

CITY OF CHARLOTTESVILLE, VA



GAS DISTRIBUTION SYSTEM STANDARD SPECIFICATIONS AND DETAILS

**Charlottesville Department of Public Works
305 4th Street, NW
Charlottesville, VA 22903
Telephone: (434) 970-3800
Fax: (434) 970-3817**

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GENERAL PROVISIONS

GENERAL PROVISIONS

SECTION 1. ABBREVIATIONS AND DEFINITION OF TERMS

1.01 ABBREVIATIONS

AASHTO – American Association of State Highway & Transportation Officials
AGA – American Gas Association
ANSI – American National Standards Institute
API – American Petroleum Institute
AREA – American Railway Engineering Association
ASME – American Society of Mechanical Engineers International
ASTM – American Society for Testing and Materials
AWS – American Welding Society
ca. – Circa
C.I. – Cast Iron
CMU – Concrete Masonry Unit
C.T.S. – Copper Tube Size
D.E.Q. – Department of Environmental Quality
Den. – Density
D.I. – Ductile Iron
DR – Dimension Ratio
EFV – Excess Flow Valve
FRP – Fiberglass Reinforced Plastic
Galv. – Galvanized
H – Horizontal
HDB – Hydrostatic Design Basis
HDPE – High Density Polyethylene
I.D. – Inside Diameter
I.P.S. – Iron Pipe Size
Min. – Minimum
Max. – Maximum
Mfgr. – Manufacturer
Nat. – Natural
No. – Number
O.D. – Outside Diameter
pcf – pounds per cubic feet
PI – Plasticity Index
PE – High Density Polyethylene
PPI – Plastics Pipe Institute
Press. – Pressure
psi – Pounds per Square Inch
psia – Pounds per Square Inch Absolute (Gage)
psig – Pounds per Square Inch Gage
Rel. – Relative
Reqmts. – Requirements
SCFH – Standard Cubic Feet Per Hour
SCG – Slow Crack Growth
SDR – Standardized Dimension Ratio
SMYS – Specified Minimum Yield Stress

Spec. – Specifications
Std. – Standard
TYP – Typical
V – Vertical
VDOT – Virginia Department of Transportation
VMRC – Virginia Marine Resources Center
VTM – Virginia Test Methods
" WC – Inches Water Column
WWF – Welded Wire Fabric

Whenever the specifications of the ASTM, ANSI, AASHTO, and/or API are referred to in these Standards, it shall be taken to mean the latest revised edition of such specifications, unless otherwise noted.

1.02 DEFINITIONS

Agreement – The written contract between Owner and Contractor covering the Work to be performed; other contract Documents are attached to the Agreement and made a part thereof as provided therein.

Bedding – A layer of granular material, gravel, or crushed rock immediately below and supporting a pipe or fully or partially encasing a pipe. Material existing in a trench, ditch, or tunnel, upon which conduit is placed directly, is considered to be bedding.

Bid – The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

Change Order – A written order issued by the Department of Public Works to the Contractor directing certain changes, additions, or reductions in the Work or in the materials used.

City – The City of Charlottesville, Virginia, referred to as Owner.

Contract Documents – The Contract, Contract Bond, General Conditions, Special Conditions, Specifications, and Plans, together with all Addenda, Change Orders, and Supplemental Agreements covering the project.

Contractor – The person, firm, or corporation with whom Owner has entered into the Agreement. The term shall apply to the Owner when the Owner is acting as its own Contractor.

Department of Public Works – The Department of Public Works of the City of Charlottesville, Virginia, its designated employ in charge of the project, or contracted representative.

Drainage Ditch – A natural or artificially constructed open depression for the purpose of carrying off surface water.

Drawings – The drawings which show the character and scope of the Work to be performed by the Contractor and which have been prepared or approved by the Department of Public Works and are referred to in the Contract Documents.

Easement (Right-of-Way) - A grant of a right of use of the property of an owner for a certain purpose at the will of the grantee.

Engineer – An individual, firm, association, properly qualified person, or the legally authorized representative(s), designated by the Owner, experienced in and legally qualified to practice the profession involved. The term shall apply to the Owner when the Owner is acting as its own Architect or Engineer.

Fuel Line, Sewer, Water Piping – In plumbing, the extensions from the building piping system to the public provided utility. Also called a customer-owned line.

Guarantee Period – One year following the date of final acceptance of the work by the Owner unless otherwise specified.

Inspector – The person appointed by the Director of Public Works, or his/her duly authorized representative, whose duty it is to inspect the materials used, and see that the work is performed in accordance with the Contract documents; and carry out such instructions as given him by the Engineer.

Invert – The lowest point in the internal cross-section of a pipe.

Laws and (or) Regulations – Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

Owner – The City of Charlottesville, Virginia.

Plans – The drawings which show the character and scope of the Work to be performed by the Contractor and which have been prepared or approved by the Department of Public Works and are referred to in the Contract Documents.

Public Utilities - Gas – The gas division of the City of Charlottesville, Virginia, Department of Public Works.

Right-of-Way (Easement) - A grant of a right of use of the property of an owner for a certain purpose at the will of the grantee.

Roadway – That portion of the street intended for use of vehicular traffic.

Sewer – A pipe or conduit that carries wastewater or drainage water.

Shop Drawings – All drawings, diagrams, illustrations, brochures, schedules, and other data that are prepared by the Contractor, a Subcontractor, manufacturer, supplier, or distributor which illustrate the equipment, material, or some portion of the Work.

Special Provisions – Special directions, provisions, or requirements peculiar to the project under consideration and not otherwise detailed or set forth in the specifications. Special provisions shall prevail over specifications or supplemental specifications and plans whenever in conflict therewith.

Specifications – Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

Storm Sewer – A sewer that carries storm water and surface water, street wash and other wash waters, or drainage, but excludes domestic wastewater and industrial wastes. Also called a storm drain.

Street – The whole right-of-way included between property lines, reserved for the accommodation of the traveling public, and its appertaining structures and slopes, and all ditches, channels, waterways, etc., necessary to its correct drainage.

Subcontractor – An individual, firm, or corporation having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the site.

Superintendent – The executive representative of the Contractor authorized to receive and fulfill instructions from the Department of Public Works and supervise and direct the construction.

Work – The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.

SECTION 2. GENERAL CONDITIONS

2.01 ENGINEERING AND ARCHITECTURAL GENERAL CONDITIONS

A. General.

1. The design of all natural gas mains, main extensions, and service connections shall be provided by the City of Charlottesville, Department of Public Works, Public Utilities - Gas, under the direction of the Public Utilities - Gas Engineer or by a Virginia Licensed Engineer contracted by the Department of Public Works, Public Utilities - Gas. Service piping design provided by Public Utilities - Gas shall terminate at the downstream end of the meter set. Fuel line piping from the meter to the point(s) of use within the building shall be provided by the building owner in compliance with the National Fuel Gas Code, latest edition, and all applicable state and local building codes.
2. Request for a gas main extension to service a proposed development, commercial facility, or industrial complex shall be made by the customer, or customer's authorized representative, in writing to the Public Utilities - Gas Manager in compliance with the requirements of the City of Charlottesville, Virginia, "Gas Main Extension Policy." The request will be evaluated with respect to the guidelines contained within said document (Design Requirements, Appendix A).
3. In areas where gas service currently exists, individual service connections will be made at the building owner's request. All requests for individual service connections shall be made by the building owner, or owner's authorized representative, at the Public Utilities - Gas offices.

B. Requirements for the installation of gas mains, services, and meters.

1. Upon request for gas main extension or service connections and upon approval of same by Public Utilities - Gas, design and installation of the required facilities will be provided contingent upon the following conditions being met:
 - a. Gas mains. Gas mains will be installed when the following conditions are met in the construction area:
 - (1) Grade is within 6 inches of final grade or base grade in roadways.
 - (2) Curb and gutter must be installed if gas main is going to be installed in or near the roadway.
 - (3) All sanitary sewers, drains, and storm sewers must be installed.
 - (4) A minimum below ground parallel separation of 5 feet is required from water, power, telephone, and cable TV; and a minimum below ground parallel separation of 10 feet is required from sanitary sewer.

Gas stubs will be installed for all road crossings if the developer has committed to all gas homes. Otherwise, the developer may install conduit, at the

developer's expense, for future road crossings in order to eliminate disturbing asphalt when services are installed. The developer shall furnish as-built drawings of the conduit placement or permanently mark conduit locations. Conduit will be furnished by Public Utilities - Gas.

b. Gas services. Gas services will be installed when the following conditions are met:

- (1) Grade is within 6 inches between the gas main and the meter location.
- (2) Outside of building (siding, brick, veneer, etc.) is to be finished around the meter location.
- (3) Street address, total gas connected load, and closing date (if applicable) is reported to Public Utilities - Gas.
- (4) A minimum notice of 2 weeks after final grade is established.

Any adjustment to the gas main or services after construction will be at the cost of the developer or owner and will be scheduled at the convenience of Public Utilities - Gas.

c. Gas meters.

- (1) Gas meters cannot be installed within 3 feet from fresh air intakes, electrical equipment (A/C compressors), and windows that open.
- (2) Delivered gas pressure to the customer will be 7 inches of water column. Higher delivered pressure (psig) is restricted to commercial and industrial applications and must be requested in writing (with appropriate justification) and is subject to approval by Public Utilities - Gas. Limitations to psig service include, but are not limited to, external fuel lines (as in rooftop units) and appropriate appliance regulators with an internal relief vented to the atmosphere.

2.02 GAS MAIN CONSTRUCTION DRAWING ORGANIZATION AND FORMAT

A. Drawing organization.

1. Drawings shall consist of the following types of sheets arranged in the order listed.
 - a. Cover sheet.
 - b. Index sheet (if necessary).
 - c. Plan and profile sheets.
 - d. Standard sheets and special details.
 - e. Erosion and sediment control details.

B. Sheet format.

1. All construction drawings shall be on sheets 24 inches by 36 inches.
2. The cover sheet shall contain the City's name and project description in large, distinctive letters, a vicinity map drawn on a scale of 1 inch = 2000 feet to indicate the general vicinity of the contemplated construction, an index to the plan sheets, and a signed stamp of the design engineer or person responsible for the design. The vicinity map shall include a North arrow and a scale.
3. A plan index map shall be prepared for all pipeline projects. The index map shall be to a scale of not less than 1 inch = 600 feet, and shall show all proposed utilities with tie-ins to existing utilities. The lines of the proposed construction, together with proposed utility structures, shall be indexed to the drawings to indicate the extent of coverage on each drawing, or, in the case of structures, to the group of drawings involved.
4. Plan sheets, as well as plan and profile sheets, shall show horizontal, vertical, and topographical data.
5. All plans shall bear a suitable title showing the City's name and project title. The plans shall also show the scale in feet, the North arrow, the date, and the name of licensed professional responsible for preparation of the plans. Each plan sheet shall bear the same general title identifying the overall project, and shall be numbered.

C. Drafting conventions.

1. Industry standard symbols should be used for drawings where applicable. When standard symbols are not used, a symbol key shall be included in the drawing set. Existing facilities shall be differentiated from new facilities.
2. Standard symbols—proposes facilities: Symbols shall be as noted above except that solid lines shall be used for pipes, line weight shall be no lighter than 0.024 inches and no heavier than 0.031 inches.
3. Text, dimensions and notes: Lettering shall be consistent and clear with a minimum height of 0.125 inches (1/8 inch). The larger size lettering type shall have proportionately wider line widths. When drawings are prepared using computer-aided drafting (CAD), the minimum text height shall be 0.10 inches.

D. Drawing standards.

1. All plans shall comply with the format and quality control requirements of the Public Utilities - Gas Standards. Plans that do not meet these criteria will not be acceptable for review.
2. Plans submitted for review shall be direct blue line or black line prints. Photocopies or telefacsimile reproductions will only be accepted for information or preliminary review purposes.

3. Drawings shall be clear and legible. Text shall be readable when drawings are reduced to half size.
 4. The contrast of the printed material shall be high, with blank areas being as white as possible, and all information being as dark as practicable, while remaining clear and distinct.
 5. Shading, such as on plan views for paving, shall not be used on the drawings where it will hide any information when the drawing is photocopied or scanned. For areas that need to be identified or highlighted, stippling or cross-hatching may be used, provided no other information is hidden.
- E. Additional information.
1. Horizontal scale in plan and profile sheets shall be no smaller than 1 inch = 50 feet.
 2. Vertical profile scale shall be no smaller than 1 inch = 10 feet.
 3. A bar scale shall be included on each sheet.
 4. All known existing structures and utilities, both above and below ground, which might interfere with the proposed construction, particularly water mains, sewer mains, gas mains, storm drains, utility service lines, etc., shall be shown in plan and profile. Approximate locations shall be noted as such.
 5. Benchmarks shall be set no more than 500 feet apart along the lines of construction but outside the limits of construction. Datum for elevations shown shall be USGS (United States Geographic System) Mean Sea Level.
 6. Drawings shall show off-site easements required and identify deed book and page number.
 7. Drawings shall show all property lines bordering the proposed work area. Property owners shall be identified.
 8. Project specifications (construction manual) shall be in the Construction Specifications Institute (CSI) 16-Division format. Specification sections contained herein shall be incorporated into the contract manual.
 9. All sub-surface investigations, including test bores, reports, etc., utilized in the design shall be incorporated into the contract manual.
 10. "As constructed" drawings shall be prepared and delivered to Public Utilities - Gas by the designer based on information provided by the Contractor. "As constructed" drawings are to be in AutoCAD ".dwg" format acceptable to Public Utilities - Gas.

2.03 CONTRACTOR GENERAL CONDITIONS

General Conditions of the Contract entitled, _____, published by _____ and as amended by Supplemental Conditions shall be made a part of the Contract documents and shall apply to all Contractors and Subcontractors.

All Contractors and Subcontractors will be held to have examined and made themselves familiar with the articles of the General Conditions and the modifications and Supplemental Conditions thereof.

END OF SECTION

DESIGN REQUIREMENTS

DESIGN REQUIREMENTS

1.01 GENERAL REQUIREMENTS -- PIPING

- A. The gas distribution system currently maintained by Public Utilities - Gas provides natural gas to customers located in the City of Charlottesville and selected areas within Albemarle County. Public Utilities - Gas will provide gas service to customers within these areas in accordance with City ordinances and the policies established by Public Utilities - Gas. Gas main extensions or enlargements required to meet a specific demand or to extend the service area will be handled in accordance with the City's "Gas Main Extension Policy."
- B. All gas lines shall be located in:
 - 1. Legally established road rights-of-way; or
 - 2. Legally established permanent easements for such purpose, either existing or as proposed by the designer.
 - 3. Legally as allowed by City Code.
- C. Alignment shall be along the centerline of rights-of-way or easements except when this location has been previously used by any other utility. Exception to this specified location will be allowed only when it can be established that it is not practical to adhere to the standard location. Minimum horizontal separation of 5 feet between the gas main and other utilities should be maintained where practicable.
- D. Gas mains shall be located a minimum of 10 feet horizontally from any part of a building, structure, or its foundation.
- E. All piping to be used for new or replacement gas lines shall be either steel or polyethylene. Steel pipe shall be used for all gas lines operating at pressures above 100 psig.

1.02 GENERAL DESIGN CRITERIA -- PIPING

- A. The designer shall consider the following factors in preparing piping layout:
 - 1. Topography of the area.
 - 2. Location of other utilities.
 - 3. Groundwater elevations.
 - 4. Sub-surface conditions.
 - 5. Possible future structure locations.
- B. Design of a gas piping system consists of three basic steps: (1) select a pipe with the correct pressure capability; (2) choose a pipe size adequate for the required flow; and (3) evaluate the pipe's ability to function when properly installed. The following guidelines are typical considerations when designing a pipe system:

- Evaluate the system's flow requirements to determine the pipe size.
- Determine pipe wall thickness to meet the project's pressure requirements.
- Verify the pipe's ability to function under planned installation conditions. Examples include burial calculations, thermal effects, etc.
- Adjust the pipe wall thickness as required for external loads.
- Review the final pipe size and wall thickness to meet flow, pressure, and external load requirements when the system is installed and operated as designed.

C. Design flow.

1. The design flow for new mains or main extensions to service proposed developments, commercial facilities, industrial complexes, or other large users is to be based on the maximum estimated gas demand provided by the customer or customer's authorized representative requesting said main or main extension plus any additional flow as determined by the Public Utilities - Gas Engineer for servicing the area traversed by the new main or main extension.
2. The design flow for services is to be based on the maximum estimated gas demand provided by the customer or customer's representative or builder. Said demand is to be based on actual appliance requirements. In the event actual appliance requirements are not known or available, the maximum demand can be estimated from tables provided as part of the **National Fuel Gas Code** or related handbooks.

D. Pipe size selection.

1. The selection of pipe size is dependent on four design criteria: (1) required maximum gas flow rate; (2) length of pipe and equivalent length at all fittings; (3) allowable pressure drop over the specified length of pipe; and (4) initial line pressure. Current design practice utilizes the empirically derived rational gas flow formula or one of its variants for determination of minimum pipe size.
2. The **National Fuel Gas Code Handbook** lists the use of the following variant of the rational gas flow formula for solutions of gas flow problems:

For line pressures ≥ 1.5 psi:

$$Q = (2237)(D^{2.623}) \left[\frac{(P_1^2 - P_2^2)(Y)}{(Cr)L} \right]^{0.541}$$

For line pressures < 1.5 psi:

$$Q = (2313)(D^{2.623}) \left[\frac{\Delta H}{(Cr)L} \right]^{0.541}$$

where: Q = Flow rate (cfh)
D = Pipe I.D.
P₁ = Initial line pressure (psia)
P₂ = Final line pressure (psia)
Y = Super-expansibility factor = 1/compressibility factor
Cr = 0.00354 ST (Z/S)^{0.152}
S = Specific gravity
T = Absolute temperature
Z = Viscosity
L = Pipe length (ft.)
ΔH = Pressure drop (" WC)

3. The Weymouth formula, presented below, is a commonly used empirical formula for solution of high pressure gas flow problems.

$$Q = 28(d^{2.667}) \left[\left[\frac{(P_1^2 - P_2^2)}{(S)(L)} \right] \left[\frac{520}{T} \right] \right]^{0.5}$$

where: Q = Flow rate (cfh)
d = Pipe I.D.
P₁ = Initial line pressure (psia)
P₂ = Final line pressure (psia)
S = Specific gravity = 0.6
L = Pipe length (mi.)
T = Absolute temperature

4. The Mueller formula, also a commonly used variant of the rational gas flow formula, is presented in Appendix B.
5. Tables and graphs for the solution of the above equations, or similar variants, can be found in the **National Fuel Gas Code** and various handbooks for a variety of line pressures and allowable pressure drops. The tables and graphs applicable to the City's distribution system are included in Appendix C.

1.03 STEEL PIPING DESIGN

- A. All steel mains and services shall be designed to operate at stresses below 20 percent specified minimum yield stress (SMYS) for the pipe being used. Minimum wall thickness shall be as specified for standard weight (Schedule 40) pipe.
- B. All steel pipe shall be either seamless or electric resistance welded.

C. Pressure design formula for steel pipe.

1. The design pressure for steel pipe is determined in accordance with the following formula:

$$P = \frac{2(S)(t)(F)(E)(T)}{D}$$

P = Design pressure (psig)

S = Yield strength of pipe (psi). If yield strength is unknown, a maximum of 24,000 psi may be used.

D = Nominal outside diameter of the pipe (in.)

t = Nominal wall thickness of the pipe (in.)

E = Longitudinal joint factor: Equals 1.00 for seamless and electric resistance welded pipe. For other pipe classes reference 49 CFR 192.113.

T = Temperature de-rating factor

F = Design factor

- a. Except as otherwise provided in paragraphs (1), (2), and (3) of this section, the design factor F to be used in the design formula is determined in accordance with the following table:

Class Location	Design Factor (F)
1	0.72
2	0.60
3	0.50
4	0.40

Class locations are as defined in 49 CFR 192.5. See Appendix D.

- (1) A design factor of 0.60 or less must be used in the design formula for steel pipe in Class 1 locations that:
- (a) Crosses the right-of-way of an unimproved public road, without a casing;
 - (b) Crosses without a casing, or makes a parallel encroachment on, the right-of-way of either a hard surfaced road, a highway, a public street, or a railroad;
 - (c) Is supported by a vehicular, pedestrian, railroad, or pipeline bridge; or
 - (d) Is used in a fabricated assembly, (including separators, mainline valve assemblies, cross-connections, and river crossing headers) or is used within 5 pipe diameters in any direction from the last fitting of a fabricated assembly, other than a transition piece or an elbow used in place of a pipe bend which is not associated with a fabricated assembly.
- (2) For Class 2 locations, a design factor of 0.50, or less, must be used in the design formula for uncased steel pipe that crosses the right-of-way of a hard surfaced road, a highway, a public street, or a railroad.

- (3) For Class 1 and Class 2 locations, a design factor of 0.50, or less, must be used in the design formula for:
 - (a) Steel pipe in a compressor station, regulating station, or measuring station; and
 - (b) Steel pipe, including a pipe riser, on a platform located offshore or in inland navigable waters.

b. The temperature de-rating factor (T) is determined in accordance with the following table:

Gas Temperature	Temperature De-rating Factor (T)
250° F (121° C) or less	1.000
300° F (149° C)	0.967
350° F (177° C)	0.933
400° F (204° C)	0.900
450° F (232° C)	0.867

1.04 POLYETHYLENE PIPING DESIGN

A. Design pressure. Subject to the limitations noted below, the design pressure for plastic pipe is determined in accordance with the following formula:

$$P = \left[\frac{2(S)}{(SDR - 1)} \right] 0.32$$

where:

P = Design pressure (psig)

S = The long term hydrostatic strength determined in accordance with the listed specification at a temperature equal to 73°F (23°C), 100°F (38°C), 120°F (49°C), or 140°F (60°C)

SDR = Standard dimension ratio

1. The design pressure may not exceed a gauge pressure of 689 kPa (100 psig) in accordance with 49 CFR 192. Design pressures in excess of 60 psig will be with the approval of the Public Utilities - Gas Engineer.
- B. The minimum SDR shall be 11 unless approved otherwise by the Public Utilities - Gas Engineer.
 - C. Polyethylene pipe may not be used where operating temperatures of the pipe will be below -20°F, or above the temperature at which the long-term hydrostatic strength used in the design formula is determined.

1.05 BURIED PIPELINE DESIGN CONSIDERATIONS

A. General.

1. Buried pipelines are subject to external loading as well as internal pressure loads. External loads include the weight of the backfill above the pipe, the weight of the water table saturating the soil, vehicular traffic, nearby structures, temporary surface loads, or any combination of these loads. All buried piping must be designed to withstand the imposed external loads assuming no internal pressure exists. For design purposes, a distinction is usually made between rigid and flexible pipes. The piping materials acceptable to Public Utilities - Gas, e.g., steel and polyethylene, are considered flexible.
2. For flexible pipelines, the resistance to external loading is derived from the wall strength of the pipe and the strength of the soil envelope surrounding the pipe. Because of the interactions of flexible pipe with the surrounding soil, the nature of the embedment materials and the quality of their placement are important to the development of a satisfactory pipe/soil system. During this development, some pipe deflection is a natural and essential response that produces balanced soil support through the entire pipe circumference. However, to safeguard the performance capabilities of the pipe, it is necessary to conduct the installation so that the initial and ultimate deflections will not produce excessive wall stressing that results in loss of volumetric flow capacity, endangers structural stability, or affects joint performance.

For buried flexible pipe, the DR of the pipe and the strength of the soil envelope must be specified to keep the three burial design parameters (wall crushing, wall buckling, and ring deflection) within acceptable limits.

3. For pipes installed per recommended practices, maximum permissible ring deflection will generally be the controlling design criteria. Consequently, the key objective and primary consideration in the selection and installation of buried flexible pipe is deflection control. The ring deflection of flexible pipe can be calculated by using the properties of the pipe and the measured compressibility of the soil. As the pipe deflects with the soil, it forms a very slight ellipse by decreasing in the vertical diameter an amount, ΔY , and by increasing in the horizontal diameter an almost equal but slightly less amount, ΔX . The horizontal diametrical increase further compacts the fill at the sides of the pipe, developing lateral support. The vertical decrease in diameter relieves the pipe of vertical soil pressure concentrations and forces the soil to support the major share of the vertical load by arching action over the pipe.
4. Deformation of buried flexible pipe becomes critical when the pipe reaches that point of ring deflection beyond which it can no longer resist any increase in soil loading. By limiting ring deflection through proper soil compaction, the loading over a pipe is distributed through the soil and across the soil arch around the pipe.
5. The total load impressed upon a buried pipe is the sum of the embedment load plus superimposed loads. Embedment loads per lineal dimension of pipe can be estimated by knowing the type of backfill, the trench dimensions, and the pipe diameter. For non-cohesive, granular materials, the load may be reduced by 10 percent. The load should be increased by 30 percent for dry clay and by 40 percent for wet clay.

B. Deflection calculation.

1. Flexible pipe deflection under earth loading can be calculated using the following equation:

$$\Delta X = \frac{(D)(K)(W)(r^3)}{(E)(I) + 0.061(E')(r^3)}$$

where

ΔX = Pipe deflection (in.)

D = Deflection lag factor: range 1.25 to 1.50

K = Bedding constant

W = Imposed load per lineal inch (lb/in.)

r = Outside radius of pipe (in.)

E = Modulus of elasticity of pipe material

I = Moment of inertia per unit length of pipe cross section

E' = Modulus of soil reaction

- a. The bedding constant, K, is dependent on the angle subtended by the pipe bedding as listed below:

Bedding Angle (Degrees)	K
0	0.110
30	0.108
45	0.105
60	0.102
90	0.096
120	0.090
180	0.083

- b. The modulus of soil reaction, E', varies widely based on soil type and level of compaction. For uniform soil fill throughout trench depth, the values for E' in Figure 1, Appendix E, may be used.

For typical trench installations where bedding and initial backfill are specified and final backfill is typically the excavated soil, the use of the E' values in Table 1, Appendix E, should be used relative to the specified laying condition.

- c. The imposed load per lineal inch, W, consists of the soil embedment load plus all surcharge loads. The imposed load/in. can be calculated from the following equation:

$$W = \frac{(c)(d)(OD)(\gamma)}{144} + (OD) (\text{surcharge loads})$$

where:

d = Depth of cover (ft.)

OD = Pipe outside diameter (in.)

γ = Soil density (lb./cf); for design purposes $\gamma = 120$ pcf

c = For soils with significant clay content, c = 1.3; otherwise c = 1.0
surcharge loads (psi)

- d. Surcharge loads can result from a wide variety of temporary or permanent loading conditions. Among the most common are earth fills, surface water (e.g., streams, rivers, etc.), vehicular loading (H-20), railroad loading (E-80), and building foundation loads.
- (1) Graphs for the determination of vehicular H-20 loading and railroad E-80 loading are included in Appendix E.
 - (2) Earth fill loading can be calculated as follows:

$$F = \frac{(d)(OD)(\gamma)}{144}$$

Variables are as noted in (c) above.

- (3) Surface water loading equals the maximum depth of water in feet times 0.43 psi.
 - (4) When buried pipelines are located in the vicinity of buildings, additional loading on the buried pipeline due to the building can be minimized by locating the pipeline a distance away from the building exterior wall equal to the depth of the bury of the pipeline plus 2 feet. Where this minimum separation cannot be maintained, the impact of the building footer load on the pipe must be considered. The designer is referred to any good text on soil mechanics for methods of computation.
2. The design percent deflection for flexible pipe is defined as the calculated deflection times 100 divided by pipe O.D. Design values for polyethylene pipe can be found in Appendix E. For steel pipe, 3 percent deflection should be used.

- C. Proper pipe embedment and backfill is essential for achieving proper support for flexible pipe. The designer is referred to Appendix F for a discussion of embedment and backfill material.
- D. Minimum cover. Minimum depth of cover for gas mains shall be 24 inches, measured from established finish grade to the top of pipe. Where heavy off-road truck or locomotive traffic exists, minimum cover shall be 36 inches. All service lines shall have a minimum cover of 24 inches if exposed to vehicular traffic, or 12 inches where no overland traffic exists.

1.06 STREAM CROSSINGS

- A. Installation method selected should be the least expensive for size of pipe and existing soil conditions.
- B. Pipeline shall pass under the streambed with 48 inches minimum separation from bottom of streambed to top of pipe.
- C. The designer is reminded that specific requirements of the Army Corp of Engineers, DEQ, and/or VMRC may apply to any stream crossing. A joint permit application may be filed with VMRC for review by these agencies.

1.07 ROADWAY CROSSINGS AND WITHIN ROADWAY RIGHTS-OF-WAY

- A. Pipeline installation within roadway rights-of-way shall be with approval of the authority having jurisdiction. Method of installation selected should be the least expensive and least disruptive to traffic. Encasement in a steel casing pipe shall be done only at the direction of the governing authority. Where encasement is required, casing pipe shall be sealed at each end with the requirements at vents to be determined by the Public Utilities – Gas Engineer.
- B. Where crossings are required to be bored or jacked, said crossings are to be in compliance with the requirements of the governing authority and Detail Drawing GG 3.0.
- C. Depth of cover shall be as required by the authority having jurisdiction, or 36 inches minimum.

1.08 RAILROAD CROSSINGS AND WITHIN RAILROAD RIGHTS-OF-WAY

- A. Pipeline installation within railroad rights-of-way are subject to the approval and requirements of the operating railway company. Crossings are to be by boring or jacking, and are to comply with the requirements of the railway and Detail Drawing GG 3.1. All crossings shall be encased in steel pipe with sealed ends and vents.
- B. Selection of carrier pipe material shall be as required by the railway.
- C. Depth of cover shall be as required by the railroad, or 5 feet minimum.

1.09 DISTRIBUTION LINE VALVES

- A. Valves should be located at intersections of gas mains as determined by the Public Utilities – Gas Engineer.
- B. Each high-pressure distribution system must have additional valves spaced so as to reduce the time to shut down a section of main in an emergency. The valve spacing shall be determined with due consideration to operating pressure, the size of the mains, and the local physical conditions.
- C. Each regulator station controlling the flow or pressure of gas in a distribution system must have a valve installed on the inlet piping at a distance from the regulator station sufficient to permit the operation of the valve during an emergency that might preclude access to the station.
- D. Each valve on a main installed for operating or emergency purposes must comply with the following:
 - 1. The valve must be placed in a readily accessible location so as to facilitate its operation in an emergency.
 - 2. The operating stem or mechanism must be readily accessible.

1.10 SIZING OF GAS SERVICES

- A. The sizing of gas services shall be governed by the maximum expected instantaneous demand, the length of the service, and the allowable pressure drop for the particular class of service. Any excess capacity provisions should be substantiated by competent data or information secured from a reliable source.

- B. Graphs and tables to assist the designer in selecting proper service pipe sizes are provided in Appendix C.

1.11 METER SELECTION

A. General.

1. Commonly used meters can be grouped into two categories: (1) displacement type, and (2) rate-of-flow type. Displacement type meters include diaphragm, rotary lobed impeller, and rotary vane meters. Rate-of-flow, or velocity, type meters include turbine and orifice meters. Turbine and orifice meters are generally reserved for high capacity applications.
2. Displacement type meters.
 - a. Diaphragm meters. Diaphragm meters are the most commonly used type of meter, being applicable for services ranging from residential to relatively high industrial and commercial installations.
 - b. Rotary meters are positive displacement meters capable of metering large load demands. They can operate under variable load conditions and meter gas at any delivery pressure. However, consideration must be given to the selection of a rotary meter for use on a low-pressure service where the meter is subject to sudden variations from maximum to minimum loads. *Rotary meters should not be used where the minimum load is less than 10 percent of the meter's rated capacity.*
3. Rate-of-flow type meters.
 - a. Turbine meters are relatively lightweight in-line meters that can be used for large capacities. The rangeability of this type of meter increases with increased metering pressure. Each installation must be individually engineered and designed under the supervision of the Public Utilities - Gas Engineer.
 - b. Orifice meters are generally restricted to very large gas flows such as power plants, town border stations, etc., where the cost of other meters would be prohibitive. Due to the varying design requirements, all installations of orifice meters must receive special engineering consideration. Orifice meters will not handle large fluctuations in pressure and capacity. Variations in loads should be less than a 3:1 ratio for a single orifice.
4. It may at times be expedient to combine meters of various types in order to secure meter accuracy at minimum loads and yet provide for economical large volume metering. Orifice meter installations with multiple orifices of varying size may also be used. These combinations of meters should be engineered individually under the supervision of the Public Utilities - Gas Engineer.

B. Selection.

1. Meter selection shall be made with regard to load demand, operating pressure, and maximum pressure exposure. Meters shall not be exposed to pressures in excess of the manufacturer's recommended working pressure or 67 percent of the manufacturer's case test pressure, whichever is lower.

2. Meter capacities. Meters must be sized to carry expected loads within the allowable pressure drops for rated capacity as specified by the manufacturer. On low-pressure systems, the pressure drop through the meter shall not exceed 1/2" WC. On medium-pressure and higher pressure systems where the pressure is regulated to 6" WC, the drop through the meter shall not exceed 1" WC, except for meters of 800 cfh capacity or greater where the pressure drop shall not exceed 2" WC.
3. Tables located in Appendix G are offered to assist the designer in the selection of an appropriate meter. The tables are intended as a guide and should not be used without further study when selecting the best meter for a particular application.

Meters currently in use by Public Utilities - Gas can be found in Appendix G.

4. When replacing an existing meter, the replacement meter shall be rated at the same capacity at the same pressure drop as the meter being replaced. Where meter replacement is required due to an increase in demand resulting from building renovations, meter selection shall be as required for a new installation.

END OF SECTION

APPENDIX A.

CITY OF CHARLOTTESVILLE, VIRGINIA

GAS MAIN EXTENSION POLICY

SECTION 1: GENERAL STATEMENT OF POLICY.

It is the policy of the City that gas main extensions and/or enlargements shall provide an adequate return to the City. The Gas Division Superintendent, or a person or persons duly authorized by the Gas Division Superintendent, shall determine whether gas mains shall be extended or enlarged, and shall approve or reject written applications for extensions and/or enlargements of gas mains based upon a variety of factors including, but not limited to, a financial test which compares reasonably projected non-gas revenues from the extension and/or enlargement to construction costs for the extension or enlargement (as further described below), an assessment of the impact of the extension or enlargement on existing City streets and rights of way, a determination as to whether the extension and/or enlargement serves the public interest, and any other relevant factors.

SECTION 2: FINANCIAL TEST FOR PROPOSED EXTENSIONS.

- A. The maximum investment in each proposed gas main extension and/or enlargement will be the net present value of estimated non-gas revenue over five years, using a minimum rate of return and an annual inflation rate specified by City Council on a periodic basis.
- B. The current minimum rate of return over five years specified by City Council pursuant to Section 4 is 10%, the assumed inflation rate is 5%. The resulting annual non-gas revenue multiplier is 4.15.
- C. Non-gas revenue is defined as total sales revenue net of all taxes less the cost of gas sold. Non-gas revenue may also be referred to as gross profit, operating margin or contribution to operations.
- D. The maximum main extension investment and potential required customer contribution, if any, for each project can be determined as follows:

1. ESTIMATED MAXIMUM MAIN EXTENSION INVESTMENT

ESTIMATED ANNUAL NON-GAS REVENUE		_____
TIMES: NON-GAS REVENUE MULTIPLIER	[x]	<u>4.15</u>
EQUALS: ESTIMATED MAXIMUM INVESTMENT	[=]	_____

2. POTENTIAL REQUIRED CUSTOMER CONTRIBUTION

ESTIMATED PROJECTED COST		_____
LESS: ESTIMATED MAXIMUM INVESTMENT	[-]	_____
EQUALS: POTENTIAL REQUIRED CUSTOMER CONTRIBUTION	[=]	_____

E. The Gas Division Superintendent shall identify and establish target areas, i.e., areas that have the best potential for future growth in gas sales, in the City's service area.

If a proposed expansion project is not located within a designated target area, only identified and committed gas sales will be used to estimate annual gas sales and the maximum city investment. Committed gas sales are potential sales to a customer that has agreed to purchase gas from the City.

If a proposed expansion project is located within a target area, the revenue estimate may include an estimate of additional sales, in addition to committed gas sales, that may be reasonably expected over the next five years.

F. If the estimated cost of the project exceeds the maximum investment as calculated in subsection D above, a potential customer may meet the financial test for a gas main extension by agreeing to compensate the City in one of the following four ways:

1. Capital Contribution By Customer.

A potential customer may make a non-refundable capital contribution of the projected cost that is in excess of the maximum investment.

2. Refundable Deposit

A potential customer may make a refundable deposit equal to the full cost of the project. At the end of each of the first five years, the maximum investment, based on actual non-gas revenue for the year for that main, will be re-determined. All non-gas revenue in excess of the re-determined required contribution will be refunded to the customer, not to exceed the total deposit. No interest will be paid on the deposit. Any deposit balance remaining after the fifth year will be forfeited as a non-refundable capital contribution.

3. Construction By Customer.

The customer may elect to build and finance the main extension, using City approved contractors and subject to City approval of all facets of the extension. Upon completion, ownership of the main will be transferred to the City. The Director of Public Works and the Director of Finance may but are not required to enter into an agreement to reimburse the customer as new gas load is connected to the extension.

4. Performance Bond.

The customer may, with the concurrence of the Gas Division Superintendent and the City Attorney, agree to reimburse the City for the cost of the extension in the event that the customer fails to purchase gas from the City at an agreed to level for a period of five (5) years from the date of completion of construction. The customer must provide a performance bond or other adequate surety to reimburse the City for all costs associated with the extension, if the customer fails to purchase gas at the required levels.

SECTION 3: PROJECT EVALUATION.

Requests for extensions and/or enlargements shall be in writing and shall contain the name and address of the applicant and a description of the anticipated use for natural gas. If possible, the written request should contain the estimated amount of gas that will be used by the customer on an annual basis.

Each written request shall be evaluated on an individual basis. In determining whether to grant a request for an extension and/or enlargement, the Gas Division Superintendent, or a person or persons duly authorized by the Gas Division Superintendent, shall consider all relevant factors including, but not limited, to the following:

1. a description of the project;
2. an estimate of the cost of the main extension and/or enlargement;
3. an estimate of the annual non-gas revenue attributable to construction of the extension or enlargement, including an explanation of the assumptions used to estimate revenues;
4. if applicable, an analysis of the details relating to performance bonds and probable contract terms;
5. a review of operational and customer service impacts;
6. a review of the impact of the proposed extension and/or enlargement on the existing City streets and rights of way;
7. an assessment as to whether sufficient funds are available to make the extension and/or enlargement;
8. a determination as to whether the proposed extension and/or enlargement serves the public interest; and
9. a review of any recommendation prepared by Gas Division staff.

All projects estimated to cost over \$100,000 must be reviewed prior to approval by the Director of Finance and the Director of Public Works.

An application for an extension and/or enlargement may be rejected even if the financial test is met if the Gas Division Superintendent, or a person or persons duly authorized or appointed by the Gas Division Superintendent, determines that the proposed extension and/or enlargement would negatively impact existing City streets and rights of way or would detrimentally impact the public interest in any other fashion.

SECTION 4: REVIEW OF MAIN EXTENSION POLICY.

The City Council may review periodically the main extension policy.

SECTION 5: WAIVER.

The Director of Public Works, or a person or persons duly authorized or appointed by the Director of Public Works, may waive any of these requirements, except those in Section 4.



GAS FLOW THROUGH PLEXCO POLYETHYLENE PIPE

Flow formulas for smooth pipe may be used to compute the gas flow rate through PLEXCO polyethylene pipe. The smooth surface of extruded PLEXCO polyethylene pipe resists scale deposits and corrosion, and minimizes friction losses due to roughness. Joint turbulence in PLEXCO polyethylene piping systems is minimal with socket and butt fusions having normal sized beads. Joint turbulence is further minimized when using coiled PLEXCO polyethylene pipe (3" or smaller) due to increased distance between fusions. The following is the Mueller formula for high pressure installations of smooth pipe carrying gas at pressures greater than 1 psig.

$$Q_h = \frac{2971 \cdot d^{2.725}}{G^{0.425}} \left[\frac{h_1 - h_2}{L} \right]^{0.575}$$

Where h_1 = inlet pressure, inches of water
 h_2 = outlet pressure, inches of water

For further information on flow of natural gas in plastic pipe, see the A.G.A. PLASTIC PIPE MANUAL FOR GAS SERVICE.

LOSSES DUE TO FITTINGS OR BENDS

Gas flowing through a valve, tee, ell or bend will experience a pressure drop, due to disturbances and swirling caused by the fitting or bend. In the design of piping systems, the usual method of handling this pressure drop is to express the friction loss through the fitting as an equivalent length of pipe having the same friction loss. The total friction loss in the system is then calculated on the sum of the linear feet of pipe and the equivalent lengths of fittings.

Below are approximate equivalent lengths for various PLEXCO fittings.

$$Q_h = \frac{2826 \cdot d^{2.725}}{G^{0.425}} \left[\frac{P_1^2 - P_2^2}{L} \right]^{0.575}$$

Where: Q_h = gas flow rate (std. cu. ft. per hr.)
 G = specific gravity of gas (air = 1.0 nat. gas = 0.65)
 P_1 = pipe inlet pressure (psi absolute)
 P_2 = pipe outlet pressure (psi absolute)
 L = length of pipe (feet)
 d = pipe internal diameter (inches)

For applications where pressures of less than 1 psig are encountered, such as landfill gas gathering, the following Mueller formula for low pressure gas may be used:

APPROXIMATE FRICTION LOSS IN EQUIVALENT FEET OF PIPE												
NOMINAL PIPE SIZE	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
90 DEGREE ELL	6'	8'	12'	18'	35'	44'	52'	57'	65'	73'	81'	97'
45 DEGREE ELL	3'	4'	5'	8'	10'	12'	14'	15'	18'	20'	22'	26'
TEE SIDE OUTLET	12'	16'	22'	32'	38'	53'	62'	69'	79'	89'	98'	118'
TEE STRAIGHT OUTLET	4'	5'	7'	10'	13'	16'	19'	20'	23'	26'	29'	35'

PLEXCO polyethylene pipe is not recommended for the transport of compressed air or other compressed gases in exposed or above ground installations. PLEXCO PE pipe may be used for compressed gas service when buried underground or encased in shatter-resistant materials.

APPENDIX C.

