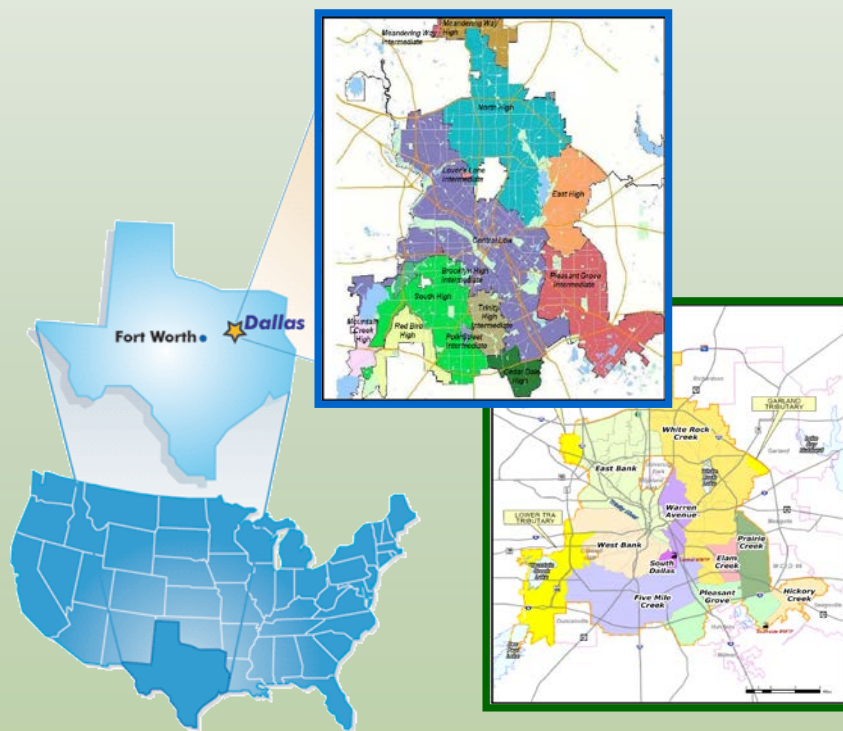




dallas water utilities
city of dallas

WATER AND WASTEWATER PROCEDURES AND DESIGN MANUAL



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PREFACE

P.1 ACKNOWLEDGMENTS:

This manual replaces the previous edition of Water and Wastewater Procedures and Design Manual by Dallas Water Utilities (DWU) dated March, 2012. The chronological list of events in developing the DWU manual is summarized as follows:

1970-1989	Letters from management to design engineers
1989	Compilation of letters into first edition of the manual
May, 1998	Revision of 1989 manual to include state regulations
February, 2010	Revision of 1998 manual to include additional sections on pavement cuts, environmental approaches, trenchless technologies, and updated state regulations
October, 2011	Revision of 2010 manual to include additional sections on subsurface utility investigations, evaluating potential for contaminants, design flow estimation criteria, and reclaimed water design guidelines.
March, 2012	Revision of 2011 manual to include additional section on water meters.
October, 2013	Entire 2012 manual is reorganized to include additional chapters on water and wastewater appurtenances, critical accesses and crossings. Design criteria for wastewater lift station, levee crossing, streetcar track access and other upgrades are also included.

The latest edition of Water and Wastewater Procedures and Design Manual is written by Engineering Services, Dallas Water Utilities. This manual is available on the internet at: http://www.dallascityhall.org/dwu/dwu_design_standards.html

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P.2 INTRODUCTION

Dallas Water Utilities (DWU) provides water, wastewater and reclaimed water services to customers within the City of Dallas and other adjacent communities. DWU maintains or exceeds current standards as set by the Texas Commission on Environmental Quality (TCEQ) for water, wastewater and reclaimed water 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, wastewater and reclaimed water mains owned and operated by DWU.

This manual applies to all distributed assets designed for City and Joint contracts where the asset(s) will be dedicated back to DWU for O&M. Additionally, pursuant to Dallas City Code Chapter 49-61(C)(5)(a), distributed assets constructed by a private party but intended for dedication back to DWU must follow the provisions of this manual.

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 eight major chapters:

CHAPTER 1: GENERAL DESIGN CRITERIA

This chapter presents general requirements at different phases of a water or 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

This chapter includes various aspects of water main design including replacement criteria, sizing, depth, embedment and location.

CHAPTER 3: WATER APPURTENANCES AND FACILITIES DESIGN

This chapter includes design criteria for various water appurtenances including different types of valves, fire hydrants, flush points, meters along with corrosion protection system.

CHAPTER 4: WASTEWATER MAIN DESIGN

This chapter includes various features of wastewater main design including replacement criteria, sizing, depth, embedment and location.

CHAPTER 5: WASTEWATER APPURTENANCES AND FACILITIES DESIGN

This chapter includes various features of wastewater appurtenances including manhole, junction structure, access device, cleanout, inverted siphon, onsite sewage facilities, lift station and force main.

CHAPTER 6: RECLAIMED WATER MAIN DESIGN

This chapter includes different aspects of reclaimed water main design including sizing, depth, embedment, location and appurtenances.

CHAPTER 7: CRITICAL ACCESS AND CROSSING CRITERIA

This chapter represents critical access and crossing criteria for water and wastewater mains including pavement cuts, highway access, railroad access, streetcar track access, DWU easement access by outside parties, levee access, creek and elevated crossing.

CHAPTER 8: SPECIAL DESIGN CRITERIA

This chapter represents special design criteria common to water and wastewater main including pipe encasement, thrust restraint and various trenchless technologies.

P.3 ABBREVIATIONS

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

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

Area

1 acre	= 43,560 ft ²
1 acre	= 4046.9 m ²
1 acre	= 0.40469 hectare
1 mi ²	= 640 acres

Volume

1 ft ³	= 7.486 gal
1 acre-ft	= 325,851 gal
1 acre-ft	= 43,560 ft ³
1 gal	= 3.7854 L
1 gal	= 1,000,000 MG
1 MG	= 3,0689 acre-ft
1 m ²	= 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

Angle

180 degree	= π radian
90 degree	= 100 grad

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

Time

1 day	= 1,440 min
1 day	= 86,400 sec

Pressure

1 psi	= 2.31 ft of water
1 psi of water	= 51.7 mm of mercury
1 atm	= 29.9 inch of mercury
1 atm	= 14.7 psi
1 bar	= 100 kilopascal
1 inch of mercury	= 1.13 ft of water
1 ft of water	= 0.443 psi

Velocity

1 ft/s	= 0.68180 mi/hr
1 ft/s	= 0.6818 mi/hr
1 cm/s	= 1.9686 ft/min

Temperature

T _F	= 9/5 T _C + 32
T _C	= 5/9 (T _F - 32)

Mics.

1 ppb	= 1000 ppm
1 N	= 100,000 dyne

CHAPTER 1

GENERAL DESIGN CRITERIA

1.1 REFERENCES

The following references are directly associated with this manual:

- Standard Drawings for Water & Wastewater Construction by DWU, Latest Edition
- Drafting Standards for Pipeline Projects by DWU, Latest Edition
- Bid Item and Cost Estimating Manual 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
- City of Dallas Addendum to the NCTCOG Standards, Latest Edition
- Standard Technical Specifications for Water & Wastewater Construction, Latest Edition

The following references shall also 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 as enforced by TCEQ, Latest Edition
- Dallas City Code: Chapter 49 (Water and Wastewater), Latest Edition
- Development Design, Procedure and Policy Manual, City of Dallas, Latest Edition
- Pavement Cut and Repair Standard Manual, City of Dallas, Latest Edition
- Traffic Barricade Manual, City of Dallas, Latest Edition
- Paving Design Manual, City of Dallas, Latest Edition
- DWU Standard Protocol for Soil and Groundwater Management on Construction Sites, Latest Edition

1.2 GENERAL DESIGN APPROACH

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

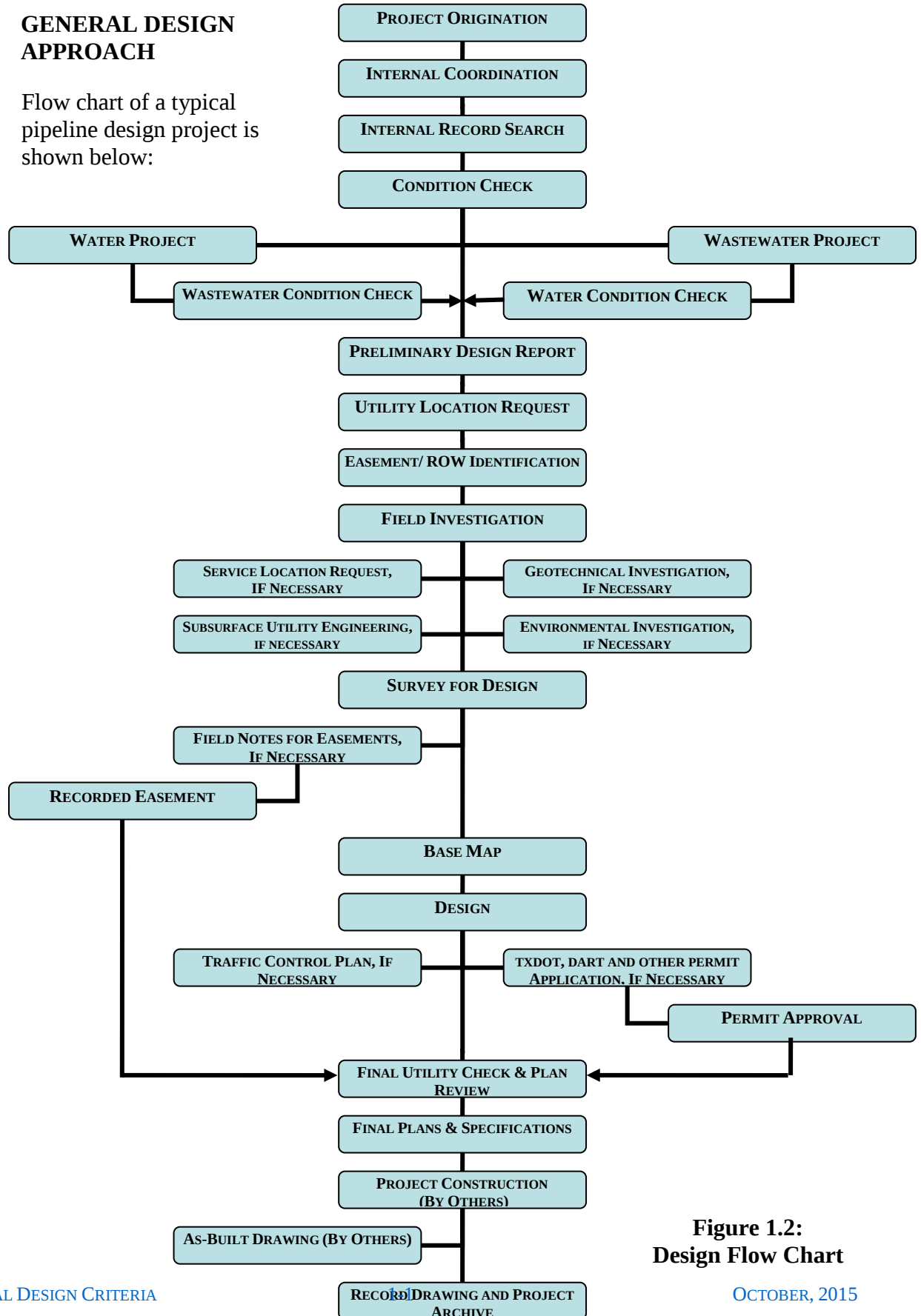


Figure 1.2:
Design Flow Chart

1.3 PROJECT ORIGATION

DWU water and wastewater main projects generally originate due to the 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 (PW), 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 the 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

1.6.4.1 General:

- A preliminary design report detailing the proposed project along with engineering recommendation shall be prepared as per 30 TAC §290.39(e)(1) and 30 TAC §217.10.
- A copy of the preliminary design report shall be submitted to DWU Water Distribution, Wastewater Collection and other divisions or outside agencies for review and approval, as necessary.

1.6.4.2 Format:

The Preliminary Design Report Checklist of a typical water/wastewater main project is included in **Appendix A**.

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 General:

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 and wastewater mains are summarized in **Table 1.8.3**:

Table 1.8.3: Minimum Easement Width

Size of Main (inch)	Depth of Pipe* (ft)	Minimum Width** (ft)
8” through 12”	≤ 8	20
	> 8	25
16” through 24”	≤ 8	25
	> 8	35
30” through 66”	≤ 8	40
	> 8	50
72” and Larger	≤ 8	60
	> 8	70

Note: *Depth of pipe shall be measured from the top of pipe to the ground surface

** Pipes shall be centered in the easement

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 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 §1.10 for the required easement. This request 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 and construction date
- Location Map: A map showing location of easement with coordinates and dimensions.

