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PREFACE

ACKNOWLEDGMENTS:

This manual replaces second edition of Water and Wastewater Pipeline Design Manual by Dallas Water Utilities (DWU) dated May, 1998. The chronological list of events in developing the DWU manual is summarized as follows:

1970-1989 MEMORANDUMS: Letters from management to design engineers

1989 FIRST EDITION: Compilation of letters into first edition of the manual

MAY, 1998 SECOND EDITION: Revision of 1989 manual to include state regulations

FEB, 2010 THIRD EDITION: Revision of 1998 manual to include additional sections on pavement cuts, environmental approaches, trenchless technologies, and updated state regulations

This third edition of Water and Wastewater Pipeline Design Manual is written by Engineering Services, Dallas Water Utilities.

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P.2  INTRODUCTION

Dallas Water Utilities (DWU) provides water and wastewater services to customers within the City of Dallas (the City) and other adjacent communities. DWU maintains or exceeds current standards as set by the Texas Commission on Environmental Quality (TCEQ) for water and wastewater main design, construction, operation and maintenances (O&M). This manual is to be used by engineering professionals for use in design and construction of water and wastewater mains owned and operated by DWU. This technical resource is not intended to substitute for any professional engineering judgment by designer who will assume ultimate responsibility for selection, reference and appropriate application of this manual.

This manual is divided into four main chapters:

CHAPTER 1: GENERAL DESIGN CRITERIA
This chapter presents general requirements at different phases of a water/wastewater main project including origination, coordination, record search, condition check, easements acquisition, investigation, surveying, plan development, traffic control, and final plan submittal.

CHAPTER 2: WATER MAIN DESIGN GUIDELINES
This chapter includes various aspects of water main design including replacement criteria, sizing, depth, embedment, location and appurtenances.

CHAPTER 3: WASTEWATER MAIN DESIGN GUIDELINES
This chapter includes various aspects of wastewater main design including replacement criteria, sizing, depth, embedment, location and appurtenances.

CHAPTER 4: SPECIAL DESIGN CRITERIA
This chapter represents special design criteria common to water and wastewater main including pavement cuts, highway access, railroad access, creek crossing, elevated crossing, pipe encasement, thrust restraint and trenchless technologies.
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<th>Full Form</th>
<th>Abbreviation</th>
<th>Full Form</th>
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<td>AC</td>
<td>Asbestos Cement</td>
<td>NA</td>
<td>Not Applicable</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
<td>NCTCOG</td>
<td>North Central Texas Council of Governments</td>
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<tr>
<td>AREMA</td>
<td>American Railway Engineering &amp; Maintenance Association</td>
<td>NASSCO</td>
<td>National Association of Sewer Service Company</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing Materials</td>
<td>PACP</td>
<td>Pipeline Assessment and Certification Program</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
<td>PCCP</td>
<td>Pre-Stressed Concrete Cylinder Pipe</td>
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<tr>
<td>BC</td>
<td>Back of Curb</td>
<td>PL</td>
<td>Property Line</td>
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<tr>
<td>BM</td>
<td>Bench Mark</td>
<td>PSI</td>
<td>Pounds Per Square Inch</td>
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<td>BOTOC</td>
<td>By Other Than Open Cut</td>
<td>PW&amp;T</td>
<td>Public Works &amp; Transportation</td>
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<tr>
<td>COD</td>
<td>City of Dallas</td>
<td>PRV</td>
<td>Pressure Reducing Valve</td>
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<tr>
<td>CO</td>
<td>Clean out</td>
<td>PC</td>
<td>Point of Curvature</td>
</tr>
<tr>
<td>DART</td>
<td>Dallas Area Rapid Transit</td>
<td>PI</td>
<td>Point of Intersection</td>
</tr>
<tr>
<td>DI</td>
<td>Ductile Iron</td>
<td>PI</td>
<td>Plasticity Index</td>
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<td>DR</td>
<td>Dimension Ratio</td>
<td>PL</td>
<td>Plastic Limit</td>
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<td>DWU</td>
<td>Dallas Water Utilities</td>
<td>PT</td>
<td>Point of Tangent</td>
</tr>
<tr>
<td>ECI</td>
<td>Enamel Lined Cast Iron</td>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
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<tr>
<td>EL</td>
<td>Elevation</td>
<td>QL</td>
<td>Quality Level</td>
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<td>EMB</td>
<td>Embedment</td>
<td>RCP</td>
<td>Reinforced Concrete Pipe</td>
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<td>ESA</td>
<td>Environmental Site Assessment</td>
<td>RCCP</td>
<td>Reinforced Concrete Cylinder Pipe</td>
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<tr>
<td>ETJ</td>
<td>Extra Territorial Jurisdiction</td>
<td>RPMP</td>
<td>Reinforced Polymer Mortar Pipe</td>
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<td>EX</td>
<td>Existing</td>
<td>RTRP</td>
<td>Reinforced Thermosetting Resin Pipe</td>
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<td>FH</td>
<td>Fire Hydrant</td>
<td>STA</td>
<td>Station</td>
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<tr>
<td>FT</td>
<td>Feet</td>
<td>SSO</td>
<td>Sanitary Sewer Overflow</td>
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<td>FL</td>
<td>Flow Line</td>
<td>SD</td>
<td>Storm Drain</td>
</tr>
<tr>
<td>LF</td>
<td>Linear Feet</td>
<td>SDR</td>
<td>Standard Dimension Ratio</td>
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<td>GIS</td>
<td>Geographical Information System</td>
<td>SUE</td>
<td>Subsurface Utility Engineering</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
<td>TAC</td>
<td>Texas Administrative Code</td>
</tr>
<tr>
<td>GPCD</td>
<td>Gallon Per Capita Per Day</td>
<td>TBM</td>
<td>Temporary Bench Mark</td>
</tr>
<tr>
<td>GPD</td>
<td>Gallon Per Day</td>
<td>TCEQ</td>
<td>Texas Commission on Environmental Quality</td>
</tr>
<tr>
<td>GPM</td>
<td>Gallon Per Minute</td>
<td>TMUTCD</td>
<td>Texas Manual on Uniform Traffic Control Devices</td>
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<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
<td>TXDOT</td>
<td>Texas Department of Transportation</td>
</tr>
<tr>
<td>HOE</td>
<td>Home Owner’s Extension</td>
<td>UG</td>
<td>Underground</td>
</tr>
<tr>
<td>HP</td>
<td>Horse Power</td>
<td>VCP</td>
<td>Vitrified Clay Pipe</td>
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<tr>
<td>I/I</td>
<td>Inflow/Infiltration</td>
<td>VCT</td>
<td>Vitrified Clay Tile</td>
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<td>ISO</td>
<td>Insurance Service Office</td>
<td>W</td>
<td>Water</td>
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<tr>
<td>LL</td>
<td>Liquid Limit</td>
<td>WW</td>
<td>Wastewater</td>
</tr>
<tr>
<td>MGD</td>
<td>Million Gallons Per Day</td>
<td>WWAD</td>
<td>Wastewater Access Device</td>
</tr>
<tr>
<td>MG/L</td>
<td>Milligrams Per Liter</td>
<td>WTP</td>
<td>Water Treatment Plant</td>
</tr>
<tr>
<td>MH</td>
<td>Manhole</td>
<td>WWTP</td>
<td>Wastewater Treatment Plant</td>
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<tr>
<td>MSL</td>
<td>Mean Sea Level</td>
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### P.4  ENGINEERING CONVERSIONS

#### Length
- 1 inch = 2.54 cm
- 1 ft = 0.3048 m
- 1 mi = 5,280 ft
- 1 mi = 1.6093 km
- 1 km = 0.6214 mi
- 1 chain = 66 ft
- 1 mm = 1000 microns

#### Weight
- 1 lb = 0.4536 kg
- 1 ton = 2000 lb
- 1 oz = 28.353 g
- 1 kg = 2.2046 lb
- 1 slug = 14.5939 kg
- 1 ft of water = 62.4 lb
- 1 gal of water = 8.34 lb

#### Area
- 1 acre = 43,560 ft²
- 1 acre = 4046.9 m²
- 1 acre = 0.40469 hectare
- 1 mi² = 640 acres

#### Volume
- 1 ft³ = 7.486 gal
- 1 acre-ft = 325,851 gal
- 1 acre-ft = 43,560 ft³
- 1 gal = 3.7854 L
- 1 gal = 1,000,000 MG
- 1 MG = 3,0689 acre-ft
- 1 m³ = 264.17 gal

#### Power
- 1 hp = 550 ft-lb/s
- 1 hp = 0.746 kw
- 1 hp = 6535 kwh/year
- 1 kw = 1.341 hp

#### Discharge
- 1 cfs = 449 gal/min
- 1 cfs = 646,000 gal/day
- 1 gal/s = 15.85 L/s
- 1 mgd = 3.07 acre-ft/day
- 1 mgd = 1120 acre-ft/year

#### Temperature
- $T_F = \frac{9}{5} T_C + 32$
- $T_C = \frac{5}{9}(T_F - 32)$

#### Angle
- 180 degree = $\pi$ radian
- 90 degree = 100 grad

#### Mics.
- 1 ppb = 1000 ppm
- 1 N = 100,000 dyne
CHAPTER 1
GENERAL DESIGN CRITERIA

1.1 REFERENCES

The following references shall be reviewed in conjunction with this manual:

- 30 TAC §290: Public Drinking Water as enforced by Texas Commission on Environmental Quality (TCEQ), Latest Edition
- 30 TAC §217: Design Criteria for Domestic Wastewater System by as enforced by TCEQ, Latest Edition
- Standard Drawings for Water & Wastewater Construction by DWU, Latest Edition
- Drafting Standards for Pipeline Projects by DWU, Latest Edition
- Public Works Construction Standards for North Central Texas by North Central Texas Council of Governments (NCTCOG), Edition as adopted by DWU
- Addendum to the NCTCOG Standards by DWU, Latest Edition
- Dallas City Code: Chapter 49 (Water and Wastewater), Latest Edition
- Paving Design Manual, City of Dallas, Latest Edition
- Water Capital Infrastructure Assessment & Hydraulic Modeling Report, July 2007 or Latest Update
- Comprehensive Wastewater Collection System Assessment- Collection System Master Plan, October 22, 2007 or Latest Update
- 2005 Update Long Range Water Supply Plan, December 31, 2005 or Latest Update
- Water Efficiency Study for City of Dallas, September 3, 2002 or Latest Update
1.2 General Design Approach

Flow chart of a typical pipeline design project is shown below:

Figure 1.2: Design Flow Chart
1.3 **PROJECT ORIGINATION**

DWU water and wastewater main projects generally originate due to following reasons:

- New development
- Main deterioration
- Capacity improvement
- Water quality improvement
- Regulatory compliance
- Relocation of existing mains to accommodate storm drains or paving improvements
- Water/wastewater master plans

1.4 **INTERNAL COORDINATION**

Internal coordination shall be conducted with all affected divisions/sections, including, but limited to, Relocations, Sustainable Development & Construction (Development Services) and Public Works & Transportation (PW&T), prior to initiation of any work in order to accomplish the following:

- Inform other divisions of the planned activity
- Insure that proposed work is not being duplicated
- Coordinate adjacent projects
1.5 **INTERNAL RECORD SEARCH**

The designer shall research all pertinent DWU records including, but not limited to, the following:

1.5.1 **Design Records:**

1.5.1.1 Water Design Plan (685 W):

These are primarily water main construction plans and do not necessarily represent as-built information.

1.5.1.2 Wastewater Design Plans (411Q):

These are primarily wastewater main construction plans and do not necessarily represent as-built information.

1.5.1.3 Water Roll Maps:

The Roll Maps show the old water lines going through open fields or rural areas in the early 1900’s. Today, many of these lines are still in service and most of the previously undeveloped areas are now developed. These roll maps come in odd sizes, some in 18 inches by 15 feet, others in 12 inches by 15 feet or longer. Each water line had a number as in water line numbers 1, 2, 3, 4, etc. This numbering system was changed to 103W, 105W, and then later changed to our present prefix file number 685W. The Roll Maps are archived references that have not been updated for many years.

1.5.1.4 Wastewater Key Maps:

Maps showing existing wastewater mains cross referenced with construction plan numbers (411Q or 685W). They also show contour lines at ten foot intervals. These maps may be used to determine the location of existing wastewater mains. Full size maps are 24” X 36”, scale 1”400’. These Wastewater Key Maps are archived references that have not been updated for many years.
1.5.2 **As-Built Records:**

As-Built Records are records that show the actual construction alignment of existing mains. These records sometimes vary from the original design due to unforeseen construction problems.

1.5.2.1 Water Permanent Maps (XX-XX-W):

These are maps, also known as water block maps, showing existing water mains with as-built horizontal ties and may be used to determine the approximate locations of existing water mains. These maps also provide a reference Water Field Books. Full size maps are 24” X 36”, scale 1”: 100’.

1.5.2.2 Wastewater Permanent Maps (XX-XX-S):

These are maps showing existing wastewater mains with as-built horizontal and vertical information, such as size, direction of flow, percent of grade and flow lines at manholes. This map series covers roughly half of the city and they are cross referenced with construction plan numbers (411Q or 685W). Full size maps are 24” X 36”, scale 1”: 100’.

1.5.2.3 Bud Holcomb Maps (BH Maps):

These maps show existing and abandoned wastewater mains that are cross referenced with construction plan numbers (411Q or 685W). Full size maps are 24” X 36”, scale 1”/400’. This is an archived reference that has not been kept up to date for many years. It is no longer being updated.

1.5.2.4 Old Sewer Maps (S- Maps):

These maps show existing and abandoned wastewater mains that are cross referenced with construction plan numbers (411, 411Q or 685W) or Ledger Books (Ledger Book number, page number). These maps were used during the same time period as the ledger books and were replaced by Bud Holcomb Maps.

1.5.2.5 As-Built Water Field Books (FBK):

These are the individual field books that are referenced on the permanent water maps. The hand sketches in the field books were the original source material for production of the permanent water maps; however, they go into more detail and sometimes provide design file numbers. Field books for new contracts have not been produced since the mid-1990s.
1.5.2.6 Water Construction Field Books (FBK):

Construction Field Books contain profile information by which existing 12” and larger water mains originally were constructed. This information would supersede the design profiles. Water Construction Books have not been maintained since the mid 1990s.

1.5.2.7 Ledger Books (LBK):

Ledger Books were the old wastewater construction books from 1889 until they were replaced by the Wastewater Construction Books. They provide the same information as the Wastewater Construction Books except that one must add 321.40 to the elevations in the Ledger Books to correlate with our present U.S. Geological Survey Sea-Level Datum.

1.5.2.8 Wastewater Construction Books (CBK):

These construction books contain profile information by which the wastewater main was originally staked for construction. This information consists of survey stationing, size of pipe, percent of grade, rod reading, ground elevation, flow line, elevation, depth of cut required and any pertinent remarks. The 411Q number, the file number and the corresponding sheet number(s) of the construction plans are sometimes given. This information should be used to supersede the design plan profile.

1.5.2.9 Red-up Drawings:

Red-up Drawings are hand-annotated design plans based on field crew inspections, which occurred at or shortly after wastewater construction projects. These drawings were quite detailed, often confirming materials used, locations of service lines, and design changes, such as changes in stationing. DWU stopped producing Red-up Drawings in the mid 1990s.

1.5.2.10 Tie Copies:

Tie Copies are manually annotated design plans produced by the DWU tie crews. The Tie crews visit locations of water and wastewater construction, sometimes several years after the construction is completed in an effort to document the locations of surface features and determine document variances from design. Specific variances from design are often speculation, in the absence of construction inspection mark-ups, but are indicated as call-out sketches on the design plans. Concurrent to the production of these marked-up plans, GPS information is collected for all surface features along with estimated locations for buried features, such as tees, bends, etc.

1.5.2.11 Construction Inspection Mark-Ups:

These are construction plans as marked-ups by city inspectors to show actual construction records.
1.5.3 **Other Resources:**

1.5.3.1 **Storm Sewer Locator Maps (421Q):**

These maps typically show storm sewer locations with pipe sizes and corresponding construction plan numbers. These are generally filed as 421Q at PW&T Vault.

1.5.3.2 **Paving Plans (311D):**

These typically show paving plans for improved street surfaces. These are generally filed as 311D in the PW&T Vault.

1.5.3.3 **Water/Wastewater Master Plans:**

Latest water and wastewater master plans must be reviewed to be in compliance with any recommendations.

1.5.3.4 **DWU Geographical Information System (GIS):**

DWU GIS integrates various geographically referenced utility infrastructure records of the City of Dallas. Currently, most of the water/wastewater main design and older as-built records can be accessed directly through DWU GIS. The water distribution and wastewater collection features were originally derived through an in-house data conversion project using the various outdated legacy paper mapping as source materials. Additional attribution was subsequently provided via the water and wastewater master plans. New and backlogged water and wastewater features are added based on the best available inputs at the time of digitizing, including design plans, GPS points, tie copies, and construction inspection mark-ups.

GIS files are available to outside parties through DWU project manager upon approval by Utility Automation and Integration (UAI) Division.
1.6 CONDITION CHECK AND PRELIMINARY DESIGN REPORT

All existing water and wastewater mains adjacent to the proposed main shall be identified from the DWU records during preliminary investigation. A condition check along with a recommendation can be requested from DWU Water and Wastewater Operation Divisions under the following criteria:

1.6.1 Wastewater Main Condition Check:

If there is an existing wastewater main in the same street or vicinity as the proposed water main, a request shall be made to the Wastewater Collection (WWC) Division for a condition check of the existing wastewater main. The following information may be obtained from WWC upon request:

- TV camera inspection record along with Pipeline Assessment Certification Program (PACP) score as per National Association of Sewer Service Company (NASSCO), if available
- Permanent/temporary flow monitoring data, if available
- Recommendation regarding wastewater main and other appurtenance replacement in conjunction with proposed water main replacement.

1.6.2 Water Main Condition Check:

If there is an existing water main in the same street or vicinity as the proposed wastewater main, a request must be made to the Distribution Division for a condition check of the existing water main. The following information may also be obtained from Distribution upon request:

- The location, type and size of any large water services and other appurtenances.
- The pressure and flow of any fire hydrant.
- History of water main break(s) and subsequent repair(s)
- Information on leak detection.
- Recommendation regarding water main and other appurtenance replacement in conjunction with proposed wastewater main replacement.

1.6.3 Variance:

If a condition check report is not available from DWU Operation Divisions, the designer shall be responsible for providing any recommendation for the replacement of the adjacent water and wastewater mains based on age, historical professional judgment, and other criteria as mentioned in §2.3 or §3.3.
1.6.4 Preliminary Design Report:

An engineering design report detailing the proposed project along with engineering recommendation is to be prepared, as necessary. This report shall include, but not limited to, the following information:

- Project Scope: General project description along with location and limit
- Supporting Data: Summary of record search and preliminary field investigation along with necessary exhibits
- Evaluation of Alternatives: Evaluation of various alignment options along with estimated construction costs, if necessary
- Recommendations: Proposed alignment, pipe size, pipe material, method of construction (open-cut or trenchless) and other pertinent information

A copy of the Preliminary Design Report shall be submitted to DWU Distribution and Wastewater Collection Divisions for review and approval, as necessary.

1.7 Utility Location Request

The designer must conduct a comprehensive investigation of all nearby existing and proposed utilities in order to avoid possible conflicts. This shall include, but not limited to, the following utilities:

- Gas (G)
- Telephone (T)
- Underground Electric (UE) and Overhead Electric (OE)
- Cable (C)
- Fiber Optic (FO)
- Storm Drain (SD)
- Petroleum (P)
1.8 EASEMENT ACQUISITION

1.8.1 General Requirements:

If it is determined that infrastructure improvements will be performed outside of existing right-of-way or existing easements, then it will be necessary to obtain a new easement. It shall be specified whether it will be for water or wastewater in the easement request. This process can take anywhere from six (6) months to several years to complete and must be started as soon as an approved pipeline alignment has been decided upon.

1.8.1.1 Pipeline Installation within the City of Dallas:

If the easement is obtained within the City of Dallas limits for the installation of a water and/or wastewater main only, the easement documents are not required to be in fee title and shall state the purposes for which they are acquired and do not include other purposes.

1.8.1.2 Pipeline Installation outside the City of Dallas:

Outside the City of Dallas limits, DWU does not have final review authority on plats. Fee title acquisition shall be considered for these cases.

1.8.1.3 Right-of-Entry:

A right-of-entry agreement can not be used in lieu of a permanent easement to place a permanent structure or facilities on private property. Good use of right-of-entry agreements are for surveying, staging, clearing/grubbing, storage, temporary construction activities and can be obtained through a request to Property Management. This document is typically signed by the property owner and has limited or no authority after the described process is completed.

1.8.2 DWU Policies:

1.8.2.1 Buildings, fences, trees, shrubs, or other permanent vertical improvements or growths are not allowed over DWU mains or in easements.

1.8.2.2 Standard Plat Provisions:

DWU standard plat provisions can be described as follows:

“No buildings, fences, trees, shrubs or other improvements or growths shall be constructed, reconstructed or placed upon, over or across the easements shown. Said easements being hereby reserved for the mutual use and accommodation of all public utilities using or desiring to use the same. All and any public utility shall have the right to remove and keep removed all or parts of any building, fences, trees or other
improvements or growths which in any way may endanger or interfere with the construction, maintenance or efficiency of its respective system on the easements and all public utilities shall at all times have the full right of ingress or egress to or from and upon the said easements for the purpose of constructing, reconstructing, inspecting, patrolling, maintaining and adding to or removing all or parts of its respective systems without the necessity at any time of procuring the permission of anyone.”

1.8.3 Minimum Easement Widths:

The minimum easement width required to install and maintain DWU water/wastewater mains are summarized in Table 1.8.3:

Table 1.8.3: Minimum Easement Width

<table>
<thead>
<tr>
<th>Size of Main (inch)</th>
<th>Minimum Width (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8” through 12”</td>
<td>25</td>
</tr>
<tr>
<td>16” through 24”</td>
<td>50</td>
</tr>
<tr>
<td>30” through 66”</td>
<td>75</td>
</tr>
<tr>
<td>72” and Larger</td>
<td>100</td>
</tr>
</tbody>
</table>

1.8.4 Minimum Vertical Clearance:

The minimum vertical clearance above any easement is 25 feet. This allows the typical backhoe to maneuver in the case where a repair is necessary and minimizes the risk to both DWU and the party who is granting the easement.

1.8.5 Easement Acquisition:

The easement acquisition process is summarized in Figure 1.8.6 for projects designed by DWU in-house staff or consultants for joint and the City of Dallas projects. However, most easements for development projects are typically granted by plat and do not require an individual instrument. The developer's consultant prepares the legal description/field notes as per Appendix A for easements outside the platted area and the procedure follows in this section. If any costs are associated with obtaining the easement, they will be paid by the developer.
1.8.5.1 Easement Identification:

- Easement acquisition process must be initiated as soon as a need for an easement is recognized and an exact horizontal location is identified.

- Property history as recorded in the County Records shall be researched to determine if any existing easements are in place.

1.8.5.2 Preparation of Legal Description:

Designer shall request a surveyor to prepare a legal description (field notes) as per Appendix A for the required easement. This request shall include, but not be limited to, following the information:

- Type of Easement: Permanent or temporary/construction
- Purpose of Easement: Water and/or wastewater easement
- Project Schedule: Planned advertisement and construction date
- Location Map: A map showing location of easement with coordinates and dimensions.

The legal description shall be submitted to PW&T Survey Division, for review and approval, as necessary.

1.8.5.3 Negotiation with Property Owner:

Property Management Division negotiates the purchase of the easement with the affected property owner(s). Upon receipt of legal description from surveyor, project manager shall request Property Management to obtain the easement. This request to Property Management shall include, but not be limited to the following information:

- Type of Easement: Permanent or temporary/construction
- Purpose of Easement: Water and/or wastewater easement
- Project Schedule: Planned advertisement/construction date
- Location Map: A map showing location of easement with coordinates and dimensions.
- Legal description (field note) as prepared by surveyor.

If the easement appears to enhance the owner, the Property Management may request the easement be obtained by dedication (cost of $1).
1.8.5.4 Property Appraisal and Subsequent Funding:

- If the easement can not be obtained by dedication, a "fair market value" shall be offered to the owner.

- If the property owner agrees to “fair market value”, the required funding information shall be obtained from the DWU program manager that requested the project.

- If the owner does not agree to the offer, the easement may be acquired through the eminent domain procedure. Accordingly, subsequent funding information for the necessary legal proceedings shall be obtained from the program manager that requested the project. In addition, a “White Paper” containing the explanation of the need for the easement, shall be included in the council agenda package.

- Upon preparation of the City Council agenda item, the City Attorney's office is contacted to coordinate the legal procedures in order to obtain the easement. If the property owner does not agree with the amount offered by the judge for the county, a public hearing shall be arranged upon request. The hearing board will make a recommendation on the amount to be offered. In either case, the city will deposit the money awarded by the judge for the county. The city can then use the easement as if the easement was obtained and filed.

1.8.5.5 Recording of Easement:

Upon filing at the county court, a copy of the recorded easement shall be furnished to the City Secretary by Property Management.

All easements must be shown on the design plans with county files volume and page numbers as shown on the DWU Drafting Standards for Pipeline Project, Latest Edition.
1.8.6 Easement Acquisition Process Diagram:

Figure 1.8.6: Easement Acquisition Process Diagram
1.9 **FIELD INVESTIGATION**

Field investigations including Geotechnical, Subsurface Utility Engineering (SUE) or Environmental Site Assessment (ESA) shall be conducted for water and wastewater main design as necessary or if requested by project manager.

1.9.1 **Geotechnical Investigation:**

The design and construction of water and wastewater mains must account for the variability of the uncertain subsurface conditions, and the potential project cost associated with the variability. This is especially critical on large projects or projects containing complex or difficult geotechnical problems where alignment and/or grade changes may be appropriate based on geotechnical recommendations. The general criteria for geotechnical investigation, is described as follows:

1.9.1.1 Investigation Requirements:

- A geotechnical investigation may be conducted prior to design and/or construction of a project. However, data from earlier project design activity can be incorporated if sufficient and reliable for the current project.