PIPE CAPACITY TABLES

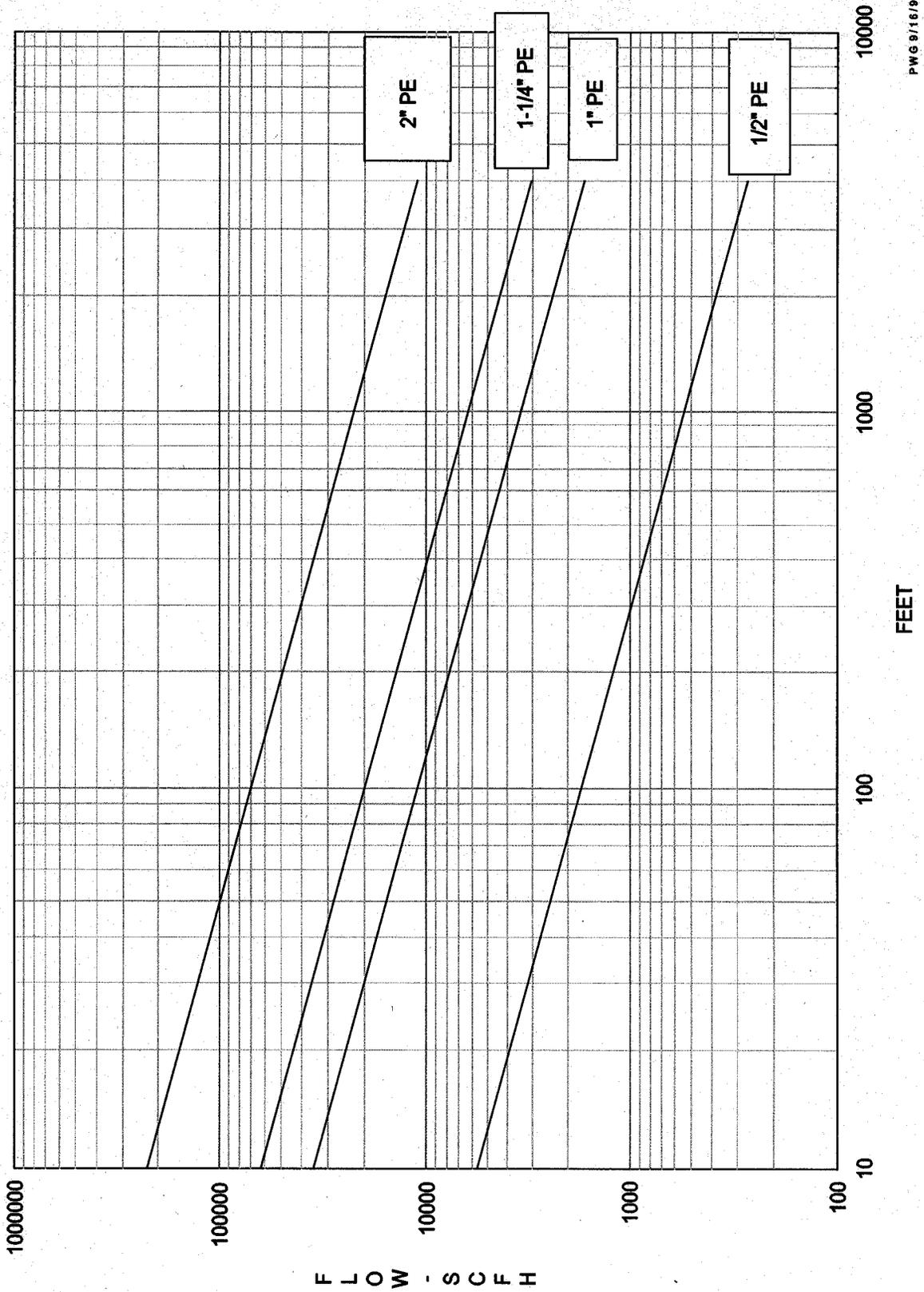
Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for
 Gas Pressures of 0.5 psi or Less and a Pressure Drop of 0.5 in. Water Column
 (Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size (in.)	Internal Diameter (in.)	Length of Pipe (ft.)													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	0.364	43	29	24	20	18	16	15	14	13	12	11	10	9	8
3/8	0.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
1/2	0.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
3/4	0.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1-1/4	1.380	1400	950	770	660	580	530	490	460	430	400	360	325	300	280
1-1/2	1.610	2100	1460	1180	990	900	810	750	690	650	620	550	500	460	430
2	2.067	3950	2750	2200	1900	1680	1520	1400	1300	1220	1150	1020	950	850	800
2-1/2	2.469	6300	4350	3520	3000	2650	2400	2250	2050	1950	1850	1650	1500	1370	1280
3	3.068	11000	7700	6250	5300	4750	4300	3900	3700	3450	3250	2950	2650	2450	2280
4	4.026	23000	15800	12800	10900	9700	8800	8100	7500	7200	6700	6000	5500	5000	4600

Pipe Sizing Table for 2 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths
 In Cubic Feet per Hour for an Initial Pressure of 2.0 psi
 With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

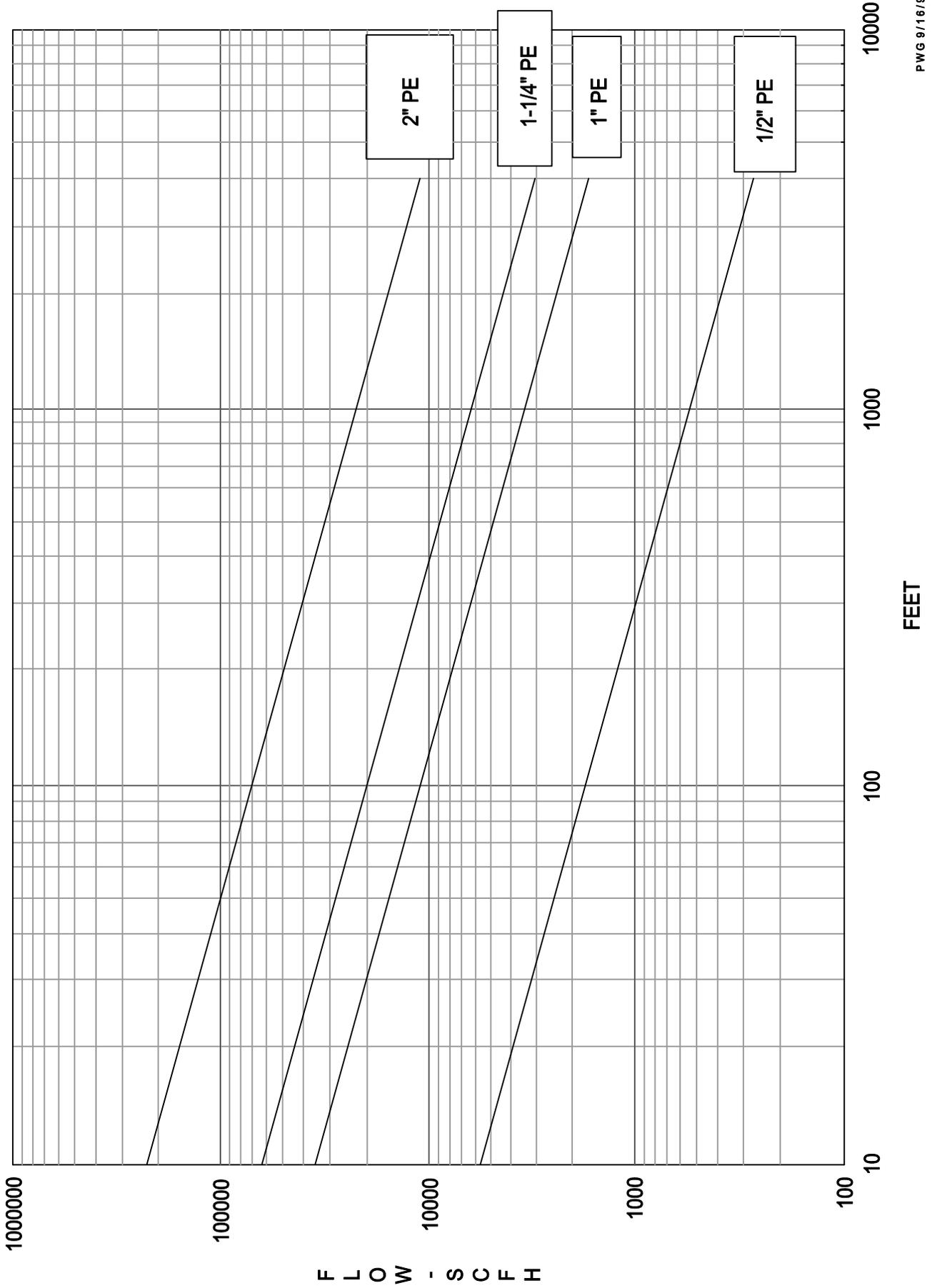
Pipe Size of Schedule 40 Standard Pipe (in.)	Internal Diameter (in.)	Total Equivalent Length of Pipe (ft.)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1112	764	614	525	466	422	361	320	220	177	151
1.25	1.380	2283	1569	1260	1079	956	866	741	657	452	363	310
1.50	1.610	3421	2351	1888	1616	1432	1298	1111	984	677	543	465
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896	1303	1046	896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022	2077	1668	1427
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342	3671	2948	2523
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821	5375	4317	3694
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895	7488	6013	5147
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711	13547	10879	9311
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917	21936	17616	15077
8.00	7.981	227906	156638	125786	107657	95414	86452	73992	65578	45071	36194	30977
10.00	10.020	413937	284497	228461	195533	173297	157020	134389	119106	81861	65737	56263
12.00	11.938	655315	450394	361682	309553	274351	248582	212754	188560	129596	104070	89071

CAPACITY OF PE PIPE
 Weymouth Formula
 90 PSI W / 10% PRESS. DROP



PWG 9/16/94

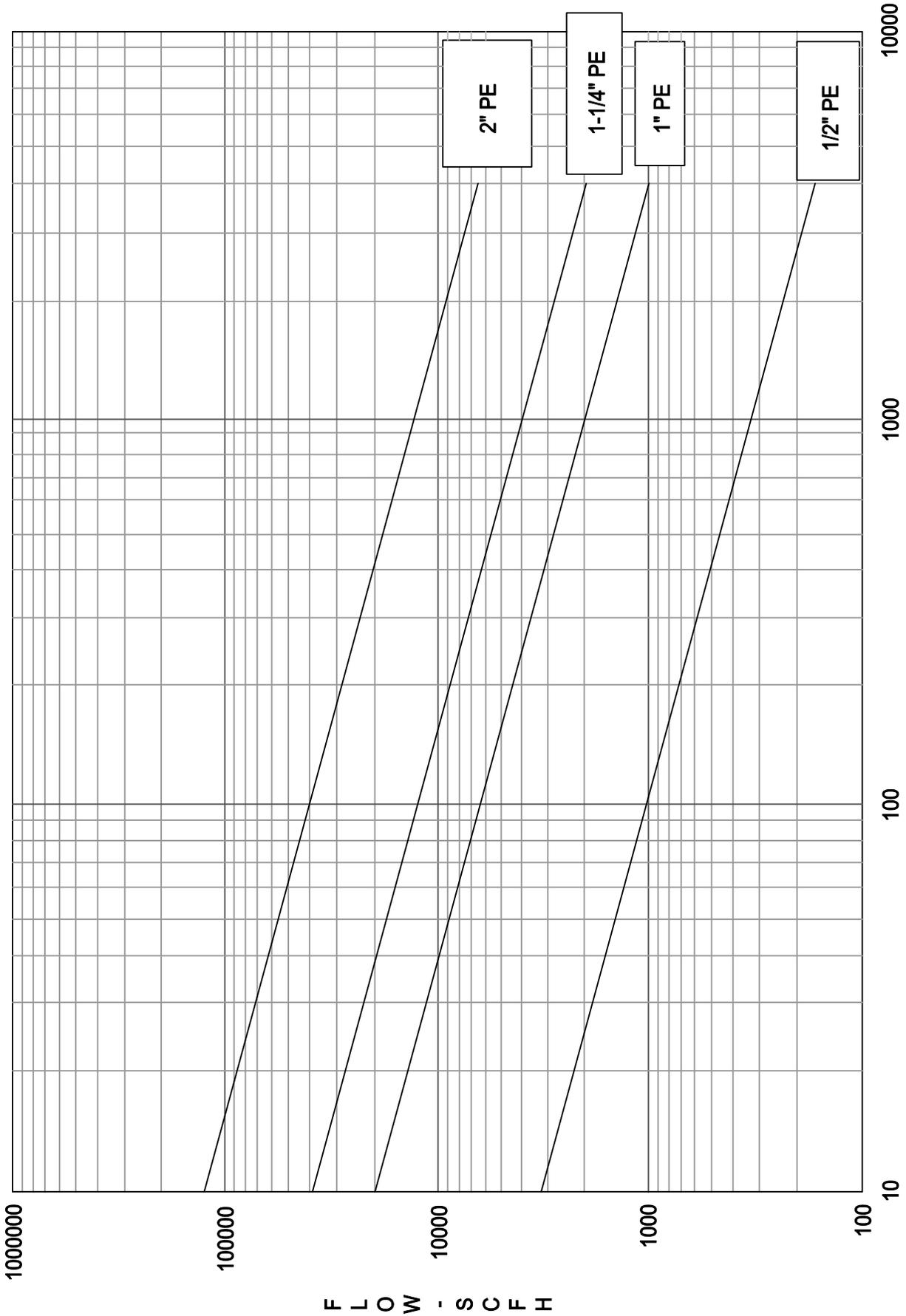
CAPACITY OF PE PIPE
 Weymouth Formula
 90 PSI W / 10% PRESS. DROP



F L O W - S C F H

Design Requirements - C3

CAPACITY OF PE PIPE
 Weymouth Formula
 50 PSI W / 10% PRESS. DROP



APPENDIX D.

49 CFR 195.5 – CLASS LOCATIONS

§192.5 Class locations.

- (a) This section classifies pipeline locations for purposes of this part. The following criteria apply to classifications under this section.
 - (1) A “class location unit” is an onshore area that extends 220 yards (200 meters) on either side of the centerline of any continuous 1- mile (1.6 kilometers) length of pipeline.
 - (2) Each separate dwelling unit in a multiple dwelling unit building is counted as a separate building intended for human occupancy.
- (b) Except as provided in paragraph (c) of this section, pipeline locations are classified as follows:
 - (1) A Class 1 location is:
 - (i) An offshore area; or
 - (ii) Any class location unit that has 10 or fewer buildings intended for human occupancy.
 - (2) A Class 2 location is any class location unit that has more than 10 but fewer than 46 buildings intended for human occupancy.
 - (3) A Class 3 location is:
 - (i) Any class location unit that has 46 or more buildings intended for human occupancy; or
 - (ii) An area where the pipeline lies within 100 yards (91 meters) of either a building or a small, well-defined outside area (such as a playground, recreation area, outdoor theater, or other place of public assembly) that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period. (The days and weeks need not be consecutive.)
 - (4) A Class 4 location is any class location unit where buildings with four or more stories above ground are prevalent.
- (c) The length of Class locations 2, 3, and 4 may be adjusted as follows:
 - (1) A Class 4 location ends 220 yards (200 meters) from the nearest building with 4 or more stories above ground.
 - (2) When a cluster of buildings intended for human occupancy requires a Class 2 or 3 location, the class location ends 220 yards (200 meters) from the nearest building in the cluster.

- (3) A Class 3 location is:
 - (i) Any class location unit that has 46 or more buildings intended for human occupancy; or
 - (ii) An area where the pipeline lies within 100 yards (91 meters) of either a building or a small, well-defined outside area (such as a playground, recreation area, outdoor theater, or other place of public assembly) that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period. (The days and weeks need not be consecutive.)
 - (4) A Class 4 location is any class location unit where buildings with four or more stories above ground are prevalent.
- (c) The length of Class locations 2, 3, and 4 may be adjusted as follows:
- (1) A Class 4 location ends 220 yards (200 meters) from the nearest building with 4 or more stories above ground.
 - (2) When a cluster of buildings intended for human occupancy requires a Class 2 or 3 locations, the class location ends 220 yards (200 meters) from the nearest building in the cluster.

APPENDIX E.

PIPE DEFLECTION CALCULATIONS



ESTIMATED DEFLECTION

$$\% \text{ deflection} = \frac{\text{Calculated deflection} \times 100}{\text{Outside diameter of pipe}}$$

$$x = \text{calculated deflection}$$

$$X = \frac{K \times D \times W}{(0.149 \times PS + 0.061 \times E')}$$

$$W = \frac{DC \times OD \times SD}{144} + (\text{Soil Pressure}^{1/} \times O.D.)$$

$$PS = \frac{E \times I}{0.149 \times R^3}$$

- Where
- OD = Outside diameter of pipe (inch)
 - K = Bedding Factor = 0.1
 - D = Deflection Lag Factor = 1.5
 - W = Weight per lineal inch (#/inch)
 - PS = Pipe Stiffness (PSI)
 - E = Soil Modulus (see figure 1)
 - E' = Flexural Modulus (PSI)
(133,000 psi for PE3408)
(100,000 psi for PE2406)
 - DC = Depth of cover (feet)
 - SD = Soil Density (#/ft³)
 - SDR = Standard Dimensional Ratio
 - t = Average Wall Thickness (inch)
- $$t = \frac{OD \times 1.06}{SDR}$$
- I = Moment of Inertia = t³/12
 - R = Mean Radii of the pipe (inch)
- $$R = \frac{(OD - t)}{2}$$

Safe design limits for the allowable deflection of polyethylene pipe of different dimension ratios have been determined¹ and are given below:

Dimension Ratio (SDR)	Safe Deflection as % of Diameter
32.5	8.5
26.0	7.0
21.0	6.0
17.0	5.0
11.0	3.0
9.0	2.5

EXAMPLE

As an example, assume a PLEXCO 12" SDR 11 PE3408 polyethylene pipe is to be buried 25 feet in the ground. This pipe is to be buried in a coarse grained soil with little or no fines and compacted to a proctor density of 90%. From Figure 1 a value of 2000 psi is obtained for E1. Soil density is assumed to be 120#/ft³.

$$\begin{aligned} OD &= 12.75 \text{ inches} \\ t &= (12.75 \times 1.06)/11 = 1.229 \\ I &= (1.229)^3/12 = 0.1547 \\ R &= (12.75 - 1.229)/2 = 5.761 \\ PS &= (133,000 \times 0.1547)/(0.149 \times 5.761^3) \\ &= 722.4 \\ W &= (25 \times 12.75 \times 120)/144 = 265.6 \\ X &= \frac{1.5 \times 0.1 \times 265.6}{(0.149 \times 722.4) + (0.061 \times 2000)} \\ X &= 0.173 \text{ inch deflection} \end{aligned}$$

$$\% \text{ deflection} = \frac{0.173 \times 100}{12.75} = 1.36\%$$

Since 1.36% is less than the allowable 3.0%, this would be an adequate burial situation.

^{1/} Soil Pressure due to live loading. See Figures 2 and 3.

The method presented for calculating deflection represents one of many methods and should be adequate in most cases. However, when special installation conditions exist, other methods of calculating deflection may need to be used. The final design is left to the discretion of the responsible engineer.

Figure 1
Bureau of Reclamation Values of E' for Iowa Formula
(For Initial Flexible Pipe Deflection)

Soil type-pipe bedding material (Unified Classification System ^{2/})	E' for degree of compaction of bedding (lb/in ²) ^{5/}			
	Dumped	Slight <85% Proctor <40% rel. den.	Moderate 85-95% Proctor 40-70% rel. den.	High >95% Proctor >70% rel. den.
<u>Fine-grained Soils (LL>50)</u> ^{3/} Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent Soils Engineer: Otherwise use $E' = 0$			
<u>Fine-grained Soils (LL<50)</u> Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
<u>Fine-grained Soils (LL<50)</u> Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles <u>Coarse-grained Soils with Fines</u> GM, GC, SM, SC ^{4/} contains more than 12% fines	100	400	1,000	2,000
<u>Coarse-grained Soils with Little or No Fines</u> GW, GP, SW, SP ^{4/} contains less than 12% fines	200	1,000	2,000	3,000
<u>Crushed Rock</u>	1,000	3,000		

^{2/} ASTM Designation D2487, USBR Designation E-3.

^{3/} LL = Liquid limit.

^{4/} Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC.).

^{5/} 1 lb/in² = 0.07 kg/cm².

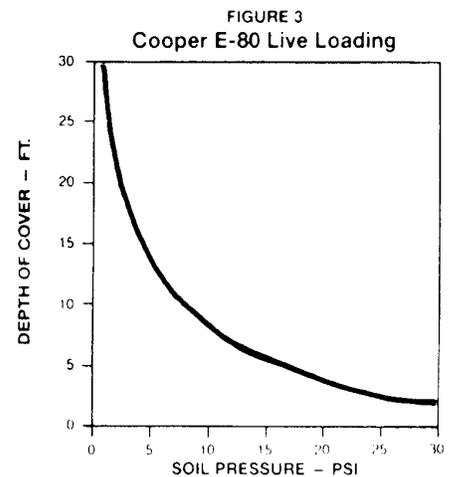
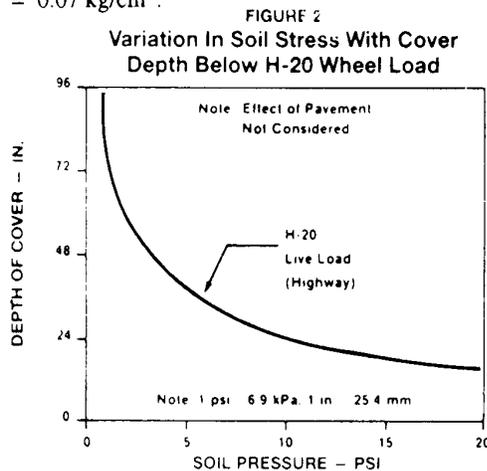
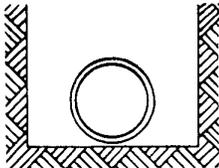
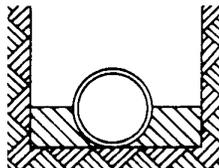
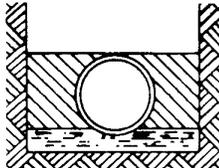
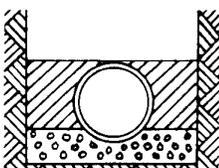
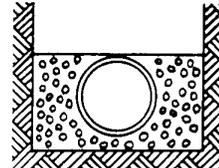


Table 1
Design Values for Standard Laying Conditions

Laying Conditions	Description	E ¹	Bedding Angle	K _b	K _x
 <p>Type 1*</p>	Flat-bottom trench.† Loose backfill.	150	30°	0.235	0.108
 <p>Type 2</p>	Flat-bottomed trench.† Backfill lightly consolidated to centerline of pipe.	300	45°	0.210	0.105
 <p>Type 3</p>	Pipe bedded in 4-in. minimum loose soil.†† Backfill lightly consolidated to top of pipe.	400	60°	0.189	0.103
 <p>Type 4</p>	Pipe bedded in sand, gravel or crushed stone to depth of 1/8 pipe diameter, 4-in. minimum. Backfill compacted to top of pipe. (Approximately 80% Standard Proctor AASHTO T-99.)	500	90°	0.157	0.096
 <p>Type 5</p>	Pipe bedded in compacted granular material to centerline of pipe. Compacted granular or select†† material to top of pipe. (Approximately 90% Standard Proctor, AASHTO T-99.)	700	150°	0.128	0.085

* For 14-in and larger pipe, consideration should be given to the use of laying conditions other than Type 1

† "Flat-bottom" is defined as undisturbed earth.

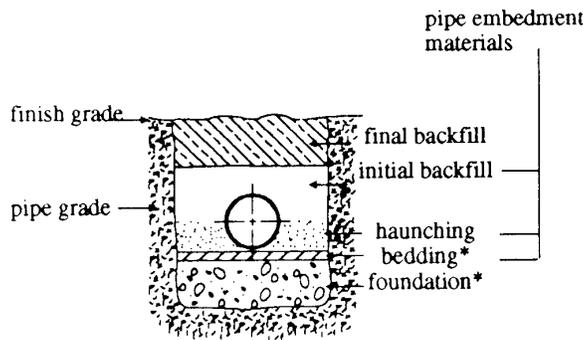
†† "Loose soil" or "select material" is defined as native soil excavated from the trench, free of rocks, foreign materials and frozen earth.

Pipe Embedment and Final Backfilling

Pipe embedment and final backfilling should be carried out so that each zone indicated in Figure 1 is in accordance with the recommendations given herein or as specified by the engineer.

Unless otherwise specified by the engineer, the haunching and initial backfilling should be performed before any leakage test. The backfilling should be completed following a satisfactory test. In all cases, the haunching and initial backfill material should be placed and compacted to provide support as specified by the engineer.

Figure 1 - Trench Construction & Terminology



* in suitable soils the construction of a bedding and/or a foundation may not be required.

Soils for Pipe Embedment

To achieve a satisfactory installation of pipe, it is essential to embed the pipe with bedding, haunching, and initial backfill materials (see Figure 1) of characteristics that provide stable and permanent support to the conduit. Soils have been grouped into five broad classes according to their suitability as embedment materials. This grouping with descriptions of soil type (GW, GP, etc.) as per ASTM D-2487, "Standard Method for Classification of Soils for Engineering Purposes," is:

Class I - Angular crushed stone, maximum size of particle, 40mm (ca. 1-1/2 inches), including materials of regional significance such as marl, coral, crushed shells, cinders, and slag.

Class II - Naturally occurring gravels and coarse sands, containing minimum fines, maximum size of particles 1-1/2 inches, and non-cohesive when wet or dry. These include soil types GW, GP, SW, and SP.

Class III - Naturally occurring fine sands, and mixtures of gravel-clay or sandy clay, including soil types GM, GC, SM, and SC.

Class IV - Very fine soils such as silt, silty-clay, lean clay, and organic clays having a liquid limit of less than 50%, including soil types ML, CL, and OL.

Other soils, such as clays of high plasticity, or having a liquid limit of more than 50%, or containing such a high organic content as soil types MH, CH, OH, or PT are not categorized by the preceding classification system as they are not recommended for bedding, haunching, or initial backfill. If their use is unavoidable, expert engineering guidance should be obtained as to how they should be used and what additional supporting structures may be required.

Class I and II materials should preferably be used for bedding (if required), haunching, and initial backfill. For 6" and smaller conduit, maximum particle size should be 1/2". Care should be taken to insure that haunching material is well placed under the haunches of the conduit and that, in the process, the conduit is not disturbed. The initial backfill should be placed in 6" layers and extend to at least 6" above the top of the conduit. Embedment materials should be compacted as specified by the design engineer.

Class III materials may also be used in the embedment zone. When so used they should be compacted as specified by the engineer, which generally will be to not less than 80% Proctor density as determined by the AASHTO Method T99 for compaction and density of soils. This may normally be accomplished by walking on soil placed in 6-inch layers or by hand-tamping same with wooden tampers.

Class IV materials should be used only with the specific approval of the engineer who will determine their acceptability, depending on the ease of placement and compaction of the particular materials under consideration.

Final Backfill

General - The final backfill, unless otherwise specified, may consist of the excavated material provided it is free of unsuitable matter, such as lumps of clay, stones, construction debris, boulders, (stones over 8 inches in their longest dimension) and frozen clods.

Final Backfill Under Roads - Trenches in the right-of-way of a road should be backfilled to finished grade with an approved granular material to a compaction density of 95% or as specified by the engineer.

APPENDIX G.

Summary of Gas Meter Selection Factors

Meter Type	GAS PROPERTIES				METER CHARACTERISTICS					
	Maximum Pressure (psig) ¹	Flowing Fluid Temperature Limits (°F)	Suitability for Corrosive Gas	Influence of Condensate	Base Maximum Capacity Range (Mcfh)	Accuracy % of Reading 10 50 90	Base Rangeability	Type of Scale	Common Construction Materials ²	Pressure Loss at Base Maximum Capacity (psi)
Diaphragm displacement	1000	-30 to +140	No	Potential	0.2 to 12	±1	200:1	Uniform	AL/CI/Brass/ Plastic/Zinc alloy	0.02 to 0.07
Rotary rotating vane	1440	-40 to +145	Yes (with special bearings and materials)	None	3 to 38	±1	25:1	Uniform	Anodized AL/ 300 SS/ Steel/Bronze	0.04
Rotary lobed impeller	1440	-40 to +140	Yes (with special bearings and materials)	None	1.5 to 102	±1	20:1	Uniform	AL/CI/Steel	0.07
Gas turbine	1440	-40 to +145	Yes (with special materials)	None	4 to 150	±1	5:1 to 25:1	Uniform	AL/DU/CS	0.04
Orifice	5000	-65 to +500	Yes	Potential	22 to 1500	±1-1/2	3:1 to 4-1/2:1	Square root	FS/SS/CS	2.5

Meter Type	INSTALLATION FACTORS				ECONOMIC FACTORS				
	Normal Line Size (in.)	Straight Pipe Reqmts. (No. of Pipe Diameter)	Ambient Temperature Range (°F)	Limitations	Approx. First Cost ³	Life Expectancy		Maintenance Cost ⁴	Installation Cost ⁴
						Between Repairs (Years)	Total (Years)		
Diaphragm displacement	1/4 to 4	None	-30 to +140	Horizontal	220	8 to 10	30 to 40	L	M
Rotary rotating vane	2 to 6	None	-40 to +145	Not critical	130	3 to 6	10 to 25	M	L
Rotary lobed impeller	1-1/2 to 10	None	-40 to +140	Horizontal and leveled	150	3 to 6	10 to 25	M	L
Gas turbine	2 to 12	4 to 10	-40 to +145	Horizontal	125	3 to 6	10 to 25	M	L
Orifice	2 to 16	3 to 40	-40 to +170	Horizontal	100	1 to 3	10 to 15	H	M

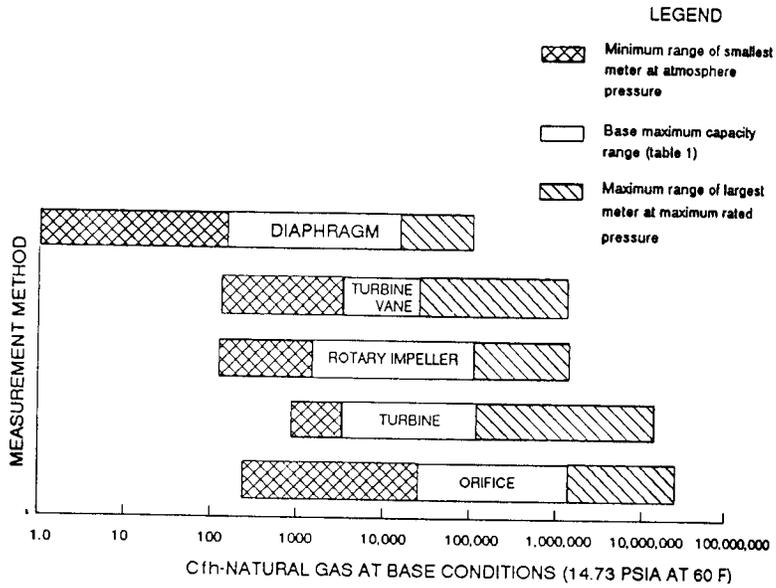
1 Refer to manufacturer's published literature for the maximum rating of a specific meter size.

2 Common construction materials: AL = Aluminum CI = Cast iron
 CS = Cast steel DU = Ductile iron
 FS = Forged steel SS = Stainless steel

3 First cost ratio is based upon a 2-in. orifice meter sized to measure approximately 5 Mcfh at atmospheric pressure.

4 Maintenance and installation costs: H = High M = Medium L = Low

Graphical Gas Measurement Meter Capacities



METER CAPACITIES

Diaphragm Meter Capacities
(Meters Currently Available)

DIAPHRAGM METERS						METER CAPACITY – C.F.H.							
SIZE	CODE	MFGR **	CASE	PRESS RATING P.S.I.	CONNECTION	DIFFERENTIAL			ELEVATED PRESSURE				
						1/2" W.C.	1" W.C.	2" W.C.	2 P.S.I.	10 P.S.I.	20 P.S.I.	50 P.S.I.	90 P.S.I.
175		A,N,R,S	AL.	5	1" 20 LT.	175			175				
200		R	AL.	5	1" 20 LT.	200			200				
225		A	AL.	5	1" 20 LT.	225			225				
250		A	AL.	5	1" 20 LT.	250			250				
415		R	AL.	10	1-1/4" 30 LT.	415	635		690				
425		A	AL.	10	1-1/4" 30 LT.	425	650		700				
675		S	AL.	25	1-1/2" 45 LT.	675	915		1430	1970	2450		
750		R	AL.	20	1-1/2" 45 LT.	750	1150		1730	2400	3000		
800		A	AL.	20	1-1/2" 45 LT.	800	1200		1840	2500	3200		
800		R	AL.	100	1-1/2" 45 LT.	800	1150		1730	2400	3000	5100	7280
1000		S	AL.	25	2" SPR-US	1000		2040	2210	3100	3800		
1000		A,R	AL.	100	2" MPT-US	1000		2200	2380	3300	4100	6700	9400
1400		A	AL.	100	3" FLG.	1400		3000	3250	4500	5600	9000	12700
3000		R	AL.	100	3" FLG.	1450		3000	3250	4500	5600		
2300		A	AL.	100	4" FLG.	2300		5000	5420	7500	9400	15000	21400
5000		R	AL.	100	4" FLG.	2500		5000	5420	7500	9400		
250B		A	AL.	100	4" FLG.	3000		6000	6500	9000	11200	18000	26400
250B		A	I.C.	75	4" FLG.	3000		6000	6500	9000	11200		
AL 5000		A	AL.	100	4" FLG.	5000		11000	11900	16500	20500	33000	46800
10000		R	AL.	100	4" FLG.	5000		10000	10840	15000	18600		

** A = American, N = Superior, R = Rockwell, S = Sprague

**Rotary and Turbine Meter Capacities
(Meters Currently Available)**

ROTARY AND TURBINE METERS						METER CAPACITY – C.F.H.			
SIZE	CODE	MFGR **	CASE	PRESS RATING P.S.I.	CONNECTION	LOW PRESSURE	ELEVATED PRESSURE		
							2 P.S.I.	10 P.S.I.	20 P.S.I.
1.5M 125		C	I.C.	125	1-1/2" N.P.T.	1500	1650	2550	3450
1.5M 125		C	I.C.	125	1-1/2" N.P.T.	1500	1650	2550	3450
R-3		R	I.C.	125	2" FLG.	3000	3300	5100	6900
3M 125		C	I.C.	125	2" FLG.	3000	3300	5100	6900
3M 125		C	I.C.	125	2" FLG.	3000	3300	5100	6900
5M 125		C	I.C.	125	3" FLG.	5000	5500	8500	11500
5M 125		C	I.C.	125	3" FLG.	5000	5500	8500	11500
7M 125		C	I.C.	125	3" FLG.	7000	7700	11900	16100
7M 125		C	I.C.	125	3" FLG.	7000	7700	11900	16100
11M 125		A	I.C.	125	3" FLG.	11000	12100	18700	25300
11M 125		C	I.C.	125	4" FLG.	11000	12100	18700	25300
11M 125		C	I.C.	125	4" FLG.	11000	12100	18700	25300
16M 125		C	I.C.	125	4" FLG.	16000	17600	27200	36800
23M 125		C	I.C.	125	6" FLG.	23000	25300	39100	52900
38M 125		C	I.C.	125	6" FLG.	38000	41800	64600	87400
56M 125		C	I.C.	125	8" FLG.	56000	61600	95200	128800
102M 125		C	I.C.	125	10" FLG.	102000	112200	173400	234600
4" TURBO		A	AL.	125	4" FLG.	16000	17600	27200	36800
4" TURBO		R	AL.	125	4" FLG.	18000	19800	30600	41400
6" TURBO		A	AL.	125	6" FLG.	30000	33000	51000	69000
6" TURBO		R	AL.	125	6" FLG.	30000	33000	51000	69000
8" TURBO		A	AL.	125	8" FLG.	60000	66000	102000	138000
8" TURBO		R	AL.	125	8" FLG.	60000	66000	102000	138000
10" TURBO		R	AL.	125	10" FLG.	140000	154000	238000	322000

** A = AMERICAN, C = ROOTS, R = ROCKWELL

Diaphragm Meter Capacities
(Currently Used But Not Purchased)

DIAPHRAGM METERS						METER CAPACITY – C.F.H.					
SIZE	CODE	MFGR **	CASE	PRESS RATING P.S.I.	CONNECTION	DIFFERENTIAL			ELEVATED PRESSURE		
						1/2" W.C.	1" W.C.	2" W.C.	2 P.S.I.	10 P.S.I.	20 P.S.I.
5B		A	I.C.	10	1" M.P.T.	175					
1A		S	I.C.	5	1A SPR.	175					
275		R	AL.	5	20 L.T.	275					
310		R	AL.	5	20 L.T.	310					
10B		A	I.C.	10	20 L.T.	300					
#2		S	I.C.	5	1" M.C.	305					
25B		A	I.C.	10	1-1/4" M.C.	400	610		610		
#3		S	I.C.	5	1-1/2" M.C.	400	610		610		
#4		S	I.C.	5	1-1/2" M.C.	675	950		950		
35B		A	I.C.	15	1-1/2" M.C.	650	1000		1630	2250	
#5		S	I.C.	5	2" M.C.	850	1300		1950		
#2-1/2		R	I.C.	20	2" F.P.T.	950		2000	2160	2990	
#3		R	I.C.	20	3" F.P.T.	1250		2500	2710	3700	
#4		R	I.C.	75	4" F.P.T.	2500		5000	5420	7500	9400
#4-1/2		R	I.C.	75	4" F.P.T.	3500		7000	7590	10500	13000
75		A	ST.	5	5 LT.	75					
210		N	ST.	5	10 LT.	210					
5B		A,R,N	TIN	1/2	5 LT.	150					
5M		A,R,N	TIN	1/2	5 LT.	210					
10B		A,R,N	TIN	1/2	10 LT.	300					
20B		A,R,N	TIN	1/2	20 LT.	450					
30B		A	TIN	1/2	30 LT.	600					
30M		A	TIN	1/2	30 LT.	900					
60B		A	TIN	1/2	60 LT.	1300					
25C		A	TIN	1/2	2-1/2 M.P.T.	2500					
40C		A	TIN	1/2	3" M.P.T.	4000					

** A = AMERICAN, N = SUPERIOR, R = ROCKWELL, S = SPRAGUE

Rotary Meter Capacities
(Currently Used But Not Purchased)

ROTARY METERS						METER CAPACITY – C.F.H.			
SIZE	CODE	MFGR **	CASE	PRESS RATING P.S.I.	CONNECTION	LOW PRESSURE	ELEVATED PRESSURE		
							2 P.S.I.	10 P.S.I.	20 P.S.I.
4 x 8		C	I.C.	125	4" FL.	8500	9210	12700	15800
3-1/2 x 10		C	I.C.	60	4" FL.	9000	9750	13500	16800
4 x 12		C	I.C.	60	4" FL.	12500	13500	18700	23300
5 x 10		C	I.C.	125	4" FL.	15500	16800	23200	28900
6 x 10		C	I.C.	125	6" FL.	18500	20050	27700	34500
5 x 15		C	I.C.	60	6" FL.	23000	24930	34400	42800
8 x 12		C	I.C.	125	8" FL.	30000	32520	45000	55900
6 x 18		C	I.C.	60	8" FL.	33000	35770	49500	61500
10 x 15		C	I.C.	125	10" FL.	55000	59620	82400	102500
8 x 24		C	I.C.	60	10" FL.	60000	65040	89900	111800
10 x 30		C	I.C.	60	12" FL.	110000	119240	164900	204900
14 x 21		C	I.C.	125	12" FL.	110000	119240	164900	204900

** C = ROOTS

Orifice Capacity in C.F.H.

ORIFICE OR DRILL SIZE MINIMUM OPENING	MINIMUM PRESSURE IN MAIN – P.S.I.													
	2	5	8	10	12	15	20	25	30	35	40	50	60	70
1/8" (0.125)	100	125	175	195	205	230	260	275	285	310	315	320	360	370
1/4" (0.250)	150	240	300	335	365	410	475	530	585	665	740	875	1010	1150
3/8" (0.375)	340	540	680	760	830	930	1070	1200	1310	1500	1625	1950	2250	2250
1/2" (0.500)	600	950	1200	1350	1480	1650	1900	2130	2325	2650	2920	3500	4050	4575
5/8" (0.625)	960	1490	1880	2100	2310	2575	2980	3330	3640	3900	4200	4700	5125	5500
3/4" (0.750)	1360	2150	2700	3035	3310	3710	4290	4780	5250	5610	6050	6740	7400	7900
7/8" (0.875)	1840	2920	3680	4140	4525	5060	5850	6500	7150	7650	8250	9150	10080	10750
1" (1.000)	2350	3750	4725	5250	5800	6400	7500	8400	9100	9900	10500	11500	12500	13500
1-1/8" (1.125)	3000	4750	5950	6600	7300	8200	9500	10500	11500	12500	13000	14500	16000	17500
1-1/4" (1.250)	3700	5900	7400	8300	9100	10200	11500	13000	14000	15500	16500	18000	20000	21000
1-3/8" (1.375)	4500	7150	9000	10000	11000	12000	14000	16000	17500	18500	20000	22000	24000	26000
1-1/2" (1.500)	5300	8500	10600	11800	13000	14500	17000	19000	20000	22000	23000	26000	29000	31000
1-5/8" (1.625)	6300	10000	12000	14000	15500	17000	20000	22000	24000	26000	28000	31000	34000	36000
1-3/4" (1.750)	7200	11500	14400	16200	17500	19500	23000	25000	28000	30000	32000	35000	39000	42000
1-7/8" (1.875)	8200	13000	16300	18300	20000	22000	26000	29000	31000	34000	36000	40000	44000	47000
2" (2.000)	9400	15000	18800	21100	23000	25000	30000	33000	36000	39000	42000	46000	50000	54000

NOTE: LOW PRESSURE SERVICE FITTINGS SHOULD BE DRILLED FULL OPENING.

COMPILED USING ABOUT 25% OF MAIN PRESSURE FOR PRESSURE DROP
(1-4-74 R F L)

APPENDIX H.

UNIFIED SOIL CLASSIFICATION CHART

Major Divisions		Group Symbols	Typical Names	Classification Criteria		
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels 50% or more of coarse fraction retained on No. 4 sieve	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	Not meeting both criteria for GW	
			GP			Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below A-line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits plot above A-line and plasticity index greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 sieve	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	Not meeting both criteria for SW	
			SP			Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below A-line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above A-line and plasticity index greater than 7	
	Fine Grained Soils 50% or more passes No. 200 sieve	Silt and Clays Liquid limit 50% or less	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	Plasticity Chart For classification of fine-grained soils and fine fraction of coarse-grained soils, Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols. Equation of A-line: $PI = 0.73(LL - 20)$	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
OL			Organic silts and organic silty clays of low plasticity			
MH			Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
Silt and Clays Liquid limit greater than 50%		CH	Inorganic clays of high plasticity, fat clays	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols.	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols	
		OH	Organic clays of medium to high plasticity			
Highly organic soils		PT	Peat, muck, and other highly organic soils	Visual Manual Identification, See ASTM Designation D 2488.		

SPECIFICATIONS

DIVISION 2 – SITE WORK

SECTION 02100

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Contractor shall provide all labor, equipment, materials, and incidentals necessary to perform all clearing and grubbing within the limits of work as shown on the Drawings and specified herein.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.
- B. Section 02270, Erosion and Sediment Control.
- C. Section 02280, Loaming and Seeding.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 CLEARING

- A. The area to be cleared and grubbed shall be completely cleared of all timber, brush, stumps, roots, grass, weeds, rubbish, and all other objectionable obstructions resting on or protruding through the surface of the ground. Clearing operations shall be conducted so as to 1) prevent damage to existing structures and installations, and to those under construction, and 2) provide for the safety of employees and others.
- B. Minimize damage to trees outside construction limits and preserve as specified hereinafter.

3.02 GRUBBING

- A. Grubbing shall consist of the complete removal of all stumps, roots larger than 1-1/2 inches in diameter, matted roots, brush, timber, logs, concrete rubble, and all other debris encountered. All depressions excavated below the original sound surface for or by the removal of such objects shall be refilled with suitable materials and compacted to a density conforming to the surrounding ground surface.

3.03 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

- A. The Contractor shall dispose of all material and debris from the clearing and grubbing operation by hauling such material and debris away to an approved dump. Disposal by burning or burial will not be permitted. Chipped material may be spread evenly across the easement or right-of-way with prior approval of the Department of Public Works.

3.04 PRESERVATION OF TREES

- A. Trees beyond construction limits shall be carefully protected from damage. The Contractor shall erect such barricades, guards, and enclosures he may consider necessary for the protection of the trees during all construction operations. Materials and equipment shall be maintained beyond the drip lines of such trees to the extent practicable. Where required, cut back limbs and branches to preserve trees and paint with an approved tree wound paint.

3.05 PRESERVATION OF DEVELOPED PRIVATE PROPERTY

- A. The Contractor shall exercise extreme care to avoid unnecessary disturbance of adjacent private property. Trees, shrubbery, gardens, lawn, and other landscaping damaged by the Contractor beyond the construction limits shall be restored to pre-construction conditions.
- B. All soil preparation procedures and replanting operations shall be performed under the supervision of a licensed nurseryman approved by the Department of Public Works or its representative.

END OF SECTION

SECTION 02140

DEWATERING AND DRAINAGE

PART 1 GENERAL

1.00 STATUTORY REQUIREMENTS

- A. Obtain and pay for all permits required for temporary dewatering and drainage systems.
- B. Original permits shall be prominently displayed on the site prior to constructing dewatering and drainage systems.

1.01 SCOPE OF WORK

- A. Furnish, install, operate, monitor, maintain, and remove temporary dewatering and drainage systems as required to lower and maintain groundwater levels below sub-grades of excavations and trenches. Prevent surface water runoff from entering or accumulating in excavations and trenches.
- B. Furnish the services of a licensed professional engineer, registered in the Commonwealth of Virginia, to prepare dewatering and drainage system designs and submittals.
- C. Collect and properly dispose of all discharge water from dewatering and drainage systems in accordance with state and local requirements and permits.
- D. Repair damage caused by dewatering and drainage system operations.
- E. Remove temporary dewatering and drainage systems when no longer needed. Restore all disturbed areas.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.
- B. Section 02270, Erosion and Sediment Control.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 GENERAL

- A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, and bearing soils are maintained undisturbed. Prevent softening, or instability of, or disturbance to, the sub-grade due to water seepage.

- B. Provide protection against flotation for all work.
- C. The anticipated subsurface soil/water conditions shall be considered when selecting methods of excavation and temporary dewatering and drainage systems. Where groundwater levels are above the proposed bottoms of excavations, a pumped dewatering system shall be evaluated for pre-drainage of the soils prior to excavation to final grade and for maintenance of the lowered groundwater level until construction has been completed to such an extent that the foundation, structure, pipe, or fill will not be floated or otherwise damaged. Type of dewatering system, spacing of dewatering units, and other details of the work are expected to vary with soil/water conditions at a particular location. Excavation support system designs shall be prepared by a licensed professional engineer registered in the Commonwealth of Virginia.

3.02 SURFACE WATER CONTROL

- A. Control surface water runoff to prevent flow into excavations. Provide temporary measures such as dikes, ditches, and sumps.

3.03 EXCAVATION DEWATERING

- A. Provide and maintain adequate equipment and facilities to promptly remove and properly dispose of all water entering excavations. Excavations shall be kept in-the-dry, so as to maintain an undisturbed sub-grade condition throughout construction below grade, including backfill and fill placement.
- B. Pipe shall not be installed in water or be allowed to be submerged prior to backfilling. Pipe which becomes submerged shall be removed and the excavation dewatered and restored to proper conditions prior to reinstalling the pipe.
- C. Excavations for foundations and structures shall be maintained in-the-dry for a minimum of 4 days after concrete placement. In no event shall water be allowed to enter an excavation and rise to cause unbalanced pressure on foundations and structures until the concrete or mortar has set at least 24 hours.
- D. Dewatering and drainage operations shall at all times be conducted in such a manner as to preserve the natural, undisturbed bearing capacity of the sub-grade at the bottom of the excavation. If the sub-grade becomes disturbed for any reason, the unsuitable sub-grade material shall be removed and replaced with compacted granular fill to restore the bearing capacity of the sub-grade to its original undisturbed condition. Costs of such removal and restoration shall be the responsibility of the Contractor.
- E. Dewatering and drainage operations shall be conducted in a manner which does not cause loss of ground or disturbance to the pipe bedding or soil that supports overlying or adjacent structures.
- F. Provide diesel or gasoline powered standby pumping units ready for immediate use to serve the system in case of failure of normal pumping units.
- G. The Contractor shall prevent flotation by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages that may result in failure of this system.

- H. The Contractor shall take all necessary precautions to preclude the accidental discharge of fuel, oil, etc., in order to prevent adverse effects on groundwater or surface water quality.
- I. If for any reason the dewatering system is found to be inadequate to meet the requirements set forth herein, the Contractor shall at his own expense make such additions, changes and/or replacements as necessary to provide a satisfactory dewatering system.
- J. Removal of dewatering equipment shall be accomplished after the system is no longer required. The Contractor shall remove the material and equipment constituting the system.

3.04 DISPOSAL OF DRAINAGE

- A. All water discharged from temporary dewatering and drainage systems shall be disposed of in accordance with the sediment and erosion control plan as specified in Section 02270.

END OF SECTION

SECTION 02200

EXCAVATION AND BACKFILL

PART 1 GENERAL

1.00 STATUTORY REQUIREMENTS

- A. All excavation, trenching, sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and any state and local requirements. Where conflict between OSHA, state, and local regulations exists, the most stringent requirements shall apply.

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable waste and surplus materials as shown on the Drawings and as specified herein.
- B. Provide the services of a licensed professional engineer, registered in the Commonwealth of Virginia, to prepare temporary excavation support system designs and to inspect the installed temporary support systems.
- C. Furnish and install temporary excavation support systems, including sheeting, shoring, and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc., in accordance with federal, state and local laws, regulations, and requirements.
- D. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

1.02 RELATED WORK

- A. Section 02100, Clearing and Grubbing.
- B. Section 02140, Dewatering and Drainage.
- C. Section 02230, Fill and Granular Fill Materials.
- D. Section 02270, Erosion and Sediment Control.
- E. Section 02280, Loaming and Seeding.
- F. Section 02575, Asphaltic Concrete Pavement and Appurtenances.

1.03 SUBMITTALS

- A. Test reports of compaction testing on embankment, fill, and backfill materials shall be submitted directly to the Department of Public Works with copies to Contractor.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM A36 - Specification for Carbon Structural Steel.
 - 2. ASTM A328 - Specification for Steel Sheet Piling.
 - 3. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soils Using Standard Efforts.
 - 4. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- B. Virginia Department of Transportation (VDOT).
 - 1. Road and Bridge Specifications.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Excavation support system designs shall be prepared by a licensed professional engineer registered in the Commonwealth of Virginia having a minimum of 5 years of professional experience in design and construction.
- B. Materials will be tested and observed as described in the following paragraphs. Free access to the work for selection of test materials and observations shall be granted to the testing agency.
 - 1. Materials to be used in the work shall be tested by a certified independent testing laboratory engaged by the Contractor and acceptable to the Department of Public Works to demonstrate conformance with the requirements of these Specifications.
 - 2. Testing methods shall comply with the latest applicable ASTM or VDOT Standards specified.
 - 3. During the placement of bedding, backfill, and fill, the soils testing laboratory shall perform in-place soil density testing to confirm that fill material has been compacted in accordance with the requirements of this Section. The Department of Public Works may designate areas where soil density testing will not be required.
 - a. At least 1 density and moisture content test for each 1,000 square feet of surface area for each compacted lift of fill at construction areas.
 - b. At least 1 density and moisture content test for each 400 linear feet of installed pipe.
 - 4. Materials that have been previously tested may be subjected to further testing from time to time and may be rejected if it is determined that they do not conform to the requirements of these Specifications. Rejected materials shall be removed from the Work immediately

when so directed by the Department of Public Works, notwithstanding the results of previous testing.