The legal description shall be submitted to Public Works 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:

1. 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.

1. 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:

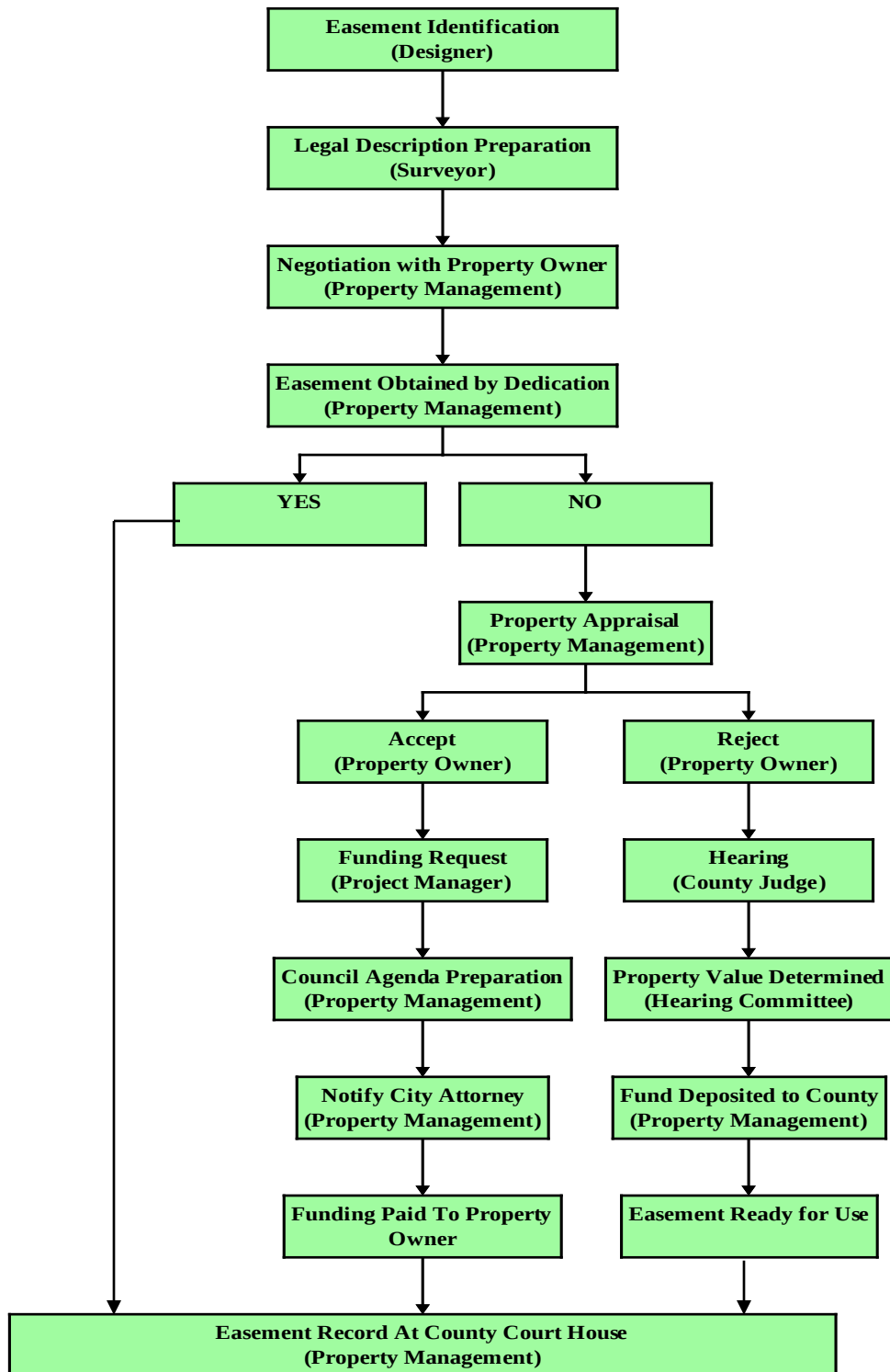


Figure 1.8.6: Easement Acquisition Process Diagram

1.9 FIELD INVESTIGATION

Field investigations including Geotechnical Investigation, Subsurface Utility Engineering (SUE) or Environmental Investigation 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 spaced closer to better defined 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 the location of the 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 trench greater than twenty-five (25) feet deep. Bore and 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, the 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 Quality Level Attributes:

Utility Quality Level (QL) attributes are described in “Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02” by American Society of Civil Engineers (ASCE), Latest Edition. Accordingly, four Quality Levels (QL) of SUE can be conducted, as needed:

Quality Level D:

- Information derived from existing records or oral recollections.
- This work shall be conducted by the designer during the preliminary project planning.

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.
- This work shall be conducted during the survey for design.

Quality Level B:

- Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities.
- This work shall be performed to obtain horizontal location of subsurface utilities in areas with congested utilities (i.e. central business district), areas where utility information is sparse or where a specific utility of high importance is being crossed (i.e. gas line).
- Typical Quality Level B requirements are included in **Appendix B**.

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.
- This work shall be performed to obtain precise horizontal and vertical locations of subsurface utilities in areas with congested utilities (i.e. central business district), areas where utility information is sparse or where a specific utility of high importance is being crossed (i.e. gas line).
- Typical Quality Level A requirements are included in **Appendix C**.

Various levels of SUE applications are summarized in **Figure 1.9.2.2:**

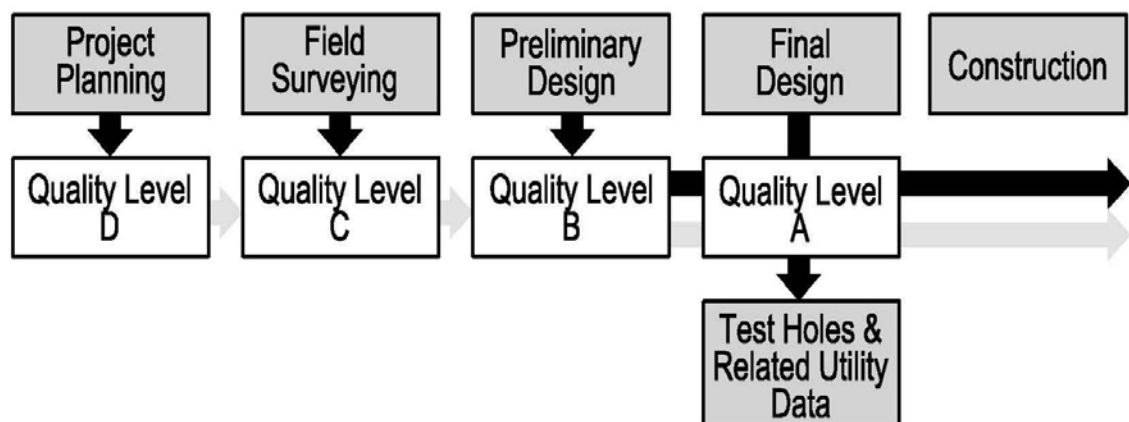


Figure 1.9.2.2: Different Levels of SUE Application

Reference (Modified): SUE Brochure, Federal Highway Association, 2007

1.9.3 Environmental Investigation

The designer shall evaluate all available resources to identify any potential environmental issues, including possible soil or groundwater contamination, during the planning phase of water or wastewater main construction projects. The designer shall follow the guidelines as specified in the “DWU Standard Protocol for Soil and Groundwater Management Plan on Construction Sites, Latest Edition” as applicable.

1.9.3.1 Step 1- Phase I Environmental Site Assessment (ESA):

The objective of conducting a Phase I ESA is to identify Recognized Environmental Condition (REC). If the project involves a property acquisition, a Phase I ESA from a qualified and experienced environmental consultant shall be requested. If the project does not involve an acquisition and no phase I ESA is available, it is recommended to skip Step 1 and proceed to Step 2 (DWU Pipeline GIS) and Step 3 (File Review/Site Screening) as necessary.

General Requirements:

- Phase I ESA should comply with the ASTM E1527: “Standard Practice for Environmental Site Assessment- Phase I Environmental Site Assessment Process”, 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 sources or supplements.

Major Components:

A Phase I ESA should include, but not be limited to, the following items:

- A review of historical land use of subject property
- A review of historical aerial photos
- Interviews with individuals 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, or easement acquisition, then construction planning should proceed with minimal environmental complications. If a REC or suspected REC is 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 (COC).
- 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 Step 2- DWU Pipeline GIS Data Search:

The DWU Pipeline GIS mapping system is intended to assist in the identification of potential contaminated sites located in the Dallas area if a Phase I ESA is not required or readily available. Prior to beginning a project, designer shall review DWU Pipeline GIS for possible environmental points of interest located on or near a project site. If the project site is located in close proximity to one of the environmental points of interest as shown in **Table 1.9.3.2** a regulatory File Review/Site Screening or Phase II ESA shall be requested from a qualified and experienced environmental consultant as necessary.

Table 1.9.3.2: Evaluating Project Proximity to Environmental Point of Interest

Facility Type	Order File Review /Site Screening or Phase II if Facility within Radius of:
Leaking Petroleum Storage Tank (LPST) ¹	1,000 feet
Petroleum Storage Tank (PST) ¹	500 feet
Voluntary Cleanup Program (VCP) ¹	1,000 feet
Municipal Setting Designation (MSD) ²	1,000 feet
Registered Dry Cleaner ¹	500 feet
Innocent Owner/Operator Program (IOP) ¹	500 feet
Monitoring Wells ³	200 feet
Landfills (Open or Closed) ^{4,5}	1,000 feet
Federal or State Superfund ^{6,1}	1,000 feet

¹TCEQ; ²City of Dallas OEQ; ³TWDB; ⁴City of Dallas Sanitation; ⁵NCTCOG; ⁶EPA

Source: DWU Standard Protocol for Soil and Groundwater Management on Construction Sites, Latest Edition

1.9.3.3 Step 3- File Review/ Site Screening:

If a Phase I ESA is not available and review of DWU Pipeline GIS does not provide sufficient information necessary to determine if contaminants may be located in the vicinity of the project, a File Review/Site Screening should be requested from an approved environmental consultant. However, if the DWU Pipeline GIS review proves to show obvious concern the designer may skip File Review/Site Screening and move straight to the Phase II ESA as necessary. Typically, a File Review/Site Screening shall include:

- A review of TCEQ and Federal regulatory databases
- A review of TCEQ files as applicable (e.g. VCP, LPST cases)
- A review of historical records (e.g. aerial photographs, city directories and Sanborn maps)
- A review of local records and permits
- A review of condition of project area and vicinity during limited site reconnaissance.

A determination of whether potential environmental concern exists and whether a Phase II ESA is warranted to evaluate COCs at the site with respect to the project

1.9.3.4 Step 4- Phase II ESA:

If review of the Phase I ESA, DWU Pipeline GIS mapping system, and/or File Review/Site Screening indicates potential for contamination at the site, a Phase II ESA should be requested from a qualified and experienced environmental consultant to evaluate the concentration of COCs in the on-site soil and/or groundwater.

General Requirements:

Phase II ESA should comply with the ASTM E1903: Standard Guide for Environmental Site Assessment- Phase II Environmental Site Assessment Process”, Latest Edition

Major Components:

A Phase II ESA should include, but not be limited to, the following components:

- Delineation of the affected zones(s) within the project limit
- Development of the scope of work
- Assessment activities
- Evaluation and presentation of data from soil and/or groundwater samples
- Presentation of findings and conclusion along with recommendation of appropriate pipe material, gasket and trench type to be used for the project.

1.10 SURVEY

A thorough review of existing plans, information, and field investigations are required prior to requesting a survey for design or easement acquisition. The survey shall be conducted under the direct supervision of a Texas Registered Professional Land Surveyor (RPLS) in accordance with all the applicable standards, policies and criteria for the City of Dallas.

1.10.1 Horizontal Control Datum

- Horizontal control datum for City of Dallas shall be the North American Datum of 1983 (NAD83) as defined by National Geodetic Survey (NGS).
- The applicable State Plane Coordinate (SPC) zone for City of Dallas is Texas North Central Zone (Code 4202)

1.10.2 Vertical Control Datum

- Vertical control datum for City of Dallas shall be based on National Geodetic Vertical Datum of 1929 (NGVD29), as defined by National Geodetic Survey (NGS).
- Vertical control for DWU project shall be determined from the network of DWU established benchmarks (BM).

1.10.3 Topographic Survey

- Topographic survey shall be used to locate and document all information that is pertinent to the design and construction of water/wastewater main projects.
- The width of a typical topographic survey shall be as follows:
 - The typical survey along a non-street or alley area shall encompass 10 ft beyond the minimum required water or wastewater easement along the proposed alignment as specified in **Table 1.8.3**.
 - The typical survey along a street shall encompass 10 ft beyond the right-of-way.
- All submittals of survey data and drawings should be in grid values using the State Plane Coordinate (SPC) System and should not to be adjusted to a local (surface) projection.
- Detailed requirements of a typical topographical survey are included in **Appendix D**.