- If required, the geotechnical report shall be prepared by a professional engineer with considerable geotechnical, design and construction experience relevant to the anticipated project.

1.9.1.2 Investigation Criteria:

1.9.1.2.1 Frequency:

- Soil borings shall be spaced no greater than 500 feet with additional borings at spaced closer to better define areas of inconsistent stratigraphy.

- Boring locations shall be within an offset distance of no more than 20 feet from the centerline alignment of the water/wastewater main or at location of proposed structure.
1.9.1.2.2 Depth:

**Open Cut Construction:** Minimum boring depths shall be:

- Trench depth plus five (5) feet for trenches up to ten (10) feet deep
- Trench depth plus ten (10) feet for trenches from ten (10) to twenty-five (25) feet deep
- One and half times trench depth for trenches greater than twenty-five (25) feet deep. Bore an additional five (5) feet if the last planned sample is in water-bearing sand.

**Trenchless Construction:** Minimum boring depth shall be:

- Entry/exit pit depth plus five (5) feet
- Pipe invert plus five (5) feet

1.9.1.2.3 Report Format:

A typical geotechnical report shall include, but not limited to, following information:

**Project Information:**

- Project location
- Scope

**Investigation Summary:**

- Summary of all subsurface exploration data, including subsurface soil profile, exploration logs, laboratory or in situ test results, and ground water information

**Data Analysis and Recommendations:**

- Engineering analysis and recommendations for design
- Recommended geotechnical special provisions.

**Attachments:**

- Project map
- Field and laboratory test data
- Boring log
- Other pertinent data including, but not limited to, soil classification, plasticity index (PI), liquid limit (LL), plastic limit (PL), moisture density (MD), rock quality designation (RQD) and blow counts.
1.9.2 **Subsurface Utility Engineering (SUE):**

Subsurface Utility Engineering (SUE) process may be conducted in project planning, design or construction phase(s) to obtain reliable subsurface utility information. Using this technology, it will be possible to avoid many utilities relocation before construction and many unexpected encounters during construction, thereby eliminating many costly, time-consuming project delays. In addition, all existing utilities shall be located and marked prior to initiation of survey for design.

1.9.2.1 **SUE Provider Requirements:**

SUE shall be conducted by well-trained, experienced and capable individuals using state-of-the-art designating equipment, vacuum excavation or comparable non-destructive locating equipment; state-of-the-art surveying and other data recording equipment and software systems, as necessary.

1.9.2.2 **Standard of Care:**

The American Society of Civil Engineers (ASCE) has developed an important standard of care guideline, entitled Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02. Accordingly, four Quality Levels (QL) of SUE can be conducted, as needed:

**Quality Level D:** Information derived from existing records or oral recollections.

**Quality Level C:** Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D.

**Quality Level B:** Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities.

**Quality Level A:** Precise horizontal and vertical location of utilities obtained by the actual exposure and subsequent measurement of subsurface utilities, usually at a specific point.
Different levels of SUE applications can be summarized as follows:

![Diagram of Different Levels of SUE Application](image)

**Figure 1.9.2: Different Levels of SUE Application**
*Reference: SUE Brochure, Federal Highway Association, 2007*

### 1.9.3 Environmental Site Assessment (ESA):

The designer shall evaluate all available resources to identify any potential environmental issues, including possible soil or groundwater contamination, during the planning phase of a water/wastewater main construction projects. In addition, an Environmental Site Assessment (ESA) may be necessary for water/waste main easement acquisition. The ESA should be conducted by qualified and experienced personnel.

#### 1.9.3.1 Phase I ESA:

The objective of conducting a Phase I ESA is to identify Recognized Environmental Condition (REC). This is the most common method of identifying potential contamination in or near a construction work area.

#### 1.9.3.1.1 General Requirements:

- Phase I ESA should comply with the ASTM E1527-05: Standard Practice for Environmental Site Assessment- Phase I Environmental Site Assessment Process”, or Latest Edition

- Phase I ESA is generally only good for a period of six (6) months from the date of the site inspection and record search

- Updates of Phase I ESA are generally not acceptable. However, previous ESA can be used as information source or supplements.
1.9.3.1.2 Major Components:

A Phase I ESA should include, but limited to, the following items:

- A review of historical land use of subject property
- A review of historical aerial photos
- Interview with individual with direct personal knowledge of the subject property and surrounding areas
- A preliminary site reconnaissance of the subject property

If no RECs or suspected historical RECs are identified on the Phase I ESA, construction planning should be proceeded with minimal environmental complications. If a REC or suspected REC identified in the Phase I ESA, then one of the following approaches can be implemented:

- Prepare a Soil and Groundwater Management Plan (SGMP) that provides contingencies for each REC and/or historical REC and the specific associated Chemical of Concern (COG)
- Conduct a Phase II ESA to reduce the uncertainty and refine the project planning process by specifically investigating each REC and/or historical REC identified in the Phase I ESA

1.9.3.2 Phase II ESA:

The objective of conducting a Phase II ESA is to evaluate the RECs identified in the Phase I ESA.

1.9.3.2.1 General Requirements:

- Phase II ESA should comply with the ASTM E1903-97 (Reapproved 2002) Standard Guide for Environmental Site Assessment- Phase II Environmental Site Assessment Process”, or Latest Edition

1.9.3.2.2 Major Components:

A Phase II ESA should include, but limited to, the following components:

- Development of the scope of work
- Assessment activities
- Evaluation and presentation of data from soil and/or groundwater samples
- Presentation of findings and conclusion
1.10 Survey

A thorough review of existing plans, information, and field investigations are required prior to requesting a survey for design. The survey shall be conducted under the direct supervision of a Texas Registered Professional Land Surveyor (RPLS) in accordance with the all the applicable standards, policies and criteria for the City of Dallas as shown Appendix B. Accordingly, all existing features which may influence the design and construction shall be surveyed:

1.10.1 Survey Control and General Features:

- Locate and establish survey control from City of Dallas Benchmark (BM). Temporary Benchmarks (TBM) are to be set within 200 feet at the beginning and end of the project and at intervals not to exceed 500 feet throughout the project or as necessary
- Establish survey control with markers of a permanent nature, such as iron rods, spikes, or other lasting identification
- Locate and tie all existing right-of-way, property line and easements to control line, as necessary
- Show centerlines and angles of intersection of the side street(s) with main roadway centerline, as necessary
- Show lot and block numbers along with adjacent street names
- Identify corporation lines with involved cities listed

1.10.2 Topographic Features:

- Identify roadways, driveways and alley with pavement type
- Identify all existing or abandoned railways with company names, if available
- Locate all trees, fences and retaining walls and special landscaping
- Show high and low banks of creek
- Identify any building with their address which might be impacted by main construction

1.10.3 Utilities:

- Locate and confirm all existing utilities and appurtenances along with type, size and materials, as possible.
- Identify all visible underground structures including storm drain inlets, junction boxes, manholes and valves along with rim and invert/operating nut elevations as available.
1.10.4 Perimeter of Typical Topographical Survey:

The typical DWU street survey boundaries are graphically depicted below:

![Perimeter of Typical Topographic Survey Diagram](image)

**Figure 1.10.4: Perimeter of Typical Topographic Survey**

1.10.5 Survey Deliverable:

Following information must be obtained from the surveyor prior to design:

- Field Data:
  - Field information depicting any field sketch, if available

- Electronic Data:
  - All MicroStation 3D Files
  - Digital Terrain Model (DTM)
  - Contours with 1-ft (minor) and 5-ft major intervals
  - Profile of the proposed preliminary alignment or centerline of the street, as necessary
1.11 **DESIGN**

Water and wastewater mains must be designed in accordance with all applicable DWU standards, policies and criteria. All drafting must be strictly in accordance with Drafting Standards for Pipeline Projects by Dallas Water Utilities, Latest Edition.

1.11.1 **Base Mapping:**

Base map for design shall be prepared in accordance to the DWU drafting standards to show all the existing features as obtained from survey and further field investigation and/or record search as necessary.

1.11.2 **Selection of Water and Wastewater Main Location:**

Water and wastewater mains shall be located within the following locations:

- Public right-of-way
- Permanent access easement with overlapping public utility easements
- Dedicated easement adjacent to and contiguous with the right-of-way
- Separate dedicated easements.

1.11.2.1 **Utility Allocation Zone in Typical Street:**

New water and wastewater main located in a typical street right-of-way shall be designed in accordance with the standard utility allocation zones as indicated in §4.03.1 of PW&T Paving Design Manual, 1998 or any revision thereafter (Figures 1.11.2.1). Accordingly, 12” and smaller mains are to be located six feet from the north or east side of the street right-of-way. 16” and larger mains are to be located in the major facility zone under the pavement towards the north or east side of the right-of-way. In addition, wastewater mains are to be located in the allocated zone in the center of the street. For additional details please see §2.7 and §3.7.

1.11.2.2 **Utility Allocation Zone in Typical Alley**

New water and wastewater main located in a typical alley shall be designed in accordance with the standard utility allocation zones as indicated in § 4.03.1 of PW&T Paving Design Manual, 1998 or any revision thereafter (Figure 1.11.2.2). Accordingly, wastewater mains are to be located in the allocated zone in the center of the alley and water mains can be located north or east side within the right-of-way. For additional details, please see §2.7 and §3.7.

1.11.2.3 **Variance:**

If utility allocation zones as indicated in above §1.11.2, are impractical, or if the construction is to be in the TXDOT right-of-way, a cost effective alignment shall be developed in coordination with all entities involved. In addition, where it is both physically feasible and to TCEQ/DWU design standards, the designer should investigate
placing both water and wastewater in a location that minimizes the replacement of pavement in order to reduce construction costs, extend the life of pavement, and minimize traffic impacts.

Figure: 1.11.2.1: Utility Allocation Zone in Typical Street
Source: PW&T Paving Design Manual, June, 1998

Figure: 1.11.2.2: Utility Allocation Zone in Typical Alley
Source: PW&T Paving Design Manual, June, 1998
1.11.3 File Number Allocation:

Design file number must be obtained from DWU Vault at 320 E. Jefferson Blvd, Room 215, Dallas, Texas 75203. Typically design file numbers are assigned as follows:

Water only Project: 685W-XXX, Sh. XX

Wastewater only Project: 411Q-XXX, Sh. XX

Water/Wastewater Projects: 685W-XXX, Sh. XX or 411Q-XXX, Sh. XX as assigned.
1.12 **Final Utility Check, Plan Review and Approval**

A copy of pre-final plans shall be submitted to the following entities for final review, comments and/or approval, as necessary:

1.12.1 **Internal Review:**

- Distribution Division
- Wastewater Collection
- Pipeline Project Management including Pipeline Inspection
- Other divisions or departments, as necessary

1.12.2 **External Review:**

- All utility companies which may have potential impact
- All involved outside entities, as necessary

1.12.3 **Regulatory Review:**

If applicable, all plan and specification shall be submitted to the following agencies for necessary approval:

- Texas Commission on Environmental Quality (TCEQ) as per 30 TAC §290 and 30 TAC §217
- Other regulatory agencies under jurisdiction
1.13 **Traffic Control Plan**

1.13.1 **General Requirements:**

The designer should determine if a detailed traffic control plan is required for any project. A traffic control plan, sealed by a professional engineer, will be required in the following cases:

- Construction is in one or more lanes of a state highway or thoroughfare
- A detour is required
- Access to business property is by other than normal ingress and egress (entrance and exit)
- One or more lanes or more of an access or frontage road are closed
- Traffic through a major intersection is disrupted

1.13.2 **Applicable Standards:**

All traffic control plans and operations shall be in accordance with following standards:

- Texas Manual on Uniform Traffic Control Devices (TMUTCD), Texas Department of Transportation, Latest Edition

1.13.3 **General Notes:**

If a traffic control plan is not required the following items shall be addressed:

- The diversion of pedestrians and vehicles during the progress of the work shall be in a manner satisfactory to City of Dallas
- All traffic variances shall be coordinated with the traffic safety coordinator of City of Dallas
- Two-way traffic shall be maintained at all times. Flagman should be used to maintain two-way traffic.
- All barricades, warning signs and traffic control devices shall conform to the City of Dallas standards.
- When closing side streets, a two working day notification shall be provided to Fire, Police, Street and Sanitation Departments.
• Access to private driveways shall be maintained at all times during construction

• Ingress and egress (entrance and exit) to a business property shall be maintained at all time. If not, specific signs along with business name and direction arrow(s) shall be used for any temporary access locations. Additional signs may be necessary if there is a detour.

1.13.4 Coordination and Approval:

All traffic control plan shall be approved by traffic control division of PW&T or TXDOT, as applicable.
1.14 **Final Plans and Specifications**

All plans and specifications must be prepared by the direct supervision of a Texas Professional Engineer (PE). Final project submittal by the designer should include, but not limited to, the following items:

1.14.1 Final Plans:

Final plans must be done strictly in accordance with the Drafting Standards for Pipeline Projects by Dallas Water Utilities, Latest Edition and sealed by a Texas Professional Engineer (PE). All the plans should be plotted on 24” x 36” standard sheet of 4-mil, double matte mylar. Other sizes including 22” x 34” ANSI standard drawing sheets may be acceptable with prior approval.

Appendix C contains the minimal and supplemental general notes are required on most, if not all, DWU pipeline project.

1.14.2 Technical Specifications:

All the necessary technical specifications must be prepared by a Texas Professional Engineer.

1.14.3 Permits:

All the required permit approval notice(s) must be included in the final submittal. These includes, but not limited to, the followings:

- TXDOT Right-of-Way Access Permit
- Approval letter from other entities or agencies under jurisdiction

In addition, all executed temporary and permanent easement documents shall be provided prior to beginning construction of a project.

When the project is completed and cross referenced, the original mylar must be forwarded to Utility Automation and Integration (UA&I) for archiving.
CHAPTER 2
WATER MAIN DESIGN GUIDELINES

2.1 REFERENCES

All water mains shall be designed in conformance with “30 TAC §290: Public Drinking Water” along with all applicable laws, regulations, codes and standards.

2.2 DWU WATER SYSTEM

2.2.1 Raw Water Sources and Treatment Facilities:

The City of Dallas holds water rights to Lake Ray Roberts, Lake Lewisville, and Lake Grapevine, which are referred to as the “western” reservoirs. Dallas also holds water rights in Lake Ray Hubbard, Lake Tawakoni, Lake Fork, and Lake Palestine, which are referred to as the “eastern” reservoirs. Currently, Lake Fork and Lake Palestine are not used or connected to the Dallas water system.

DWU operates three surface water treatment plants (WTP), which treat the raw water obtained from the lakes described above:

- East Side WTP
- Elm Fork WTP
- Bachman WTP

The raw water is conveyed to these treatment plants by two primary methods:

- Gravity through creeks and rivers
- Pump stations located at the lakes
Figure: 2.2.1: DWU Raw Water Sources and Treatment Facilities
Source: City of Dallas Planning and Water Supply Strategies, December 6, 2006
2.2.2 Water Distribution System:

The DWU water distribution system is divided into several pressure zones in order to serve the wide range of ground elevations within the City while maintaining residual pressures within acceptable level. Based on 2007 DWU Water Master Plan, there are nine (9) major and secondary pressure zones that are supplied by one or more pump stations and have elevated or ground storage facilities that establish the static hydraulic gradient for each zone. In addition, there are eight (8) intermediate pressure zones that generally serve very small, localized areas throughout the DWU service area. These intermediate zones are supplied through pressure-reducing valves (PRV) from an adjacent major or secondary pressure zone or by single, small booster pump stations. The intermediate pressure zones do not have elevated or ground storage facilities that establish their static hydraulic gradient.

The DWU water distribution network is isolated from adjacent pressure zones by using closed valves known as “High-Low” valves and inter-looping mains. Two flush points are typically included, one on either side of the High-Low valves. DWU As-built water maps show the designated closed valves between pressure zones. The Distribution Division also maintains a "High-Low Closed Valve Book" that identifies the pressure zone boundaries. Water mains near a pressure zone boundary are looped within their pressure district to minimize dead end mains.

DWU pressure zones are shown in Figure 2.2.2 and summarized in Table 2.2.2.
Figure: 2.2.2: DWU Water Pressure Zones
Source: DWU Water Master Plan, July 2007
Table 2.2.2: DWU Water Distribution System

<table>
<thead>
<tr>
<th>Pressure Zone</th>
<th>Elevated Tank</th>
<th>Overflow Elev. (ft)</th>
<th>Bottom Elev. (ft)</th>
<th>Storage Capacity (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major (4)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Low</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>North High</td>
<td>Forest Lane</td>
<td>751.5</td>
<td>716.5</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Plano Road</td>
<td>751.5</td>
<td>716.5</td>
<td>2.0</td>
</tr>
<tr>
<td>South High</td>
<td>American Way</td>
<td>795.0</td>
<td>770.0</td>
<td>3.0</td>
</tr>
<tr>
<td>East High</td>
<td>Garland Road</td>
<td>714.0</td>
<td>679.0</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Secondary (5)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cedardale</td>
<td>Cedardale</td>
<td>708.0</td>
<td>670.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Pleasant Grove</td>
<td>Pleasant Grove</td>
<td>650.0</td>
<td>615.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Meandering Way</td>
<td>Highlands</td>
<td>820.0</td>
<td>780.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Red Bird High</td>
<td>Red Bud</td>
<td>875.0</td>
<td>840.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Trinity Heights</td>
<td>Trinity Heights</td>
<td>717.0</td>
<td>982.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Intermediate (8)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arcadia Park</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brooklyn Heights</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Brooklyn Heights</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hidden Valley</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lone Star</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Meandering Way</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mountain Creek</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polk Street</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Whispering Hills</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: DWU Water Master Plan, July 2007
### 2.3 Evaluation of Water Mains for Replacement

Existing water mains shall be considered for replacement if they meet one or more of the following criteria as approved by DWU Distribution Division:

#### Table 2.3: Water Main Replacement Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>DWU Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Integrity</strong></td>
<td><strong>Pipe Age:</strong> 40 years or older mains, but age shall not be the lone factor</td>
</tr>
<tr>
<td></td>
<td><strong>Water Break Index (WBI):</strong> Water mains with WBI &gt; 1. WBI as recorded by Distribution Division, can be defined as: WBI = Total Breaks Over a Segment Life/ (Pipe Length/1000)*(Pipe Age)</td>
</tr>
<tr>
<td><strong>System Capacity</strong></td>
<td><strong>Substandard Mains:</strong> Typically, smaller mains (&lt; 8&quot;) which are inadequate to meet domestic and fire demand for existing and/or potential future development</td>
</tr>
<tr>
<td></td>
<td><strong>System Wide Growth:</strong> Water mains serving areas expected to gain in water usage</td>
</tr>
<tr>
<td><strong>Regulatory/Undesirable Material</strong></td>
<td><strong>Undesirable Material or Appurtenances:</strong> Presence of following material(s)</td>
</tr>
<tr>
<td></td>
<td>- Asbestos Cement (AC) pipe</td>
</tr>
<tr>
<td></td>
<td>- Unlined grey iron pipe</td>
</tr>
<tr>
<td></td>
<td>- Lead sealed joints</td>
</tr>
<tr>
<td></td>
<td>- Lead or galvanized water services</td>
</tr>
<tr>
<td></td>
<td>- 4-way cross fittings</td>
</tr>
<tr>
<td><strong>Project Coordination</strong></td>
<td><strong>Water Main Condition Check:</strong> Existing deteriorated water mains in the vicinity of a proposed wastewater main</td>
</tr>
<tr>
<td></td>
<td><strong>Minimize Pavement Cut:</strong> Existing water mains may be replaced if future maintenance of the main requires cutting of new pavement within next 10 years.</td>
</tr>
<tr>
<td></td>
<td><strong>Water Master Plan:</strong> Compliance to any specific recommendations as per current DWU water master plans</td>
</tr>
</tbody>
</table>
2.4 Water Main Sizing

2.4.1 Water Pipeline Network:

DWU water pipeline network system can be summarized as follows:

Table 2.4.1: DWU Water Main Classification

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical Size Range (in)</th>
<th>Direct Service Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution Main</td>
<td>16” and Smaller</td>
<td>Permitted</td>
</tr>
<tr>
<td>Transmission Main</td>
<td>Larger than 16”</td>
<td>Not Permitted</td>
</tr>
</tbody>
</table>

2.4.2 Water Demand:

DWU water system must be able to supply water at rates which fluctuate over a wide range during different times of year and hours of the day. Per capita usage can vary greatly depending on the area’s zoning and the efforts made by the owners for water conservation. Typically, a customer with a yard will use more water than a customer without a yard. The rates most important to the design and operation of a water system are as follows:

2.4.2.1 Average Daily Flow (ADF):

Average daily demand can be defined as the total annual volume of water delivered to the water distribution system divided by the number of days in the year. This rate is not a critical demand rate for distribution system planning, but it should be considered in raw water supply planning to determine annual withdrawals and required sustainable yields from water supply sources.

The DWU per capita water use varies from year to year, primarily because of varying weather conditions and the amount and distribution of rainfall. Based on DWU Water Master Plan dated 2007, total per capita treated water use in Dallas since 1980 to 2005 has ranged from 211 gallons per capita per day (gpcd) to 259 gpcd, with an average use of 235 gpcd.

2.4.2.2 Peak Daily Flow (PDF):

Peak daily demand can be defined as the maximum quantity of water used on any day of the year. Raw water transmission and water treatment facilities are typically sized to meet the peak daily demand. Distribution systems shall also be designed to satisfy the peak daily demand, without depleting water from ground or elevated storage facilities. Pursuant to 30 TAC §290.38(38), in the absence of verified historical data or in cases
where a public water system has imposed mandatory water use restrictions within the past 36 months, peak daily demand means 2.4 times the average daily demand of the system.

Based on DWU Water Master Plan dated 2007, the ratio of peak daily flow to average daily flow (PDF/ADF) of City of Dallas (1980-2005) has ranged from 1.40 to 1.84, with an average ratio of 1.62. The aggregate PDF/ADF ratio for the customer cities has ranged from 1.40 to 2.05, with an average ratio of 1.74.

2.4.2.3 Peak Hourly Flow (PHF):

Peak hourly flow is the highest hourly rate of water use during the peak day demand period. Even though it occurs for a short time period, this rate often imposes the most severe hydraulic condition on the distribution system. Peak hourly demands are typically supplied by a combination of high service pumping from treatment and storage facilities and by gravity flow from elevated storage facilities. Pursuant to 30 TAC §290.38(53), in the absence of verified historical data, peak hourly demand means 1.25 times the peak daily demand.

Based on DWU Water Master Plan dated 2007, the ratio of peak hourly flow to peak daily flow (PHF/PDF) for the City of Dallas (1980 to 2005) has ranged from 1.20 to 1.42, with an average ratio of 1.32. The aggregate PHF/PDF ratio for the customer cities has ranged from 0.96 to 1.09, with an average ratio of 1.03.

2.4.2.4 Fire Flow (FF):

Fire flow can be defined as the amount of water that should be available for providing fire protection at selected locations throughout a community. Fire flows of up to 3,500 gpm are the maximum required by the ISO of a utility, and these flows can be supported by existing storage facilities. This rate can be reduced if items such as internal sprinkler systems are added to the facility.

2.4.3 Sizing Criteria:

The water mains must be sized in accordance with any approved master plan established for that area. If a master plan is not available, the sizing of the water main must be based on engineering analysis of initial and future demand of the area to be served. Water transmission and distribution mains must be sized to meet peak daily water demand plus any additional criteria as needed. The following minimum criteria shall be used for sizing distribution mains:

- Fire Flow: A minimum of 1500 gpm at each fire hydrant in the vicinity. Buildings in specific areas may require higher flows as per Insurance Service Office (ISO) as enforced by Dallas Fire-Rescue Department.
• Headloss: Less than one foot of head loss per 1,000 ft of main at a Hazen-Williams coefficient of C=110

• Velocity: The velocity of distribution main shall be maintained between 5 and 8 feet per second

• Service: The size of the services must be at least one standard size smaller than the proposed and existing water main.

2.4.4 Minimum Pipe Size:

• General Area: Minimum 8” main shall be used for all general areas.

• Central Business District (CBD): Minimum 12” main shall be used for CBD area which is approximately bounded by IH-45, IH-30, IH-35 and Woodall Rogers Freeway.

• Industrial Area: Minimum 12” for industrial areas shall be used.

• Non-Standard Pipe Sizes: 10”, 14”, and 18” water pipes are considered nonstandard for the DWU system and shall not be used.

2.5 Depth of Cover

The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe.

2.5.1 Terminology:

2.5.1.1 Unimproved Area: Unimproved area is defined as public right-of-way or easement without permanent pavement including natural ground, asphalt pavement with no base, gravel surface, and streets without curb and gutter.

2.5.1.2 Improved Area: Improved area is defined as public right-of-way or easement with paving and base including areas behind the curb, or streets where permanent pavement is proposed in the near future.
2.5.2 Minimum Cover:

The following guideline applies to water main installation in public right-of-way or easements:

Table 2.5.2: Minimum Depth of Cover for Water Main

<table>
<thead>
<tr>
<th>Size of Main (in)</th>
<th>Unimproved Area</th>
<th>Improved Area</th>
<th>Highway/Railroad Crossing**</th>
</tr>
</thead>
<tbody>
<tr>
<td>12” and Smaller</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>16”</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>20” and Larger</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

* Mains shallower than 3 feet will require special engineering evaluation and engineering controls.
** Water mains under highway and railroad right-of-way must meet all additional criteria as required.
2.6  WATER PIPE MATERIALS & EMBEDMENTS

2.6.1  Pipe Material Selection:

Designers are responsible for specifying the type of pipe to be used in any design. Pipe material shall be selected on the basis of lowest life cycle cost. For smaller pipe sizes (<16” dia.) PVC is the material preferred by DWU. For pipe sizes 20” and larger DWU prefers reinforced concrete cylinder pipe (RCCP). Other materials such as ductile iron and steel may be specified upon approval by the Distribution Division.

