent pipe shall be installed at the seal on the other end of the casing. The filler and vent pipes shall be PVC and extend up to an elevation above the highest part of the casing or to ground level. The top of the filler pipe shall be located at an elevation approximately 6-inches higher than the vent. Sand slurry shall be added to the void between the casing pipe and carrier pipes until the slurry flows from the vent pipe. After 24 hours, the filler and vent pipes shall be removed at the end seals.

Pressure Grouting

Pressure grouting, where required, shall be done by qualified mechanics under supervision of experienced foremen. The apparatus for mixing and placing cement grout shall be of a type

acceptable to the Engineer and shall be capable of effectively mixing and stirring the grout and forcing it into the holes or grout connections in a continuous, uninterrupted flow at any specified pressure up to a maximum of 15 pounds per square inch. Gauges shall be provided, with and accurate meter reading in cubic feet to tenths of a cubic foot, for controlling the amount of mixing water used in the grout. In addition to the grout mixer, holdover mechanical agitator tanks shall be provided. All grout shall be pumped with a duplex piston –type pump.

Prior to grouting, systems and holes to be grouted shall be thoroughly washed clean. No washing will be required for grouting soil voids outside pipe cylinders or casing pipes. Grouting once started shall be completed without stoppage. In case of breakdown of equipment, the Contractor, at the Engineer's option, shall wash out the grouting system. Grout pressure shall be maintained until grout has set.

Testing

After the carrier pipe is installed the ends shall be sealed and braced and it shall be tested in accordance with the requirements for the carrier pipe. The carrier pipe may be tested separately or it may be tested with the pipeline segment it is associated with.

Basis of Payment

Mobilization and Demobilization

The lump sum price in the proposal schedule for mobilization and demobilization of boring and jacking equipment shall include all plant, labor, equipment, and material as necessary to install and remove the boring and jacking equipment, provide access to the site, maintain site drainage, provide dust abatement, provide construction utilities, construct and fill jacking and access pits, clean up the site, and all incidentals necessary to complete the work, as shown and specified. After the equipment is set up and ready for use 60 percent of the amount shall be paid. The remaining 40 percent of the amount shall be paid after the equipment is removed from the site and clean up is completed.

Casing

The unit price in the proposal schedule for construction of casing shall be per lineal foot for the size and type of casing specified. The unit price shall include all labor, equipment, and material, required for furnishing and installing the casing, filling space between casing and carrier pipe and capping, as shown and specified.

Carrier Pipe

The unit price in the proposal schedule for construction of carrier pipe shall be per lineal foot for the size and type of carrier pipe specified. The unit price shall include all labor, equipment, joint restraint system and materials to install and test the carrier pipe, as shown and specified.

DIRECTIONAL DRILLING

Scope

Directional drilling includes all plant, labor, equipment, and materials as required or necessary to drill holes and install pipe for the construction of pipelines and appurtenances as shown and specified.

General Requirements

The Contractor shall submit a drilling plan for each installation. The plan shall identify the method and equipment to be used, the location and size of the access pits, the limits of the proposed drilling and the method of field verifying the location and elevation of the existing utilities and the pipeline being installed.

Construction

Guidance System

The Contractor shall use a manufactured guidance system that provides a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance system shall be capable of tracking the drill head at all depths up to 50 feet and in any soil condition. The guidance system shall provide immediate information on the tool face, azimuth and inclination. The guidance system shall be calibrated to the manufacturer's specifications. The guidance system shall be accurate at sensing the drill head's position within plus or minus one (1) foot horizontally and plus or minus 0.25 foot vertically. The Contractor shall not proceed with directional drilling unless the guidance system is operating correctly.

Site Survey

The entire directional drill route shall be accurately surveyed. The entry and exit locations shall be marked as shown on the Contractor's directional drilling plan. The Contractor shall field verify the location and elevation of all existing utilities that will be crossed during the directional drilling operation. The directional drill route shall be surveyed for any surface geo-magnetic variations or abnormalities if the Contractor is using a magnetic guidance system.

Trenchless Installation

A pilot hole shall be drilled at the alignment and grade shown on the construction drawings. Readings shall be taken with the guidance system after each successive drill pipe but not more than ten (10) feet. At no time shall the deflection radius of the drill pipe exceed the maximum specified deflection of the pressure pipe to be installed. Upon approval of the pilot hole location, the pilot hole shall be reamed larger. The pilot hole shall be reamed to the diameter recommended by the pipe manufacturer or a maximum of 1.5 times larger than the largest outside diameter of pipe, whichever is smaller. The Contractor shall select the drilling fluid based on the existing soils. The drilling fluid shall be acceptable to the pipe manufacturer.

Tracer wire shall be attached to the pulling eye and the top of the pressure pipe. The tracer wire shall be secured to the pressure pipe every five (5) feet using a minimum of two (2) wraps of tape around the pressure pipe.

The pipe shall be pulled through the drilled hole using constant tension throughout the operation. The pulling device shall have a direct reading gauge to indicate the pulling tension. The Contractor shall select wall thickness for the pipe that will withstand the pulling forces exerted on the pipe. The minimum wall thickness for the pipe shall be listed in the piping system specifications. The actual tension shall never exceed the safe pulling tension of the pipe. HDPE pipe shall be allowed to relax for 24 hours prior to making the final connections.

Documentation

The Contractor shall record the ground elevation at the point of measurement and the alignment and depth of the pipeline every ten (10) feet and at all changes in direction and changes in grade. All depth measurements shall be referenced to the center line of the pulling head. The alignment and depth information shall be documented on a set of as-built drawings. Depth measurements shall be converted to elevations using the project vertical datum.

Basis of Payment

No separate payment will be made for work specified in this section. All costs involved with directional drilling work for the pipeline installation shall be included in the unit price for the work it is associated with.

GENERAL REQUIREMENTS FOR PRESSURE PIPELINE CONSTRUCTION

Scope

No separate payment will be made for work specified in this section. All costs involved with directional drilling work for the pipeline installation shall be included in the unit price for the work it is associated with.

General requirements

No separate payment will be made for work specified in this section. All costs involved with directional drilling work for the pipeline installation shall be included in the unit price for the work it is associated with.

Materials

Thrust Blocking

Thrust blocks shall be constructed with solid 16 inch x 8 inch x 4 inch cement blocks (half course solids) or poured in place concrete having a minimum 28-day compressive strength of 2,000 psi. The minimum cement content shall be 4-1/2 bags of cement per cubic yard of concrete. The allowable slump shall be 4 to 5 inches. The bearing area of the thrust blocking shall be as shown on the drawings or as required by the Engineer.

Joint Restraint System

- **Mechanical Joint Restraint**
Mechanical joint restraint shall consist of multiple gripping wedges incorporated into a single restraint/gland ring for use in place of the standard mechanical joint retainer gland. Mechanical joint restraints shall be Megalug Series 1100 for ductile iron pipe, Megalug Series 2000PV for PVC pipe or Series 2000 for HDPE pipe as manufactured by EBAA Iron Sales, Inc. or approved equal.
- **Push-On Joint Restraint**
Push-on joint restraint shall consist of the two ASTM A 536 ductile iron restraint rings and high strength, low alloy steel connection rods. One ring shall be mounted to the spigot pipe end with second ring mounted just behind the bell end of the pipe. The two restraint rings shall be fastened together using the low alloy steel connection rods. Push-on joint restraints shall be Megalug Series 1700 for ductile iron pipe or Megalug Series 1600 for PVC pipe as manufactured

by EBAA Iron Sales, Inc., or Series 1390 Joint Restraint System as manufactured by Uni-Flange Corporation, or equal.

- **Restrained Joint Systems**
Restrained joint system shall, as a minimum, be designed to restrain the pipe or fitting when subjected to the full pressure rating of the pipe or fitting. The Contractor shall submit complete details for all restrained joint systems.
- **Mechanical Pipe Couplings**
Mechanical pipe couplings for joining pipe of different material or outside diameter shall be Ford F style cast coupling or Romac Style 501 cast coupling, or equal. Couplings shall be epoxy coated with high strength low alloy steel bolts per AWWA C111.
- **Insulation**
Insulation used for frost prevention shall be expanded or extruded polystyrene foam insulation with a minimum thickness of 2 inches with a minimum "R" value of 8.7 (at 75 degrees Fahrenheit mean temperature). Insulation shall have a minimum compressive strength of 40 psi.
- **Polyethylene Wrap and Tape**
Polyethylene wrap shall meet the requirements of AWWA C105 (ANSI A21.5). Wrap shall be linear low-density polyethylene film with a minimum tensile strength of 3,600 psi and a nominal thickness of 8 mils. Tape for securing the wrap shall be a thermoplastic material with a pressure sensitive adhesive face capable of bonding to metal, asphaltic coating and polyethylene. Tape shall have minimum thickness of 8 mils and a minimum width of one inch.

Construction

Laying of Pipe

The Contractor shall uncover the existing pipeline to which the new pipeline is to be connected to verify or determine the type of material, type of joint and elevation of existing pipeline. This will permit adjustments in line and grade and avoid the use of extra fittings. The exposed section of an existing main must be protected and blocked by the Contractor to prevent the blowing out of the plug or cap at the end of the main.

- **Handling of Pipe and Fittings**
The Contractor shall have sufficient and adequate equipment on the site of the work for unloading and lowering pipe and fittings into the trench. Extreme care shall be exercised by the Contractor in handling all pipe, fittings, and special castings so as to prevent breakage and coating damage. Any significant damage to the coating shall be repaired before installation. Under no circumstances shall pipe or fittings be dropped into the trench or so handled as to receive hard blows or jolts. All mud or concentration of dirt shall be removed prior to installation. Every precaution shall be taken to prevent foreign materials from entering the pipe while it is being placed in the line. If the pipe cannot be placed in the trench without earth entering, the Engineer may require a heavy, tightly woven canvas bag of suitable size be placed over each end and left until the connection is to be made to the adjacent pipe. During the laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

- **Direction of Laying**
Unless otherwise ordered, pipe shall be laid with the bell ends facing the direction of laying. When the grade exceeds two feet of rise per one hundred feet of trench, the bells shall face upgrade. Pipe shall be installed according to the line and grade as shown on the drawings.
- **Cleaning of Pipe**
The interior and exterior of all pipe shall be clean and free from all foreign material before being installed. The Contractor shall provide the necessary means to wipe, brush, swab, or air blast to remove any foreign material from the interior of the pipe as required by the Engineer.

Protection of Open Pipe

At all times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug, cap, or other means accepted by the Engineer. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry. No pipe shall be laid in water or when trench conditions are unsuitable.

Thrust Restraint Systems

All pressure piping shall be provided with a thrust restraint system to prevent movement caused by hydraulic thrust and pressure. Exposed pressure piping shall have restrained joints. Horizontal buried pressure piping, unless noted otherwise, shall be restrained by thrust blocking. Thrust blocks shall be cast against solid undisturbed ground and shall be installed so as to prevent contact or interference with pipe or fitting joints. Fittings shall be wrapped in plastic to prevent the concrete from bonding to the surface of the fitting. If adequate support against undisturbed soil cannot be obtained, restrained joints shall be used. Vertical buried pressure piping shall have an acceptable type of restrained joint.

Protection of Buried Metal Surfaces

All steel clamps, rods, bolts, and other metal accessories using reaction anchorages or joint harness and all mechanical pipe couplings, flanges, and sleeves installed underground shall be protected from corrosion by use of two layers of polyethylene wrap installed in accordance with AWWA C105 (ANSI A21.5). Metal surfaces must be kept clean of mortar, cement, clay, sand or other foreign material.

Joining Pipe of Different Material or Outside Diameter

Where specified or required, pipes of different material or outside diameter shall be joined with mechanical pipe couplings. Couplings shall be suitable for the intended service and shall be installed in accordance with manufacturer's instructions.

Insulation

All pipeline constructed within 6 feet of the ground surface or within two vertical foot of a storm sewer shall be protected from frost with insulation. The minimum width of insulation varies with the depth of ground cover as shown in the following table:

<u>Depth of Pipeline (Feet)</u>	<u>Minimum Width of Insulation (Feet)</u>
2.0	9
2.5	8
3.0	7
3.5	6

4.0	5
4.5	4
5.0	3
5.5	2

The insulation shall be placed immediately above the bedding section or a minimum of 6 inches above the pipeline.

Line and Grade for Open-Cut Construction

It is the intent of this paragraph to require the contractor to use a laser beam to facilitate the installation of the water mains. Initial staking will be furnished for all fittings and a limited amount of control points. Any subsequent staking for line and grade shall be done by the contractor.

Basis of Payment

Rigid insulation for frost protection shall be paid for by the square foot in place at the unit price listed in the proposal schedule. No separate payment will be made for all other work covered in this article, unless noted otherwise in the proposal schedule. All costs shall be included in the unit price of work it is associated with.

DUCTILE IRON PIPE AND FITTINGS

Scope

Ductile iron pipe and fittings includes all labor, materials, and equipment as necessary and required to furnish, install, and test 4-inch to 36-inch pressure pipe and fittings, as shown and specified.

General Requirements

The Contractor shall submit manufacturer's data for the pipe, fittings, gaskets, and appurtenances.

Materials

Pipe

Pipe with mechanical and push-on joints shall meet the requirements of AWWA C151 (ANSI A21.51). Pipe with flanged joints shall meet the requirements of AWWA C115 (ANSI A21.15). Pipe with mechanical and push-on joints shall be thickness Class 52, unless specified otherwise. Pipe with flanged or grooved ends shall not be less than thickness Class 53. Pipe shall be cement-mortar lined in accordance with AWWA C104 (ANSI A21.4). Cement-mortar lining shall be standard thickness, unless specified otherwise. The exterior of the pipe for buried service shall have an asphaltic coating. The exterior of pipe for exposed service shall have a primer coat of paint compatible with the specified finish coat.