1.10.4 Boundary Survey

- Boundary survey shall be used to locate and prepare legal descriptions for fee title conveyances, right-of-way, easement, lease agreement, abandonment and licenses.
- Detailed requirements of a typical boundary survey along with field notes are included in **Appendix E**.

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 according 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 City of Dallas 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 City of Dallas 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.

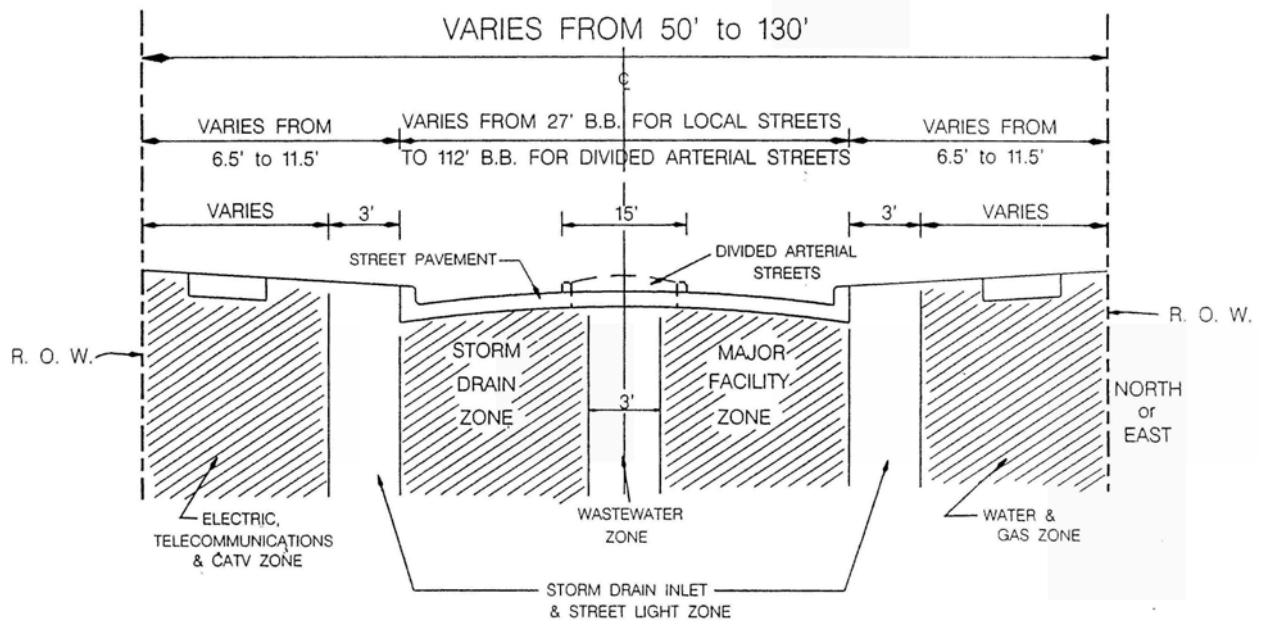


Figure: 1.11.2.1: Utility Allocation Zone in Typical Street

Source: City of Dallas Paving Design Manual, June, 1998

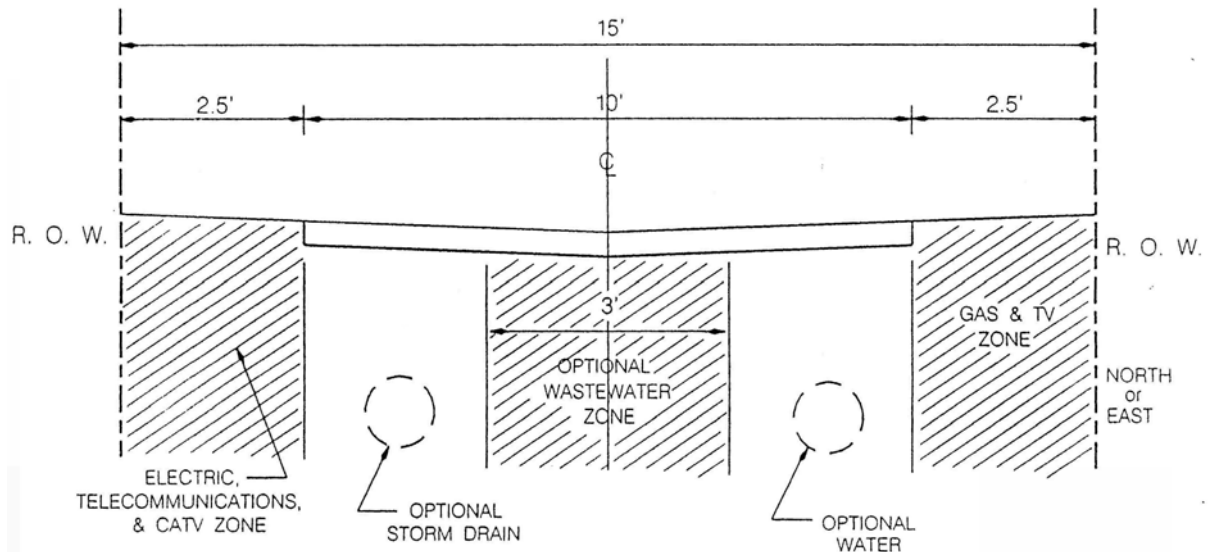


Figure: 1.11.2.2: Utility Allocation Zone in Typical Alley

Source: City of Dallas 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, 30 TAC §217 and 30 TAC §210
- 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 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:

- Traffic Barricade Manual, City of Dallas, Latest Edition
- 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 City of Dallas Public Works or Texas Department of Transportation, 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 all applicable DWU standards 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. Following references shall be used in conjunction with final plans as applicable:

- Standard Drawings for Water & Wastewater Construction by DWU, Latest Edition
- Drafting Standards for Pipeline Projects by DWU, Latest Edition
- General Notes for Typical Water/Wastewater Main Capital Improvement Project (**Appendix F**)
- General Notes for Typical Water/Wastewater Main Joint Contract (**Appendix G**)
- A typical Final Plan Review Checklist is included under **Appendix H**.

1.14.2 Technical Specifications

All the necessary technical specifications must be prepared by a Texas Professional Engineer. The following references shall be used in conjunction with Technical Specifications as applicable:

- Public Works Construction Standards for North Central Texas by North Central Texas Council of Governments (NCTCOG), Edition as adopted by DWU
- City of Dallas Addendum to the NCTCOG Standards, Latest Edition
- Standard Technical Specifications for Water & Wastewater Construction, Latest Edition
- Bid Item and Cost Estimating Manual by DWU, Latest Edition

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
- Executed temporary and permanent easement documents
- Approval letter from other entities or agencies under jurisdiction

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

1.15 PROJECT CONSTRUCTION

All projects shall be constructed in conformance with approved sealed plans and specifications as possible. Any field change shall be documented in As-Built Drawings in accordance to the guideline as specified in DWU Drafting Standards for Water/Wastewater Pipeline Projects, Latest Edition:

- As-Built Drawings are to be prepared by the inspector by marking with red pen on copy of full-size plan
- As-Built disclaimer consisting of name(s) of contractor and inspector shall be posted
- As-Built Drawings shall be provided to the designer though the DWU Project Manager for preparing Record Drawings.

1.16 RECORD DRAWING AND PROJECT ARCHIVE

All as-built changes shall be incorporated in Record Drawings by the designer in accordance with the guidelines as specified in DWU Drafting Standards for Water/Wastewater Pipeline Projects, Latest Edition:

- Record Drawing shall be prepared by the designer by drafting on final design plan and to be printed on Mylar
- Record Drawing disclaimer consisting of name(s) of contractor, inspector and personnel preparing drawing to be posted
- Laying plan reference at pipe alignment on plan view if available
- Completed Record Drawing shall be submitted to the DWU Project Manager.

Upon expiration of construction warranty period, all pertinent project files shall be archived.

CHAPTER 2

WATER MAIN DESIGN

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

The City of Dallas holds water rights to several local area lakes as shown in **Figure 2.2.1**:

Western Reservoirs:

- Lake Ray Roberts
- Lake Lewisville
- Lake Grapevine

Eastern Reservoirs:

- Lake Ray Hubbard
- Lake Tawakoni
- Lake Fork
- Lake Palestine

Currently Lake Fork and Lake Palestine are not used or connected to the Dallas water system.

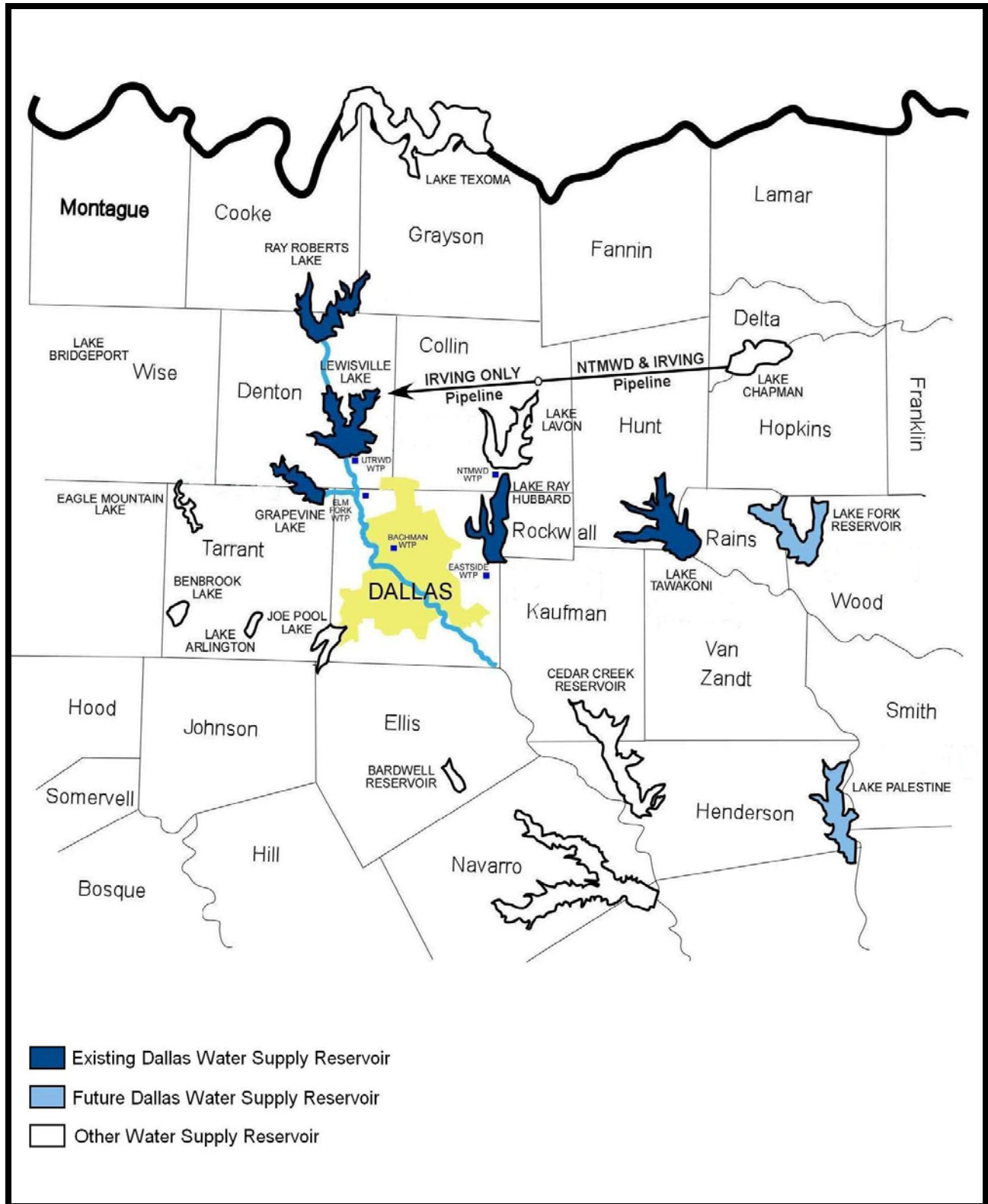


Figure 2.2.1: DWU Raw Water Sources and Treatment Facilities

Source: City of Dallas Planning and Water Supply Strategies, December 6, 2006

2.2.2 Water Treatment Facilities

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

- East Side WTP:

The East Side WTP is located in Sunnyvale, approximately three (3) miles southwest of Lake Ray Hubbard. Raw water for the East Side WTP is pumped to the head of the plant through transmission mains from Lake Ray Hubbard and Lake Tawakoni.

- Elm Fork WTP:

The Elm Fork WTP is located in Carrollton, northwest of the intersection of Old Denton Road and Whitlock Lane. Raw water for the Elm Fork WTP is conveyed through creek channels from Lake Ray Roberts, Lake Lewisville, and Lake Grapevine. These sources all converge in the Elm Fork of the Trinity River.