1.06 PROJECT/SITE CONDITIONS

- A. Boring locations and logs, if available, are included in the Contract documents. The data and recommendations presented are based on observations at specific boring locations as designated therein. Conditions between or away from the borings may vary from the conditions reported. No warranty of subsurface conditions, expressed or implied, is intended or made to any reviewer of the report.
- B. Existing structures. The Drawings may show certain surface and underground structures adjacent to the Work. This information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the Contractor. Contractor shall explore ahead of the required excavation to determine the exact location of all structures. They shall be supported and protected from damage by Contractor. If they are broken or damaged by Contractor, Contractor shall restore them immediately at his expense.
- C. Existing utilities.
 - 1. It shall be the responsibility of the Contractor to conduct the Work in such a manner as to avoid damage to, or interference with, any utility services. The Contractor is responsible for providing temporary supports for any utility that may be affected by its work. If any damage, interference, or interruption of service occurs as a result of its work, it shall be the Contractor's responsibility to promptly notify the City and utility owner of the occurrence and to repair, or cause to be repaired, the damage immediately, at Contractor's expense, and to the satisfaction of the City and the owner of the utility.
 - 2. It shall be the Contractor's responsibility to uncover and expose the location of all service connections to avoid damage or interruption of service. If damage occurs, the Contractor shall make the necessary repairs in accordance with the above requirements.
 - 3. It is the responsibility of the Contractor to determine in advance of beginning the construction effort the exact location of all utilities, and the affect they will have on the Work. Contractor shall contact "Miss Utility" 48 hours prior to starting work. All costs related to identification of utility location shall be the responsibility of the Contractor.
 - 4. Do not interrupt existing utilities serving facilities occupied and used by the City or others, except when permitted in writing by the City and then only after acceptable temporary utility services have been provided.
 - 5. Demolish and completely remove from site the existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
- D. If conditions at variance with those described in the Contract Documents or Supplemental Project Information are encountered during construction, immediately notify the Department of Public Works in accordance with the requirements of the General Conditions.

1.07 DEFINITIONS

- A. Where the phrase "in-the-dry" is used in this Section, it shall be defined to mean a soil sub-grade that is stable with no ponded water, mud, or muck, and is able to support construction equipment without rutting or disturbance.
- B. Where used in this Section, "structures" refers to all buildings, wet wells, manholes, and below-grade vaults. Storm water structures and duct banks are not considered structures in this context.

PART 2 PRODUCTS

2.01 GENERAL

- A. Fill materials designated for use in this Section are specified in Section 02230.
- B. Filter fabric.
 - 1. Filter fabric shall conform to the following requirements.
 - a. Minimum grab strength of 120 lbs. per ASTM D1682.
 - b. Apparent opening size to be equal to or greater than the U.S. Standard Sieve No. 100 (0.210 mm) per ASTM D4751.
 - c. Percent open area not to exceed 30 percent. The "percent open area" is defined as the ratio of the sum of 20 or more individual open areas (times 100) to the sum of the corresponding 20 or more individual total areas.
 - d. Coefficient of permeability shall not be less than 0.2 cm/sec.
 - e. Filter fabric shall be Mirafi Type 140N; Dupont Type PAR, Style 3401; or equal product by Amoco.
- C. High strength geotextile fabric.
 - 1. Geotextile fabric shall conform to the following requirements.
 - a. Minimum tensile strength of 360 lbs. per ASTM D4632.
 - b. Minimum puncture strength of 150 lbs. per ASTM D4833.
 - c. Apparent opening size to be equal to or greater than the U.S. Standard Sieve No. 40 per ASTM D4751.
 - d. Fabric material shall be woven polypropylene or polyester.
 - e. High strength geotextile fabric shall be LINQ Industrial Fabrics, Inc., GTF 375N, or equal.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contact “Miss Utility” before beginning excavations. Before excavating within 20 feet of utility poles and after pipeline stake out, coordinate construction with the appropriate utility company. Immediately notify the Department of Public Works of any conflict of new Work with existing utilities that may require relocation of new Work or of existing utilities.
- B. Test holes.
 - 1. Perform exploratory excavation work (test holes) for the purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work.
 - 2. Test holes shall be backfilled as soon as the desired information has been obtained. Backfilled surfaces shall be stabilized in accordance with approved erosion and sediment control plans.
- C. Dewatering and drainage systems.
 - 1. Temporary dewatering and drainage systems shall be in place and operational prior to beginning excavation work.

3.02 EXCAVATION SUPPORT

- A. Furnish, install, monitor, and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc.) as required by federal, state, or local laws, ordinances, regulations, and safety requirements. Support the sides of excavation to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement, or other damage. Take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with common fill material. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete.
- B. Install excavation supports outside the neat lines of foundations. Supports shall be plumb and securely braced and tied in position. Excavation support shall be adequate to withstand all pressures to which the supports will be subjected. Any movement or bulging of supports shall be corrected to provide the necessary clearances, dimensions, and structural integrity.
- C. Excavation supports left in place.
 - 1. Excavation supports are required to remain in place if installed below the foundation and within a zone extending from the edge of the foundation and then outward and downward at 1H:1V below the pipe springline, or as specified on the Drawings.
 - 2. The Department of Public Works may direct that certain excavation supports remain in place, or be cut off at any specific elevation. If the Contractor believes that such a directive

increases Contractor's cost and would thereby entitle Contractor to a change in contract cost, Contractor shall notify the Department of Public Works in accordance with the applicable article(s) in the Contract General Conditions pertaining to changes in the Work.

3. The right of the Department of Public Works to direct that certain excavation supports remain in place shall not be construed as creating any obligation to give such direction, nor shall failure to give such direction relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence, or otherwise growing out of a failure on the part of the Contractor to leave in place sufficient excavation supports to prevent any movement of the ground or damage to adjacent structures.

D. Excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with sand and compacted.

E. Excavation support systems shall be inspected during and after installation and monthly thereafter by the support system design engineer. The support system design engineer shall submit a written report to the Contractor for each inspection describing recommendations, if any.

3.03 EXCAVATION BELOW GRADE

A. If the bottom of any excavation is taken out below the limits shown on the Drawings, specified, or directed by the Department of Public Works, it shall be refilled at the Contractor's expense with 4-inch layers of compacted structural fill or other approved material. The type of material to be used shall be at the City's option.

B. If the sub-grade is damaged by water, remove the unsuitable material and replace it with compacted structural fill or other approved material at Contractor's own expense so that the condition of the sub-grade meets with the approval of the Department of Public Works before any work is placed thereon.

C. If, in the opinion of the Department of Public Works, the material, in its undisturbed natural condition at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for the work being performed, it shall be removed to such depth and width as directed and be replaced with suitable material for which compensation will be made at the unit prices established in the Contract.

3.04 STRUCTURE EXCAVATION

A. Excavation shall be made to the grades shown on the Drawings and to such widths as will give suitable room for construction of the structures for bracing, shoring, and dewatering. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Department of Public Works.

B. Excavation and dewatering shall be accomplished by methods that preserve the undisturbed state of sub-grade soils. Exposed soil and rock sub-grades shall be proof rolled with at least two

coverages of the compaction equipment. Sub-grade soils that become soft, loose, "quick," or otherwise unsatisfactory for support of structures as a result of inadequate excavation dewatering, proof rolling, or other construction methods shall be removed and replaced by structural fill at the Contractor's expense.

- C. Dewatering shall be such as to prevent boiling or detrimental under-seepage at the base of the excavation as specified herein.
- D. Excavation equipment shall be satisfactory for carrying out the Work in accordance with the requirements specified. In no case shall the earth be ploughed, scraped, or dug with machinery so near to the finished sub-grade as to result in excavation of or disturbance of material below grade. Equipment used for excavation to final sub-grade shall furnish an undisturbed sub-grade surface.
- E. During final excavation to sub-grade level, take whatever precautions are required to prevent disturbance and remolding. Material that has become softened and mixed with water shall be removed. Hand excavation of the final 3 to 6 inches may be required to obtain a satisfactory undisturbed bottom. The Department of Public Works will be the sole judge as to whether the work has been accomplished satisfactorily.

3.05 EXCAVATION AND BACKFILLING FOR UNDERSLAB TRENCHES

- A. Excavation for all pipelines beneath structures shall be carried out with the excavating equipment operating from above the sub-grade for the structure. The excavation shall be carried out in-the-dry and in a manner that will preserve the undisturbed state of the sub-grade soils. The excavations may be completed with shoring and bracing at the Contractor's option with no additional cost to the City.

3.06 TRENCH EXCAVATION AND BACKFILLING

- A. Excavation for all trenches required for the installation of pipes shall be made to the depths indicated on the Drawings and in such a manner and to such widths as will give suitable room for laying the pipe within the trench, for bracing and shoring, and dewatering. Render the bottom of the excavations firm and dry and in all respects acceptable to the Department of Public Works.

Pavement, when encountered, shall be cut along straight lines before excavating. All excavations in concrete shall be pre-cut in neat straight lines with a pavement breaker or saw. In sidewalks the excavation shall be a minimum of one "block" in size. If a combined curb and gutter sidewalk, the curbing shall also be removed.

- B. Rock shall be removed to a minimum 6-inch clearance around the bottom and 12-inch minimum clearance on the sides of all pipe being laid.
- C. Excavation of earth material below the bottom of a trench shield shall not exceed the limits established by ordinances, codes, laws, and regulations.
 - 1. When using a trench shield for installing rigid pipe (R.C., V.C., etc.), any portion of the shield extending below mid-diameter shall be raised above this point prior to moving the shield ahead to install the next pipe.

2. When using a trench shield for installing flexible pipe (PVC, PE, etc.), the bottom of the shield shall not extend below mid-diameter at any time.
 3. When a shield is removed or moved ahead, extreme care shall be taken to prevent the movement of pipe or the disturbance of the pipe bedding. Pipe that has been disturbed shall be removed and reinstalled at Contractor's own expense.
- D. Where pipelines are to be constructed in fill areas, all fill material to a level 2 feet above the "top of pipe" elevation shall be placed and compacted to 95 percent dry density as determined by ASTM D698 prior to excavating pipe trench.
 - E. Backfill excavations as promptly as work permits, removing bracing and shoring as backfilling progresses.
 - F. In rock excavations, granular fill as noted on the Detail Drawings shall be placed and compacted in 6-inch lifts to a minimum depth of 12 inches above top of pipe. Compaction shall be to 95 percent of maximum dry density as determined by ASTM D698.
 - G. In earth excavations, backfill as noted on the Detail Drawings shall be placed and compacted in 6-inch lifts to a minimum depth of 12 inches above top of pipe. Compaction shall be to 95 percent of maximum dry density as determined by ASTM D698. Pipe bedding shall be as shown on the Detail Drawings.
 - H. Where the pipes are laid in unpaved areas, the remainder of the trench shall be filled with common fill in lifts not to exceed 1 foot and thoroughly compacted by rolling or tamping to prevent subsequent settling. The top 1-foot lift shall be select common fill. The backfill shall be mounded 3 inches above the existing grade or as directed. Wherever a loam or gravel surface exists prior to excavations, it shall be removed, conserved, and replaced to the full original depth as part of the Work. In some areas it may be necessary to remove excess material during the clean-up process so that the ground may be restored to its original level and condition. If storage of loam, gravel, or topsoil is not preferred, replace it with material of equal quality and in equal quantity at Contractor's own expense.
 - I. Where the pipes are laid in streets or other paved areas, the remainder of the trench shall be backfilled with VDOT #21A crushed stone in 1-foot layers thoroughly compacted by rolling or tamping. The top 1-foot lift below the bottom of the specified paving shall be compacted in 6-inch layers.
 - J. Along the length of all pipeline, construct impervious dams or bulkheads of clay or concrete in the trench bottom at 300-foot intervals or at manholes and structures, whichever is less, to obstruct the free flow of groundwater after construction is completed. Install impervious dams at all points where a pipe trench enters an excavated area where a permanent under-drain system is installed.

3.07 MISCELLANEOUS EXCAVATION

- A. Perform all miscellaneous excavations as required to complete the Work. Make all excavations necessary to permit the placing of loam and plants, for constructing roadways, and any other miscellaneous earth excavation required under the Contract.

3.08 ROCK AND BOULDER EXCAVATION AND DISPOSAL

- A. Rock excavation may be performed by jack hammering, expansive chemical splitting, or other similar processes. Blasting will not be permitted without written authorization by the Department of Public Works. The Department of Public Works must approve all rock excavation processes prior to any rock excavation.

- 1. All blasting operations required for the purpose of rock excavation, including but not limited to permit acquisition, employee training/certification, explosives handling/storage and charge detonation, shall be performed in accordance with 29 CFR 1926, Subpart U – Blasting and the Use of Explosives.

The Contractor shall be responsible for securing any and all required permits and for providing trained and certified blasting personnel. Prior to blasting, the Contractor shall submit to the Department of Public Works for approval a written blasting procedure that includes addressing the protection of existing subsurface utilities and structures.

Blasting mats shall be required for all blasting operations. Blasting operations shall not be performed within 15 feet, or a distance otherwise determined by the Department of Public Works, of any existing water, gas, fuel, and/or sanitary sewer lines or drainage structures. The Contractor shall provide the Department of Public Works with charge specifications and soil type in the area adjacent to these utilities for review and approval prior to initiating any blasting operations.

Any and all damage resulting from blasting operations shall be the responsibility of the Contractor, and shall be promptly repaired to the satisfaction of the Engineer at no cost to the City.

- 2. **EXCAVATION IS UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION.**

- B. Fragmented rock with dimensions not exceeding 4 inches in any direction may be mixed with common fill and used as common fill in accordance with Section 02230.
- C. Unused rock and boulders shall be removed and disposed off site.

3.09 BACKFILLING - COMMON FILL

- A. Common fill may be used as trench backfill, as embankment fill, or in other areas as designated by the Department of Public Works. Material conforming to the requirements of common fill shall be placed in lifts having a maximum thickness of 1 foot measured before compaction.
- B. Common fill shall be compacted to at least 95 percent of maximum density as determined by ASTM D698.

- C. Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making due allowance for settlement of the material and for the placing of loam thereon.
- D. The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the Plans. No soft spots or uncompacted areas will be allowed in the Work.
- E. No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.10 BACKFILLING - STRUCTURAL FILL

- A. Structural fill shall be placed in lifts having a maximum thickness of 6 inches in open areas and 4 inches in confined areas including points where piping joins structures, measured before compaction. Each lift of fill shall be compacted to at least 95 percent of maximum dry density determined by ASTM D698 using methods approved by the Department of Public Works. The limits of structural fill adjacent to structures shall extend as shown on the Drawings.
- B. Structural fill shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice, or frozen earth be incorporated in the compacted fill.
- C. Structural fill shall be compacted by at least 4 coverages of all portions of the surface of each lift by compaction equipment. "One coverage" is defined as the condition obtained when all portions of the surface of the fill material have been subjected to the direct contact of the compactor.

3.11 BACKFILLING - CRUSHED STONE

- A. Place granular fill within pipe trenches and under structures as shown on the Drawings.
- B. Crushed stone fill shall be placed in lifts having a maximum thickness of 1 foot measured before compaction. Each lift shall be compacted to at least 95 percent of maximum dry density determined by ASTM D698.
- C. Crushed stone fill shall be compacted by at least 4 coverages of each lift with vibratory compaction equipment acceptable to the Department of Public Works.

3.12 EARTH EMBANKMENTS

- A. Prior to placing embankment fill materials, all organic materials (including peat and loam) and loose inorganic silt material (loess) shall be removed from areas beneath the embankments. If the sub-grade slopes are excessive, the sub-grade shall be stepped to produce a stable, horizontal surface for the placement of embankment materials. The existing sub-grade shall then be scarified to a depth of at least 6 inches. Adjust the moisture content of the scarified zone to slightly above optimum, and compact the sub-grade.
- B. Embankment fill shall consist of common fill material and shall be placed and compacted in even lifts of 12 inches (compacted thickness) and compacted to at least 90 percent of maximum dry density as determined by ASTM D698.

- C. Rock may not be used in embankment fill.

3.13 IMPERVIOUS FILL

- A. Impervious fill shall be placed in controlled, even lifts having a maximum thickness (measured before compaction) of 6 inches. Compaction shall be sufficient to attain a permeability of less than 1×10^{-7} cm/sec.
- B. Moisture content of impervious fill to be compacted shall be maintained at or near its optimum moisture content (-2 to +3 percent).

3.14 DISPOSAL OF SURPLUS MATERIAL

- A. Excess excavated materials shall be removed from the site and disposed of in accordance with local, state, and federal regulations. Materials shall be neatly piled so as to inconvenience as little as possible the public and adjoining property owners until used or otherwise disposed of as specified below.
- B. Suitable excavated material meeting the requirements of Section 02230 may be used for fill embankments or backfill on the different parts of the Work as required.
- C. Surplus materials shall become the property of the Contractor and shall be removed and disposed off site.

3.15 GRADING

- A. Grading in preparation for placing of loam, planting areas, paved walks and drives, and appurtenances shall be performed in all places that are indicated on the Drawings, to the lines, grades, and elevations shown, and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature within the limits indicated, shall be removed and disposed of in accordance with these specifications. During the process of grading, the sub-grade shall be maintained in such condition that it will be well drained at all times.
- B. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C. The Department of Public Works reserves the right to make minor adjustments or revisions in lines or grades if found necessary as the Work progresses.
- D. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 12 inches of the finished sub-grade of all fills or embankments.
- E. In cuts, all loose or protruding rocks on the bank slopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the Drawings.

3.16 RIPRAP FOR SLOPE STABILIZATION

- A. Prepare sub-grade for riprap. Remove vegetation, brush, tree stumps, or other objectionable material. Cut or fill to the required lines and grades. Any fills required shall be of the same type as and compacted to a density approximating that of the surrounding undisturbed material.
- B. Before installing riprap, install geotextile filter fabric as shown on the Drawings and in accordance with the geotextile manufacturer's instructions.
- C. Place riprap as soon as practicable after embankment construction. Limit lag between placement of embankment and riprap protection to the least time possible, and prevent mixture of soil with riprap material.
- D. Place riprap as shown on the Drawings and in conformance to the requirements of VDOT Section 418 – Riprap. Place stones so that the weight of the stones is carried by the underlying material and not by the adjacent stones. Place large stones at the bottom of the slope. Fill spaces between stones with spalls of suitable size to construct a solid, stable slope, free from large voids and defects.

END OF SECTION

SECTION 02230

FILL AND GRANULAR FILL MATERIALS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Granular fill materials are specified in this Section, but their use for bedding pipe, replacement of unsuitable materials, cushion in ledge excavation, pavement base, foundation support, fill and backfill, and similar uses are specified in detail elsewhere.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.

1.03 SUBMITTALS

- A. At least 5 working days prior to the date of anticipated use of any backfill or fill material, submit a representative sample of the proposed material weighing at least 50 pounds to the soils testing laboratory for analyses.
- B. Test reports.
 - 1. For each fill material proposed for incorporation into the Work or reuse, submit the following test results. Indicate the testing standard and method used for each material.
 - a. Gradation test in accordance with ASTM D422, AASHTO T27, or VTM-25 as noted.
 - b. Moisture-density test in accordance with ASTM D698 or ASTM D1557.
 - c. Atterberg limits (liquid limit, plastic limit, and plasticity index) in accordance with ASTM D4318 or VTM-7 as noted.
 - d. Unified Soil Classification System identity in accordance with ASTM D2487.
 - 2. At the discretion of the Department of Public Works, the Contractor may furnish a certification of conformity to VDOT Road and Bridge Specification requirements from the material manufacturer in lieu of testing. Confirm acceptability of such a certification for each material before submitting.

1.04 REFERENCE STANDARDS

- A. American Association of State Highway & Transportation Officials (AASHTO).
 - 1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing.
- B. American Society for Testing and Materials (ASTM).

1. Standard Specifications as referenced.
- C. Virginia Department of Transportation (VDOT).
1. Road and Bridge Specifications.
 2. Materials Division, Virginia Test Methods (VTM).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Riprap shall conform to VDOT Section 204.02b and shall be sound, durable stone of igneous or metamorphic origin, and shall be free from seals, cracks, or structural defects.
- B. Gravel or crushed stone shall be open-graded coarse aggregate with clean, hard, tough, and durable pieces free from adherent coatings and deleterious amounts of friable, thin, elongated, or laminated pieces, soluble salts, or organic materials. Coarse aggregate shall conform to VDOT Section 203 and the following requirements.
 1. VDOT No. 57: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.

Sieve	% Passing by Weight
1-1/2"	Min. 100
1"	95 ± 5
1/2"	43 ± 17
No. 4	Max. 7
No. 8	Max. 3

2. VDOT No. 68: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.

Sieve	% Passing by Weight
1"	Min. 100
3/4"	95 ± 5
3/8"	48 ± 17
No. 4	Max. 20
No. 8	Max. 8
No. 16	Max. 5

3. VDOT No. 1: Grade B or better stone conforming to the following gradation when tested in accordance with AASHTO T27.

Sieve	% Passing by Weight
4"	Min. 100
3-1/2"	95 ± 5
2-1/2"	43 ± 17
1-1/2"	Max. 15
3/4"	Max. 5

- C. Crusher run aggregate shall be crushed from stone, slag or gravel, and shall contain all of the sizes produced when the original aggregate is reduced through a series of crushers to the maximum size specified. The material shall conform to the following gradation when tested in accordance with AASHTO T27.

Sieve	% Passing by Weight
1-1/2"	Min. 100
3/4"	95 ± 5
No. 4	32 ± 18

- D. Fine aggregate shall be crushed from Grade A stone or gravel and shall conform to the requirements of VDOT Road and Bridge Specifications Section 202, Grading F or G. The material shall conform to the following gradations when tested in accordance with AASHTO T27.

Sieve	Grading F % Passing by Weight	Grading G % Passing by Weight
3/8"	100	100
No. 4	92 ± 8	
No. 8	80 ± 20	
No. 16	62 ± 22	70 ± 30
No. 30	39 ± 19	50 ± 35
No. 50	Max. 26	Max. 26
No. 100	Max. 10	Max. 10
No. 200	Max. 7	Max. 5

- E. Structural fill shall consist of gravel stone or slag screenings; fine aggregate and crushed coarse aggregate; sand-clay-gravel mixtures; or combinations of these materials. It shall be free of organic material, loam, wood, trash, snow, ice, frozen soil, and other objectionable material and shall conform to the following requirements which includes the acceptance of VDOT No. 21A.

Sieve	% Passing by Weight
2"	100
No. 4	20 to 70
No. 40	5 to 35
No. 200	0 to 12

- F. Screened gravel shall be hard, durable, rounded, or sub-angular particles of proper size and gradation and shall be free from sand, loam, clay, excess fines, and other deleterious materials. Screened gravel shall be graded within the following limits:

Sieve Size	% Finer by Weight
5/8"	100
1/2"	40 to 100
3/8"	15 to 45
No. 10	0 to 5

- G. Common fill shall consist of uniformly graded mineral soil, substantially free of clay, organic material, loam, wood, trash, snow, ice, frozen soil, and other objectionable material which may be compressible, or which cannot be compacted properly. Common fill shall not contain rocks larger than 4 inches in any dimension, broken concrete, masonry, rubble, asphalt pavement, or other similar materials.

1. Common fill shall have a maximum 75 percent passing the No. 40 sieve and a maximum of 20 percent passing the 200 sieve.
2. Soft, wet, plastic soils that may be expansive, and clay soils having natural in-place water content in excess of 30 percent, shall not be used.
3. Soils containing more than 5 percent (by weight) fibrous organic materials or having a plasticity index (PI) greater than 30 shall not be used.
4. Rocks larger than 2 inches in any dimension shall not be permitted within 12 inches of finished grade.

- H. Select fill shall be as specified for common fill, except that the material shall contain no stones and shall have a plasticity index less than 20.

- I. Sand shall conform to VDOT Section 202, Grade A for fine aggregate.

- J. Impervious fill shall consist of on-site clayey sandy silt or imported material with a K less than 1×10^{-7} that can be readily spread and compacted. Low permeability fill shall not be placed under sidewalks or paved areas.

END OF SECTION

SECTION 02270

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals necessary to perform all installation, maintenance, removal, and area cleanup related to sedimentation control work as specified, shown, and required by the City, local sediment control inspectors, and any other regulatory agency that has control or jurisdiction in the area in which the project is located. The Work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, silt fences, block and gravel filters, sediment traps, diversion dikes, splash aprons, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, erosion control matting installation, and final cleanup.

1.02 RELATED WORK

- A. Section 02100, Clearing and Grubbing.
- B. Section 02140, Dewatering and Drainage.
- C. Section 02200, Excavation and Backfill.
- D. Section 02280, Loaming and Seeding.

1.03 SUBMITTALS

- A. Contractor shall submit to the Department of Public Works an Erosion and Sediment Control Plan showing details of erosion and sediment control devices and locations, and technical product literature for all commercial products to be used for sedimentation and erosion control.
- B. Contractor shall submit copies of approved Erosion and Sediment Control Permits from appropriate governing agencies.

1.04 REFERENCE SPECIFICATIONS

- A. The materials and method of construction shall be in accordance with the latest edition of the Virginia Erosion and Sediment Control Handbook.

1.05 PERFORMANCE REQUIREMENTS

- A. Contractor shall be responsible for obtaining all erosion and sediment control permits required prior to any land-disturbing operations.
- B. Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off-site areas or into the stream system via surface runoff or underground drainage systems.

Measures in addition to those shown on the Erosion and Sediment Plan necessary to prevent the movement of sediment off-site shall be installed, maintained, removed, and cleaned up at no additional cost to the City.

- C. Sedimentation and erosion control measures shall conform to the requirements of the Virginia Sediment and Erosion Control Regulations.
- D. Where Contractors' efforts to control erosion have been demonstrated to be ineffective or potentially ineffective in the opinion of the Department of Public Works, the Department of Public Works may order that the Erosion Control Plan be amended and that additional erosion control measures be constructed at no additional cost to the City.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coarse aggregate shall conform to Section 02230.
- B. Silt fence.
 - 1. Steel posts shall be a minimum of 5 feet in length, 2-1/2-inch by 2-1/2-inch by 1/4-inch angle post with self-fastening tabs and a 5-inch by 4-inch (nominal) steel anchor plate at bottom.
 - 2. Welded wire fabric shall be 6-inch by 6-inch mesh of 14.5 gauge by 14.5 gauge steel wire.
 - 3. Silt fence fabric shall be extra strength filter cloth fabric.
 - 4. Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings), or 1/32-inch diameter soft aluminum wire.
 - 5. Commercially available silt fence assemblies (2-inch by 2-inch wooden posts with attached filter fabric) may be substituted in lieu of separate steel posts and filter fabric.
- C. One quarter (1/4) inch woven wire mesh shall be galvanized steel or hardware cloth.
- D. Straw mulch shall be utilized on all newly graded areas to protect against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold, or other objectionable material. The straw mulch shall contain at least 50 percent by weight of material to be 10 inches or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.
- E. Latex acrylic copolymer, such as Soil Sealant with coalescing agent as manufactured by Soil Stabilization Co., Merced, CA, or approved equivalent shall be used as straw mulch tackifier.
- F. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer, and only with prior written approval from the Department of Public Works.

- G. Erosion control matting shall be installed in all seeded drainage swales and ditches as directed by the Department of Public Works. Erosion control matting shall be from the Virginia Department of Transportations approved products list for the use specified, or equal.
- H. CMU units for block and gravel curb inlet sediment filter shall conform to ASTM DC90, lightweight Grade N, Type 1, hollow units of 8 inch by 16-inch nominal face size.
- I. Pipe for slope drains shall be flexible, corrugated polyethylene pipe, non-perforated, as manufactured by Advanced Drainage Systems, Inc., Columbus, OH, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Silt fence installation.
 - 1. Silt fences shall be positioned as necessary to prevent off-site movement of sediment produced by construction activities.
 - 2. Dig trench approximately 6 inches wide and 4 inches deep along proposed fence lines.
 - 3. Drive steel posts 10 feet on center (maximum) at back edge of trenches. Posts shall be driven 2 feet (minimum) into ground.
 - 4. Hang 6-inch by 6-inch woven wire mesh on posts, setting bottom of wire in bottom of trench. Secure wire to posts with self-fastening tabs.
 - 5. Hang filter fabric on wire carrying to bottom of trench with about 8 inches of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and secure with tie wires 12 inches on center both directions.
 - 6. Backfill trench with excavated material and tamp.
- B. Construct block and gravel curb inlet sediment filters from 1/4-inch woven wire mesh, CMU, and crushed gravel. Lower course of CMU shall be laid with openings facing to the side. Top course shall be placed with openings facing up. Cover lower course of CMU openings with woven wire mesh and crushed stone.
- C. Staging areas and access ways shall be surfaced with a minimum depth of 4 inches of crusher run aggregate.

3.02 MAINTENANCE AND INSPECTIONS

A. Inspections.

1. Contractor shall make a visual inspection of all sedimentation control devices once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to off-site areas, Contractor shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device maintenance.

1. Silt fences.
 - a. Remove accumulated sediment once it builds up to one-half of the height of the fabric.
 - b. Replace damaged fabric, or patch with a 2-foot minimum overlap.
 - c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.
2. Block and gravel curb inlet sediment filters: Replace crushed stone when it becomes saturated with silt.
3. Rock check dams.
 - a. Sediment must be removed when the level of deposition reaches approximately one-half the height of the barrier.
 - b. Erosion caused by high flows around the edges of the dam should be corrected immediately.
4. Add crushed stone to access ways and staging areas as necessary to maintain a firm surface free of ruts and mud holes.

3.03 TEMPORARY MULCHING

- A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.
- B. Straw mulch shall be applied at rate of 100 lbs./1000 ft.² and tackified with latex acrylic copolymer at a rate of 1 gal./1000 ft.² diluted in a ratio of 30 parts water to 1 part latex acrylic copolymer mix.

3.04 EROSION CONTROL MATTING

- A. Erosion control matting shall be installed in all seeded drainage swales, ditches, and slopes greater than 2 to 1 as directed by the Department of Public Works in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, fertilized, and seeded with permanent vegetation before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. The blankets shall be applied in the direction of water flow, and stapled. Blankets shall be placed a minimum of 3 rows (of 4 foot) wide (total approximately 12 foot width) within the drainage swale/ditch and stapled together in accordance with manufacturer's instructions. Side overlaps shall be a minimum of 4 inches. The staples shall be made of wire, .091 inch in diameter or greater, U-shaped with legs 10 inches in length and a 1-1/2-inch crown.

Upper and lower ends of the matting shall be buried to a depth of 4 inches in a trench. Erosion stops shall be created every 25 feet by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be 4 inches below the ground surface. Staple on both sides of fold. Where the matting must be cut or more than 1 roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of 4 inches. Overlap lower end of upstream roll 4 inches past edge of downstream roll, and staple.

To ensure full contact with soil surface, roll matting with a roller weighing 100 pounds per foot of width perpendicular to flow direction after seeding, placing matting, and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

3.05 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as specified herein.

END OF SECTION

SECTION 02280

LOAMING AND SEEDING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to place topsoil, finish grade, and apply lime, fertilizer, seed, and mulch. Maintain all seeded areas as specified herein, including all areas disturbed by the Contractor.

1.02 RELATED WORK

- A. Section 02100, Clearing and Grubbing.
- B. Section 02200, Excavation and Backfill.
- C. Section 02270, Erosion and Sediment Control.

1.03 SAMPLES AND APPROVAL OF MATERIAL

- A. Samples of all materials shall be submitted for inspection and acceptance upon request.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil shall be fertile, friable, natural topsoil typical of topsoil of the locality, and shall be obtained from a well-drained site that is free of flooding. It shall be without admixture of subsoil or slag and free of stones, lumps, plants or their roots, sticks, clay, peat, and other extraneous matter. Topsoil shall not be placed while in a frozen or muddy condition. Topsoil delivered to the site shall have pH between 6.0 and 7.0 and shall contain not less than 3 percent organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees Celsius.
- B. Fertilizer shall be commercially mixed free flowing granules or pelleted fertilizer, 10-10-10 (N-P205-K2O) grade for lawn and naturalized areas. Fertilizer shall be delivered to the site in original unopened containers each showing the manufacturer's guaranteed analysis conforming to applicable state fertilizer laws. At least 40 percent of the nitrogen in the fertilizer used shall be in slowly available (organic) form.
- C. Seed shall be labeled in accordance with USDA Rules and Regulations under the Federal Seed Act and shall comply with the requirements of the Virginia Erosion and Sediment Control Handbook standard. Seed shall be furnished in sealed bags or containers bearing the date of the last germination, which date shall be within a period of 6 months prior to commencement of planting operations. Seed shall be from same or previous year's crop; each variety of seed shall have a purity of not less than 85 percent, a percentage of germination not less than 90 percent,

shall have a weed content of not more than 1 percent and contain no noxious weeds. The seed mixtures shall consist of seed proportioned by weight as follows.

Seed mix for use in all areas:

Common Name	Ingredients
Kentucky 31	70%
Perennial Rye	30%

Seed shall be accompanied by an affidavit for seed conforming to Section 244.02 (c) of Virginia Department of Transportation Road and Bridge Specifications, latest edition.

- D. The seed shall be furnished and delivered pre-mixed in the proportions specified above. The manufacturers for each seed type shall submit a manufacturer’s certificate of compliance to the specified mixes. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
- E. Seed shall be delivered in sealed containers bearing the dealer's guaranteed analysis.
- F. Straw mulch shall be as specified in Section 02270.
- G. Mulch for hydroseeding operations shall be a specially processed cellulose fiber containing no growth or germination inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form an homogeneous slurry. When sprayed on the ground, the material shall allow absorption and percolation of moisture. Each package of the cellulose fiber shall not contain in excess of 10 percent moisture and shall be marked by the manufacturer to show the air-dry weight content.
- H. Mulch tacking agent shall be as specified in Section 02270.

PART 3 EXECUTION

3.01 APPLICATION

- A. Acceptable topsoil shall be placed to a minimum compacted depth of 6 inches on all disturbed areas.
- B. For all areas to be seeded:
 - 1. Fertilizer (10-10-10) shall be applied at the rate of 40 pounds per 1,000 square feet and lightly worked in by approved methods.
 - 2. Seed mix shall be applied at a rate of 20 pounds per 1,000 square feet.
 - 3. Mulch shall be applied at the rate of 40 pounds per 1,000 square feet.

- C. The application of fertilizer may be performed hydraulically in one operation with hydroseeding and fiber mulching. The Contractor is responsible for cleaning all structures and paved areas of unwanted deposits of the hydroseeded mixture.

3.02 INSTALLATION

- A. Previously established grades as shown on Drawings shall be maintained in a true and even condition.
- B. The topsoil shall be carefully prepared by scarifying or harrowing and hand raking after it has been spread. All stiff clods, lumps, roots, litter, and other foreign material shall be removed from the loamed area and disposed of by the Contractor. The areas shall also be free of smaller stones in excessive quantities as determined by the Department of Public Works. The whole surface shall then be rolled with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, all depressions caused by settlement of rolling shall be filled with additional loam and the surface shall be re-graded and rolled until a smooth and even finished grade is created.
- C. Seeding, mulching, and conditioning shall only be performed during those periods within the seasons that are normal for such work as determined by the weather and locally accepted practice.
- D. Schedules for seeding and fertilizing must be submitted to the Department of Public Works for approval prior to the work. Seeding as specified herein shall be accomplished between the period of April 1 to May 31 or August 16 to October 15. Seeding during the periods from October 16 to March 31 and from June 1 to August 15 shall only be undertaken upon approval of the Department of Public Works.
- E. Seeding shall be done within 5 days following soil preparation. Seed shall be applied at the rates and percentages indicated.
- F. Slopes whose vertical height is less than 20 feet but more than 5 feet shall be seeded in 2 equal increments. Slopes whose vertical height is 5 feet or less may be seeded in one operation. Slopes greater than 2H:1V shall be protected by erosion control matting acceptable to the Department of Public Works.
- G. In order to prevent unnecessary erosion of newly topsoiled and graded slopes and unnecessary siltation of drainage ways, the Contractor shall carry out seeding and mulching as soon as he has satisfactorily completed a unit or portion of the project or when 1,000 square feet of ground surface has been disturbed. When protection of newly loamed and graded areas is necessary at a time which is outside of the normal seeding season, the Contractor shall protect those areas by whatever means necessary as approved by the Department of Public Works and shall be responsible for prevention of siltation in the areas beyond the limit of Work.
- H. When newly graded sub-grade areas cannot be topsoiled and seeded because of season or weather conditions and will remain exposed for more than 30 days, the Contractor shall protect those areas against erosion and washouts by whatever means necessary such as straw applied with a tar tack, wood chips, or by other approved measures. Prior to application of topsoil, any such materials applied for erosion control shall be thoroughly incorporated into the sub-grade by disking. Fertilizer shall be applied prior to spreading of topsoil.

- I. On slopes, the Contractor shall provide against washouts by an approved method. Any washout that occurs shall be re-graded and re-seeded at the Contractor's expense until a good sod is established.

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

- A. The Contractor shall maintain seeded areas, re-seeding if and when necessary, until a good, healthy, uniform growth is established over the entire area seeded.
- B. The Department of Public Works will inspect all work for provisional acceptance at the end of a 10-week maintenance period upon receiving written request from the Contractor at least 10 days prior to the anticipated date of inspection.
- C. A satisfactory stand will be defined as a section of turf of 1,000 square feet or larger that has:
 - 1. No bare spots larger than three square feet.
 - 2. No more than 10 percent of total area with bare spots larger than 1 square foot.
 - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.
- D. After all necessary corrective work and clean up has been completed, certification of provisional acceptance will be issued. The Contractor's responsibility for maintenance of lawns, or parts of lawns, shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

- A. The Contractor shall guarantee all seeded areas for not less than 1 full year from the time of provisional acceptance.
- B. At the end of the guarantee period, the Department of Public Works will make an inspection upon written request submitted by the Contractor at least 10 days before the anticipated inspection date. Seeded areas not demonstrating satisfactory stands as outlined above shall be renovated, re-seeded, and maintained meeting all requirements as specified herein.
- C. After all necessary corrective work has been completed, the Department of Public Works shall certify in writing the final acceptance of the seeded areas.

END OF SECTION

SECTION 02575

ASPHALTIC CONCRETE PAVEMENT AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install asphaltic paved roadways, parking areas, temporary paving, markings, tie-ins to existing paving, and appurtenances as shown on the Drawings and as specified herein.
- B. Maintain new pavements for one year after Final Completion. Promptly refill and repave areas that have settled or are otherwise unsatisfactory for traffic.

1.02 RELATED WORK

- A. Section 02100, Clearing and Grubbing.
- B. Section 02200, Excavation and Backfill.

1.03 REFERENCE STANDARDS

- A. Where reference is made to the standards listed below, the revision in effect at the time of bid opening shall apply.
- B. Except as otherwise specified herein, materials and construction shall be in accordance with the Virginia Department of Transportation Road and Bridge Specifications, latest edition.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Asphaltic concrete paving wearing course shall be Type SM-2C as specified in Section 211.04 of the above-referenced specifications.
- B. Asphaltic concrete binder course shall be Type BM-2 as specified in Section 211.04 of the above-referenced specifications.
- C. Aggregate base material shall be as specified in the Drawings.
- D. Tack coat shall consist of either emulsified asphalt or cutback asphalt conforming to the requirements of Section 311 of the above-referenced specifications.
- E. Gravel sub-base shall be as specified in the Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. Pavements shall be placed at the locations shown on the Drawings and as directed.
- B. The work for new or for repair of existing pavement shall include the placing and compacting of the base course, the priming of the base, the placing and maintaining of the binder and surface treatments, and any special requirements, all as specified herein.
- C. Pavement, at a minimum, shall consist of a 4-inch layer of asphaltic concrete binder course, Type BM-2, placed on a 6-inch compacted stone base course, with a 2-inch asphaltic concrete surface course, Type SM-2C, placed so that the top layer matches the grade of existing pavement.
- D. The binder course shall be placed as soon as possible after the 6-inch stone base has been prepared, shaped, and compacted.
- E. The binder course shall be placed and compacted by steel-wheeled rollers with a minimum weight of 3 tons. New pavement shall be rolled smooth and even with the existing pavement.
- F. All pavement thicknesses referred to herein are compacted thicknesses. Place sufficient mix to ensure that the specified thickness of pavement is achieved.
- G. Hose clean all road surfaces after backfilling and before any surfacing, but in no case shall pavement be placed until the stone base is dry and compacted to at least 95 percent maximum dry density at optimum moisture content as determined by ASTM D698.
- H. All manhole frames and utility boxes are to be set to the grade of the wearing course. At no time shall the frames or boxes be allowed to protrude above the surface of the wearing course.
- I. The contact surfaces of castings and other structures shall be painted with a tack coat.
- J. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers weighing not less than 240 pounds per inch width of tread.
- K. Final compaction of the surface shall be accomplished by rollers weighing not less than 285 pounds per inch width of tread. Along curbs, structures, and all places not accessible with a roller, the mixture shall be thoroughly compacted with tampers. Such tampers shall weigh not less than 25 pounds and shall have a tamping face of not more than 50 square inches. The surface of the mixture after compaction shall be smooth and true to the established line and grade.
- L. When the air temperature falls below 50° F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and placing and compacting the mixtures.
- M. No mixtures shall be placed when the air temperature is below 40° F, nor when the material on which the mixtures are to be placed contains frost or has a surface temperature less than 35° F.

- N. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Department of Public Works.

3.02 CUTTING PAVEMENT

- A. Cut and remove existing pavement as necessary for installing the new pipe lines and appurtenances, for making connections to existing pipe lines, and for making tie-ins between existing and new pavements.
- B. Pavements to be cut shall be marked neatly, paralleling pipe lines and street lines. Asphaltic concrete pavement shall be cut along the markings with a jackhammer, rotary saw, or other suitable tool. Concrete pavement and asphaltic pavement on concrete base shall be scored to a depth approximately 2 inches below the surface of the concrete along the marked cuts. Scoring shall be done by use of a rotary saw, after which the pavement may be broken below the scoring with a jackhammer or other suitable equipment.
- C. No pavement shall be machine pulled until completely broken and separated along the marked cuts.

3.03 PAVEMENT REPAIR AND REPLACEMENT

- A. All existing pavement cut or damaged by construction shall be repaired to match the original surface material and original grade unless otherwise specified or shown on the Drawings. Materials and construction procedures for sub-base, base course, and pavement repair shall conform to VDOT standards.
- B. The width of all repairs shall extend at least 6 inches beyond the excavation or limits of any damaged section. The edge of the pavement to be left in place shall be saw cut to a true edge so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.
- C. After all repair and restoration or paving has been completed, all excess asphalt, dirt, rock, and other debris shall be removed from the roadways. All storm sewers and inlets shall be checked and cleaned of any construction debris.
- D. The pavement adjacent to pipeline trenches shall neither be disturbed nor damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, the damaged pavement shall be removed and replaced at no expense to the City.

3.04 TRENCH PAVEMENT RESTORATION

- A. Place 6-inch compacted stone base course and 4-inch minimum binder course over trenches cut in existing paved areas no later than 1 week after the trench has been backfilled. The paving shall be maintained until overlaid with a 2-inch wearing course.
- B. If points of settlement or holes appear in the pavement, repair the same within 3 days of notification by the Department of Public Works. If after due notice Contractor fails to make the

repairs, the work will be done by the Department of Public Works and the total cost of such repairs will be charged to the Contractor.

3.05 CUTTING CONCRETE STRUCTURES

- A. Cut and remove concrete sidewalks, curbs, gutters, etc., as necessary for the installation of new piping. Cutting and removal of concrete sidewalk sections shall correspond to existing jointing of the sidewalk. Removal of partial sidewalk sections shall not be permitted.
- B. Cutting of sidewalks, curbs, gutters, etc., shall be performed using appropriate concrete saws and shall be in a neat and workmanlike manner. The Contractor shall only remove sections necessary for the proper installation of the piping or sections damaged as a result of the construction activity.
- C. All concrete sections removed as part of the Work shall be removed from the jobsite and disposed of in accordance with the requirements of federal, state, and local regulations.

3.06 CONCRETE STRUCTURE REPAIR AND REPLACEMENT

- A. Concrete structures, including but not limited to curbing, gutters, driveways, and sidewalks, damaged during construction shall be promptly and satisfactorily restored to pre-construction condition, or as directed by the Department of Public Works, in accordance with all applicable sections of the Virginia Department of Transportation Road and Bridge Specifications, latest edition.
- B. Sidewalks and driveways shall be repaired or replaced to the thickness of the adjacent undisturbed sections or 4 inches, whichever is greater. The finish shall be floated or broomed to match the existing concrete. Joints shall be tooled to match the spacing of the existing sections. Steel mesh reinforcement consisting of 6" x 6"/1.4 x 1.4 WWF shall be required for all installations.
- C. Curbing and gutters shall be rebuilt to original lines, grade, cross-section, and finish. Any curbing or gutters that have settled or shifted as a result of the Work shall be replaced at the Contractor's expense.

3.07 MAINTENANCE AND GUARANTEE

- A. All wearing surfaces shall be maintained in good order and be suitable for traffic at all times for a period of 1 year after Final Completion and acceptance of the Work.
- B. At the end of the maintenance period, a final inspection will be made of the repaired and new surfaces and any settlement or depression shall be repaired as specified above.

END OF SECTION

DIVISION 15 -- MECHANICAL

SECTION 15055

PIPING INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all piping, fittings, and specials. The Work includes, but is not limited to, the following:

1. All types and sizes of piping.
2. Supports and restraints.
3. Pipe encasements.
4. Work on or affecting existing piping.
5. Testing.
6. Cleaning.
7. Welding, fusion, and all other Work required to complete the piping installation.

B. Related sections.

1. Section 02100, Clearing and Grubbing.
2. Section 02200, Excavation and Backfill.
3. Section 02230, Fill and Granular Fill Materials.
4. Section 02270, Erosion and Sediment Control.
5. Section 15060, Pipe Testing and Purging.
6. Section 15066, High Density Polyethylene Pipe and Tubing.
7. Section 15075, Steel Pipe.
8. Section 15079, Steel Pipe Corrosion Protection.

1.02 QUALITY ASSURANCE

A. All pipe to be installed under this Contract may be inspected at the place of manufacture for compliance with the Specifications by an independent testing laboratory provided by the City. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of inspection of all pipe approved for this Contract will be borne by the City.

- B. The Department of Public Works or other representatives of the City will inspect the pipe after delivery. The pipe shall be subject to rejection at any time due to failure to meet any of the specified requirements herein, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.
- C. Reference standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. 49 CFR Part 192 – Transportation of Natural and Other Gas by Pipeline; Minimum Federal Safety Standards.
 - 2. API 1104 – Welding of Pipelines and Related Facilities.
 - 3. ASTM D2774 – Practice for Underground Installation of Thermoplastic Pressure Piping.
 - 4. ASTM D3261 – Butt heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
 - 5. ASME/ANSI B31.8 – Gas Transmission and Distribution Piping Systems.

1.03 SUBMITTALS

- A. Shop drawings. Submit for approval the following:
 - 1. Laying schedules for all pipe.
 - 2. Full details of piping, specials, joints, and connections to existing piping, equipment, and appurtenances.
- B. Certificates. Submit certificates of compliance with referenced standards.
- C. Record drawings. Submit record drawings prior to the time of final completion.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Handle all pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material off trucks. Do not otherwise drop, roll, or skid piping.
- B. Store pipes and fittings on heavy wood blocking or platforms so they are not in contact with the ground. Pipe shall not be stacked higher than the limits recommended by the manufacturer and shall conform to the manufacturer's recommendations.
- C. Unload pipe, fittings, and specials opposite to or as close to the place where they are to be installed as is practical to avoid unnecessary handling. Keep pipe interiors completely free from dirt and foreign matter. Ends of plastic pipe shall be capped during storage.
- D. Inspect delivered pipe for cracks, gouges, chips, dents, or other damages and immediately remove damaged pipe from site.