Fittings

Fittings with flanged, mechanical, and push-on joints shall meet the requirements of AWWA C110 (ANSI A21.10) or AWWA C153 (ANSI A21.53). Fittings with grooved end joints shall meet the dimensional requirements of AWWA C110 (ANSI A21.10). Fittings shall have the same lining and coating as the pipe. Fittings shall be ductile iron 350 psi pressure rating or cast iron 250 psi pressure rating, unless specified otherwise. Fittings shall be Tyler/Union, American Flow Control, Sigma or approved equal.

Joints and Couplings

- Fittings - Fittings with flanged, mechanical, and push-on joints shall meet the requirements of AWWA C110 (ANSI A21.10) or AWWA C153 (ANSI A21.53). Fittings with grooved end joints shall meet the dimensional requirements of AWWA C110 (ANSI A21.10). Fittings shall have the same lining and coating as the pipe. Fittings shall be ductile iron 350 psi pressure rating or cast iron 250 psi pressure rating, unless specified otherwise. Fittings shall be Tyler/Union, American Flow Control, Sigma or approved equal. Mechanical and Push-on Joints - Mechanical and push-on joints for ductile iron pipe and fittings shall conform to the requirements of AWWA C111 (ANSI A21.11). Bolts for mechanical joints shall be high strength low-alloy steel per the same standard.
- Restrained Joints – Restrained joints shall meet the applicable requirements of ANSI A21.11 (AWWA C111). The joint shall provide for a minimum deflection of not less the five degrees for pipes 12 inches in diameter and smaller and three degrees for pipes 14 inches in diameter through 30 inches in diameter. The joint shall be capable of providing full restraint for the thrust generated at the rated working pressure of the pipe. Restrained joints shall be Griffin Snap-Lok, or Bolt-Lok; Clow Super-Lok Joint; American Flex-Ring, Lok-Ring, or Lok-Fast Joint; U.S. Pipe TR FLEX; or equal.
- Restrained Joint Gaskets – The joint shall be capable of providing full restraint for the thrust generated at the rated working pressure of the pipe. Restrained joint gaskets shall be Griffin Field-Lok 350 Gaskets or U.S. Pipe Field-Lok Gasket; or equal.
- Flexible Joints – Flexible joints shall meet the applicable requirements of ANSI A21.11 (AWWA C111). The joint shall provide for a minimum deflection of not less than 12 degrees. The joint shall be capable of providing full restraint for the thrust generated at the working pressure of the pipe without the use of bolts. Flexible joints shall be Clow Ball and Socket Joint, American Flex-Lok Joint, U.S. Pipe USIFLEX Joint, or equal.
- Pipe Threads - Unless noted otherwise, all pipe threads shall conform in dimensions and limits of size to ANSI B2.1, taper joint thread.
- Grooved Joints - Grooved pipe couplings and joints shall conform to the requirements of AWWA C606.
- Couplings shall be Victaulic Style 31, Gustin-Bacon 500 Series or equal. Coupling gaskets shall be as recommended by the coupling manufacture for the intended service.
- Flange Coupling Adapters - Flanged-coupling adapters shall be Clow F-2535, Dresser Style 127 or 128, or equal. Coupling gaskets shall be as recommended by the coupling manufacturer for the intended service.
- Mechanical Pipe Couplings (for pipe 14" in diameter & larger) - Mechanical pipe couplings for joining pipe of different outside diameters shall be Ford F style cast coupling or Romac Style 501 cast coupling, or equal. Couplings shall be epoxy coated with high strength low alloy steel bolts per AWWA C111.
- Mechanical Flange Connectors – Mechanical flange connectors shall be manufactured from ASTM A536, Grade 65-45-12 or Grade 60-42-10, ductile iron. Flange shall include setscrews that shall provide a safety factor of two without leaking. Flange shall have bolt circles and holes conforming to ANSI B16.1. Couplings gasket shall be as recommended by the coupling manufacturer for the intended service. Mechanical flange connectors shall be Uni-Flange Series 200 of EBAA Iron Series 1000.

Sleeves

- Tapping Sleeves - Tapping sleeves shall be of the MJ branch type designed for attachment of the MJ inlet of a standard MJ gate valve. Sleeve body shall be all stainless steel and shall have a 3/4-

inch NPT test plug. Sleeve shall be rated for 150 psi working pressure. Tapping sleeve shall be Power Seal model 3490MJ or approved equal.

- Cutting-In Sleeve - Cutting-in sleeves shall be Clow F-1220 or equal. Sleeve shall provide a minimum of 10 inches of adjustment.
- Solid Sleeve - Solid sleeves shall be Clow F-1012 or F-1014.

Polyethylene Wrap and Tape

Polyethylene wrap shall meet the requirements of AWWA C105 (ANSI A21.5). Wrap shall be linear low-density polyethylene film with a minimum tensile strength of 3,600 psi and a nominal thickness of 8 mils. Tape for securing the wrap shall be a thermoplastic material with a pressure sensitive adhesive face capable of bonding to metal, asphaltic coating and polyethylene. Tape shall have minimum thickness of 8 mils and a minimum width of one inch.

Construction

General

Unless otherwise indicated, buried, embedded, and encased pipe and fittings shall have push-on joints. Fittings shall be set on hardwood blocking 2 x 6 x 18 inch with the long side of the block set perpendicular to the water main. Mechanical joint pipe and fittings shall be used where specified or when accepted by the Engineer. Unless otherwise indicated exposed pipe and fittings shall have grooved or flanged joints.

Joining Pipe

- Push-On Joints - Thoroughly clean the groove and bell socket and insert the gasket, making sure that it faces the proper direction and that it is correctly seated. After cleaning dirt or foreign material from the plain end, apply lubricant in accordance with the pipe manufacturer's recommendations. Joint lubricant will be non-toxic, tasteless, odorless, and will not support bacterial growth or contain bacterial contaminants. Be sure that the plain end is beveled. A square or sharp edges may damage or dislodge the gasket and cause a leak. Push the plain end into the bell of the pipe. Keep the joint straight while pushing. Gaskets to be installed in cold weather shall be warmed first. Make deflection after the joint is assembled. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Whenever it is desirable to deflect push-on joint pipe, the amount of deflection shall not exceed the maximum limits shown in the following table:

DETAILED SPECIFICATIONS WATER MAIN CONSTRUCTION

Nominal Pipe Size-Inches	Deflection Angle Degrees	Maximum Offset Inches		Approx. Radius of Curve-R Produced by Succession of Joints – Feet	
		18 ft L	20 ft L	18 ft L	20 ft L
4	5	19	21	205	230
6	5	19	21	205	230
8	5	19	21	205	230
10	5	19	21	205	230
12	5	19	21	205	230
14	3	11	12	340	380
16	3	11	12	340	380
18	3	11	12	340	380
20	3	11	12	340	380
24	3	11	12	340	380
30	3	11	12	340	380
36	3	11	12	340	380

- Mechanical Joints** - Wipe the socket and the plain end clean. Wash the plain end, socket, and gasket with pipe joint lubricant to improve gasket seating. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly. Make deflection after joint assembly but before tightening bolts. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand tighten nuts. Tighten the bolts to the normal range of bolt torque while at all times maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This shall be accomplished by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, finally the remaining bolts. Repeat the process until all bolts are within the appropriate range of torque. All nuts shall be tightened with a suitable (preferably torque-limiting) wrench. The torque for various sizes of bolts shall be as follows:

Size (inches)	Range of Torque (ft - lb)
5/8	40-60
3/4	60-90
1	70-100
1-1/4	90-120

Whenever it is desirable to deflect mechanical-joint pipe, the amount of deflection shall not exceed the maximum limits shown in the following table:

Nominal Pipe Size-Inches	Deflection Angle Degrees	Maximum Offset Inches		Approx. Radius of Curve-R Produced by Succession of Joints - Feet	
		18 ft L	20 ft L	18 ft L	20 ft L
4	8-18	31	35	125	140
6	7-07	27	30	145	160
8	5-21	20	22	195	220
10	5-21	20	22	195	220
12	5-21	20	22	195	220
14	3-35	13 ½	15	285	320
16	3-35	13 ½	15	285	320
18	3-00	11	12	340	380
20	3-00	11	12	340	380
24	2-23	9	10	450	500
30	2-23	9	10	450	500
36	2-05	8	9	500	550

- Flanged Joints - Clean all parts thoroughly. Wipe off the gasket. Support the pipe so that no strain is placed on the joint. Align the flanges and check with a level both horizontally along the pipe and vertically across the flange faces. With the flanges secured in position, coat the gasket with a recommended lubricant and insert it between the flanges. Install the bolts and hand turn them as tight as possible. Tighten the bolts with a wrench using a crossover pattern to load the bolts evenly and eliminate concentrated stresses. Continue to tighten the bolts using the crossover pattern until the joint is uniformly tight. The torque for various sizes of pipe shall be as recommended by the pipe manufacturer.
- Restrained and Flexible Joints – Restrained and flexible joint pipe shall be assembled in strict accordance with the manufacturer's written instructions. Pipe joints shall not be assembled underwater.

Polyethylene Wrap

Unless specified otherwise, all pipe, fittings, valves, and appurtenances shall be protected from corrosion by use of two layers of polyethylene wrap installed in accordance with AWWA C105 (ANSI A21.5) with two equally spaced circumferential tape wraps per pipe section. Contractor may use either method "A" or "B". Service taps shall be made through the polyethylene adhesive tape as described in the "preferred" method in AWWA C105 (ANSI A21.5). Pipe and fittings must be kept clean of mortar, cement, clay, sand or other foreign material.

Field Closure

Field closures shall be made by cutting the pipe in a neat workmanlike manner perpendicular to the axis of the pipe without damage to the pipe or lining so as to leave a smooth end. All cuts shall be made with an acceptable mechanical cutter. When the field cut pipe is to be used with rubber gasket joints, it shall be tapered by grinding or filing about 1/8-inch back at an angle of about 30 degrees and all sharp edges shall be removed. Plain end pipe shall be joined with a mechanical pipe coupling.

Bedding

Unless otherwise indicated all pipelines shall have Class "B" bedding.

Testing

All pipelines and appurtenances shall be tested by a hydrostatic test composed of a pressure test and a leakage test.

Basis of Payment

Ductile Iron Pipelines

Ductile iron pipelines shall be measured by the lineal foot in place, and the quantity measured for payment shall be the number of lineal feet of each of the various sizes and types completed and accepted in accordance with the contract, measured along the centerline of the pipeline excluding fittings and valves. The quantity of pipeline, measured as specified herein, will be paid for at the contract unit price per lineal foot of the various sizes and types of pipeline. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, forming foundation, laying pipe, joining pipe, making connections, and anchoring pipe, for backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

Ductile Iron Fittings

Ductile iron fittings shall be measured separately as a unit and paid for per unit installed of the various sizes and types completed and accepted in accordance with this contract. The quantity of fittings, measured as specified herein, will be paid for at the contract unit price per each of various sizes and types of fittings. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, forming foundation, installing fitting, making connections, for backfilling grading and cleaning up, and for all labor tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

Scope

Polyvinyl chloride pressure pipe and fittings includes all labor, materials, and equipment as necessary and required to furnish, install, and test 4-inch to 12-inch PVC pressure pipe and fittings, as shown and specified.

General Requirements

The Contractor shall submit manufacturer's data for the pipe, fittings, gaskets, and appurtenances.

Materials

Pipe

Pipe furnished under this section shall meet the requirements of AWWA C900 for bell end pipe with elastomeric-gasket joints. The pipe shall have the same outside diameter as ductile iron pipe. The pipe shall be DR18 with a pressure class rating of 235 PSI, unless noted otherwise.

Fittings

Fittings shall meet the requirements of AWWA C110 (ANSI A21.10) or AWWA C153 (ANSI A21.53). Fittings shall be ductile iron 350 psi pressure rating or cast iron 250 psi pressure rating and cement

mortar lined in accordance with AWWA C104 (ANSI A21.4). Cement-mortar lining shall be standard thickness, unless noted otherwise. The exterior of the fitting for buried service shall have an asphaltic coating. Fittings shall be Tyler/Union, American Flow Control, Sigma or approved equal.

Joints and Couplings

- Fitting Joints - Fittings shall have mechanical or push-on joints that conform to the requirements of AWWA C111 (ANSI A21.11). Bolts for mechanical joints shall be high strength low-alloy steel per the same standard.
- PVC Pipe Joints – PVC pressure pipe shall have bell and spigot type joints with the bell being integrally formed with the pipe. The joint shall be sealed using an elastomeric gasket meeting the requirements of ASTM D3139.
- PVC Pipe Restrained Joints – PVC restrained pipe joints shall consist of a PVC coupling with beveled edges, two sealing gaskets, and two restraining grooves, plain end pipe with a restraining groove at each end, and nylon splines for each groove. The joint shall be capable of providing full restraint for the thrust generated at the working pressure of the pipe. PVC restrained pipe joints shall be CertainTeed Certa-Lok AWWA C900/RJ PVC pipe.
- Restrained Joint Gaskets – The joint shall be capable of providing full restraint for the thrust generated at the working pressure of the pipe. Restrained joint gaskets shall be JM Eagle-Loc 900 or equal.