- Bachman WTP:

The Bachman WTP is located just north of Love Field Airport, adjacent to Bachman Lake. Raw water for the Bachman WTP is obtained from the same sources as the Elm Fork Plant, except that the intake structure for the Bachman Plant is located upstream of the Frazier Dam.

2.2.3 Raw Water Mains

The raw water obtained from the lakes described above is conveyed to water treatment plants by two primary methods:

- Gravity through creeks and rivers
- Pump stations located at the lakes

2.2.4 Pressure Zone

Based on 2007 DWU Water Master Plan, the Dallas water distribution system is divided into 17 pressure zones in order to serve the wide range of ground elevations within the City, while maintaining residual pressures within acceptable levels.

- Major/ Secondary Pressure Zones:

There are four (4) major pressure zones (Central Low, North High, South High, and East High) which comprise most of the Dallas service area. There are five (5) smaller secondary pressure zones (Cedardale, Pleasant Grove, Meandering Way High, Red Bird High, and Trinity Heights) which also serve significant portions of the Dallas service area. Each of the nine (9) major and secondary pressure zones are supplied by one or more pump stations and have elevated or ground storage facilities that establish the static hydraulic gradient for each zone.

- Intermediate Pressure Zones:

There are eight (8) intermediate pressure zones that generally serve very small, localized areas throughout the Dallas service area. These intermediate zones are supplied through pressure-reducing valves 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.

DWU pressure zones are shown in **Figure 2.2.4** and summarized in **Table 2.2.4**.

2.2.5 Ground Storage Reservoir

There are twelve (12) ground storage reservoirs in DWU water distribution system to provide suction storage for the high service pumping stations. In addition to providing suction storage for high service pumps, three of the ground reservoirs are at a height that allows them to also function as elevated (floating) storage.

2.2.6 Elevated Tanks

There are eight (8) elevated storage tanks located throughout the distribution system. These tanks provide floating storage for the primary and secondary pressure zones.

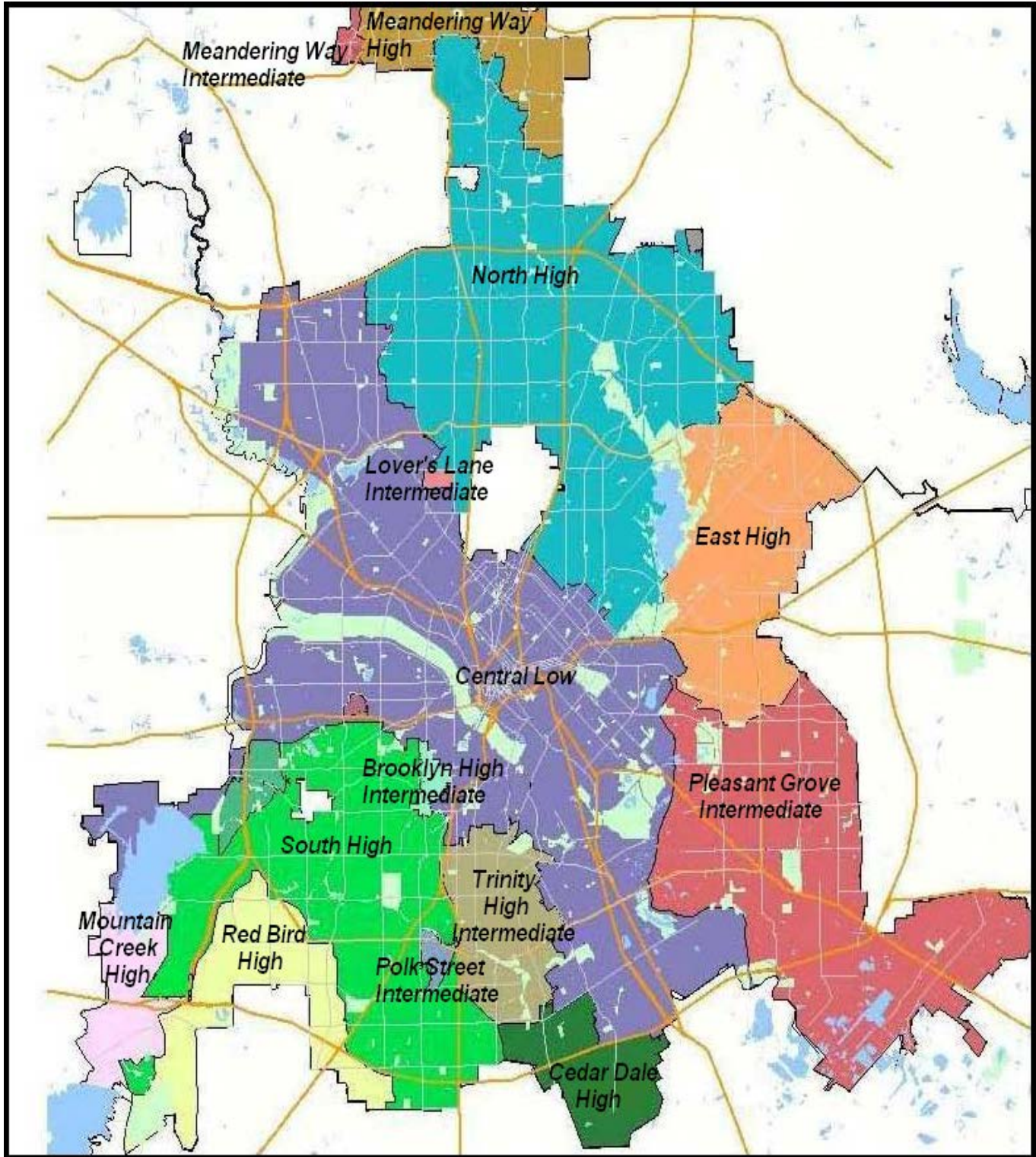


Figure 2.2.4: DWU Water Pressure Zones

Source: Water Capital Infrastructure Assessment and Hydraulic Modeling by Black & Veatch Corp., July, 2007

Table 2.2.4: DWU Water Distribution System

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

Source: Source: Water Capital Infrastructure Assessment and Hydraulic Modeling by Black & Veatch Corp., 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

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

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

Type	Typical Size Range (in)	Direct Service Connection
Distribution Main	16" and Smaller	Permitted
Transmission Main	Larger than 16"	Not Permitted

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 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 pumpage 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.

2.4.2.3 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.

2.4.2.4 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. 2006 International Fire Code (IFC) or Latest Edition as adopted by City of Dallas shall be applicable for estimating minimum required fire flow at any facility.

The minimum fire flows required for residential and commercial areas are 1,500 gpm and 1,750 gpm, respectively. Fire flows of up to 3,500 gpm are the maximum required by the Insurance Services Office (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. When site-specific data is unavailable, designer shall use the most conservative data while meeting or exceeding the following minimum criteria 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.
- Comply with Tables 2.4.3.1 and 2.4.3.2 as applicable

**Table 2.4.3.1:
Water Design Flow Estimation with Limited Available Data**

Source	Remarks	Average Daily Water Flow (gals/person)
Municipality	Residential	180
Subdivision	Residential	180
Trailer Park (Transient)	2½ Persons per Trailer	85
Mobile Home Park	3 Persons per Trailer	110
School	Cafeteria & Showers	30
	Cafeteria/No Showers	22
Recreational Parks	Overnight User	45
	Day User	8
Office Building Factory	A facility must be designed for the largest shift	35
		28
Hotel/Motel	Per Bed	110
Restaurant	Per Meal	15
Restaurant with bar or cocktail lounge	Per Meal	18
Hospital	Per Bed	350
Nursing Home	Per Bed	180
Apartments	Per Unit	430

Table 2.4.3.2: Water Design Flow Estimation with Available Zoning/Property Data

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
		A(A)	Agricultural (Agricultural, Single Family)	1 per 3 acre	3.25	200	650
RESIDENTIAL	Single Family	R-1ac(A)	Single Family	1 per 1 acre	3.25	200	650
		R-1/2ac(A)	Single Family	2 per 1 acre	3.25	200	650
		R-16(A)	Single Family	1 per 16000 sq. ft.	3.25	200	650
		R-13(A)	Single Family	1 per 13,000 sq. ft.	3.25	200	650
		R-10(A)	Single Family	1 per 10,000 sq. ft.	3.25	180	585
		R-7.5(A)	Single Family	1 per 7,500 sq. ft.	3.25	180	585
		R-5(A)	Single Family	1 per 5,000 sq. ft.	3.25	180	585
	Duplex/ Townhome	D(A)	Duplex	1 per 3,000 sq. ft.	2.5	180	450
		TH-1(A)	Townhouse	6 per acre	2.25	180	405
		TH-2(A)	Townhouse	9 per acre	2.25	180	405
		TH-3(A)	Townhouse	12 per acre	2.25	180	450
	Clustered Housing/ Multifamily	CH	Clustered Housing (Multi/Single Family)	18 per acre	2.0	180	360
		MF-1(A)	Multifamily	Min. Lot: 3,000 1,000 sq ft- E 1,400 sq ft- 1 BR 1,800 sq ft- 2 BR +200 sq ft each add BR	2.00 2.25 2.50	180	360 405 450
		MF-2(A)	Multifamily	Min. Lot: 1,000 8,00 sq ft- E 1,000 sq ft- 1 BR 1,200 sq ft- 2 BR +150 sq ft each add BR	2.00 2.25 2.50	180	360 405 450
		MF-3(A)	Multifamily	Min. Lot: 6,000 450 sq ft- E 500 sq ft- 1 BR 550 sq ft- 2 BR +50 sq ft each add BR	2.00 2.25 2.50	180	360 405 450
		MF-4(4)	Multifamily	Min. Lot: 6,000 225 sq ft- E 275 sq ft- 1 BR 325 sq ft- 2 BR +50 sq ft each add BR	2.00 2.25 2.50	180	360 405 450
		MH(A)	Mobile Home	1 per 4000 sq. ft.	2.50	180	450

Table 2.4.3.2 contd.
2

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
NONRESIDENTIAL	Office	NO(A)	Neighborhood Office	0.5 FAR	1 per 400 sf	35	35 per 400 sf
		LO-1	Limited Office	1.0 FAR	1 per 400 sf	35	35 per 400 sf
		LO-2	Limited Office	1.5 FAR	1 per 400 sf	35	35 per 400 sf
		LO-3	Limited Office (Office, Lodge)	1.75 FAR	1 per 400 sf	35	35 per 400 sf
		MO-1	Mid-Range Office (Office, Lodging)	2.0 FAR	1 per 400 sf	35	35 per 400 sf
		MO-2	Mid-Range Office (Office, Lodging)	3.0 FAR	1 per 400 sf	35	35 per 400 sf
		GO(A)	General Office (Office, Lodging)	4.0 FAR	1 per 400 sf	35	35 per 400 sf
	Retail	NS(A)	Neighborhood Service	0.5 FAR	1 per 400 sf	35	35 per 400 sf
		CR	Community Retail	0.75 FAR overall 0.5 office	1 per 400 sf	35	35 per 400 sf
		RR	Regional Retail	1.5 FAR overall 0.5 Office	1 per 400 sf	35	35 per 400 sf
	Commercial/ Industrial	CS	Community Service	0.75 FAR overall 0.5 office/lodging/retail	1 per 400 sf	35	35 per 400 sf
		LI	Light Industrial	1.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	35	35 per 400 sf
		IR	Industrial Research	2.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	35	35 per 400 sf
		IM	Industrial Manufacturing	2.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	35	35 per 400 sf
	Central Area	CA-1(A)	Central Area	20.0 FAR	1 per 400 sf	35	35 per 400 sf
		CA-2(A)	Central Area	20.0 FAR	1 per 400 sf	35	35 per 400 sf
	Mixed Use	MU-1	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	35	35 per 400 sf
		MU-2	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	35	35 per 400 sf
		MU-3	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	35	35 per 400 sf

Table 2.4.3.2 contd.

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
NONRESIDENTIAL	Multiple Commercial	MC-1	Multiple Commercial	0.8 FAR base 1.0 max.	1 per 400 sf	25	25 per 400 sf
		MC-2	Multiple Commercial	0.8 FAR base 1.0 max.	1 per 400 sf	25	25 per 400 sf
		MC-3	Multiple Commercial	1.2 FAR base 1.5 max.	1 per 400 sf	25	25 per 400 sf
		MC-4	Multiple Commercial	1.6 FAR base 2.0 max.	1 per 400 sf	25	25 per 400 sf
	Urban Corridor	UC-1	Urban Corridor	10 DU/ acre 0.6 FAR base 2.0 max.	1 per 400 sf	25	25 per 400 sf
		UC-2	Urban Corridor	35 DU/acre 0.85 FAR base 3.6 max.	1 per 400 sf	25	25 per 400 sf
		UC-3	Urban Corridor	45 DU/acre 1.0 FAR base 4.5 max.	1 per 400 sf	25	25 per 400 sf
	Parking	P(A)	Parking	-	-	-	-

Note: FAR denotes to Floor Area Ratio and DU denotes to Dwelling Unit.