Although PVC is the preferred material for smaller mains, there are some restrictions on its use. PVC may not be used within the following areas or circumstances:

- Central Business District (CBD), Dallas Love Field and Executive Airports
- Elevated crossings or situation where pipe will be permanently exposed
- Encased pipe where the method of anchoring is by means of hold-down jacks

When a metal pipe including concrete cylinder, ductile iron or steel is specified, the pipe must be protected from corrosion. Corrosion protection measures should be part of any pipeline design using these materials. For ductile iron pipes a double layer of polyethylene wrapping is required. When steel pipe is utilized, the pipe interior lining shall be cement-mortar and exterior coating shall be either cement-mortar, tape or polyurethane as approved by Distribution Division. All joints on metal pipe shall be bonded, and in locations with reactive soils or induced currents a cathodic protection system may be necessary.

2.6.2  Fittings:

All PVC and ductile iron pipe shall use ductile iron fittings. Compacted fittings are not allowed. All 90 degree bends shall be avoided in the system, if possible.

2.6.3  Embedment Requirements:

Designers shall specify class of embedment on design drawings. The type of embedment to be used is determined by pipe material and depth of cover. Please see DWU Standard Drawings 113-119 for the various classes of embedment.

2.6.4  Recommended Pipe Material and Embedment:

The following table summarizes recommended pipe material and embedment for different water mains:
### Table: 2.6.3: Recommended Water Pipe Materials & Embedments*

<table>
<thead>
<tr>
<th>Pipe &amp; Material Specification</th>
<th>Allowable Size (in)</th>
<th>Joint Specification</th>
<th>Embedment Class Per Depth of Cover** (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC AWWA C900 (DR-14)</td>
<td>6 – 12</td>
<td>Bell &amp; Spigot</td>
<td>&lt;8’ : C+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joints: ASTM D3139</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gasket: ASTM F477</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fusible Fusible C 900(R) &amp; Fusible C 900(R)</td>
<td>8’-16’ : B+</td>
</tr>
<tr>
<td>PVC AWWA C905 (DR-14)</td>
<td>16</td>
<td>Certa-Lok Certa-Lok C900/J(TM) &amp; Certa-Lok C905/J(TM)</td>
<td></td>
</tr>
<tr>
<td>Ductile Iron (DI) ANSI/AWWA C151/A21.50</td>
<td>6 – 60</td>
<td>Bell &amp; Spigot/ Push On ANSI/AWWA C111/A21.11</td>
<td>&lt;16-in Dia: &gt;16-in Dia:</td>
</tr>
<tr>
<td>Class 52 or Class 54</td>
<td></td>
<td>Mechanical ANSI/AWWA C111/A21.11</td>
<td>&lt; 8’ (Rock): C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flanged ANSI/AWWA C115/A21.15</td>
<td>&lt;8’: B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8’-16’ : C</td>
</tr>
<tr>
<td>RCCP- Bar Wrapped ANSI/AWWA C303 Class 150</td>
<td>16 – 42</td>
<td>Bell &amp; Spigot ANSI/AWWA C303</td>
<td>16-in Dia: &gt;18-in Dia:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; 16’ : C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 16’ : B</td>
</tr>
<tr>
<td>PCCP- Lined Cylinder ANSI/AWWA C301 Class 150</td>
<td>20 – 60</td>
<td>Bell &amp; Spigot ANSI/AWWA C301</td>
<td>&lt; 16’ : C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 16’ : B</td>
</tr>
<tr>
<td>PCCP- Embedded Cylinder ANSI/AWWA C301 Class 150</td>
<td>54 – 144</td>
<td>Bell &amp; Spigot ANSI/AWWA C301</td>
<td>&lt; 16’ : C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 16’ : B</td>
</tr>
<tr>
<td>Steel ANSI/AWWA C200</td>
<td>24 – 156</td>
<td>Welded Joints or Bell &amp; Spigot ANSI/AWWA C200</td>
<td>&lt; 8’ : C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt; 8’ : C</td>
</tr>
</tbody>
</table>

* Reference to Standard Drawing 113-119 for details and dimensions of the class of embedment

** Steel and other pipe materials can only be considered on case-by-case basis as approved by Distribution Division
2.7 LOCATION

2.7.1 New Main Installation:
New water mains shall be placed in the appropriate standard allocation zone as shown in §1.11.2 and as described below:

- 12” and smaller mains are to be located six feet from the north or east side of the street right-of-way.
- 16” and larger mains are to be located in the major facility zone under the pavement towards the north or east side of the right-of-way.
- In some areas of the Central Business District (CBD) where basements extend into the right-of-way, and in areas where large service meter vaults are required, smaller mains may be located in the major facility zone. If the standard allocation zones are occupied by other utilities, new water mains may be located elsewhere in the street right-of-way, but should follow the other guidelines in this section as closely as possible.
- New water mains within highway or railroad right-of-ways must be coordinated with appropriate agency while meeting DWU criteria.

2.7.2 Main Replacement:
Replacement of water mains shall be located in the standard allocation zone as per §1.11.2 and as described below:

- If the existing main is in the standard allocation zone, the replacement main may be located parallel to and no closer than three (3) feet horizontally from the existing main, as measured from the outside edge of both pipes.
- The replacement main may not be located closer than three (3) feet from the edge of the right-of-way, as measured from the outside edge of the new pipe.
- If there is not enough room to install a new main, as is often the case in narrow alleys or congested streets, the new main may be installed in the same location as the existing main. In this case a temporary water main must be installed during construction, and should be noted on the design drawings.
- Water main replacement within highway or railroad right-of-way must be coordinated with appropriate agency while meeting DWU criteria.
2.8 **HORIZONTAL ALIGNMENT**

2.8.1 **Pipe Laying:**

All water mains shall be laid as straight as possible between intersections and follow right-of-way or centerline alignment curves at a uniform distance from the right-of-way or centerline, as appropriate.

2.8.2 **Deflection Angle:**

The Minimum radius of curve and maximum deflection angle of pipe joints are restricted to 80% of the manufacturer's recommendation. Otherwise, horizontal bends will be required.

Water main curve radius due to joint deflection can be calculated as shown in **Figure 2.8.2**.

![Water Main Joint Deflection Diagram]

- Curve Radius, \( R = \frac{L}{\tan\left(\frac{\theta}{2}\right)} \)
- Joint Deflection Offset, \( S = \sin\theta \times L \)

Where,

- \( L = \) Laying Length
- \( \theta = \) Deflection Angle

**Figure 2.8.2: Water Main Joint Deflection**
Accordingly, typical minimum curve radius of various water sizes are summarized in Table 2.8.2:

Table 2.8.2: Minimum Water Main Curve Radius

<table>
<thead>
<tr>
<th>Size (in)</th>
<th>Deflection (Degree)</th>
<th>Curve Radius (ft)</th>
<th>Deflection (Degree)</th>
<th>Curve Radius (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PVC 20’ Joint</td>
<td>PVC 10’ Joint</td>
<td>PVC 20’ Joint</td>
<td>PVC 10’ Joint</td>
</tr>
<tr>
<td></td>
<td>DI 20’ Joint</td>
<td>DI 10’ Joint</td>
<td>DI 20’ Joint</td>
<td>DI 10’ Joint</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>230</td>
<td>115</td>
<td>230</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>230</td>
<td>115</td>
<td>230</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>230</td>
<td>115</td>
<td>230</td>
</tr>
</tbody>
</table>

*Allowable maximum deflection by DWU is based on 80% of the typical recommended maximum deflection by manufactures. Allowable minimum curve radius by DWU is calculated accordingly and should be verified with specific pipe manufacture, as required.
2.8.3 Bends:

Horizontal bends shall be restrained type fittings/joints and shall also be blocked with concrete as necessary. Horizontal bends shall also be placed such that the concrete blocking can be poured against undisturbed earth and will not bear against the backfill or bedding of another utility. Horizontal curve can be calculated as follows:

![Diagram of Water Main Horizontal Curve]

Where,

- \( C \) = Long Chord
- \( E \) = External Distance
- \( L \) = Curve Length
- \( M \) = Middle Ordinate
- \( R \) = Radius
- \( T \) = Tangent
- \( \Delta \) = Deflection Angle

\[
C = 2R \sin \left( \frac{\Delta}{2} \right) \\
C = 2T \cos \left( \frac{\Delta}{2} \right) \\
E = R \left( \sec \left( \frac{\Delta}{2} \right) - 1 \right) \\
L = 2 \pi R \left( \frac{\Delta}{360^\circ} \right) \\
L = R \Delta/57.2958 \\
M = R(1 - \cos(\Delta/2)) \\
M = (C/2)\tan(\Delta/2) \\
R = T/\tan (\Delta/2) \\
R = C/(2 \sin(\Delta/2)) \\
T = R \tan(\Delta/2) \\
\Delta^\circ = \left( \frac{L}{R} \right) \left( \frac{360^\circ}{2\pi} \right) \\
\Delta^\circ = \left( \frac{L}{R} \right) 57.2958
\]

Figure 2.8.3: Water Main Horizontal Curve
2.8.4 Stationing:

Stations must be to the tenth of foot (Ex: STA. 1+90.5). If necessary, station equations can be used at a point along the alignment where the stationing changes. The station equation generally represents the meeting of two stationing systems or the change in authority over the centerline:

2.8.4.1 Gap Station Equation:

The gap station equation is commonly encountered in curve. A survey is run in straight line segment with a curve calculated to fit within the segment. Because the tangent segments of a curve are longer than the curve itself, an equation is necessary to adequately reference to the survey stations (Figure 2.8.4.1).

![Figure 2.8.4.1: Gap Station Equation](image)

2.8.4.2 Overlap Station Equation:

The overlap station equation is used when the pipeline, as designed, is longer the original survey. When the pipeline is realigned and placed on the survey line, or parallel to it, an equation is usually required (Figure 2.8.4.2).

![Figure 2.8.4.2: Overlap Station Equation](image)
2.9 Vertical Alignment

2.9.3 Pipe Laying:

Mains are to be installed as straight as possible, but excessive depths shall be avoided. For reference, excessive depths are lines designed over 20 feet. This is due to limited ability of standard equipment by operations to reach these mains.

2.9.2 High Points:

Excessive high points that trap air and restrict water flow must be avoided. High points should be designed to coincide with the location of proposed fire hydrants, where possible. Where high points are unavoidable, air valves should be considered.

2.9.4 Bends:

Vertical bends shall be restrained type fittings/joints and to be blocked with concrete as necessary. All DI pipe will be restrained with retainer glands and concrete blocking.

2.9.5 Combined Angle Bend:

Combine angle bend can used where horizontal point of intersection (PI) and point of vertical intersection (PVI) are located at the same point. Combined angle can be shown in Figure 2.9.5 and calculated in Table 2.9.5.

\[
\cos A = (\cos H) (\cos V) \\
\cos A = \frac{x}{m} \\
\cos H = \frac{x}{n} \\
\cos V = \frac{n}{m}
\]

Where,
- \(A\) = Combined Angle
- \(H\) = Horizontal Angle
- \(V\) = Vertical Angle

![Figure 2.9.5: Combined Horizontal and Vertical Angle](image-url)
Table 2.9.5: Combined Horizontal and Vertical Angle

<table>
<thead>
<tr>
<th>H*</th>
<th>V*</th>
<th>5°</th>
<th>10°</th>
<th>11°15’</th>
<th>15°</th>
<th>20°</th>
<th>22°30’</th>
<th>25°</th>
<th>30°</th>
<th>35°</th>
<th>40°</th>
<th>45°</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°</td>
<td></td>
<td>7°04’</td>
<td>11°10’</td>
<td>12°18’</td>
<td>15°48’</td>
<td>20°35’</td>
<td>23°01’</td>
<td>25°28’</td>
<td>30°23’</td>
<td>35°19’</td>
<td>40°16’</td>
<td>45°13’</td>
</tr>
<tr>
<td>10°</td>
<td></td>
<td>11°10’</td>
<td>14°05’</td>
<td>14°59’</td>
<td>17°57’</td>
<td>22°15’</td>
<td>24°30’</td>
<td>26°48’</td>
<td>31°28’</td>
<td>36°13’</td>
<td>41°01’</td>
<td>45°09’</td>
</tr>
<tr>
<td>15°</td>
<td></td>
<td>12°18’</td>
<td>14°59’</td>
<td>15°52’</td>
<td>18°40’</td>
<td>22°50’</td>
<td>25°01’</td>
<td>27°16’</td>
<td>31°51’</td>
<td>36°33’</td>
<td>41°18’</td>
<td>46°05’</td>
</tr>
<tr>
<td>20°</td>
<td></td>
<td>15°48’</td>
<td>17°57’</td>
<td>18°40’</td>
<td>21°05’</td>
<td>24°49’</td>
<td>26°49’</td>
<td>28°54’</td>
<td>33°13’</td>
<td>37°42’</td>
<td>42°16’</td>
<td>46°55’</td>
</tr>
<tr>
<td>22°30’</td>
<td></td>
<td>20°35’</td>
<td>22°15’</td>
<td>22°50’</td>
<td>24°49’</td>
<td>27°59’</td>
<td>29°45’</td>
<td>31°36’</td>
<td>35°32’</td>
<td>39°40’</td>
<td>43°57’</td>
<td>48°22’</td>
</tr>
<tr>
<td>25°</td>
<td></td>
<td>23°01’</td>
<td>24°30’</td>
<td>25°01’</td>
<td>26°49’</td>
<td>29°45’</td>
<td>31°24’</td>
<td>33°09’</td>
<td>36°52’</td>
<td>40°49’</td>
<td>44°57’</td>
<td>49°13’</td>
</tr>
<tr>
<td>30°</td>
<td></td>
<td>25°28’</td>
<td>26°48’</td>
<td>27°16’</td>
<td>28°54’</td>
<td>31°36’</td>
<td>33°09’</td>
<td>34°47’</td>
<td>38°17’</td>
<td>42°04’</td>
<td>46°02’</td>
<td>50°09’</td>
</tr>
<tr>
<td>35°</td>
<td></td>
<td>30°23’</td>
<td>31°28’</td>
<td>31°51’</td>
<td>33°13’</td>
<td>35°32’</td>
<td>36°52’</td>
<td>38°17’</td>
<td>41°25’</td>
<td>44°49’</td>
<td>48°26’</td>
<td>52°14’</td>
</tr>
<tr>
<td>40°</td>
<td></td>
<td>35°19’</td>
<td>36°13’</td>
<td>36°33’</td>
<td>37°42’</td>
<td>39°40’</td>
<td>40°49’</td>
<td>42°04’</td>
<td>44°49’</td>
<td>47°51’</td>
<td>51°08’</td>
<td>54°36’</td>
</tr>
<tr>
<td>45°</td>
<td></td>
<td>40°16’</td>
<td>41°01’</td>
<td>41°18’</td>
<td>42°16’</td>
<td>43°57’</td>
<td>44°57’</td>
<td>46°02’</td>
<td>48°26’</td>
<td>51°08’</td>
<td>54°04’</td>
<td>57°12’</td>
</tr>
</tbody>
</table>

*H and V represent horizontal and vertical angles, respectively
2.9.6  **Slope:**

All water mains shall be designed to have minimum 0.1% slope in order to allow draining and flushing, if necessary. The vertical change in slopes is restricted to 80% of the manufacturer's recommended deflection. Otherwise, vertical bends will be required. Vertical bevels can be considered to accommodate long vertical curves of bevel or deflected joints in lieu of a bend for large concrete main in accordance with manufacturer’s recommendations. Vertical curves are not to be less than 100 feet in length. The PVC, PVI, and PVT should be at quarter, half, or full stations (Ex: PC Sta. 0+00, PI Sta. 0+50 and PT Sta. 1+00).

2.9.6.1  **Types of Vertical Curves:**

Two types of vertical curves can be used in water main: (1) Crest and (3) Sag curves:

![Vertical Curve Types](source: PW&T Paving Design Manual, June, 1998)
2.9.6.2 Calculation of Vertical Curve:

Vertical curves can be calculated by the following methods:

2.9.4.2.1 Algebraic Method:

\[
FL \text{ Elev.} = PVI. + \frac{1}{8} \left( |G1 - G2| \right) \times \left( \frac{L}{100} \right)
\]

**Example:**

\[
FL \text{ Elev.} = 495.40 + \frac{1}{8} \left( |5.20 - 0.80| \right) \times \left( \frac{100}{100} \right) = 495.95
\]

2.9.4.2.2 Averaging Method:

\[
FL \text{ Elev.} = \left\{ \frac{(P.V.C. + P.V.T.)}{2} + P.V.I. \right\} / 2
\]

**Example:**

\[
FL \text{ Elev.} = \left\{ \frac{(495.00 + 498)/2} + 495.40 \right\}/2 = 495.95
\]

![Figure 2.9.6.2: Vertical Curve](image)

2.9.7 Profile:

- All 12" or larger water main design must have a vertical profile.

2.9.8 Slope Designation:

- Design slopes shall be to the nearest hundredth of a percent (Ex: Slope 5.20%).

2.9.9 Elevation Designation:

- Elevations shall be shown to the nearest hundredth of a foot (Ex. El. 495.95).
2.10 **Separation Distance Between Water and Wastewater Mains**

When a water main is built near an existing wastewater facility, conveyance, or appurtenance, 30TAC §290.44.e as enforced by TCEQ, governs the minimum separation distances:

### 2.10.1 Ideal Case:

When new potable water distribution lines are constructed, they shall be installed no closer than nine feet in all directions to wastewater collection facilities. All separation distances shall be measured from the outside surface of each of the respective pieces.

### 2.10.2 Pipe Trench:

Potable water distribution lines and wastewater mains or laterals from parallel utility lines shall be installed in separate trenches.

### 2.10.3 Cross Connection:

No physical connection shall be made between a drinking water supply and a sewer line. Any appurtenance shall be designed and constructed so as to prevent any possibility of sewage entering the drinking water system.

### 2.10.4 Variances:

Where the nine-foot separation distance cannot be achieved, the following criteria shall apply as per 30TAC §290.44.e(4):

#### 2.10.4.1 New Waterline Installation - Parallel Lines:

##### 2.10.4.1.1 Parallel to Existing Non-Leaking Wastewater Main:

Where a new potable waterline parallels an existing, non-pressure or pressure rated wastewater main or lateral and the licensed professional engineer licensed in the State of Texas is able to determine that the existing wastewater main or lateral is not leaking, the new potable waterline shall be located at least two feet above the existing wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the existing wastewater main or lateral. Every effort shall be exerted not to disturb the bedding and backfill of the existing wastewater main or lateral.
2.10.4.1.2 Parallel to Existing Leaking Wastewater Main:

Where a new potable waterline parallels an existing pressure rated wastewater main or lateral and it cannot be determined by the licensed professional engineer if the existing line is leaking, the existing wastewater main or lateral shall be replaced with at least 150 psi pressure rated pipe. The new potable waterline shall be located at least two feet above the new wastewater line, measured vertically, and at least four feet away, measured horizontally, from the replaced wastewater main or lateral.

2.10.4.1.3 Pressure Rating of Wastewater Main:

Where a new potable waterline parallels a new wastewater main, the wastewater main or lateral shall be constructed of at least 150 psi pressure rated pipe. The new potable waterline shall be located at least two feet above the wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the wastewater main or lateral.
2.10.4.2 New Waterline Installation - Crossing Lines:

2.10.4.2.1 Crossing Existing Non-Pressure Rated Wastewater Main:

Where a new potable waterline crosses an existing, non-pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral is disturbed or shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure rated pipe.
2.10.4.2.2 Crossing Existing Pressure-Rated Wastewater Main:

Where a new potable waterline crosses an existing, pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the existing wastewater main or lateral shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with at least 150 psi pressure rated pipe.

![Figure 2.10.4.2.2: New Water Main Crossing Existing Pressure Rated Wastewater Main](image)

2.10.4.2.3 Crossing New Wastewater Minimum Pipe Segment:

Where a new potable waterline crosses a new, non-pressure rated wastewater main or lateral and the standard pipe segment length of the wastewater main or lateral is at least 18 feet, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The wastewater main or lateral shall be embedded in cement stabilized sand (see clause 2.10.4.2.4 of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.
2.10.4.2.4 Variance for Crossing New Wastewater Minimum Pipe Segment:

Where a new potable waterline crosses a new, non-pressure rated wastewater main or lateral and a standard length of the wastewater pipe is less than 18 feet in length, the potable water pipe segment shall be centered over the wastewater line. The materials and method of installation shall conform with one of the following options:

2.10.4.2.4.1 Within nine feet horizontally of either side of the waterline, the wastewater pipe and joints shall be constructed with pipe material having a minimum pressure rating of at least 150 psi. An absolute minimum vertical separation distance of two feet shall be provided. The wastewater main or lateral shall be located below the waterline.

Figure 2.10.4.2.4.1:
Variance for Crossing New Wastewater Main with 2’ Minimum Vertical Separation
2.10.4.2.4.2 All sections of wastewater main or lateral within nine feet horizontally of the waterline shall be encased in an 18-foot (or longer) section of pipe. Flexible encasing pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The encasing pipe shall be centered on the waterline and shall be at least two nominal pipe diameters larger than the wastewater main or lateral. The space around the carrier pipe shall be supported at five-foot (or less) intervals with spacers or be filled to the springline with washed sand. Each end of the casing shall be sealed with watertight non-shrink cement grout or a manufactured watertight seal. An absolute minimum separation distance of six inches between the encasement pipe and the waterline shall be provided. The wastewater line shall be located below the waterline.

![Diagram of Variance for Crossing New Wastewater Main with 6" Minimum Vertical Separation]

2.10.4.2.4.3 When a new waterline crosses under a wastewater main or lateral, the waterline shall be encased as described for wastewater mains or laterals in subclause §2.10.4.2.4.2 of this clause or constructed of ductile iron or steel pipe with mechanical or welded joints as appropriate. An absolute minimum separation distance of one foot between the waterline and the wastewater main or lateral shall be provided. Both the waterline and wastewater main or lateral must pass a pressure and leakage test as specified in AWWA C600 standards.
2.10.4.2.5. Crossing New Pressure-Rated Wastewater Main:

Where a new potable waterline crosses a new, pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater line such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the center line of the wastewater main or lateral. The potable waterline shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pressure rating of at least 150 psi. The wastewater main or lateral shall be embedded in cement stabilized sand (see clause under §10.4.2.6 of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.
2.10.4.2.6 Special Bedding Materials:

Where cement stabilized sand bedding is required, the cement stabilized sand shall have a minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume (at least 2.5 bags of cement per cubic yard of mixture). The cement stabilized sand bedding shall be a minimum of six inches above and four inches below the wastewater main or lateral. The use of brown coloring in cement stabilized sand for wastewater main or lateral bedding is recommended for the identification of pressure rated wastewater mains during future construction.

2.10.5 Waterline and Wastewater Main, Lateral, Manhole or Cleanout Separation:

The separation distance from a potable waterline to a wastewater main or lateral manhole or cleanout shall be a minimum of nine feet. Where the nine-foot separation distance cannot be achieved, the potable waterline shall be encased in a joint of at least 150 psi pressure class pipe at least 18 feet long and two nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five-foot intervals with spacers or be filled to the springline with washed sand or grout as necessary. The encasement pipe shall be centered on the crossing and both ends sealed with cement grout or manufactured sealant.

Figure 2.10.5:
Separation between Waterline and Wastewater Mains/Lateral/Manhole/Cleanout
2.10.6 Location of Fire Hydrants:

Fire hydrants shall not be installed within nine feet vertically or horizontally of any wastewater main, wastewater lateral, or wastewater service line regardless of construction.

2.10.7 Location of Potable or Raw Water Supply or Suction Lines:

Suction mains to pumping equipment shall not cross wastewater mains, wastewater laterals, or wastewater service lines. Raw water supply lines shall not be installed within five feet of any tile or concrete wastewater main, wastewater lateral, or wastewater service line.

2.10.8 Proximity of Septic Tank Drainfields:

Waterlines shall not be installed closer than ten feet to septic tank drainfields.

2.10.9 Reclaimed Water Mains

Reclaimed water mains located adjacent to potable water mains shall comply with the separation criteria established for pressure wastewater mains.
2.11 Connection to Existing Mains

Services lines from properties shall only be connected directly to distribution mains unless otherwise approved by DWU Distribution Division.

2.11.1 Primary Considerations:

2.11.1.1 Minimize Service Interruption:

Connections are to be made in locations where existing valves can be closed to isolate the connection point while keeping as much of the surrounding system in service as possible. If not, a tapping sleeve and valve shall be used.

![Diagram showing connection to existing water main by tapping](image1)

**Figure 2.11.1.1:**
Connection to Existing Water Main by Tapping

2.11.1.2 Minimize Headloss:

Connection types which result in unnecessary head losses are to be avoided, if possible. Connections using 90° bends should be avoided whenever possible. In addition, when connecting a larger pipe to a smaller pipe with a tee, reducers are to be placed only on the straight sides, not on the branch (**Figure 2.11.1.2**).

![Diagram showing placement of reducer at tee](image2)

**Figure 2.11.1.2:**
Placement of Reducer at Tee
2.11.1.3 Provision for Future Replacement:

Connections are to be designed to facilitate future replacements and improvements. Additional piping, valves, and fittings shall be used where necessary to accommodate future replacements.

![Figure 2.11.1.3: Connection to Existing Water Main for Future Extension](image)

2.11.1.4 Methods of Connection

2.11.1.4.1 Tapping Sleeve and Valve:

Tapping sleeve and valve shall be used whenever possible for connections to existing mains in order to avoid interruption of water services.

- Taps are restricted to one standard pipe size smaller than the tapped pipe. If the existing main is 16", the largest pipe that can be tapped will be 12”.