1.05 JOB CONDITIONS

- A. Protection. Guardrail, fences, signs, lights, barricades, barrels, and all other necessary protective items shall be provided in accordance with the requirements of all applicable permits, laws, regulations, and ordinances, including the Virginia Work Area Protection Manual, and as necessary to prevent damage or injury to private or public property or to workmen or the general public.
- B. Adequately support and protect utilities and facilities that are encountered in, or may be affected by, the Work.
- C. If the railroad company requires the installation of track supports, the Contractor shall install such supports. If the railroad company does not furnish the supports, the Contractor shall be responsible for fabricating the track supports in accordance with the requirements of the railroad company's chief engineer. It should be noted, however, that railroad companies usually require that any work involving rails, ties, or other track material be performed by their own forces. The cost of such work, even though carried out by the railroad company, is at the expense of the Contractor.
- D. The Contractor must observe all necessary and appropriate safety precautions when working on railroad rights-of-way or property. At the discretion of the railroad, the Contractor shall provide a qualified watchman or pay for a watchman supplied by the railroad to warn workmen of the approach of any train or other moving equipment upon the tracks of the railroad, and to keep all workmen or other persons, equipment, and materials from the tracks including any power, communication, and signal wires, so that there will be no contacts with trains, rolling equipment, or wires. Contractor shall comply with all railroad requirements.
- E. All excavations shall be sheeted, shored, and braced as required to prevent subsurface subsidence.
- F. Boring pits shall be kept dewatered, and pumps shall be attended on a 24-hour basis, if conditions so require. Close observation shall be maintained to detect any settlement or displacement of facilities during dewatering operations. Dewater into a sediment trap and comply with applicable environmental protection criteria specified in Section 02270.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Refer to applicable Pipe Sections for material specifications.
- B. Steel casing pipe.
 - 1. Casing pipe shall be new steel casing pipe meeting the requirements of ASTM A139, Grade B, leak proof construction, or API Standard 5L, Grade B. Minimum impact factor shall be 1.0. Pipe shall be seamless or have not more than one longitudinal weld.
 - 2. Minimum wall thickness shall be as shown on the Details.

3. Casing pipe shall be designed for earth cover shown on the Plans and live load, including impact, equal to Cooper E-80 railroad loading for railroad crossings and HS-20 wheel loading for roadway crossings.
4. If the casing pipe is furnished in sections to be field welded, then casing pipe shall be supplied with plain ends, mill beveled for field butt welding. Field welded joints shall be performed by API 1104 certified welders and be full penetration single-vee groove, butt type welds around the entire circumference of the pipe. Welding may be subject to non-destructive testing. Copies of test reports shall be submitted to the Department of Public Works.

C. Casing spacers.

1. Provide bolt-on style casing spacers for positioning carrier pipe within casing pipe and for electrically isolating the carrier pipe from the casing pipe.
2. The casing spacers shall support the carrier pipe in the center of the casing pipe.
3. Materials.
 - a. Shell. Type 304 stainless steel with PVC liner.
 - b. Runners. Ultra high molecular weight polymer supported by Type 304 stainless steel risers welded to the shell. All welds shall be passivated.
 - c. Bolts and nuts. Type 304 stainless steel.
4. Spacer width. 12 inches.
5. Spacer location. Spacer to be placed as shown on the Detail Drawings.
6. Manufacturer. Advance Product Systems, Inc., or approved equal.
7. Plastic (PE) casing pipe spacers may be used for cased installations of all polyethylene carrier pipe and 4" and smaller steel carrier pipe. Type and design shall be approved by the Public Utilities - Gas Engineer prior to use.

D. Casing vents.

1. All pipe used for casing vents shall be 2-inch steel conforming to API Standard 5L, Grade B specifications.
2. The minimum wall thickness for the casing vent piping shall be Schedule 40 pipe. All casing vents shall be turned down and directed away from streets and highways.
3. Contractor shall provide the Public Utilities - Gas Engineer with a manufacturer's affidavit of conformance to the above Specifications, and may further be required to furnish mill control check records indicating the results of physical and chemical tests.

- E. Casing end seals. End seals for casings on steel carrier pipe shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the casing and the carrier pipe. The elastomeric element shall be sized as per the manufacturer's recommendations. Where differences in carrier pipe outer diameter and casing pipe inner diameter prohibit the use of modular, mechanical-type, link seals, alternate means of sealing the casing ends shall be provided with approval of the Department of Public Works.

End seals for PE carrier pipe shall be pull-on boot type, synthetic rubber with stainless steel clamps.

- F. Tracer wire. Tracer wire shall be AWG No. 12, single-conductor solid copper with 600-volt insulation designed to meet U.S.E. requirements for buried service. Tracer wire shall be installed with all PE pipe.
- G. Warning tape. Warning tape shall have a minimum 5.0 mil overall thickness. The warning tape, including labeling, shall not contain any dilutants, pigments, or other contaminants, and shall resist degradation by elements encountered in the soil. The warning tape for gas main and service installations shall be color-coded yellow and imprinted with the words, "Caution – Gas Line Buried Below."

PART 3 EXECUTION

3.01 INSTALLATION

A. General.

1. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed. Handling and laying of pipe and fittings shall be in accordance with the manufacturer's instructions and as specified herein.
2. If there is a conflict between manufacturer's recommendations and the Drawings or Specifications, request instructions from Public Utilities - Gas before proceeding.
3. The Contractor shall be responsible for notifying appropriate governmental agencies, other utilities involved, and/or property owners prior to any construction.
4. Prior to excavation, other utilities and underground facilities shall be located to confirm location, proper depth, and clearances. Care shall be taken in excavating to prevent damage to underground structures, utilities, and adjacent properties. When approaching and crossing such installations, a combination of installation methods may be used, such as boring or hand digging. Trenching equipment shall not be used within 2 feet of existing utilities.

5. All gas mains shall have no less than 24 inches cover with a nominal cover of 30 inches (36 inches in VDOT rights-of-way). Gas services shall have no less than 12 inches cover with a nominal cover of 18 to 24 inches. When underground structures prevent installation at the minimum depth, Public Utilities - Gas shall be notified to determine what course of action should be taken.
6. All gas mains and services shall be installed true to the horizontal and vertical alignment indicated on the Plans, or as otherwise directed by the Public Utilities - Gas Engineer. The Contractor shall make no deviations to the proposed horizontal and/or vertical alignment of the gas mains or services unless otherwise directed to do so by the Public Utilities - Gas Engineer. In such cases where the proposed horizontal and/or vertical pipeline alignment will cause conflict with other utilities or structures, or result in less than the specified minimum clearance or cover, the Public Utilities - Gas Engineer shall be notified and the pipeline relocated as per his direction.
7. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plugs or other approved means.
8. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at the Contractor's own expense.
9. All steel gas mains shall receive cathodic protection.

B. Clearance with other utilities and structures.

1. Gas lines shall be installed with 12 inches minimum clearance from any utility and other visible underground structures not associated with the gas line. If this clearance cannot be obtained, the gas line shall be protected by installing casing or other suitable protective material as directed by the Department of Public Works.
2. A minimum horizontal separation of 5 feet is required between parallel gas line and electric, telephone, cable television, and other "wire type" utilities not associated with the gas line.

A minimum horizontal separation of 5 feet shall be maintained between parallel gas lines and sanitary sewers within the City limits (10 feet in Albemarle County).

Should the horizontal separations noted above not be feasible, the Contractor shall request instructions on how to proceed from Public Utilities - Gas.

C. Rights-of-way and easements.

1. The Contractor shall confine construction operations to the immediate vicinity of the project location as shown on the Plans and in no case shall the Contractor encroach beyond the limits of the City's property or rights-of-way. He shall further use due care in placing construction tools, equipment, excavated materials, and pipeline facility materials and supplies so as to cause the least possible damage to property and the least interference with traffic. The placing of such tools, equipment, and materials shall be subject to the approval

of the Department of Public Works. Any damage resulting from the placement of equipment and materials or construction operation occurring outside of City rights-of-way or designated work areas shall be the sole responsibility of the Contractor. The Contractor shall make satisfactory settlement for any damage directly with the property owner involved.

2. The Contractor shall conduct the construction in such a manner to cause the least inconvenience to the citizens of the area, thereby maintaining good public relations. The Contractor shall not unnecessarily interfere with the use of any public or private improvements, including landscaping; nor shall he unnecessarily damage such improvements. The Contractor shall repair any damage to such improvements to pre-construction condition, or as otherwise directed by the Department of Public Works.
3. The Contractor shall use care in protecting existing property irons and monuments adjacent to his working area. If a property iron or monument must be removed to install new facilities, the Contractor shall retain the services of a properly registered surveyor to immediately replace it after construction of the new facilities.

D. Work within city rights-of-way, VDOT rights-of-way, and railroad property.

1. Permits. The Contractor shall be responsible for obtaining and paying for all permits, insurance, and bonds required to complete the Work.
2. The Contractor shall comply with all provisions of all permits required by the governing authorities at his own expense. The Contractor's responsibility under this paragraph may include, but is not limited to, the following:
 - a. Constructing and removing temporary facilities or structures.
 - b. Providing details of construction methods.
 - c. Providing detailed construction schedules.
 - d. Reimbursing the applicable authority for all expenses incurred by them in connection with the Work.
 - e. Traffic maintenance.
 - f. Coordination of scheduling with the authority.
 - g. Necessary clean up and restoration.
3. Maintenance of traffic.
 - a. The Contractor shall provide maintenance of traffic within the construction area for the duration of the construction period, including during any temporary suspension of Work. Maintenance of traffic shall conform to the current editions of the "Manual on Virginia Traffic Control Devices," "Virginia Work Area Protection Manual," "Virginia Department of Transportation Road and Bridge Specifications," and the "Virginia Department of Transportation Guidelines for Temporary Traffic Control."

- b. The Department of Public Works may provide a detailed Traffic Maintenance Plan for portions of the Work to be performed under this contract. If a Traffic Maintenance Plan is provided, the Contractor is required to conform to this plan. The Department of Public Works may require that the Contractor submit a Traffic Maintenance Plan prior to commencing work on a particular portion of the project. If The Contractor is asked to submit such a plan, work must not commence on the portion of the project covered by the plan until approval of the Traffic Maintenance Plan by the Department of Public Works.
 - c. The amount of roadway closure shall be limited to the immediate work area and shall be in accordance with the above-mentioned manuals and specifications.
 4. Maintenance of ingress and egress. The Contractor shall strive to maintain, at all times during the execution of the Work, continuous ingress and egress to all affected parcels and traveled ways. When ingress and egress to affected parcels must be blocked due to the direct execution of the Work, 24 hours advance notice must be given to the affected property owner. In no case shall the blocking of ingress and egress be allowed for more than 24 consecutive hours.
 5. Construction activities within City rights-of-way are subject to the requirements of the Department of Public Works. Contractor shall ascertain from the Department of Public Works its rules, regulations, and requirements.
 - a. The Contractor shall maintain traffic control in a safe and professional manner. All traffic control measures, including signage, shall be in conformance with VDOT "Guidelines for Temporary Traffic Control."
 - b. Contractor shall erect and maintain barriers, lights, and other necessary protective devices as required by the Department of Public Works. Road, sidewalk, or other access-way closure will only be allowed with prior approval of the Department of Public Works.
 - c. Required notice for work within City roadways is 7 calendar days.
 6. Construction within VDOT rights-of-way shall be subject to the approval and issuance of a construction permit by VDOT. Contractor shall at all times conduct his work and operations in accordance with the issued permit and the "Virginia Department of Transportation Road and Bridge Specifications." If required by VDOT, the Contractor shall submit for approval specific details of construction methods proposed for Work within VDOT rights-of-way.
 7. Materials and methods of construction used on railroad company property shall be subject to the approval of the railroad company. Contractor shall at all times conduct his work and operations fully within the railroad company's rules, regulations, and requirements. The Contractor must ascertain from the railroad company its rules, regulations, and requirements, and what, if any, delays may be encountered. If required by the railroad company, the Contractor must submit for approval specific details of the methods of construction he intends to utilize together with any sketches or drawings.

The Contractor must observe all necessary and appropriate safety precautions when working on railroad rights-of-way or property. At the discretion of the railroad, the Contractor shall

provide a qualified watchman or pay for a watchman supplied by the railroad to warn workmen of the approach of any train or other moving equipment upon the tracks of the railroad, and to keep all workmen or other persons, equipment, and materials from the tracks including any power, communication, and signal wires, so that there will be no contacts with trains, rolling equipment, or wires. Contractor shall comply with all railroad requirements

E. Welding of steel pipe and fittings.

1. All steel pipe and/or fittings, connections, and other fabrications within the gas distribution system shall be welded unless otherwise specified or directed by the Public Utilities - Gas Engineer. All welds shall be performed in accordance with the requirements of API 1104. Public Utilities - Gas may periodically ask for sample welds of the work in progress to test for quality. The kind, character, and disposition of all welds shall be subject to the approval of Public Utilities - Gas. All steel welding shall be performed by persons certified by the City on the City's welding procedures.
2. All welding material and/or equipment shall at all times be protected from damage and kept in good working condition. Filler metals and fluxes shall be protected from deterioration and excessive moisture changes. Welding rods and other materials that show signs of deterioration or damage shall be replaced. Welding machines, which, in the opinion of the Public Utilities - Gas Engineer, are in poor repair or are not of sufficient capacity to perform the Work shall be replaced at the Contractor's expense.
3. Suitable wind guards shall be provided to protect the Work during periods of excessive wind.

The Contractor shall, at the direction of the Department of Public Works, temporarily suspend all welding operations whenever conditions are not conducive to the performance of good work.

4. All steel pipe, fittings, connections, and fabrications shall be butt welded by either oxyacetylene gas welding or a manual, shielded arc welding process, unless alternative methods have been submitted to and approved by the Public Utilities - Gas Engineer.

All surfaces to be welded shall be properly cleaned and free of material that may be detrimental to the integrity of the completed weld. All paint, rust, scale, dirt, and other foreign materials that might adversely affect the welding operation, shall be removed.

The ends of pipe and/or fittings at all welded joints shall be properly beveled using an appropriate pipe-beveling machine as approved by the Engineer. Adjoining lengths of pipe shall be properly aligned and shall be accurately spaced. Each tack weld in steel pipe shall be a thickness of not more than 2/3 of the pipe wall. The tacking weld shall be free of pinholes. The completed weld shall have 100 percent of the pipe's strength at the point of tacking.

Each completed weld shall be free of overlaps, undercuts, excessive convexity, scale, oxides, pinholes, non-metallic inclusions, air pockets, and all other defects.

All welds shall be air-cooled. Accelerated cooling by any method shall not be permitted.

5. Arc burns on the pipe and/or fittings shall be removed by grinding, provided the resulting pipe wall thickness is not less than 90 percent of the required design wall thickness. Arc burns that grinding cannot repair and repair attempts that result in less than 90 percent of the original wall thickness shall be cut out.
6. Visual, nondestructive, and/or destructive testing procedures shall be implemented, as required by the Public Utilities - Gas Engineer, to determine the quality of all welds.

The Engineer may, at his discretion, require x-ray or other nondestructive testing of any and all welds prior to the initiation of coating or coating repair procedures. Should any weld prove to be defective for any reason, the Contractor shall assume any and all costs associated with the testing, cutting out, and replacement of the weld.

The Contractor shall be required, at his expense, to radiograph all welds within all railroad rights-of-way and all welds within the limits of all bridge crossings. In addition, the Contractor may be required to have certain welds radiographed, at his expense, to verify compliance with API 1104 Standards. Such tests shall be required on all welds identified by Public Utilities - Gas as resulting from poor welding techniques, previously identified substandard welds, and/or evidence of leakage during pressure testing.

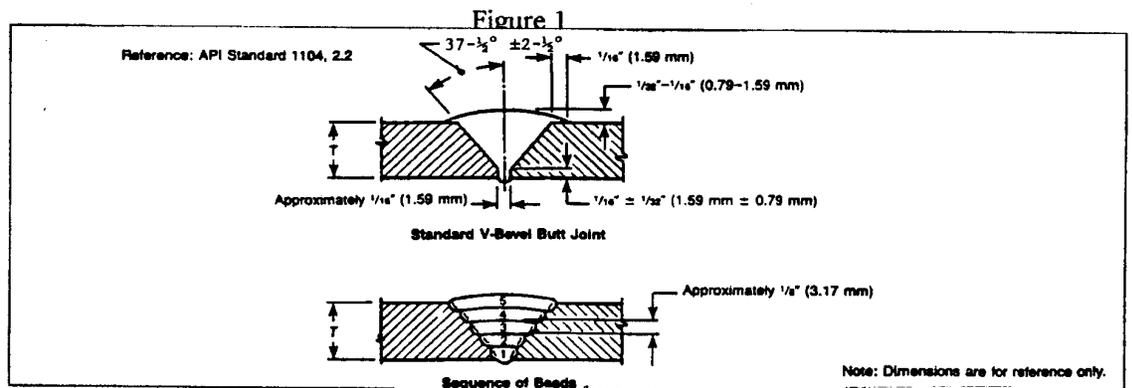
The Public Utilities - Gas Engineer shall make all determinations as to what constitutes an acceptable weld as well as the disposition of all defective welds. These determinations shall be made upon completion of either a visual or radiograph inspection.

7. Public Utilities - Gas welding procedures.

- a. Oxyacetylene gas welding.

- 1) *Process*: Oxyacetylene Gas Welding
- 2) *Material*: API Standard 5L Grade B Line Pipe
- 3) *Diameter and Wall Thickness*: Under 2.375, Less than 3/16"
- 4) *Joint Design*: Machine V bevel 30 + 5 (-) 0
- 5) *Filler Metal and Number of Beads*: One pass with steel rod
- 6) *Flame Characteristics*: Neutral flame
- 7) *Position*: Horizontal roll
- 8) *Direction of Welding*: Up-hill
- 9) *Number of Welders*: One
- 10) *Time Lapse Between Passes*: Not applicable
- 11) *Type of Line-up Clamp*: External
- 12) *Removal of Line-up Clamp*: After pipe has been tacked

- 13) *Cleaning*: Power and hand tools on completed weld
 - 14) *Preheat, Stress Relief*: Not required
 - 15) *Shielding Gas and Flow Rate*: Not required
 - 16) *Shielding Flux*: Not applicable
 - 17) *Speed of Travel*: As required
 - 18) *Sketched and Tabulations (To Be Attached)*: None
 - 19) A final visual inspection shall be done to verify the quality of the Weld.
- b. Manual, shielded arc welding.
- 1) *Process*. All welding done under this procedure shall be by the manual, shielded arc process.
 - 2) *Pipe and Fitting Material*. Pipe and fittings are to conform to API Standard 5L or the equivalent ASTM specifications and have a specified minimum yield strength less or equal to 42,000 pounds per square inch.
 - 3) *Diameter Group – Wall Thickness Group*. This procedure is for pipe diameters 2-3/8" to 12-3/4" inclusive and for pipe wall thickness of 3/16" to 3/4" inclusive.
 - 4) *Joint Design*. Joint to be butt weld of the standard "V" bevel. Pipe and fittings to have a $37\text{-}1/2 \pm 2\text{-}1/2^\circ$ bevel with root face of $1/16" \pm 1/32"$. Root space for welding to be approximately $1/16"$. See Figure 1.



- 5) *Filler Metal and Number of Beads*. All beads are to be made with electrodes of ASTM specification E-8010 such as Lincoln Shield – Arc 70+. The minimum number of beads to depend upon wall thickness of the pipe. For Schedule 40 pipe, the following minimum number of passes should be used:

Nominal Pipe Size	Minimum No. of Passes
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2"	2
3"	3
4"	3
6"	4
8"	4
10"	5
12"	5

- 6) *Electrical Characteristics.* Welding to be done with reverse polarity, direct current. The following voltage and amperage shall be used for the listed rod size.

Rod Size	Voltage	Amperage
1/8"	80-130	60-80
5/32"	120-190	70-90
3/32"	80-100	60-70

- 7) *Position.* All welding to be done with the pipe in a horizontal, fixed position.
- 8) *Direction of Weld.* All welding to be done in the downhill direction.
- 9) *Number of Welders.* Only one welder shall work on each weld in accordance with this specification.
- 10) *Time Lapse Between Passes.* The second pass shall be started within 5 minutes after completion of the stringer or root pass.
- 11) *Type of Line-Up Clamp.* As a standard, external line-up clamp is to be used for all welds. Care should be exercised to see that the clamps are properly adjusted.
- 12) *Removal of Line-up Clamp.* The external line-up clamp is not to be removed until there is sufficient support of the stringer bead.
- 13) *Cleaning.* The entire welded area shall be carefully cleaned with a power grinder or power wire brush between each pass.
- 14) *Preheat, Stress Relief.* Pipe ends to be welded shall be preheated to 150° - 200° F when the ambient temperature is below 32° F. Stress relieving is not required for this procedure.
- 15) *Inspection.* A final visual inspection shall be performed to verify the quality of the weld.

F. Heat fusion of polyethylene pipe and fittings.

1. General.

- a. All polyethylene pipe and fitting connections and other fabrications within the gas distribution system shall be made by heat fusion. Heat fusion shall include: butt

fusion, saddle fusion, and electrofusion. All fusions shall be performed by persons certified by the City on the City's fusion procedures.

- b. All heat fusion jointing procedures shall be performed in accordance with the City's fusion procedures.
- c. Heat fusion equipment shall at all times be protected from damage and kept in good working condition. Fusion equipment that shows signs of deterioration or damage shall be replaced. Heat fusion machines that, in the opinion of the Public Utilities - Gas Engineer, are in poor repair or are not of sufficient capacity to perform the Work shall not be used in conjunction with Work on the City's gas distribution system.
- d. Suitable wind guards shall be provided to protect the Work during periods of excessive wind or cold weather. When the ambient temperature is below 32° F, care must be taken to maintain the proper heater plate temperature.

The Contractor shall, at the direction of the Department of Public Works, temporarily suspend all heat fusion operations whenever conditions are not conducive to the performance of good work.

- e. All fused joints and other connections shall be air-cooled. Accelerated cooling by any method shall not be permitted.
 - f. Visual and destructive testing procedures shall be implemented as required by the Public Utilities - Gas Engineer to determine the quality of the fused joints. The Engineer may, at his discretion, require destructive testing and inspection of any or all fused joints prior to the initiation of backfilling or insertion operations. The Public Utilities - Gas Engineer shall make all determinations as to what constitutes an acceptable fused joint as well as the disposition of all defective joints. These determinations shall be made upon completion of a visual inspection. Defective joints shall be removed from the piping system at the Engineer's direction and at no cost to the City.
2. Polyethylene pipe fusion procedures. The following are the certified plastic (PE) fusion procedures that will be used for all PE fusion operations and for testing of appropriate personnel. All fusions shall be visually inspected as per Plexco Bulletin No. 106.
- a. Butt fusion.
 - 1) Clean pipe before facing operation.
 - 2) Align pipe ends.
 - 3) Face ends of pipe, remove shavings and check alignment. If re-alignment of pipe is necessary, then the facing operation has to be repeated to check alignment of the two ends of the pipe. Do not touch or clean faced ends of pipe after facing operation is completed.
 - 4) Pre-heat. Check temperature of heater iron to make sure that it is at a temperature of 500° ± 10° F (check with temperature sticks). Apply pressure until a bead of molten

material is first visible around the complete circumference of both ends of pipe, then heating time begins. Release pressure.

- 5) Heating cycle: No pressure applied (pipe ends to heater face) during heating time. Do not force bead to form; uniformly sized bead all around pipe on both ends. Pipe is properly heated when bead width matches the following table:

Pipe Size	Bead Width
1-1/4" to 3"	About 1/16"
3" to 6"	1/16" to 1/8"
6" to 8"	1/8" to 3/16"
8" and larger	3/16" to 1/4"

- 6) Fusion cycle: Apply pressure when bringing the heated ends of the pipe together to be fused. Bring heated pipe ends together quickly, **DO NOT SLAM THEM TOGETHER**. Apply enough pressure to roll out a bead that will roll back and touch pipe.
 - 7) The fused joint should be held steady in the fusion equipment for the recommended cooling time or until cool. Cool under pressure for about 30 seconds per inch of pipe diameter. Do not remove the fused joint from equipment for an additional 3 minutes after cooling. Clean heater faces – be careful not to damage the coated surfaces. Allow additional 20 to 60 minutes cooling time before rough handling or testing (longer times needed for larger sizes).
- b. Cross fusion procedures – butt fusion. Procedures are the same, except for the melt bead size. Should it be like materials, such as 3408 to 3408, but different manufacturers, use the manufacturer’s fusion melt cycle with the smaller bead size.
- c. Fusing tapping tees and service saddles.
- 1) Install sidewinder unit on pipe with proper pipe bolster and sidewall clamping inserts. Use bolster plats on 4" IPS and smaller sizes.
 - 2) Abrade fusion surface of fitting base and main with medium grit emery cloth. A thin surface must be removed. Abrade a large enough area on the main so the heater will seat only on abraded surface. Brush residue away with a clean, dry cloth.
 - 3) Insert the fitting chimney into the sidewinder pivot release master and slightly tighten knurled handle. Lower fitting onto the main and apply about 150 lbs. of pressure, seating the fitting to the main. Tighten knurled handle. Lower pressure on fitting and raise off main.
 - 4) Check heater faces for 500° ±10° F surface temperature.
 - 5) Place heating iron on main centered beneath fitting. Lower fitting against heater face. Watch for proper melt bead on the crown of pipe. See table below for proper melt bead size. During heating, the heating iron may be rocked about 2 percent to assure full contact with the main surface.

Force Applied During Heating and Fusion

	Heating	Fusion and Cooling
Standard Tapping Tee and Service Saddle	All sizes: 60#	All sizes: 60#
HVTT and Branch Saddle	All sizes: 120#	2": 70# 3": 90# 4" and 6": 110#

Approximate Melt Bead Size

Pipe Size	Bead Thickness
1-1/4"	1/32"
2"	1/16"
3" & larger	1/8"

- 6) Raise fitting from heater and heater from main with quick snapping action and quickly inspect melt surface for full release from iron and complete melting. If surfaces are unacceptable, continue with steps 7 and 8, then cut off top of fitting to prevent use, and apply a new fitting to a new section of main.
 - 7) Within 3 seconds from heater removal, press fitting onto pipe with firm pressure. See Force Applied During Heating and Fusion above.
 - 8) After 3 more minutes cooling time, remove sidewinder.
 - 9) Inspect fusion for full melt around fitting base: If bead appearance is unacceptable, cut off top of fitting to prevent use.
 - 10) Let fusion cool for an additional 10 minutes prior to pressure testing and tapping out procedures.
- d. Socket fusion procedures (up to and including 4")
- 1) Using pipe cutter, cut off damaged or oval ends of the pipe squarely.
 - 2) Use chamfering tool to remove about 1/16" of the shaped corner at the pipe end on the outside surface of the pipe size 1-1/4" I.P.S. and larger. Remove burrs and chips inside pipe ends.
 - 3) To prepare pipe for correct penetration into socket, place depth gauge down flush on end of pipe.
 - 4) Place cold ring clamp around pipe, adjacent to depth gauge. After securing cold ring clamp, remove depth gauge.
 - 5) Fitting surfaces and pipe ends should be roughed up using medium grit emery cloth and wipe clean with dry, clean cloth - do not touch with your hands.

- 6) Check temperature of heater face to make sure it is at $500^{\circ} \pm 10^{\circ}$ F and that the surfaces are clean.
- 7) Firmly seal the socket fitting on the male face of the heating tool. Then place the female face on the end of the pipe firmly against the cold ring clamp.

Heating time starts now. Check manufacturer's recommended fusion time cycle card for the heating time for the particular make and size being used.

Note: While holding the fitting firmly in a fixed position, rotate heating tool slightly to feel the melt and promote uniform heating of pipe and fitting.

- 8) Remove the heating tool and fitting from melted pipe. Immediately remove fitting from heating tool.
- 9) Inspect the heated parts quickly to make sure all surfaces have been melted.

Note: If melt is not complete, cut off melted pipe end, use a new fitting and repeat fusion steps 1 through 8.

- 10) Within 3 seconds after the heating tool has been removed, firmly push the melted fitting squarely onto the pipe until it makes firm contact with the cold ring clamp.

DO NOT TWIST

Hold the fitting firmly in place for the recommended cooling time found on the manufacturer's fusion time cycle card. After waiting the additional 3 minutes cooling time, remove the cold ring clamp and inspect the joint.

A good joint will have a uniform melt ring that is flat against the socket and perpendicular to the pipe.

There should be no cavity between the fitting and the pipe.

- 11) Wait an additional 10 minutes to complete cooling before the pipe joint is tested or stressed during burial.
- e. Electro-fusion certification procedures. All fusions shall be visually inspected as per Innogaz Bulletin No. QM-90-5.
- 1) Cut pipe square.
 - 2) The pipe ends are laid along side of the coupling until they butt together at molded centerline of the coupling. CLEARLY mark the proper insertion depth on both ends of the pipe.
 - 3) Using the pipe scrapper, scrape off surface oxidation of all area of the pipe to be fused, up to the previously made marks. Re-mark pipe if necessary as explained above. Scraped areas must be kept clean (see caution notes below.)

- 4) Secure one pipe end into alignment clamp so that the end of the pipe is at the centerline of the clamp. Clean pipe ends and coupling with alcohol impregnated cloth. (Note: If necessary, re-mark pipe with coupling as above.)
- 5) Slide coupling fully onto clamped pipe end.
- 6) Install second pipe end into alignment clamp, until it butts against the first pipe, then secure it within the clamp. Check alignment of pipe ends. Clean pipe ends again, if necessary, with alcohol.
- 7) Center coupling by sliding it back onto second pipe. Make sure it is properly centered by viewing both of the previously made insertion depth marks. Make sure coupling turns freely on both pipe ends, not binding (see caution notes below).
- 8) Test proper function of micro-pressure sensors.
- 9) Remove protective caps from terminal wells of the fitting.
- 10) Connect fusion control box leads to fitting. Ensure leads are connected properly.
- 11) Activate the fusion cycle. When the fusion is complete, the fusion "END" light on the control box will light.
- 12) Allow proper cooling time before removing fusion leads and clamp (see cooling timetable below).

NOMINAL O.D.	FUSION TIME*	COOLING TIME
1/2"	23 sec.	40 min.
1-1/4"	43 sec.	30 min.
2"	76 sec.	40 min.
3"	130 sec.	40 min.
4"	250 sec.	60 min.
6"	350 sec.	60 min.

*Average value with 39.5 volts at 68° F ambient.

- 13) Soap leak test all joints.
- 14) CAUTIONS:
 - a) Ensure that fusion areas of the pipe and fitting are kept free of contaminants (grease, mud, moisture, etc.) prior to the fusion. Make sure that all areas of pipe over which coupling or tapping tees will be slid or positioned are free of such contaminants. If contamination is present, or has occurred, additional cleaning with an alcohol-impregnated cloth will be necessary. Allow drying of pipe before fusion.
 - b) Failure to properly center the coupling over the butted-together pipe may result in a "short stab" and failure of the joint. If this occurs, the coupling must be removed and the pipe rejoined with a new coupling.

- c) The coupling must not move during the fusion and until it has properly cooled. If movement inadvertently occurs, the coupling must be cut out and the joint refused. After the electro-fusion of each joint, allow each one to cool at least 1 hour (or in compliance with the test procedures of CFR Title 49, Part 192.283) before proceeding to the Inspection and Testing phase of this qualification procedure.

3.02 PIPE LOCATING DEVICES

- A. The Contractor shall install tracer wire with all polyethylene pipe to facilitate location of the pipe with commercially available electronic pipe locators. **Warning tape shall also be installed with all direct buried mains and shall be continuous over the length of the mains.** Installation of tracer wire and warning tape shall be as noted below:

INSTALLATION OF LOCATING DEVICES

Method of Construction	Tracer Wire Location	Locating Tape Location
Direct bury	4" min./12" max. above pipe	Min. 12" above pipe
Directional drill	Pull through drill hole with pipe	Not required
Plow-in	4" min./12" max. above pipe	Min. 12" above pipe
Bored	Pull through bore hole or casing with pipe	Not required

- B. Electrically conductive tracer wire.
 1. The Contractor shall be required to install an electrically conductive tracer wire as a means of facilitating the location of buried or inserted polyethylene pipe.
 2. When polyethylene pipe is installed by directional drilling or boring, the tracer wire shall be attached to the bull-nose in order to facilitate installation.
 3. Polyethylene pipe that is plowed-in shall be installed with the tracer wire attached to the plow blade such that the tracer wire will be plowed-in 4 to 12 inches above the top of the pipe.
 4. For the installation of polyethylene service lines, tracer wire shall be installed with the piping. The tracer wire shall terminate above ground and shall be sleeved in 1/2" PE pipe and taped to the riser below the shut-off valve. The tracer wire shall not be bonded to the anode-less riser.
 5. The tracer wire shall be pulled into each locating station with sufficient slack to extend a minimum of 24 inches above finished grade. The tracer wire shall not be cut, but should remain continuous. Any underground connections shall be made with a 3M underground splice kit, or approved equal.
 6. In the event that the continuity of the tracer wire is broken during installation, the Contractor shall repair with 3M underground splice kit (or equal) at no additional cost to the City.
 7. Tracer wire shall not be mechanically fastened to the pipe, and under no circumstances shall the tracer wire be wrapped around polyethylene pipe.

8. Where new tracer wire is connected to existing tracer wire or where separate spools of tracer wire are connected, the tracer wire shall be spliced using a 3M underground splice kit, or approved equal.
- C. Warning tape. The Contractor shall be required to install warning tape as a safety measure for all direct buried gas mains and services. Where new warning tape is connected to existing warning tape or where separate rolls of warning tape are connected, the warning tape shall be joined to provide continuous coverage over the mains and services.

3.03 INSTALLATION BY DIRECT BURY (OPEN TRENCH)

A. General.

1. Trench excavation, pipe bedding, and backfill shall conform to the requirements of Section 02200, Excavation and Backfill; Section 02230, Fill and Granular Fill Materials; and trench detail drawings.
2. The requirements of 3.01 above shall apply.
3. Excavate trenches below the pipe bottom by the amount specified on the trench detail drawings for the material and conditions present. Remove all loose and unsuitable material from the trench bottom. Carefully and thoroughly compact pipe bedding with hand-held compactors.
4. A firm, even bearing throughout the length of the pipe shall be constructed of compacted fine aggregate or rock-free selected materials as noted in the Detail Drawings.
5. It is important that stresses induced in the pipeline by construction be minimized. The pipe shall fit the ditch without the use of external force to hold it in place until the backfill is complete. Where long sections of pipe have been welded or fused either alongside or over the ditch and lowering is necessary, care shall be exercised so as not to jerk the pipe or impose any strains that may put a kink or a permanent bend in the pipe. The pipe shall be carefully handled while lowering so as to avoid rolling or skidding on the carrying ties, or other hard surfaces, and in a manner that will prevent coating lacerations, cuts, grooves, scratches, or other damage to pipe or coating. Under no circumstances shall any length or portion of pipe be dragged, slid, pushed, or pulled on any surface to the trench.
6. The Contractor shall install warning tape as a safety measure for all direct buried gas mains. Warning tape shall be located as noted in 3.02 A above and shall be continuous over the length of the main. Where new warning tape is connected to existing warning tape or where separate rolls of warning tape are connected, the warning tape shall be joined to provide continuous coverage over the mains and services.

B. Steel pipe and fittings.

1. The requirements of 3.01 A, B, and C above shall apply.
2. The joining of all steel pipe and fittings shall be by welding as specified in paragraph 3.01 D above unless approved otherwise by the Public Utilities - Gas Engineer. All personnel performing welds on the gas distribution system shall be qualified in accordance with Section 15075, Part 3.

3. The requirements of Part 3.03 A above shall apply.
4. All changes in direction required in the installation of the piping shall be made by standard weld fittings or cold bending of pipe. Where the pipe cannot be bent or the angle is such that standard fittings cannot be used, fittings are to be cut to the required angle. Miter cutting and welding of the pipe will not be allowed.
 - a. All bends in steel pipe shall be made by a smooth bending method. They shall be made with a bending shoe, as approved by the Public Utilities - Gas Engineer. When bends are required in steel pipe, they shall be made in the pipe section prior to welding said bent section to the rest of the piping. Bends shall be free of wrinkles, buckles, cracks, or other evidence of damage or characteristics that, in the opinion of the Engineer, will reduce the quality of the finished pipeline. Miter bends shall not be accepted. In no case shall a bend section contain a weld joint. The longitudinal weld of steel pipe shall be located near the neutral axis of the bend.

Field bends in steel pipelines that damage the pipe coating shall require the area of damaged coating to be repaired with a hot applied wrap, tape, or other approved coating material prior to lowering the pipe into the trench.
 - b. Bends in steel pipe to be made with fabricated fittings shall be made with standard weight long radius weld fittings approved by Public Utilities - Gas.
5. The Contractor shall apply protective coating to ends of pipes, fittings, joints, etc., and shall repair all pipe coating damage prior to placing pipe within trench.
 - a. The Contractor shall furnish high voltage electric detectors of a type approved by Public Utilities - Gas to verify that no breaks exist in the coatings on steel pipe at the time of backfill. All such breaks shall be repaired and such repairs shall again be tested with the detectors to make sure that repairs are adequate.
 - b. All pipe coating to be patched or joints to be wrapped shall be thoroughly cleaned of all dirt, rust, and scale. Damaged mill coating shall be removed down to clean metal.
 - c. Primers shall be applied over clean steel pipe and the primed pipe shall be kept clean of any foreign matter until after the primer has properly cured and until after the coating has been applied. Joint wrapping tape shall be installed in accordance with manufacturer's recommendations.
6. Trench shall not be backfilled until a smooth, firm, and continuous support exists along the entire length of the pipe.
7. Backfill shall conform to the requirements of Section 02200. The backfill placed from the bottom of the trench to the top of the pipe shall be placed in the trench simultaneously on both sides of the pipe for the full width of the trench in layers not to exceed 6 inches in depth. The backfill material shall be thoroughly compacted under and on each side of the pipe to provide solid backing against the external surface of the pipe and to remove all voids. The trench may be backfilled from 1 foot above the pipe to the top of the trench in layers not to exceed 12 inches.

8. All trenched construction shall be compacted by means of rolling, tamping with mechanical rammers, or hand tamping such that no future settlement of the trench backfill will occur. If vibratory rollers are used for backfill compaction, vibratory motors shall not be activated until at least 2 feet of backfill has been placed and compacted around the pipe. Backfill compaction achieved by means of driving any type of construction equipment and/or vehicles, other than those specifically designed for trench compaction work, across any part of the trench shall not be permitted. The Contractor shall refill and compact backfill areas where settlement occurs.
9. The Contractor shall install warning tape as a safety measure for all direct buried gas mains. Warning tape shall be located 12 inches minimum above the pipe and shall be continuous over the length of the main. Where new warning tape is connected to existing warning tape or where separate rolls of warning tape are connected, the warning tape shall be joined to provide continuous coverage over the mains and services.

C. Polyethylene pipe and fittings.

1. The joining of all polyethylene (PE) pipe and fittings shall be by heat fusion as specified in paragraph 3.01 E above unless approved otherwise by the Public Utilities - Gas Engineer. All personnel performing heat fusion operations on the gas distribution system shall be qualified in accordance with Section 15065, Part 3.
2. The requirements of Part 3.03 A above shall apply.
3. The Contractor shall exercise due care during handling to prevent gouges, scratches, cuts, kinks, or punctures in the pipe. All defects or damage which could impair the serviceability of the polyethylene pipe, in the opinion of the Public Utilities - Gas Engineer, including cuts, gouges, or scratches which are deeper than 10 percent of the wall thickness of the pipe, shall be removed from the pipe joint or the piping system. When loading, unloading, moving, and placing polyethylene pipe, the Contractor shall avoid dropping or dragging the pipe. Chains shall not be used for handling polyethylene pipe. Belt slings and/or padded calipers that are sized to the particular pipe being laid shall be used to handle the pipe provided such slings or calipers are free of all characteristics that might damage the pipe.
4. All changes in direction required in the installation of the piping shall be made by bending the pipe no less than a minimum radius of 25 times the pipe outside diameter, or by use of standard fusion fittings.
5. Polyethylene pipe shall be installed in accordance with the manufacturer's recommendations, these specifications, and Public Utilities - Gas representative's instructions. Low points in the line shall be bent so that the pipe will bear firmly on the bottom of the trench.
6. All PE pipe greater than 2 inches shall be jointed by butt fusion. PE pipe 2 inches and smaller shall be jointed by socket fusion.
7. Polyethylene piping shall be installed in such a way that shear or tensile stresses resulting from construction, backfill, thermal contraction and external loading are minimized. The piping shall be laid on undisturbed soil or well-compacted granular bedding. Blocking shall not support the piping.

Polyethylene pipe shall be installed with sufficient slack to provide for possible thermal contraction. Under extremely high temperature conditions, cooling may be necessary before the last connection is made.

Pipe shall be lowered in such a manner as to prevent surface damage from abrasions, scuffing, or sharp protrusions.

Pipe shall be inspected for defects before lowering it into the trench.

8. The Contractor shall install an electrically conductive tracer wire as a means of facilitating the location of buried polyethylene pipe. Tracer wire shall be TW insulated, AWG #12 minimum size, solid-copper wire.

Tracer wire shall not be mechanically fastened to the pipe, and under no circumstances shall the tracer wire be wrapped around the polyethylene pipe. Where new tracer wire is connected to existing tracer wire or where separate spools of tracer wire are connected, the trace wire shall be spliced using a 3M underground splice kit, or approved equal. The tracer wire shall be located 4 to 12 inches above the top of the pipe.

9. Backfill shall conform to the requirements of Section 02200. The backfill placed from the bottom of the ditch to the top of the pipe shall be placed in the trench simultaneously on both sides of the pipe for the full width of the trench in layers not to exceed 6 inches in depth. The backfill material shall be thoroughly compacted under and on each side of the pipe to provide solid backing against the external surface of the pipe and to remove all voids. The trench may be backfilled from 1 foot above the pipe to the top of the trench in layers not to exceed 12 inches.
10. All trenched construction shall be compacted by means of rolling, tamping with mechanical rammers, or hand tamping such that no future settlement of the trench backfill will occur. If vibratory rollers are used for backfill compaction, vibratory motors shall not be activated until at least 2 feet of backfill has been placed and compacted around the pipe. Backfill compaction achieved by means of driving any type of construction equipment and/or vehicles, other than those specifically designed for trench compaction work, across any part of the trench shall not be permitted. The Contractor shall refill and compact backfill areas where settlement occurs.
11. The Contractor shall install warning tape as a safety measure for all direct buried gas mains and services. Warning tape shall be located 12 inches minimum above the top of pipe and shall be continuous over the length of the main. Where new warning tape is connected to existing warning tape or where separate rolls of warning tape are connected, the warning tape shall be joined to provide continuous coverage over the mains and services.

3.04 INSTALLATION BY PLOWING

- A. When the integrity of the pipe will not be compromised, polyethylene pipelines up to 2 inches in nominal diameter may be installed by plowing as an alternative means of installation. Plowing shall not be allowed in rocky soils, congested areas, or any other areas deemed inappropriate by the Public Utilities - Gas Engineer. The Public Utilities - Gas Engineer will make all determinations as to where the Contractor shall be allowed to plow-in pipe.
- B. The requirements of 3.01 A, B, C, and E above shall apply.

- C. The joining of all polyethylene (PE) pipe and fittings shall be by heat fusion as specified in paragraph 3.01 E above unless approved otherwise by the Public Utilities - Gas Engineer. All personnel performing heat fusion operations on the gas distribution system shall be qualified in accordance with Section 15065, Part 3.
- D. The Contractor shall be allowed to plow-in a section of pipe 300 feet or less in length at a time. The pipe shall be inspected at sufficient intervals, by means of bell holes, and at all exit holes, to determine the condition of the pipe. A minimum of one bell hole, located at the midpoint of the plowed segment, shall be required for inspection purposes. Stretched, gouged, scratched, kinked, or cut pipe will not be accepted. If damage to the pipe is noted, the earth shall be excavated away from the pipe in both directions until the full extent of the damage is exposed to the satisfaction of the Engineer. The damaged pipe shall then be cut out and replaced.
- E. Polyethylene pipe shall be allowed to relax for a sufficient length of time prior to joining sections of plowed-in pipe or making tie-ins to existing mains. Sections of plowed-in pipe to be joined or tied into existing mains shall be sufficiently overlapped in the tie-in bell holes to allow for shrinkage due to relaxation of the pipe. Fused joints shall be allowed to cool for a minimum of 20 minutes prior to being installed by plowing.
- F. Tracer wire shall be installed along with all plowed in polyethylene pipe. Tracer wire shall not be mechanically fastened to the pipe, and under no circumstances shall the tracer wire be wrapped around the polyethylene pipe. Where new tracer wire is connected to existing tracer wire or where separate spools of tracer wire are connected, the trace wire shall be spliced using a 3M underground splice kit, or approved equal. The tracer wire shall be located 4 to 12 inches above the top of the pipe.
- G. The Contractor shall install warning tape as a safety measure for all plowed-in gas mains or services. Warning tape shall be located 12 inches minimum above the top of pipe and shall be continuous over the length of the main. Where new warning tape is connected to existing warning tape or where separate rolls of warning tape are connected, the warning tape shall be joined to provide continuous coverage over the mains and services.

3.05 INSTALLATION BY DIRECTIONAL DRILLING

- A. The Contractor may, with approval from the Public Utilities - Gas Engineer, choose to utilize directional drilling as an alternative method of installing polyethylene and steel gas mains or services. Prior to commencing directional drilling operations, the Contractor shall provide proof to the Department of Public Works that the personnel performing the drilling operations have a minimum of 1-year experience performing directional drilling operations of this type.
- B. The requirements of 3.01 above shall apply.
- C. The length of each continuous directionally drilled installation shall be limited by the size and type of drilling equipment utilized for the operation, or as otherwise determined by Public Utilities - Gas. A minimum of 1 bell hole per 500-foot interval shall be excavated around the pipe to verify its location, depth, and structural integrity. The sending and receiving pits for the directional drilling operation shall not be considered as part of the required number of inspection bell holes.
- D. Tracer wire shall be installed along with all directionally drilled polyethylene pipe. Tracer wire shall not be mechanically fastened to the pipe, and under no circumstances shall the tracer wire be

wrapped around the polyethylene pipe. Where new tracer wire is connected to existing tracer wire or where separate spools of tracer wire are connected, the tracer wire shall be spliced using an approved waterproof splice kit.

- E. Equipment. The directional drilling equipment used for pipe installation as specified herein shall be subject to the approval of Public Utilities - Gas and shall incorporate the following features:
1. The system shall be remotely steerable, permitting control of horizontal and vertical alignment within ± 2 inches.
 2. The system shall provide for electronic monitoring of horizontal and vertical alignment. The locating tool shall be calibrated daily to an accuracy of ± 2 inches.
 3. The system shall be capable of turning 90° in a radius of 35 feet.
 4. The system may utilize an inert and environmentally safe drilling fluid. No toxic or otherwise hazardous chemical additive shall be added to the drilling fluid.
 5. Back reaming bits shall be of a diameter at least 2 inches larger than the outside diameter of the pipe to be installed.
 6. Drilling equipment shall be fitted with a permanent alarm system capable of detecting an electric current. The system shall have an audible alarm to warn the operator when the drill head nears electrified cables.

- F. Procedure. The leading end of the pipe shall be capped prior to insertion through the boring hole or sleeve.