Sleeves and Transition Couplings

- Tapping Sleeves - Tapping sleeves shall be of the MJ branch type designed for attachment of the MJ inlet of a standard gate valve. Sleeve body shall be all stainless steel and shall have a 3/4-inch NPT test plug. Sleeve shall be rated for 150 psi working pressure. Tapping sleeves shall be PowerSeal model 3490MJ or approved equal.
- Cutting-In Sleeve - Cutting-in sleeves shall be Clow F-1220 or equal. Sleeve shall provide a minimum of 10 inches of adjustment.
- Solid Sleeve - Solid sleeves shall be Clow F-1012 or F-1014. Solid sleeves may be cast or ductile iron construction and shall meet the requirements of AWWA C110 and C111
- Mechanical Pipe Transition Couplings - Mechanical pipe transition couplings for joining pipe of different outside diameter shall be Romac Style 501 epoxy coated or Ford Transition Coupling Style FC2A epoxy coated. Coupling gaskets shall be as recommended by the coupling manufacturer for the service intended. Mechanical pipe couplings for buried PVC shall be ductile iron or cast iron couplings with high strength low alloy steel bolts per AWWA C111.

Polyethylene Wrap and Tape

Polyethylene wrap shall meet the requirements of AWWA C105 (ANSI A21.5). Wrap shall be linear low density polyethylene film with a minimum tensile strength of 3,600 psi and a nominal thickness of 8 mils. Tape for securing the wrap shall be a thermoplastic material with a pressure sensitive adhesive face capable of bonding to metal, asphaltic coating, PVC and polyethylene. Tape shall have minimum thickness of 8 mils and a minimum width of one inch.

Tracer Wire

Tracer wire shall be NEC Type THWN, 600 volts No. 12 AWG solid copper wire plastic coated and designed for underground use. The wire gage and insulation specified shall be considered a minimum. Provide a thicker gage wire, thicker insulation, or pull multiple wires to assure that the locating wire survives the loads imposed if a trenchless operation is involved.

Tracer Wire Connectors

Tracer wire connectors shall consist of a mechanical connector, vinyl mastic pad and polyethylene wrap. Wire connectors shall be a Type H-high strength 8 AWG brass split bolt connector as manufactured by Blackburn or equal. Vinyl mastic pad shall be Scotch 2200 Vinyl Mastic Pad as manufactured by 3M Electrical Products Division or equal.

Construction

General

Unless otherwise indicated, buried, embedded, and encased pipe and fittings shall have push-on joints. Restrained joint pipe may be used as carrier pipe in casings. Fittings shall be set on hardwood blocking 2 x 6 x 18 inch with the long side of the block set perpendicular to the water main. Mechanical joint fittings shall be used where specified or when accepted by the Engineer.

Joining Pipe to Fittings

- **Push-On Joints** – Thoroughly clean the groove and bell socket and insert the gasket, making sure that it faces the proper direction and that it is correctly seated. After cleaning dirt or foreign material from the spigot end, apply lubricant in accordance with the pipe manufacturer's recommendations. Joint lubricant will be non-toxic, tasteless, odorless, and will not support bacterial growth or contain bacterial contaminants. Be sure that the spigot end is beveled. A square or sharp edge may damage or dislodge the gasket and cause a leak. Keep the joint straight while pushing the spigot end into the bell of the fitting. Gaskets to be installed in cold weather shall be warmed first. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint.

Make deflection after the joint is assembled. Whenever it is desirable to deflect push-on joint PVC pipe with ductile iron fittings, the amount of deflection shall not exceed the maximum limits shown in the following table:

Nominal Pipe Size Inches	Deflection Angle degrees	Maximum Offset Inches – 20 ft L
4	5°	22
6	5°	22
8	5°	22
10	5°	22
12	5°	22

- **Mechanical Joints** - Wipe the socket and the plain end clean. Wash the spigot end, socket, and gasket with pipe joint lubricant to improve gasket seating. Place the gland on the spigot end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the spigot end. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly. Make deflection after joint assembly but before tightening bolts. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand tighten nuts. Tighten the bolts to the normal range of bolt torque while at all times maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This shall be accomplished by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, finally the remaining bolts. Repeat the process until

all bolts are within the appropriate range of torque. All nuts shall be tightened with a suitable (preferably torque-limiting) wrench. The torque for various sizes of bolts shall be as follows:

Size (inches)	Range of Torque (ft - lb)
5/8	40-60
3/4	60-90
1	70-100
1-1/4	90-120

Whenever it is desirable to deflect mechanical-joint pipe, the amount of deflection shall not exceed the maximum limits shown in the following table:

Nominal Pipe Size Inches	Deflection Angle degrees	Maximum Offset Inches – 20 ft L
4	8°	35
6	7°	30
8	5°	22
10	5°	22
12	5°	22

Joining Pipe

- Push On Joints - Contractor shall provide a bell hole at each joint for push on joint pipe. The bell hole shall be no larger than necessary to accomplish proper joint assembly. When the joint has been made, the void under the bell should be filled with bedding material to provide adequate support to the pipe throughout its entire length.

Assemble all joints in accordance with recommendations of the manufacturer. Proper jointing may be verified by rotation of the spigot by hand or with a strap wrench. If unusual joint resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint, inspect for damage, reclean the joint components and repeat the assembly steps. Note that fitting bells may permit less insertion depth than pipe bells. Whenever it is desirable to deflect push-on joint PVC pipe joints, the pipe manufacturer's recommendations shall be followed.

For shorter than standard pipe lengths, field cuts may be made with either hand or mechanical saws or plastic pipe cutters. Ends shall be cut square and perpendicular to the pipe axis. Spigots shall have burrs removed and ends smoothly beveled by a mechanical beveller or by hand with a rasp or file. Field spigots shall be stop-marked with felt tip marker or wax crayon for the proper length of assembly insertion. The angle and depth of field bevels and lengths to stop-marks shall be comparable to factory pipe spigots.

Thoroughly clean the groove and bell socket and insert the gasket, making sure that it faces the proper direction and that it is correctly seated. After cleaning dirt or foreign material from the plain end, apply lubricant in accordance with the pipe manufacturer's recommendations. Joint

lubricant will be non-toxic, tasteless, odorless, and will not support bacterial growth or contain bacterial contaminants. Be sure that the spigot end is beveled. A square or sharp edge may damage or dislodge the gasket and cause a leak. Keep the joint straight while pushing the spigot end into the bell of the fitting. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Push pipe home by using a cross member and levers or jacks. It will not be permissible to push pipe home with motor powered excavation equipment. Use pipe manufacturer's recommendations for the type of joint.

Deflected joints shall be made by pushing the spigot into the bell about ½-inch short of the reference line then moving the loose bell end of the assembled length not more than the maximum allowable offset. Pipe offsets shall only be made with manual effort.

Whenever it is desirable to deflect push-on joint PVC pipe, the amount of deflection shall not exceed the pipe manufacturer's written recommendations or the maximum limits in the following table, which ever is more restrictive:

Nominal Pipe Size Inches	Deflection Angle degrees	Maximum Offset Inches – 20 ft L	Approx. Radius of Curve-R Produced by Succession of
4	3°	12	382
6	3°	12	382
8	3°	12	382
10	3°	12	382
12	2.5°	10	458

- Restrained Joints - Assemble restrained joints in accordance with recommendations of the manufacturer. Clean surfaces to be joined. Lubricate and align pipe. Insert pipe into coupling and insert spline through insertion hole in coupling. Cut off spline so that it protrudes from the insertion hole approximately 3/8 inch.

Trenchless Installation

Trenchless installation by directional drilling shall utilize a system as approved by the Engineer prior to installation. A pilot hole shall be drilled at the alignment and depth shown on the drawings. The pilot hole shall be reamed to the diameter recommended by the pipe manufacturer. The Contractor shall select the drilling fluid based on the existing soils. The drilling fluid shall be as recommended by the pipe manufacturer. The PVC pipe shall be pulled through the drilled hole using a constant tension throughout the operation. The pulling device shall have a direct reading gauge to indicate the pulling tension. The actual tension shall never exceed the safe pulling tension of the pipe. The pipe shall be allowed to relax for 24-hours prior to making final connections.

Polyethylene Wrap

Unless specified otherwise, all fittings, valves, service saddles, and appurtenances shall be protected from corrosion by use of two layers of polyethylene wrap installed in accordance with AWWA C105 (ANSI A21.5).

Field Closure

Field closures shall be made by cutting the pipe in a neat workmanlike manner perpendicular to the axis of the pipe without damage to the pipe so as to leave a smooth end. All cuts shall be made with

an acceptable mechanical cutter. When the field cut pipe is to be used with rubber gasket joints, it shall be tapered by grinding or filing about 1/8-inch back at an angle of about 30 degrees and all sharp edges shall be removed. Plain end pipe shall be joined with a solid sleeve.

Bedding

Unless otherwise indicated all PVC pipelines shall have Class "E" bedding.

Tracer Wire

Tracer wire shall be taped at the center and each end of each length of pipe. Tracer wire shall be run from hydrant to hydrant. Not more than one splice will be permitted per run. Tracer wire shall extend up the barrel section of the hydrant and terminate with four feet of wire above finished grade. Tracer wire shall be inserted through a 3-foot section of two (2") inch diameter PVC schedule 40 DWV access pipe taped to the hydrant at ground level and on street side of hydrant barrel. The top of the three foot section of two inch PVC access pipe shall terminate approximately two inches above finish grade and the four feet of wire shall be neatly folded into this section of pipe. Seal off the top of this two inch pipe with tape so the pipe does not fill up during backfilling and leave the end of the tracer wire exposed for locating purposes.

Tracer Wire Connectors

The wire connector will be sealed with 3M Scotch Vinyl Mastic Pad and two layers of polyethylene wrap.

Testing

All pipelines and appurtenances shall be tested by a hydrostatic test composed of a pressure test and a leakage test. A continuity test shall be performed for all tracer wires. All tracer wire failing the continuity test shall be repaired and the test shall be repeated.

Basis of Payment

Polyvinyl Chloride (PVC) Pressure Pipelines

Polyvinyl chloride (PVC) pressure pipelines shall be measured by the lineal foot in place, and the quantity measured for payment shall be the number of lineal feet of each of the various sizes and types completed and accepted in accordance with the contract, measured along the centerline of the pipeline excluding fittings and valves.

The quantity of pipeline, measured as specified herein, will be paid for at the contract unit price per lineal foot of the various sizes and types of pipeline. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, tracer wire, forming foundation, laying pipe, joining pipe, making connections, and anchoring pipe, for backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

Ductile Iron or Cast Iron Fittings

Ductile or cast iron fittings shall be measured separately as a unit and paid for per unit installed of the various sizes and types completed and accepted in accordance with this contract.

The quantity of fittings, measured as specified herein, will be paid for at the contract unit price per each of various sizes and types of fittings. This price shall be payment in full for all materials,

including harnesses and blocking, for excavation, sheeting and shoring, for bedding, forming foundation, installing fitting, making connections, for backfilling grading and cleaning up, and for all labor tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

LARGE DIAMETER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

Scope

Large diameter polyvinyl chloride (PVC) pressure pipe and fittings includes all labor, materials, and equipment as necessary and required to furnish, install, and test 14-inch to 24-inch PVC pressure pipe and fittings, as shown and specified.

General Requirements

The Contractor shall submit manufacturer's data for the pipe, fittings, gaskets, and appurtenances.

Materials

Pipe

Large diameter PVC pressure pipe shall meet the requirements of AWWA C905 for bell end pipe with elastomeric-gasket joints. The pipe shall have the same outside diameter as ductile iron pipe. The pipe shall be DR 18 with a pressure rating of 235 psi, unless noted otherwise.

Fittings

Fittings shall conform to the requirements of AWWA C110 (ANSI A21.10) or AWWA C153 (ANSI A21.53). Fittings shall be pressure Class 350 ductile iron. Fittings shall be cement-mortar lined in accordance with AWWA C104 (ANSI A21.4). Cement-mortar lining shall be standard thickness, unless noted otherwise. The exterior of the fitting for buried service shall have an asphaltic coating. Fittings shall be Tyler/Union, American Flow Control, Sigma or approved equal.

Joints

- Fitting Joints - Fittings shall have mechanical or push-on joints that conform to the requirements of AWWA C111 (ANSI A21.11).
- Large Diameter PVC Pipe Joints - Large diameter PVC pressure pipe shall have bell and spigot type push-on joints with the bell being integrally formed with the pipe. The joint shall be sealed using an elastomeric gasket meeting the requirements of ASTM D3139.
- Large Diameter PVC Restrained Pipe Joints - Large diameter PVC restrained pipe joints on 14-inch and 16-inch diameter shall consist of a PVC coupling with beveled edges, two sealing gaskets, and two restraining grooves, plain end pipe with a restraining groove at each end, and nylon restraining splines for each groove. The joint shall be capable of providing full restraint for the thrust generated at the working pressure of the pipe. Large diameter PVC restrained pipe joints shall be CertainTeed Certa-Lok AWWA C905/RJ PVC pipe.

Polyethylene Wrap and Tape

Polyethylene wrap shall meet the requirements of AWWA C105 (ANSI A21.5). Wrap shall be linear low-density polyethylene film with a minimum tensile strength of 3,600 psi and a nominal thickness of 8 mils. Tape for securing the wrap shall be a thermoplastic material with a pressure sensitive adhesive face capable of bonding to metal, asphaltic coating, PVC and polyethylene. Tape shall have minimum thickness of 8 mils and a minimum width of one inch.