** Average daily demands for non-residential units are based on the assumption of 1 person per unit and 400 square feet (sf) per unit. Actual estimation shall be based on the designed floor area, FAR and DU as necessary.

Water demand for any **Planned Developments (PD)**, as defined by City Code 51A.472, shall be estimated using the most conservative adjacent zoning unless otherwise written in the ordinance for the specific PD as approved by the City of Dallas.

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.

2.2.1.2 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 guidelines apply to water main installation in public right-of-way or easements:

Table 2.5.2: Minimum Depth of Cover for Water Main

Size of Main (in)	Min. Depth* (ft)		
	Unimproved Area	Improved Area	Highway/Railroad Crossing**
12" and Smaller	6	4	6
16"	6	5	6
20" and Larger	7	6	6

* 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 " diameter) PVC is the material preferred by DWU. For larger pipe sizes (> 16 " diameter) 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
- Selected congested utility corridor within TXDOT right-of-way
- 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 minimum single layer of 8-mil liner low density polyethylene (LLDPE) 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 full body 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 113-119C 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*

Pipe & Material Specification	Allowable Size (in)	Joint Specification	Embedment Class Per Depth of Cover** (ft)
PVC AWWA C900 (DR-14)	6 – 12	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477	< 8' : C+ 8'-16' : B+
PVC AWWA C905 (DR-14)	16	Fusible Fusible C 900 ^(R) Fusible C 900 ^(R) Certa-Lok Certa-Lok C900/RJ ^(TM) Certa-Lok C905/RJ ^(TM)	
Ductile Iron (DI) ANSI/AWWAC151/A21.51 Min. Class 52 (Special Thickness Class)	6 – 54	Bell & Spigot/ Push On ANSI/AWWA C111/A21.11 Mechanical ANSI/AWWA C111/A21.11 Flanged ANSI/AWWA C115/A21.15	≤16-in Dia: >16-in Dia: < 8' (Rock): C < 8' (Earth): D+ <8" : B 8'-16' : C 8'- 16' : B > 16' : B >16' : B
RCCP- Bar Wrapped ANSI/AWWA C303 Class 150	16 – 42	Bell & Spigot ANSI/AWWA C303	16-in Dia: >18-in Dia: < 16' : C <16' : B > 16' : B >16' : B
PCCP- Lined Cylinder ANSI/AWWA C301 Class 150	20 – 60	Bell & Spigot ANSI/AWWA C301	< 16' : C > 16' : B
PCCP- Embedded Cylinder ANSI/AWWA C301 Class 150	54 – 144	Bell & Spigot ANSI/AWWA C301	< 16' : C >16' : B
Steel** ANSI/AWWA C200	24 – 156	Welded Joints or Bell & Spigot ANSI/AWWA C200	< 8' : C > 8' : C

* 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

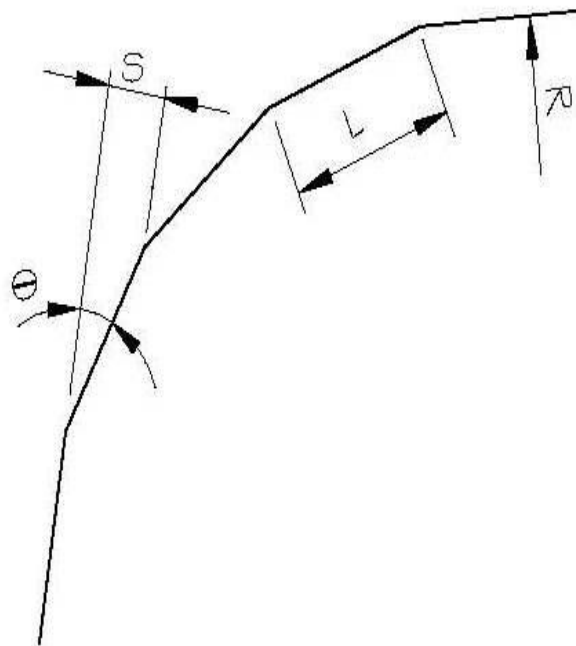
2.8.1 Pipe Laying

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 Joint Deflection

The maximum deflection angles of pipe joint are typically restricted to 80% of the manufacturer's recommendation. Otherwise, horizontal bends will be required.

The minimum curve radius due to maximum joint deflection can be calculated as shown in **Figure 2.8.2**.



Curve Radius, $R = 57.3 * L / \theta$

Where,
 L = Laying Length, ft.
 θ = Deflection Angle, Degree

Figure 2.8.2: Water Main Joint Deflection

Source: Handbook of PVC Pipe- Design and Construction by Unibell PVC Pipe Association, 4th Edition, August, 2011

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

		Recommended by Manufacturers (Typical)				Allowable by DWU***			
Type of Pipe	Size (in)	Max. Deflection		Min. Curve Radius		Max. Deflection		Min. Curve Radius	
		Angle (deg.)	Offset (in)	20' Joint (ft)	10' Joint (ft)	Angle (deg.)	Offset (in)	20' Joint (ft)	10' Joint (ft)
*PVC DR 14	6	2	8	573	286	1.6	6.4	716	358
	8	2	8	573	286	1.6	6.4	716	358
	12	1.5	6	764	382	1.2	4.8	956	478
**DI Push-On	6	5	21	230	N/A	4	15.75	306	N/A
	8	5	21	230		4	15.75	306	
	12	5	21	230		4	15.75	306	

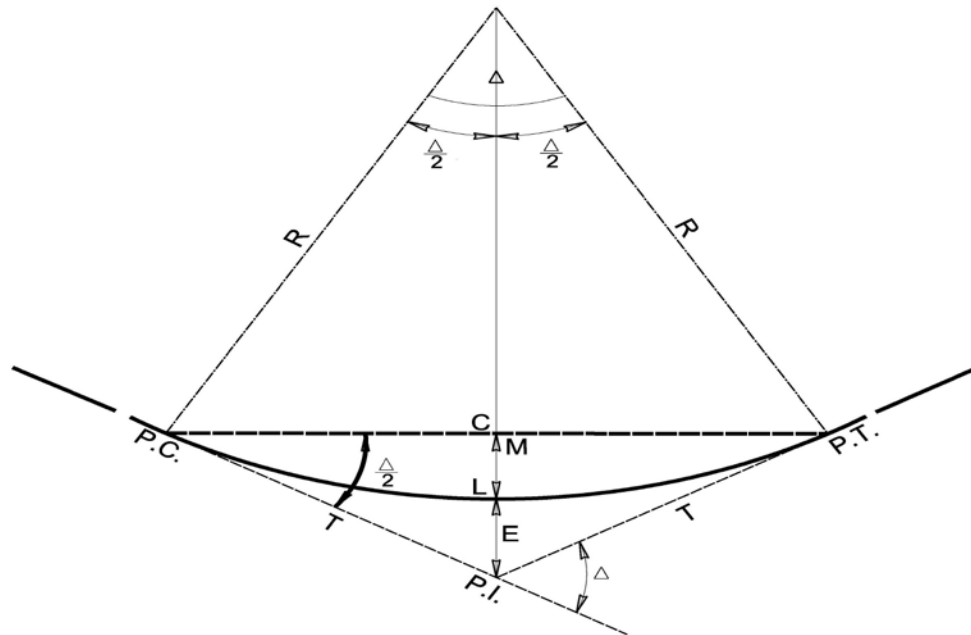
* PVC pipe data is obtained from National Pipe & Plastics, Inc.

** DI data obtained from American Ductile Iron Pipe, Inc.

*** Allowable maximum deflection by DWU is based on 80% of the typical recommended maximum deflection by the pipe manufacturer(s). Accordingly, allowable minimum curve radius by DWU is calculated and must be verified with the specific pipe manufacturer(s). Steeper curve(s) with uniform longitudinal bending of PVC pipe may be allowed if joints are blocked or restrained contingent upon manufacturer's recommendation. However, both joint deflection and axial bending on same length of pipe are not allowed.

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:



Where,

C	=	Long Chord	$C = 2R \sin (\Delta/2)$ $C = 2T \cos (\Delta/2)$
E	=	External Distance	$E = R (\sec (\Delta/2) - 1)$
L	=	Curve Length	$L = 2\pi R (\Delta/360^\circ)$ $L = R \Delta/57.2958$
M	=	Middle Ordinate	$M = R(1 - \cos (\Delta/2))$ $M = (C/2) \tan (\Delta/2)$
R	=	Radius	$R = T / \tan (\Delta/2)$ $R = C / (2 \sin (\Delta/2))$
T	=	Tangent	$T = R \tan (\Delta/2)$
PC	=	Point of Curvature	
PI	=	Point of intersection	
PT	=	Point of Tangency	
Δ	=	Deflection Angle	$\Delta^\circ = (L/R) (360^\circ/2\pi)$ $\Delta^\circ = (L/R) 57.2958$

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 a curve. A survey is run in a 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 the survey stations (Figure 2.8.4.1).

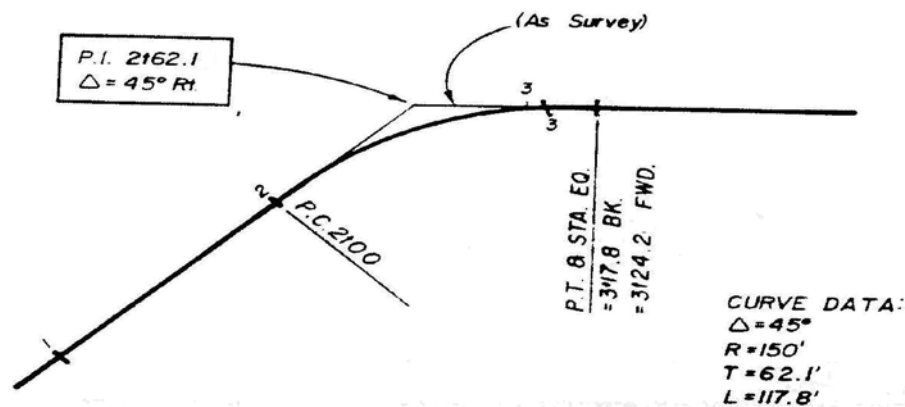


Figure 2.8.4.1: Gap Station Equation

2.8.4.2 Overlap Station Equation:

The overlap station equation is used when the pipeline, as designed, is longer than 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).

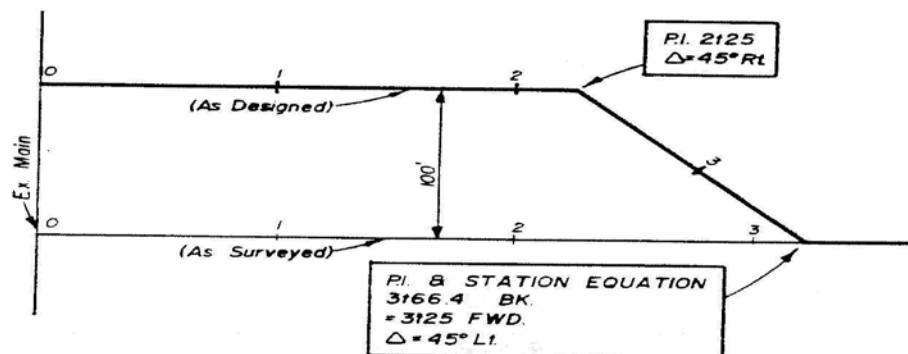


Figure 2.8.4.2: Overlap Station Equation

2.9 VERTICAL ALIGNMENT

2.9.1 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.

2.9.3 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.