A “weak link,” consisting of smaller diameter pipe or tubing or an approved commercially available fitting, shall be fused to the leading end of the main or service being pulled. Standard pipe used as the weak link shall be half the diameter of the main or service being installed and shall be a minimum of 3 feet in length.

If the weak length breaks or is otherwise substantially damaged during installation, the drilling operation shall be abandoned and new undamaged main or service piping reinstalled at the Contractor’s expense.

The leading 6 feet of the installed main or service shall be pulled through the receiving pit and inspected. If any abrasions, gouges, or lacerations are present which, in the opinion of the Department of Public Works, may compromise the integrity of the pipe, the pipe shall be exposed back to the point where the damage originated. All damaged pipe that is determined by the Department of Public Works to be unacceptable shall be removed and replaced at the Contractor’s expense.

3.06 INSTALLATION BY BORING

A. General.

1. Contractor shall install bored crossings where indicated on the Plans.
2. The requirements of 3.01 above shall apply.
3. All boring methods shall be subject to the approval of the Public Utilities - Gas Engineer, and may include: dry boring, boring and jacking, auguring, and pushing. The boring methods and equipment utilized shall be industry proven and acceptable to Public Utilities - Gas. All employees of the Contractor utilized in boring operations shall be trained and experienced with the specific boring method and equipment chosen. The Contractor shall, as required, provide Public Utilities - Gas with documentation of said training and experience.

All boring equipment utilized shall be properly sized to install the casing or carrier pipe without removing any excess soil. The diameter of the auger used in any boring operation shall not, in any case, be greater than 4 inches larger than the outside diameter of the casing or carrier pipe to be installed.

4. Boring operations shall be performed in such a manner that settlement, displacement, distortion, or any other damage to the existing ground surface, utilities, and/or structures will not occur. Where a utility is damaged or severely displaced, the authority having jurisdiction over the utility shall be contacted immediately. The Contractor shall be responsible for promptly repairing or having repaired any such damage, to the Department of Public Works’ and affected utility owner’s satisfaction, at no cost to the City.

Boring operations shall at all times be conducted in a manner that does not create a hazard or impede the flow of traffic.

5. Casing or carrier pipe installation shall be performed immediately upon completion of the boring operation. Soil voids that remain around the pipe after installation shall be properly filled with hydraulic cement grout, as directed by the Public Utilities - Gas Engineer. The grout shall be placed under pressure in a manner approved by the Engineer.

If the bored casing or carrier pipe strikes an obstruction during installation, the cost of removing the obstruction shall be borne by the Contractor. If the obstruction cannot be removed, the boring operation shall be abandoned, the pipe filled with cement grout, and plugged. The bore shall be reattempted at a different location as directed by the Public Utilities - Gas Engineer. The Contractor shall be responsible for any and all costs associated with an abandoned bore. No payment will be allowed for the abandoned section(s) of pipe or casing.

6. When, in the opinion of the Public Utilities - Gas Engineer, a completed bore results in a deficiency which renders the pipe unusable, including but not limited to: insufficient cover; insufficient clearance with existing underground utilities and/or structures; excessive curvature of the pipe; excessive damage to the pipe and/or coating; or failure to stay within the right-of-way, the bore shall be abandoned; the pipe filled with cement grout and plugged; and a new bore completed at no additional cost to the City.
7. The lengths of all required bores shall be as shown on the Plans or as otherwise directed by Public Utilities - Gas.

B. Bored crossings with casing.

1. All bored crossings shall include casing unless shown otherwise on the Plans or directed by the Public Utilities - Gas Engineer. Under extenuating circumstances, the Contractor may, with the approval of the Public Utilities - Gas Engineer and the governing jurisdiction, install casing by open cut (direct bury).
2. The casing pipe shall be a minimum of 4 inches larger than the outside diameter of the carrier pipe, joints, or couplings. The Contractor may, upon the approval of the Public Utilities - Gas Engineer, install a larger diameter casing pipe than is specified or otherwise shown on the Plans. If a larger diameter casing pipe is installed, all minimum cover and clearance requirements, as specified herein, shall be met.
3. The casing pipe shall be installed true to line and grade; sloping to one end with an even bearing throughout its length. The casing pipe installation shall be made so as to allow free and unrestricted movement of the carrier pipe during insertion. Lengths of steel casing pipe shall be joined by welding the joints completely around the circumference of the pipe. All steel casing pipe shall receive cathodic protection.
4. Casing pipe vents shall be installed at the ends of the casing pipe as shown on the detail drawings. The vents shall be painted above grade with a corrosion resistant primer and paint as directed by Public Utilities - Gas. The vent openings shall be screened and turned downward. Approved gas warning signs shall be attached to the vents or placed immediately adjacent to the vent at each end of the casing pipe. Both ends of all casing pipe installations shall be sealed.
5. Insulating casing spacers shall be used with all encased piping. Placement of casing spacers shall be as noted on the Detail Drawings. Steel carrier pipe shall be checked for electrical isolation from the steel casing immediately following insertion. The Contractor shall correct any

shorting to the casing and/or carrier pipe using a method approved by the Public Utilities - Gas Engineer at not additional cost to the City. Cathodic protection test stations shall be installed at each casing per the construction Plans. Public Utilities - Gas shall be contacted to verify and approve all cathodic protection devices and connections prior to backfilling.

For a polyethylene piping system, the casing pipe shall be prepared to the extent necessary to remove any sharp edges, projections, or abrasive material which could damage the piping during and after insertion. Polyethylene pipe shall be inserted into the casing pipe in such a manner so as to protect the polyethylene pipe from damage. The leading end of the polyethylene pipe shall be capped prior to insertion.

- C. Bored crossings without casing.
 - 1. Certain boring operations, as indicated on the Plans or as otherwise directed by the Public Utilities - Gas Engineer, may not require the main or service to be installed within a casing.
 - 2. Tracer wire shall be installed along with all polyethylene carrier pipes bored without a casing pipe.

3.07 STREAM CROSSINGS

- A. The requirements of 3.01 above shall apply.
- B. Where gas mains or services cross watercourses or drainage ditches, the pipe shall be provided with a minimum of 48 inches cover between the top of the pipe and the bottom of the watercourse or ditch. The pipe shall be fitted to the terrain with any necessary bends and/or fittings. Bends shall not exceed the minimum bending radius specified by the manufacturer.
- C. The Contractor shall perform all pipe installation operations in a manner that will minimize disturbances to the watercourse. The appropriate diversion channels, flumes, and/or cofferdams shall be installed and maintained in accordance with the "Virginia Erosion and Sediment Control Handbook," latest edition.
- D. The watercourse banks shall be backfilled to the original alignment of the bank line (maximum slope of 1:1) and protected from erosion, as indicated on the Plans and in accordance with the "Virginia Erosion and Sediment Control Handbook," latest edition, and any other regulatory agencies, as required. Where necessary, the Contractor shall obtain all required permits for stream crossings. The Contractor shall comply with all provisions of the permits.

3.08 INSTALLATION IN RAILROAD RIGHTS-OF-WAY

- A. The requirements of 3.01 above shall apply.

- B. Piping passing under the right-of-way of a commercial railroad shall be installed in accordance with Part 5 of the American Railway Engineering Association (AREA) Specifications, or as otherwise directed by the railway company permit requirements. Where necessary, the City will obtain all required permits for installations in railroad rights-of-way. The contractor shall comply with all provisions of the permits.

3.09 INSTALLATION BY INSERTION

A. General.

1. Polyethylene gas mains and services may be installed by insertion within existing iron and steel mains and/or services as indicated on the Plans, or as otherwise directed by the Public Utilities - Gas Engineer.
2. Prior to insertion, a tapered nose plug or suitable end cap shall be installed on the leading end of the polyethylene pipe.
3. The external fusion bead on butt-fused pipe may be removed with a bead cutter prior to insertion, if so desired, to ease the insertion process.
4. Extreme care shall be taken to ensure the polyethylene pipe is not dragged, pushed, pulled, or rolled across the ground at any time during the insertion process.
5. Protective sleeves shall be used between the carrier pipe and the edge of the existing service line.
6. **Under no circumstances shall the Contractor operate any existing valves within the City distribution system.**
7. The requirements of Part 3.01 A, B, C, and E above shall apply.

B. Live insertion.

1. The Contractor shall utilize live insertion as a method of installing polyethylene pipe within low-pressure metallic gas mains or services only when shown on the Plans or as otherwise directed by the Public Utilities - Gas Engineer.
2. The live insertion method and equipment utilized shall be industry proven and accepted, subject to the approval of the Engineer. All employees of the Contractor performing live insertion operations shall be trained for and experienced with the specific live insertion method and equipment chosen. The Contractor shall provide the Engineer with documentation of said training and experience.

C. Dead insertion.

1. The Contractor shall utilize dead insertion as a method of installing polyethylene mains and services only where shown on the Plans or as otherwise directed by the Public Utilities - Gas Engineer.

2. Prior to insertion, the section of existing main or service (host pipe) shall be isolated from the rest of the distribution system and purged of all natural gas. The host pipe shall be prepared to receive the inserted polyethylene pipe by removing all valves, couplings, fittings, sharp edges, projections, punch coupons, dirt, and welding slag which would otherwise hinder the insertion process and/or damage the inserted pipe.
 3. The dead insertion method and equipment utilized shall be industry proven and accepted. All employees of the Contractor performing dead insertion operations shall be experienced with the specific dead insertion method and equipment chosen. The Contractor shall provide the Department of Public Works with documentation of adequate experience.
- D. At all locations where tees, valves, service saddles and/or other fittings are installed on an inserted polyethylene main, a section of the host pipe shall be cut out to provide adequate clearance for the operation of the required fusion equipment. The cut out section shall be adequate to allow full cycle expansion and contraction of the inserted polyethylene pipe without the risk of the fused fittings, valves, or couplings being pulled into or against the ends of the host pipe.

Protective sleeves constructed of fiberglass reinforced polyethylene (FRP) shall be permanently installed between the host pipe and the inserted polyethylene pipe at all locations where the existing pipe and/or fittings have been removed to accommodate the inserted pipe and/or fittings. The FRP sleeves shall be designed and located so as to protect the polyethylene pipe and fittings from cuts, scratches, gouges, and external shear loads.

3.10 TESTING OF PIPING

- A. Test in accordance with Section 15060.

3.11 TIE-INS TO EXISTING SYSTEM

- A. It is the responsibility of the Contractor to connect the Work to existing or previously installed facilities as shown on the Plans or as directed by the Public Utilities - Gas Engineer.
- B. The Contractor shall have available the appropriate drilling, tapping, and stopping equipment necessary for the various fittings shown on the Plans and trained and experienced personnel to operate this equipment. The tie-in operations shall be performed in a sequence as directed by the Public Utilities - Gas Engineer.

The Contractor shall have available the appropriate squeeze-off tools for polyethylene pipe. Squeeze-off operations will be allowed on polyethylene pipe which is 4 inches or smaller. All points on the pipe where the squeeze-off is applied shall have a full encirclement clamp or an electrofusion coupling installed to mark the location and to reinforce the pipe.

- C. All tie-in operations, including but not limited to installation of the tie-in fittings and main and/or service line blow-downs, shall be performed under the direct supervision of the Public Utilities - Gas Engineer or his representative. The Contractor shall provide the Engineer with at least 48 hours advance notice prior to initiating tie-in procedures.
- D. The Contractor shall not commence any tie-in operations until the new mains and/or services have been cleaned and tested.

- E. **Under no circumstances shall the Contractor operate any valves within the existing gas distribution system, or otherwise interrupt or restore gas service to any customer. City personnel shall perform all valve operations and service restorations, as required.**

3.12 AS-BUILT DOCUMENTS

- A. Upon completion of the project, the Contractor shall provide the Department of Public Works with one complete set of as-built Plans. The as-built Plans shall be updated daily during the course of construction and shall be made available to the Public Utilities – Gas representative for review prior to each request for progress payment. Progress payments may be withheld from the Contractor for his failure to maintain neat, accurate, and complete as-built documentation.
- B. As-built documentation shall include the following minimum information, as applicable:
 - 1. Size, type, material, and horizontal and vertical location of any and all existing utilities exposed during the course of the Work, including but not limited to telephone cables and conduits, TV cables, electrical cables and conduits, gas mains, water mains and services, sewer force mains, sanitary sewers, and storm sewers and associated facilities.
 - 2. Any parts of the Work that vary from that indicated in the Contract documents shall be neatly and clearly marked on the as-built drawings. Where deviation occurs, the main shall be located at a minimum of 100-foot stations or at the location of the deviation. Where sizes or types of materials installed differ from the Contract documents, the type and size installed shall be clearly noted.
 - 3. Where possible, the location of all valves, bends, sleeves, plugged or capped ends, and any other fittings installed shall be measured to the nearest fire hydrant, light pole, sewer manhole, or other fixed object. A minimum of two dimensions shall be provided for each item located and shall be labeled on the as-built drawings.

END OF SECTION

SECTION 15056

GAS SERVICE INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Scope: Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all piping, fittings, and specials. The Work includes, but is not limited to, the following:
 - 1. All types and sizes of piping.
 - 2. Supports and restraints.
 - 3. Pipe encasements.
 - 4. Work on or affecting existing piping.
 - 5. Testing.
 - 6. Cleaning.
 - 7. Welding, fusion, and all other Work required to complete the piping installation.
- B. Classification. Services shall be designated according to size and the pressure class in which they serve. The highest pressure of a gas service will normally be a maximum of 100 psig. Higher pressures will be handled on a case-by-case basis by the Public Utilities - Gas Engineer.
- C. Related sections.
 - 1. Section 02200, Excavation and Backfill.
 - 2. Section 02230, Fill and Granular Fill Materials.
 - 3. Section 15055, Piping Installation.
 - 4. Section 15060, Pipe Testing and Purging.
 - 5. Section 15066, High Density Polyethylene Pipe and Tubing.
 - 6. Section 15075, Steel Pipe.
 - 7. Section 15079, Steel Pipe Corrosion Protection.

1.02 QUALITY ASSURANCE

- A. All pipe to be installed under this Contract may be inspected at the place of manufacture for compliance with the Specifications by an independent testing laboratory provided by the City. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of inspection of all pipe approved for this Contract will be borne by the City.
- B. The Department of Public Works or other representatives of the City will inspect the pipe after delivery. The pipe shall be subject to rejection at any time due to failure to meet any of the specified requirements herein, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.
- C. Reference standards. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. 49 CFR Part 192 – Transportation of Natural and Other Gas by Pipeline; Minimum Federal Safety Standards.
 - 2. API 1104 – Welding of Pipelines and Related Facilities.
 - 3. ASTM D2774 – Practice for Underground Installation of Thermoplastic Pressure Piping.
 - 4. ASTM D3261 – Butt heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
 - 5. ASME/ANSI B31.8 – Gas Transmission and Distribution Piping Systems.

1.03 SUBMITTALS

- A. Shop drawings. Submit for approval the following:
 - 1. Laying schedules for all pipe.
 - 2. Full details of piping, specials, and connections to gas main.
- B. Certificates. Submit certificates of compliance with referenced standards.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Refer to applicable pipe sections for pipe specifications.
- B. Refer to Section 15106 for valves, regulators, and related appurtenances.

- C. Tapping tees and service saddles.
1. For use on polyethylene mains.
 - a. All tapping tees and service saddles for use on PE gas mains shall be injection molded from PE 3408 polyethylene resins meeting the applicable requirements of ASTM D2513.
 - b. Tapping tees and service saddles shall be Yellowstripe 8300 Piping Products by Chevron Phillips Chemical Company.
 2. For steel pipe mains.
 - a. All service tees for connections to steel mains shall be forged steel fittings with welded inlets and welded or transition outlets as applicable. The fitting shall comply with 49 CFR Part 192 and ASTM A105 for forged steel components.
 - b. Tees for use on steel mains shall be Mueller No-Blo Curb Valve Steel Service Tees, or approved equal.
 - 1) Mueller Autoperf Tees, or approved equal, with welded inlets and welded or transition outlets shall be allowed for use on services 1/2 inch in size.
 3. For iron (low pressure) mains.
 - a. All service tees for connection to cast or ductile iron mains shall be forged brass fittings with threaded inlets and high-density polyethylene transition outlets. Fittings shall comply with 49 CFR Part 192 and ASTM D698 for polyethylene transitions.
 - b. Maximum diameter of the tapped hole in the iron main shall not be greater than 25 percent of the nominal diameter of the main, except that a 1-1/4" tap may be made in a 4-inch main. Service saddles may be required in certain circumstances as noted on the Plans or as otherwise directed by the Public Utilities - Gas Engineer. Service saddles shall be single-strap type suitable for use on iron gas mains. Manufacturers shall be Mueller, Dresser, or approved equal.
- D. All valves, regulators, fittings, and other appurtenances installed in gas services shall be joined to the pipe either by welding, heat fusion, or mechanical coupling.
1. Heat fusion shall be used for all connections to polyethylene pipe and shall either be butt fusion, socket fusion, saddle fusion, or electrofusion, as described in Section 15055.
 2. Welded and mechanical coupled joints shall be used for all connections to metallic pipe.
 - a. Welded steel joints shall be either butt welded or socket welded type.
 - 1) Butt welding fittings shall be standard wall steel (Schedule 40). Socket weld fittings must be 3000 lb. forged minimum. For making 90° bends on the riser connections of services, prefab risers or socket welding fittings are recommended.

- 2) Welding saddles. Any welded lateral connections made on high pressure services without the use of standard welding fittings shall be reinforced by the use of welding saddles or socket welding outlets.
 - 3) Thread-o-lets. Welded lateral connections to steel pipes requiring a threaded outlet may be made by use of Thread-o-lets.
- b. Mechanically joined components shall be threaded or compression type.
- 1) Threaded fittings shall be standard weight banded malleable iron. For all new construction, fittings shall be new and made up on undamaged pipe threads that comply with ANSI B2.1. Damaged threads shall not be used.
 - 2) Compression coupled fittings shall be standard weight malleable iron. They shall be fitted with beaded or armored composition gaskets and installed on clean smooth pipe surfaces. In all service sizes available, couplings shall be of the boltless type, with 5" barrel.
 - a) Locking type fittings. The compression fitting nuts of all mechanical coupled fittings shall be of locking type if within 8 feet of any structure or bend.
 - b) Insulating fittings. Insulating type fittings shall be used on all connections made to cast iron or bare steel mains. An insulating union valve or insulating type meter bar shall be used at the meter set.
- E. Tracer wire. Tracer wire shall be AWG No. 12, single-conductor solid copper with 600-volt insulation designed to meet U.S.E. requirements for buried service.
- F. Warning tape. Warning tape shall have a minimum 5.0 mil overall thickness. The warning tape, including labeling, shall not contain any dilutants, pigments, or other contaminants, and shall resist degradation by elements encountered in the soil. The warning tape for gas main and service installations shall be color-coded yellow and imprinted with the words, "Caution – Gas Line Buried Below."

PART 3 EXECUTION

3.01 LOCATION

- A. Services shall be run on the most practical and unobstructed route from the main to the designated meter location. The location selected must provide access to the service and be free of hazards where possible gas leakage would cause undue danger. A straight run for the service pipe is preferred; however, consideration shall be given to factors such as paved driveways, walks, areaways, porches or breezeways, unstable soil conditions, water and sewer connections, and landscaping.
- B. Gas services shall be located a minimum of 5 feet horizontally from sewer, water, or other building utilities. Where this horizontal separation cannot be maintained, route the gas service as directed by the Public Utilities - Gas Engineer or his representative.

- C. Gas services shall not be located under building foundations, breezeways, porches, or other surface structures without prior approval of the Public Utilities - Gas Engineer.

Where approved, service pipe installations through or under such locations shall be kept as short as possible. Gas services of all pressure classes must be encased where they pass through or under the above-listed items. The casing must extend over the entire distance that possible escaping gas would become a hazard. The opening between the casing and service pipe at the downstream end must be sealed to prevent water or escaping gas from entering the service entrance. Upstream end of casing shall be left open or sealed and vented as directed by the Public Utilities - Gas Engineer.

3.02 INSTALLATION

- A. Pipe for new construction or replacement of gas services shall be either steel or polyethylene. Polyethylene pipe shall be used for all services operated at 100 psi and below unless otherwise shown on the plans or directed by the Public Utilities - Gas Engineer. Steel pipe only shall be used for services to be operated over 100 psi.
- B. Service pipe shall be installed in accordance with Section 15055, Piping Installation.
- C. All gas service lines shall be installed with a minimum of 12 inches cover, with a normal depth of 18 to 24 inches..
- D. Each service line shall have a meter valve installed above ground, upstream of the regulator, or, if there is no regulator, upstream of the meter.
- E. Inspection of premises. Premises should be examined for damage or defects before service installation work is started. Any damage or defects noted that could be attributed to service installation operations shall be called to the attention of the owner or building contractor prior to start of installation. All notices to owner or building contractor shall be written, with copies to the Public Utilities - Gas office.
- F. Street and property considerations. Roadway and driveways should be kept as free from obstruction as possible. A free and safe passage on the sidewalk shall be maintained. Grass areas, shrubbery, and flower beds should be protected from damage. Established lawns shall be covered with burlap or canvas before excavated earth is thrown on them. Sod and topsoil should be removed and placed so that it can be properly restored. Cutting of tree roots should be avoided so that the trees will not be damaged.
- G. Each service line shall be properly supported on undisturbed or well-compacted soil. Material used for backfill shall be free of rocks or other debris that could damage the pipe or coating.
 - 1. Particular emphasis must be given to the service pipe entrance at the wall of new construction. The fresh fill around a basement wall generally receives inadequate compaction for the installation of the gas service and meter. To secure adequate compaction of the soil under the service pipe, it is necessary to excavate down within 18 inches of the basement wall footing and to backfill and thoroughly tamp a section about 2' wide by 8' the full distance up to the service pipe level.

Side services that run parallel to basement walls should be located a distance from the structure to avoid to the extent possible being placed in freshly filled excavation.

- H. Low pressure service lines shall be graded so as to drain any condensate that may form back into the main.
- I. Each service line connection to a main shall be located at the top of the main, or, if that is not practical, at the side of the main.
 - 1. Use protective sleeves on all polyethylene service tee outlets, transition joints, and ends of casings where the service is 2 inches or smaller.
- J. All polyethylene services shall terminate below ground with an approved coupling and riser. The polyethylene pipe and riser shall NOT be used to support the meter or piping.
- K. Warning tape and tracer wire. Warning tape shall be installed 6" to 12" above all gas service lines. Tracer wire shall be installed with all polyethylene services. Tracer wire must not touch metallic portions of the meter or riser and shall be connected to the main tracer wire with an approved electrical wire connector.
- L. Under no circumstances shall the Contractor interrupt or restore gas service to any customer. All gas service interruptions and restorations will be performed by Public Utilities - Gas personnel. Public Utilities - Gas shall be given a minimum of 5 days advanced notice for interruption and restoration of services.

3.03 BRANCH SERVICES

- A. Branched services supplying more than one landowner will not be installed. For all normal building construction where the structures are placed along a dedicated street, a separate service will be run to each separately owned building or part of a building separated by a common property wall.

Exceptions to the branch service policy shall be housing projects where buildings are scattered over an extended area without direct access to a street. All exceptions must receive prior approval from the Public Utilities - Gas Engineer.

- B. Services run on private property to serve two or more commonly owned structures shall be allowed. The number of customers or structures served from a single service should be kept to a minimum. A separate service with a shut-off shall be installed for each structure served or to individual tenants of a multiple tenant structure where required.

3.04 TESTING

- A. Service line testing shall be in compliance with Section 15060.

3.05 NEW SERVICE LINES NOT PLACED IN USE

- A. Each new service line installed and gassed-up but not placed in use shall have the meter valve locked in the closed position using a Public Utilities - Gas approved locking device.

- B. Only Public Utilities - Gas servicemen shall remove the valve lock and open the meter valve.

3.06 RESIDENTIAL EXCESS FLOW VALVE (EFV)

- A. Excess flow valves shall be installed in all new or renewed single-family residential customer service lines which operate at 10 psig or above. EFV's shall not be installed on low-pressure residential services.
- B. EFV Installation Procedure
 1. Install and air test service.
 2. After successful test, purge service to 100% gas.
 3. Install EFV in service line as close as practical to the tapping tee, typically within 3 to 4 feet.
 4. Release squeeze-off or operate valve very slowly after EFV is installed to prevent premature closure.
 5. Soap test EFV connections for leaks. Repair any leaks.
 6. Place EFV sticker on service riser.
 7. Record installed measurements of EFV and show in materials list on service card.

3.07 SERVICE SHUT-OFF VALVES

- A. Shut-off valves may be installed at the discretion of Public Utilities - Gas in all new or renewed service lines to commercial, industrial, multi-family, or other buildings for public gathering where no EFV is required. The shut-off valves shall be installed in conjunction with the service line.
- B. Shut-off valves will be installed within road or street rights-of-way, behind curb and gutter and sidewalk, or in sodded area outside of the paved travel area.
- C. Service shut-off valve installation shall include the valve and complete valve box assembly. Prior to installation, all valves shall be fully opened and closed a sufficient number of times to ensure that all parts are in proper working order.
- D. All polyethylene shut-off valves shall be joined to the adjacent pipe below grade by butt fusion, unless otherwise directed by the Public Utilities - Gas Engineer. Butt fusion operations on polyethylene valves shall be in accordance with Section 15055. The valve shall be installed as close to the customer service tapping tee at the main as possible, unless otherwise directed by the Engineer.
- E. Valve boxes shall be installed plumb and directly over the valve in such a manner as to not hinder the operation of the valve.

- F. The service shut-off valve shall be pressure and leak tested in conjunction with the service line. All valves shall be in the open position during the pressure/leak testing, and shall remain open upon completion of the tests.

END OF SECTION

SECTION 15057

METER INSTALLATION

PART 1 GENERAL

1.01 GENERAL

- A. Each meter and service regulator, whether inside or outside of a building, shall be installed in a readily accessible location and shall be protected from corrosion, vehicular, and other damage. The meter must be accessible for meter reading or other service requirements. Unless absolutely unavoidable, meters shall not be installed indoors.

1.02 RELATED WORK

- A. Section 15056, Gas Service Installation.
- B. Section 15075, Steel Pipe.
- C. Section 15079, Steel Pipe Corrosion Protection.
- D. Section 15106, Valves, Service Regulators, and Appurtenances.

1.03 REFERENCE STANDARDS

- A. 49 CFR, Part 192.
- B. ANSI B2.1--Amended Standard for Taper Pipe Threads.
- C. ANSI B16.5--Steel Pipe Flanges and Flanged Fittings.
- D. MSS SP44--Steel Pipe Flanges.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel pipe for use in meter setting shall be as specified in Section 15075.
- B. Fittings.
 - 1. Threaded fittings shall be standard weight banded malleable iron. For all new construction, fittings shall be new and made up on undamaged pipe threads that comply with ANSI B2.1.
 - 2. Each flange or flange accessory shall meet the minimum requirements of ANSI B16.5 and MSS SP44.

Each flange assembly shall withstand the maximum pressure at which the service may be exposed and shall maintain its physical and chemical properties at any anticipated service temperature.

- C. Valves and regulators for use in meter setting shall be as specified in Section 15106.

2.02 METERS

- A. Meter selection shall be made with regard to load demand, operating pressure, and maximum pressure exposure.
- B. Meters shall not be exposed to pressures in excess of the manufacturer's recommended working pressure or 67 percent of the manufacturer's case test pressure, whichever is lower.
- C. Diaphragm meters shall be used from residential services to relatively high industrial and commercial installations. All diaphragm meters shall be temperature compensating.

Hard case meters shall be constructed of aluminum or aluminum alloy. Five pound working pressure meters are approved for use on services where an approved service regulator with self-contained or an external full capacity relief device precedes the meter. Five pound working pressure meters shall be subjected to a ten-pound case test before shipment from the factory.

- D. Rotary meters are positive displacement meters capable of metering large load demands. They can operate under variable load conditions and meter gas at any delivery pressure. However, consideration must be given to the selection of a rotary meter for use on a low-pressure service where the meter is subject to sudden variations from maximum to minimum loads. *Rotary meters should not be used where the minimum load is less than 10 percent of the meter's rated capacity.*
- E. Turbine meters are relatively lightweight in-line meters that can be used for large capacities. The range ability of this type of meter increases with increased metering pressure. Each installation must be individually engineered and designed by the Public Utilities - Gas Engineer.
- F. Orifice meters are generally restricted to very large gas flows such as power plants, town border stations, etc., where the cost of other meters would be prohibitive. Due to the varying design requirements, all installations of orifice meters must receive special engineering consideration. Orifice meters will not handle large fluctuations in pressure and capacity. Variations in loads should be less than a 3:1 ratio for a single orifice.

It may at times be expedient to combine meters of various types in order to secure meter accuracy at minimum loads and yet provide for economical large volume metering. Orifice meter installations with multiple orifices of varying size may also be used. These combinations of meters will be engineered individually.

- G. Meter capacities. Meters must be sized to carry expected loads within the allowable pressure drops for rated capacity as specified by the manufacturer. On low-pressure systems, the pressure drop through the meter shall not exceed 1/2" WC. On medium-pressure and higher pressure systems where the pressure is regulated to 6" WC, the drop through the meter shall not

exceed 1" WC, except for meters of 800 cfh capacity or greater where the pressure drop shall not exceed 2" WC.

- H. All meters will be furnished by Public Utilities - Gas.

PART 3 EXECUTION

3.01 LOCATION OF CUSTOMER METERS AND REGULATORS—GENERAL

- A. Each meter and service regulator shall be installed in a readily accessible location protected from corrosion and other damage. Meters shall be easily accessible for reading, testing, and making necessary adjustments and repairs.
- B. Unless absolutely unavoidable, all new or replacement meters shall be installed outdoors in locations where visits by City personnel or contractors will cause the least annoyance to the customer or inconvenience to the servicemen. Indoor installations shall be with the approval of the Public Utilities - Gas Engineer only.
- C. Meters and associated regulators shall be installed with a minimum of 6 inches clearance on all sides of the meter with not less than 30 inches in front. Meter and regulator locations shall not be closer than 3 feet of any source of ignition such as electric meters, switches, and transformers, and shall maintain clearance from windows, water taps, air intake vents, etc., as shown on detail drawing GF 1.0.
- D. When a number of meters are placed in the same location, each meter shall be tagged or marked to indicate the customer served. Such identification shall be preserved and maintained by the property owner.
- E. All meters shall be set in place by Public Utilities - Gas personnel.

3.02 INSTALLATION

- A. Residential meters.
 - 1. All residential meters shall be installed outdoors at locations shown on detail drawing GF 1.0.
 - 2. Only hard case diaphragm-type meters with appropriate service regulators shall be used.
 - 3. Meter, regulator, and piping shall be installed in such a manner as to avoid undue strains. Support for the meter shall be by mounting bracket or post as applicable.
- B. Industrial and commercial meters.
 - 1. All meters shall be installed outdoors unless approval for indoor installation within a separate meter room or building is granted by the Public Utilities - Gas Engineer.

2. Meter and piping shall be installed to avoid undue strains. Support for meter by means of mounting bracket, meter shelf, or slab may be provided as required.
 3. Meters shall not be installed where rapid deterioration from corrosion or other causes are likely.
 4. A suitable protective device, such as a backpressure regulator or check valve, shall be installed by the customer downstream of the meter under the following conditions.
 - a. If the nature of the utilization equipment is such that it may induce a vacuum at the meter, a backpressure regulator shall be installed downstream from the meter.
 - b. If the utilization equipment might induce a back-pressure; or if the gas utilization equipment is connected to a source of oxygen or compressed air; or if liquefied petroleum gas or other supplementary gas is used as a standby fuel supply, a check valve shall be installed downstream of the meter and upstream of all utilization equipment.
 - c. Standby fuel supply shall at all times be isolated from the City's gas system by valving. A 3-way valve installed to admit the standby supply and, at the same time, shut off the regular gas supply is recommended.
 5. Outside meters and associated regulation and relief valves shall not be closer than 50 feet to any standby propane storage tank or fuel transfer points.
- C. Special large capacity meter installations.
1. Special new meter installations covered in this section that require more than the normal metering facilities, include the following:
 - a. Installations where metering is done at unregulated medium pressure and above.
 - b. Installations where metered gas exceeds 5 Mcf per hour (any pressure class).
 - c. Installations where meter house or enclosure is required.
 2. In selecting the type of installation for a specific metering application, factors that should govern the degree of special treatment are the volume of gas to be delivered to the customer, the pressure of the gas at the delivery or metering point, the type of structure to be served in respect to its public or other nature (hospital, school, auditorium, hotel, businesses with many employees, etc.), and need for securing accessibility to the metering facilities.
 3. Where the customer requests, or Public Utilities - Gas requires, a separate meter room or house, as Division Engineering will provide information and must approve final plan.

END OF SECTION

SECTION 15060

PIPE TESTING AND PURGING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Each gas main and service installed within the City's distribution system shall be pressure and leak tested, as specified herein. The contractor shall provide the necessary materials, labor and equipment required to pressurize the gas main and services and to perform testing and purging in a satisfactory and efficient manner. **All pressure and leak testing shall be done in the presence of a Public Utilities - Gas representative. Tests done without supervision of Public Utilities - Gas will not be accepted and the Contractor shall be required to retest at his expense.**

1.02 SUBMITTALS

- A. Test records
 1. Maintain records of all tests performed
 2. Test records shall include:
 - a. Name of testing company.
 - b. Name of person performing test.
 - c. Date of testing.
 - d. Identification of piping tested.
 - e. Test medium.
 - f. Test pressure.
 - g. Test duration.
 - h. Pressure recording charts, or other record of pressure readings.
 - i. Signature of Contractor.
 3. If leaks are found, they shall be noted on the record, and then repaired. After repair, retest as specified for original test.
 4. Submit test records to the Public Utilities - Gas Engineer within 24 hours of testing.

1.03 GENERAL REQUIREMENTS

A. General

1. When any work is done of any nature that affects the containment of gas in lines or equipment, a test must be made to prove that the construction is sound and gas tight. Such tests should be made under the close supervision of the Contractor's foreman and a Public Utilities - Gas representative. Attention must always be given to dead end coupled test caps to be sure they are properly secured. Where any doubt exists regarding the safety of pipeline pressure testing, engineering assistance should be requested.
2. Public Utilities - Gas shall be given 48 hours advance notice prior to commencing any testing operation.
3. All testing apparatus, including pumps, hoses, gages, recording instruments, and fittings, necessary to perform testing as described herein, shall be provided.
4. Pipelines that fail to hold specified test pressure or which exhibit visible leakage shall be repaired and retested.
5. All tests shall be conducted in the presence of an authorized Public Utilities - Gas representative.
6. When the length of any pipe section exceeds 1,000 feet, Public Utilities - Gas reserves the right to require the pipe to be tested in sections determined by the Public Utilities - Gas Engineer.
7. All new gas mains and services shall be pressure tested using compressed air or nitrogen. Water shall not be used as a test medium for gas mains and services. The method and procedure for each pressure test shall be subject to the approval of Public Utilities - Gas.
8. Natural gas shall not be admitted into any gas main or service line prior to the successful completion of all required pressure tests, and approval by the Public Utilities - Gas Engineer.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 SAFETY

- A. All tests shall be performed under the direct supervision of the Contractor and in the presence of a representative of Public Utilities - Gas.
- B. Restrict personnel in the test area to those involved in the test.
- C. Safety glasses must be worn throughout testing.

3.02 PREPARATION

- A. Prior to testing, each section of 2-inch or larger nominal diameter main shall be thoroughly cleaned by forcing a pig-type mechanical cleaner through the pipe a sufficient number of times to remove all foreign matter which may have been trapped inside the pipe during construction. A minimum of 2 pig runs shall be required.
- B. Mains that have a nominal diameter of less than 2 inches and service lines shall be cleaned by swabbing or by forcing compressed air through the pipe at a sufficient rate such that all foreign matter is removed.
- C. With the exception of certain bellholes for the installation and operation of testing equipment, each test segment shall be completely backfilled along its entire length prior to testing.
- D. Twenty-four (24) hours prior to commencing any testing operation, the Contractor shall submit a test schedule to Public Utilities - Gas for approval.

3.03 PROCEDURE

- A. After the pipe has been prepared in accordance with 3.02, "Preparation," pressure and leak tests shall be performed as specified herein in accordance with 49 CFR 192, Subpart J.
- B. Gas main pressure tests shall be monitored by means of chart recording devices located, as directed by the Public Utilities - Gas Engineer or his representative. The chart recording devices shall be capable of recording the sustained test pressure for the duration of the test. The Contractor shall provide evidence of recent and accurate calibration of all chart-recording instruments. The date and time of commencement and completion of the pressure test shall be recorded on the pressure chart, which shall be signed by the Contractor's representative performing the test. The recording chart shall be a minimum of 8 inches in diameter. A pressure gauge shall be used in combination with the recording chart. The pressure difference between the gauge and recording chart shall not exceed 5 psig. The test pressure shall be governed by the pressure device with the lowest reading.

At the discretion of the Public Utilities - Gas Engineer, Public Utilities - Gas reserves the right to utilize its own test recording apparatuses on any job.

- C. The Contractor shall prove the entire system of gas main included in the contract to be gas tight. The test shall be made by air pressure unless directed otherwise by the Public Utilities - Gas Engineer. The pipe under test shall be completely isolated from all sources of air during the test.
- D. The hourly pressure shall be recorded for the duration of the test on an approved form. The date and time of the commencement and completion of the pressure test shall also be recorded on the form. The test form shall be signed by the Contractor's representative performing the test.
- E. All test gauge charts and test forms shall be given to the Public Utilities - Gas representative for approval of the test and shall become a part of the City's permanent record.

F. Pressure testing.

1. Testing of gas mains. The test will be completed with air/nitrogen at a minimum pressure of 150 psig for 12 continuous hours or as otherwise directed by the Public Utilities - Gas Engineer. In the event of a loss of pressure, the leak shall be located and repaired by the Contractor at the Contractor's expense, and additional pressure tests made until the installation is satisfactory. Mains less than 1000 feet in length may be tested for less than 12 hours as per Leak Test Duration Table below.
2. Testing of service lines. All new service lines or temporarily disconnected services must be tested in their entirety (gas main to meter valve) with a minimum pressure of 150 psig with air/nitrogen for a minimum of 15 minutes or as per the following Leak Test Duration Table, or as otherwise directed by the Public Utilities - Gas Engineer.

LEAK TEST DURATION TABLE (HOURS)

Length (Feet)	Diameter (Inches)				
	1-1/2	2	3	4	6
200	1/2	3/4	1-1/2	3	6
400	1	1-1/2	3	5-1/2	12
600	1-1/2	2	4-1/2	8	18
800	2	2-1/2	6	11	24
1000	2	3-1/2	8	14	
1200	3	4	9	16	
1400	3	5	11	19	
1600	4	5	12	22	
1800	4	6	14	24	
2000	5	6	16		

Note: Table based on a 100 psig test pressure.

Services larger or longer than those shown in the above table should be:

- (a) Sectionalized and tested in shorter lengths.
- (b) Tested for correspondingly longer periods of time (engineering help is required to determine the longer times).

- G. All tie-in welds, fusions, and fittings not included in the pressure test shall be leak tested with a foaming leak locating compound solution after the main or service line has been placed into service.
- H. Any and all breaks, leaks, or defects in the pipe, valves, and fittings discovered during the pressure and/or leak tests shall be repaired or replaced, and re-tested by the Contractor, at the Contractor's expense.

3.04 PURGING

- A. Upon the successful completion of the pressure and/or leak test, and after the gas line or each section thereof has been cleaned and approved in every respect, the Contractor shall notify Public Utilities - Gas and, under its supervision, natural gas will be admitted into the completed mains and/or services in sufficient quantities such that all air is purged out of the line(s).
- B. The Contractor shall provide a minimum of 24 hours notice to Public Utilities - Gas prior to commencing any purging operations.
- C. An approved and calibrated combustion gas indicator (CGI) shall be used in all purging operations.
- D. All purging operations shall be in accordance with ANSI B31.2.

When a reading of 100 percent gas is measured using the CGI, meter valve shall be closed and pressure continuously maintained in the line.

- E. **FAILURE TO PURGE LINES APPROPRIATELY MAY RESULT IN THE FORMATION OF AN EXPLOSIVE GAS-AIR MIXTURE.** Contractor shall take all safety precautions necessary to prevent accidental ignition of vented gas or gas-air mixture.

END OF SECTION

SECTION 15063

DEMOLITION AND ABANDONMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope.

1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required for demolition, removal, and disposal Work.
2. Included, but not limited to, are demolition and removal of existing materials, equipment, or work necessary to install the new Work as shown, specified, and required. Demolition may include paving, piping, attachments, appurtenances, curbs, walks, fencing, and similar existing facilities.

A. Related Sections.

1. Section 02100, Clearing and Grubbing.
2. Section 02200, Excavation and Backfill.
3. Section 02270, Erosion and Sediment Control.

1.02 SUBMITTALS

- ###### A. Schedule: Submit for approval proposed methods, equipment, and operating sequences. Include coordination for shut-off, capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of the City's or other's operations.

1.03 JOB CONDITIONS

A. Protection.

1. Perform all demolition and removal Work to prevent damage or injury to persons, structures, and adjacent features, and so as not to interfere with the use and free and safe passage to and from adjacent structures.
2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted. All operations shall be conducted with a minimum interference to vehicular and pedestrian traffic on these ways.
3. Erect and maintain barriers, lights, and other necessary protective devices in accordance with the approval of authorities having jurisdiction. Road, sidewalk, or other access way closure will only be allowed with approval of authorities having jurisdiction.

- B. Notification: At least 48 hours prior to commencement of a demolition or removal, notify the Public Utilities - Gas Engineer in writing of the proposed schedule. Public Utilities - Gas will inspect the existing equipment and mark for identification those items that are to remain the property of the City.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 GENERAL

- A. All materials and equipment removed from existing work shall become the property of the Contractor, except for those that the City has identified and marked for their use. All cobblestones, paving bricks, and other materials and equipment marked by the City to remain theirs shall be carefully removed by the Contractor, so as not to be damaged, and shall be cleaned and stored on or adjacent to the site in a protected place specified by the City or loaded onto trucks provided by the City.
- B. Contractor shall dispose of all demolition materials, equipment, debris, and all other items not marked by the City to remain as property of the City, off the site and in conformance with all existing applicable laws and regulations.
- C. All mains or services to be abandoned or removed shall be purged of all gas in compliance with ANSI B31.2. Purging of gas mains and services shall be performed with compressed air and shall continue until a reading of zero percent gas is measured using an approved, calibrated combustible gas indicator (CGI). All purging operations shall be done under the direct supervision of the Contractor's foreman and in the presence of a Public Utilities - Gas representative. A minimum of 24 hours advance notice shall be provided to Public Utilities - Gas.
- D. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping shall be left in place unless it interferes with new Work or is shown or specified to be removed.

3.02 ABANDONMENT OF EXISTING FACILITIES

- A. The Contractor shall, as indicated on the Plans or as otherwise directed by the Public Utilities - Gas Engineer, be required to remove from service certain sections of the existing gas distribution system, including but not limited to mains, services, various fittings, valves, and valve boxes.
- B. Abandonment of existing facilities shall be accomplished by either in-place abandonment or complete removal of these facilities, as indicated on the Plans or otherwise directed.
- C. In-place abandonment shall consist of disconnection of the facilities from the existing system, purging abandoned pipe of natural gas, properly sealing the ends of all abandoned pipe, backfilling all exposed portions of abandoned pipe, removing top section of abandoned valve

boxes and backfilling with sand, asphalt, concrete, or dirt, and restoration of the affected area as directed by Public Utilities - Gas.

- D. Sealing of gas mains shall be accomplished using appropriate welded, fusion welded, or mechanical joint fittings as directed by the Public Utilities - Gas Engineer. When gas service lines are abandoned in-place in conjunction with the main, the Contractor shall cut off the service piping a minimum of 6 inches below the finished grade at the customer meter and fill the end of the service piping with an appropriate sealant.
- E. Valves and valve boxes, including service line cut-off boxes, shall be abandoned in place, unless otherwise directed by the Plans or the Public Utilities - Gas Engineer. Valve abandonment shall not be performed until the abandonment of the main is complete. The Contractor shall render the valve inoperable by breaking off the top section of the valve box a minimum of 6 inches below the surface of the surrounding pavement or grade and filling the valve box with the same material (asphalt, concrete, dirt, etc.) directly adjacent to the valve box. Compaction of the material used to fill the valve box shall be completed such that settlement will not result.
- F. Detailed information concerning all abandoned facilities, including, but not limited to, size of pipe, length of pipe abandoned, fittings installed, etc., shall be collected and submitted to Public Utilities - Gas by the Contractor.

3.03 REMOVAL OF BELOW GROUND FACILITITES

- A. Removal of pipe, valves, valve boxes, etc., will only be required where indicated on the Plans, or as directed by the Public Utilities - Gas Engineer.
- B. No buried pipe, valve, or appurtenance shall be removed until it has been isolated and purged of all gas. Upon completion of purging, the pipe, valve, or appurtenance shall be unearthed and removed from the trench, and the trench shall be backfilled and compacted. Compaction shall be equal to that of the surrounding soil or as otherwise specified in Section 02200. Compaction within traveled ways, including drives, walks, streets, or alleys shall meet the density requirements as specified in Section 02200. Following backfilling and compaction, the surface shall be graded to match the existing grade and contour. Removed piping and materials shall be properly disposed of or otherwise handled as directed by Public Utilities - Gas.

3.04 REMOVAL OF ABOVE GROUND FACILITITES

- A. Removal of above ground facilities shall only be performed where indicated on the Plans, or as directed by the Public Utilities - Gas Engineer.
- B. All above ground facilities to be removed shall be properly isolated and purged of all gas prior to start of demolition.
- C. The above ground piping and appurtenances shall be removed beginning at points sufficiently below the surface grade to prevent the piping stubs from interfering with the current or planned use of the adjacent ground surface, or as required by the Plans. Below grade stubs shall be properly capped per these Specifications.

3.05 CLEAN-UP

- A. Contractor shall remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the Work, all materials, equipment waste, and debris of every sort shall be removed and premises shall be left clean, neat and orderly.
- B. Contractor shall provide all Work necessary to restore the damaged area, road rights-of-way, or private property, to pre-construction condition.
- C. Finish grading shall be performed as necessary to re-establish slopes and contours. The grades shall be sloped towards inlets and ditches, as appropriate.
- D. Developed property including walks, steps, fences, mailboxes, etc., disturbed by the Work shall be restored or replaced to their original or better condition. Ditches shall be restored to their original shape and slope. All disturbed areas not covered by pavement or structures shall be fertilized, limed, seeded, and mulched in accordance with Section 02280. All disturbed pavement, driveways, and walkways shall be restored in accordance with Section 02575.

END OF SECTION

SECTION 15066

HIGH DENSITY POLYETHYLENE PIPE AND TUBING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install polyethylene (PE) pipe, complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.
- B. Section 02230, Fill and Granular Fill Materials.
- C. Section 15106, Valves, Service Regulators, and Appurtenances.

1.03 SUBMITTALS

- A. Submit shop drawings and schedules of all PE pipe and fittings as required to the Department of Public Works.
- B. Submit tabulated layout drawings showing actual pipe lengths, diameters, fittings, and appurtenances.
- C. Prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM Standards specified herein.

1.04 REFERENCE STANDARDS

- A. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
- B. ASTM D3035 – Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
- C. ASTM D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- D. ASTM 3350 – Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
- E. ASTM F714 – Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- F. PPI TR-4 – Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings Compounds.