Tracer Wire

Tracer wire shall be NEC Type THWN, 600 volts No. 12 AWG solid copper wire plastic coated and designed for underground use. The wire gage and insulation specified shall be considered a minimum. Provide a thicker gage wire, thicker insulation, or pull multiple wires to assure that the locating wire survives the loads imposed if a trenchless operation is involved.

Tracer Wire Connectors

Tracer wire connectors shall consist of a mechanical connector, vinyl mastic pad and polyethylene wrap. Wire connectors shall be a Type H-high strength 8 AWG brass split bolt connector as manufactured by Blackburn or equal. Vinyl mastic pad shall be Scotch 2200 Vinyl Mastic Pad as manufactured by 3M Electrical Products Division or equal.

Construction

General

Unless otherwise indicated, buried, embedded, and encased pipe and fittings shall have push-on joints. Restrained joint pipe may be used as carrier pipe in casings. Mechanical joint fittings shall be used where specified or when accepted by the Engineer.

Joining Pipe

- Push-on Joints - Contractor shall provide a bell hole at each joint for push-on joint pipe. The bell hole shall be no larger than necessary to accomplish proper joint assembly. When the joint has been made, the void under the bell should be filled with bedding material to provide adequate support to the pipe throughout its entire length.

Assemble joints in accordance with recommendations of the manufacturer. Proper jointing may be verified by rotation of the spigot by hand or with a strap wrench. If unusual joint resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint, inspect for damage, reclean the joint components and repeat the assembly steps. Note that fitting bells may permit less insertion depth than pipe bells.

For shorter than standard pipe lengths, field cuts may be made with either hand or mechanical saws or plastic pipe cutters. Ends shall be cut square and perpendicular to the pipe axis. Spigots shall have burrs removed and ends smoothly beveled by a mechanical beveller or by hand with a rasp or file.

Field spigots shall be stop-marked with felt tip marker or wax crayon for the proper length of assembly insertion. The angle and depth of field bevels and lengths to stop-marks shall be comparable to factory pipe spigots.

Thoroughly clean the groove and bell socket and insert the gasket, making sure that it faces the proper direction and that it is correctly seated. After cleaning dirt or foreign material from the spigot end, apply lubricant in accordance with the pipe manufacturer's recommendations. The lubricant shall be supplied in sterile cans and every effort shall be made to keep it sterile. Confirm that the spigot end is beveled. A square or sharp edges may damage or dislodge the gasket and cause a leak. Keep the joint straight while pushing the spigot end into the bell of the pipe. Push pipe home by using a cross member and levers or jacks. It will not be permissible to push pipe

home with motor powered excavation equipment. Use pipe manufacturer's recommendations for the type of joint.

Deflected joints shall be made by pushing the spigot into the bell about ½-inch short of the reference line then moving the loose bell end of the assembled length not more than the maximum allowable offset. Pipe offsets shall only be made with manual effort. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the required depth of the joint.

Whenever it is desirable to deflect push-on joint PVC pipe, the amount of deflection shall not exceed the pipe manufacturer's written recommendations or the maximum limits in the following table, which ever is more restrictive:

Nominal Pipe Size-inches	Deflection Angle degrees	Maximum Offset Inches - 20ft L	Approx. Radius of Curve-R Produced by Succession of Joints - 20ft L
14 and larger	1.5	6¼	764

- **Restrained Joints** - Assemble restrained joints in accordance with recommendations of the manufacturer. Clean surfaces to be joined. Lubricate and align pipe. Insert pipe into coupling and insert spline through insertion hole in coupling. Cut off spline so that it protrudes from the insertion hole approximately 3/8 inch.

Joining Pipe to Fittings

- **Push-on Joints** - Thoroughly clean the groove and bell socket and insert the gasket, making sure that it faces the proper direction and that it is correctly seated. After cleaning dirt or foreign material from the spigot end, apply lubricant in accordance with the pipe manufacturer's recommendations. The lubricant shall be supplied in sterile cans and every effort shall be made to keep it sterile. Confirm that the spigot end is beveled. A square or sharp edge may damage or dislodge the gasket and cause a leak. Keep the joint straight while pushing the spigot end into the bell of the fitting. In cold weather, gaskets shall be warmed prior to being installed.

Whenever it is desirable to deflect large diameter push-on joint PVC pipe, with ductile iron or cast iron push-on joint fittings, the amount of deflection shall not exceed the maximum limit of 3 degrees.

- **Mechanical Joints** - Wipe the socket and the spigot end clean. Wash the spigot end, socket, and gasket with a soap solution to improve gasket seating. Place the gland on the spigot end with the lip extension toward the spigot end, followed by the gasket with the narrow edge of the gasket toward the spigot end. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly. Make deflection after joint assembly but before tightening bolts. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand tighten nuts.

Tighten the bolts to the normal range of bolt torque while at all times maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

This shall be accomplished by partially tightening the bottom bolt first, then the top bolt, next the bolts at either side, finally the remaining bolts. Repeat the process until all bolts are within the appropriate range of torque. All nuts shall be tightened with a suitable (preferably torque-limiting) wrench. The torque for various sizes of bolts shall be as follows:

<u>Size (in.)</u>	<u>Range of Torque (ft-lb)</u>
5/8	45-60
3/4	75-90
1	100-120
1¼	120-150

Whenever it is desirable to deflect push-on joint PVC pipe with ductile iron or cast iron mechanical joint fittings, the amount of deflection shall not exceed the maximum limit of 3.58 degrees.

Polyethylene Wrap

Unless specified otherwise, all fittings, valves, and appurtenances shall be protected from corrosion by use of two layers of polyethylene wrap installed in accordance with AWWA C105 (ANSI A21.5).

Field Closure

Field closures shall be made by cutting the pipe in a neat workmanlike manner perpendicular to the axis of the pipe without damage to the pipe or lining so as to leave a smooth end. All cuts shall be made with an acceptable mechanical cutter. When the field cut pipe is to be used with rubber gasket joints, it shall be tapered by grinding or filing about 1/8 inch back at an angle of about 30 degrees and all sharp edges shall be removed. Plain end pipe shall be joined with a solid sleeve.

Bedding

Unless otherwise noted, all large diameter PVC pressure pipelines shall have Class "E" bedding.

Tracer Wire

Tracer wire shall be taped at the center and each end of each length of pipe. Tracer wire shall be run from hydrant to hydrant. Not more than one splice will be permitted per run. Tracer wire shall extend up the barrel section of the hydrant and terminate with four feet of wire above finished grade. Tracer wire shall be inserted through a 3-foot section of two (2") inch diameter PVC schedule 40 DWV access pipe taped to the hydrant at ground level and on street side of hydrant barrel. The top of the three foot section of two inch PVC access pipe shall terminate approximately two inches above finish grade and the four feet of wire shall be neatly folded into this section of pipe. Seal off the top of this two inch pipe with tape so the pipe does not fill up during backfilling and leave the end of the tracer wire exposed for locating purposes.

Tracer Wire Connectors

The wire connector will be sealed with 3M Scotch Vinyl Mastic Pad and two layers of polyethylene wrap.

Testing

All pipelines and appurtenances shall be tested by a hydrostatic test composed of a pressure test and a leakage test.

Basis of Payment

Large Diameter PVC Pressure Pipelines

Large diameter PVC pressure pipelines shall be measured by the lineal foot in place, and the quantity measured for payment shall be the number of lineal feet of each of the various sizes and types completed and accepted in accordance with the contract, measured along the centerline of the pipeline excluding fittings and valves.

The quantity of pipeline, measured as specified herein, will be paid for at the contract unit price per lineal foot of the various sizes and types of pipeline. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, anchoring pipe, for backfilling, grading, and cleaning-up, for plugging and abandoning-in-place existing water main pipelines, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

Ductile Iron Fittings

Ductile iron fittings shall be measured separately as a unit and paid for per unit installed of the various sizes and types completed and accepted in accordance with this contract.

The quantity of fittings, measured as specified herein, will be paid for at the contract unit price per each of various sizes and types of fittings. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, forming foundation, installing fittings, polyethylene wrap, making connections, and anchoring fittings, for backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

HIGH DENSITY POLYETHYLENE PRESSURE PIPES AND FITTINGS

Scope

HDPE pressure pipe and fittings include all labor, materials, and equipment necessary and required to furnish, install, and test 4-inch to 16-inch HDPE pressure pipe and fittings as shown and specified.

General Requirements

Submittals

The Contractor shall submit manufacturer's data for the pipe, fittings, gaskets, and appurtenances. The Contractor shall submit information on the procedure and equipment that will be used to join the pipe and fittings. Contractor shall submit shop drawings of concrete thrust collar showing concrete mix designs, reinforcing details, and strap and attachment hardware details. Contractor shall submit copies of the manufacturers proposed joint restraint system for approval by the Engineer. The Contractor shall submit complete details of the procedure and equipment to be used for directional drilling.

Manufacturer

HDPE pipe and fittings shall be Performance Pipe Series 4000 ductile iron pipe size, Plexco BLUESTRIPE ductile iron pipe size, CSR PolyPipe, or equal.

MaterialsPipe

All pipe and fittings shall meet the requirements of AWWA C906. The pipe shall have an SDR of 11 or less. The pipe and fittings shall have the same outside diameter as ductile iron pipe. The pipe shall have an internal pressure rating of 160 psi at 73.4 degrees Fahrenheit temperature and a service life of 50 years.

Pipe materials shall be high density polyethylene pipe (HDPE), PE3408, meeting the requirements of ASTM D3350. Pipe shall have a minimum cell classification of PE334434C. The polyethylene pipe material shall have a minimum tensile yield strength of 3,200 psi; a minimum flexural modulus of 135,000 psi; and a minimum Modulus of Elasticity of 125,000 psi. The polyethylene pipe shall have a hydrostatic design basis (HDB) rating of 1,600 psi at 73.4 degrees Fahrenheit and 800 psi at 140 degrees Fahrenheit.

The pipe shall be homogenous throughout and free of cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be uniform in color, density, and other physical properties.

Pipe Color Coding and Marking

The pipe shall be color coded with blue stripes and coded at intervals not greater than six feet. Markings shall include manufacturer's name and codes, nominal pipe size, type, and SDR or pressure rating.

Fittings and Joints

- Fittings - Polyethylene fittings shall be from material the same requirements as the pipe. The pipe manufacturer must certify that they produced the pipe, fabricated the fitting, and provide the warranty. Fittings shall be pressure rated to match the system piping to which they are joined.

Molded fittings shall be manufactured in accordance with either ASTM D2683 (socket fused) or ASTM D3261 (butt fused) and shall be so marked. At the point of fusion, the outside diameter and minimum wall thickness shall meet the outside diameter and minimum wall thickness specifications of AWWA C906.

- Joints - Fittings for joining polyethylene pipe to other materials shall be molded stub end type with flange back-up ring. External mechanical joint restraints shall be used when polyethylene pipe is joined with non-polyethylene piping components and shall be used in conjunction with a stiffener as recommended by the pipe manufacturer.

Flanges, bolts, and gaskets for joining polyethylene pipe to other pipe shall be suitable for the intended service. Restrained joints shall be assembled in accordance with recommendations of the pipe and restrained joint manufacturer.

Concrete Thrust Collar

Concrete thrust collar shall be constructed of reinforced concrete having a minimum 28 day compressive strength of 4,000 psi. Concrete shall have an air content of 6 percent. Minimum cement content shall be 5½ bags (517 lbs.) of cement per cubic yard of concrete. Reinforcing steel shall conform to ASTM A615, Grade 60. Steel for the strap shall meet the requirements of ASTM A36. Straps and attachment hardware shall be hot-dip galvanized after fabrication. Damaged galvanized

surfaces shall be coated in a manner acceptable to the Engineer.

Tracer Wire

Tracer wire shall be NEC Type THWN, 600 volts No. 12 AWG solid copper wire plastic coated and designed for underground use. The wire gage and insulation specified shall be considered a minimum. Provide a thicker gage wire, thicker insulation, or pull multiple wires to assure that the locating wire survives the loads imposed if a trenchless operation is involved.

Construction

Joining the Pipe

The pipe shall be joined by butt fusion, utilizing heat and pressure according to manufacturer's recommendations. The butt fusion work shall be performed by skilled technicians certified to perform the work by the Plastic Pipe Institution. Prior to starting the work, the Contractor shall submit to the Engineer current certifications of the personnel employed to perform the butt fusion work.

- Butt Fused Joints - Prior to actual fusion, the pipe ends shall be thoroughly cleaned inside and out, removing all foreign material. The pipe ends shall be squared on the fusion machine, and checked so that the pipe ends meet uniformly around the entire circumference of the surfaces to be fused. The pipe ends shall then be fused by heat and pressure sufficient to provide a bead of at least 3/16-inch wide around the entire circumference of the pipe. The Contractor shall guarantee in writing that each joint has been made so that it will not leak, and that it will be of equal or greater strength than the specified pipe.

Trenchless Installation

Trenchless installation by directional drilling shall utilize a system as approved by the Engineer prior to installation. A pilot hole shall be drilled at the alignment and depth shown on the drawings. The pilot hole shall be reamed to the diameter recommended by the pipe manufacturer. The Contractor shall select the drilling fluid based on the existing soils. The drilling fluid shall be as recommended by the pipe manufacturer. The HDPE pipe shall be pulled through the drilled hole using a constant tension throughout the operation. The pulling device shall have a direct reading gauge to indicate the pulling tension. The actual tension shall never exceed the safe pulling tension of the pipe. The pipe shall be allowed to relax for 24-hours prior to making final connections.