![Figure 2.11.1.4.1: Tapping Criteria for Water Mains](image)

- For all concrete water mains, taps are restricted to no larger than 75% of the diameter of the tapped pipe.
2.11.1.4.2 Connections:

- When connecting to a crossing water main, two tees with intervening valve(s) are required.

![Figure 2.11.1.4.2a: Standard Connection](image)

- Crosses are not permitted. However, Type-D connections may be allowed when other types of connection are not feasible.

![Figure 2.11.1.4.2b: Type D Connection](image)

2.11.1.4.3 Cut-in Connection:

If a tap is not possible, or if the system needs an additional valve, then a cut-in connection with a valve and tee should be used.

![Figure 2.11.1.4.3: Cut-In Connection](image)
2.12 WATER MAIN APPURTENANCES

2.12.1 Isolation Valves

2.12.1.1 Type and Spacing:

Following three (3) types of isolation valves to be considered for water mains:

- Vertical Gate Valve
- Horizontal Gate Valve
- Butterfly Valve

General criteria for various types of isolation valves are summarized in the following table:

<table>
<thead>
<tr>
<th>Valve Size</th>
<th>Valve Type</th>
<th>Bypass Size</th>
<th>Access Manhole Size</th>
<th>Valve Blow Off Manhole Size</th>
<th>Max. Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 or Smaller</td>
<td>Vertical Gate Valve</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>1000</td>
</tr>
<tr>
<td>18 thru 30</td>
<td>Horizontal Gate Valve w/ Integral Bypass and Access Manhole</td>
<td>As Per Manufacturer</td>
<td>5</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>26 thru 42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 thru 66</td>
<td>Butterfly Valve w/ External Bypass and Access Manhole</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>72 thru 90</td>
<td></td>
<td>8</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>96 or Larger</td>
<td></td>
<td>12</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.12.1.1: Valve Spacing and Appurtenances Criteria
2.12.1.2 Location:

Following guideline should aid designer in placement of valves:

2.12.1.2.1 Valves shall be designed at locations that will not unduly impact the customer or reduce fire protection and be easy to locate.

2.12.1.2.2 Valves are to be located such that three valves are normally required to isolate a section of main.

![Valve Location Configuration](image)

*Figure 2.12.1.2.2: Valve Location Configuration*

2.12.1.2.3 The total number of valves at any water main intersection shall equal total number of lines leading out from the intersection point minus one, such as minimum two valves to be used at a tee.

2.12.1.2.4 Valves, except tapping sleeve and valves shall be located at street intersections at the projection of property lines projected across the water main.

![Valve Location at Street Intersection](image)

*Figure 2.12.1.2.4: Valve Location at Street Intersection*
2.12.1.2.5 All fire hydrants shall have a mainline valve adjacent to the fire hydrant lead or positioned such that the closing of three valves shuts down the main and only puts one fire hydrant out of service.

![Figure 2.12.1.2.5: Valve between Fire Hydrants]

2.12.1.2.6 Valve shall not be located at the street gutter, roadside ditch slope or flowline.

2.12.1.3 Reference Schematics:

DWU Standard Drawing Nos. 212-218

2.12.2 Fire Hydrants

2.12.2.1 Spacing:

The general spacing between fire hydrants are summarized in the following Table:

Table 2.12.2.1: Fire Hydrant Spacing

<table>
<thead>
<tr>
<th>Dwelling Type</th>
<th>Spacing (ft)</th>
<th>Remarks*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Residential Development or Single Family Duplex</td>
<td>700</td>
<td>A fire hydrant shall be located so to reach each building with no more than 400 feet of hose along the most direct route considering all physical impediments.</td>
</tr>
<tr>
<td>All Other Areas</td>
<td>500</td>
<td>A fire hydrant shall be located so to reach each building with no more than 300 feet of hose along the most direct route considering all physical impediments.</td>
</tr>
</tbody>
</table>

*Maximum hose laying rule may not be applicable for extra large lots which should be evaluated on case by case basis
2.12.2.2 Location:

- Water main serving a fire hydrant must be 8” or larger and the minimum acceptable fire hydrant lead is 6”
- No more than one fire hydrant will be allowed on a dead end main.
- Fire hydrant shall be located as near to the street intersections as possible but out of the radius of curb turnouts, within 2.5 to 7.5’ behind curb or projected future curb.
- Fire hydrant locations between street intersections shall be at the projection of a property line between owners.
- New fire hydrants shall be placed as near the location of the existing fire hydrant to be replaced as possible.
- Rail lines, controlled access highways, divided roadways, fences and walls will inhibit laying the fire hose in the most direct route and must be considered as barriers.
- For commercial development, provide an isolation valve at each end of fire loop requiring a fire hydrant.
- The Fire Marshall will establish or approve the location of fire hydrants in apartment complexes, platted private street developments, and other multifamily developments within the City and Extra Territorial Jurisdiction (ETJ).

2.12.2.3 Reference Schematic:

- DWU Standard Drawing No. 224.

2.12.3 Water Services

2.12.3.1 General Requirements:

- Each lot must have its own water service which must not cross any existing or projected lot line(s).
- Water services are not to cross railroad, interstate or state highways.
- Water service shall be at least one size smaller than the proposed or existing main. Size on size connections are generally not allowed unless special permission is granted from Distribution Division.
2.12.3.2 Small Water Service:

- Typical small water services range from 3/4” through 2” in diameter. Water service over 30 feet shall be a minimum of 1” in diameter.

- Water service shall be located at the center of the lot from the main to a point beyond the curb line known as “Deadhead” until the meter box is installed.

- Apartment complex and commercial development usually will require coordination of the deadhead location with architectural or plumbing plans.

- Designer shall show all DWU service meters on drawings.

2.12.3.3 Large Water Service:

- Typical large water services are greater than 2” in diameter.

- Large service meter vaults shall be located in areas adjacent to right-of-way with easy access and with protection from vehicular traffic.

- Designer shall work with DWU Distribution on the evaluation of all large meter vaults.

- Various types large water services are summarized below:

<table>
<thead>
<tr>
<th>Large Service Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Domestic waterline through single waterline and meter</td>
</tr>
<tr>
<td>Closed Fireline</td>
<td>Fireline to serve automatic sprinklers only</td>
</tr>
<tr>
<td>Combined Water</td>
<td>Fire protection and domestic water through a single water service and meter</td>
</tr>
<tr>
<td>Irrigation Water</td>
<td>Single water service for irrigation without a bypass</td>
</tr>
</tbody>
</table>
2.12.4 Air Valves

2.12.4.1 General Requirements:

- Air valves are to be installed primarily on all treated or untreated water transmission main to exhaust and admit air to prevent vacuum conditions and air related surges.

- Air valves are not required in smaller water distribution mains of 12” or small in diameter where fire hydrants and service connections provide a means for venting trapped air.

- The designer is responsible for selection, location and sizing of air valves.

2.12.4.2 Type:

There are three (3) basic air valves to be considered as per ANSI/AWWA C512:

- Air Release Valve (ARV)
- Air/Vacuum Valve (AVV)
- Combination Air Valve (CAR)

2.12.4.3 Locations:

Following locations shall be considered for locating air valves:

- High Points: Combination Air Valve
- Long Horizontal Runs: Air Valve or Combination Air Valve at 1250-2500 ft. intervals
- Long Descents: Combination Air Valve at 1250 to 2500 ft. intervals
- Long Ascents: Air/Vacuum Valves at 1250 to 2500 ft. intervals
- Decrease in an Up Slope: Air/Vacuum Valve
- Decrease in a Down Slope: Combination Air Valve

It should be noted that Combination Air Valves can be used at any location in lieu of Air Release or Air/Vacuum Valves to provide added air release capacity on the pipeline. It is also important to establish a smooth pipeline grade in order to avoid an excessive number of air valves and not to follows the terrain. In addition, the height of the air vent riser shall be evaluated on case-by-case basin in order to be well above 100-year flood plain.
The following **Figure: 2.12.4.2** illustrates various locations of air valves:

**Figure: 2.12.4.2:**

**Sample Pipeline Profile Illustrating Air Valve Locations**


2.12.4.3 **Sizing:**

Air valve can be sized as per “Manual of Water Supply Practice, M51: Air-Release, Air/Vacuum & Combination Air Valve by AWWA, latest edition” or other methods as applicable.

2.12.4.4 **Reference Schematic**

- Type I Air Release Valve Assembly:
  DWU Standard Drawing No. 208 for 2” valve

- Type II Air Release Valve Assembly
  DWU Standard Drawing Nos. 209-210 for large than 2” valve
2.12.5 Pitot Outlet:

2.12.5.1 General Requirements:

- If requested by Distribution Division, pitot outlets can be installed on water transmission mains of 20” or larger. These outlets are typically used to calculate the flow rate, roughness coefficient, and the head loss between locations. The calculated roughness coefficient and head loss calculations indicate the condition of the interior of the pipe.

- Pitot outlets shall be consist of a tube having a short right angled bend which is to be placed vertically in the large water pipe with the mouth of the bend directed upstream and used with a manometer to measure the velocity of the water.

2.12.5.2 Design Consideration:

- Pitot manholes are to be located at least 20 (twenty) pipe diameters from a bend, valve or other feature that would create turbulence.

- The location shall not be excessively deep and are to be in an area that is accessible to vehicles which transport the testing crew and equipment.

- Connections to the transmission line shall be located outside the boundary of the two manhole locations used for the test. If this cannot be accomplished, the connecting mains shall have valves that isolate them from the tested section.

- The water main between the two pitot outlets must be of same pipe size, pipe material, and approximately the same age.

- Pitot manholes are to be spaced so there will be at least ten feet of head loss. To estimate the potential head loss, assume a velocity of 3 fps and a Hazen-Williams coefficient of 130.
2.12.5.3 Minimum Spacing:

The following tables show suggested minimum spacing between pitot outlets:

Table 2.12.5.3: Spacing between Pitot Outlets

<table>
<thead>
<tr>
<th>Pipe Dia. (in)</th>
<th>Spacing Between Pitot Outlet (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>7,500</td>
</tr>
<tr>
<td>24</td>
<td>8,500</td>
</tr>
<tr>
<td>30</td>
<td>11,500</td>
</tr>
<tr>
<td>36</td>
<td>12,500</td>
</tr>
<tr>
<td>42</td>
<td>13,500</td>
</tr>
<tr>
<td>48</td>
<td>18,500</td>
</tr>
<tr>
<td>54</td>
<td>21,700</td>
</tr>
<tr>
<td>60</td>
<td>23,400</td>
</tr>
<tr>
<td>66</td>
<td>27,200</td>
</tr>
<tr>
<td>72</td>
<td>28,700</td>
</tr>
<tr>
<td>84</td>
<td>32,200</td>
</tr>
<tr>
<td>96</td>
<td>41,000</td>
</tr>
</tbody>
</table>

Note: If computer simulations, pumping rates, or other information indicates that velocities may exceed three fps, the distances shown in the table may be reduced.

2.12.5.4 Reference Schematic:

- DWU Standard Drawing. No. 220
2.12.6 Mainline Blowoff Manhole

Mainline Blowoff manhole shall be considered for all water transmission mains at the following locations in order to flush the mains, if necessary:

- At low points
- At isolation valves (>48” diameter) where the main slopes towards the valve

Minimum size of Mainline Blowoff Manhole shall be five (5) feet in diameter. However, Valve Blowoff Manhole of four (4) feet in diameter may be allowed at isolation valves where direct access to pipe is not required.

2.12.7 Access Manhole

Access manhole shall be considered for the water transmission mains of 48” or larger in diameter under following conditions, as necessary:

- Every 1000 feet
- Tunnel entry/exist locations

However, 30” flanged outlets for air release valve, blowoff valve or pitot outlets assembly can be used as access points in lieu of access manholes.

2.12.8 Backflow Preventer

Backflow preventer shall be considered at the following locations in order to protect public water system from cross contamination:

- Commercial property water service line
- Dedicated irrigation lines
- Fire Lines
- Multi-residential units
2.12.9 Pressure Reducing Valves:

2.12.9.1 General Requirements:

Pressure Reducing Valves (PRV) are to be designed to provide a steady pressure into a system that operates at a lower pressure zone than the supply zone as shown on Figure: 2.2.2 and Table 2.2.2.

- PRV shall be set for any desired downstream pressure within the design limits of the valve.
- PRV must be selected based on the flow and pressure not the size of the pipe to which they will be attached.
- PRV over sizing shall be avoided.

2.12.9.2 Configurations:

PRV can be designed with following configurations:

2.12.9.2.1 Single PRV Assembly:

This configuration is to be used to achieve basic pressure reducing application.

![Single PRV Assembly Diagram]

Figure: 2.12.9.2.1: Single PRV Assembly
2.12.9.2.2 Two Parallel PRV Assembly:

This approach shall be used wherever there is a wide variation of reduced pressure requirements such as an apartment building where demand could be 0.5 gpm at 1am and 100 gpm at 6am and a continuous water supply must be maintained. This typical configuration shall be used at the major pressure boundaries of DWU water distribution system. However, when installing PRVs of equal diameters in parallel, the individual pressure settings cannot be equal as the valves will not respond equally and one valve will try to do most of the work. This is the most preferred PRV configuration for DWU.

Figure: 2.12.9.2.2: Two Parallel PRV Assembly

2.12.9.2.3 Two Stage Series PRV Assembly:

Two stage reduction is to be designed when initial pressures are 200 psi or greater, or when the desired pressure reduction ratio is greater than 4:1, e.g., from 200psi to 50psi, or where the inflow pressure fluctuates greatly. This configuration is not common and can only be if requested by DWU.

Figure: 2.12.9.2.3: Two Staged Series PRV Assembly
2.12.10 Deadend Mains

2.12.10.1 General Requirements:

- Deadend main situations are to be avoided whenever possible since they have been known to cause taste and odor problems and low chlorine residuals.

- All deadend mains must have a provision so that it can be periodically flushed of stagnant water through a flushing device. An automatic flushing device must be used where it can be flushed into a storm drain, wastewater service lateral or natural ditch, as needed.

2.12.10.2 Special Consideration:

- If the deadend main is 8” or larger, a fire hydrant shall be installed five (5) feet from the end.

- No more than one fire hydrant shall be connected to a dead-end main

- If the dead-end is less than 8” an automatic flushing device shall be installed. A Flush Point may be considered if installation of an automatic flush point is not feasible.

2.12.10.3 Reference Schematics:

- DWU Drawing No. 224 for Fire hydrant

- DWU Drawing No. 207 for Flush Point
2.13 **CORROSION PROTECTION**

This section is applicable to all metal water pipes where corrosive environments or soil may potentially damage the pipes and appurtenances. Typically, soil resistivity less than 1000 ohms-cm can be considered as extremely corrosive soil.

2.13.1 **Terminology:**

2.13.1.1 **Corrosion Principles:**

Corrosion can be defined as physical degradation of a metal due to the electro-chemical reaction involving transfer of electron between the pipe metal and the surrounding environment. For iron corroding in water with a near neutral pH, corrosion involve two half-cell reactions:

Anode Reaction: \[ 2 \text{Fe}^{2+} = 2\text{Fe}^{2+} + 4e^- \]
Cathode Reaction: \[ \text{O}_2 + 2\text{H}_2\text{O} + 4e^- = 4\text{OH}^- \]
Rust Formation: \[ 2\text{Fe}^{2+} + 4\text{OH}^- = 2\text{Fe(OH)}_2 \]

![Corrosion Principle](image)

**Figure 2.13.1.1: Corrosion Principle**

2.13.1.2 **Galvanic Corrosion:**

Galvanic corrosion occurs when two dissimilar metals electrically contact each other and are immersed in an electrolyte. This is most common form of external corrosion.

![Galvanic Corrosion](image)

**Figure 2.13.1.2: Galvanic Corrosion**
2.13.1.3 Electrolytic Corrosion:

Electrolytic corrosion occurs due to outside source of direct current (DC). When stray currents from DC systems including railways, trolley bus systems or rectified protected gas mains are unintentionally picked up by a buried metallic pipeline, loss of metal will occur at any point where the current discharges from the unintended pipe (Figure 2.13.1.3).

![Figure 2.13.1.3: Electrolytic Corrosion](image)

2.13.2 Preventive Requirements:

2.13.2.1 Material Selection:

- PVC pipe shall be used for all mains 12” or smaller except as specified in §2.6.1.
- All RCCP, PCCP, DI, and Steel pipe shall be used with required dielectric coatings, as necessary.

2.13.2.2 Dielectric Coating:

External and internal protective coating shall be considered for all metallic pipes as necessary to limit the rate of cathodic reaction.

2.13.2.3 Electrical Isolation:

Isolating Joints by using insulating kits or other means are required to prevent galvanic corrosion for all metallic pipes in the following locations:

- Changes in pipeline materials
- Connections to existing piping, i.e. old and new piping
- Inlet and outlet piping of plant facilities
- Laterals from transmission mains
- Taps to existing RCCP, PCCP, DI, Steel pipes
- Valve to RCCP, PCCP, DI, Steel pipes
- Metallic casing spacer to RCCP, PCCP, DI, Steel pipes
2.13.2.4 Polyethylene Encasement:

- All DI pipe and fittings shall be poly wrapped.

2.13.3 Monitoring Requirements:

2.14.3.1 Corrosion Test Station (CTS):

All RCCP, PCCP, DI and Steel pipe of 16” or larger shall be designed with CTS at least at every 1000 feet to measure any potential current or resistance.

2.13.3.2 Electrical Continuity:

All pipelines shall be electrically continuous between CTSs through joint bonding wires, or welded joints, as necessary.

2.13.4 Corrosion Protection System (CPS):

If necessary, water main Corrosion Protection System (CPS) is to be designed to introduce an external DC current which makes the structure a cathode. The CPS must be designed by a NACE certified professional engineer with considerable experience in corrosion engineering.

2.13.4.1 Corrosion Survey:

A detailed corrosion survey shall be conducted along the proposed or existing water main alignments. This investigation, shall include, but not be limited to the followings:

- Field soil resistivity measurements
- Soil and groundwater sample analysis
- Stray DC earth current and foreign line cathodic protection system activity
- Identification of potential corrosion problems

2.13.4.2 Data Evaluation:

All field and laboratory data obtained from the corrosion survey shall be used to develop corrosion prevention and monitoring design recommendations.
2.13.4.3 Final Design:

Based on the corrosion survey and subsequent data evaluation and approval by DWU, a corrosion protection system shall be designed, if necessary. This system may include, but not be limited to, the following methods:

2.14.4.3.1 Galvanic Protection (GP) System: Current generated from metal at higher energy level.

![Galvanic Protection (GP) System](image1)

**Figure 2.13.4.3.1: Galvanic Protection (GP) System**

2.14.4.3.2 Impressed Current Cathodic Protection (ICCP) System: Current generated from transformer-rectifier energizing a relatively inert anode.

![Impressed Current Cathodic Protection (ICCP) System](image2)

**Figure 2.13.4.3.2: Impressed Current Cathodic Protection (ICCP) System**
2.14 **ABANDONMENT OF WATER MAINS AND APPURTENANCES**

2.14.1 **Water Mains:**

- Mains shall be abandoned by cutting and plugging and it is not necessary to remove the existing pipe.

- The cut and plug shall be as close to the main left in service as practical unless there is other impending utility work planned that could disturb the plug. If the new main is to be constructed to connect to the existing main at the point of cut, a cut and plug is not required.

- If the main to be abandoned at a tap and valve, the abandoned tapping sleeve and valve shall be removed.

- If the construction necessitates abandoning the existing main prior to the new main being put in service, provisions must be made for temporary mains.

2.14.2 **Fire Hydrants:**

- If a fire hydrant can be used for spare parts, the contractor will deliver the hydrant to the location as designated by the City.

- If the fire hydrant is not salvageable, it will become the property of the contractor for disposal.

2.14.3 **Valves:**

2.14.3.1 **Small Valve:**

Valves smaller than 24" are not to be salvaged. Upon removal of the valve cover, stack and stem extension, the valve body must be abandoned by filling with 2 sacks per cubic yard mix of sand to a point at least 12 inches below the pavement.

2.14.3.2 **Large Valve:**

Valves 24" and larger may be salvaged if requested by the Distribution Division.

2.14.3.3 **Reference Schematics:**

- DWU Drawing No. 219 for 4”-16” Gate Valve Abandonment
2.15 **HYDROSTATIC TESTING & CHLORINATION**

While this is not a requirement for design it should be considered by the designer when understanding the constructability and final acceptance of the water main. All assets must be tested an approved per TCEQ standard before placing into service.

2.15.1 **General Requirements:**

All water mains shall be hydrostatically tested and chlorinated before being put in service. Only the City is permitted to perform the sterilization procedure.

2.15.2 **Hydrostatic Testing:**

Hydrostatic testing of all water mains must be in accordance with Addendum to the NCTCOG Standards by DWU, Latest Edition.

2.15.3 **Chlorination:**

Chlorination of all water mains must be in accordance with AWWA Standards as specified in Addendum to the NCTCOG Standards by DWU, Latest Edition.

2.15.4 **Disposal:**

The heavily chlorinated water can be hauled off in water trucks or discharged into wastewater manholes as approved by Wastewater Collection Division. It is important there be an air gap between the end of the discharge piping and the discharge point.
2.15.5 **Flow Diagram:** A typical hydrostatic and bacteriological testing process diagram of DWU water main can is shown below:

Figure 2.15.5: Flow Diagram for Hydrostatic & Bacteriological Testing Process
3.1 REFERENCES

Wastewater main design shall be in conformance with “30 TAC §217: Design Criteria for Domestic Wastewater System” along with all applicable laws, regulations, codes and standards.

3.2 DWU WASTEWATER INFRASTRUCTURE:

3.2.1 Wastewater Basin and Wastewater Shed:

The DWU wastewater collection system is divided into a number of primary wastewater basins based on the drainage pattern for the wastewater within the basin. Based on 2007 Wastewater Master Plan, there are twelve (12) primary basins where ten (10) of the basins transport flow to DWU Wastewater Treatment Plants (WWTP). These basins are (alphabetically) the Elam Creek, East Bank, Five Mile Creek, Hickory Creek, Pleasant Grove, Prairie Creek, South Dallas, Warren Avenue, West Bank and White Rock Creek Basins. Each basin is named for, and discharges flow into, the major interceptor sewer line traversing the area. The other two primary basins transport flow to other regional sewer providers. These basins, the TRA and Garland basins, are named after the regional provider. Figure 3.2 on the following page shows the basin delineations for the DWU wastewater service area.

The primary basins are further divided into smaller drainage basins, termed wastewater sheds. The wastewater infrastructure within these wastewater sheds consists of gravity collection mains, interceptor mains, lift stations and the permanent flow monitoring network, termed the Environmental Data Acquisition Telemetry (EDAT) system. The purpose of the EDAT system is to monitor wastewater flows in order to maximizing the performance of the City’s wastewater interceptor and treatment facilities and to give a preliminary indication of areas experiencing large or increasing amounts of inflow/infiltration (I/I). EDAT flow monitoring sites are strategically located within the collection system to collect flow data in the City’s interceptor mains.

DWU wastewater basins are wastewater sheds are shown in Figure 3.2 and summarized in Table 2.2.
Figure 3.2: DWU Wastewater Basin Delineations
Source: DWU Comprehensive Wastewater Collection System Assessment, Oct 22, 2007
Table 3.2: DWU Wastewater Sheds/Basins

<table>
<thead>
<tr>
<th>Basin Name/ Wastewater Shed No.</th>
<th>Wastewater Shed Name</th>
<th>Basin Name/ Wastewater Shed No.</th>
<th>Wastewater Shed Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>White Rock Basin</strong></td>
<td></td>
<td><strong>South Dallas Basin</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>North White Rock</td>
<td>29</td>
<td>Oak Cliff</td>
</tr>
<tr>
<td>2</td>
<td>McKamy Branch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Upper White Rock Relief</td>
<td>30</td>
<td>Shady Trail</td>
</tr>
<tr>
<td>4</td>
<td>Cottonwood Branch</td>
<td>31</td>
<td>Joe’s Creek</td>
</tr>
<tr>
<td>5</td>
<td>Central Branch</td>
<td>32</td>
<td>Bachman Relief #2</td>
</tr>
<tr>
<td>6</td>
<td>Central White Rock</td>
<td>33</td>
<td>Bachman Relief #3</td>
</tr>
<tr>
<td>7</td>
<td>Ferris Branch</td>
<td>34</td>
<td>Bachman Creek Shorecrest</td>
</tr>
<tr>
<td>8</td>
<td>Dixon’s Branch</td>
<td>35</td>
<td>Bachman Relief #1</td>
</tr>
<tr>
<td>9</td>
<td>Lower West White Rock</td>
<td>36</td>
<td>Nobles Branch</td>
</tr>
<tr>
<td>10</td>
<td>Lower White Rock Relief #1</td>
<td>37</td>
<td>Knights Branch</td>
</tr>
<tr>
<td>11</td>
<td>Ash Creek</td>
<td>38</td>
<td>East Bank</td>
</tr>
<tr>
<td>12</td>
<td>Lower White Rock Relief #2</td>
<td>39</td>
<td>Cedar Springs Branch</td>
</tr>
<tr>
<td>13</td>
<td>Lower East White Rock Relief</td>
<td>40</td>
<td>Turtle Creek</td>
</tr>
<tr>
<td>14</td>
<td>South White Rock</td>
<td>41</td>
<td>Upper North Interceptor</td>
</tr>
<tr>
<td>15</td>
<td>Southside Diversion</td>
<td>42</td>
<td>Lower North Interceptor</td>
</tr>
<tr>
<td>16</td>
<td>Sludge Force Mains 1</td>
<td>43</td>
<td>Mill Creek</td>
</tr>
<tr>
<td><strong>Elam Creek Basin</strong></td>
<td></td>
<td><strong>Prairie Creek</strong></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Elam Creek</td>
<td>44</td>
<td>South Interceptor</td>
</tr>
<tr>
<td>18</td>
<td>Prairie Creek</td>
<td>45</td>
<td>Lower East Bank 1</td>
</tr>
<tr>
<td><strong>Hickory Creek Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Hickory Creek Interceptor</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td><strong>Pleasant Grove Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Pleasant Grove Interceptor</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td><strong>TRA Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Lower Five Mile</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Woody Branch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Upper Five Mile</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Garland Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>West Bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Upper Coombs Creek</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Lower Coombs Creek</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Elmwood Branch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Cedar Creek</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: DWU Comprehensive Wastewater Collection System Assessment, Oct 22, 2007*
3.2.2 Wastewater Treatment Plants (WWTP) and Other Facilities:

DWU treats wastewater from the City and its wholesale customer cities at one of two wastewater treatment plants: the Central WWTP and the Southside WWTP (Figure 3.2.2). Both are advanced wastewater treatment plants producing a high quality discharge to the Trinity River.