1.05 QUALITY ASSURANCE

- A. The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these Specifications.
- B. Polyethylene pipe and fittings shall be supplied by the same manufacturer. Pipe and fittings from different manufacturers shall not be interchanged.
- C. The Department of Public Works may make inspections of the pipe after delivery. The pipe shall be subject to rejection at any time due to failure to meet any of the Specification requirements. Pipe rejected shall be marked for identification and shall be removed from the job at once.
- D. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier, and verified by manufacturer's quality control.
 - 1. Outgoing materials shall be checked for:
 - a. Outside diameter, wall thickness, and eccentricity as per ASTM D2122.
 - b. Out-of-roundness.
 - c. Straightness, inside and outside surface finish, markings, and end cuts shall be visually inspected as per ASTM F714 on every length of pipe.
 - 2. Quality Control shall verify production checks and test for:
 - a. Density as per ASTM D1505.
 - b. Melt index as per ASTM D1238.
 - c. Carbon content as per ASTM D1603.
 - d. Quick burst pressure (sizes through 4 inches) as per ASTM D1599.
 - e. Ring tensile strength (sizes above 4 inches equipment permitting) as per ASTM D2290.
 - f. SCG per ASTM F1473.
 - 3. X-ray inspection shall be used to inspect molded fittings for voids, and knit line strength shall be tested. All fabricated fittings shall be inspected for joint quality and alignment.
 - 4. The manufacturer shall maintain permanent quality control and quality assurance records.

- E. Certificates of compliance with applicable ASTM designations and strength classifications covering the pipe and fittings will be required directly from the pipe manufacturer as deemed necessary by the Department of Public Works.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cell Classification. Materials used for the manufacture of polyethylene pipe and fittings shall be PE 3408 high density polyethylene meeting cell classification 345464C per ASTM D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
- B. Hydrostatic Design Basis. Materials used for the manufacture of polyethylene pipe and fittings shall have a HDB rating of 1600 psi at 73° F in accordance with ASTM D2837. In addition, the material shall be listed with the Plastics Pipe Institute and shall have a PPI recommended HDB of 1600 psi at 73° F and 1000 psi at 140° F.
- C. SCG Resistance. Materials used for the manufacture of polyethylene pipe and fittings shall be tested for resistance to slow crack growth in accordance with ASTM F1473, Standard Test Method to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins. Typical test values shall be greater than 1000 hours before failure with no samples less than 500 hours.

2.02 POLYETHYLENE PIPE

- A. Polyethylene pipe shall be manufactured in accordance with ASTM D2513, and shall be so marked. Each production lot of pipe shall be tested for melt index, density, % carbon, dimensions, and either quick burst or ring tensile strength (equipment permitting).
- B. All PE pipe shall have a maximum allowable operating pressure rating of 100 psi at 73° F and minimum SDR of 11.0.
- C. Permanent identification of piping service shall be provided by co-extruding 4 equally-spaced color stripes into the pipe outside surface. The striping material shall be the same material as the pipe material except for color. Yellow stripes shall be used to identify piping service for gaseous fuels.
- D. Pipe shall be CPChem Performance Pipe Yellowstripe 8300, or approved equal.

2.03 POLYETHYLENE FITTINGS

- A. Polyethylene fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness, and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.

- B. Molded polyethylene fittings.
 - 1. Molded fittings shall be manufactured in accordance with ASTM D2683 for socket-type fittings and ASTM D3261 for butt-fusion fittings, and shall be so marked. Each production lot of molded fittings shall be subjected to the tests required under the appropriate ASTM specification.
 - 2. The manufacturer shall submit samples from each molded fittings production lot to x-ray inspection for voids, and shall certify that voids were not found.
 - 3. Fittings shall be CP Chem Performance Pipe Yellowstripe 8300, or approved equal.
- C. Fabricated polyethylene fittings.
 - 1. Fabricated polyethylene fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock, or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the mating pipe.
- D. Fittings 2" and smaller in size shall be socket fusion type. Fittings 3" to 8" in size shall be butt-fusion type.

PART 3 EXECUTION

3.01 QUALIFICATIONS

- A. The Contractor shall use only competent and skilled workmen for the performance of any and all Work on the gas distribution system. The workmen shall not perform any heat fusion operations on any pipe or associated fittings within the system until they have been qualified to perform such operations in accordance with the requirements of the City of Charlottesville Public Utilities - Gas. The Contractor shall furnish evidence, as required by and to the satisfaction of the Public Utilities - Gas Engineer, that the specified requirements have been met for each employee engaged in the joining of polyethylene pipe and fittings prior to their utilization on the Work.
- B. The Contractor shall ensure that persons making heat fusion joints have received training in the manufacturer's recommended procedure. The Contractor shall maintain records of trained personnel, and shall certify that training was received not more than 12 months before commencing construction.
- C. Operators of heat fusion equipment, including butt fusion, saddle fusion, and electrofusion, shall be tested and certified in accordance with the requirements of 49 CFR 192, Subpart F, Paragraph 285, along with any and all additional requirements of the specific pipe and/or fitting manufacturer. In addition to and in accordance with the requirements above, all personnel performing heat fusion operations shall be certified by the City to join polyethylene pipe prior to commencing work by the following procedures:

1. Certification. Each technician making joints in polyethylene pipe must provide evidence of current heat fusion certification from an approved pipe manufacturer, pipe vendor, or gas distribution company. Additionally, each technician must be “qualified” by Public Utilities - Gas before making joints on polyethylene pipe that will be installed in the gas distribution system using the City’s fusion procedures.
2. Testing. Each technician must show proof of satisfactory training and practice in making heat-fused joints on polyethylene pipe and fittings. A technician will be tested with the following procedure. The examiner may waive all or part of these tests if he is familiar with quality of the technicians’ work.
 - a. Make 3 joints in 2-inch polyethylene pipe. The Public Utilities - Gas examiner will observe the joining without interference except to prevent damage to the equipment or injury to personnel. If it is necessary for the examiner to interfere in the joining procedure, a complete explanation will be made on the record of examination.
 - b. After the joints have cooled, the pipe and joints will be examined visually. Results will be recorded on the examination form.
 - c. The joints will be cut into four longitudinal strips of equal width. The 8 surfaces exposed by the cutting will be examined for evidence of voids or discontinuities. Results of this test will be recorded.
 - d. The examiner will comment on each part of the test. If the examinee has failed, a complete explanation will be entered into the record.
 - e. When the examinee has passed the test, his record of training, the completed examination sheet, and the test specimens will be forwarded to the Public Utilities - Gas Safety and Training Officer. If the Safety and Training Officer approves the test and specimens, they will be so annotated on the examination form and the technician shall be allowed to make heat fusion joints on plastic pipe that will be installed in the City’s gas distribution system.
 - f. Public Utilities - Gas reserves the right to revoke approval to fuse polyethylene pipe on the City’s gas system for any technician whose performance during the execution of the Work proves to be unsatisfactory in the opinion of the Public Utilities - Gas Safety and Training Officer.

3.02 JOINING OF POLYETHYLENE PIPE AND FITTINGS

- A. Sections of polyethylene pipe 2-inches diameter and larger shall be joined by the butt fusion process into continuous lengths at the job site. The joining method shall be the heat fusion method and shall be performed in strict accordance with the City’s procedures. All polyethylene pipe sections less than 2-inches diameter shall be joined by the socket fusion method. The heat fusion equipment used in the joining procedures shall be capable for meeting all conditions recommended by the pipe manufacturer. Properly executed electrofusion fittings may also be used. Extrusion welding or hot gas welding of HDPE pipe or fittings is not acceptable.

- B. Branch connections to the main shall be made with tapping tees. Polyethylene tapping tees shall be saddle-fused to the main by heat fusion.

3.03 INSTALLATION OF POLYETHYLENE PIPE AND FITTINGS

- A. Polyethylene pipe and fitting installations shall be in strict accordance with manufacturer's instructions and Section 15055 herein.

END OF SECTION

SECTION 15075

STEEL PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install steel pipe, complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.
- B. Section 02230, Fill and Granular Fill Materials.
- C. Section 15055, Piping Installation.
- D. Section 15079, Steel Pipe Corrosion Protection.
- E. Section 15106, Valves, Service Regulators, and Appurtenances.

1.03 SUBMITTALS

- A. Submit shop drawings and schedules of all steel pipe and fittings as required to the Department of Public Works.
- B. Submit tabulated layout drawings showing actual pipe lengths, diameters, fittings, and appurtenances.
- C. Prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the standards specified herein.

1.04 REFERENCE STANDARDS

- A. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- B. API 5L – Specification for Line Pipe.
- C. API 1104 – Welding of Pipelines and Related Facilities.
- D. ASME/ANSI B31.8 – Gas Transmission and Distribution Piping Systems

1.05 QUALITY ASSURANCE

- A. The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by the standard

specifications to which the material is manufactured. Furnish to the Department of Public Works sworn certificates of such tests and their results prior to the shipment of the pipe.

- B. All steel pipe and fittings shall be from a single manufacturer unless otherwise approved by the Department of Public Works.
- C. The Department of Public Works may make inspections of the pipe after delivery. The pipe shall be subject to rejection at any time due to failure to meet any of the Specification requirements. Pipe rejected shall be marked for identification and shall be removed from the job at once.
- D. All pipe and fittings shall be permanently marked with the following information.
 - 1. Manufacturer.
 - 2. Size, schedule, or wall thickness.
 - 3. Kind of pipe.
 - 4. Standard to which produced (API, ASTM, etc.).
 - 5. Length.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior or interior surfaces of the pipe.
- B. Materials, if stored, shall be kept safe from damage. The interior of all pipes, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times.
- C. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All steel pipe and fittings shall be manufactured to the requirements of ASTM A53 and shall be suitable for use in a natural gas distribution system. Pipe and fittings shall be Grade B, Type E or S, with a minimum tensile strength of 60,000 psi and minimum yield strength of 35,000 psi. Alternately, pipe and fittings shall conform to API Standard 5L, Grade B specifications.
- B. Pipe and fittings shall be plain end, suitable for butt-welding.

- C. Pipe and fittings shall be Schedule 40.
- D. All steel pipe shall be plant-coated with 12-14 mils of fusion bonded epoxy coating, cut back 4 inches at the pipe ends. Pipe coating shall be in accordance with specification Section 15079.

PART 3 EXECUTION

3.01 WELDING OF STEEL PIPE AND FITTINGS

- A. The Contractor shall use only competent and skilled workmen for the performance of any and all Work on the gas distribution system. The workmen shall not perform any welding operations on any pipe or associated fittings within the system until they have been qualified to perform such operations in accordance with the requirements of the City of Charlottesville Public Utilities - Gas. The Contractor shall furnish evidence, as required by and to the satisfaction of the Public Utilities - Gas Engineer, that the specified requirements have been met for each employee engaged in the welding of pipe and fittings prior to their utilization on the Work.
 - 1. Testing and certification of welders, whether by destructive or nondestructive inspection methods, shall be in accordance with the Minimum Federal Safety Standards for Welding and the American Petroleum Institute Standard API 1104, "Standard for Welding Pipelines and Related Facilities."
 - 2. Each welder must be qualified by the City in accordance with Section 3 of API Standard 1104.
 - 3. Each welder shall have engaged in the particular welding process to be used within the last 6 months prior to performing any welds on the City's gas system.
 - 4. Each welder shall have had at least one weld tested and found acceptable under Section 3 or Section 6 of API Standard 1104 within the 6 months prior to performing any welds on the City's gas system.
- B. The Contractor shall provide documentation to the Public Utilities - Gas Engineer as evidence that all welders performing welds for the Contractor on the City's facilities are certified according to the above requirements.

3.02 INSTALLATION OF STEEL PIPE AND FITTINGS

- A. Steel pipe and fitting installations shall be in strict accordance with Section 15055 herein.

END OF SECTION

SECTION 15079

STEEL PIPE CORROSION PROTECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to install corrosion and cathodic protection for all steel gas pipe, fittings, and incidentals and steel casing pipe as shown on the Drawings and as specified herein.
- B. These standards outline a general program for the control of corrosion on metallic gas system facilities. They must be carried out under the direction of a corrosion engineer qualified by experience and training in pipeline corrosion control methods.

1.02 RELATED WORK

- A. Section 15055, Piping Installation.
- B. Section 15056, Gas Service Installation.
- C. Section 15057, Meter Installation.
- D. Section 15075, Steel Pipe.
- E. Section 15106, Valves, Service Regulators, and Appurtenances.

1.03 SUBMITTALS

- A. Submit for approval shop drawings or catalog cuts of all primers, tapes, coatings, etc., intended for field application.
- B. Submit a laying schedule for all cathodic protection measures. Lay schedule shall include all materials to be installed as part of the protection system and drawings showing all proposed locations.
- C. Submit records of all testing performed as required within this section.
- D. Submit "as-built" drawings in accordance with this section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Corrosion protection materials shall be in accordance with the recommendations of the designated corrosion engineer and as approved by Public Utilities - Gas.

PART 3 EXECUTION

3.01 COATINGS

- A. General. Coatings furnish much of the protection that steel receives against corrosion. All new and replacement steel piping and components shall be coated. It is imperative that the utmost care be exercised in handling, fabricating, and repairing coated steel piping and components.
- B. Pipe. All new and replacement steel pipe for underground use must be coated with an approved mill-applied coating. This includes gas mains, gas services, gas service risers, and control piping.
 - 1. Epoxy coating. Pipe coated with epoxy shall meet the following specifications:
 - a. Pipe preparation. The pipe shall be shot blasted to a white metal surface and provide an anchor profile not to exceed 2.0 mils. All oil, grease, and other contaminants shall be removed with an acceptable solvent.
 - b. Coating application. The preheated pipe shall be coated with Scotchkote 202, or equal, to a nominal thickness of 12-14 mils with a minimum thickness of 8-12 mils. The coating thickness shall be measured with a permanent magnet-type thickness gauge, or equivalent, of known accuracy. The gauge shall be calibrated to an appropriate standard in accordance with manufacturer's operating procedures and shall be checked at sufficient intervals to insure maximum accuracy.
 - c. Cure. The coated pipe shall be kept at the curing temperature for such duration as to effect a complete and satisfactory cure prior to coming in contact with any other objects such as rollers, supports, quenching stream, etc.
 - d. Electrical inspection. All pipe shall be electrically inspected for holidays and thin spots with a holiday detector energized to 1500 V DC.
 - e. Coating repair. All holidays are to be repaired with original coating material or an approved tape to a maximum thickness of 12 mils and rechecked electrically.
 - f. Acceptance. Only those lengths of pipe that are holiday free and have a maximum of 0.1% of the surface area less than 12 mils in thickness will be accepted.
 - g. Packing. The material shall be so packed as to reach destination without injury.
- C. Pipe joints and fittings. It is imperative that the same quality of protection be given to underground metallic joints and fittings as to the pipe. Service tees, welded joints, flanges, valves, compression couplings, and all other miscellaneous metallic fittings shall be coated with an approved field-applied coating. Surfaces to be coated shall be cleaned of oil with an approved solvent and be cleaned of rust, dirt, and other foreign matter to a clean surface with a wire brush. Any burrs or protruding defects on metal surfaces shall be removed with a file or grinder. The manufacturer's instructions shall be followed regarding the application of all approved primers and field coatings.
 - 1. Application – tapes. On mill-coated X-Tru or coal tar coated pipe, any damaged coating adjacent to the surface to be wrapped shall be removed. On coal tar coated pipe the Kraft

paper adjacent to the area to be wrapped shall be removed. The coating of epoxy-coated pipes need not be removed before repair.

- a. Primer. Primers are required with most field-applied tapes. Use the primer recommended by the manufacturer of the tape being used. The primer shall be applied over the entire surface to be wrapped, including a 2- to 3-inch overlap on the mill coating, in as thin a film as possible. Allow the primer to become "tacky" before applying the tape. Follow the manufacturer's instructions.
 - b. Tape. Tapes shall be wrapped spirally around the pipe or fitting with a 50% overlap. Use sufficient tension when applying tape to obtain perfect conformance to the pipe or fitting. Wrapping shall extend 2 to 3 inches over the mill coating. Follow the manufacturer's instructions.
 - c. All underground metallic fittings and/or irregular shapes shall be wrapped with an approved wax tape as detailed above.
- D. Inspection of pipe coating for underground use.
1. General. Effective protection of steel pipe materials depends on the correct application of approved coatings, elimination of voids or holidays in the coatings, and prevention of damage to coatings in handling and construction. All tests and visual inspections shall be made immediately before lowering the main into the trench. Every effort must be made to eliminate any damage to the coating during pipe installation. Testing and visual inspections shall be the responsibility of the crew foreman or Contractor's representative. Any defective areas must be cut back to the pipe surface and restored.
 2. Coating inspection -- holiday test. All coated mains and services shall be tested for holidays using an approved holiday detector of the proper voltage range for the coating being tested. Piping on which coal tar enamel coatings are used shall be tested by means of a holiday detector energized to 8,000 volts. Piping on which epoxy coatings are used shall be tested with a holiday detector energized to 1500 volts DC. Wherever possible, coated, welded joints shall be included in the test. All coating defects shall be repaired in an appropriate manner. After such repairs, a final test shall be made to ensure holiday-free coating prior to lowering of pipe in trench.
 3. Coating inspection – visual. A visual inspection shall be conducted on all coated pipe for underground use. It shall be a thorough examination for coating cracks, voids, nicks, incomplete adhesion, or other construction damage, and must include all gas carrying components.
- E. Piping exposed to the atmosphere. Each exposed pipeline and its associated equipment must be cleaned as described in 3.01B and C above and either coated or jacketed with an approved material. This includes hairpin regulators, piping installed on bridges or other structures, piping installed in vaults, and meter installations.

3.02 INSULATED FITTINGS

- A. General. Insulating fittings are used to prevent the flow of corrosion currents caused by dissimilar metal coupling. They are also used to isolate systems for cathodic protection purposes. Under no circumstances should an insulating device be installed where an explosive or combustible environment is present. Select locations where an electrical spark or discharge across the dielectric materials of the isolation device cannot produce ignition.
- B. Required locations. It is important to locate isolators so they will not be by-passed or short-circuited by other connections or piping. Whenever possible, locate isolating devices in an accessible place where repairs can be made.
 - 1. Meters. All new gas services shall be insulated at the meter inlet valve. In all cases pipe or associated equipment between the soil and the insulator must not contact other metal so as to cause a short.
 - 2. Bridge crossings (rivers and streams). Bridge crossings shall be insulated on each end above grade and near the bridge abutment. Support hangers shall be insulating type. Provisions shall be made for carrying cathodic protection current from one side of the bridge to the other by installing #6 compound insulated wire (cable) across the bridge and making connections between the insulator and bridge abutment. Consult with designated corrosion engineer.
 - 3. Service taps. Coated steel services off cast iron shall be insulated at the outlet of the tap.
 - 4. Main extensions. Coated steel main extensions shall be insulated from cast iron mains at every location where a tie-in is made. Coated steel main extensions must not be insulated from mill-coated existing mains, except when specified by the designated corrosion engineer.
 - 5. Replacement main or service piping. New coated pipe shall be insulated from cast iron pipe. New coated pipe must not be insulated from mill-coated pipe, unless specified by the designated corrosion engineer.
 - 6. Miscellaneous steel components. Miscellaneous steel components shall be insulated from cast iron piping. Miscellaneous steel components must not be insulated from mill-coated existing piping, except where specified by the designated corrosion engineer.
- C. Installation procedures. The proper procedure must be followed to insure a functional insulator. When disassembling or cutting gas piping to install an insulating fitting, bonding cable shall be used across the pipe separation.
 - 1. General assembly procedures. All insulating fittings shall be installed with the parts as supplied by the manufacturer. Substitution or omission of parts may result in loss of the insulating ability of the fitting. The use of torque wrenches is preferred for installing bolted insulating fittings.
 - a. Compression couplings. When insulating coated pipe from cast iron or bare pipe with a compression coupling, the insulating sleeve shall be installed on the cast iron

or bare pipe. Proper line up and backfilling is essential to prevent strain and breakdown of the insulating material.

- b. Flanges and weld-in fittings. The use of insulating flanges underground is not recommended. The use of weld-in insulating fittings is preferred for underground applications. When converting non-insulating flanges to the insulating type, only insulating sleeves and washers shall be installed, as it is not necessary to replace the gasket. The conversion can usually be done “hot.”
2. Requirements against pullout. Where un-reinforced insulating compression couplings are not allowed due to potential pullout of piping, insulating weld-in fittings, insulating flanges, or other Public Utilities - Gas approved insulating fittings shall be used.
- D. Testing insulating fittings. Except for insulating meter valves on anodeless risers, each insulating fitting shall be tested by the designated corrosion engineer or his designee. The test shall be conducted immediately after the piping installation is complete and before backfilling over the insulating fitting. Defective insulating fittings shall be repaired or replaced. Fittings to be tested include meter inlet valve insulators, insulating unions, insulating compression couplings, insulating flanges, insulating service taps, and other miscellaneous insulating fittings.
 - E. Protection from electric surges. When it is necessary to install an insulating fitting in an area where fault currents, unusual risk of lightning, or induced voltage on the pipeline is anticipated, a zinc anode-grounding cell shall be installed across the insulating fitting as shown in drawing GC 1.0.
 - F. Casings. All casings shall be insulated from the main with non-metallic spacers as shown on the Detail Drawings. Each end of the casing shall be sealed with water-tight end seals.

3.03 CATHODIC PROTECTION

- A. General. Cathodic protection of buried pipe systems is achieved by impressing a DC voltage on the gas structures to be protected. This is accomplished by sacrificial magnesium anodes or by rectifiers. Magnesium anodes are usually used for services and shorter lengths of gas mains, whereas rectifiers are better suited on longer pipelines.
- B. Application. Every effort must be made to cathodically protect all new and replacement steel piping and components for underground use at the time of installation. However, all new and replacement steel pipe shall be cathodically protected and tested within one year of the time they are placed underground.

1. Coated steel mains. Coated steel mains to be protected are: 1) new construction piping of any length, 2) replacement or offset steel piping, and 3) steel piping of any length which is open trenched, pulled, pushed, or cased and then incorporated in a plastic system. A copy of all work orders, job orders, plans, and drawings in regard to any steel main shall be submitted to the designated corrosion engineer for cathodic protection recommendations prior to acquisition of materials for the project.
2. Coated steel services. Coated steel services to be protected are: 1) new construction steel service piping of any length, and 2) steel replacement service piping of any length. All coated steel services connected to mill-coated steel mains shall be cathodically protected in conjunction with the mains. All coated steel services that are electrically isolated from adjacent piping shall be protected with magnesium anodes. Every effort must be made to install magnesium anodes at the time the service piping is installed, but no later than one year from the time of installation.
3. Steel meter risers. Each steel meter riser on a plastic service shall be cathodically protected with a magnesium anode. Efforts must be made to install the anode at the same time the riser is installed, but no later than one year from the time of installation. Anodeless risers shall be used whenever possible.
4. Miscellaneous steel components. Miscellaneous steel components are defined as:
 - a. Any new or replacement segment with three or more discrete parts;
 - b. Replacement or offset steel piping less than 50 feet in length;
 - c. Metallic valves in plastic mains or plastic services; and
 - d. Steel cross tie-ins or steel tee tie-ins to cast iron, uncoated or plastic systems.

All miscellaneous steel components that are electrically isolated from adjacent piping shall be cathodically protected with magnesium anodes. The anodes shall be installed at the time the component is installed, but no later than one year from the time of installation.

C. Test leads.

1. General. Test leads shall be placed on gas mains and other structures to determine the adequacy of cathodic protection or electrical insulation.
2. Location.
 - a. Casings. One test lead shall be connected to the casing and one test lead to the main at each casing location, or where practical. The test leads shall be terminated in a test lead box placed at the base of the casing vent pipe. When it is impractical to connect wire to the casing, welded vent pipe is a good substitute for a test lead. See Drawing GC 2.0, Figure D.
 - b. Insulating fittings. A test lead shall be attached to the main on each side of each insulating fitting installed in the main except where otherwise specified by the designated corrosion engineer. See Drawing GC 2.0, Figure A.
 - c. Foreign pipelines. A test lead shall be provided at each location where a main

crosses a foreign cross-country pipeline. See Drawing GC 2.0, Figure C. The owners of the foreign pipeline shall be contacted requesting a test lead connection on their facilities.

- d. Coated steel main. Contact to the steel main shall be provided by either a test lead that is requested by the designated corrosion engineer or by a steel service that is not insulated at the main. Test leads are preferred at the end points of steel mains. See Drawing GC 2.0, Figure B.
 - e. Miscellaneous steel components. A test lead shall be attached to each miscellaneous steel component that requires a magnesium anode. See Drawing GC 2.0, Figure B.
3. Test lead installation.
- a. Test lead connection. Test leads shall be #12 TW insulated stranded copper wire or #6 compound insulated wire attached to the piping by cadwelding. When preparing the pipe surfaces and making the attachment, care must be taken to minimize damage to the coating on the piping. Each bared test lead wire and bared metallic area at point of connection to the piping must be coated with materials such as are specified in 3.01C and made equal to the original coating on the main.
 - b. Test lead terminals and boxes. The test lead(s) shall run to the boulevard along a city street or to the edge of a rural road or highway and terminate in a Public Utilities - Gas approved test lead box. The test lead box shall be placed where it can be easily located such as at a power pole, casing vent, water hydrant, stop sign, curb, sidewalk, or other landmark. If it is necessary to place the test box in a street or in any paved area, the lead(s) shall then be terminated in the upper section of a valve box. After the box has been set, a field drawing of the test lead location shall be made on the street order and routed through Public Utilities - Gas corrosion personnel. Public Utilities - Gas uses two types of test lead terminals, one for aboveground use (i.e., Big Fink) and the other for underground (valve box). Consult the designated corrosion engineer for the placement and type.
 - c. Test lead identification. Where more than one lead terminates in a box, the leads shall have means of identification (i.e., tagged with punched brass or plastic identification tags). When test leads from more than one pipeline terminate in a box, the leads shall be tagged to indicate their point of attachment. Tags stamped C and M will be used to identify casing and main test leads. Each tag will be attached to the end of the appropriate test lead. In case of a 4-wire test station (IR drop test station), gas flow would be used for the progression of the numbering system. When test leads terminate at a Big Fink test box, wires must be attached to the appropriate numbered terminal (i.e., #1 wire to the # 1 terminal, #2 to the #2). See Drawing GC 3.0.

D. Magnesium anodes.

1. General. The standard anode for coated steel mains is a 17 pound packaged magnesium anode. The standard anode for steel service is a 3 pound packaged magnesium anode depending on length of service. The standard anode for miscellaneous steel components is a 3 pound packaged magnesium anode. The standard anode for steel risers is a minimum 1 pound magnesium anode. Consult the designated corrosion engineer for the anode size.
2. Installation and placement.
 - a. Coated steel mains. Where cathodic protection will be provided by anodes, 17 pound packaged magnesium anodes shall be used in a centralized anode bed system. The designated corrosion engineer shall specify spacing, placement, and the number of anodes to be installed.
 - b. Isolated coated steel services. Anodes shall be installed on all coated steel gas services. They shall be placed approximately 2 feet horizontally from the service pipe and a minimum of 1 foot below pipe. If more than one anode is required, the designated corrosion engineer shall specify spacing, size, placement, and the number of anodes to be installed.
 - c. Steel meter risers on plastic services. An anode shall be installed on each steel meter riser. The anode shall be placed at least 1 foot below pipe. See Drawing GC 5.0.
 - d. Isolated miscellaneous steel components. An anode shall be installed on each isolated miscellaneous steel component. The anode shall be placed at least 2 feet horizontally from the component and a minimum of 1 foot below. For size and placement, consult the designated corrosion engineer. See Drawing GC 4.0.

E. Rectifiers and ground beds.

1. General. Cathodic protection rectifier-ground bed installations shall be designed by the designated corrosion engineer.
2. Installation. The installation of rectifiers and ground beds shall be in accordance with specifications, instructions, and drawings provided by the designated corrosion engineer with the following notes:
 - a. The fused disconnect switch shall be placed ahead of every rectifier even though the rectifier itself has an internal breaker.
 - b. The rectifier cabinet shall be grounded to ground rods driven at the unit location.
3. Initial energizing. The designated corrosion engineer is responsible for initially energizing the rectifier and shall either supervise or perform the initial current and voltage output adjustments.

F. Cathodic protection testing. All new and replacement steel piping and components for underground use shall be tested within one year of the time they are placed underground. This testing shall be done after the installation of cathodic protection equipment.

1. Coated steel main. The designated corrosion engineer shall supervise or perform the

initial testing for presence and adequacy of corrosion control devices. The results shall be recorded and forwarded to Public Utilities - Gas where they shall be kept on file for the life of the system.

2. Isolated coated steel services and steel meter risers. Isolated services and steel meter risers shall be tested for presence and adequacy of corrosion control devices by local personnel/corrosion consultants. The results shall be recorded and forwarded to Public Utilities - Gas where they shall be kept on file for the life of the system.
3. Isolated miscellaneous steel components. Isolated miscellaneous steel component shall be tested for presence and adequacy of corrosion control devices by local personnel/corrosion consultants. The results shall be recorded and forwarded to Public Utilities - Gas where they shall be kept for the life of the system.

3.04 CORROSION CONTROL MAPS AND RECORDS

- A. General. Complete records of each aspect of the corrosion control program must be prepared, maintained, and permanently retained. Public Utilities - Gas shall keep on file: 1) system maps, 2) records of initial tests and periodic inspections conducted by its personnel, and 3) all correspondence, plans, specifications, drawings, and other data necessary to demonstrate the presence and adequacy of corrosion control devices.

The designated corrosion engineer shall keep on file: 1) records of all initial tests and periodic inspections conducted or supervised by him, and 2) all correspondence and other data necessary to demonstrate the presence and adequacy of corrosion control devices.

- B. Maps and drawings.
1. Maps. System maps shall show test stations and rectifiers.
 2. Drawings. An "as-built" drawing showing measurements and the details of test stations, rectifier ground beds, anodes installed on steel mains, steel services, steel meter risers, and miscellaneous steel components incorporated into the gas system as part of the Work shall be prepared by the Contractor and forwarded to Public Utilities - Gas.
- C. Corrosion control records. The following records and forms shall be retained and forwarded to Public Utilities - Gas at the completion of the Work. Public Utilities - Gas shall retain these records for the life of the system:
1. Records of all tests, surveys, inspections, and correspondence.
 2. Street orders showing test lead locations.

END OF SECTION

SECTION 15106

VALVES, SERVICE REGULATORS, AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required, and install complete and ready for operation, all valves, service regulators, and appurtenances as shown on the Drawings.

1.02 RELATED WORK

- A. Section 02200, Excavation and Backfill.
- B. Section 15065, High Density Polyethylene Pipe and Tubing.
- C. Section 15075, Steel Pipe.
- D. Section 15079, Steel Pipe Corrosion Protection.

1.03 DESCRIPTION OF SYSTEMS

- A. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of natural gas.

1.04 QUALIFICATIONS

- A. All of the types of valves, service regulators, and appurtenances shall be products of well-established firms who are fully experienced, reputable, and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable.

1.05 SUBMITTALS

- A. Copies of all materials required to establish compliance with these Specifications shall be submitted. Submittals shall include at least the following:
 - 1. Certified drawings showing all important details of construction and dimensions.
 - 2. Descriptive literature, bulletins, and/or catalogs of the equipment.
 - 3. The total weight of each item.
 - 4. A complete bill of materials for each item.

1.06 OPERATING INSTRUCTIONS

- A. Operating and maintenance instructions shall be furnished to Public Utilities - Gas. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.07 TOOLS

- A. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment.

PART 2 PRODUCTS

2.01 GENERAL

- A. All valves, service regulators, and appurtenances shall be of the size shown on the Drawings and as far as possible all items of the same type shall be from one manufacturer.
- B. All valves shall have the name of the manufacturer, flow directional arrows, and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
- C. All valves and service regulators shall have a working pressure rating in excess of the maximum line pressure in which installed.
- D. All valves shall open left (counterclockwise).

2.02 VALVES

- A. Steel gate valves.
 - 1. Steel gate valves shall be flange x flange for above ground use and weld x weld for below ground use unless otherwise shown on the drawings and shall meet the requirements of API 6D and 49 CFR 192. Gate valves shall be working pressure rated for the maximum pressure of the line in which installed, with a minimum working pressure of 150 psi. Valves shall be steel body, full opening, non-rising stem type. Valves shall open counterclockwise and shall be equipped with a 2-inch square operating nut unless shown otherwise on the drawings.
 - 2. Gate valves shall be Model 1 Gate Valve by Kerotest Manufacturing Co., or approved equal.
- B. Ball valves.
 - 1. Ball valves for installation in steel lines shall be weld end x weld end unless shown otherwise on the drawings and shall comply with the requirements of API 6D and 49 CFR 192. Valves shall be working pressure rated for the maximum pressure of the line in which installed with a minimum working pressure of 150 psi. Valves shall be steel body with

stainless steel ball and Teflon seat. Valves shall open counterclockwise, 1/4 turn, and shall be equipped with a 2-inch square operating nut.

Ball valves for installation in steel lines shall be Weldball by Kerotest Manufacturing Co., or approved equal.

2. Ball valves for installation in polyethylene mains shall be manufactured from 3408 polyethylene material with valve inlet and outlet manufactured for butt fusion. Valves shall comply with 49 CFR 192 and ASME B16.40 and shall have a minimum SDR of 11.0.

All ball valves installed in 2" and larger polyethylene lines shall be full port opening, maintenance free type equipped with a 2-inch square operating nut and designed for a working pressure of 100 psi. Valve opening shall be counterclockwise, 1/4 turn.

Ball valves for installation in 2-inch and larger PE lines shall be Polytec Ball Valves by Kerotest Manufacturing Co., or approved equal.

3. Ball valves for installation in polyethylene service lines shall be manufactured from 3408 polyethylene material with fused-end inlet and outlet. Valves shall comply with ASME B16.40 with a minimum SDR of 11.0. Service valves shall be maintenance free, 1/4-turn counterclockwise opening, with a service-key operating nut. Valves shall be working pressure rated at 100 psi.

Service ball valves shall be Polyethylene Fused-End Service Valve or Polytec Ball Valve by Kerotest Manufacturing Co., or approved equal.

- C. Meter valves. All meter valves shall be tamper proof, brass ball valve with lockwing. The valve body shall be brass with internal pipe thread inlet and insulated outlet connection. Working pressure rating shall be 175 psi. Meter valves shall be Jomar Model 175 LWNP, or approved equal

2.03 SERVICE REGULATORS

- A. General. Service regulators shall be selected with respect to load requirements and class of service on which to be used. The regulator case must be designed to withstand a minimum of 125-psi pressure. Diaphragms must be reinforced neoprene or other synthetic material applicable for the particular pressure range and diaphragm size. Leather diaphragms are not acceptable. Orifice size must be selected to ensure pressure control within the limits of good operation. Regulators for low-pressure service to customers shall be specified for 6" W.C. outlet pressure. Loading types (pilot tube or other) shall be specified for installation where straight line or increasing pressure with increasing gas flow through the regulator is desired. Service regulators designed with provisions for rotating the diaphragm case in respect to the inlet and outlet positions are preferred for facilitating installation.

Regulators shall have female internal pipe threaded inlet and outlet unless shown otherwise on the drawings or directed by the Public Utilities - Gas Engineer.

- B. Vents. Service regulators with internal relief must have a screened vent connection adequately sized to discharge the gas from the regulator case in the event of internal regulator failure. A

common breather and relief vent may be used. Vent caps shall be bug proof and shall not permit rain or snow to enter the vent lines.

- C. Over-pressure control. All service regulators supplying gas in inches WC shall include provisions to limit outlet pressure from the regulator to 1-1/2 psi in the event of regulator failure. These provisions must be ample under conditions of maximum inlet pressure to the regulator, wide-open orifice and no load on the service. Regulators and over-pressure devices considered as meeting these requirements are as follows:
 - 1. A service regulator with a full capacity internal relief. Any regulator vent line installed must have a capacity at least equal to the capacity of the regulator, as installed, with a combined pressure drop of not over 1-1/2 psi.
 - 2. A non-relief type regulator, installed with a properly sized external relief, Fisher type 289, or equal. Any combined breather and relief vent line installed must have a capacity at least equal to the capacity of the regulator, as installed, with not over 1-1/2 psi pressure drop.
- D. Regulators shall be Series 1200 (residential use), or Series 1800/2000 (industrial use), as manufactured by American Meter Company, or equal.

2.04 SERVICE RISERS

- A. Service risers shall be prefabricated and anodeless, requiring no cathodic protection and shall meet or exceed the requirements of 49 CFR 192. The above-grade portion of the riser shall provide a gas tight seal between the casing pipe and the carrier pipe. A minimum 12-inch polyethylene pigtail inlet shall be provided. The polyethylene pigtail shall be manufactured of 3408 polyethylene and shall have fusion compatibility with the service line piping. The outlet of the riser shall be threaded to accommodate a meter valve.

2.05 VALVE BOXES

- A. All buried valves shall be provided with valve boxes.
- B. Valve boxes shall be as manufactured by Bingham and Taylor, or equal, and shall be a heavy-pattern cast iron, 3-piece, screw-type adjustable box with dome base suitable for installation over the buried valve. Inside barrel diameter shall be at least 5-1/4 inches. Barrel length shall be adapted to the depth of cover. Covers shall be cast iron with "GAS" integrally cast. Aluminum or plastic valve boxes are not acceptable.
- C. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall impart no load on the valve or piping.

PART 3 EXECUTION

3.01 VALVE INSTALLATION

A. General.

1. Valves shall be installed at all locations indicated on the Plans, or as otherwise directed by the Public Utilities - Gas Engineer.
2. Prior to installation, all valves shall be fully opened and fully closed a sufficient number of times to ensure that all parts are in proper working order.
3. Valves shall be set with the operating nut vertically aligned.

B. Buried valves.

1. Valve installations shall include the valve, complete valve box assembly, and any required blocking.
2. Valve boxes shall be installed vertically, centered over the operating nut, and the elevation of the top shall be adjusted to conform to the finished surface of roadway or other surface at the completion of the contract. Boxes shall be adequately supported during backfilling to maintain vertical alignment.
3. Valve boxes shall be isolated from the valve and piping by blocking under the valve box with brick, concrete block, or suitable masonry material. Similar material shall be used to block under the center of the valve. Backfill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet, such that the plumbness of the valve box is maintained.

C. Above-grade valves.

1. All valves installed above grade shall be rigidly supported so as not to impart undue stresses on connected piping.
2. Valves shall be located and installed such that valve operation and maintenance are unencumbered.
3. All valves shall be installed in strict compliance with the manufacturer's instructions.

3.02 SERVICE REGULATORS

- A. Regulators shall be installed upstream of the meter in strict compliance with manufacturer's instructions unless otherwise instructed by the Public Utilities - Gas Engineer.

3.03 INSPECTION AND TESTING

- A. Valve operation shall be satisfactory to Public Utilities - Gas in all respects.

- B. Valves shall be tested in conjunction with testing of the gas lines in which installed. Any valve or appurtenance found to be defective during testing shall be adjusted, removed and replaced, or otherwise made acceptable to Public Utilities - Gas.
- C. All buried valves shall be in the open position during pressure testing, and shall remain open upon completion of the tests.
- D. Under no circumstances shall the Contractor operate any valves within the existing gas distribution system, or otherwise interrupt or restore gas service to any customer. City personnel shall perform all valve operations and service restoration, as required.

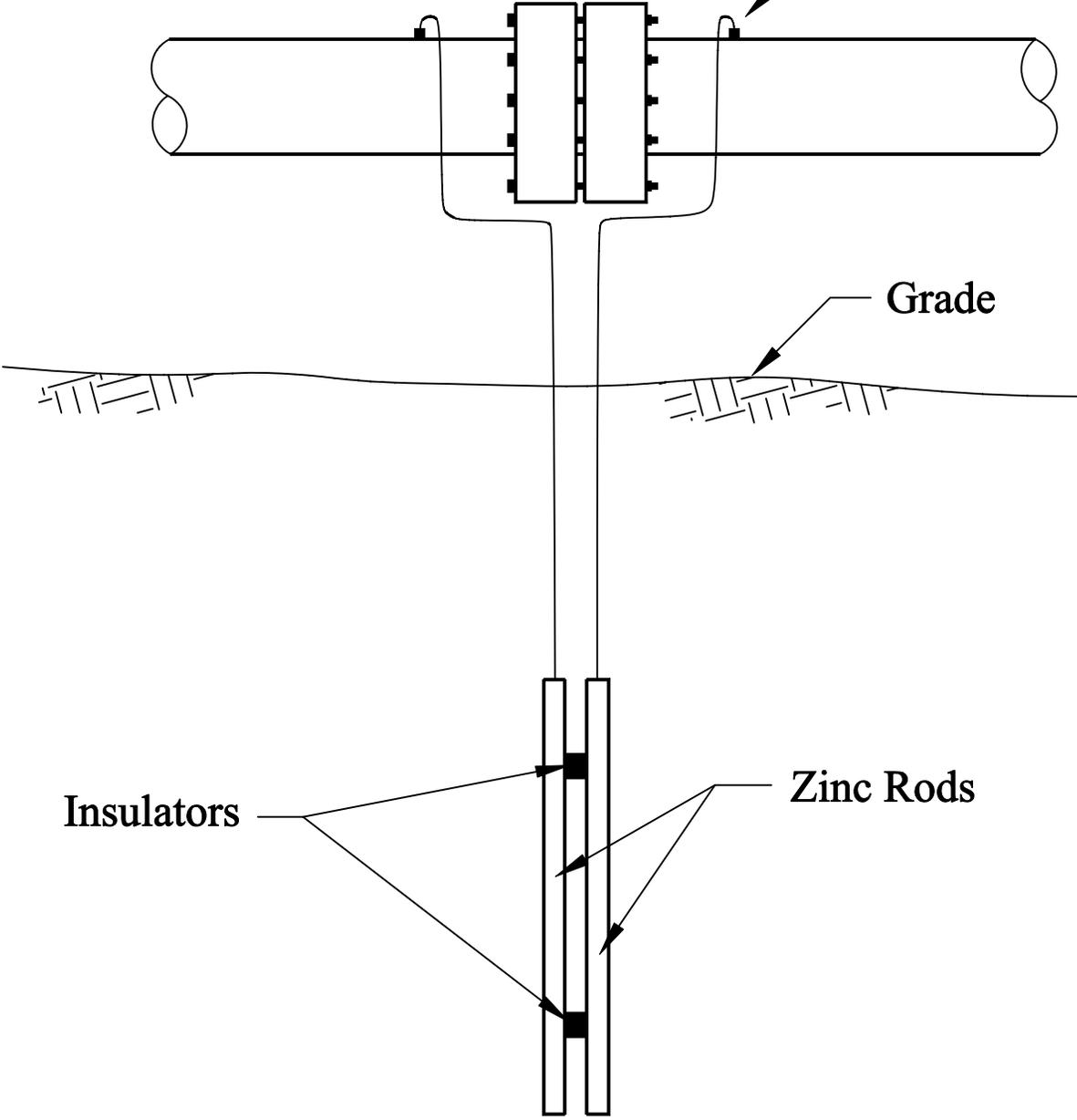
END OF SECTION

DETAIL DRAWINGS

SECTION 1. CORROSION PROTECTION

Insulating Flange
(Coupling, Fitting)

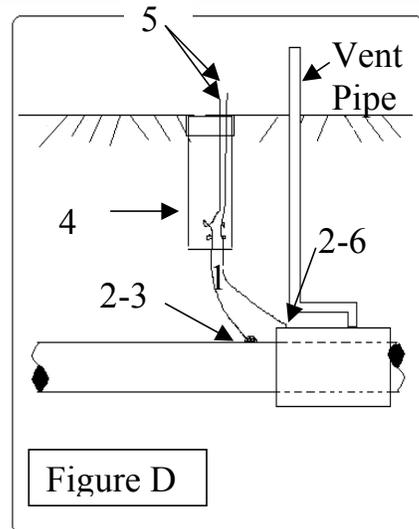
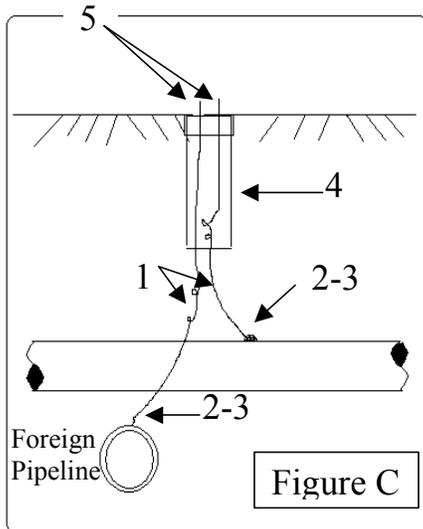
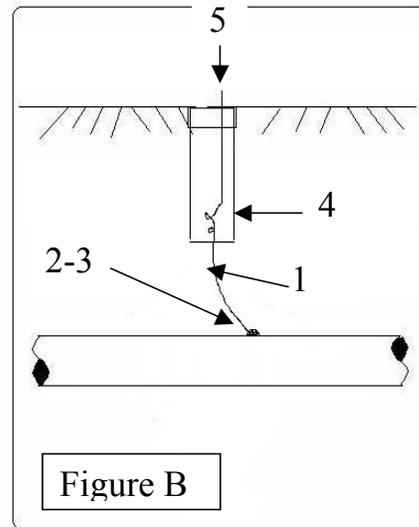
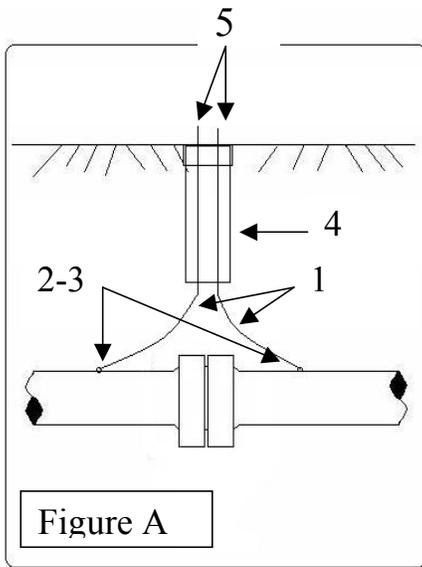
Cadweld
to pipeline