The trench width below the top of the pipe to the bottom shall be not less than the pipe outside diameter plus 12 inches, nor greater than the pipe outside diameter plus 24 inches. The trench walls shall be kept vertical to the top of pipe whenever possible. Unless otherwise indicated, all HDPE pressure pipelines shall have Class "E" bedding. At least 30 inches of cover shall be provided over the top of the pipe before the trench is wheel loaded, and at least 48 inches of cover prior to using heavy compactor equipment.

Tracer Wire

Install tracer wire by pulling it along with the HDPE pipe. No splices will be permitted along the directional bored HDPE pipeline. Test tracer wire to verify conductivity. Repair wires not showing conductivity.

Testing

All HDPE pipelines and appurtenances shall be tested by a pressure test. The pressure test shall be

performed at the test pressure as defined in "Pressure Pipeline Testing"

The HDPE pipeline shall be filled and maintained at the test pressure for four (4) hours before the pressure test shall begin. The Contractor may use either Test Method A or Method B. There shall be no observable leakage. The total length of time that the pipeline is at the test pressure shall not exceed 8 hours. There shall be at least 8 hours of unpressurized time between any two successive hydrostatic tests.

Test Method 'A'

The pipeline shall be pressurized to the test pressure and held for a two-hour period. Water shall be added to the pipeline at the end of the test period to return the pipeline to the test pressure. The amount of water added at the end of the test shall not exceed the following values:

<u>Pipe Size, inches</u>	<u>Gallons per 100 feet of pipe</u>
4	0.25
6	0.60
8	1.00
10	1.30
12	2.30
14	2.80
16	3.30

Test Method 'B'

The pipeline pressure shall be reduced to 10 psi less than the test pressure and held for a one-hour period. The pressure shall not drop more than five percent of the test pressure in the one-hour period.

Basis of Payment

HDPE Pressure Pipe and Fittings

HDPE pressure pipelines shall be measured by the lineal foot in place, and the quantity measured for payment shall be the number of lineal feet of each of the various sizes and types completed and accepted in accordance with the contract, measured along the centerline of the pipeline excluding fittings and valves.

The quantity of pipeline, measured as specified herein, will be paid for at the contract unit price per lineal foot of the various sizes and types of pipeline. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, directional drilling, drilling fluids, sheeting and shoring, for bedding, anchoring pipe, for backfilling, grading, and cleaning-up, for plugging and abandoning-in-place existing water main pipelines, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

Polyethylene Fittings

Polyethylene fittings shall be measured separately as a unit and paid for per unit installed of the various sizes and types completed and accepted in accordance with this contract.

The quantity of fittings, measured as specified herein, will be paid for at the contract unit price per each of various sizes and types of fittings. This price shall be payment in full for all materials, including harnesses and blocking, for excavation, sheeting and shoring, for bedding, forming

foundation, installing fittings, making connections, and anchoring fittings, for backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

RESILIENT-SEATED GATE VALVES AND BOXES

Scope

Resilient-seated gate valves and boxes includes all labor, material, equipment, and services necessary to furnish, install and test under actual operating conditions 4- to 12-inch resilient-seated gate valves and boxes, as shown and specified.

General Requirement

Submittals

The Contractor shall submit manufacturer's data and shop drawings for valves and valve boxes.

General

Unless otherwise indicated valves shall be as specified herein. Buried valves shall have push-on or mechanical joint ends and a 2-inch operating nut. Exposed valves shall have flanged ends. Exposed valves above grade shall have a hand wheel or crank type operator. Exposed valves below grade (e.g. in a manhole) will have a 2-inch operating nut operable from the surface. The direction of the valve operating wheel, lever, or wrench nut shall be to the left (counterclockwise) to open the valve.

Materials

Resilient-Seated Gate Valves

Resilient-seated gate valves shall be full opening, non-rising stem, compression seated wedge type valves conforming to the requirements of AWWA C509. Valves shall have an epoxy coated iron body, bronze stem, and a double sealing permanently bonded fully encased gate. Valve bonnet and stuffing box nuts and bolts shall be AISI Type 304 stainless steel. Valve stem shall have O-ring seals. The O-ring stem seal shall be so designed that the seal above the stem collar can be replaced with the valve under pressure in the full open position. Resilient-seated gate valves shall be Waterous Series 2500, Clow, Kennedy, Mueller, or equal.

Valve Boxes

Valve boxes shall be cast iron, three piece screw type with 5-1/4 inch shaft diameter. Cover shall be marked "Water". Valve box shall be Tyler Series 6860, or equal.

Valve Box Adapters

Valve box adapters shall be a fabricated steel assembly with a ½ inch thick neoprene gasket. The valve box adapter shall be as manufactured by Adaptor, Inc. or equal.

Installation

Buried Valves

The valve shall be set on hardwood blocking 2 x 6 x 18 inch with the long side of the block set perpendicular to the water main. Valve shall be protected from corrosion by use of two layers of polyethylene wrap. Pipe bedding material shall be tamped in place from a point above the main to

a point 6 inches above the bottom of the valve box base to prevent the valve box or base from shifting. A sheet of polyethylene shall be placed over the operating nut to prevent bedding material from entering around the operating nut. A valve box shall be set over all gate valves unless vaults or special chambers are specified. The valve box shall be set on a valve box mounting bracket. Valve boxes and covers shall be centered over the valve operating nut and the entire box assembly secured in place before backfilling operations. Valve boxes that become shifted or filled during backfilling shall be entirely uncovered and reset.

Exposed Valves

Each valve shall be aligned, connected and installed at the location shown in accordance with the manufacture's recommendations. The valve shall be supported so it does not induce strain on the pipe. The valve operator shall be arranged to provide ease of access for operation and maintenance.

Testing

The valve shall be opened and closed after installation. After testing for proper operation the valve shall be closed and pressure tested at 150 percent of working pressure in both directions.

Basis of Payment

Gate valves and valve boxes completed in accordance with this contract shall be measured separately as a unit. The gate valve and valve box shall be paid for per unit installed. Price shall be payment in full for all materials, for excavation, sheeting and shoring, for bedding and installing the valve with valve box and valve box mounting bracket, backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

BUTTERFLY VALVES AND BOXES

Scope

Butterfly valves and boxes includes all labor, material, equipment, and services necessary and required to furnish, install, and test under actual operating conditions 14 to 30 inch butterfly valves and boxes, as shown and specified.

General Requirements

Submittals

The Contractor shall submit manufacturer's data and shop drawings for valves and valve boxes.

General

Unless otherwise indicated valves shall be as specified herein. Buried valves shall have push-on or mechanical joint ends and a 2-inch operating nut. Exposed valves shall have flanged ends and a hand wheel or crank type operator. The direction of the valve operating wheel, lever, or wrench nut shall be to the left (counterclockwise) to open the valve.

Materials

Butterfly Valves

Butterfly valves shall meet or exceed the requirements of AWWA C504 for Class 150B valves. Valve body shall be ASTM A126 Class B cast iron. Valve disc shall be ASTM A48 Class 40 or ASTM A536

ductile iron with ASTM A276 Type 304 or 316 stainless steel shafts. Shaft sleeves shall be O-ring seals or V-type packing. Flanged valves shall have short body laying lengths with 125 pound flanged ends. The valve operator shall be a totally enclosed worm gear or traveling nut, as required, capable of withstanding an overload input torque of 450 ft. lbs. at full open or closed position without damage to the valve or the valve operator. Bolts, nuts, washers and other attachment hardware shall be AISI Type 304 stainless steel. Valves shall be M & H/Clow Valve Company Style 4500 and 1450, Pratt "Groundhog", Mueller "Lineseal" or equal.

Valve Boxes

Valve boxes shall be cast iron, three piece screw type with 5-1/4 inch shaft diameter. Cover shall be marked "Water". Valve box shall be Tyler Series 6850 or equal.

Butterfly Valve Box Adapters

Butterfly valve box adapters shall be a fabricated steel assembly. The valve box adapter shall be as manufactured by Adaptor, Inc. or equal.

Installation

Buried Valves

The valve body and the valve actuator shall be set on hardwood blocking 2 x 6 x 18 inch with the long side of the block set perpendicular to the pipeline. The valve shall be protected from corrosion by use of two layers of polyethylene wrap. Pipe bedding material shall be tamped in place from a point above the main to a point 6 inches above the bottom of the valve box base to prevent the valve box or base from shifting. A sheet of polyethylene shall be placed over the operating nut to prevent bedding material from entering around the operating nut. A valve box shall be set over all operating housings for butterfly valves unless vaults or special chambers are specified. The valve box shall be set on a valve box adapter that is supported by hardwood blocking. Valve boxes and covers shall be centered over the valve operating nut and the entire box assembly secured in place before backfilling operations. Valve boxes that become shifted or filled during backfilling shall be entirely uncovered and reset.

Exposed Valves

Each valve shall be aligned, connected and installed at the location shown in accordance with the manufacture's recommendations. The pipes around the valve shall be supported so they do not induce strain on the valve. The valve operator shall be arranged to provide ease of access for operation and maintenance. Each valve shall have a position indicator needle.

Testing

The valve shall be opened and closed after installation. After testing for proper operation the valve shall be closed and pressure tested at 150 percent of working pressure in both directions.

Basis of Payment

Butterfly valves and valve boxes completed in accordance with this contract shall be measured separately as a unit. The butterfly valve and valve box shall be paid for per unit installed. Price shall be payment in full for all materials, for excavation, sheeting and storing, for bedding and installing the valve with valve box and valve box adapter, backfilling, grading, and cleaning-up, and for all labor, tools, equipment, and incidentals necessary to complete and test the work in accordance with the contract.

FIRE HYDRANTS

Scope

Fire hydrants include all labor, materials, and equipment necessary and required to furnish, install, and test under actual operating conditions fire hydrants, as shown and specified.

General Requirements

Submittals

The Contractor shall submit manufacturer's data and shop drawings for fire hydrants.

Special Requirements

The fire hydrants shall be painted yellow and shall have National Standard 1 1/2" pentagon operating nuts.

Materials

Hydrants shall be traffic pattern, dry barrel fire hydrants conforming to the requirements of AWWA C502. The hydrant shall have a 5-1/4 inch main valve opening, 6-inch mechanical joint or push-on joint connection, two 2-1/2 inch hose connections, one 4-1/2 inch pumper connection (National Standard Threads), O-ring seals and compression type shutoff. Hydrant length shall provide a minimum of 6 feet of cover over inlet pipe, and shall open by turning clockwise. Bolts, nuts, washers and other attachment hardware between the hydrant bottom and the hydrant barrel shall be AISI Type 304 stainless steel. Hydrants shall be Waterous - Pacer WB-67 or approved equal.

Construction

Hydrants shall be set on hardwood blocking and the portion of the hydrant below ground shall be protected from corrosion by use of two layers of polyethylene wrap. The polyethylene wrap must be installed so as to insure that the drain holes on the hydrant are not sealed. Immediately before installation the hydrant shall be thoroughly inspected and cleaned on the interior and shall be opened and closed as many times as necessary to determine if all parts are in proper working order.

Location and Position

Hydrants shall be located as shown or as required so as to provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians. All hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the curb, with the pumper nozzle facing the curb. Hydrants shall be set to the established grade, with nozzles at least 20 inches above the ground as shown or as required by the Engineer.

Hydrant Drainage

Drainage shall be provided by placing approximately 2 cubic yards of drain rock around the hydrant to a minimum of 24 inches above the waste opening in the hydrant, and at least 2 feet around the hydrant. The drain rock will then be covered with a sheet of 8-mil polyethylene to prevent soil from filling the voids in the drain field.

Basis of Payment

Fire hydrants completed in accordance with this contract shall be measured separately as a unit. The fire hydrant shall be paid for per unit installed. Price shall be payment in full for all materials, for excavation, sheeting and shoring, for installing the hydrant, for backfilling, grading, and cleaning-up, and

for all labor, materials, equipment, tools, and incidentals necessary to complete and test the work in accordance with the contract.

POLYETHYLENE WATER SERVICE

Scope

Polyethylene water services include all labor, material, equipment, and services necessary and required to furnish, install, and test under actual operating conditions 1 inch to 2-inch polyethylene water service lines, including corporation stop, saddle if required, coupling, curb stop, curb box and tracer wire, for new water services as shown and specified.

General Requirements

Submittals

The Contractor shall submit manufacturer's data and shop drawings for corporation stops, service saddles, couplings, curb stops, curb boxes, polyethylene water service piping, tracer wire and pipe fittings.

General

All corporation stops, curb stops, and fittings shall be Ford, McDonald, Mueller or equal.

Materials

Service Pipe

The service pipe shall be copper tube size high density polyethylene tubing manufactured from PE-3408/PE-3608 conforming to AWWA C901 and ASTM D2837. The pipe shall be pressure class 200 (DR-9) unless otherwise noted. Use of stainless steel pipe insert stiffeners with fittings will be based on the pipe manufacturer's recommendations.

Fittings

Fittings for polyethylene service piping shall be cast brass. Fittings shall have a uniform wall thickness and strength, and shall be free of defects, which may affect their serviceability. Fittings shall be compression type only. Unions shall be extra heavy 3-part type.

Corporation Stop, Coupling, and Curb Stop

Corporation stops shall be the ball valve type with AWWA taper thread inlet, McDonald 4701B-22 or equal. 1" services shall have corporation stops with ¾" inlet, ¾" valve and 1" outlet. 1 ¼" services shall have corporation stops with 1" inlet, 1" valve, and 1 ¼" outlet. Couplings shall be McDonald 4758T for tube compression to tube compression, or equal. Curb stops shall be ball valve type, McDonald 6100T, or equal. 1" services shall have curb stops with 1" valve size with 1" inlet and outlet. 1 ¼" services shall have curb stops with 1" valve size with 1 ¼" inlet and outlet. 1 ½", and 2" polyethylene services shall have the valve size the same as the service pipe.