Figure 3.2.2: DWU Wastewater Treatment Plants (WTP)
Source: DWU Comprehensive Wastewater Collection System Assessment, Oct 22, 2007

In addition, there are approximately 14 lift stations and 50 permanent flow monitoring sites in the EDAT within the wastewater collection system. Locating, placing, and sizing new lift stations or permanent flow monitoring site within the system requires approval by both DWU Wastewater Collection and Engineering Services Divisions.
### 3.3 Evaluation of Wastewater Mains for Replacement

Existing wastewater mains shall be considered for replacement if they meet one or more of the following criteria as approved by DWU Wastewater Collection System:

Table 3.3: Wastewater Main for Replacement Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>DWU Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural Integrity</strong></td>
<td><strong>Pipe Age</strong>: 40 years or older mains, but age shall not be the lone factor&lt;br&gt;&lt;br&gt;<strong>Inflow/Infiltration (I/I)</strong>: Presence of excessive sources of I/I including pipe joint offset, longitudinal or transverse pipe cracking, missing pipe, root intrusion and other defects as recorded by CCTV camera inspection, smoke testing, flow monitoring and other field investigation and data evaluation. A PACP score as per NASSCO is generally required before proceeding with the replacement of a wastewater main.</td>
</tr>
<tr>
<td><strong>Capacity Analysis</strong></td>
<td><strong>Substandard Mains</strong>: Smaller mains (&lt; 8”) due to difficulties in maintenance and cleaning&lt;br&gt;&lt;br&gt;<strong>System Wide Growth</strong>: Wastewater main serving areas which is subjected to further growth</td>
</tr>
<tr>
<td><strong>Regulatory</strong></td>
<td><strong>Sanitary Sewer Overflow (SSO)</strong>: Wastewater mains subjected to backups and surcharge at adjacent manholes</td>
</tr>
<tr>
<td><strong>Project Coordination</strong></td>
<td><strong>Wastewater Main Condition Check</strong>: Existing deteriorated wastewater mains in the vicinity of a proposed water main&lt;br&gt;&lt;br&gt;<strong>Minimize Pavement Cut</strong>: Existing mains shall be replaced if future maintenance of the main requires cutting of new pavement within next 10 years&lt;br&gt;&lt;br&gt;<strong>Wastewater Master Plan</strong>: Compliance to any specific recommendations as per current wastewater master plans</td>
</tr>
</tbody>
</table>
3.4 SIZING WASTEWATER MAINS

3.4.1 DWU Wastewater Collection System:

Table 3.4.1: Wastewater Mains Classifications

<table>
<thead>
<tr>
<th>Type of Main</th>
<th>Size Range (in)</th>
<th>Direct Service Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>Less than 18”</td>
<td>Permitted</td>
</tr>
<tr>
<td>Interceptor</td>
<td>18” to 30”</td>
<td>*Not Permitted</td>
</tr>
<tr>
<td></td>
<td>Larger than 30”</td>
<td>Not Permitted</td>
</tr>
</tbody>
</table>

*Note: Service connection may be allowed through a manhole upon approval from Wastewater Water Collection

3.4.2 Wastewater Flow:

Typically, 60-90% of the potable water is directed to a wastewater system. The rates most important to the design and operation of wastewater systems are as follows:

3.4.2.1 Average Daily (AD):

The average daily flow can be defined as the total annual volume of wastewater flowing into a wastewater system divided by the number of days of the year.

This rate is not used for collection and interceptor system design, but it shall be considered in wastewater system master planning and Wastewater Treatment Plant (WWTP) design.

3.4.2.2 Peak Hourly (PH):

The highest two-hour flow expected under any operational conditions, including times of high rainfall based on a two-year 24-hour storm or a prolonged period of wet weather.

Wastewater collection and interceptor and water treatment facilities are typically sized to carry the peak hourly wastewater flow.
3.4.3 Sizing Criteria:

The wastewater mains shall be sized in accordance with any master plan established for that area. If a master plan is not available, the sizing of the wastewater pipe must be based on engineering analysis of initial and future flow of the area to be served. The collection and interceptor main shall be sized for the peak flow which is based on the estimated average daily flow. When site-specific data is unavailable, designer may use following table which meets or exceed the minimum requirements as set by TCEQ (30 TAC §217.32(a)(3):

**Table 3.4.3.1: Average Daily Flows**

<table>
<thead>
<tr>
<th>Source</th>
<th>Remarks</th>
<th>Average Daily Wastewater Flow (gals/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality</td>
<td>Residential</td>
<td>125</td>
</tr>
<tr>
<td>Subdivision</td>
<td>Residential</td>
<td>125</td>
</tr>
<tr>
<td>Trailer Park (Transient)</td>
<td>2½ Persons per Trailer</td>
<td>60</td>
</tr>
<tr>
<td>Mobile Home Park</td>
<td>3 Persons per Trailer</td>
<td>75</td>
</tr>
<tr>
<td>School</td>
<td>Cafeteria &amp; Showers</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Cafeteria/No Showers</td>
<td>15</td>
</tr>
<tr>
<td>Recreational Parks</td>
<td>Overnight User</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Day User</td>
<td>5</td>
</tr>
<tr>
<td>Office Building Factory</td>
<td>A facility must be designed for the largest shift</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Day User</td>
<td>20</td>
</tr>
<tr>
<td>Hotel/Motel</td>
<td>Per Bed</td>
<td>75</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Per Meal</td>
<td>10</td>
</tr>
<tr>
<td>Restaurant with bar or cocktail lounge</td>
<td>Per Meal</td>
<td>12</td>
</tr>
<tr>
<td>Hospital</td>
<td>Per Bed</td>
<td>250</td>
</tr>
<tr>
<td>Nursing Home</td>
<td>Per Bed</td>
<td>125</td>
</tr>
<tr>
<td>Apartments</td>
<td>Per Unit</td>
<td>300</td>
</tr>
</tbody>
</table>
Each wastewater main shall be sized with peaking factor to appropriately handle infiltration and inflow. The peaking factor shall be evaluated by the Engineer from known metering and flow data for the particular basin or area under design. In absence of actual peaking flow, the following table can be used to determine the minimum peaking flow:

**Table 3.4.3.2: Wastewater Peaking Factor***

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Peaking Factor</th>
<th>Depth of Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 24&quot;</td>
<td>4</td>
<td>Full</td>
</tr>
<tr>
<td>24&quot; thru 42&quot;</td>
<td>3</td>
<td>Full</td>
</tr>
<tr>
<td>Larger Than 24&quot;</td>
<td>2</td>
<td>Full</td>
</tr>
</tbody>
</table>

*Peaking factors may be evaluated by the designer from known metering and flow data for the particular basin or area under design.

### 3.4.4 Minimum Pipe Sizes:

- The minimum pipe diameter for any public gravity wastewater collection main shall be 8 inches for maintenance and easy cleaning.

### 3.4.5 Minimum and Maximum Slope:

As per 30 TAC §217.53(l), following criteria must be used for selecting water main slope:

- All wastewater collection mains must contain slope sufficient to allow a velocity when flowing full of not less than 2 ft/sec.

- The maximum velocity of any wastewater collection system is restricted at 10 ft/sec when flowing full.
Accordingly, as per 30 TAC §217.53(2)(A), using “n factor” of 0.013 DWU acceptable slope are calculated are as follows:

Table 3.4.4: Allowable Wastewater Main Slope

<table>
<thead>
<tr>
<th>Size of Pipe* (in)</th>
<th>Min. Slope (%)</th>
<th>Max. Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.50</td>
<td>12.35</td>
</tr>
<tr>
<td>8</td>
<td>0.33</td>
<td>8.40</td>
</tr>
<tr>
<td>10</td>
<td>0.25</td>
<td>6.23</td>
</tr>
<tr>
<td>12</td>
<td>0.20</td>
<td>4.88</td>
</tr>
<tr>
<td>15</td>
<td>0.15</td>
<td>3.62</td>
</tr>
<tr>
<td>18</td>
<td>0.11</td>
<td>2.83</td>
</tr>
<tr>
<td>21</td>
<td>0.09</td>
<td>2.30</td>
</tr>
<tr>
<td>24</td>
<td>0.08</td>
<td>1.93</td>
</tr>
<tr>
<td>27</td>
<td>0.06</td>
<td>1.65</td>
</tr>
<tr>
<td>30</td>
<td>0.055</td>
<td>1.43</td>
</tr>
<tr>
<td>33</td>
<td>0.05</td>
<td>1.26</td>
</tr>
<tr>
<td>36</td>
<td>0.045</td>
<td>1.12</td>
</tr>
<tr>
<td>39</td>
<td>0.04</td>
<td>1.01</td>
</tr>
<tr>
<td>&gt;39</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

* 6" pipe will not be allowed for wastewater mains
** For pipe diameter greater than 39 inches in diameter, the slope is determined by Manning’s Formula to maintain a velocity greater than 2.0 ft/sec and less than 10 ft/sec when flowing full
3.5 **Depth of Cover**

The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe. The main must be deep enough to serve adjacent properties. Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction methods where high groundwater conditions are anticipated.

3.5.1 **Terminology:**

3.5.1.1 Unimproved Area: Unimproved area is defined as public right-of-way or easements without permanent pavement including natural ground, asphalt pavement with no base, gravel surface and streets without curb and gutter.

3.5.1.2 Improved Area: Improved area is defined as public right-of-way or easements with paving and base including areas behind the curb, or streets where permanent pavement is proposed in the near future.

3.5.2 **Minimum Cover:**

The following guideline applies to wastewater main installation in public right-of-way:

<table>
<thead>
<tr>
<th>Size of Main</th>
<th>Min. Depth (ft)*</th>
<th>Highway/Railroad Crossing **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unimproved</td>
<td>Improved</td>
</tr>
<tr>
<td>12” and Smaller</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>16”</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>20” and Larger</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

*Mains shallower than 3 feet will require special engineering evaluation and engineering controls.

**Wastewater mains under highway and railroad right-of-way must also meet all additional criteria as required.
3.6 WASTEWATER PIPE MATERIALS AND EMBEDMENT

3.6.1 Pipe Material Selection:

Designers are responsible for specifying the type of pipe to be used in any wastewater main design. Pipe material shall be selected on the basis of lowest life cycle cost. Typically, minimum 150-psi pressured rated wastewater pipes (PVC ASTM D2241/SDR 26) or AWWA C905/DR (18) are preferred for small diameter (<18”) pressure and gravity mains, as applicable.

3.6.2 Embedment Requirements:

Designers shall specify the class of embedment on the design drawings. The type of embedment to be used is determined by pipe material and the depth of cover. The depth of cover is measured from the top of the pipe to the natural or finished ground surface above the pipe. Please see DWU Standard Drawing Nos. 113-119 for the details of various types of embedments.

General terminology of a typical pipe trench is as follows:

![Typical Pipe Trench Diagram]

*Figure 3.6.2: Typical Pipe Trench*

*Source: 30 TAC §217.54: Criteria for Laying Pipe*
3.6.3 **Recommended Pipe Material and Embedment:**

The following table summarizes recommended pipe material and embedment for wastewater mains:

**Table 3.6.3: Recommended Wastewater Pipe Materials and Embedments**

<table>
<thead>
<tr>
<th>Pipe &amp; Material Specification</th>
<th>Allowable Size (in)</th>
<th>Joint Specification</th>
<th>Embedment Class Per Depth Of Cover (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC ASTM D 3034 (SDR 35)</td>
<td>6”– 15”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC ASTM F 679</td>
<td>18”– 24”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC ASTM F 949 (Corrugated)</td>
<td>6”–36”</td>
<td>Bell &amp; Spigot</td>
<td></td>
</tr>
<tr>
<td>PVC ASTM F 794 (Profile Wall)</td>
<td>15”–48”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC ASTM F 1803 (Closed Profile)</td>
<td>21”–54”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC- Pressure Rated* ASTM D 2241 (SDR 26) Class 160</td>
<td>6”–12”</td>
<td>Bell &amp; Spigot</td>
<td></td>
</tr>
<tr>
<td>PVC- Pressure Rated* AWWA C 905 (DR 25)</td>
<td>14”– 30”</td>
<td>Bell &amp; Spigot</td>
<td></td>
</tr>
</tbody>
</table>

*Typically, minimum 150-psi pressured rated wastewater pipes [(PVC ASTM D2241/SDR 26, AWWA C905/DR (18)] are preferred for all small diameter (<18”) gravity and pressure main replacements*
Table 3.6.3: Recommended Materials for Wastewater Pipe and Embedment  
(Contd.)

<table>
<thead>
<tr>
<th>Pipe &amp; Material Specification</th>
<th>Allowable Size (in)</th>
<th>Joint Specification</th>
<th>Embedment Class Per Depth Of Cover (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCP*** ASTM C 76 Specify Class I, II, III, IV, V</td>
<td>54”– 120”</td>
<td>Bell &amp; Spigot ASTM C 361</td>
<td>&lt;3.5’ : G &lt;br&gt; 3.5’-10’ : C &lt;br&gt; &gt;10’ : B</td>
</tr>
<tr>
<td>RCP*** ASTM C 361 Specify Class A, B, C, D</td>
<td>54”–102”</td>
<td>Bell &amp; Spigot AWWA C 301</td>
<td>&lt;10’ : C &lt;br&gt; &gt;10’ : B</td>
</tr>
<tr>
<td>PCCP-Embedded Cylinder AWWA C 301</td>
<td>54”– 144”</td>
<td>Bell &amp; Spigot AWWA C 301</td>
<td></td>
</tr>
<tr>
<td>HDPE ASTM F714 (DR 17) Specify IPS or DIPS</td>
<td>6”- 30”</td>
<td>Fusion ASTM F2620</td>
<td></td>
</tr>
<tr>
<td>HDPE- Pressure Rated ASTM F714 (DR 11) Specify IPS or DIPS</td>
<td>6”- 30”</td>
<td>Fusion ASTM F2620</td>
<td></td>
</tr>
</tbody>
</table>

*** RCP Pipe shall only be installed with plastic or sprayable liner as approved by Wastewater Collection Division
Table 3.6.3: Recommended Materials for Wastewater Pipe and Embedment
(Contd.)

<table>
<thead>
<tr>
<th>Pipe &amp; Material Specification</th>
<th>Allowable Size (in)</th>
<th>Joint Specification</th>
<th>Embedment Class Per Depth Of Cover (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTRPα &amp; RPMPβ</td>
<td>18” – 102”</td>
<td>Bell &amp; Spigot</td>
<td>&lt; 8’ : B-1</td>
</tr>
<tr>
<td>ASTM D 3262 (Fiberglass)</td>
<td></td>
<td>Joints: ASTM D3212</td>
<td>8’-25’ : B-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gasket: ASTM F477</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; 25’ : Modified Flowable Backfill within Easement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;25’ : Engineering Evaluation Required</td>
</tr>
<tr>
<td>Pressure-Rated RTRPα</td>
<td>18” –102”</td>
<td>Bell &amp; Spigot</td>
<td>&lt; 8’ : B-1a</td>
</tr>
<tr>
<td>&amp; Pressure-Rated- RPMPβ</td>
<td></td>
<td>Joints: ASTM D3212</td>
<td>8’-25’ : B-2a</td>
</tr>
<tr>
<td>ASTM D 3754 (Fiberglass)</td>
<td></td>
<td>Gasket: ASTM F477</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt; 25’ : Modified Flowable Backfill within Easement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;25’ : Engineering Evaluation Required</td>
</tr>
<tr>
<td>VCT</td>
<td>6”–24”</td>
<td>Bell &amp; Spigot</td>
<td>&lt; 3 ½’ : G</td>
</tr>
<tr>
<td>ASTM C 700</td>
<td></td>
<td>Joints: ASTM C425</td>
<td>3 ½’-10’ : C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gasket: ASTM C425</td>
<td>&gt;10’ : B</td>
</tr>
</tbody>
</table>

α RTRP denotes Reinforced Thermosetting Resin Pipe
β RPMP denotes Reinforced Polymer Mortar Pipe
Any pipe material not listed in this table shall use the manufacturers recommended embedment and will require approval from DWU.
3.7 Location

3.7.1 New Wastewater Mains:

New wastewater mains shall be placed in the appropriate standard allocation zone as shown in §1.11.2:

- Mains are to be located in the allocated zone in the center of the street.
- Wastewater manholes shall not be located in the flowline of an existing creek or drainage area. The main may follow the alignment of the creek along the high bank. If necessary, two parallel mains may be designed on either sides of the creek to serve the drainage area.

3.7.2 Replacement Mains

Replacement of wastewater mains shall be located in the standard allocation zone as per §1.11.2 whenever possible:

- Install the replacement main in the same trench as the existing main at six (6)-twelve (12) inches below the existing grade, if feasible
- Install the replacement main three (3) feet parallel to the existing main, as measured from the outside edge of both.

3.8 Horizontal Alignment

- All mains should be laid as straight as possible between intersections.
- If curves are justified, the minimum radius of curve and maximum deflection angle of pipe joints are to be restricted to 80% of the manufacturer's recommendation.
- Stations shall be to the tenth of a foot (Ex: STA. 10+11.4).
3.9 **Vertical Alignment**

- Mains shall be straight between manholes, but excessive depths should be avoided. Drop manholes may be used to minimize excessive depth, as necessary.

- Vertical bends are not allowed.

- Design slopes shall be to the nearest hundredth of a percent (Ex: Slope 5.20%).

- Elevations shall be shown to the nearest hundredth of a foot (Ex. El. 495.95).

3.10 **Separation Distance Between Wastewater and Water Mains**

When a wastewater main is built near an existing water facility, conveyance, or appurtenances, 30TAC §217.53.d governs the minimum separation distances.

3.10.1 **Pipe Trench:**

Collection system pipes must be installed in trenches separate from public water supply trenches.

3.10.2 **Ideal Case:**

Collection system pipes must be no closer than nine feet in any direction to a public water supply line.

3.10.3 **Variances:**

If a nine-foot separation distance cannot be achieved, the following guidelines will apply as per 30TAC §217.53.d(3):

3.10.3.1 **New Wastewater Installation- Parallel Lines:**

If a collection system parallels a public water supply pipe the following requirements will apply:

3.10.3.1.1 **Pipe Material:** A collection system pipe must be constructed of cast iron, ductile iron, PVC or other materials meeting ASTM specifications with at least 150 pounds per square inch (psi) pressure rating for both the pipe joints.

3.10.3.1.2 **Vertical Separation:** A vertical separation must be at least two feet between the outside diameters of the pipes.

3.10.3.1.3 **Horizontal Separation:** A horizontal separation must be at least four feet between the outside diameters of the pipes.
3.10.3.1.4 Vertical Location: A collection system pipe must be below a public water supply line.

![Diagram showing vertical separation between wastewater and water main]

Figure 3.10.3.1: New Wastewater Main Parallel to Existing Water Main

3.10.3.2 New Wastewater Installation- Crossing Lines:

If a collection system pipe crosses a public water supply pipe, the following requirements apply:

3.10.3.2.1 Criteria for Pressure Rated Wastewater Pipe Material:

If a collection system is constructed of cast iron, ductile iron, or PVC with a minimum pressure rating of 150 psi, the following requirements apply:

3.10.3.2.1.1 *A minimum separation distance is six inches between outside diameters of the pipes.*

3.10.3.2.1.2 *A collection system pipe must be below a public water supply pipe.*
3.10.3.2.1.3 Collection system pipe joints must be located as far as possible from an intersection with a public water supply line.

Figure 3.10.3.2.1:
Criteria for Pressure-Rated Wastewater Pipe Material

3.10.3.2.2 Criteria for Non-Pressure-Rated Wastewater Pipe Material:

If a collection system pipe crosses under a public water supply pipe and the collection system pipe is constructed of acrylonitrile butadiene styrene (ABS) truss pipe, similar semi-rigid plastic composite pipe, clay pipe, or concrete pipe with gasketed joints, the following requirements apply:

3.10.3.2.2.1 A minimum separation distance is two feet.

3.10.3.2.2.2 If a collection system pipe is within nine feet of a public water supply pipe, the initial backfill around the collection system pipe must be:

3.10.3.2.2.2.1 Sand stabilized with two or more 80 pound bags of cement per cubic yard of sand for any section of collection system pipe within nine feet of a public water supply pipe.
3.10.3.2.2 Installed from one quarter of the diameter of the collection system pipe below the centerline of the collection system pipe to one pipe diameter (but not less than 12 inches) above the top of the collection system pipe.

Figure 3.10.3.2.2: Criteria for Non-Pressure-Rated Wastewater Pipe Material

3.10.3.2.3 Criteria for Wastewater Pipe over Water Pipe: If a collection system crosses over a public water supply pipe, one of the following procedures must be followed:

3.10.3.2.3.1 Each portion of a collection system pipe within nine feet of a public water supply pipe must be constructed of cast iron, ductile iron, or PVC pipe with at least a 150 psi pressure rating using appropriate adapters.

3.10.3.2.3.2 A collection system pipe must be encased in a joint of at least 150 psi pressure class pipe that is:

3.10.3.2.3.2.1 Centered on the crossing;

3.10.3.2.3.2.2 Sealed at both ends with cement grout or manufactured seal;

3.10.3.2.3.2.3 At least 18 feet long;

3.10.3.2.3.2.4 At least two nominal sizes larger than the wastewater collection pipe; and
3.10.3.2.3.2 Supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.

Figure 3.10.3.2.3.2: Criteria for New Wastewater Pipe over Existing Water Pipe

3.10.4 Manhole Separation:

3.10.4.1 Ideal Case:

Unless collection system manholes and the connecting collection system pipe are watertight, as supported by leakage tests showing no leakage, they must be installed with a minimum of nine feet of horizontal clearance from an existing or proposed public water supply pipe.

3.10.4.2 Variance:

If a nine-foot separation cannot be achieved, the requirements in paragraph §3.10.3 of this subsection apply.

3.10.5 Building Laterals and Taps

Building laterals and taps on an installation must:

3.10.5.1 Include a manufactured fitting that limits infiltration

3.10.5.2 Prevent protruding service lines; and

3.10.5.3 Protect the mechanical and structural integrity of a wastewater collection system
3.10.6  **Reclaimed Water Pipes**

Reclaimed water pipes located adjacent to wastewater pipes shall comply with the separation criteria established for water mains.

3.11  **Connections to Existing Mains**

- The connection, other than at a manhole, should be made with the same type and size of pipe.
- Wastewater Laterals should not be connected to wastewater mains over 18” due to the potential of odor migrating into the property.

3.12  **Wastewater Appurtenances**

3.12.1  **Manhole (MH):**

3.12.1.1  Location:

  Manholes shall be placed at:

- All points of changes in pipe alignments, grade, size and material
- At intersection of all pipes
- At end of all pipes that may be extended in the future. Manhole placed at the end of a wastewater collection system pipe that may be extended in future must include pipe stub outs with plugs.
- An intersection of three or more collection pipes

  **Variances:**

- Tunnels are exempt from manhole spacing requirements because of construction restraints
- A manhole must not be located in the flow path of a watercourse, or in an area where ponding of surface water is probable.
3.12.1.2 Material:

- A manhole must be made of monolithic, cast-in-place concrete, pre-cast concrete, fiberglass or other equivalent material as approved by DWU.
- The use of bricks to adjust manhole cover to grade or construct a manhole is prohibited.
- The inclusion of steps inside the manhole are prohibited due to history of corrosion
- Manhole should be concentric type unless otherwise approved by DWU.

3.12.1.3 Spacing:

- Manhole may be spaced no further apart than the distance specified in the following table:

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Max. Manhole Spacing (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-15</td>
<td>500</td>
</tr>
<tr>
<td>18-30</td>
<td>800</td>
</tr>
<tr>
<td>36-48</td>
<td>1000</td>
</tr>
<tr>
<td>54 or Larger</td>
<td>2000</td>
</tr>
</tbody>
</table>

- The maximum allowable manhole spacing for collection systems with horizontal curvature is 300 feet. A manhole must be at point of curvature (PC) and the point of termination of a curve (TC).

3.12.1.2 Type:

There are generally three (3) types of manholes installed in the DWU wastewater collection system:
- Standard Manholes
- Drop Manholes
- Type-S Manhole
3.12.1.4 Size:

The inside diameter of a manhole must not be less than 48 inches:

<table>
<thead>
<tr>
<th>Pipe Diameter (in)</th>
<th>Min. Manhole Diameter (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-18</td>
<td>4</td>
</tr>
<tr>
<td>21-30</td>
<td>5</td>
</tr>
<tr>
<td>33-48</td>
<td>6</td>
</tr>
<tr>
<td>48 or Larger*</td>
<td>As Approved by DWU</td>
</tr>
</tbody>
</table>

* Manholes 7’-8’ in diameter may be used if approved by Wastewater Collection Division. If the distance between the outside diameter of any two pipes is less than <1’ then a junction structure may be required.

3.12.1.5 Manhole Cover:

A manhole must meet the following requirements for covers, inlets and bases as per 30TAC §217.55 (l):

- A manhole where personnel entry is anticipated requires at least 30 inch diameter clear opening.

- A manhole located within the 100 year floodplain must be installed to prevent inflow and infiltration. This manhole type is referred to at DWU as a Type S manhole

- A manhole cover construction must be constructed by impervious material as approved by DWU.