Grade

Insulators

Zinc Rods

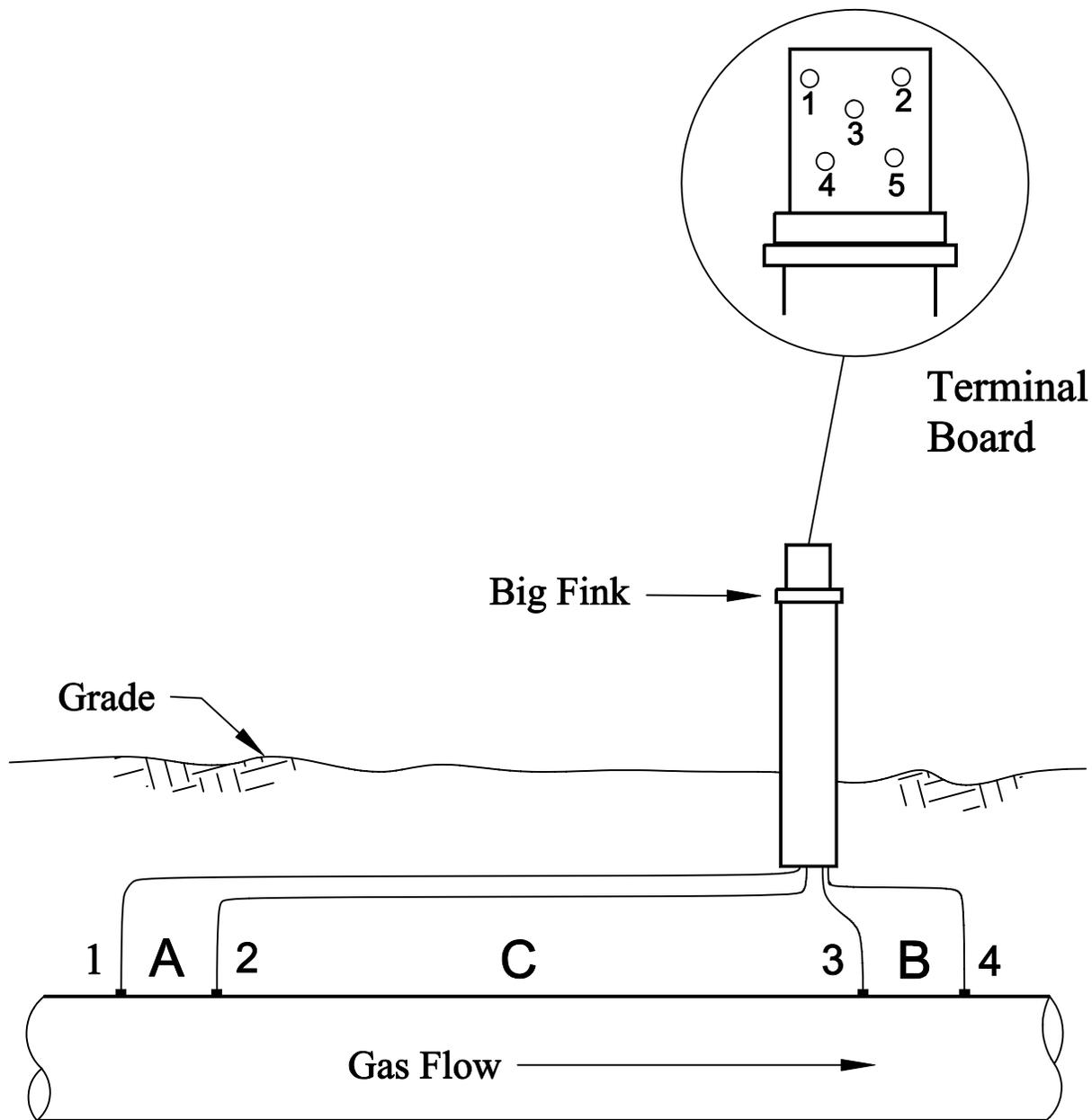


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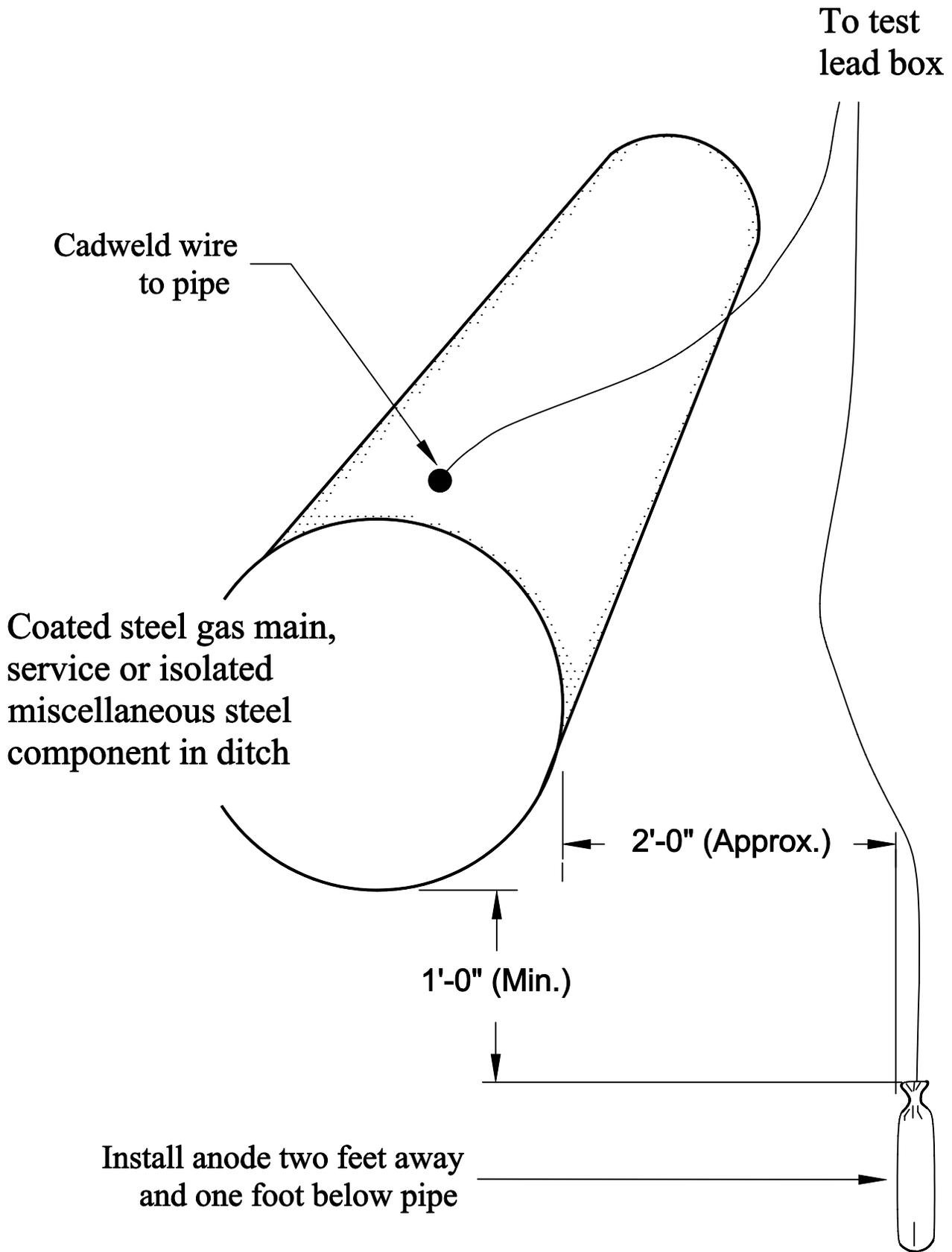
1. Lead wire, slack loop all wires (see note A)
2. Cadweld wire to main (see drawing)
3. Repair coating
4. Test lead box (see note B)
5. Identification Tags
6. Field coat connection on casing

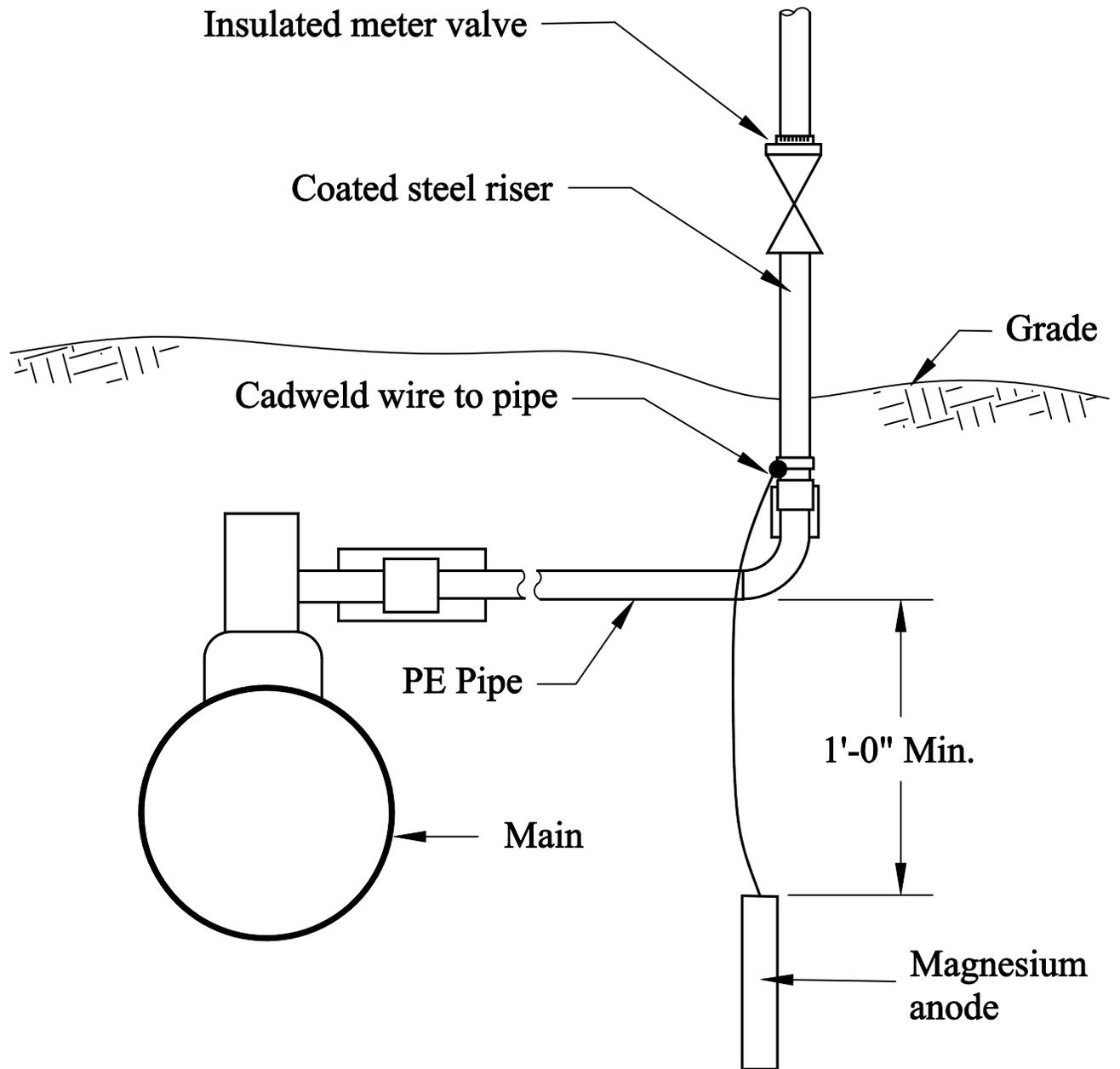
Notes

- A. Lead wires are # 12 /6 stranded copper wires insulated for direct burial.
- B. Use valve box with cover for street or paved areas.
Use cathodic protection terminal box for boulevard installations

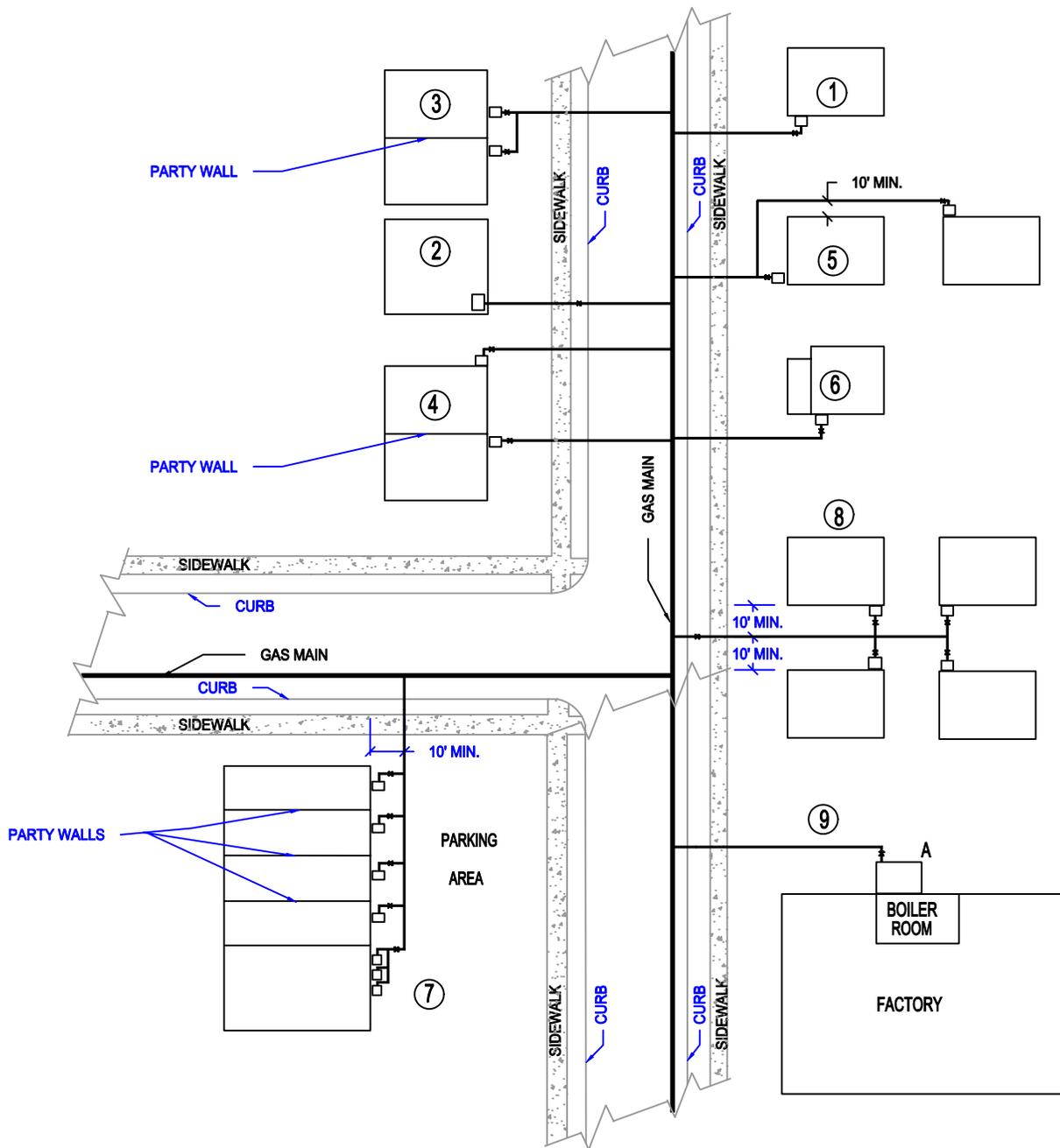


- Notes:
- A. Distance between 1 and 2 is five times diameter of pipe.
 - B. Distance between 3 and 4 is five times diameter of pipe.
 - C. Distance between 2 and 3 is 100'.





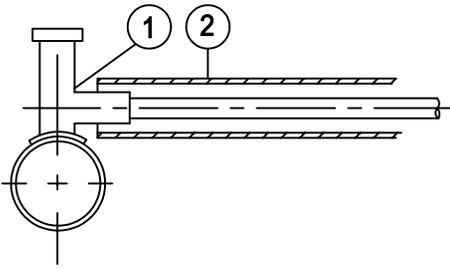
SECTION 2. SERVICE CONNECTIONS



Service Types

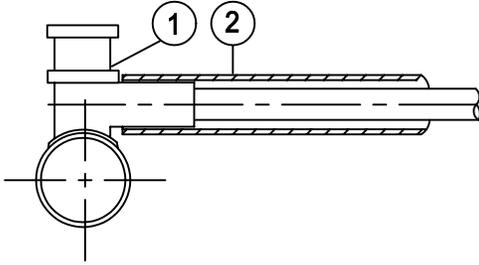
1. Normal service (outside meter where possible)
2. Normal service (inside meter)
3. Single ownership structure, multi-meter installation
4. Separate ownership structure, common party wall
5. Multiple structure, single ownership on same lot
6. Obstructed front structure. Side service for company or customer's convenience
7. Master service shopping center or apartments set back from street, single ownership, multiple tenants with individual meters
8. Master service, housing projects or similar installations, single ownership, multiple structure not in close proximity to gas main supply, individual meters
9. Special service industrial or commercial high capacity service with or without meter house

Item	Description
A	Meter house
—*	Service stop or valve located on riser for outside meters and at curb for inside meters



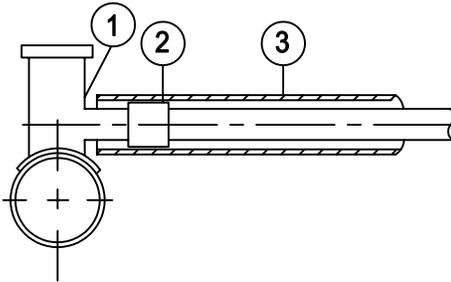
1/2" (5/8") SERVICE

ITEM	MATERIAL DESCRIPTION
1	1/2" (5/8") OUTLET, PE SERVICE TAPPING TEE
2	1-1/2" PE PROTECTIVE SLEEVE 12" TO 24" LONG (SCRAP MATERIAL)



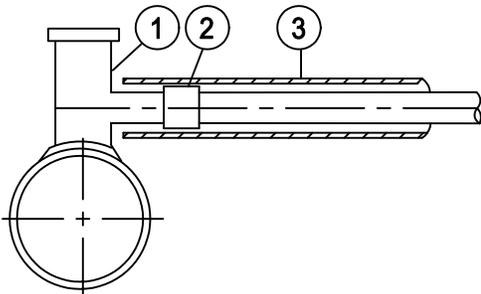
1" (1-1/8") SERVICE

ITEM	MATERIAL DESCRIPTION
1	1" (1-1/8") PE SERVICE TAPPING TEE
2	1-1/2" PE PROTECTIVE SLEEVE 12" TO 24" LONG (SCRAP MATERIAL)



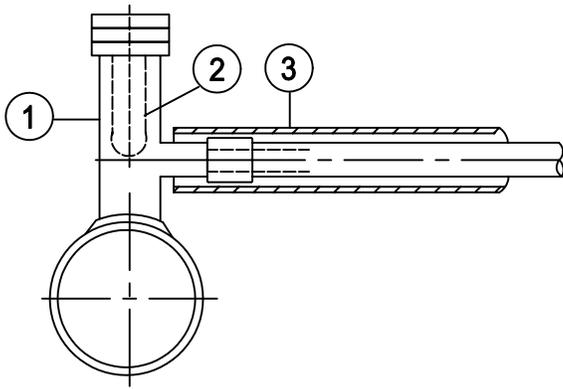
1" (1") SERVICE

ITEM	MATERIAL DESCRIPTION
1	1" PE SERVICE TAPPING TEE
2	1" (1") PE EXTERNAL SOCKET
3	1-1/2" PE PROTECTIVE SLEEVE 12" TO 24" LONG (SCRAP MATERIAL)



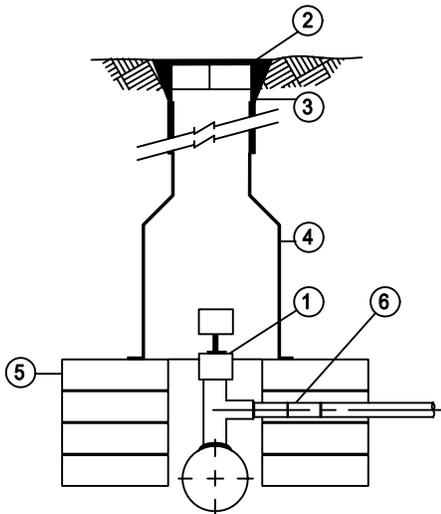
1-1/4" SERVICE

ITEM	MATERIAL DESCRIPTION
1	1-1/4" PE SERVICE TAPPING TEE
2	1-1/4" I. P.S. PE SOCKET
3	2" PE PROTECTIVE SLEEVE 12" TO 24" LONG (SCRAP MATERIAL)



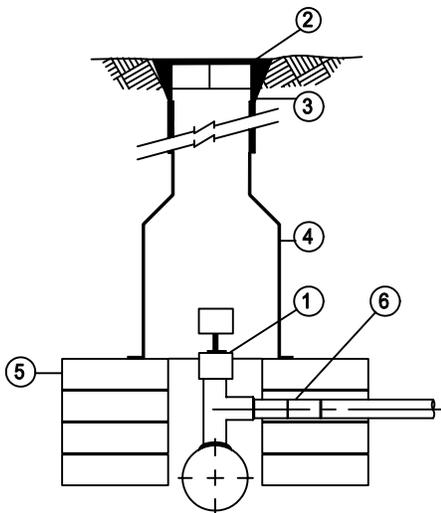
1/2" (5/8") SERVICE

ITEM	MATERIAL DESCRIPTION
1	3/4" PUNCH VALVE TEE, WELD INLET - 5/8" COMP. OUTLET AND 5/8" INSERT
2	MAIN PUNCH FOR STEEL SERVICE TEE
3	1-1/2" PE PROTECTIVE SLEEVE 12" TO 24" LONG (SCRAP MATERIAL)



1" SERVICE

	MATERIAL DESCRIPTION
1	1" CURB VALVE TEE, WELD INLET AND OUTLET
2	CAST IRON VALVE BOX COVER
3	CAST IRON VALVE BOX UPPER SECTION
4	CAST IRON VALVE BOX LOWER SECTION
5	CHASKA BRICK
6	1" STEEL TO PE TRANSITION FITTING

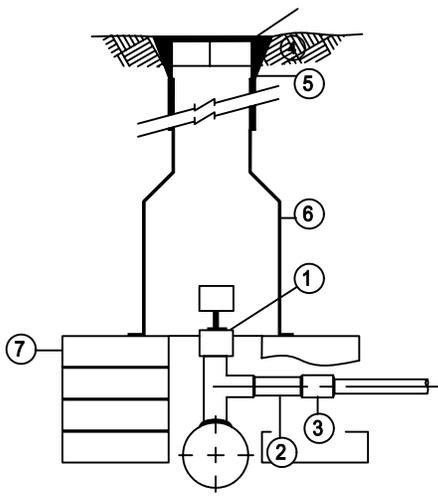


2" SERVICE

	MATERIAL DESCRIPTION
1	2" CURB VALVE TEE, WELD INLET AND OUTLET
2	CAST IRON VALVE BOX COVER
3	CAST IRON VALVE BOX UPPER SECTION
4	CAST IRON VALVE BOX LOWER SECTION
5	CHASKA BRICK
6	2" STEEL TO PE TRANSITION FITTING

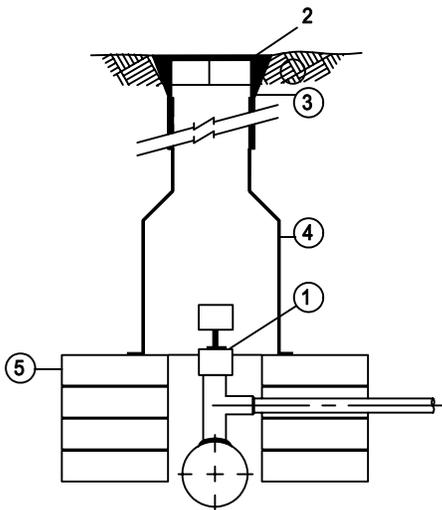
3/4" SERVICE

ITEM	MATERIAL DESCRIPTION
1	1-1/4" CURB VALVE TEE, WELD INLET AND OUTLET
2	1" STANDARD BLACK BARE STEEL PIPE NIPPLE, 4" LONG, PLAIN ENDS
3	1" x 3/4" FORGED STEEL SOCKET WELD REDUCER, 3000 LB.
4	CAST IRON VALVE BOX COVER
5	CAST IRON VALVE BOX UPPER SECTION
6	CAST IRON VALVE BOX LOWER SECTION
7	CHASKA BRICK



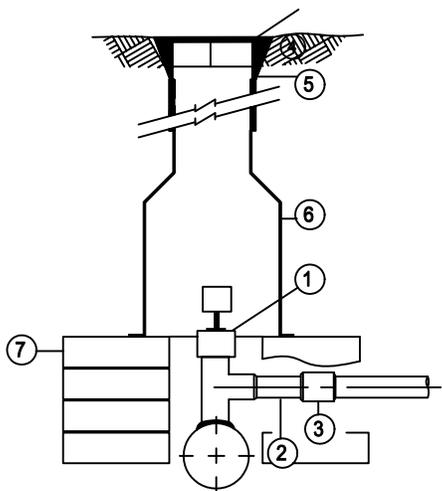
1" SERVICE

ITEM	MATERIAL DESCRIPTION
1	1-1/4" CURB VALVE TEE, WELD INLET AND OUTLET
2	CAST IRON VALVE BOX COVER
3	CAST IRON VALVE BOX UPPER SECTION
4	CAST IRON VALVE BOX LOWER SECTION
5	CHASKA BRICK

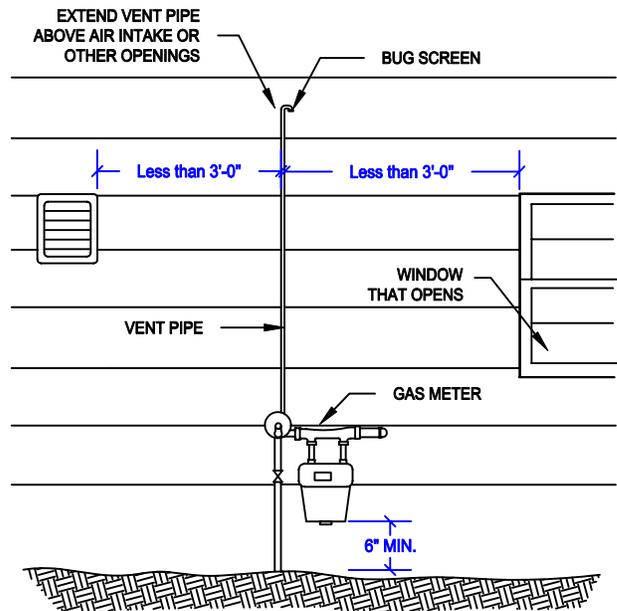
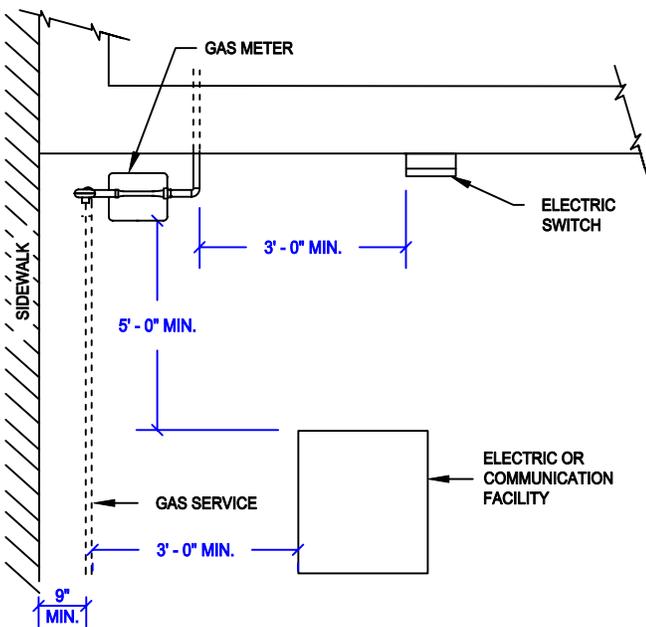
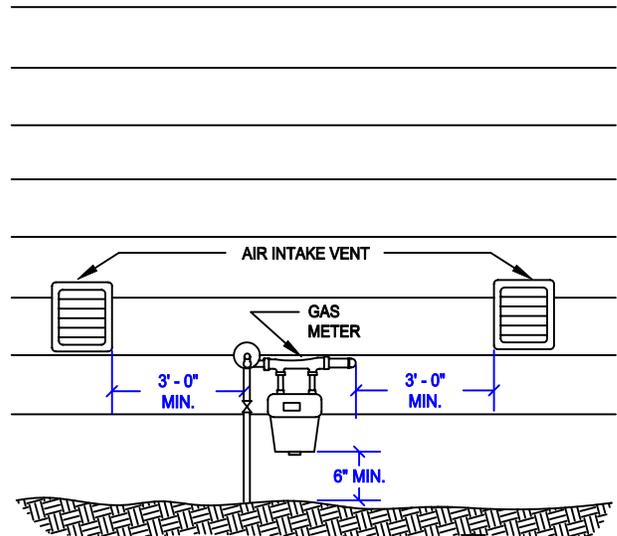
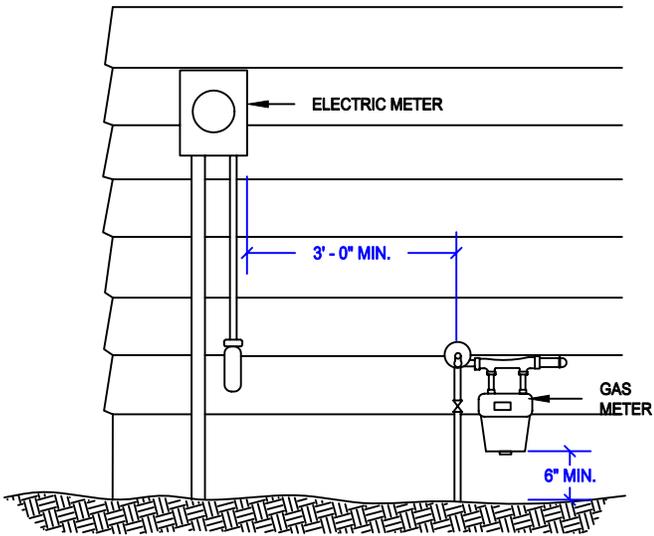


2" SERVICE

ITEM	MATERIAL DESCRIPTION
1	2" CURB VALVE TEE, WELD INLET AND OUTLET
2	2" STANDARD BLACK BARE STEEL PIPE NIPPLE, 4" LONG, PLAIN ENDS
3	2" FORGED STEEL SOCKET WELD COUPLING, 3000 LB.
4	CAST IRON VALVE BOX COVER
5	CAST IRON VALVE BOX UPPER SECTION
6	CAST IRON VALVE BOX LOWER SECTION
7	CHASKA BRICK



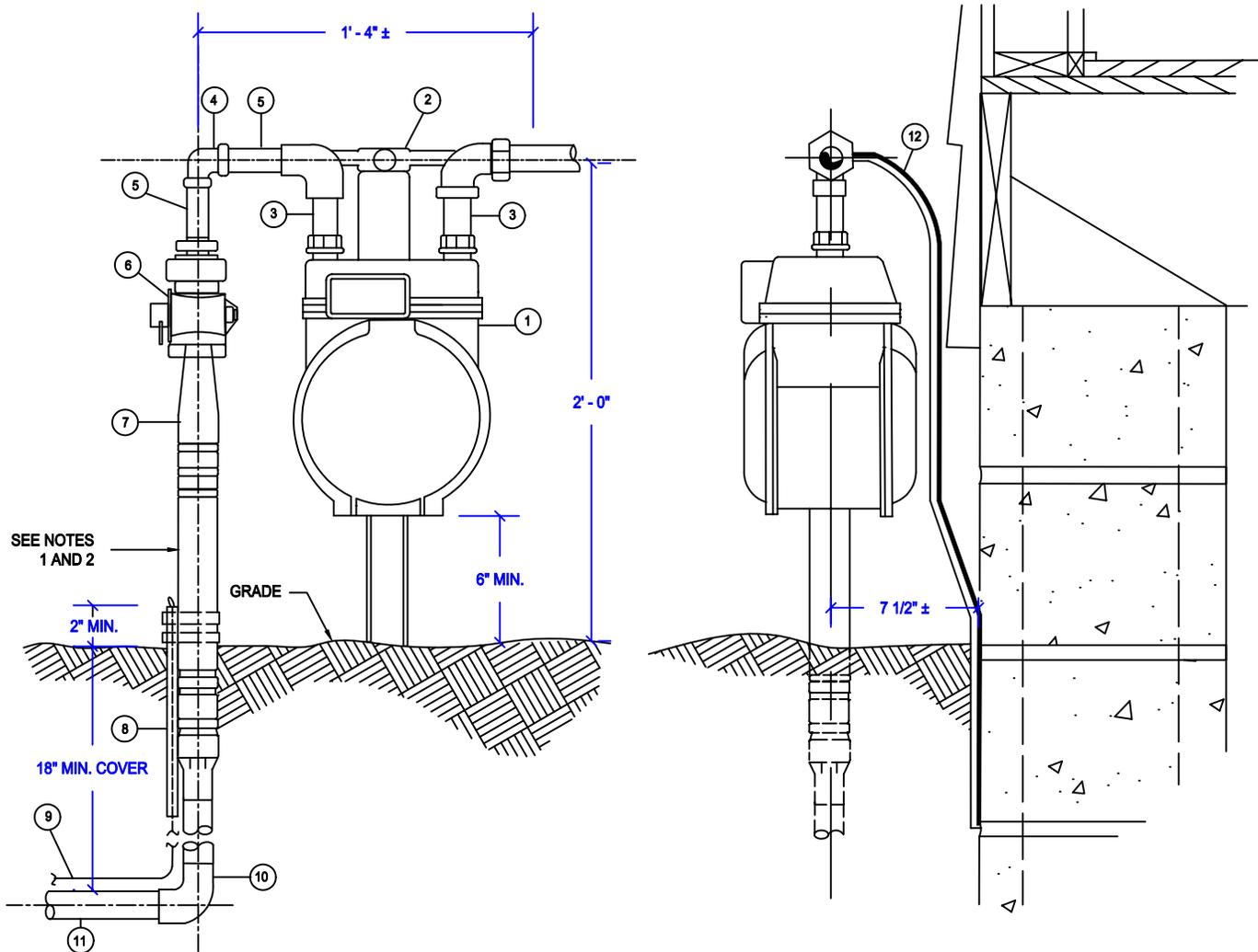
SECTION 3. METER INSTALLATIONS



NOTE: VENT PIPE TO BE EXTENDED TO ACQUIRE AT LEAST A 3' - 0" DIMENSION FROM AIR INTAKES OR OTHER OPENINGS

Vents

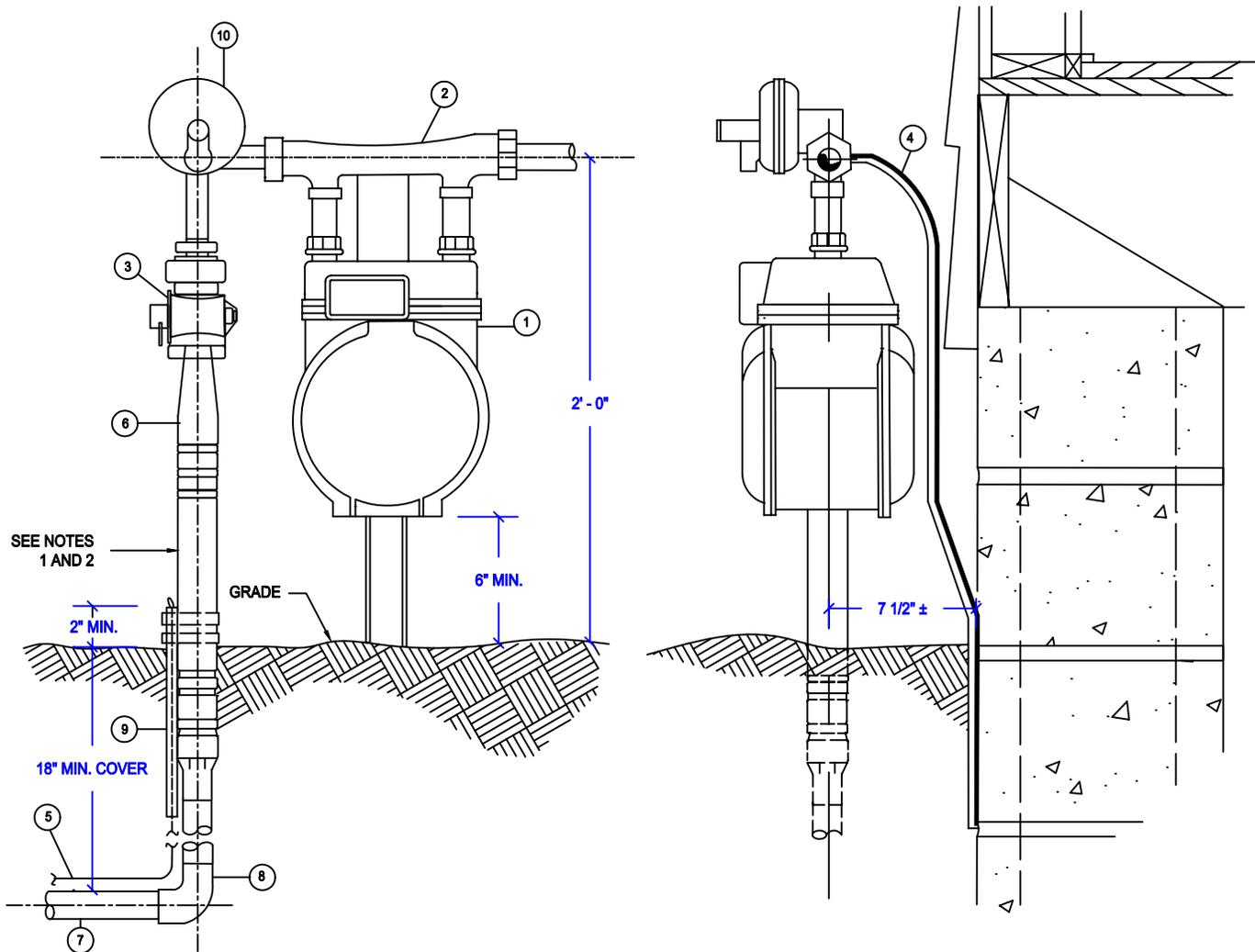
Service regulators with internal relief must have a vent connection which will adequately provide for discharging the gas from the regulator case in the event of internal regulator failure. A common breather and relief vent may be used. For out-of-doors installations the vent may be directly connected to a protected vent cap. Vent caps shall be bug proof and shall not permit rain or snow to enter the vent lines. The discharge point of regulator or relief valve vents shall not be placed under windows, ventilator ducts, or any source of ignition. The discharge point shall be a minimum of 3 feet horizontally or above any point where escaping gas may create undue hazards.



ITEM	NO. REQ'D	MATERIAL DESCRIPTION
1	1	TEMPERATURE COMPENSATED METER – SIZES 175, 225, 230 OR 425
2	1	METER BAR WITH INSULATED UNION OUTLET
3	2	1" 20 LT. METER SWIVEL, BLACK
4	1	1" 90° ELBOW, BLACK BANDED MALLEABLE IRON
5	2	1" X 4" PIPE NIPPLE, BLACK STEEL
6	1	1" LUBRICATED STOP-COCK, UNION TYPE WITH INSULATED OUTLET
7	1	1" C.T.S. METER RISER, ANODELESS TYPE
8	1	1/2" C.T.S. POLYETHYLENE PIPE SLEEVE 12" LONG (SCRAP)
9	VARIABLES	TRACER WIRE, NO. 14 PVC COATED
10	1	1" C.T.S. 90° POLYETHYLENE ELBOW
11	VARIABLES	1" C.T.S. POLYETHYLENE PIPE, TYPE II, GRADE 3
12	1	MOUNTING BRACKET (LONG SHOWN), SHORT BRACKET CR POST TYPE

GENERAL NOTES

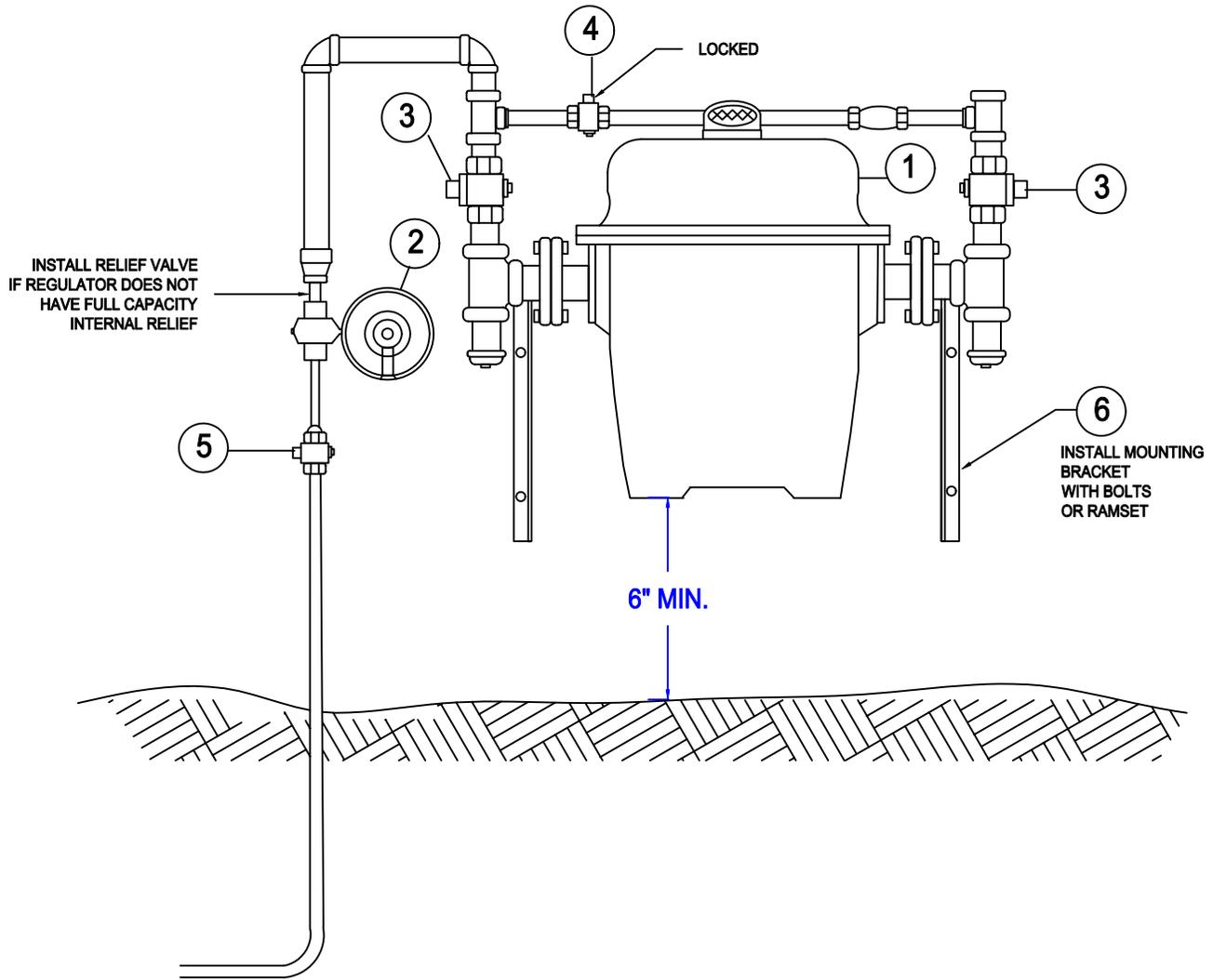
- 1/2" C.T.S. PE PIPE SLEEVE (ITEM NO. 8) TO BE TAPED TO RISER (ITEM NO. 7) WITH APPROVED TAPE.
- TRACER WIRE (ITEM NO. 9) SHALL BE LOOPED BACK INTO 1/2" C.T.S. PE PIPE SLEEVE.
- SERVICE TRACER WIRE (ITEM NO. 9) SHALL BE SPLICED TO GAS MAIN TRACER WIRE WITH SPLICE KIT.
- FOR SERVICE OFF MAIN CONNECTIONS SEE DRAWINGS.



ITEM	MATERIAL DESCRIPTION
1	TEMPERATURE COMPENSATED METER
2	3/4" METER BAR WITH INSULATED UNION OUTLET
3	3/4" X 3/4" LUBRICATED STOP-COCK, UNION TYPE WITH INSULATED OUTLET
4	MOUNTING BRACKET (LONG SHOWN), SHORT BRACKET CR POST TYPE
5	TRACER WIRE, NO. 14 PVC COATED
6	3/4" GALV. X 3/4" I.P.S. THREADED X 1/2" C.T.S. PE RISER, ANODELESS TYPE
7	1/2" C.T.S. POLYETHYLENE PIPE
8	1/2" C.T.S. 90° POLYETHYLENE ELBOW
9	1/2" C.T.S. POLYETHYLENE PIPE SLEEVE 12" LONG (SCRAP PIPE)
10	3/4" PRESSURE REGULATOR WITH INTERNAL RELIEF

GENERAL NOTES

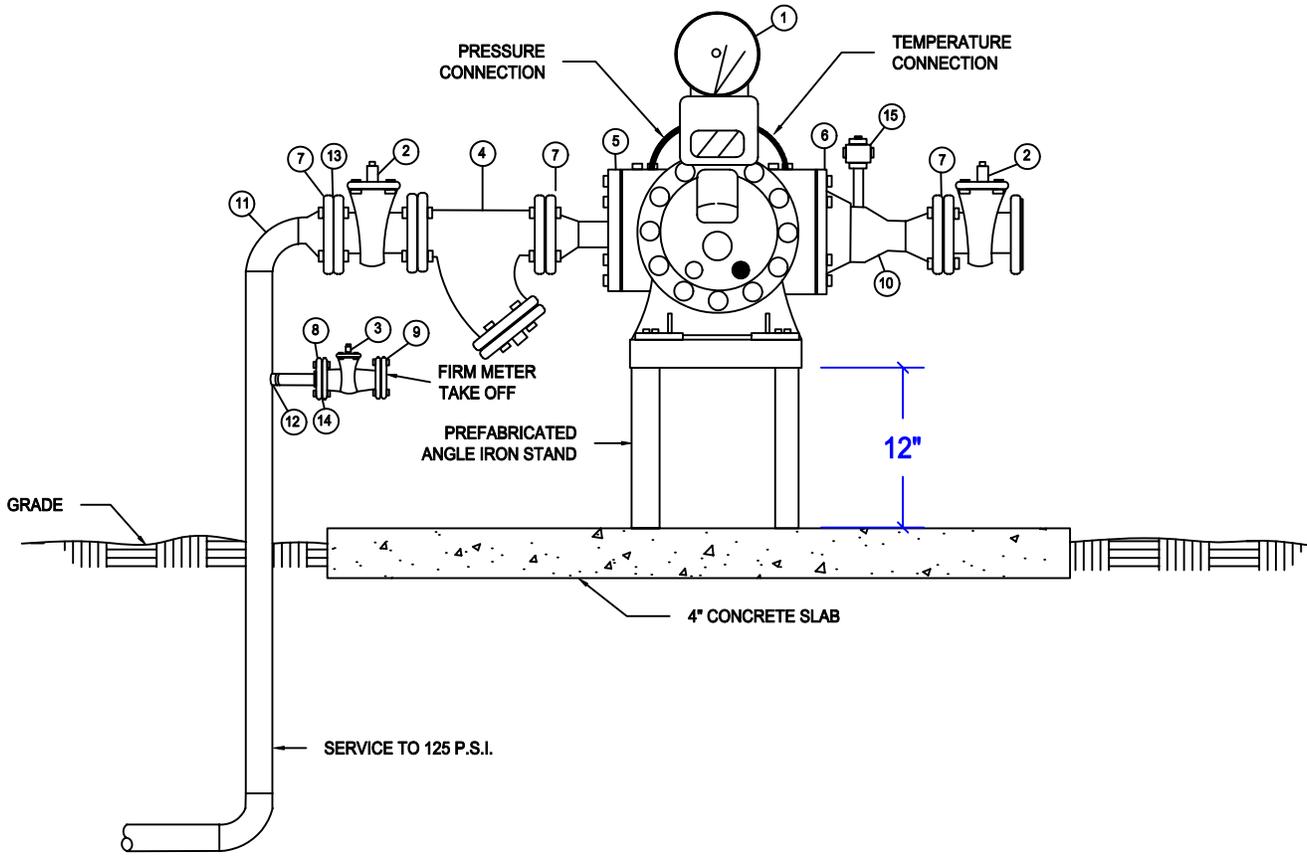
1. ITEM NO. 8 TO BE TAPED TO RISER WITH APPROVED TAPE.
2. TRACER WIRE WILL BE LOOPED BACK INTO POLY SLEEVE.
3. SPLICE TRACER WIRE INTO MAIN TRACER WIRE WITH SPLICE KIT.
4. FOR SERVICE OFF MAIN CONNECTIONS SEE DRAWINGS.