Curb Box

Curb boxes shall be Tyler 6500 Series adjustable screw-type cast iron service boxes. Curb boxes shall consist of a lid, top section, extension section, bottom section, and base. Curb boxes shall be

adjustable from 60 to 84 inches. Curb boxes for 1 - inch curb stops shall have a standard base. Curb boxes for 1 ½ inch to 2 - inch curb stops shall have an enlarged base.

Service Saddles

- Ductile Iron Pipe - Service saddles shall be used on all 1 ½-inch and 2-inch services and shall be of the double stainless steel strap type and ductile iron bodies. The saddle casting shall be covered by a 10-12 mil. thickness black nylon fused coating. Saddles shall be Style 202N nylon saddle with stainless steel straps as manufactured by Romac Industries, Inc. or equal.
- PVC Pipe – Service saddles shall be used on all services. Saddles shall be full circle double bolt style, all 18-8 type 304 stainless steel, fully passivated and sized for C900 PVC main. Saddles shall be Romac Style 306 or Ford Style FS303, or equal.

Insulation

Insulation used for frost prevention shall be expanded or extruded polystyrene foam insulation with a minimum thickness of 2-inches with a minimum “R” value of 8.7 (at 75 degrees F mean temperature). Insulation shall have a minimum compressive strength of 40 psi.

Tracer Wire

Tracer wire shall be NEC Type THWN, 600 volts No. 12 AWG solid copper wire plastic coated and designed for underground use. The wire gage and insulation specified shall be considered a minimum. Provide a thicker gage wire, thicker insulation, or pull multiple wires to assure that the locating wire survives the loads imposed if a trenchless operation is involved.

Tracer Wire Connectors

Tracer wire connectors shall consist of a mechanical connector, vinyl mastic pad and polyethylene wrap. Wire connectors shall be a Type H-high strength 8 AWG brass split bolt connector as manufactured by Blackburn or equal. Vinyl mastic pad shall be Scotch 2200 Vinyl Mastic Pad as manufactured by 3M Electrical Products Division or equal.

Construction

General

To prevent the entry of highly chlorinated water into the water service pipe, services shall only be connected to the new water main after final flushing has been completed and a safe bacteriological sample has been obtained. The minimum size of water services shall be 1 inch, unless noted otherwise. A polyethylene water service shall consist of a corporation stop, service saddle if required, service pipe, tracer wire if required and curb stop with box. The corporation stop and curb stop shall be the same size as the service pipe except for 1 ¼” services. The polyethylene service pipe will extend from the corporation stop to the curb stop without additional joints or couplings. A kink or gouge that deforms the diameter of the pipe will be subject to rejection.

Joining Pipe

The pipe shall be joined with compression type fittings in accordance with the manufacturer’s instructions for the fittings provided. The use of stainless steel pipe insert stiffeners in the polyethylene tubing with fittings will be based on the pipe manufacturer’s recommendations. All ends shall be cut squarely and rough edges or burrs removed.

Bedding

Unless otherwise indicated, water services shall have Class "B" bedding.

Connection to Water Main

Two layers of pipe thread sealant tape will be required on each corporation stop. The tap for the corporation stop shall be located a minimum of two foot from any pipe or fitting joint and shall have a minimum of one and one half feet of clearance between taps. All service connections (including the saddle and corporation stop) shall be encased in two layers of polyethylene wrap.

- Ductile Iron Pipe - Corporation stops that are 1-inch shall be direct-tapped. Corporation stops that are 1 ½-inch or 2-inch shall require the use of a service saddle.
- PVC Pipe - Service saddles shall be used for all service connections.

Alignment and Grade

Unless otherwise indicated, the service pipe shall be constructed at a right angle to the roadway or parallel to the sanitary sewer lateral. New water services shall be constructed with a minimum cover of 6.5 feet and a minimum of two feet of vertical separation between any storm sewer. Curb stops shall be placed at a depth between 6 and 7 feet below established or proposed grade. Where 6.5 feet of cover or the two foot vertical separation from a storm sewer cannot be maintained, the water service shall be insulated.

Insulating

All pipeline constructed within 6 feet of the existing ground surface, proposed finish grade elevation or within two vertical feet of a storm sewer shall be protected from frost with insulation.

<u>Depth of Pipeline (Feet)</u>	<u>Minimum Width of Insulation (Feet)</u>
2.0	9
2.5	8
3.0	7
3.5	6
4.0	5
4.5	4
5.0	3
5.5	2

The insulation shall be placed immediately above the bedding section or a minimum of 6-inches above the water main.

Curb Box Installation

The curb box shall be installed in the R/O/W approximately six feet off of R/O/W line so the box will not fall into the sidewalk. The curb box shall be centered over the curb stop and shall be brought to proper grade. The legs of the curb box shall rest firmly upon a 2 x 6 x 8-inch wood block. Clearance

shall be provided so that the curb box does not rest upon the water service pipe. Where the bench does not afford a firm support for the service box blocking, such support shall be furnished by the use of a 2 x 6-inch plank placed across the building sanitary sewer trench and firmly supported in each bank.

The curb box shall be plumbed and braced so it will remain vertical throughout the backfilling. Sufficient excavation shall be made for the curb box installation to insure proper setting and backfilling around the curb box. Curb boxes that become shifted or filled during backfilling shall be entirely uncovered and reset.

Before placing backfilling around the curb box, the Contractor shall wrap polyethylene around the base to prevent entrance of backfill materials into the openings at the base of the curb box.

Curb Stop and Service Pipe Closure

A copper or plastic disc shall be inserted in the curb stop on the building side if no service pipe is provided.

Tracer Wire

Tracer wire shall be required on all service pipe. Tracer wire shall accurately follow the pipeline and be taped to the polyethylene service pipe at a maximum of ten-foot intervals. Tracer wire shall be connected to the main line tracer wire and run from water main to curb stop box without any splices in this run. Tracer wire will be run up the outside of the service box without taping the wire or wrapping the wire to the top section of service box to allow for an adjustment in grade of the box. Tracer wire will terminate with approximately one foot of wire above finish ground grade and for grounding purposes strip two feet of insulation off the end of the tracer wire run. Tracer wire will be wrapped over top center of service box and back down the other side of box.

Tracer Wire Connectors

The wire connector will be sealed with 3M Scotch Vinyl Mastic Pad and two layers of polyethylene wrap.

Testing

The water service installation shall be tested for leaks prior to the placement of backfill and before the curb box is installed. The corporation stop at the water main shall be turned on and the curb stop opened until a full flow of water is obtained. The curb stop shall then be turned off and all joints and couplings checked for leaks. Upon acceptance of the service piping, the remainder of the installation work shall be completed.

Basis of Payment

Corporation Stop, Curb Stop, and Box

Corporation stop including service saddle, if required, curb stop and box shall be paid for by the unit in place at the unit price listed in the proposal for the various sizes. The unit price shall include all site preparation, trenching, installation of the corporation stop, service saddle, polyethylene wrap, curb stop, and box, site restoration, and incidental work associated with the installation.

Service Pipe

Service pipe shall be paid for by the lineal foot in place at the unit price listed in the proposal for the various sizes. The unit price shall include all site preparation, trenching, installation of the service pipe, tracer wire, site restoration, and incidental work associated with installing the service pipe.

RECONNECTION OF WATER SERVICE

Scope

Reconnection of water services includes all labor, material, equipment, and services necessary and required to furnish, install, and test under actual operating conditions 3/4-inch to 2-inch water service lines, including corporation stop, service saddle if required, water service pipe, polyethylene wrap, coupling, curb stop, and curb box, as shown and specified. Water main specifications shall apply for water services larger than 2 – inch.

General Requirements

Submittals

The Contractor shall submit manufacturer's data and shop drawings for corporation stops, saddles, couplings, curb stops, curb boxes, copper water service piping, and pipe fittings.

General

All corporation stops, couplings, curb stops, curb boxes, and fittings shall be Mueller, Ford, McDonald or equal.

Materials

Service Pipe

The service pipe shall be copper tube size high density polyethylene tubing manufactured from PE-3408 conforming to AWWA C901 and ASTM D2737. The pipe shall be pressure class 200 (DR-9)

unless otherwise noted. Use of stainless steel pipe insert stiffeners with fittings will be based on the pipe manufacturer's recommendations.

Fittings

Fittings for polyethylene water service piping shall be cast brass. Fittings shall have a uniform wall thickness and strength, and shall be free of defects, which may affect their serviceability. Fittings shall be of the compression type only. Unions shall be extra heavy 3-part type and for the size and type of pipe indicated on the plans or special provisions.

Corporation Stop, Curb Stop

Corporation stops shall be ball valve type with AWWA taper thread inlet, McDonald 4701B-22 or approved equal. Curb stops shall be ball valve type, McDonald 6100-22, or approved equal.

Service Saddles

- Ductile Iron Pipe - Service saddles shall be used on all 1 ½-inch and 2-inch services and shall be of the double stainless steel strap type and ductile iron bodies. The saddle casting shall be covered by a 10-12 mil. thickness black nylon fused coating. Saddles shall be Style 202N nylon saddle with stainless steel straps as manufactured by Romac Industries, Inc. or equal.
- PVC Pipe – Service saddles shall be used on all services. Saddles shall be full circle double bolt style, all 18-8 type 304 stainless steel, fully passivated and sized for C900 PVC main. Saddles shall be Romac Style 306 or Ford Style FS303, or equal.

Curb Box

Curb boxes shall be Tyler 6500 Series adjustable screw-type cast iron service boxes. Curb boxes shall consist of a lid, top section, extension section, bottom section, and base. Curb boxes shall be adjustable from 60 to 84 inches. Curb boxes for ¾ to 1 - inch curb stops shall have a standard base. Curb boxes for 1 ½ inch to 2 - inch curb stops shall have an enlarged base.

Insulation

Insulation used for frost prevention shall be expanded or extruded polystyrene foam insulation with a minimum thickness of 2-inches with a minimum "R" value of 8.7 (at 75 degrees F mean temperature). Insulation shall have a minimum compressive strength of 40 psi.

Tracer Wire

Tracer wire shall be NEC Type THWN, 600 volts No. 12 AWG solid copper wire plastic coated and designed for underground use. The wire gage and insulation specified shall be considered a minimum. Provide a thicker gage wire, thicker insulation, or pull multiple wires to assure that the locating wire survives the loads imposed if a trenchless operation is involved.

Tracer Wire Connectors

Tracer wire connectors shall consist of a mechanical connector, vinyl mastic pad and polyethylene wrap. Wire connectors shall be a Type H-high strength 8 AWG brass split bolt connector as manufactured by Blackburn or equal. Vinyl mastic pad shall be Scotch 2200 Vinyl Mastic Pad as manufactured by 3M Electrical Products Division or equal.

Construction

General

The reconnection of the water service line shall include one corporation stop, service saddle if required, curb stop, curb box, coupling, and polyethylene tubing of the size indicated. The water services shall only be connected to the new water main after a safe bacteriological sample has been obtained and all hydrostatic testing has been completed. Water services shall not be disconnected for more than 4 hours and the owner will be notified prior to reconnection. The polyethylene service pipe will extend from the corporation stop to the curb stop without additional joints or couplings unless previously approved by the engineer. A transitional coupling, if needed, will be installed after the curb stop to connect the new polyethylene service piping to the existing service piping. A kink or bend that deforms the diameter of the pipe will be subject to rejection.

Joining Pipe

The pipe shall be joined with compression type fittings in accordance with the manufacturer's instructions for the fittings provided. All ends shall be cut squarely and rough edges or burrs removed.

Connection to Water Main

Two layers of pipe thread sealant tape will be required on each corporation stop. The tap for the corporation stop shall be located a minimum of two feet from any pipe or fitting joint and must have a minimum of one and one half feet between connections. All service connections (including the saddle and corporation stop) shall be protected from corrosion by use of two layers of polyethylene wrap.

- Ductile Iron Pipe - Corporation stops that are ¾-inch or 1-inch shall be direct-tapped. Corporation stops that are 1 ½-inch or 2-inch shall require the use of a service saddle.
- PVC Pipe - Service saddles shall be used for all service connections.

Bedding

Unless otherwise indicated, water services shall have Class "B" bedding.

Location and Position of Curb Stop

The water service shall be laid as required to reconnect the existing service with the new water main. The existing curb stop shall be removed and the new curb stop installed in the R/O/W, perpendicular to R/O/W line and approximately six feet off of R/O/W line so the box will not fall into the sidewalk. The curb stop shall be placed below established or proposed grade at a minimum depth of six feet. If the existing water service has less than six feet of cover the difference in depth between the new service and the existing service will be made up immediately on the property owner's side of the curb stop. The curb box shall be centered over the curb stop and shall be brought to proper grade. The legs of the service box shall rest firmly upon a 2 x 6 x 8-inch hardwood block. Clearance shall be provided so that the service box does not rest upon the water service pipe. Where the bench does not afford a firm support for the service box blocking, such support shall be furnished by the use of a 2 x 6-inch plank placed across the building sanitary sewer trench and firmly supported in each bank. The curb box shall be plumbed and braced so it will remain vertical throughout the backfilling. Sufficient excavation shall be made for the curb box installation to insure proper setting and backfilling around the curb box. Curb boxes that become shifted or filled during backfilling shall be entirely uncovered and reset. Each curb box will be marked with a wooden stake. Before placing backfill around the curb service box, the Contractor shall wrap polyethylene around

the base and bedding material shall be tamped in place from a point above the main to a point 6 inches above the blocking to prevent entrance of backfill materials in to the openings at the base.