- A manhole cover that is located in a roadway must meet or exceed the American Association of State Highway and Transportation Standard M-306 as approved by DWU
3.12.1.6 Manhole Invert:

- The bottom of a manhole must contain a U-shaped channel that is a smooth continuation of the inlet and outlet pipe.

- A manhole connected to a pipe less than 15 inches diameter must have a channel depth equal to at least half of the largest pipe diameter.

- A manhole connected to a pipe at least 15 inches diameter but not more than 24 inches in diameter must have a channel depth equal to at least three-fourths of the largest pipe diameter.

- A manhole connected to a pipe greater than 24 inches diameter must have a channel depth equal to the largest pipe diameter.

- A manhole with pipes of different sizes must have the tops of the pipes at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe.

![Figure 3.12.1.6.5
Crown Elevation of Different Pipe Sizes within a Manhole](image)

- A bench provided above a channel must slope at a minimum of 0.5 inch per foot.

- Invert must be filleted to prevent solids being deposited if a wastewater collection system pipe enters a manhole higher than 24” inches above a manhole invert.

- A wastewater collection system pipe entering a manhole more than 24 inches above an invert must have a drop connection.

- Minimum 12 inches separation measured from the outside of each pipe should be maintained among pipes at manhole.
3.12.1.7 Connections

- A manhole-pipe connection must use water tight, size on size resilient connectors that allow for differential settlement and must conform to ASTM C-923.

- A drop pipe shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert shall be filleted to prevent solids deposition.

- Drop manholes should be constructed with an outside drop connection. Inside drop connections (when necessary) shall be secured to the interior wall of the manhole and provide access for cleaning.

- Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete or granular material as necessary.

- Reference Schematics: DWU Standard Drawing Nos. 307 and 308 for outside and inside drop connections, respectively.

3.12.1.8 Venting:

An alternate means of venting must be used if manholes are spaced at 1,500 foot intervals. Gasketed manhole covers are required for more than three manholes in sequence. Venting must meet following requirements:

- Vent design must minimize inflow.
- Vents must be located above a 100-year flood elevation
- Tunnel must be vented as needed
3.12.3 **Wastewater Junction Structure:**

A wastewater junction structure is generally required where two or more wastewater pipelines can not be connect at a manhole due to inadequate separation distance between the outer diameters of the mains (Figure 3.12.3). Following items, but not limited to, must be considered for designing a wastewater Junction structure:

- The separation distance between pipes must be at a minimum of 1 foot.
- All pipes entering a junction structure must be at right angle at the junction wall.

![Figure 3.12.3: Typical Wastewater Junction Structure](image)

3.12.4 **Wastewater Access Device (WWAD) and Cleanout (CO):**

A Wastewater Access Device or Cleanout is required at the end of all wastewater lines for accessibility in cleaning

3.12.4.1 **Wastewater Access Device (WWAD):**

Wastewater Access Device (WWAD) is the preferred appurtenance to use for insertion or removal of cleaning equipment. Minimum depth of cover for WWAD is 3.5 feet. It may be installed in lieu of a manhole at the end of wastewater collection system pipe if no extensions are anticipated.

3.12.4.2 **Cleanout:**

A cleanout (CO) may be installed where there is not enough cover or vertical clearance for a WWAD. The size of mainline cleanout must be equal to the size of the wastewater collection system, if used.

3.12.4.3 **Reference Schematics:**

DWU Standard Drawing Nos. 317 and 328 for Cleanout (CO) and Wastewater Access Device (WWAD), respectively.
3.12.5 Wastewater Service

3.12.5.1 General Requirements:

- Each lot must have its own wastewater service which must not cross any existing or projected lot line(s)
- Wastewater service will not be directly connected to wastewater mains larger than 18”
- Wastewater service connection to a main larger than 30” may be allowed through a manhole only upon prior approval from Wastewater Collection Division

3.12.5.2 Location:

- Wastewater service should be located ten feet downstream of the water service which is usually located at the center of the lot facing the main.

3.12.5.3 Size:

- The size of the wastewater service from the main to the property line should be six (6) inches unless other conditions warrant a larger size. The following criteria may be used as a guide:

<table>
<thead>
<tr>
<th>Fixtures</th>
<th>Flow (gpm)</th>
<th>Size (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0- 720</td>
<td>0- 180</td>
<td>6</td>
</tr>
<tr>
<td>720- 2640</td>
<td>180- 4000</td>
<td>8</td>
</tr>
<tr>
<td>2640- 4680</td>
<td>4000- 7000</td>
<td>10</td>
</tr>
<tr>
<td>4680- 8200</td>
<td>7000- 11600</td>
<td>12</td>
</tr>
</tbody>
</table>

3.12.5.4 Depth:

- The wastewater service should be at a depth sufficient to insure the dwelling to be connected, will be served using a minimum lateral grade of 2% and minimum cover of 2 feet

- The top of the downstream manhole should be a minimum of 18 inches below the finish floor (FF) elevation of the dwelling to be connected. In cases where this is not achievable approval must come from Wastewater Collection and will generally require a backflow prevention device and damage waiver from the property owner. A typical wastewater service is shown in shown in Figure 3.12.3.3.
3.13 **INVERTED SIPHONS:**

An inverted siphon is applied to a portion of a wastewater main which dips below the hydraulic grade line to avoid such obstructions as a drainage structure, tunnel, or stream.

A siphon pipe must include:

- Two or more barrels
- A minimum pipe diameter of 8 inches
- The necessary appurtenances for convenient flushing and maintenance.
- Two manholes must be included, one upstream and one downstream with adequate clearance for cleaning equipment, inspection, and flushing.
- The siphon pipes must be sized and designed with sufficient heads to achieve velocity of at least 3 ft/sec at initial and design flows.
- The arrangement of inlet and outlet details must divert the normal flow to one barrel.
- The system must allow any barrel to be taken out of service for cleaning.
- Provisions must be made to allow cleaning across each bend with equipment available to Wastewater Collection Division
- Siphon pipe must be designed to minimize nuisance odors
3.14 **ABANDONMENT OF WASTEWATER MAINS AND APPURTEANCES:**

3.14.1 Wastewater Mains:

- Wastewater mains shall be abandoned by cutting and plugging and it is not necessary to remove the existing pipe.

- If the construction necessitates abandoning the existing main prior to the new main being put in service, provisions must be made for temporary bypass.

3.14.2 Manhole, Cleanout and Wastewater Access Device:

- Manhole, cleanout and wastewater access device shall be abandoned by filling with sand and/or gravel compacted to 90% (95% in pavement) of maximum standard proctor dry density.

- The bottom of manhole, cleanout and wastewater access device shall be filled with class B concrete up to the top of wastewater pipe(s).

2.14.3.3 Reference Schematics:

- DWU Drawing No. 316: Abandonment of manhole in and out of Pavement
CHAPTER 4
SPECIAL DESIGN CRITERIA

4.1 GENERAL

This chapter addresses various special design criteria common to water and wastewater projects.

4.2 PAVEMENT CUT AND REPAIR CRITERIA

4.2.1 Authority

The pavement cut due to construction of water and wastewater mains, and subsequent repair must be in compliance with all applicable DWU standards and required criteria or variance as approved by City of Dallas Public Works and Transportation (PW&T). Following reference must be reviewed in conjunction with this manual:


The most current “Pavement Cut and Repair Standards Manual” dated October, 2003 by PW&T, was published in response to a January 24, 2001 Dallas City Council amendment to Chapter 43 of the Dallas City Code. Where it is both physically feasible and to TCEQ/DWU design standards, the designer should investigate placing both water and wastewater in a location that minimizes the replacement of pavement in order to reduce construction costs, extend the life of pavement, and minimize traffic impacts.

Two separate approaches should be used for pavement cut and repair: the first approach is where the pavement is more than 5 years old and the second is where the pavement is less than 5 years old. Pavement age can be obtained from PW&T database. In case of unavailability, engineer’s judgment, historical records, and record drawing information can be used to determine pavement age.

4.2.2 Pavement Types and Cut Limit:

The size of the pavement repair will typically always be larger than the size of the excavated area. Pavement cut for the installation of water and wastewater mains must be done in two steps. Initial pavement cut shall be along the proposed water/wastewater main trench. Final pavement cut beyond the firm bank of the trench, will follow upon installation, backfill and necessary testing of water/wastewater mains.
4.2.2.1 Concrete Pavement:

Following pavement types shall be removed to a line at least one (1) foot back of the firm banks of the trench of water/wastewater main:

- Full Depth Concrete Pavement: Pavement consists of 6-10” thickness of concrete surface (Figure 4.2.2.1.1).

![Figure 4.2.2.1.1: Full Depth Concrete Pavement](source)

- Asphalt Concrete Pavement with Concrete Base: Pavement consists of 6-10” of concrete base with 2” asphaltic concrete surface course (Figure 4.2.2.1.2).

![Figure 4.2.2.1.2: Asphalt Concrete Pavement with Concrete Base](source)
4.2.2.2 Asphalt Pavement:

Following pavement types shall be removed to a line at least two (2) feet back of the firm banks of the trench of water/wastewater main:

- Full Depth Asphaltic Concrete Pavement on Natural Soil Base: Pavement consists of 6-10” of natural base with 2” asphaltic concrete surface course (Figure 4.2.2.2.1)

  ![Asphalt Pavement](image1)

  **Figure 4.2.2.2.1:**
  **Asphalt Pavement**
  *Source: Pavement Cut and Repair Standards Manual by PW&T, 2003*

- Asphalt Concrete on Flexible Base: Pavement consists of minimum 6” flexible base with 2” asphaltic concrete surface course (Figure 4.2.2.2.2).

  ![Asphalt Concrete on Flexible Base](image2)

  **Figure 4.2.2.2.2:**
  **Asphalt Concrete on Flexible Base**
  *Source: Pavement Cut and Repair Standards Manual by PW&T, 2003*
• Penetration Type Pavement on Flexible Base: Pavement consists of 6” flowable fill base with 2” asphaltic concrete surface course or two course penetration asphaltic surface (Figure 4.2.2.2.3).

![Figure 4.2.2.2.3: Penetration Type Pavement on Flexible Base](image)


4.2.2.3 Special Pavement:

Special pavements are those with a surface of brick, stone, exposed aggregate, manufactured paving blocks or other surface designed to present unique visual images, color or designs (Figure 4.2.2.3).

![Figure 4.2.2.3: Special Pavement](image)

Following criteria shall be considered for cutting special pavements:

- Cuts or excavations in these special pavements shall be avoided whenever possible, by accomplishing repairs through boring or tunneling.

- Whenever a cut or excavation in a special pavement in a street alley, median or sidewalk of the public street right-of-way is unavoidable, the contractor shall, in addition to complying with the requirements of all applicable preceding repair standards, take whatever additional measures are necessary to restore the pavements area to a condition equal to or better than the preexisting condition.

- Removal shall be from joint or back of curb to joint or back of curb. Saw cutting of special pavement shall not be permitted.

4.2.3 **Trench Backfill:**

All water and wastewater trenches shall be backfilled with select materials from the excavation or flowable fill as per Pavement Cut and Repair Standards Manual by PW&T, Latest Edition.
4.2.4 Repair Criteria for Streets of More Than 5 Years Old:

4.2.4.1 General Considerations:

- Remove and replace a minimum 3’ (concrete) and 4’ (asphalt) longitudinal and 1’ (concrete) and 2’ (asphalt) from the edge of trench, whichever is greater.

- If within 3’ of an existing joint, then remove to the existing joint.

- Multiple locations are to be a minimum of 10’ apart from edge of repair to edge of repair, if less than 10 feet apart, a continuous section must be replaced.

- A gutter of at least 12’ may remain, provided that the curb and gutter is not damaged by the construction activity.

- Exact pavement removal location to be approved by the City prior to construction.

4.2.4.2 Residential Street of 30’ or Greater:

- Option 1: Trench edge plus 1 feet (concrete) or 2 feet (asphalt) is greater than 5 feet from pavement centerline and within 10 feet from pavement edge:

![Diagram](image)

Figure 4.2.4.2.1:
Option 1: Pavement Cut and Repair Extent for Residential Street of 30 Feet or Greater
• Option 2: Trench edge is less than 5 feet from center line but greater than 1 feet (concrete) or 2 feet (asphalt) from centerline:

Figure 4.2.4.2.2:
Option 2: Pavement Cut and Repair Extent for Residential Street of 30 Feet or Greater

4.2.4.3 Residential Street of Less Than 30’:

• Trench edge is less than 5 feet from center line but greater than 1 feet (concrete) or 2 feet (asphalt) from centerline:

Figure 4.2.4.3:
Pavement Cut and Repair Extent for Residential Street of Less Than 30 Feet
4.2.4.4 All Residential Streets:

- Trench edge is less than 1 feet (concrete) or 2 feet (asphalt) from the centerline:

![Figure 4.2.4.4: Pavement Cut and Repair Extent for All Residential Streets](image)

4.2.4.5 All Service Laterals:

![Figure 4.2.4.5: Pavement Cut and Repair Extent for Service Laterals](image)
4.2.4.6  Multiple Lane Concrete Street:

- Option 1: Trench edge is greater than 1 feet from lane line:

```
        Lane Line
       /\                /\        
      /  \              /  \        
    W/WW Main          W/WW Main     
       \  \              \  \        
        Curb            Curb        
```

Figure 4.2.4.6.1: Option 1: Pavement Cut and Repair Extent for Multiple Lane Concrete Streets

- Option 2: Trench edge is less than 1 feet from lane line:

```
        Lane Line
       /\                /\                
      /  \              /  \              
    W/WW Main          W/WW Main            
       \  \              \  \                
        Curb            Curb                
```

Figure 4.2.4.6.2: Option 2: Pavement Cut and Repair Extent for Multiple Lane Concrete Streets
4.2.4.7 Multiple Lane Asphalt Street:

- Option 1: Trench edge plus 2 feet is less than ½ lane width:

![Figure 4.2.4.7.1: Option 1: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets](image1)

- Option 2: Trench edge is less than ½ lane width but greater than 2 feet from lane line:

![Figure 4.2.4.7.2: Option 2: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets](image2)
• Option 3: Trench edge is less than 2 feet from lane line:

Figure 4.2.4.7.3:
Option 3: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets
4.2.5 Repair Criteria for Streets of Less Than 5 Years Old:

Replacement of pavements in a newly constructed, reconstructed or resurfaced street may not be made for 5 years after substantial completion of the work unless otherwise approved by PW&T.

4.2.5.1 Concrete Street:

If approved by PW&T, the removal limit for concrete streets will extend beyond the edge of the cut to the nearest expansion, construction or dummy joint or to the point halfway between the joints where the edge of the cut terminates, whichever is less. The cut width includes the required 1 feet ledge to undisturbed soil on both sides of the trench excavation.

Figure 4.2.5.1: Pavement Cut and Repair Extent for Concrete Streets of Less Than 5 years Old
4.2.5.2 Asphalt Street:

If approved by PW&T, the restoration limit for asphalt streets will be no less than one lane width and extend no less than 3 (three) in the longitudinal direction from the edge of the cut. The cut width includes the required 2 (two) feet ledge to undisturbed soil on both sides of the trench excavation.

For asphalt streets, the contractor will be required to slurry seal or micro-surface the asphalt pavement for uniformity, or other acceptable method to match the pavement color. The determination shall be made by the City. The treatment will be made for the entire block in which the cut was made.

Figure 4.2.5.2: Pavement Cut and Repair Extent for Asphalt Multilane Streets of Less Than 5 years Old
4.3 **HIGHWAY ACCESS CRITERIA**

4.3.1 **Authority:**

The design and construction of water and wastewater mains within a state highway must be in compliance with all applicable DWU standards and required criteria or variance as approved by the Texas Department of Transportation (TXDOT). The following reference must be reviewed in conjunction with this manual:


4.3.2 **Location:**

4.3.2.1 **General Requirements:**

Water and wastewater mains shall be located so as to avoid or minimize the impact for future highway projects and improvements, to allow other utilities in the right-of-way, and to permit access to utility facilities for their maintenance with minimum interference to highway traffic.

4.3.2.2 **Transverse Installation:**

New water and wastewater mains crossing a highway shall be installed at approximately 90 degrees to the centerline of the highway, if possible.

4.3.2.3 **Longitudinal Installation:**

- Longitudinal installation, if allowed shall be located on uniform alignments to the right-of-way line to provide space for future highway construction and possible future utility installation.

- Water and wastewater mains on controlled access highways or freeways shall be located so as to permit maintenance crews access from frontage roads, nearby or adjacent roads and streets, trails along or near the right-of-way line without access from lanes or ramps. Mains shall not be located longitudinally in the center median or outer separation of control access highways or freeways.

- On highways with frontage roads, longitudinal main installations may be located between the frontage road and the right-of-way line. Mains shall not be placed or allowed to remain in the center median, outer separation or beneath any pavement, including shoulders.
4.3.3. **Material Type:**

All material type used for water and wastewater mains shall conform to applicable DWU standards as shown in §2.6 and 3.6 of this manual, as approved by TXDOT.

4.3.4 **Depth of Cover:**

The minimum depth of cover for water and wastewater mains shall conform to applicable DWU standards as shown in §2.4 and §3.4 of this manual, as approved by TXDOT.

4.3.5 **Encasement:**

4.3.5.1 **Water Main Crossing:**

All water mains crossing under paved highways within the limits of the right-of-way shall be placed in an encasement pipe, unless otherwise approved. The encasement may be omitted under center medians and outer separations that are more than 76 feet wide. Encasement under side road entrances may be omitted in consideration of traffic volume and condition of highway as approved by TXDOT.

4.3.5.2 **Wastewater Main Crossing:**

Pressurized wastewater mains crossing under paved highways within the limits of the right-of-way shall be placed in steel encasement pipe. Gravity wastewater mains not conforming to the minimum 30” cover or 18” below any pavement structure shall be encased in steel or concrete. The encasement may be omitted under center medians and outer separations that are more than 76 feet wide.

4.3.5.3 **Uncurbed Highway Crossing:**

For rural, uncurbed highway crossings, all borings shall extend beneath all travel lanes. Unless precluded by right-of-way limitations, the following are required for rural highway crossings:

- Thirty (30) feet from all freeway main lanes and other high-speed (exceeding 40 mph) the edge of pavement of high speed, high volume highways.

- Sixteen (16) feet for high-speed highways with current average daily traffic volume of 750 vehicles per day or fewer

- Sixteen (16) feet for ramps

- Ten (10) feet for low speed (40 miles or less) highways
4.3.5.4 Curbed Highway Crossing:

For curbed highway crossings, all borings shall extend beneath travel and parking lanes and extend beyond the back of curb, plus

- Thirty (30) feet from facilities with speed limits of 40 mph or greater

- Five (5) feet from facilities with speed limits of less than 40 mph, plus any additional width necessary to clear an existing sidewalk.

4.3.5.5 Appurtenances:

- Water valves, manhole and other appurtenances shall not be placed in the pavement or shoulder of highway.

- When feasible, fire hydrants and blow-off valves are to be located at the right-of-way line. Fire hydrants shall not be placed in the sidewalk or any closer than five feet from the back of the curb. Valve locations shall be placed so as not to interfere with the maintenance of the highway.

- The maximum inside diameter of the water manhole chimney shall not exceed 48 inches. The outside diameter of the manhole chimney at the ground level shall not exceed 36 inches. The manhole lid shall be installed flush with the ground, meet HS-20 loading and weigh at least 175 pounds.

- Manholes serving wastewater mains up to 12 inches shall have a maximum inside diameter of 48 inches. For mains larger than 12 inches, the manhole inside diameter may be increased an equal amount, up to a diameter of 60 inches. Manholes for large interceptor mains shall be designed to keep the overall dimensions to a minimum. The outside diameter of the manhole chimney at the ground level shall not exceed 36 inches.

- Individual service meter shall be placed outside the limit of right-of-way. Master meters for a point of services connection may be placed as approved by TXDOT.

4.3.5.6 Permit

- All applicable permits should be obtained by the designer prior to any construction. All permit information must be shown on design plans as show in DWU Standard Drafting Manual, Latest edition.

- Any variance to criteria set forth in 43 TAC §21 must be preapproved by TXDOT and other jurisdictions as necessary prior to any construction.
4.3.5.7 Construction

While entry (bore) and exit (receiving) pits are not generally designated on the plans the designer must consider the location, size and depth of these when he/she chooses the beginning and ending stations for borings. Location of the entry pit is preferred at the lower elevation end of the tunnel when there is a slope. This will allow any groundwater or any boring slurry to flow by gravity from the tunnel into the entry pit where it can be pumped out during construction. Entry and exit pits must be located beyond the limits of paving.
4.4 RAILROAD ACCESS CRITERIA

4.4.1 Authority:

The design and construction of water and wastewater mains within a railroad right-of-way must be in compliance applicable DWU standards and required criteria or variance as approved by appropriate railroad authority. Railroad crossings are generally unique for each railroad company. The challenge is determining which railroad company right-of-way is being crossed because of the continual merger of railroads. It is important that the designer determine which railroad company right-of-way is being crossed and obtain their utility accommodation policies prior to beginning the design. The following references, as applicable, must be reviewed in conjunction with this manual:

- American Railway Engineering & Maintenance Association (AREMA), Latest edition

4.4.2 Location:

Water and wastewater mains shall be located so as to avoid or minimize the need for future railroad projects and improvements, to allow other utilities in the right-of-way and to permit access to utility facilities for their maintenance with minimum interference to railroad service.

4.4.2.1 Transverse Crossing:

New mains crossing the railroad shall be installed at approximately 90 degrees to the centerline of the railroad, if possible.

4.4.2.2 Longitudinal Crossing:

- Longitudinal installation, if allowed shall be located on uniform alignments to the right-of-way line to provide space for future railroad construction and possible future utility installation.

- All new mains shall be located on top of back slope at the outer limits of railroad property.
• If main is located forty (40) feet or less from centerline of track, the mains shall be encased in a steel pipe as approved by the railroad authority under jurisdiction. No pipe may be placed closer than twenty-five (25) feet from the centerline of the track.

4.4.3 Material Type:

All materials used for water and wastewater mains shall conform to applicable DWU standards as shown in §2.6 and 3.6 of this manual, as approved by railroad authority under jurisdiction.

4.4.4 Depth of Cover:

The minimum depth of cover for water and wastewater mains shall conform to applicable DWU standards as shown in §2.4 and §3.4 of this manual, as approved by railroad authority under jurisdiction.

4.4.5 Encasement:

4.4.5.1 General Requirements:

• All mains crossing under railway track shall be placed in an encasement pipe, unless otherwise approved by railroad authority.

• Casing pipe and joints shall be made of metal capable of withstanding the railroad loadings and other loads superimposed upon them.

4.4.5.2 Variances:

In circumstances where it is not feasible to install encasement from right-of-way line to right-of-way, casing pipe under railroad track and across railroad property shall extend to greater of the following distances, measured at the right angles to the centerline of the track:

• Two (2) feet beyond toe of slope

• Three (3) feet beyond ditch line.

• Twenty-five (25) feet from centerline of outside track when casing is sealed at both ends

• Forty-five (45) feet from centerline of outside track when casing is open at both ends.

• If additional track is planned for future construction, casing must be extended far enough to meet above distances given the additional track requirement.
4.4.6 Appurtenances:

Due to difficulty in maintenance, all new water and wastewater manholes, valves and other appurtenances shall be located outside the railroad property when possible. No appurtenance shall be located in the shoulder, shoulder slope, ditch or backslope or within 25 feet of the centerline of track, and shall not protrude above surrounding ground without approval from railroad authority.

4.4.7 Permit:

- All applicable permits should be obtained by the designer prior to any construction.

- Any variance to above criteria and or applicable railroad policy must be preapproved by railroad authority under jurisdiction prior to any construction.

4.4.8 Construction:

While entry (boring) and exit (receiving) pits are not generally designated on the plans the designer should consider the location, size and depth of these when he chooses the beginning and ending stations for pits. Location of the entry pit is preferred at the lower elevation end of the tunnel when there is a slope. This will allow any groundwater or any boring slurry to flow by gravity from the tunnel into the bore pit where it can be pumped out during construction. Entry and exit pits must be located beyond the limits of railroad tracks.
4.5 **CREEK CROSSING**

Following items must be considered for a water or wastewater main crossing under a flowing stream or semi-permanent body of water such as a marsh or pond:

### 4.5.1 Material and Appurtenances:

- A watertight encasement pipe with a manhole on each side of the crossing should be used for wastewater mains.

- Watertight encasement pipe for water main with a valve on each side of the crossing should be used.

### 4.5.2 Erosion Control:

- Proper erosion control must be incorporated in the design. As a minimum, cement stabilized backfill shall be used from bank to bank. The cement stabilized backfill shall be covered with riprap if the velocity of the flowing water is anticipated to be greater than ten (10) feet per second.

- In areas where there is a planned channel improvement, the stabilized backfill shall be used up to the line of planned improvement. The area above this planned line of improvement shall be compacted fill. In addition, the main must be designed with a minimum clearance from the top of the pipe to the bottom of the channel of four (4) feet.

### 4.5.3 Reference Schematic

DWU Standard Drawing No. 102: Stabilized Backfill and Rip-Rap Detail for Embankment Slope Protection.
4.6 ELEVATED CROSSING

4.6.1 General Option:

- Bridge Attachment: Pipeline to be attached to an exiting or proposed roadway bridge.
- Utility Bridge: Bridge constructed to support pipeline.