2.9.4 Combined Angle Bend

Combine angle bend can be used where horizontal point of intersection (PI) and point of vertical intersection (PVI) are located at the same point. A combined angle can be shown in **Figure 2.9.4** and calculated in **Table 2.9.4**.

$$\begin{aligned}\cos A &= (\cos H) (\cos V) \\ \cos A &= x/m \\ \cos H &= x/n \\ \cos V &= n/m\end{aligned}$$

Where,
 A = Combined Angle
 H = Horizontal Angle
 V = Vertical Angle

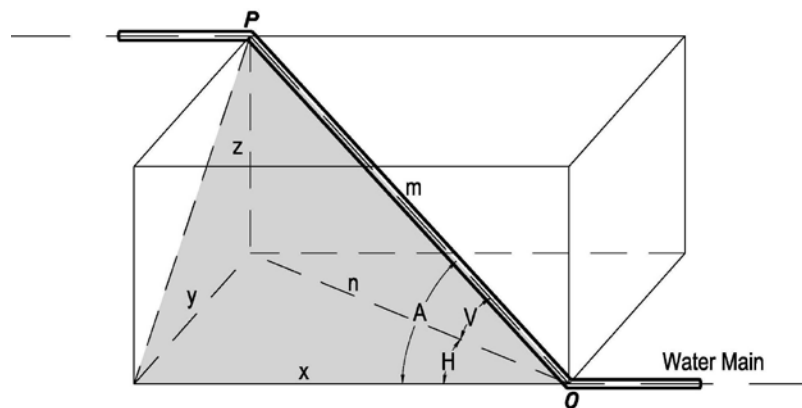


Figure 2.9.4: Combined Horizontal and Vertical Angle

Table 2.9.4: Combined Horizontal and Vertical Angle

Horizontal Angles											
5°	10 °	11°15'	15 °	20 °	22 °30'	25 °	30 °	35 °	40 °	45 °	

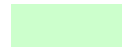
Vertical Angles	5 °	7 °04'	11 °10'	12 °18'	15 °48'	20 °35'	23 °01'	25 °28'	30 °23'	35 °19'	40 °16'	45 °13'
	10 °	11 °10'	14 °05'	14 °59'	17 °57'	22 °15'	24 °30'	26 °48'	31 °28'	36 °13'	41 °01'	45 °09'
	11°15'	12 °18'	14 °59'	15 °52'	18 °40'	22 °50'	25 °01'	27 °16'	31 °51'	36 °33'	41 °18'	46 °05'
	15 °	15 °48'	17 °57'	18 °40'	21 °05'	24 °49'	26 °49'	28 °54'	33 °13'	37 °42'	42 °16'	46 °55'
	20 °	20 °35'	22 °15'	22 °50'	24 °49'	27 °59'	29 °45'	31 °36'	35 °32'	39 °40'	43 °57'	48 °22'
	22°30'	23 °01'	24 °30'	25 °01'	26 °49'	29 °45'	31 °24'	33 °09'	36 °52'	40 °49'	44 °57'	49 °13'
	25 °	25 °28'	26 °48'	27 °16'	28 °54'	31 °36'	33 °09'	34 °47'	38 °17'	42 °04'	46 °02'	50 °09'
	30 °	30 °23'	31 °28'	31 °51'	33 °13'	35 °32'	36 °52'	38 °17'	41 °25'	44 °49'	48 °26'	52 °14'
	35°	35 °19'	36 °13'	36 °33'	37 °42'	39 °40'	40 °49'	42 °04'	44 °49'	47 °51'	51 °08'	54 °36'
	40 °	40 °16'	41 °01'	41 °18'	42 °16'	43 °57'	44 °57'	46 °02'	48 °26'	51 °08'	54 °04'	57 °12'
	45 °	45 °13'	45 °09'	46 °05'	46 °55'	48 °22'	49 °13'	50 °09'	52 °14'	54 ° 36'	57 °12'	60 °00'

Legends: Allowable Combined Angles for Various Standard Fittings are as follows:

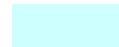
11°15':



22°30':



45°:



Note: Gray areas represent horizontal and vertical components of standard combined angle (in Color) using various standard fitting.

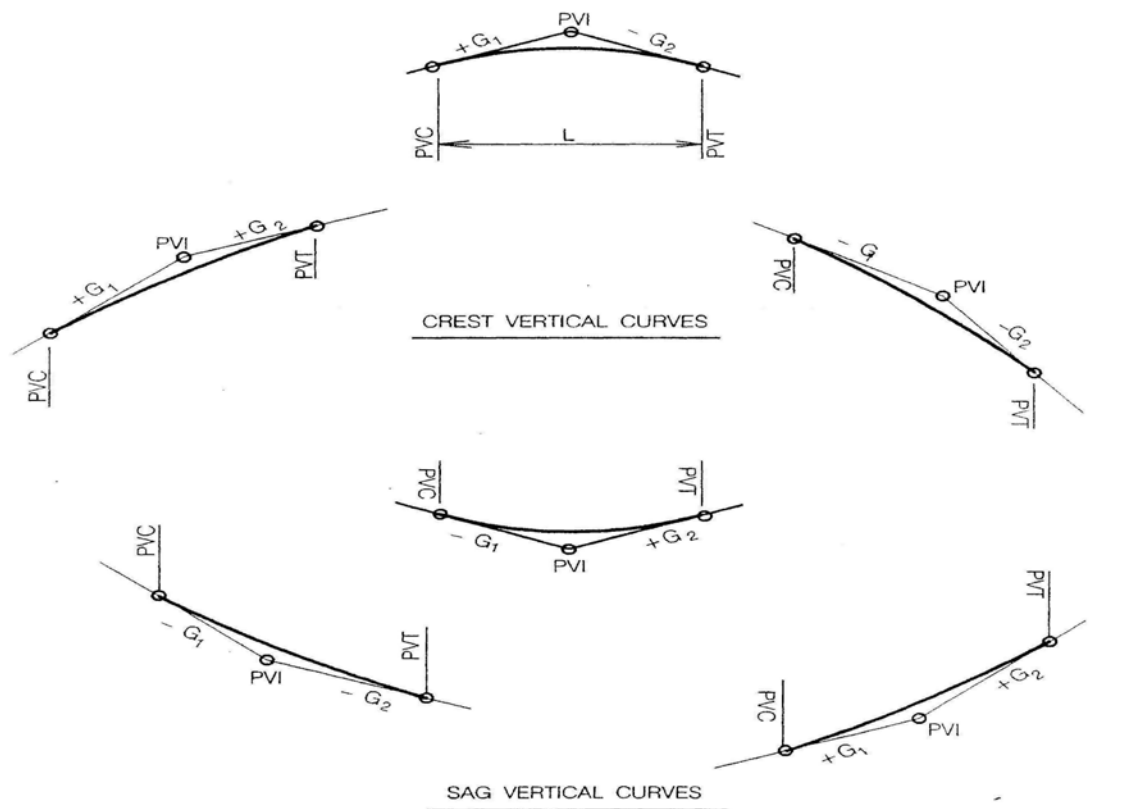
Example: A standard fitting of 22°30' can be used for a horizontal angle of 20° and vertical angle of 15° with combined angle of to 24° 49'.

2.9.5 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).

2.9.5.1 Types of Vertical Curves:

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



LEGEND

- G_1 & G_2 = TANGENT GRADES IN PERCENT
- L = LENGTH OF VERTICAL CURVE
- PVI = POINT OF VERTICAL INTERSECTION
- PVC = POINT OF VERTICAL CURVATURE
- PVT = POINT OF VERTICAL TANGENCY

VERTICAL
CURVE TYPES
FIGURE IV - 16

Figure 2.9.5.1: Vertical Curve Types

Source: PW&T Paving Design Manual, June, 1998

2.9.5.2 Calculation of Vertical Curve:

Vertical curves can be calculated by the following methods:

2.9.5.2.1 Algebraic Method:

$$FL\ Elev. = PVI. + \frac{1}{8} (|G_1 - G_2|) \times (L/100)$$

Example:

$$\begin{aligned} FL\ Elev. &= 495.40 + \frac{1}{8} (|5.20 - 0.80|) \times (100/100) \\ &= 495.95 \end{aligned}$$

2.9.5.2.2 Averaging Method:

$$FL\ Elev. = \{[(P.V.C. + P.V.T.) / 2] + P.V.I.\} / 2$$

Example:

$$\begin{aligned} FL\ Elev. &= \{[(495.00 + 498)/2] + 495.40\} / 2 \\ &= 495.95 \end{aligned}$$

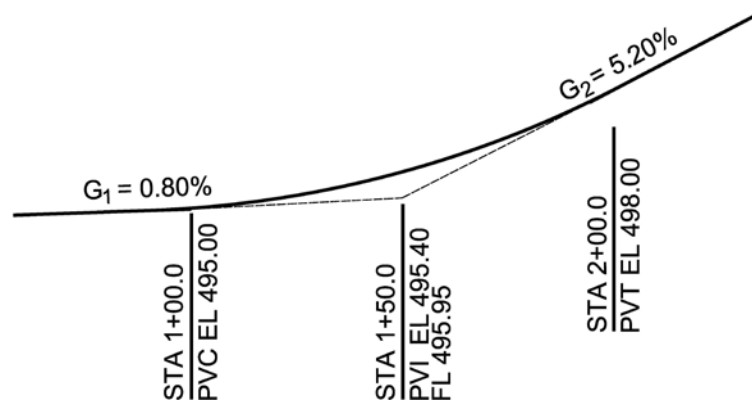


Figure 2.9.5.2: Vertical Curve

2.9.6 Profile

- All 12" or larger water main designs must have a vertical profile.
- All 8" or larger water mains in advance of a permanent pavement and/or storm drain project must have a vertical profile in order to avoid any potential conflict with proposed storm drain and pavement adjustments.
- All 8" or larger water mains installed in an unimproved street (with no curb and gutter) must have vertical profile.

2.9.7 Slope Designation

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

2.9.8 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.

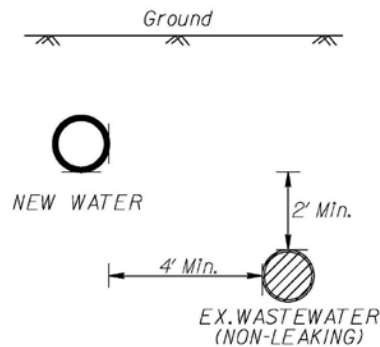


Figure 2.10.4.1.1:
New Water Main Parallel to Existing Non-Leaking Wastewater Main

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.

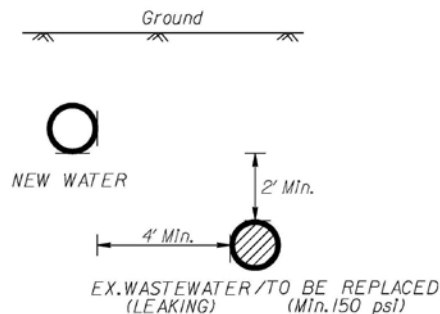
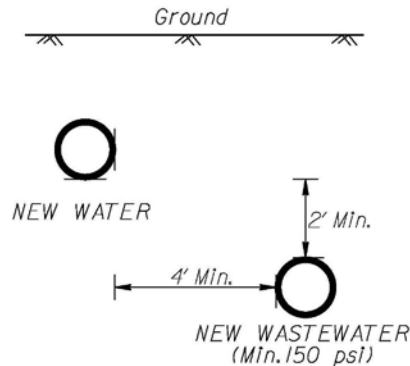


Figure 2.10.4.1.2:
New Water Main Parallel to Existing Leaking Wastewater Main

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.



**Figure 2.10.4.1.3:
New Water Main Parallel to New Wastewater Main**

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.

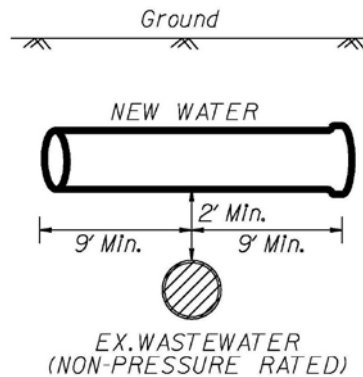


Figure 2.10.4.2.1:
New Water Main Crossing Existing Non-Pressure Rated Wastewater Main

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.

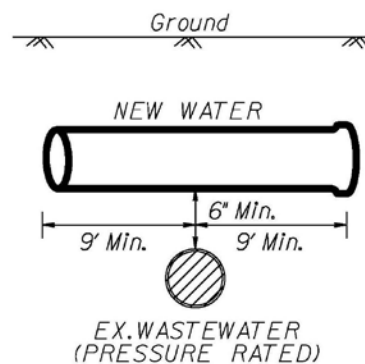


Figure 2.10.4.2.2:
New Water Main Crossing Existing Pressure Rated Wastewater Main

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.

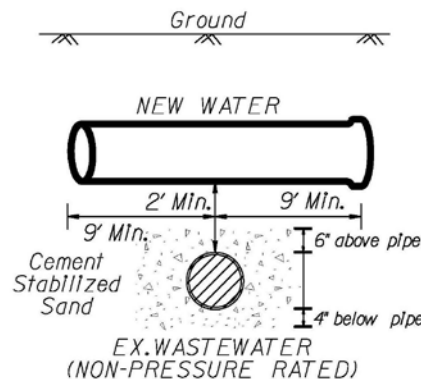


Figure 2.10.4.2.3:
Crossing New Wastewater Main Minimum Pipe Segment

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.*

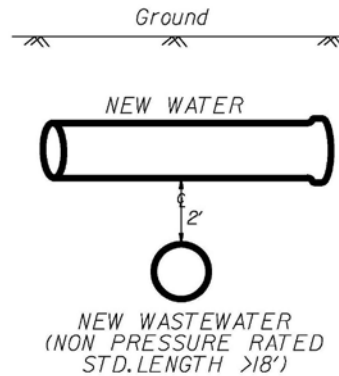


Figure 2.10.4.2.4.1:
Variance for Crossing New Wastewater Main
with 2' Minimum Vertical Separation

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.