Insulating

All pipeline constructed within 6 feet of the ground surface or within two vertical feet of a storm sewer shall be protected from frost with insulation.

<u>Depth of Pipeline (Feet)</u>	<u>Minimum Width of Insulation (Feet)</u>
2.0	9
2.5	8
3.0	7
3.5	6
4.0	5
4.5	4
5.0	3
5.5	2

The insulation shall be placed immediately above the bedding section or a minimum of 6-inches above the water main.

Tracer Wire

Tracer wire shall be required on all service pipe. Tracer wire shall accurately follow the pipeline and be taped to the polyethylene service pipe at a maximum of ten-foot intervals. Tracer wire shall be connected to the main line tracer wire and run from water main to curb stop box without any splices in this run. Tracer wire will be run up the outside of the service box without taping the wire to the service box or wrapping the wire around the service box to allow for an adjustment in grade of the service box. Tracer wire will terminate with approximately one foot of wire above finish ground grade and for grounding purposes strip two feet of insulation off the end of the tracer wire run. Tracer wire will be wrapped over top center of service box and back down the other side of box.

Tracer Wire Connectors

The wire connector will be sealed with 3M Scotch Vinyl Mastic Pad and two layers of polyethylene wrap.

Testing

The water service installation shall be tested for leaks under normal main pressure prior to the placement of backfill and before the curb box is installed. The corporation stop at the water main shall be turned on and the curb stop opened until a full flow of water is obtained. The curb stop shall then be turned off and all joints and couplings checked for leaks. Upon acceptance of the service piping, the remainder of the installation work shall be completed.

Basis of Payment

Corporation Stop, Curb Stop, Box and Union

Corporation stop including service saddle, if required, curb stop and box shall be paid for by the unit in place at the unit price listed in the proposal for the various sizes. The unit price shall include all

site preparation, trenching, installation of the corporation stop, service saddle, polyethylene wrap, curb stop, and box, site restoration, and incidental work associated with the installation.

Service Pipe

Service pipe shall be paid for by the lineal foot in place at the unit price listed in the proposal for the various sizes. The unit price shall include all site preparation, trenching, installation of the service pipe, tracer wire, site restoration, and incidental work associated with installing the service pipe.

DISINFECTION AND FLUSHING OF WATER MAINS

Scope

Disinfection of water mains includes all material, equipment, labor, and services necessary to disinfect, flush, and test water mains, as shown and specified.

General Requirements

The Contractor shall submit his proposed procedure for disinfecting and flushing the water mains for review prior to performing the work. Disinfection shall be in accordance with AWWA C651. If water services are involved in the disinfection procedure, provision will have to be made to flush each water service to rid the service line of the chlorinated water.

Materials

Chlorine compounds that shall be used for disinfection shall be sodium hypochlorite solution or calcium hypochlorite granules or tablets. Sodium hypochlorite solution shall contain 5 percent to 15 percent available chlorine and shall be packaged in glass, rubber-lined, or plastic containers, one quart to five gallons in size. Calcium hypochlorite shall contain approximately 65 percent available chlorine by weight and shall be tablet or granular form.

Construction

Disinfecting

- Tablet Method - Tablet method shall consist of placing calcium hypochlorite granules or tablets in the water main as it is being installed. Pipes and fittings must be kept clean and dry during construction. The quantity of granules or tablets shall be as shown in Tables 1 or 2.

Table 1 - Weight of Calcium Hypochlorite Granules to be Placed at Beginning of Main and at each 500 Feet Interval

<u>Pipe Diameter, Inches</u>	<u>Calcium Hypochlorite Granules, Ounces</u>
4	1.7
6	3.8
8	6.7
12	15.1
14 and larger	$D^2 \times 15.1$

Where D is the inside pipe diameter in feet $D=d/12$

When installation has been completed, the main shall be filled with water at a rate such that water within the main will flow at a velocity no greater than 1 foot per second and all air

pockets are eliminated. The water shall remain in the pipe for at least 24 hours. All valves shall be positioned so that the strong chlorine solution in the treated main will not flow into water mains in active service.

Table 2 - Number of 5-g Calcium Hypochlorite Tablets Required for Dose of 25 mg/l (a)

Pipe Diameter Inches	Length of Pipe Section in feet		
	13 or less	18	40
	Number of 5-g Calcium Hypochlorite Tablets		
4	1	1	1
6	1	1	2
8	1	2	4
10	2	3	5
12	3	4	7
16	4	6	13

Based on 3.25 g available chlorine per tablet; any portion of tablet rounded to next higher number.

- Continuous-feed Method - Calcium hypochlorite granules or tablets shall be placed in the pipe sections using the tablet method. A preliminary flushing of the water main shall be performed to remove particles and the pipe shall be refilled with potable water. The flushing velocity shall be a minimum of 2.5 feet per second in the water main. A chlorine solution shall be injected in the water main at a point no more that 10 feet downstream of the beginning of the new main. The chlorine solution shall be added at a constant rate such that the water shall have not less than 25 mg/l of free chlorine. Chlorine application shall not stop until the entire main is filled with heavily chlorinated water. At the end of a 24-hour period, the treated water shall have a residual of not less than 10 mg/l free chlorine.
- Slug method - Calcium hypochlorite granules or tablets shall be placed in the pipe sections using the tablet method. A preliminary flushing of the water main shall then be performed to remove particles and the pipe shall be refilled with potable water. The flushing velocity shall be a minimum of 2.5 feet per second in the water main. A chlorine solution shall then be injected in the water main at a point not more than 10 feet downstream of the beginning of the new main. The chlorine solution shall be added at a constant rate such that the water shall have not less than 100 mg/l of free chlorine. The chlorine shall be applied continuously and for a sufficient period to develop a solid concentration or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of 100 mg/l for at least 3 hours. Free chlorine residual shall be measured as the slug moves through the pipeline. If the

concentration falls below 50 mg/l the flow shall be stopped and the chlorination equipment shall be located ahead of the slug. Chlorine shall be added to the slug until a concentration of 100 mg/l is obtained.

Final Flushing

Final flushing of the water main shall not commence until after required retention period for disinfection. The flushing velocity shall be a minimum of 2.5 feet per second in the water main. Heavily chlorinated water shall not remain in the water main for prolonged periods. The main shall be flushed until the chlorine measurements show the concentration in the water leaving the main is no higher than 1.0 mg/l. The environment to which the chlorinated water is to be discharged shall be inspected. If there is any question that the chlorinated discharge will cause damage to the environment, then a reducing agent shall be applied to the water to be wasted to thoroughly neutralize the chlorine residual remaining in the water. Where necessary, federal, state, and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

Testing

Testing for bacteriological safe samples shall be completed no sooner than 24 hours after final flushing and prior to placing the water main in service. The bacteriological safe samples shall be obtained in accordance with NR 810.09 (4) Wisconsin Administrative Code. If the initial disinfection fails to produce safe bacteriological samples, the main shall be reflushed and resampled. If check samples fail, the main shall be rechlorinated by the continuous-feed or slug method of chlorination until safe results are obtained.

Basis of Payment

No separate payment will be made for disinfection and flushing of water mains. All costs involved in disinfection and flushing of water mains shall be included in the unit price of the work it is associated with.

PRESSURE PIPELINE TESTING

Scope

Pressure pipeline testing includes all labor, equipment, and material as required or necessary to hydrostatically test pipelines as shown and specified.

General Requirements

Test Pressure

All pressure pipelines shall be tested, by the Contractor, and shall successfully pass a hydrostatic test composed of a pressure test and a leakage test. Pressure test gauge shall be graduated in 5 P.S.I. increments at a maximum. Working pressure is defined as follows:

- Upper Pressure Zone 2- WP, $\text{psi} = (1106 - \text{Pipeline Elevation, ft})(0.433 \text{ psi/ft})$
- Upper Pressure Zone 1- WP, $\text{psi} = (960 - \text{Pipeline Elevation, ft})(0.433 \text{ psi/ft})$
- Lower Pressure Zone - WP, $\text{psi} = (900 - \text{Pipeline Elevation, ft})(0.433 \text{ psi/ft})$

Submittals

The Contractor shall submit three copies of the results of all hydrostatic tests.

Procedure

Pipelines shall have a pressure test followed by a leakage test. If it is found unnecessary to add water to maintain pressure during the duration of the pressure test, the leakage test may, with the approval of the Engineer, be waived.

In lieu of separate leakage and pressure tests, a combination leak/pressure test can be run at a pressure of 150 psi for a duration of two hours at the discretion of the Engineer.

Pressure Test

After the test connections are made and the main filled with water, the test section shall be subjected to water pressure normal to the area. After examination of exposed parts of the system, the pressure will be increased to 150 pounds per square inch on the main at the lowest elevation. The main shall be examined and if any defects are found, the Contractor shall immediately make the necessary repairs at their own expense. The pressure test shall be repeated until no defects can be found. The duration of the final pressure test shall be one hour. If it is found unnecessary to add water during the duration of the pressure test, the leakage test may be waved at the direction of the Engineer. If waived by the Engineer, a combination leak/pressure test will be performed.

Leakage Test

The leakage test, if required, shall be conducted after satisfactory completion of the pressure test. The test section shall be subjected to approximately 100 pounds per square inch gauge pressure at the point of highest elevation of the main under test. The duration of the leakage test shall be two hours unless otherwise specified.

Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled.

Leakage for buried pipelines shall not exceed the number of gallons per hour as determined by the following formula for rubber-sealed joints during the duration of the test.

$$L = SD \times \text{square root } P / 148,000$$

L – allowable leakage in gallons per hour

S - length of pipe tested in feet

D - nominal diameter of main in inches

P - average pressure in pounds per square inch gauge

In case the section under test contains joints of various diameters, the allowable leakage will be the sum of the computed leakage for each size of joint.

Leakage for exposed piping (not buried) shall be zero throughout the duration of the test.

Should any test section fail to meet the leakage test, the Contractor shall immediately make the necessary repairs at his own expense. The duration of the final leakage test shall be one continuous hour.

Basis of Payment

No separate payment will be made for testing of pressure pipelines. All costs involved in testing of pressure pipelines shall be included in the unit price of the work it is associated with.

SITE RESTORATION

Scope

Site restoration includes all labor, materials, equipment, and services as required or necessary to replace and restore all surfaces to their original condition, after construction of utilities, that are not indicated to be removed, modified, repaired or improved, as shown and specified.

General Requirements

General

Whenever any of the work is performed on or through property other than that owned by the City, the Contractor shall furnish the City, before final acceptance of the work by the City, a written release from the owner, or proper authority acting for the owner of the property affected, stating that the restoration of structures and surfaces has been satisfactorily accomplished. If, in the opinion of the City, the release is arbitrarily withheld, the City may in its sole discretion, accept the portion of the work involved and cause final payment to be made.

Submittals

The Contractor shall submit details on the materials and methods he proposes to use for each type of surface or site.

Qualifications

Replacement and restoration shall be performed by a subcontractor regularly engaged in the type of work to be performed.

Materials

Unless noted otherwise all materials shall conform to the requirements of these specification and the applicable sections of the "State of Wisconsin Department of Transportation Standard Specifications for Road and Bridge Construction," latest edition.

Construction

General

When the work is completed on construction of pipelines and appurtenances, that portion of the surface disturbed by construction under this Contract shall be left in an equal or better condition as it was before the commencement of the work. All restoration work shall be promptly and regularly maintained in such condition for a period of one year after acceptance of the work. Maintenance work shall apply under this contract. Maintenance measures needed for ordinary wear and tear from normal use shall not be at the expense of the Contractor. All repairs required because of unsatisfactory trench backfilling, however, shall be at the expense of the Contractor.

Structures

The Contractor shall rebuild all structures removed in as good a condition as found, and shall repair all existing structures which may be damaged as a result of the work under this contract.

Curbs, Gutters, Driveways, and Sidewalks

All curbs, gutters, driveways, sidewalks, and similar structures that are broken, damaged or otherwise affected due to the Contractor's operations shall be reconstructed by the Contractor. Reconstruction shall be of the same kind of material with the same finish and in not less than the same dimensions as the original work. Repairs shall be made by removing and replacing the entire portions between joints or scores and not merely refinishing any damaged part. All work shall match the appearance of the existing improvements as nearly as possible.

Roads and Streets

All roads and streets in which the surface is removed, broken or damaged, or in which the ground has caved or settled due to work under this contract, shall be completely resurfaced to the original thickness and brought to the original grade and crown section unless otherwise indicated. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of any loose material. Cement concrete pavement shall have the entire portions between joints removed and reconstructed. Bituminous concrete shall have a minimum replacement width of 10 feet. Roadways used by the Contractor for hauling materials, equipment, supplies, or other work, shall be cleaned and repaired if the condition of the roadway is damaged or otherwise affected due to the Contractor's operations. Minimum requirements for roadway preparation and paving are specified in "Restoration of Asphalt Roadway Pavement".

Cultivated Areas and Other Surface Improvements

All cultivated areas, either agricultural or lawns, and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition, or as required by the terms of the easements or permits on file at the City. Minimum requirements for seeding are specified in "Seeding".

Waterways, Channels and Drainage Ditches

All waterways, channels, drainage ditches and similar facilities, which are damaged by actions of the Contractor, shall be restored as nearly as possible to their original condition. Where necessary, the Contractor shall provide temporary facilities or temporarily realign such watercourses to maintain a continuously serviceable facility until it is restored to its original location and condition. Restoration of such facilities shall be as shown and specified.