4.6.2 Design Considerations:

- Provisions must be made for thrust restraints at the points of transition from a buried pipe to an exposed pipe.
- Water main must be fully restrained at changes in alignment and at fittings, as necessary.
- Wastewater mains shall be fully restrained across aerial section with manholes at each end.
- The designer must evaluate the increased loading on the bridge created by a full main and its supports.
- Access to the main must be considered.
- Provisions for corrosion control must be considered.
- PVC pipe shall not be used for the exposed portion of the main.
- The designer must consider freeze potential for small, low flow, mains.
- As a minimum, each joint of pipe will have two supports with one support near the bell. The pipe supports shall be constructed of either stainless or galvanized steel.
- Air relief provisions shall be considered at the high points.
- A minimum of one expansion joint shall be designed which shall coincide with an expansion joint on the bridge unless push-on ductile iron pipe is used.
- The force of the flow of the stream during flooding shall be considered.
4.7 **Pipe Encasement:**

Water/wastewater main shall be considered for encasement under following condition:

- Highway/railroad crossing
- Water/wastewater main crossing
- Creek/water body crossing
- As required by the design

4.7.1 **General Consideration:**

- **Location of Excavation Pits:** The location, size and depth of the boring pits shall be evaluated during design. Location of the entry pit is preferred at the lower elevation end of the tunnel when there is a slope. This will allow any groundwater or any boring slurry to flow by gravity from the tunnel into the bore pit where it can be pumped out during construction.

- **Size of Encasement Pipe:** The minimum of size of encasement pipe shall be at least two (2) to three (3) standard pipe sizes larger than the carrier pipe.

- **Loading:** Encasement pipe and joints shall be designed to withstand the imposed loading.

- **Annular Space:** The annular space between the encasement and carrier pipe shall be filled by slurry grout or other materials as approved by DWU.

- **Corrosion Protection:** Encasement pipe shall be protected against corrosion. Where both carrier pipe and casing pipe are metallic, they shall be separated electrically by using insulated spacers.

- **Reference Schematics:** DWU Standard Drawing No. 101-109A.

4.7.2 **Encasement Materials:**

Following encasement materials can be used as approved by the appropriate authority under jurisdiction:

4.7.2.1 **PVC Casing Pipe:**

4.7.2.1.1 **Applicability:**

- Water/wastewater main crossing with carrier pipe 12” or smaller within DWU R.O.W. or easement
- Other applications as approved by DWU
4.7.2.1.2 Minimum Specifications:

- Pressure rated PVC C900 or C905 with minimum pressure rating 150 psi

4.7.2.2 Reinforced Concrete Casing Pipe:

4.7.2.2.1 Applicability:

- Water/wastewater main crossing
- Open cut application or shorter length (<20 LF)
- Other applications as approved by DWU

4.7.2.2.2 Minimum Specifications:

- Reinforced Concrete Pipe C76, Class IV

4.7.2.3 Ductile Iron Casing Pipe:

4.7.2.3.1 Applicability:

- Water/wastewater main crossing
- Open cut application or shorter length (<20 LF)
- Other applications as approved DWU

4.7.2.3.2 Minimum Specifications:

- Ductile Iron Pipe, ANSI/AWWA A21.50, Class 51
- The pipe shall be connected with mechanical type joint

4.7.2.4 Steel Casing Pipe:

4.7.2.4.1 Applicability:

- Highway/Railroad crossing
- Large utility or structure crossing
- Creek/Water Body Crossing
- Water/wastewater main crossing
- Other applications as approved DWU

4.7.2.4.2 Minimum Specifications:

Designer shall be responsible for determining the minimum wall thickness of steel encasement pipe as required for any specific application with following minimum conditions:

- Steel pipe with minimum yield strength of 35,000 psi
Minimum thicknesses of steel encasement pipe for different diameters are shown under Table 4.7.2.4.2, which must be verified by the designer. These wall thicknesses shall be increased by at least 0.063 inch for uncoated casing and by at least 0.063 inch for coated or uncoated steel casing to be installed by jacking or boring.

Table 4.7.2.4.2: Minimum Thickness of Steel Encasement Pipe*

<table>
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<tr>
<th>Encasement Pipe I.D. (in)</th>
<th>DWU* Minimum Thickness (Coated) (in)</th>
<th>DART** Minimum Thickness (Coated) (in)</th>
<th>BNSF Railroad*** Minimum Thickness For E-80 Loading (in)</th>
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<td>0.25 0.344 0.438</td>
<td></td>
<td>0.250</td>
</tr>
<tr>
<td>18</td>
<td>0.25 0.344 0.438</td>
<td></td>
<td>0.281</td>
</tr>
<tr>
<td>20</td>
<td>0.25 0.344 0.438</td>
<td></td>
<td>0.281</td>
</tr>
<tr>
<td>21</td>
<td>0.312 0.312 0.438 0.562</td>
<td>Coated</td>
<td>0.312</td>
</tr>
<tr>
<td>22</td>
<td>0.25 0.438 0.562</td>
<td>Non-Coated</td>
<td>0.406</td>
</tr>
<tr>
<td>24</td>
<td>0.375 0.25 0.438 0.562</td>
<td></td>
<td>0.344</td>
</tr>
<tr>
<td>27</td>
<td>0.438 0.25 0.562</td>
<td></td>
<td>0.438</td>
</tr>
<tr>
<td>28</td>
<td>0.25 0.438 0.562</td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>30</td>
<td>0.438 0.25 0.562</td>
<td></td>
<td>0.406</td>
</tr>
<tr>
<td>32</td>
<td>0.438 0.562</td>
<td></td>
<td>0.438</td>
</tr>
<tr>
<td>34-36</td>
<td>0.50</td>
<td></td>
<td>0.469</td>
</tr>
<tr>
<td>38-42</td>
<td>0.50</td>
<td></td>
<td>0.500</td>
</tr>
<tr>
<td>44</td>
<td>0.500</td>
<td></td>
<td>0.531</td>
</tr>
<tr>
<td>46</td>
<td>0.625</td>
<td></td>
<td>0.531</td>
</tr>
<tr>
<td>48</td>
<td>0.625</td>
<td></td>
<td>0.563</td>
</tr>
<tr>
<td>50</td>
<td>0.625</td>
<td></td>
<td>0.594</td>
</tr>
<tr>
<td>52</td>
<td>0.750</td>
<td></td>
<td>0.625</td>
</tr>
<tr>
<td>54</td>
<td>0.750</td>
<td></td>
<td>0.656</td>
</tr>
<tr>
<td>56-58</td>
<td>0.813</td>
<td></td>
<td>0.688</td>
</tr>
<tr>
<td>60</td>
<td>0.813</td>
<td></td>
<td>0.719</td>
</tr>
<tr>
<td>62</td>
<td>0.750</td>
<td></td>
<td>0.719</td>
</tr>
<tr>
<td>64</td>
<td>0.844</td>
<td></td>
<td>0.813</td>
</tr>
</tbody>
</table>

* Minimum thickness as acceptable by DWU must be verified by designer for any specific application
*** Minimum thickness as per Utility Accommodation Policy by Burlington Northern Santa Fe (BNSF), May 5, 2007. Latest updates must be verified.
4.7.2.5 Liner Plate:

4.7.2.5.1 Applicability:

- Highway crossing/railroad crossing
- Large utility or structure crossing
- Water/wastewater main crossing with minimum casing size of 48 inch
- 2-flange liner plate typically applicable for construction by hand mining
- 4-flange liner plate typically applicable for construction by mechanical means including Tunnel Boring Machine (TBM).
- Other applications as approved by DWU

4.7.2.5.2 Design Criteria:

All liner plate must be designed in accordance with AASHTO Design Specifications for Tunnel Liner Plates, Section 15, Latest Edition:

- Seam/Joint Strength: The seam/joint strength of liner plates must be sufficient to withstand the thrust developed from the total load supported by the liner plate.

- Installation Stiffness: The liner plate ring shall have enough rigidity to resist the unbalanced loads of normal construction including grouting pressure, local slough-ins, and miscellaneous construction loads.

- Critical Bucking: The wall bucking of the liner plate shall not exceed the critical bucking.

- Deflection: Deflection of a tunnel depends significantly on the over-excavation of the bore and is affected by delay in backpacking or inadequate backpacking. Where the tunnel clearances are important, the designer should oversize the structure to provide for a normal deflection.

- Safety Factors: Minimum allowable factors of safety for liner plate design are as follows:

  "Table 4.7.2.5.2.1: Factor of Safety for Liner Plate Design"

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Factor of Safety (AASHO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seam/Joint Strength</td>
<td>3</td>
</tr>
<tr>
<td>Installation Stiffness</td>
<td>3</td>
</tr>
<tr>
<td>Critical Bucking</td>
<td>2</td>
</tr>
<tr>
<td>Allowable Deflection</td>
<td>3%</td>
</tr>
</tbody>
</table>

- Minimum thicknesses of tunnel liner plate for different diameters are shown under "Table 4.7.2.5.2.2", which must be verified by the designer for any specification application. Steel tunnel liner plates shall be of heavier gage or
thickness or protected by coatings or other means when required for resistance to abrasion or corrosion.

Table 4.7.2.5.2.2: Minimum Thickness of Liner Plates*

<table>
<thead>
<tr>
<th>Nominal Diameter (in)</th>
<th>Inside Diameter (in)</th>
<th>Thickness (Gauge)</th>
<th>Inside Diameter (in)</th>
<th>Thickness (Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2- Flanged Liner Plate</td>
<td>Bury Depth: 8’-16’</td>
<td>4- Flanged Liner Plate</td>
<td>Bury Depth: 8’-16’</td>
</tr>
<tr>
<td>48</td>
<td>45.25</td>
<td>14</td>
<td>43.00</td>
<td>12</td>
</tr>
<tr>
<td>54</td>
<td>51.25</td>
<td>14</td>
<td>49.00</td>
<td>12</td>
</tr>
<tr>
<td>60</td>
<td>57.25</td>
<td>14</td>
<td>55.00</td>
<td>11</td>
</tr>
<tr>
<td>66</td>
<td>63.25</td>
<td>12</td>
<td>61.00</td>
<td>10</td>
</tr>
<tr>
<td>72</td>
<td>69.25</td>
<td>12</td>
<td>67.00</td>
<td>8</td>
</tr>
<tr>
<td>78</td>
<td>75.25</td>
<td>12</td>
<td>73.00</td>
<td>8</td>
</tr>
<tr>
<td>84</td>
<td>81.25</td>
<td>12</td>
<td>79.00</td>
<td>5</td>
</tr>
<tr>
<td>90</td>
<td>87.25</td>
<td>12</td>
<td>85.00</td>
<td>3</td>
</tr>
<tr>
<td>96</td>
<td>93.25</td>
<td>10</td>
<td>91.00</td>
<td>3</td>
</tr>
<tr>
<td>102</td>
<td>99.25</td>
<td>10</td>
<td>97.00</td>
<td>3/8”</td>
</tr>
<tr>
<td>108</td>
<td>105.25</td>
<td>10</td>
<td>103.00</td>
<td>3/8”</td>
</tr>
<tr>
<td>114</td>
<td>111.25</td>
<td>8</td>
<td>109.00</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>117.25</td>
<td>8</td>
<td>115.00</td>
<td></td>
</tr>
<tr>
<td>126</td>
<td>123.25</td>
<td>7</td>
<td>121.00</td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>129.25</td>
<td>5</td>
<td>127.00</td>
<td></td>
</tr>
<tr>
<td>138</td>
<td>135.25</td>
<td>5</td>
<td>133.00</td>
<td></td>
</tr>
<tr>
<td>144</td>
<td>141.25</td>
<td>3</td>
<td>139.00</td>
<td></td>
</tr>
</tbody>
</table>

*The information in the above table is based on the following assumptions: AASHTO Section 16: “Steel Tunnel Liner Plates”, H20 loading, soil friction angle of zero (0) and a bury depth range of 8 feet to 16 feet.
4.8 THRUST RESTRAINT

4.8.1 General Requirements

All pressurized water and wastewater mains shall be restrained against unbalanced thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.

4.8.2 Thrust Restraint System:

Any or a combination of the following thrust restraint systems are acceptable for DWU mains:

- Horizontal Thrust Block
- Vertical Thrust Block/ Anchor Block
- Joint Restraint System

4.8.3 Horizontal Thrust Block:

4.8.3.1 Applicability:

Horizontal thrust block shall be designed to transfer horizontal thrust force to larger bearing area, as needed.

4.8.3.2 Design Consideration:

4.8.3.2.1 Design Pressure (P):

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most applications.

4.8.3.2.2 Thrust Force (T):

Unbalanced thrust force occurs at the following configurations shall be restraint as needed (Figure 4.8.3.2.2):

- Bend
- Wye
- Deadend
- Bifurcation
- Tee
- Reducer
- Closed Valve
Figure 4.8.3.2.2: Unbalanced Thrust Force at Various Configurations

Where, $T =$ Hydrostatic Thrust (lb)  
$A =$ Cross-Sectional Area of Pipe (in$^2$)  
$P =$ Internal Pressure (psi)  
$\Delta =$ Deflection Angle (degree)

4.8.3.2.3 Bearing Area ($A_b$):

Thrust bearing area can be calculated as follows:

$$A_b = \frac{S_f T}{S_b}$$

Where,

- $A_b$ = Bearing Area
- $S_f$ = Factor of Safety, Typically 1.5
- $S_b$ = Horizontal Bearing Strength
- $T$ = Hydrostatic Thrust

Figure 4.8.3.2.3: Horizontal Thrust Bearing Area


In absence of actual Horizontal Bearing Strength, Table 4.8.3.2.3 can be used to estimate bearing strength:

**Table 4.8.3.2.3**

<table>
<thead>
<tr>
<th>Soil</th>
<th>Bearing Strength (lb/ft^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muck</td>
<td>0</td>
</tr>
<tr>
<td>Soft Clay</td>
<td>1,000</td>
</tr>
<tr>
<td>Silt</td>
<td>1,500</td>
</tr>
<tr>
<td>Sandy Silt</td>
<td>3,000</td>
</tr>
<tr>
<td>Sand</td>
<td>4,000</td>
</tr>
<tr>
<td>Sandy Clay</td>
<td>6,000</td>
</tr>
<tr>
<td>Hard Clay</td>
<td>9,000</td>
</tr>
</tbody>
</table>

4.8.3.2.4 Block Dimension:

- Block dimension shall be determined based on the required bearing area with following criteria:

\[ b = \frac{A_b}{h} \]

Where,
- \( A_b \) = Bearing Area
- \( b \) = Block Width
- \( h \) = Block Height

- Block height (h) shall be equal to or less than one-half the total depth to the bottom of the block, \((H_t)\), but not less than the pipe diameter (D).

  - \( h \leq 0.5 \ H_t \)
  - \( h > D \)

- Block height (h) should be chosen such that the calculated block width (b) varies between one and two times the height.

  - \( h = b \sim 2b \)

4.8.3.3 Installation:

- Bearing surface shall be placed against undisturbed soil extending beyond joints. If not, the fill between the bearing surface and undisturbed soil must be compacted to at least 90% Standard Proctor density.

- Thrust block shall not be used in swamps or marshes.

- Horizontal thrust block may not be practical for large water main due to size restriction.

4.8.3.4 Reference Schematics:

For general application see DWU Standard Drawing Nos. 229-232.
4.8.4 **Vertical Thrust Block/Anchor Block:**

4.8.4.1 **Applicability:**

Vertical thrust block shall be designed to counter vertical thrust force by weight and to transfer horizontal thrust force to larger bearing area, as needed.

4.8.4.2 **Design Consideration:**

4.8.4.2.1 **Design Pressure (P):**

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most application.

4.8.4.2.2 **Thrust Force (T)**

Unbalanced thrust force occurs at the configuration shown in **Figure 4.8.4.2.2:**

![Vertical Thrust Block](image)

**Figure 4.8.4.2.2 Vertical Thrust Block**

Horizontal Hydrostatic Thrust, \( T_y = PA \sin \Delta \)

Horizontal Hydrostatic Thrust, \( T_x = PA \sin \Delta \)

Where,

- \( P \) = Internal Pressure (psi)
- \( A \) = Bearing Area
- \( \Delta \) = Deflection Angle (degree)
4.8.4.2.3 Volume of Vertical Thrust Block (V)

Vertical thrust block shall be designed to provide equilibrium by the weight of the block.

Required Volume, V

\[ V = \frac{S_f T_y}{W_m} \]

\[ = \frac{S_f P A \sin \Delta}{W_m} \]

Where,

- \( S_f \) = Factor of Safety, Typically 1.5
- \( T_y \) = Vertical Component of Thrust
- \( S_b \) = Horizontal Bearing Strength
- \( W_m \) = Density of Block Material

4.8.4.3 Reference Schematics:

For general application see DWU Standard Drawing No. 233

4.8.5 Restraint Pipe Joint:

4.8.5.1 Applicability:

Restraint Pipe Joint shall be designed to transfer horizontal and vertical thrust force, as needed.

4.8.5.2 Design Consideration:

The design pressure for horizontal thrust restraint system shall be the maximum anticipated water pressure. Hydrostatic test pressure can be used as the thrust restrained design pressure for most application.

4.8.5.3 Reference:

The following technical references shall be used for calculating thrust restraint system, as required

- AWWA M9: Concrete Pressure Pipe by AWWA, Latest Edition
4.9 TRENCHLESS TECHNOLOGY

4.9.1 General Requirements:

The deterioration of DWU underground water and wastewater infrastructure systems and a growing demand for new utility services within the congested urban areas have increased the necessity for trenchless technology. These technologies shall be considered in order to minimize the disturbance of the environment, traffic, congested living or working areas while utilizing more efficient methods of installation, inspection, repair, rehabilitation, and replacement of underground utilities.

4.9.2 Technical References:

The following references, as applicable, may be reviewed in conjunction with this manual:


4.9.3 Selection Criteria:

The following items, but limited to, shall be considered prior to selecting any specific trenchless technology:

- Pipe size, shape, depth and alignment
  - Potential environmental, social and traffic impact
  - Existing flow and bypass pumping, if necessary
  - Bore pit locations, if necessary

4.9.4 Acceptable Trenchless Technologies:

Most commonly acceptable Trenchless Technologies utilized by DWU are summarized in Figure 4.9.4. These technologies are primarily divided into two major categories as Trenchless Construction Methods (TCM) and Trenchless Rehabilitation Methods (TRM). TCM can be used for new utility installation where TRM is used for renewing, rehabilitating, and/or renovating an existing utility main. Other technologies may be used on case-by-case basis upon approval by DWU:
Figure 4.9.4: DWU Acceptable Trenchless Technologies
4.9.5 Utility Tunneling (UT):

4.9.5.1 General Description:

The Utility Tunneling (UT) involves manual excavation or use of self-propelled tunnel-boring machine (TBM) to install a pipe supported by a segmental liner from a drive shaft to a reception shaft. Manual access to the tunnel face is generally necessary.

4.9.5.2 Applicability:

<table>
<thead>
<tr>
<th>Table 4.9.5.2: Utility Tunneling (UT) Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items</strong></td>
</tr>
<tr>
<td>Typical Application</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Encasement Size</td>
</tr>
<tr>
<td>Encasement Material</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
</tr>
<tr>
<td>Maximum Installation</td>
</tr>
<tr>
<td>Special Consideration</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*Rib & lagging to be used for wastewater main with prior approval
4.9.6 Pipe Jacking (PJ):

4.9.6.1 General Description:

The pipe jacking involves the use of a jacking system to install a prefabricated pipe through the ground from a drive shaft to a reception shaft. This process involves workers to be inside the pipe during the jacking operation.

4.9.6.2 Applicability:

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Water Main</td>
</tr>
<tr>
<td></td>
<td>Wastewater Main- Gravity &amp; Pressure</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>Not Used</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>42” or Larger</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>RCP, Steel</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>1500 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- Suitable for almost all types of soil</td>
</tr>
<tr>
<td></td>
<td>- Requires worker entry</td>
</tr>
<tr>
<td></td>
<td>- Directional changes only possible at the shafts.</td>
</tr>
</tbody>
</table>
4.9.7 Pipe Ramming (PR)

4.9.7.1 General Description:

Pipe ramming utilizes pneumatic tool to hammer a pipe or casing into the ground while the excess soil from the borehole is removed to the surface. The method is most valuable for installing larger pipes over shorter distances and for installations at shallower depths. Pipe ramming can be combined with directional drilling and used to free the product pipe during pullback.

4.9.7.2 Applicability:

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Water Main</td>
</tr>
<tr>
<td></td>
<td>Wastewater Main- Pressure</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>N/A</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>4- 60”</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>Concrete, Steel, DI</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>200’- 400’</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- Not suitable for gravity application or pipeline with grade</td>
</tr>
<tr>
<td></td>
<td>- High Noise level, ground vibration, surface disruptions</td>
</tr>
</tbody>
</table>

Table 4.9.7.2: Pipe Ramming (PR) Criteria
4.9.8  Impact Moling (IM)

4.9.8.1 General Description:

Impact Moling (IM), also known in the field as Missiling, utilizes percussion or hammering action of a pneumatic piercing tool to create bore hole by compacting and displacing soil rather than removing it. Non-steerable moles are the more commonly used. Typically, non-steerable moles are intended for straight bores and steerable moles are intended for inclined or curved bores. This method is most valuable for installing smaller water main or water service over shorter distances and for installations at shallower depths.

4.9.8.2 Applicability:

Table 4.9.7.2: Pipe Ramming (PR) Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Small Water Main</td>
</tr>
<tr>
<td></td>
<td>Water Service Lateral</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>N/A</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>3/8” - 6”</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>PVC, Steel, Copper</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>Non-Steerable Mole: 35 LF</td>
</tr>
<tr>
<td></td>
<td>Steerable Mole: 200 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- May cause surface damage for too shallow installation</td>
</tr>
<tr>
<td></td>
<td>- Most conservative depth for installation of a pipe is 4 feet or 10 times diameter of the pipe</td>
</tr>
<tr>
<td></td>
<td>- High Noise level, ground vibration, surface disruptions</td>
</tr>
</tbody>
</table>
4.9.9 **Horizontal Earth Boring (HEB):**

Horizontal Earth Boring (HEB) involves borehole excavation for pipe installation by utilizing mechanical means without workers being inside the borehole. The DWU acceptable HEB methods include Horizontal Auger Boring (HAB), Microtunneling (MT) and Horizontal Direction Drilling (HDD).

4.9.9.1 **Horizontal Auger Boring (HAB):**

4.9.9.1.1 **General Description:**

The Horizontal Auger Boring (HAB) method involves simultaneous pushing of a steel casing from a drive pit through the earth while removing the spoil inside the casing by rotating flight auger.

4.9.9.1.2 **Applicability:**

**Table: 4.9.9.1.2:**

**Horizontal Auger Boring (HAB) Criteria**

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Water Main</td>
</tr>
<tr>
<td></td>
<td>Wastewater Main - Gravity &amp; Pressure</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>4” - 60”</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>Steel</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>2” - 48”</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>PVC, RCP, Steel, RTRP, RPMP, HDPE</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>600 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- Does not require worker entry</td>
</tr>
<tr>
<td></td>
<td>- May require dewatering under water table</td>
</tr>
</tbody>
</table>
4.9.9.2 Horizontal Direction Drilling (HDD):

4.9.9.2.1 General Description

Horizontal Directional Drilling (HDD) is a steerable method for the installation of pressure pipe in a shallow arc with a surface-launched drilling rig. This method involves simultaneously drilling a fluid-lubricated pilot hole and enlarging the pilot hole with back reamers to accommodate and pull a utility main.

4.9.9.2.2 Applicability:

Table 4.9.9.2.2: Horizontal Direction Drilling (HDD) Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Wastewater Main- Pressure</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>Not Used</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>2”- 48”</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>PVC- Fusible/Certa-Lok, HDPE, Steel, DI</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>600- 6000 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- May cause significant ground movement especially for shallow ground cover.</td>
</tr>
<tr>
<td></td>
<td>- Disposal of drilling fluid may be required</td>
</tr>
<tr>
<td></td>
<td>- May cause community problem due to surfacing of drilling fluid known as “Frack Outs”</td>
</tr>
</tbody>
</table>
4.9.9.3 Microtunneling (MT)

4.9.9.3.1 Genera Description

Microtunneling (MT) is a precise remotely controlled method of jacking pipe behind a Microtunnel Boring Machine (MTBM), where the earth is continuously supported at the face.

4.9.9.3.2 Applicability:

Table 4.9.9.3.2: Microtunneling Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Wastewater Main- Gravity</td>
</tr>
<tr>
<td>Encasement Size</td>
<td>10-136”</td>
</tr>
<tr>
<td>Encasement Material</td>
<td>N/A</td>
</tr>
<tr>
<td>Carrier Pipe Size</td>
<td>4”-108”</td>
</tr>
<tr>
<td>Carrier Pipe Material</td>
<td>RCP, Steel, DI, RTRP, RPMP</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>600 LF</td>
</tr>
<tr>
<td>Special Considerations:</td>
<td>- Does not require worker entry</td>
</tr>
</tbody>
</table>
4.9.10  Pipe Bursting (PB):

4.9.10.1 General Descriptions

Pipe bursting is a method by which the existing pipe is forced outward and opened by a bursting tool. During the pipe bursting process, the rehabilitated pipe segment must be taken out of service by rerouting flows around it. After the pipe bursting is completed, laterals are to be re-connected with robotic cutting devices or other approved methods, as needed.

4.9.10.2 Applicability:

Table 4.9.10.2:
Pipe Bursting (PB) Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Wastewater Main- Gravity/Pressure</td>
</tr>
<tr>
<td>Host Pipe Size</td>
<td>4”- 48”</td>
</tr>
<tr>
<td>Host Pipe Material</td>
<td>PVC, Clay, DI, RTRP*, RPMP**</td>
</tr>
<tr>
<td>New Pipe Size</td>
<td>4”-48”</td>
</tr>
<tr>
<td>New Material</td>
<td>HDPE</td>
</tr>
<tr>
<td>Maximum Installation</td>
<td>750 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- Upsize allowable up to 1.5 times of the diameter of the host pipe</td>
</tr>
<tr>
<td></td>
<td>- Bypass or diversion of flow required</td>
</tr>
<tr>
<td></td>
<td>- Insertion pit required</td>
</tr>
<tr>
<td></td>
<td>- Percussive action can cause significant ground movement</td>
</tr>
<tr>
<td></td>
<td>- Point repair may be required</td>
</tr>
</tbody>
</table>

* RTRP denotes Reinforced Thermosetting Resin Pipe
** RPMP denotes Reinforced Polymer Mortar Pipe
4.9.11 Slip Lining (SL)

4.9.11.1 General Description:

The Slip Lining (SL) process involves insertion of a new liner of smaller diameter inside the existing pipe and grouting the annular space to provide structural integrity. After the slip lining is completed, laterals to be re-connected by excavation or by a remote-cutter, as possible. SL by the segment method can be accomplished without rerouting the existing flow.