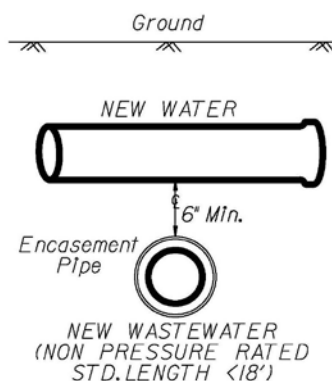
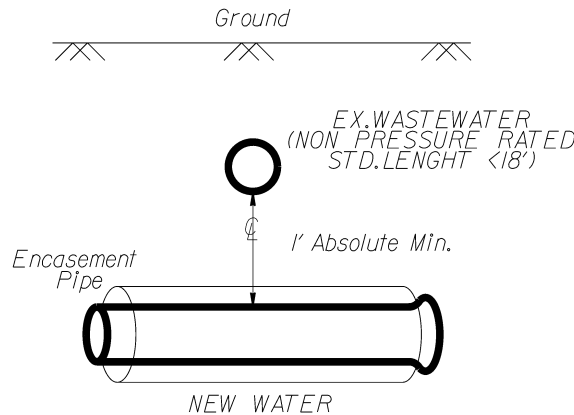


Figure 2.10.4.2.4.2:
Variance for Crossing New Wastewater Main
with 6" Minimum Vertical Separation

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.



**Figure 2.10.4.2.4.3:
Variance for Crossing New Wastewater Main
With 1' Minimum Separation**

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.

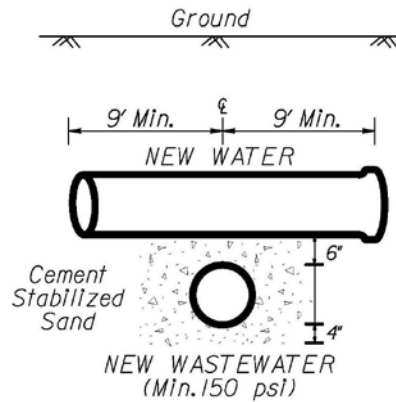


Figure 2.10.4.2.5
New Water Main Crossing New Pressure Rated Wastewater Main

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 Proximity of Wastewater Main, Lateral, Manhole or Cleanout

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.

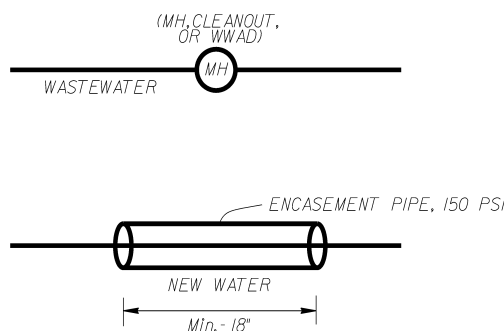


Figure 2.10.5:
Separation between Waterline and Wastewater Mains/Lateral/Manhole/Cleanout

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 Proximity of Reclaimed Water Mains

Water mains located adjacent to reclaimed water main shall comply with the separation criteria established in §4.10 regarding separation distance between reclaimed water and water/wastewater mains.

2.10.10 Proximity of Storm Drain and Gas Mains

- The horizontal separation distance from a potable waterline of 20" diameter or smaller to a storm drain shall be 4 feet (preferred) and 3 feet (minimum).
- The horizontal separation distance from a potable waterline of 20" diameter or smaller to a gas main shall be 4 feet (minimum).
- The separation distance for a potable waterline of larger than 20" diameter to a storm drain or gas main shall be considered on a case-by-case basis.

2.10.11 Proximity of Piers, Foundations and Vertical Structures

- The minimum horizontal separation distance between proposed water and existing/proposed piers, foundations or vertical structures shall be 10 feet from outside edge to outside edge as applicable.
- If 10 feet horizontal separation is not available, then each situation should be evaluated on case-by-case basis to allow adequate space for future maintenances.

2.10.12 Foreign Mains Crossing DWU Water Easements

See §7.6.1 and §7.6.2.

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.

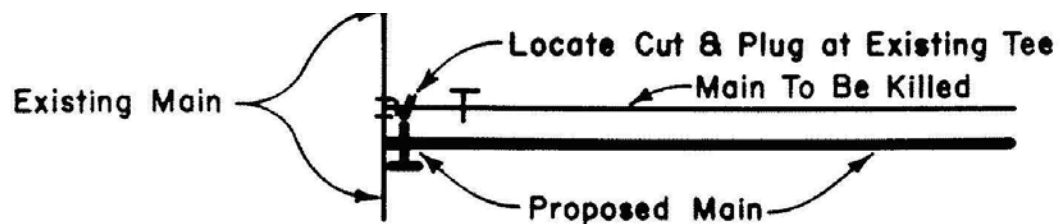


Figure 2.11.1.1:
Connection to Existing Water Main by Tapping

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).

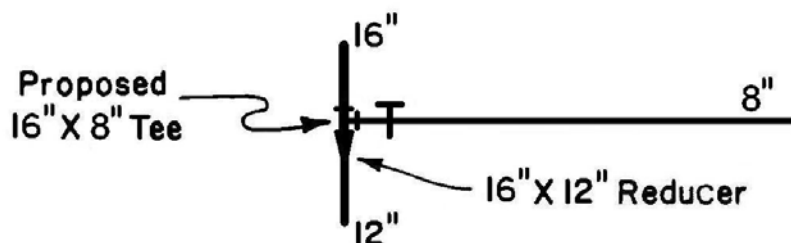
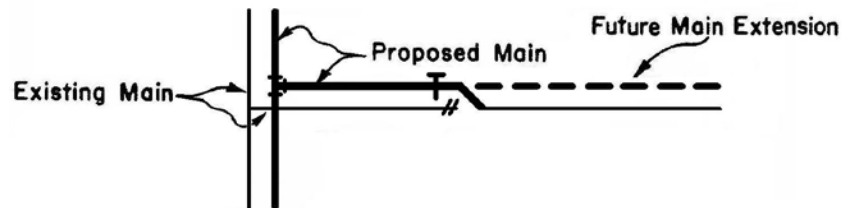


Figure 2.11.1.2:
Placement of Reducer at Tee

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.



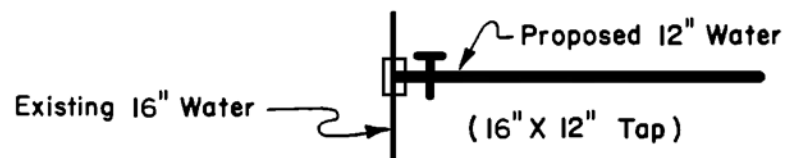
**Figure 2.11.1.3:
Connection to Existing Water Main for Future Extension**

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".

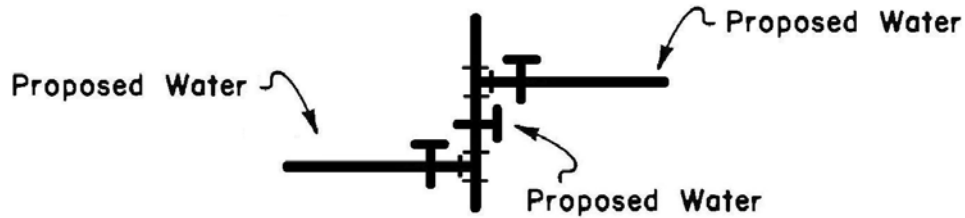


**Figure 2.11.1.4.1:
Tapping Criteria for Water Mains**

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

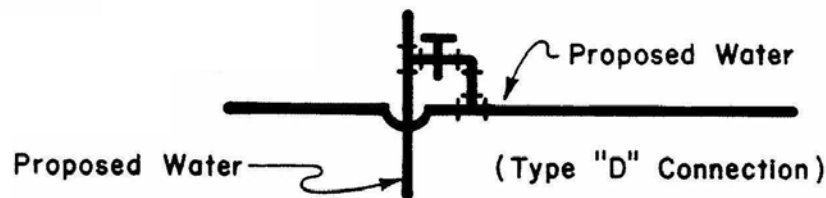
2.11.1.4.2 Connections:

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



**Figure 2.11.1.4.2a:
Standard Connection**

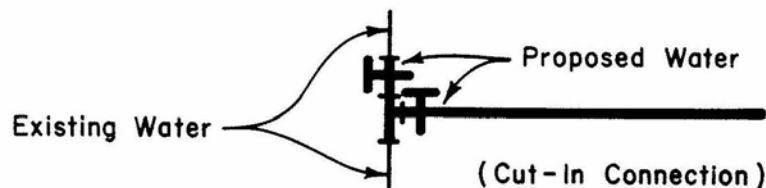
- Crosses are not permitted. However, Type-D connections may be allowed when other types of connection are not feasible.



**Figure 2.11.1.4.2b:
Type D Connection**

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**

2.12 DEADEND MAINS

2.12.1 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 in accordance with **Table 2.12.1** unless otherwise required by DWU:

Table 2.12.1: Deadend Main Requirements

Deadend Length (ft)	Requirements
Less Than 100	Flush Point
100- 300	Flush Point or Fire Hydrant
More than 300	Flush Point and Fire Hydrant

2.12.2 Special Consideration:

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

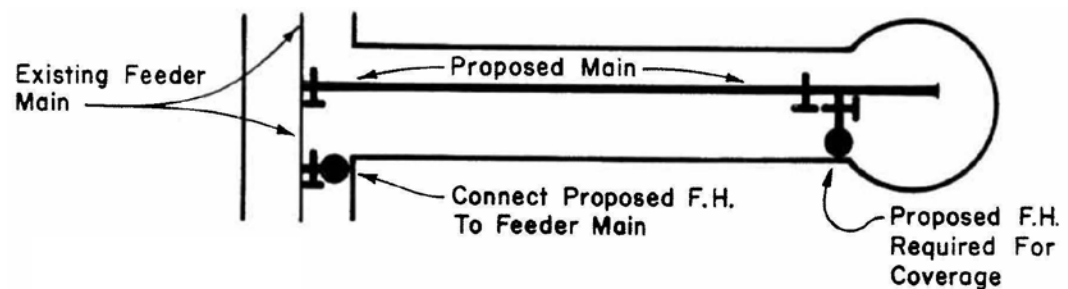


Figure 2.12.2: Deadend Mains

- No more than one fire hydrant shall be connected to a deadend main
- If the deadend is less than 8" a flushing device shall be installed.

2.12.3 Reference Schematics:

- DWU Drawing No. 224 for Fire hydrant
- DWU Drawing No. 207 for Flush Point

2.13 WATER SERVICES

2.13.1 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.

2.13.2 Small Water Service:

- Typical small water services range from 5/8" through 2" in diameter. Water service over 30 feet shall be a minimum of 1" in diameter.
- Typically copper (Type K) is to be used for small water service.
- For a typical single family residential lot, 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.
- The minimum size of deadheads that can be connected to multiple services and meters are as follows:

**Table 2.13.2:
Minimum Deadhead Size for Multiple Services and Meters**

Deadhead Size (in)	Supporting Meters (in)
1"	2- 5/8" or 2- 3/4"
1-1/2"	2- 1" or 4- 3/4"
2"	6- 3/4 or 4- 1"

- Bull head services intended for two lots shall be located in the common property line between two lots and are to be installed as per DWU Standard Drawings Manual.
- Designer shall show all DWU service meters on drawings.
- Reference Schematics: DWU Standard Drawing Nos. 201- 206A.

2.13.3 Large Water Service:

- Typically large water services are greater than 2" in diameter. A service line of minimum 4" will be required for a 3" meter.
- Typically PVC C900 (DR 14) or ductile iron pipe shall be used for large water services.
- 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.
- Standpipe fire line services are not allowed unless otherwise approved by DWU. Typically a standpipe is an old fire protection system with a fire hydrant or hose connection from which water may be taken manually.
- Reference Schematics: DWU Standard Drawing Nos. 501- 521.

2.13.4 Reference:

See §3.5 (**Water Meter**) for additional requirements on water service and meters.

2.14 ABANDONMENT OF WATER MAINS

- Water 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.

2.15 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 (Ref: §506.6.2.COD-506.7.5.4.COD of the City of Dallas NCTCOG Addendum).