Basis of Payment

No separate payment shall be made for site restoration work unless noted otherwise in the proposal schedule. All costs involved in site restoration shall be included in the unit price of the work it is associated with.

ROADWAY PREPARATION

Scope

Roadway preparation includes all labor, materials, plant and equipment to construct gravel drives and parking areas and to construct all aggregate base course for paved surfaces.

General Requirements

General

Whenever any part of this specification refers to the State of Wisconsin or Standard Specification it shall be understood that it is referring to "State of Wisconsin, Department of Transportation, Division of Highways, Standard Specifications for Road and Bridge Construction," latest edition.

Submittals

The Contractor shall submit gradation results and labeled 80-pound samples of the aggregate base course and sub-base course for the Engineer's review. No material shall be used until it is accepted by the Engineer.

Materials

Aggregate Base

Materials for aggregate base course shall conform to gradation No. 2 or No. 3 of Section 304 Standard Specification. Materials for aggregate sub-base course shall conform to gradation No. 1 of Section 304 Standard Specifications.

Construction

General Drives, parking areas, and aggregate base course shall be constructed to the widths, grades, and lines shown. Thicknesses shown are for compacted material. Aggregate base course shall not be constructed until the Engineer has accepted the subgrade. Maximum variation in finished grade shall be plus or minus 0.05 feet.

Subgrade Preparation

In cut areas over which the aggregate base is to be placed, the natural subgrade shall be scarified to a depth of 6 inches and then compacted to 95 percent of the maximum dry density as determined by ASTM D1557. In fill areas, the subgrade shall be constructed of engineered fill above the stripped surface.

Aggregate Base Course

Aggregate base course shall be constructed in accordance with Section 304 Standard Specifications. Base course shall be compacted to 95 percent of maximum dry density as determined by ASTM D1557. Base course material shall be of the type and thickness shown on the drawings.

PAVING

Scope

Paving includes all labor, materials, plant and equipment to construct all bituminous concrete and portland cement concrete pavement.

General Requirements

Whenever any part of this specification refers to the State of Wisconsin or Standard Specification it shall be understood that it is referring to "State of Wisconsin, Department of Transportation, Division of Highways, Standard Specifications for Road and Bridge Construction," latest edition.

Materials

Bituminous Concrete

Materials for bituminous concrete shall conform to Standard Specification Sections 401 and 405 for the particular class type and grade of material specified. Bituminous material shall be Type AC asphalt in the 85-100 penetration grade. Aggregates shall conform to gradation No. 1 for the binder course and No. 3 for the surface course.

Portland Cement Concrete

Materials for Portland cement concrete, with or without reinforcement shall conform to Standard Specification Section 409. Steel reinforcement shall conform to Standard Specification Section 505.

Construction

General

Pavements shall be constructed to the widths, grades and lines shown. Thicknesses shown are for compacted material. The aggregate base course shall be accepted by the Engineer prior to final surfacing.

Bituminous Concrete

Bituminous concrete shall be constructed in accordance with Standard Specification Section 407. Binder course and surface course shall be of the type and thickness shown on the drawings.

Portland Cement Concrete

Portland cement concrete shall be constructed in accordance with Standard Specification Section 407. Minimum thickness shall be 6 inches.

SEEDING

Scope

Seeding shall include all labor, materials, equipment, and services necessary to topsoil, seed, and mulch the site of the work.

General Requirements

General

Whenever any part of this specification refers to the State of Wisconsin or Standard Specification, it shall be understood that it is referring to "State of Wisconsin, Department of Transportation Division of Highway, Standard Specifications for Road and Bridge Construction," latest edition.

Submittals

The Contractor shall submit supplier's grass seed data showing percent by weight of the seeding mixture and fertilizer.

Materials

Topsoil

Topsoil material shall be free of stones and consist of pulverized rich earth with no clods larger than 1" in diameter and suitable for growing grass.

Seed

The seed mixtures shall conform to mixtures No. 30 and No. 40, Section 630, Standard Specifications.

Fertilizer

Fertilizer used shall be standard commercial grade granular form with a minimum of 10 percent nitrogen, 10 percent phosphoric acid and 10 percent potash.

Mulch

Mulch material shall consist of straw or hay chopped to a length of 6 inches or less, free of noxious weed seeds and objectionable foreign materials.

Construction

Grading

Areas to be seeded shall be graded and shaped to the exact finish grade and contour as shown on the plans. Grades not indicated on the plans shall be uniformly leveled on slopes between grade points and existing finish grade. Abrupt changes in grade shall be rounded.

Lawn Areas

- Topsoil shall be placed at a minimum depth of 3 inches.
- Fertilizer shall be applied at a uniform rate of 20 pounds per 1,000 square feet.
- Seed shall be mixture No. 40 and applied at a rate of 5 pounds seed mixture per 1,000 square feet.
- Mulching shall be applied in accordance with Section 627, Standard Specifications. After mulching, the areas shall be rolled to achieve a good soil seed contact.

Unimproved Areas

- Fertilizer shall be applied at a uniform rate of 15 pounds per 1,000 square feet.
- Seed shall be mixture No. 30 and applied at a rate of 3 pounds seed mixture per 1,000 square feet.
- Mulching shall be applied in accordance with Section 627, Standard Specifications. After mulching, the areas shall be rolled to achieve a good soil seed contact.

Clean-up

Prior to final acceptance, the Contractor shall perform final weeding, rake all planted areas, and clear all debris from work site.

Basis of Payment

No separate payment will be made for seeding work. All cost involved with seeding shall be included in the work it is associated with.

ROCK EXCAVATION

Scope

Rock excavation includes all labor, materials, tools and equipment as required and necessary to loosen, load, transport and dispose of all hard solid rock and boulders larger than one (1) cubic yard.

General Requirements

Rock

Rock is any material which by actual demonstration by the Contractor cannot, in the Engineer's judgment, be reasonably excavated with standard equipment and which is in fact removed by breaking with power operated tools designed for rock excavation, or by drilling and blasting. The Engineer may waive the demonstration if the material encountered is well-defined rock.

Blasting

All blasting shall be performed in accordance with Wisconsin Administrative Code Chapter Ind. 5. All blasting operations shall be conducted by persons holding a valid Class IV or V blasters license issued by the Department of Industry, Labor and Human Relations. Proof of the blaster's license shall be submitted to the Engineer for review. When blasting is used, the Contractor shall have a seismograph available at all times, which is acceptable to the Engineer, to be used at any location designated by the Engineer. The Contractor shall secure all permits or licenses required for blasting or use of explosives.

Dust Control

The Contractor shall take all necessary precautions to minimize construction dust. All plant and equipment shall be fitted with suitable dust control devices such as continuous water spray systems or vacuum filter systems, which shall be maintained in good working order. The Engineer shall decide on the adequacy of provision and maintenance of dust control systems. When so instructed in writing by the Engineer, the Contractor shall immediately withdraw any item of plant or equipment from service and carry out all necessary additions, replacements, or repairs to the dust control systems to the satisfaction of the Engineer.

Materials

Explosives shall be fresh stable materials manufactured to the standards of the "Institute of Makers of Explosives".

Construction

Inspection and Measurement

When rock is encountered it shall be exposed by removing the material above it and notifying the Engineer in order that he may measure and record the amount of material to be removed. In lieu of exposing the rock surface, the Engineer and the Contractor may agree on a method to define the vertical limits of the rock. Any rock excavated before such measurement is made will not be paid for.

Method of Removal

After measurement of the rock the Contractor may proceed with drilling or breaking the rock with power operated tools specially designed for rock excavation. After the rock is broken it shall be loaded and disposed of unless the Engineer allows its temporary storage or reuse on site.

Use of Explosives

Use of explosives shall be avoided as far as practicable. Such blasting as must be done shall be controlled in a manner which will avoid possible shattering or loosening of materials outside of the lines to which the damages to property or injury to persons resulting from blasting or handling explosives. The Contractor shall give adequate warnings to all affected persons or adjacent property owners prior to blasting. The Contractor shall use blasting mats or other acceptable type of protective material to prevent scattering of rock fragments outside the excavation area.

Limits of Removal

Rock shall be removed to provide a minimum of 6 inches of clearance on the sides and 6 inches of clearance below all pipelines. The minimum trench width is 24 inches.

Basis of Payment

Rock excavation shall be paid for by the cubic yard in place at the unit price listed in the proposal schedule. The pay width for rock excavation in trenches shall be the pipeline outside diameter plus 12 inches but not less than 30 inches. The pay width for rock excavation in common trench construction shall be the pipelines outside diameter plus 48 inches. The pay depth for rock excavation in trenches shall be the depth from the rock surface to 6 inches below the bottom of the pipeline.

RIPRAP

Scope

Riprap includes all labor, material, equipment, and services as required or necessary to furnish, install, and maintain riprap for protection of unstable construction areas as shown and specified.

General Requirements

Submittals

The Contractor shall submit information on each type of riprap being used. The information shall include type of rock, location of rock, and a photograph of the materials.

General

Prior to construction, the source of riprap shall be inspected by the Engineer. No riprap shall be placed until it has been inspected by the Engineer.

Materials

General

Stone used for riprap shall be durable field or quarry stone of approved quality. The stone shall be sound, hard, dense, and free of seams, cracks, or other structural defects.

Light Riprap

Light riprap shall be of a size and shape acceptable to the Engineer, shall be well graded, and shall range in weight from approximately 25 to 150 pounds. Not less than 50 percent of the total volume shall consist of pieces weighing more than 60 pounds.

Construction

General

The bed for riprap shall be properly trimmed and shaped so that the finished riprap surface is of the same elevation as the adjacent surface. Whenever possible or unless specified otherwise, provide a minimum of two feet of riprap above the high water elevation.

Light Riprap

Light riprap above the water line shall be placed by hand. It should be laid with close broken joints and shall be firmly bedded into the slope and against adjoining stones by mechanical means if required. The stones shall be laid perpendicular to the slope and shall be thoroughly compacted as construction progresses. The larger stone shall be placed in the lower courses and the finished surface shall present an even, tight surface. Unless provided otherwise, light riprap shall be at least 12 inches in thickness as measured perpendicular to the slope.

Basis of Payment

Riprap will be paid for by the cubic yard in place at the unit price listed in the proposal schedule.

SACRIFICIAL ANODE BAGS

Scope

Anode bag installation includes all labor, material, equipment and services as required or necessary to furnish and Cad weld magnesium sacrificial anode bags to iron water main or fittings.

General Requirements

The contractor shall submit manufacturer's data for anode bags.

Materials

Anode Bag

Each 32-pound high-potential magnesium anode bag is to be furnished with ten lineal feet of type TW No. 12 AWG solid copper wire lead.

Copper Wire Sleeve

Copper wire sleeve is required to Cad weld copper wire lead of bag to iron water main.

747 Aerosol Primer

Primer adhesive to install handy cap.

Handy Caps

Bituminous coating to protect cad-weld on main.

Installation

Straight Pipe

Strip off approximately 1" to 1-1/2" of coating from end of wire on anode bag. Slide copper sleeve onto wire and crimp with a wire crimping tool to secure it to the wire. Copper wire sleeve and copper wire must be bright, clean and dry. Remove scale and bituminous coating on outside of iron pipe in preparation for cad-weld. Iron pipe should be bright, clean and dry. Cast iron surface must be free from large pits and flaws. Under some conditions of temperature and humidity the surface

to be welded will sweat causing porous welds. This can be eliminated by warming the surface with a hand torch prior to welding. Use #25 charge with powder marked C.I. for cast iron. Do not use regular powder. Check mold tag for material to be welded and proper cartridge size. Make sure all surfaces and conductors are clean and dry. Prepare Cad weld furnace. Inspect furnace for damage or overuse. If the combustion chamber shows signs of erosion or loss of wall thickness, it may not properly contain the weld casing a blowout to weld material. Replace the furnace when such deterioration is found. Open the door on top of furnace. Insert metal disk into bottom of furnace. Open Cad weld cartridge and dump into furnace on top of metal disk. The cartridge may have to be tapped to remove hardened powder from cartridge bottom. Close the door. Place furnace on top of pipe with slot opening, located at the bottom of the furnace, facing the anode wire. Slide end of wire into slot of furnace. Use an igniting tool or a small torch to ignite the Cad weld cartridge. Follow all safety rules for personal protection. Hold furnace on pipe until weld has solidified. The appearance of weld should match the mold of the furnace closely. Tap weld with a hammer to remove any slag and to check for a sound weld. Clean weld with a wire brush, prime and install handy cap to protect mold. If cast iron main or unwrapped ductile iron main the installation is complete. If ductile iron water main with polyethylene wrap, the main should be rewrapped with polyethylene wherever the existing wrap has been damaged or removed.

Bell & Spigot Joint or Fitting

If a pipe joint or fitting is uncovered a jumper wire will be installed across the joint with No 12 AWG copper wire Cad welded onto the pipe on each side of the pipe joint or fitting. The copper wire lead of the anode bag will be installed on this jumpered wire with a No. 8 AWG brass split bolt connector. Wire connector will be sealed with 3M Scotch Vinyl Mastic Pad and two layers of polyethylene wrap.

Testing

Electrical continuity will be tested by visual inspection of welds.

Basis of Payment

Anode bags shall be measured separately as a unit and paid for at the unit price per unit installed of the various sized bags completed and accepted in accordance with this contract. The price shall be payment in full for all materials, including anode bag, copper wire, Cad weld charges, for installing anode bag and for all labor, tools, equipment and incidentals necessary to complete and test the work in accordance to this contract.