4.9.11.2 Applicability:

Table 4.9.11.2:
Slip Lining (SL) Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
</table>
| **Typical Application**      | Water
|                              | Wastewater Main- Pressure/Gravity                         |
| **Host Pipe Size**           | 4”- 144”                                                  |
| **Host Pipe Material**       | PVC, Clay, DI, RCP, CI                                    |
| **Liner Pipe Size- Segmental** | 24”-144”                                                 |
| **Liner Pipe Size- Continuous** | 4”- 60”                                                  |
| **Liner Material***          | Water: Fusible PVC                                        |
|                              | Wastewater: HDPE, RTRP, RPMP                              |
| **Maximum Installation**     | 1500 LF                                                   |
| **Special Considerations**   | - Reduce pipe size                                        |
|                              | - Insertion pit required                                  |
|                              | - Not well suited for small diameter pipes                |
|                              | - Point repair may be required                            |

*Reference: ASTM F585: Practice for Insertion of Flexible Polyethylene pipe into Existing Sewers
4.9.12 Cured-In-Place Pipe (CIPP):

4.9.12.1 General Description:

Cured-In-Place Pipe (CIPP) process involves the insertion of a thermosetting resin coated flexible fabric liner into the existing pipeline and cured by hot water, steam or UV light to form a new liner. The liner is typically inserted into the existing pipe through an existing manhole.

4.9.12.2 Applicability:

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Wastewater Main- Pressure/Gravity</td>
</tr>
<tr>
<td>Host Pipe Size</td>
<td>8” - 120”</td>
</tr>
<tr>
<td>Host Pipe Material</td>
<td>PVC, Clay, DI</td>
</tr>
<tr>
<td>Liner Pipe Size- Inverted</td>
<td>8”-108”</td>
</tr>
<tr>
<td>Liner Pipe Size- Winched</td>
<td>8”- 100”</td>
</tr>
<tr>
<td>Liner Material</td>
<td>Thermoset Rasin/ Fiber Composite</td>
</tr>
<tr>
<td>*ASTM D5813, Specify Class I,II or III</td>
<td></td>
</tr>
<tr>
<td>Max. Installation- Inverted</td>
<td>3000 LF</td>
</tr>
<tr>
<td>Max. Installation- Winched</td>
<td>1500 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>- Bypass or diversion of flow required</td>
</tr>
<tr>
<td></td>
<td>- Curing can be difficult for long pipe segments</td>
</tr>
<tr>
<td></td>
<td>- Must allow adequate curing time</td>
</tr>
<tr>
<td></td>
<td>- Resin may clump together on bottom of pipe</td>
</tr>
<tr>
<td></td>
<td>- Reduces pipe diameter</td>
</tr>
<tr>
<td></td>
<td>- Point repair may be required</td>
</tr>
</tbody>
</table>

*References:
ASTM F1216: Practice for Rehabilitation of Existing Pipeline s and Conduits by the Inversion and Curing of a Resin Impregnated Tube
ASTM F1743: Practice for Rehabilitation of Existing Pipeline s and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
ASTM F2019: Practice for Rehabilitation of Existing Pipeline s and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GPR) Cured-in-Place Thermosetting Resin Pipe (CIPP)
4.9.13 Fold & Form Pipe (F&FP):

4.9.13.1 General Description:

The Fold & Form Pipe process involve insertion of a folded liner into the existing pipe and expanding it through pressure, heat or mechanical means to restore its original circular shape. The annular space between the old pipe and the liner may require grouting, unless the old pipe and the new pipe fit closely together.

4.9.13.2 Applicability:

Table 4.9.13.2: Fold & Form (F&FP) Criteria

<table>
<thead>
<tr>
<th>Items</th>
<th>Acceptable Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Application</td>
<td>Wastewater Main- Pressure/Gravity</td>
</tr>
<tr>
<td>Host Pipe Size</td>
<td>8’ - 15”</td>
</tr>
<tr>
<td>Host Pipe Material</td>
<td>PVC, Clay, DI</td>
</tr>
<tr>
<td>Liner Pipe Size</td>
<td>&lt;15”</td>
</tr>
<tr>
<td>Liner Material*</td>
<td>PVC, HDPE</td>
</tr>
<tr>
<td>Max. Installation</td>
<td>350- 600 LF</td>
</tr>
<tr>
<td>Special Considerations</td>
<td>It was not used on line segments which had broken or collapsed</td>
</tr>
</tbody>
</table>

*References:
ASTM F1867: Practice for Installation of Folded/Formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F1871: Specification for Folded/formed Poly (Vinyl Chloride) (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation
ASTM F1947: Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)
APPENDIX A

FIELD NOTE GUIDELINES
The following guidelines are to be used and incorporated into the preparation of real property descriptions for fee title conveyances, rights of way, easements, lease agreements, abandonments, licenses, etc., either for or on behalf of the City of Dallas. Field notes will be subjected to a review process to insure substantial compliance with both the form and content outlined in these guidelines. Your cooperation is needed to assist the City of Dallas in preparing and processing the legal instruments to which these field note descriptions can be relied upon to provide certain relevant information in a reasonably standard format. Surveys and field note descriptions must meet all of the rules of the Texas Board of Professional Land Surveying, and fully comply with the Professional Land Surveying Practices Act. For the laws regarding land surveying and the preparation of field note descriptions, please refer to the publications of the Texas Board of Professional Land Surveying.

Field notes for the purposes of these guidelines are defined as a worded metes and bounds description of the results of an on the ground survey of real property. Field notes shall include sufficient information to identify the location, boundaries, monumentation, and area of the described tract, as well as its relationship to the parent tract out of which it was surveyed. Each field note description will be accompanied by a sketch or plat which graphically depicts the worded description.

Field notes submitted to the Survey Section for review shall be typed on plain 8½” x 11” white bond paper and shall include at least two sets bearing the original seal, date, and signature of the responsible surveyor. All originals are to be of high reproductive quality and legibility.

Each of the two sets of field note descriptions are to consist of the following three parts:
PART I - HEADING

This part shall appear on the top of each page and include the following information:

• The type of conveyance for which the tract is being described, i.e. drainage easement, street widening, corner clip, water easement, wastewater easement, covenant, abandonment, license agreement, ingress-egress, etc. Include proposed width and area.

• The official city block number affected or adjacent block numbers.

• The name of the effected roadway on right-of-way acquisition projects, creek, etc. if applicable.

PART 2 - GENERAL DESCRIPTION OR STATEMENT

This section provides information to generally identify and locate both the described tract and the parent tract, and shall include the following information:

• The Survey and Abstract number.

• The area described by the field notes. State the area in square feet where the total area is less than 1 acre and in acres otherwise.

• The subdivision name, lot and block designation, when applicable, citing the appropriate County (Dallas, Denton, Collin, Rockwall, Ellis, Tarrant) Records recording information. A legible copy of the recorded plat cited must be supplied with the field notes.

• Official City of Dallas Lot and Block numbers (sometimes different from Addition Plat lot and Block numbers).

• The current record owner’s name and the type of conveyance instrument, i.e. Warranty Deed, Quit Claim Deed, etc.. A Deed of Trust does not convey title, and therefore is not acceptable. A legible copy of the recorded instrument must be supplied with the field notes.

• The conveyance instrument recording information, (Deed Record, Volume and Page, cause Number, execution date, etc.).

• The city, county, and state where the described tract is located.

• All right of way abandonments must include reference information as to how the right of way was created, such as by deed with volume and page, date, or dedicated by Addition, with recording information.
PART 3 - BODY, PRINCIPLE, OR PARTICULAR DESCRIPTION

This part shall contain specific information identifying the boundary of the described tract. As a general rule, descriptions should be written with the calls proceeding in a clockwise direction from the point of beginning. The mathematical figure described must close with a precision of at least 1: 15,000. The following items should be clearly identified within this part of the description:

- The point of beginning, identifying the type and size of monument found or set, and it’s relationship to the parent tract, explaining which corner of the described tract it represents. As a general rule, the Point of Beginning shall be tied to a dedicated street intersection, or recorded Addition lot corner. All monuments set shall be iron rods capped with Surveyor’s Registration Number, or company name, where permissible.

- Points of reference or commencement, if applicable, identifying the types and size of monuments and their relationship to the point of beginning.

- Metes and bounds calls, stating bearings in degrees, minutes, and seconds, and distances in feet and hundredths of feet.

- Curved lines should be defined by their direction left or right, angle of intersection or central angle, radius, arc length, and chord bearing and distance. Non-tangent curves should be identified as such.

- References to adjoining properties (calls for adjoiners), right-of-ways (indicating width), natural or physical locative features, witness or reference monumentation, etc., which would help to identify or clarify the described boundaries.

- Reference discrepancies, noting when recorded measurements and field measurements differ.

- Clearly state the basis on which the bearings cited in the description were established. This shall include the bearing of an identifiable line (Cite I label the controlling monuments). Reference or cite the recording information of the instrument.

- Type and Volume and Page or any covenants, licenses, or easements the described tract is “SUBJECT TO”.

- Each page of multiple pages must be referenced to each other, with page number plus total number of pages included, i.e. Page 1 of 4.
SKETCH, PLAT, OR STRIP MAP

Field note descriptions shall be accompanied by a sketch or plat produced on plain 8 1/2”X 11” white bond paper bearing the seal, date, and signature of the responsible surveyor. All copies shall be of high reproductive quality and legibility. In an instance where the field note description represents a part of a larger plat or strip map, you will be requested to reproduce the appropriate portion of the larger plat or map. Sketches or plats shall show the following:

• All bearings and distances referred to in the field note description.
• Location of the point of beginning and any reference points.
• A legend which includes symbols for all monumentation found or set.
• The graphic scale, a reference to north, and the date of the survey.
• The name(s) of present owners of record of the described tract, showing the recording information cited in the field note description.
• Area of described tract.
• The relationship of the described tract to its parent tract, showing any appropriate lot and block designations, subdivision names, and recording information.
• Information to identify adjoining properties or locative features, including subdivision, lot and block designations, names of adjoining owners of record and volume and page references to instruments defining adjoining boundaries, including roadways (widths) or prominent natural features.
• A notation describing the basis of bearings. This shall include the bearing of an identifiable line (Cite I label the controlling monuments). Reference or cite the recording information of the instrument.
• Each page of multiple pages must be referenced to each other, with page number plus total number of pages included, i.e. Page 1 of 4.
• Reference discrepancies, i.e. measured bearings and distances vs. recorded bearings and distances.
• Easements shall be shown and identified by width, use and ownership, where applicable.
Locator Map

Locator maps are used for Council Agenda items. It is drawn on plain 8 1/2” x 11” bond paper - not necessarily to scale - which generally indicates the subject parcel boundaries and including readily recognized streets. The effected parcel shall be cross hatched. No company letter heads or logos please. A legend shall denote the purpose of the cross hatched area, i.e. Area to be acquired for Street Widening; Area to be acquired for Drainage Easement; etc. As the locator map will not be filed for record, it will not be necessary to number this page.

Describing Easements

Easements will be prepared by metes and bounds, unless prior approval is granted to use another method of description. Descriptions for easements will be subject to the same guidelines as for fee title or right of way conveyances, with the exception that it will generally not be required to monument all easement corners, as long as sufficient monumentation is provided. However, there may be exceptions and situations where all of the easement corners must be monumented as determined by the City of Dallas. All metes and bounds descriptions prepared for easements shall be tied to physical monuments of record related to the boundary of the affected tract.

Temporary Work Spaces

Temporary work spaces will require a metes and bounds description, when a temporary work space is prepared to accompany and adjoin a permanent easement. The guidelines for easements will be used for temporary work spaces.

The following checklist is provided for your convenience.

Field Note Checklist

For your help in field note submittal to the Survey Services Section of the Public Works and Transportation Department, have you included the following where applicable:

Two (2) sets of signed, sealed and dated field notes of the R.P.L.S. who prepared description.

Part One (1) - Heading

______ Type of conveyance.

______ City lot and block number or adjacent block numbers.

______ Name of effected roadway, creek, project, etc.
**Part Two (2) - General Description or Statement**

_______ Area described by field notes (must be in square feet if less than 1 acre).
_______ Current record owners name.
_______ Type of conveyance instrument (Deed of Trust not acceptable).
_______ Copy of recorded instrument attached.
_______ Recording information - V & P. cause number, execution date, etc.
_______ Survey name, abstract number.

_______ Subdivision name, lot and block designation and county land records recording information. Copy of subdivision map must be supplied with recording information.

_______ Official City of Dallas lot and block numbers (sometimes different from Addition Plat numbers).

_______ City, County and State.

**Part Three (3) - Body, Principle, or Particular Description**

_______ Point of Commencing.

_______ Point of Beginning.

_______ Iron rods or monuments set or found noted (size, type, with plastic cap stamped R.P.L.S. # or company name.

_______ Basis of Bearing to an identifiable line.

_______ Curve data, direction left or right., tangent or non-tangent, with all significant elements.

_______ Adjoining properties - Any adjoining property calls must have recording information, with copies of recorded deeds attached.

_______ Any easements, covenants, licenses, etc., that tract is “Subject To” included in description and shown on sketch. Note: Recorded copies of instrument must be furnished.

_______ Seal, signature and date of R.P.L.S. who prepared description.

_______ Page Reference.
Part Four (4) - Sketch, Plat or Map

_____ Current ownership labeled as called in field notes.

_____ All bearings and distances as referred to in field notes, noting differences in record and measured.

_____ P.O.B. and/or P.O.C. shown.

_____ Ownership or Addition name of all adjoined properties called in field notes (Vol. & Pg.).

_____ Legend or symbols for monuments found or set.

_____ Graphic scale noted.

_____ North reference.

_____ Notation for basis of bearings (Vol. & Pg.) with controlling monuments, indicating size and type, shown.

_____ Area notation in square feet or acres of prepared description.

_____ Seal, signature and date of R.P.L.S. who prepared description.

_____ Page Reference

_____ Identify specific purpose areas shown on plat (detention area, escarpment area, floodway easement, park and common areas, etc.).

_____ Corporation (City Limits) and County Lines, where applicable.

_____ Easements - show and identify all easements with width, use and ownership (where applicable).

_____ All curve elements are shown, including central angle, radius, arc length, chord bearing and distance. Identify non-tangent curves.

Part Five (5) - Locator Map

_____ Recognizable streets.

_____ Effected parcel shaded or hatched.

_____ Legend
APPENDIX B

REQUIREMENTS FOR LAND SURVEYING
CITY OF DALLAS REQUIREMENTS FOR LAND SURVEYING.

Consultants wishing to provide Professional Land Surveying Services for City of Dallas projects will be governed by the following Scope of Services:

- All firms selected to provide Surveying services shall have as a full time employee a Registered Professional Land Surveyor holding a current license in the State of Texas.
- All Surveying services provided will be under the review and direction of the City of Dallas Public Works and Transportation Department, Survey Division and the Chief City Surveyor.
- Any contract requirement for determination of Boundary, Right-of-Way, Property, Lot, Tract or any other reference of ownership boundary determination is controlled by the Professional Land Surveying Practices Act of the State of Texas (“The Act”). All the requirements of the act with respect to records, historical and other research, field surveys and monumentation will be considered a professional responsibility of the survey provider.
- Records research in support of Right-of-Way or other boundary determination shall include all public records archives (County, State, private or other) as well as the records contained in the City of Dallas Public Works & Transportation Survey Records Vault.
- Boundary descriptions (“field notes”) prepared for City of Dallas projects shall follow the Field Note Guidelines published by Public Works & Transportation Survey Division (as revised June, 1996 and available from the office of the Chief City Surveyor.
- All submittals of Survey Drawings, Field Notes or other final deliverables for Boundary Surveys shall have the Seal and Signature of the surveyor of record affixed to the submittal. The City of Dallas will not review any documents submitted which are not final documents intended for filing.

- All topographic surveys shall be properly monumented as set forth in the Paving...
- Design Manual, with approved monument types set at the intervals and in the manner specified.
- Where a Survey Baseline is specified in the contract, the surveyor shall establish and monument the Survey Baseline in accordance with the requirements of the Paving Design Manual.
- Vertical Control for all projects shall be established using Best Practice techniques with automatic level and level rod and the City of Dallas Water Department Bench Mark network. Documentation of a closed bench mark field loop, to include at least two (2) City of Dallas Standard Water Department Bench Marks used to establish the
project vertical control monuments shall be submitted for review by the City of Dallas Public Works & Transportation Survey Division, office of the Chief City Surveyor*.
- Complete descriptions of the location and type of bench marks set for project purposes shall be submitted with the bench mark loop documentation, and included on the construction plans.

*Datum for the City of Dallas Water Department Vertical Control Network is the North American Vertical Datum of 1929. While USC&GS Bench Marks may be used on City of Dallas projects, reference and ties to the Water Department Vertical Control Network is necessary to assure compatibility with the record drawings filed in the Survey Vault.

Global Positioning System Survey Procedures:

When Instruments employing Global Positioning System (GPS) Survey Technology are used on City of Dallas projects, the following procedures will be required:

- A notation to the fact that GPS Survey Procedures were used in the performance of the surveys shall be placed in all field notes and final drawings.
- When a State Plane projection is employed, the NOAA monument used for control shall be listed in all field notes and final drawings. Submittals of data and drawings produced in State Plane Coordinate Datum shall state whether the coordinate datum is Grid values or has been adjusted to a local projection.
- Control monuments established or used in a GPS survey shall have the World Geodetic System (WGS) Latitude and Longitude values derived from the raw observation data listed along with the monument type, location and other coordinate data.
- GPS Survey Instrument Technology will not be approved for use in surveys for any design or construction purposes where vertical accuracy greater than .07 feet is required.
- GPS Survey Instrument Technology and procedures will not be approved for use in establishing vertical control for project bench marks.

The preceding is intended as a general overview of the City of Dallas requirements for consultants providing survey services. Consultant surveyors shall meet with City of Dallas Survey Staff before submitting any proposal to determine whether there are project specific requirements which will involve either additional, or more stringent survey procedures than those listed here.

Questions about Surveying Services and Surveying Specifications for the City of Dallas may be addressed to the office of the Chief City Surveyor, 320 E. Jefferson, Room 318, Dallas 75203, or by telephone at (214) 948-4150.
APPENDIX C

GENERAL NOTES
PROJECT CONTACTS:

DWU PROJECT MANAGER:
DWU DISTRIBUTION DIVISION:
DWU WASTEWATER COLLECTION DIVISION:
CITY OF DALLAS PW&T- STREET CUTS:
CITY OF DALLAS PW&T- STORMWATER:
CITY OF DALLAS PW&T- TRAFFIC CONTROL:

GENERAL

1. All work shall be done in accordance with the North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction (Version: Month, Year) and Dallas Water Utilities Addendum (Version: Month, Year) to these specifications.

2. Reference to standard drawings shall mean those shown in the DWU Standard Drawings for Water & Wastewater Construction (Version: Month, Year).

3. All items of work required to complete the work as shown or implied by the plans and as specified in the contract documents which are not listed as a pay item in the proposal, shall be considered subsidiary.

4. The location, elevation, and size of existing utilities shown on the plans as obtained from the City of Dallas and utility company records, are considered approximate. The engineer does not certify that all utilities are shown. The Contractor shall verify exact locations, sizes, and depths of existing utilities before beginning construction (including ordering of pre-cast manholes and concrete pipe if applicable). NO SEPARATE PAY ITEM

5. The Contractor shall contact Texas Excavation Safety System (800-DIG-TESS: 800-344-8377) and other utility companies 48 hours prior to locating existing utilities and or construction activities.

6. The Contractor shall preserve, protect and support all existing utilities at all times during construction. Any damage to utilities resulting from the contractor’s operation shall be restored at his expense. NO SEPARATE PAY ITEM

7. Power poles may have to be braced at the Contractor’s expense.

8. No machinery, construction access or storage shall be allowed on park property beyond the limits of the temporary workspace as defined by the City of Dallas Inspector.
TRAFFIC CONTROL

1. The Contractor shall develop a traffic control plan in accordance with the City Of Dallas Traffic Barricade Manual, Latest Edition and the TXDOT Texas Manual on Uniform Traffic Control Devices (TMUTCD), latest version, if necessary. NO SEPARATE PAY ITEM

2. The diversion of pedestrians and vehicles during the progress of the work shall be in a manner satisfactory to the City of Dallas Inspector.

3. The Contractor shall coordinate all traffic variances with City of Dallas Traffic Safety Coordinators at XXX-XXX-XXXX.

4. Two-way traffic shall be maintained at all times and flagmen should be used to maintain two-way traffic as necessary.

5. All barricades, warning signs and traffic control devices shall conform to the City Of Dallas standards. NO SEPARATE PAY ITEM

6. When closing side streets, two working days notification is required for Fire, Police, Streets and Sanitation Departments. Please contact XXX at XXX-XXX-XXXX to notify traffic restrictions.

7. Contractor shall maintain access private driveways at all times during construction. NO SEPARATE PAY ITEM

8. Vehicular ingress and egress (entrance and exit) to a business property shall be maintained at all time. If not, specific signs along with business name and direction arrow(s) shall be used for any temporary access locations. Additional signs may be necessary if there is a detour. NO SEPARATE PAY ITEM
PAVEMENT REPLACEMENT


2. All disturbed pavement markings including, but not limited to, striping, traffic buttons, crosswalks shall be restored to same or improved condition as per City of Dallas Specifications for Public Works Construction, Standard Construction Details and all Addenda Thereto. NO SEPARATE PAY ITEM

Supplementary Notes for Relocation Project:

3. For proposed paving, drainage, and traffic control plans see following references:

   Name of Outside Agency:
   Project Title:
   Contract No:
   Reference Sheet No(s): (EX: 311D-XXX, SH and 421Q-XXX, SH)
   Location of Project:
      Location: XXX Street
      Limit: From XXX Street – XXX Street

TREES AND LANDSCAPING

1. The Contractor shall not damage or remove any trees or landscaping unless otherwise authorized by the City of Dallas Inspector. Any trees or landscaping that are damaged or removed during the construction shall be replaced by the contractor at his expense.

WATER MAIN AND APPURTEYNANCES:

1. All 6", 8" and 12” water mains shall be PVC C900 (DR-14) water pipe, with Class "C+" embedment, except as noted.

2. All water mains with no profiles shall have a minimum cover of four (4) feet below street grade in an improved street and five (5) feet of cover in an unimproved street or alley.

3. Compact fittings are not authorized for this project. All ductile iron pipe, fittings and fire hydrant bases shall be encased with polyethylene wrap.

4. All bends, tees, fire hydrants and plugs are to be restrained type fittings and to be blocked with Class "B" Concrete as per DWU Standard Drawing No. 229-234, in addition to restrained joints.

5. If required by the City of Dallas Inspector, the Contractor shall install temporary water lines on both sides of the street until the new water main has been completed, tested, approved, and accepted by DWU. NO SEPARATE PAY ITEM
6. If no temporary mains are required by the City of Dallas Inspector, then the existing water mains are to be in service with the fire hydrants until the new water main has been tested, approved and accepted by DWU. NO SEPARATE PAY ITEM

7. The contractor will ensure that fire hydrants are accessible to fire trucks at all times. NO SEPARATE PAY ITEM

8. The Contractor shall sequence his construction such that no more than one fire hydrant is out of service at any given time.

9. All fire hydrants shall be installed as per DWU Standard Drawing No. 224. Existing fire hydrants on killed water lines are to be removed and delivered to DWU Distribution Division at XXX XX, Dallas, Texas, if required by City of Dallas Inspector; otherwise they become the property of the contractor.

10. Backfill made on break repairs to existing water mains may have been made with crushed rock. This could present a cave-in danger to a new ditch; therefore, precautions should be taken by the contractor. NO SEPARATE PAY ITEM.

11. Abandon all water valves on existing mains being killed as per DWU Standard Drawing No. 219. NO SEPARATE PAY ITEM.

12. The Contractor shall coordinate all water main ties-ins with City of Dallas Inspector.

13. The Contractor shall verify the location and number of all existing active water services and construct new services up to the meter prior to killing existing main.

14. Water services greater than 30 feet shall be minimum of 1 inch in diameter.

**Supplementary Notes for Relocation Project:**

15. All water services are to be replaced from the proposed water main to the meter clearing all existing and proposed utilities and pavement. Relocate and reset all water meters as required and reconnect to existing house services. Install water deadheads to unimproved lots.

16. Fire hydrant leads and barrels shall be set to the grade established for the proposed paving.
If the hydrant is not accessible because of existing ground conditions, the hydrant shall be raised with extension(s) as directed by the City of Dallas.
WASTEWATER MAIN AND APPURtenANCES:

1. The Contractor shall maintain existing wastewater flow at all times. NO SEPARATE PAY ITEM.

2. Abandon all manholes on abandoned wastewater mains.

3. The Contractor shall verify the location of all the wastewater laterals and construct new laterals from the wastewater main to the property line with cleanouts and reconnect to the existing laterals. Dye testing may be required at no additional cost to the owner.

3. Prior to reconnection of wastewater laterals, the Contractor shall verify whether the existing lateral is active or inactive. The Contractor is required, as a minimum, to include T.V. survey & perform dye testing. All laterals determined to be inactive shall not be reconnected. The City of Dallas Inspector shall approve all laterals targeted for reconnection. NO SEPARATE PAY ITEM

4. The backfill around manholes located in existing or new pavement shall be flowable backfill as per Specifications. NO SEPARATE PAY ITEM