ITEM	MATERIAL DESCRIPTION
1	AMERICAN AL-5000 AND SMALLER ALUMINUM METER OR EQUAL
2	REGULATOR WITH INTERNAL RELIEF
3	STOP COCK MUELLER – 11170 OR EQUAL
4	STOP COCK MUELLER – 11175 OR EQUAL
5	STOP COCK MEULLER – 11179 (INSULATED OUTLET) OR EQUAL
6	MOUNTING BRACKET

NOTES:

1. THIS INSTALLATION MAY BE INSTALLED ON A CONCRETE SLAB.

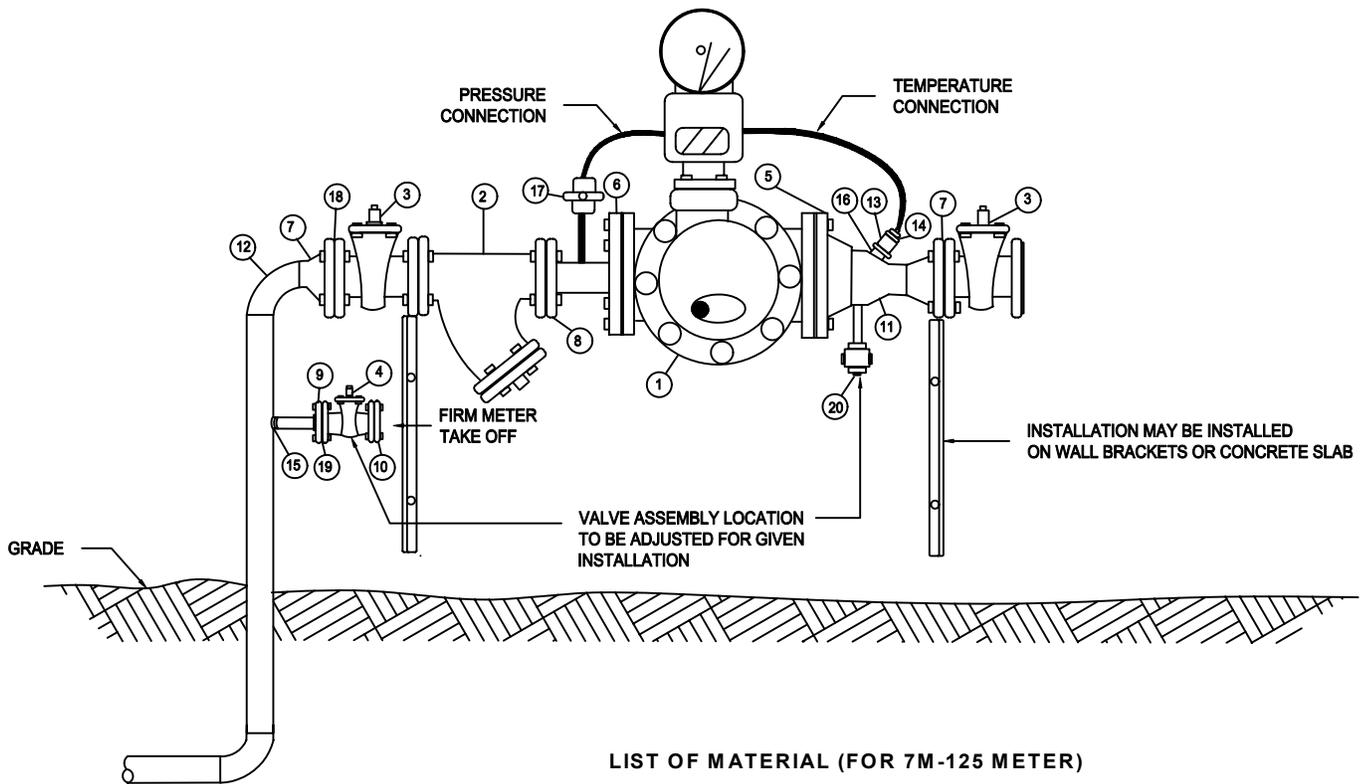


LIST OF MATERIAL (FOR 16M-125 METER)

ITEM	DESCRIPTION
1	4" ROTARY METER WITH INSTRUMENT
2	2" FLANGED VALVE
3	1" FLANGED VALVE
4	2" FLANGED STRAINER
5	4" X 2" REDUCING SLIP-ON FLANGE
6	4" WELDING NECK FLANGE
7	2" WELDING NECK FLANGE
8	1" SLIP-ON FLANGE
9	1" BLIND FLANGE
10	4" X 2" CONCENTRIC REDUCER
11	2" 90° LONG RADIUS ELBOW
12	2" X 1" SOCK-O-LET
13	2" INSULATING SET
14	1" INSULATING SET
15	3/4" VALVE ASSEMBLY, MUELLER H-11175, OR EQUAL, 3/4" x 3" NIPPLE THREADED ONE END, 3/4" SCREW PLUG

NOTE:

1. ALL VALVES MUST BE LOCKED TO PREVENT REMOVAL OF VALVE CORE.

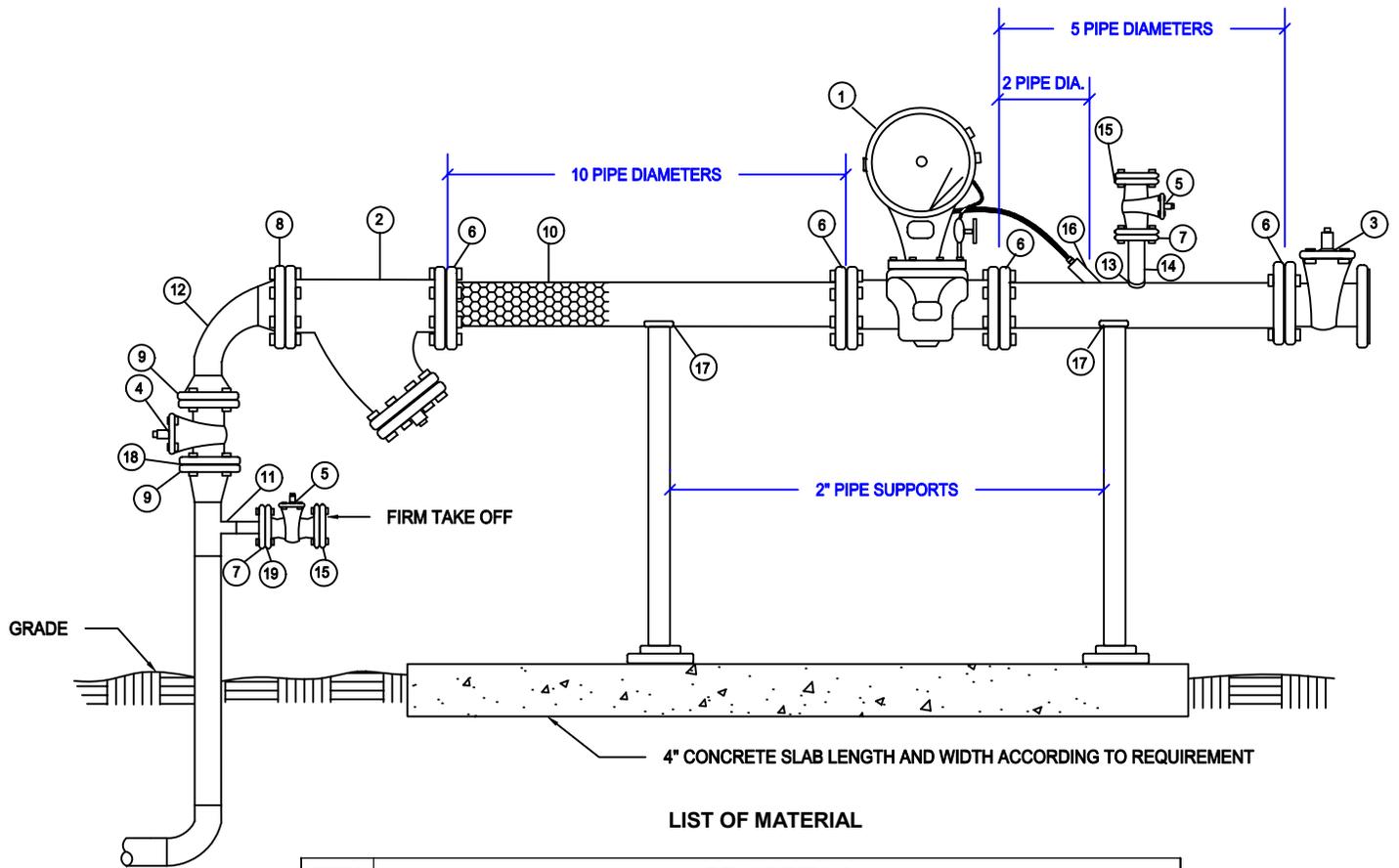


LIST OF MATERIAL (FOR 7M-125 METER)

ITEM	DESCRIPTION
1	3" ROTARY METER WITH INSTRUMENT
2	2" FLANGED STRAINER
3	2" FLANGED VALVE
4	1" FLANGED VALVE
5	3" WELDING NECK FLANGE
6	3" X 2" REDUCING SLIP-ON FLANGE
7	2" WELDING NECK FLANGE
8	2" SLIP-ON FLANGE
9	1" SLIP-ON FLANGE
10	1" BLIND FLANGE
11	3" X 2" CONCENTRIC REDUCER
12	2" 90° LONG RADIUS ELBOW
13	1-1/4" X 1" SCREWED REDUCER
14	1" TEMPERATURE WELL
15	2" X 1" SOCK-O-LET
16	1-1/4" X 2" 45° NIPPLE, THREADED ONE END
17	1/4" BAR STOCK NEEDLE VALVE, 1/4" X 3" LONG NIPPLE
18	2" INSULATING SET
19	1" INSULATING SET
20	3/4" VALVE ASSEMBLY MUELLER H-11175, OR EQUAL, 3/4" x 3" NIPPLE THREADED ONE END, 3/4" SCREW PLUG

NOTES:

1. METER INSTRUMENT DRIVE MUST BE ORDERED INDICATING SIDE OR BOTTOM INLET.
2. ADJUST LENGTH OF 1-1/4" NIPPLE 16 FOR MAXIMUM TEMPERATURE WELL DEPTH.
3. TOTAL WEIGHT OF METER RUN (AS SHOWN) IS APPROX. 275 LBS.
4. ALL VALVES MUST BE LOCKED TO PREVENT REMOVAL OF VALVE CORE.



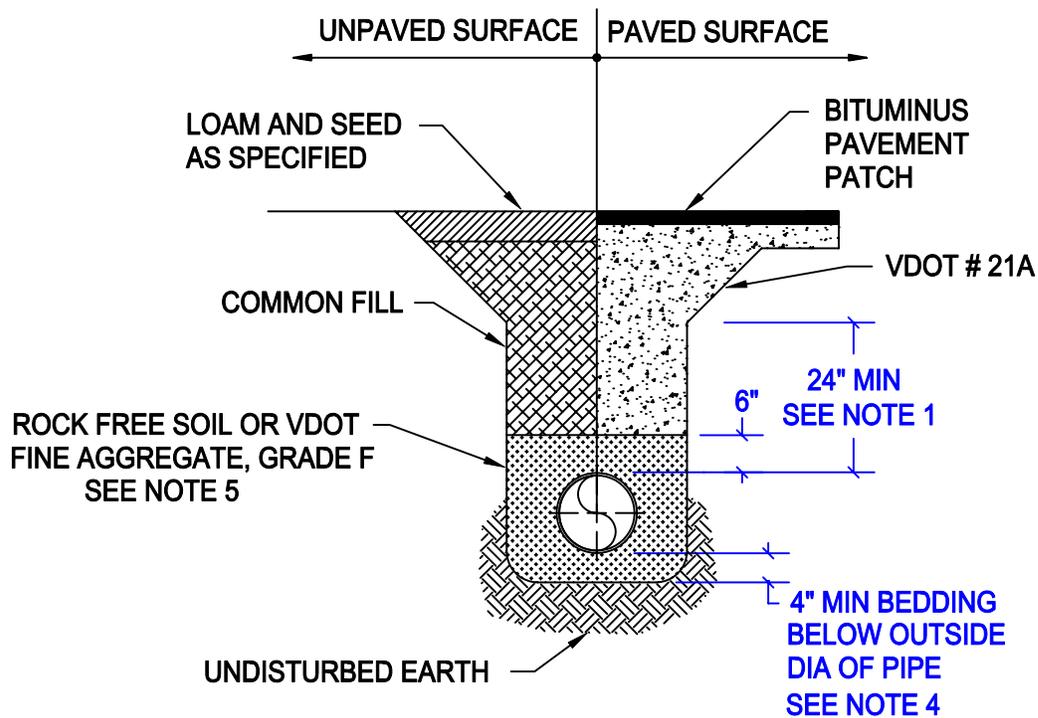
LIST OF MATERIAL

ITEM	DESCRIPTION
1	TURBO METER WITH INSTRUMENT
2	STRAINER
3	FLANGED VALVE
4	FLANGED VALVE
5	1" FLANGED VALVE
6	SLIP-ON FLANGE
7	1" SLIP-ON FLANGE
8	WELDING NECK FLANGE
9	WELDING NECK FLANGE
10	STRAIGHTENING VANES (ONE SET)
11	REDUCING TEE, OR SOCK-O-LET
12	REDUCING 90° ELBOW
13	1" SOCK-O-LET
14	1" X 3" LONG NIPPLE
15	1" BLANK FLANGE
16	1" X 2" LONG 45° COUPLING FOR TEMPERATURE WELL
17	SADDLE OR WALL SUPPORT BRACKET, PREFABRICATE FOR METER SIZE
18	INSULATING SLEEVE AND WASHER SET
19	1" INSULATING SLEEVE AND WASHER SET

NOTE:

1. ALL VALVES MUST BE LOCKED TO PREVENT REMOVAL OF VALVE CORE.

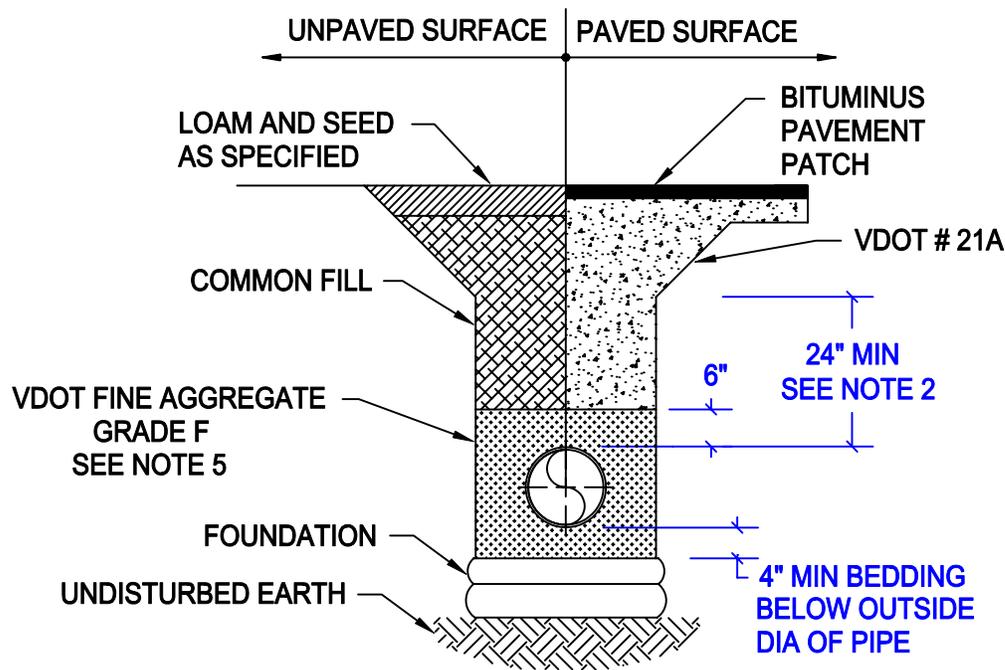
SECTION 4. GENERAL



PE and STEEL PIPE

NOTES:

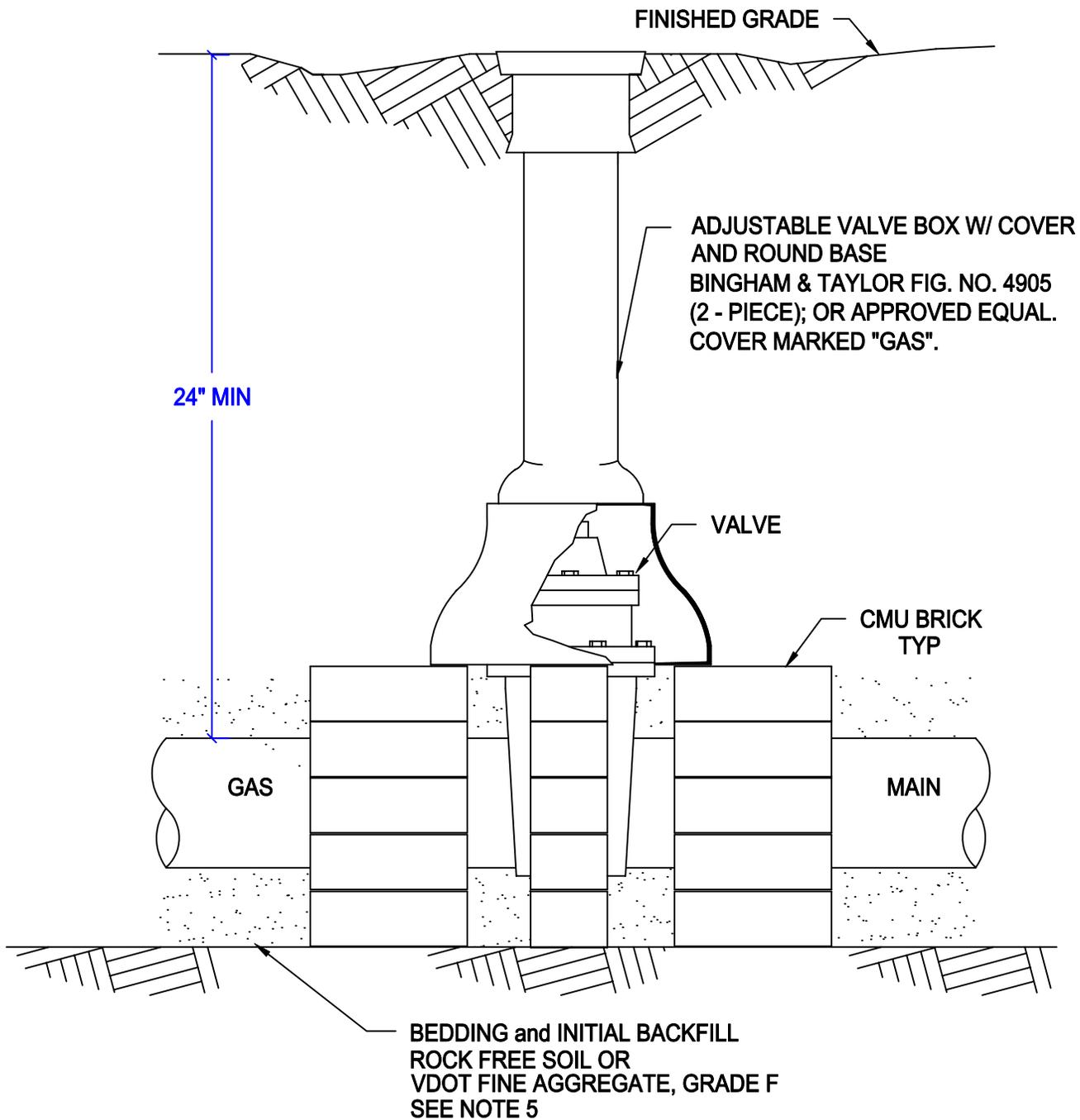
1. MAINTAIN VERTICAL TRENCH WALLS FROM BOTTOM OF TRENCH TO 24" ABOVE CROWN OF PIPE.
2. FOR EXCAVATIONS OVER 5 FT. DEEP, SLOPE TRENCH WALLS AS REQUIRED AND/OR PROVIDE OTHER SAFETY MEASURES IN ACCORDANCE WITH OSHA GUIDELINES.
3. ALL BACKFILL SHALL BE PLACED IN 6" LIFTS COMPACTED TO 95% MAXIMUM DENSITY PER ASTM D698.
4. BEDDING MAY BE OMITTED WHERE A FIRM, EVEN TRENCH BOTTOM EXIST.
5. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.



PE and STEEL PIPE

NOTES:

1. IN UNSTABLE SOILS, PROVIDE A FOUNDATION MAT FROM THE BOTTOM OF PIPE BEDDING TO UNDISTURBED STABLE SOIL, OR 18" MAX. DEPTH. THE FOUNDATION MAT SHALL CONSIST OF TWO (2) MATS (9" MAX. EACH) OF VDOT #1 CRUSHED STONE WRAPPED IN A HIGH STRENGTH GEOTEXTILE FABRIC; LINQ INDUSTRIAL FABRICS, INC. GTF 375N OR EQUAL. MATS SHALL EXTEND FULL WIDTH OF TRENCH EXCAVATION WITH MINIMUM FABRIC OVERLAP OF 18".
2. MAINTAIN VERTICAL TRENCH WALLS FROM BOTTOM OF TRENCH TO 24" ABOVE CROWN OF PIPE.
3. FOR EXCAVATIONS OVER 5 FT. DEEP, SLOPE TRENCH WALLS AS REQUIRED AND/OR PROVIDE OTHER SAFETY MEASURES IN ACCORDANCE WITH OSHA GUIDELINES.
4. ALL BACKFILL SHALL BE PLACED IN 6" LIFTS COMPACTED TO 95% MAXIMUM DENSITY PER ASTM D698.
5. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.

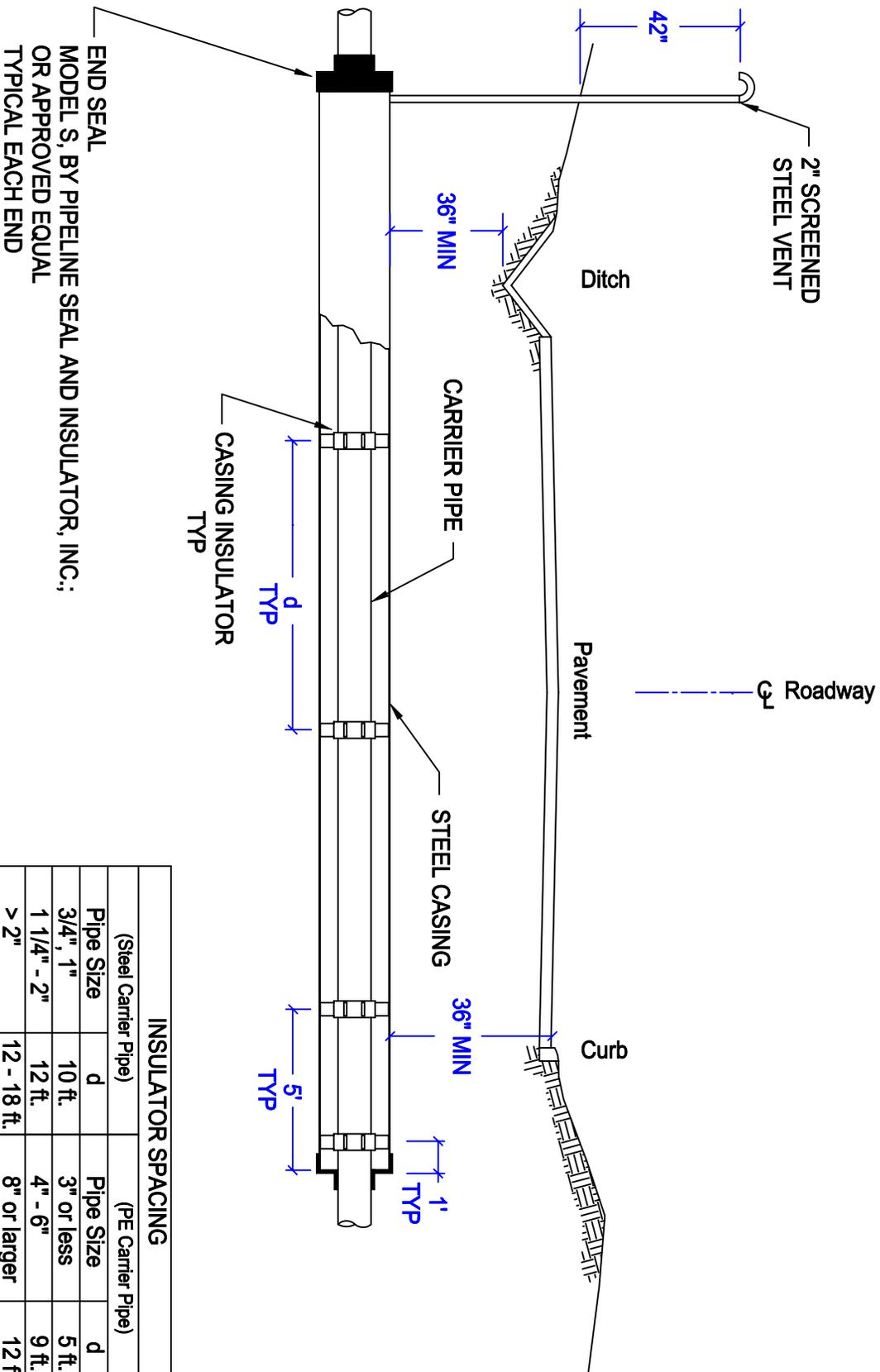


NOTE:

1. IN REMOTE AREAS, VALVE BOXES SHALL EXTEND SIX (6) INCHES ABOVE FINISHED GRADE.
2. BRICK COURSES SHALL BE LOCATED RADIALLY AROUND CIRCUMFERENCE OF VALVE BOX BASE.
3. DEPICTED BURIED VALVE INSTALLATION IS TYPICAL FOR ALL BURIED VALVE TYPES.
4. NUMBER OF BRICK COURSES REQUIRED IS DEPENDENT ON LINE SIZE AND VALVE TYPE.
5. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.

Steel Casing Installation Under Roadways

Not to Scale



END SEAL
MODEL S, BY PIPELINE SEAL AND INSULATOR, INC.;
OR APPROVED EQUAL
TYPICAL EACH END

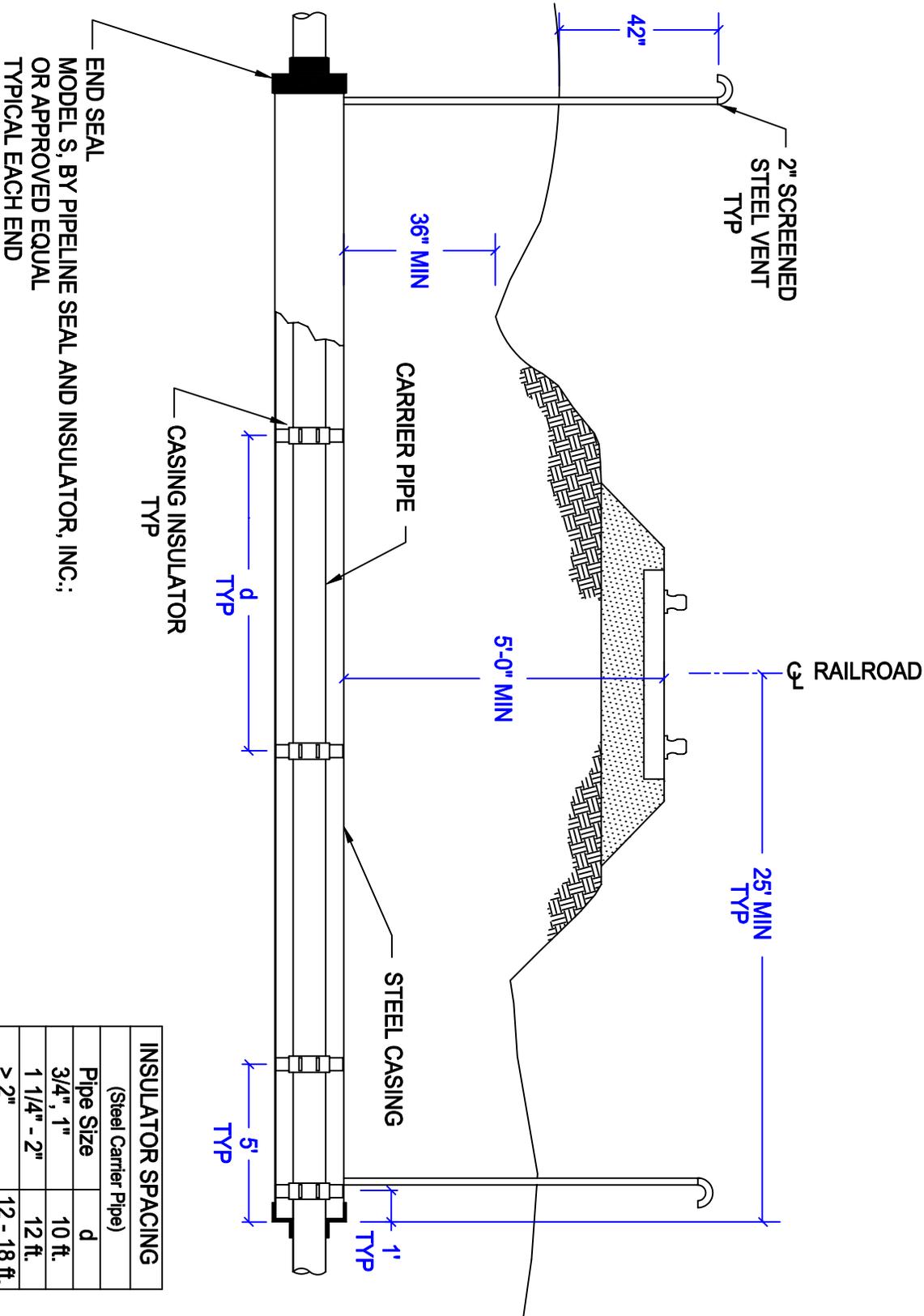
INSULATOR SPACING

(Steel Carrier Pipe)	d	(PE Carrier Pipe)	d
3/4", 1"	10 ft.	3" or less	5 ft.
1 1/4" - 2"	12 ft.	4" - 6"	9 ft.
> 2"	12 - 18 ft.	8" or larger	12 ft.

- NOTE: 1. STEEL CASING TO EXTEND TO BACK OF CURB, DITCH, SIDEWALK, ETC. OR A MINIMUM OF 5' BEYOND THE EDGE OF PAVEMENT, WHICHEVER IS GREATER.
2. REFERENCE DRAWING GG 3.2 FOR MINIMUM STEEL CASING SIZE AND WALL THICKNESS.

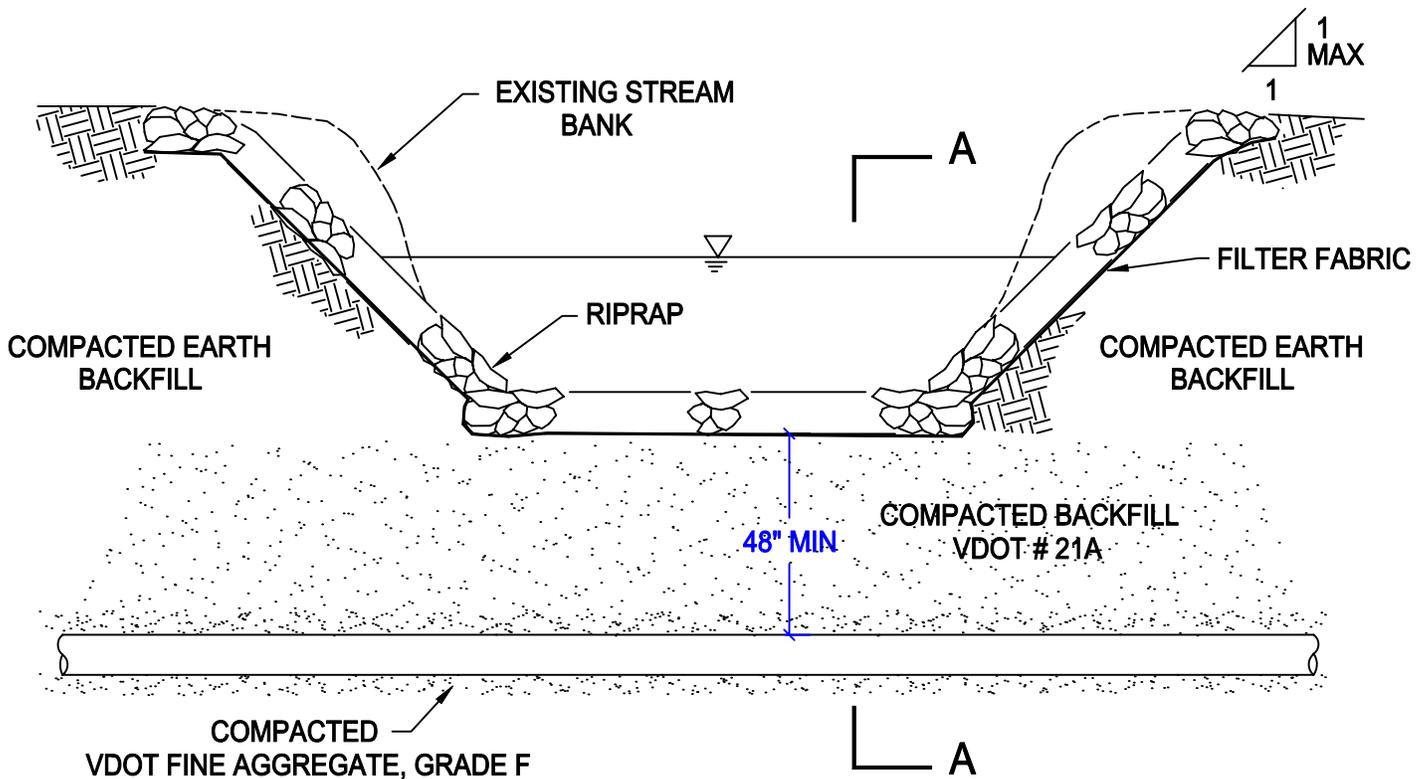
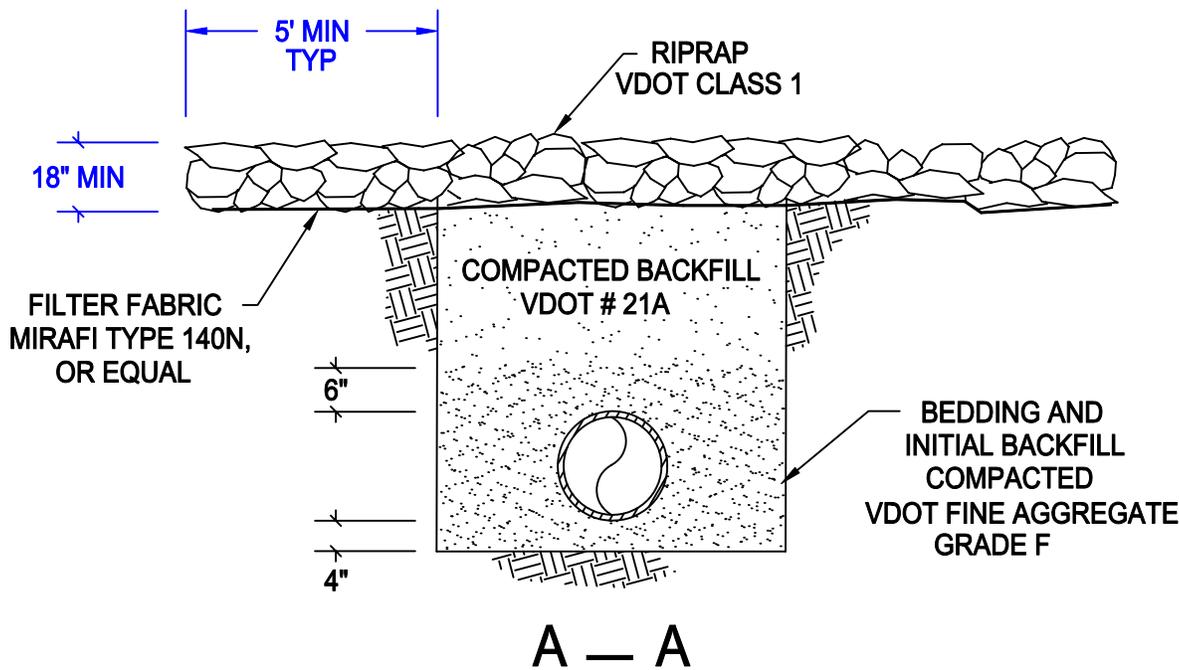
Steel Casing Installation Under Railways

Not to Scale

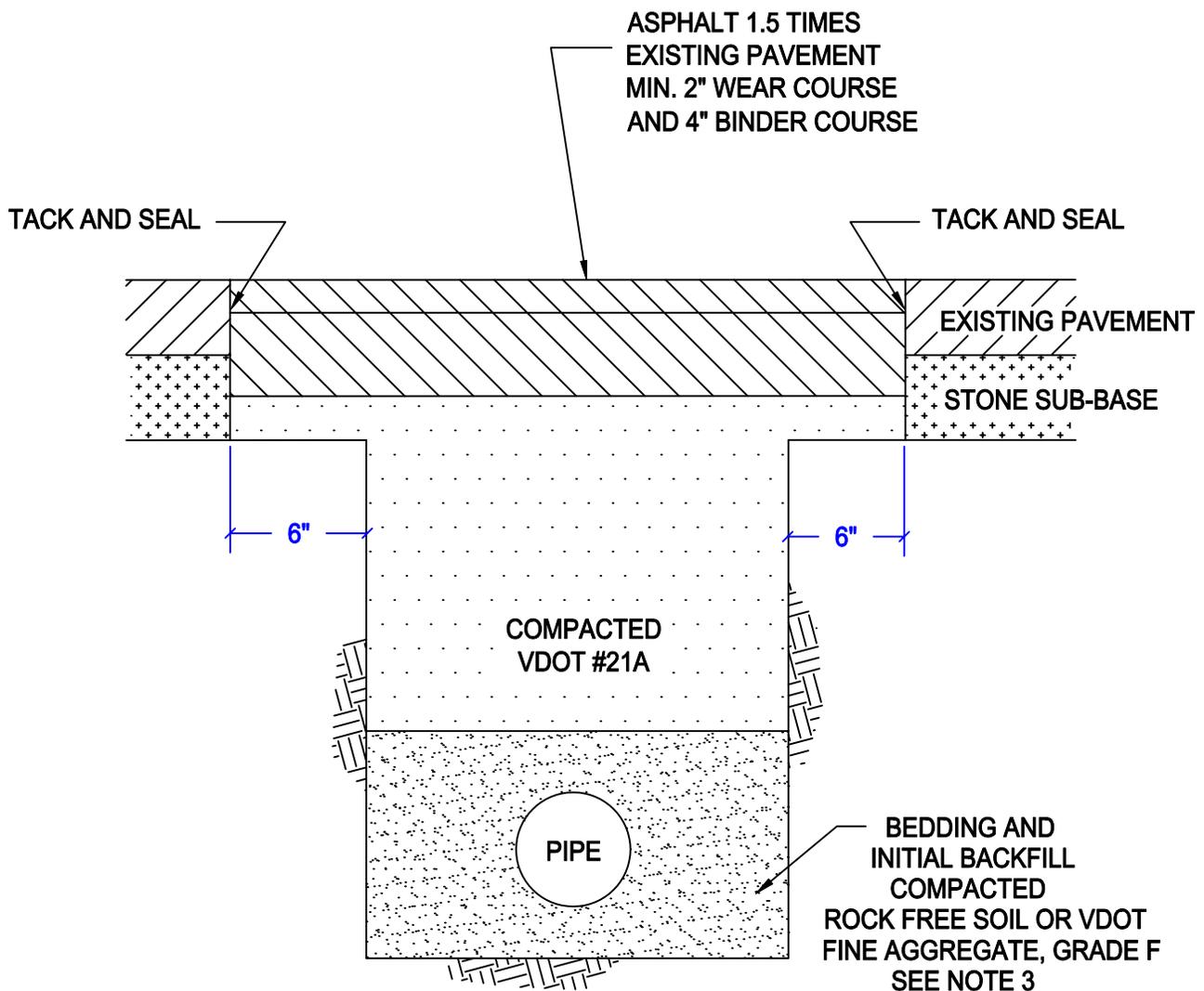


NOTE: 1. ALSO REFERENCE THE AREA MANUAL FOR RAILWAY ENGINEERING - PART 5, PIPELINES
2. REFERENCE DRAWING GG 3.2 FOR MINIMUM STEEL CASING SIZE AND WALL THICKNESS.

CARRIER PIPE SIZE (IN.)	PIPE CASING		
	CASING PIPE SIZE (IN.)	MINIMUM WALL THICKNESS (IN.)	
		WITHIN RAILROAD RIGHT-OF-WAY	WITHIN CITY OR VDOT RIGHT-OF-WAY
3/4	5	0.258	0.250
1	5	0.258	0.250
1-1/4	6	0.280	0.250
1-1/2	6	0.280	0.250
2	6	0.280	0.250
3	8	0.322	0.250
4	8	0.322	0.250
6	10	0.365	0.250
8	12	0.375	0.250
10	14	0.375	0.250
12	16	0.375	0.250

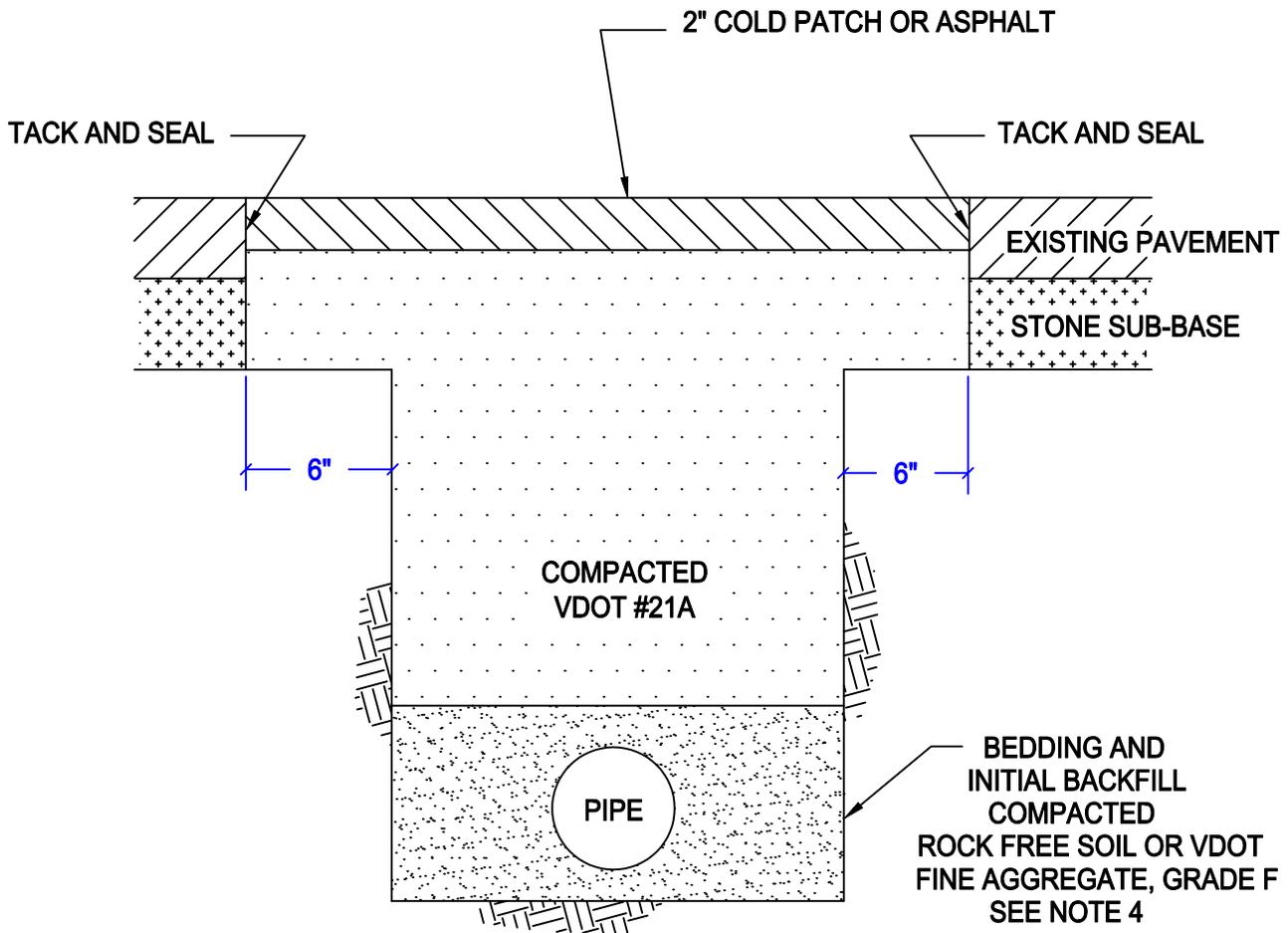


- NOTE: 1. BACKFILL FROM TOP OF INITIAL BACKFILL TO BOTTOM OF STREAM CHANNEL WITH VDOT # 21A CRUSHED STONE COMPACTED TO 95% MAXIMUM DENSITY PER ASTM D 698. CRUSHED STONE BACKFILL SHALL EXTEND FROM TOP OF BANK TO TOP OF BANK.
2. COMPACTED EARTH BACKFILL WITHIN EXTENTS OF STREAM CROSSING SHALL EXTEND FROM TOP OF # 21A BACKFILL TO TOP OF TRENCH. COMPACT TO 95% MAXIMUM DENSITY PER ASTM D 698.
3. MATCH EXISTING BANK PROFILE EXCEPT WHERE SLOPE OF BANK EXCEEDS 1 TO 1.
4. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.



NOTES:

1. PAVEMENT CUTS SHALL BE STRAIGHT AND VERTICAL.
2. REMOVE TEMPORARY PATCH IF PRESENT. EXCAVATE COMPACTED BACKFILL AS REQUIRED TO INSTALL NEW BITUMINOUS ASPHALT. RE-COMPACT SURFACE OF BACKFILL PRIOR TO INSTALLATION OF PATCH.
3. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.



NOTES:

1. TEMPORARY PAVEMENT REPAIR WILL BE REQUIRED IF PERMANENT PAVEMENT REPAIR CAN NOT BE PERFORMED WITHIN 24 HOURS OF TRENCH BACKFILLING.
2. PAVEMENT CUTS SHALL BE STRAIGHT AND VERTICAL.
3. CONTRACTOR SHALL MAINTAIN THE TEMPORARY REPAIR UNTIL PERMANENT PAVEMENT REPAIR IS MADE.
4. LOCALLY AVAILABLE "ROCK DUST" MAY BE SUBSTITUTED FOR VDOT FINE AGGREGATE WITH PRIOR APPROVAL OF PUBLIC UTILITIES - GAS.