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:

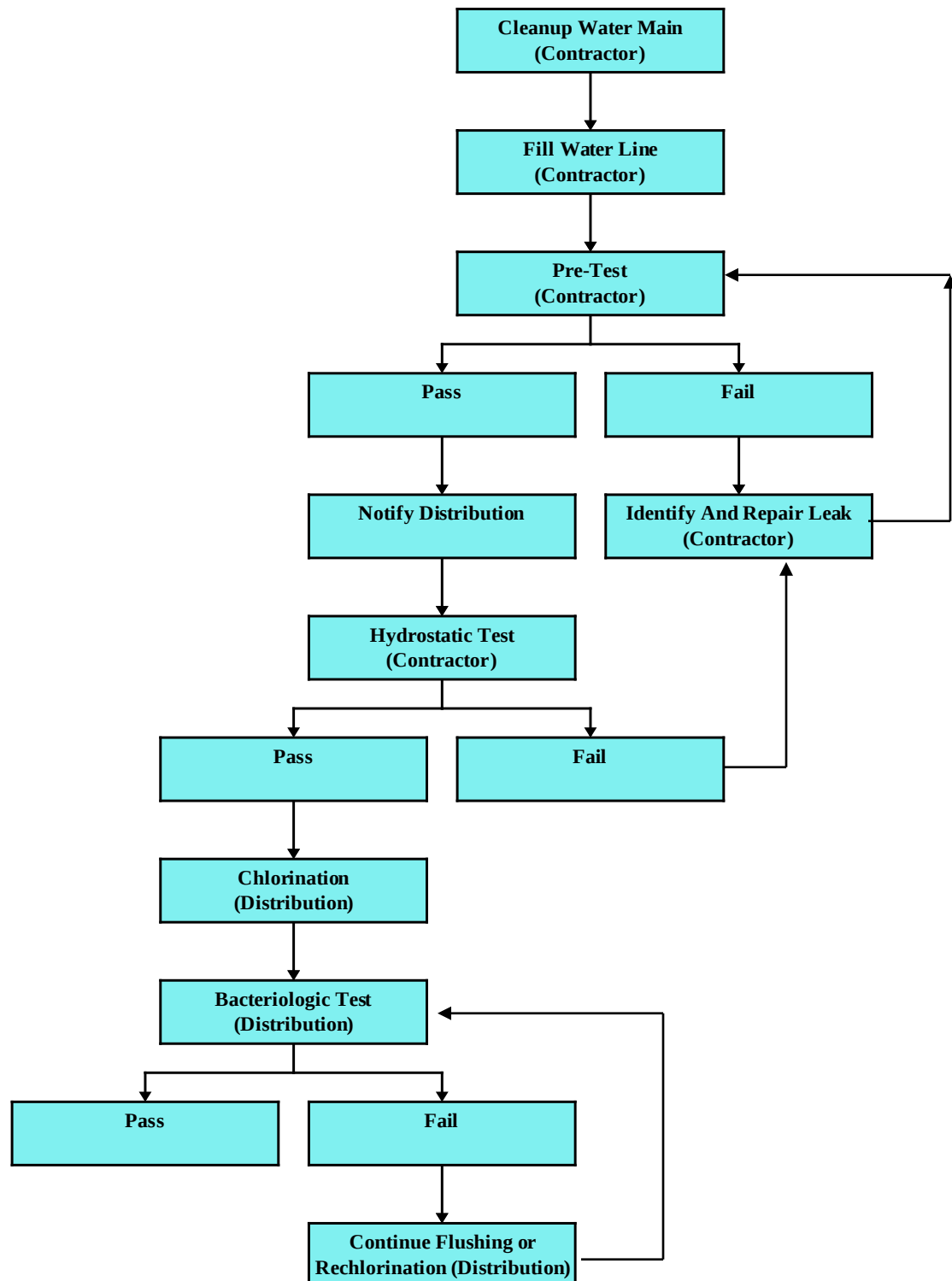


Figure 2.15.5: Flow Diagram for Hydrostatic & Bacteriological Testing Process

CHAPTER 3

WATER APPURTENANCES AND FACILITIES DESIGN

3.1 REFERENCES

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

3.2 ISOLATION VALVE

3.2.1 Type and Spacing

The following three (3) types of isolation valves are 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 3.2.1: Valve Spacing and Appurtenances Criteria

Valve Size (in)	Valve Type	Bypass Size (in)	Valve Access Manhole Size (ft)	Valve Blow Off Manhole Size (ft)	Max. Spacing (ft)
16 or Smaller	Vertical Gate Valve	N/A	N/A	N/A	1000
18 thru 30	Horizontal Gate Valve w/ Integral Bypass and Access Manhole	As Per Manufacturer	5	N/A	As Per Distribution Division
36 thru 42			6	N/A	
48 thru 66	Butterfly Valve w/ External Bypass and Access Manhole	6	6	4	
72 thru 90		8	6	4	
96 or Larger		12	6	4	

3.2.2 Location

The following guideline should aid designer in placement of valves:

- 3.2.2.1 Valves shall be designed at locations that will not unduly impact the customer or reduce fire protection and be easy to locate.
- 3.2.2.2 Valves are to be located such that three valves are normally required to isolate a section of main (**Figure 3.2.2.2**).

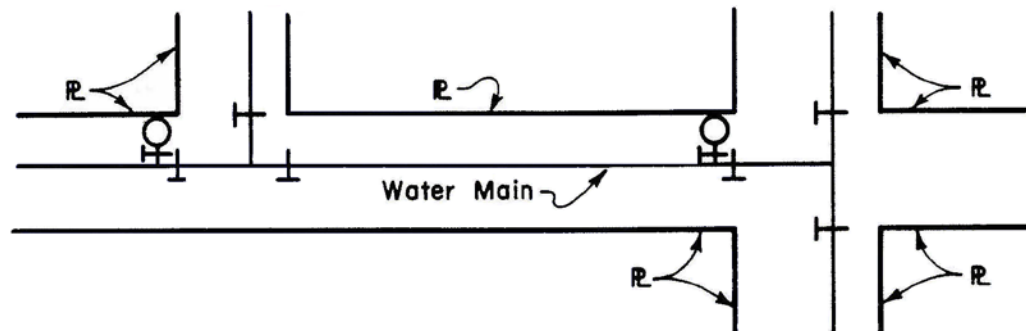


Figure 3.2.2.2:
Valve Location Configuration

- 3.2.2.3 The total number of valves at any water main intersection shall equal the total number of lines leading out from the intersection point minus one, therefore a minimum of two valves to be used at a tee.
- 3.2.2.4 Valves, except tapping valves shall be located at street intersections at the projection of property lines projected across the water main (**Figure 3.2.2.4**).

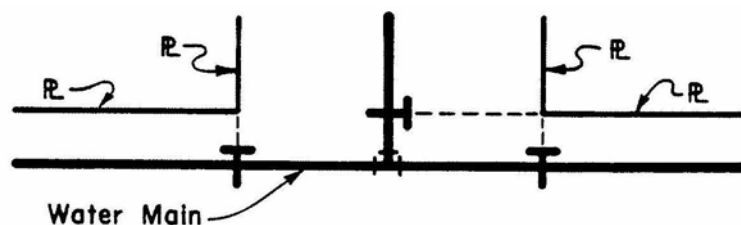
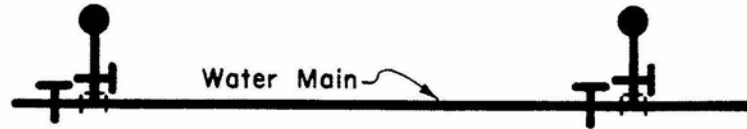


Figure 3.2.2.4:
Valve Location at Street Intersection

- 3.2.2.5 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 3.2.2.5**).



**Figure 3.2.2.5:
Valve between Fire Hydrants**

- 3.2.2.6 Valves shall not be located at the street gutter, roadside ditch slope or flowline.

3.2.3 Reference Schematics

DWU Standard Drawing Nos. 212- 218

3.3 FIRE HYDRANT

3.3.1 Type

3.3.1.1 Private Fire Hydrant:

- Private fire hydrants are to be located outside public R.O.W. and within private property to provide fire protection as approved by Dallas Fire and Rescue.
- Water main serving a private fire hydrant must be 8" or larger and the minimum acceptable fire hydrant lead is 6.
- Maximum length of fire hydrant lead shall be 100 feet unless otherwise approved by DWU. Any lead over 50 feet requires an 8" lead.
- Dallas Fire and Rescue establishes the design and construction criteria and reviews and inspects private fire hydrants.
- The City Fire Marshall typically establishes or approves the location of private fire hydrants in apartment complexes, platted private street developments, and other multifamily developments within the City and Extra Territorial Jurisdiction (ETJ) as needed.
- The private line feeding a private fire hydrant cannot be looped back into the DWU distribution system. Any loop shall be internal and to be fed by the metered private line.
- Gate valves shall be provided between every fire hydrant.
- All private fire hydrants shall be metered and to be maintained by property owner.

3.3.1.2 Public Fire Hydrant:

- Public fire hydrants are to be located in the public right-of-way to provide fire protection as approved by DWU.
- Water main serving a public fire hydrant must be 8" or larger and the minimum acceptable fire hydrant lead is 6".
- Maximum length of fire hydrant lead shall be 100 feet unless otherwise approved by DWU. Any lead over 50 feet requires an 8" lead.

3.3.2 Spacing

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

Table 3.3.2: Public Fire Hydrant Spacing

Dwelling Type	Spacing (ft)	Remarks*
Single Family Residential Development or Single Family Duplex	700	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.
All Other Areas	500	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.

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

3.3.3 Location

The location of all public fire hydrants shall meet the following criteria:

- Fire hydrants 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.
- No more than one fire hydrant will be allowed on a dead end main.
- Fire hydrant locations between street intersections shall be at the projection of a property line between owners.
- New fire hydrants shall be placed as close 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.

3.3.4 Color Code

- Typical Color to be used for all fire hydrants are as follows

Table 3.3.4: Fire Hydrant Color Code

Main Size (in)	Fire Hydrant Color
4	Red
6	Silver
8	Blue
10+	Yellow

Note: All new water main serving a fire hydrant must be 8" or larger

3.3.5 Fire Flow Test

Upon request by the designer, fire flow test may be performed by the Distribution Division in order to evaluate the fire flow capacity to a specific site.

- The following items shall be addressed when performing a fire flow test:
 - A pressure hydrant and flow hydrants need to be chosen as shown in **Figure 3.3.5**.
 - The pressure hydrant should be closer to a feed main than the flow hydrant.
 - The number of flow hydrants should be determined.
- The following data need to be recorded during a fire flow test:
 - Static Pressure: This refers to the pressure reading before water flows. It is taken from the pressure hydrant just prior to time of the fire flow test.
 - Residual Pressure: This refers to the pressure reading while water is flowing. It is taken from the pressure hydrant while the flow hydrants are flowing full. This pressure is taken to determine the fire flow for sufficient fire coverage.
 - Pitot Pressure: This reading is taken by a pitot gauge from the flow hydrants. The pitot gauge should be inserted into the center of the flowing outlet at approximately half of the diameter away from the nozzle.

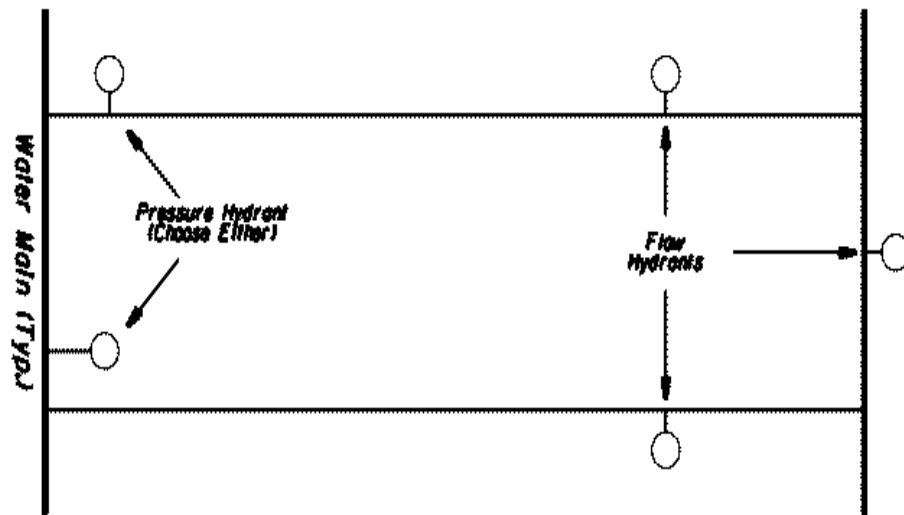


Figure 3.3.5: A Typical Configuration of Fire Hydrants for Fire Flow Test

- Using the readings recorded during the fire flow test the following equations can be used to determine the fire flow:

$$Q_r = 29.83 c_d D^2 \sqrt{P_p}$$

$$Q_f = Q_r \left(\frac{P_s - 20}{P_s - P_r} \right)^{0.54}$$

Where:

Q_r = Residual flow at the pitot pressure, gpm

c_d = Friction loss coefficient (typically 0.9 for a smooth 2 ½" opening)

D = Diameter of the opening, in

P_p = Pitot pressure, psi

Q_f = Fire flow, gpm at 20 psi

P_s = Static pressure, psi

P_r = Residual pressure, psi

3.3.6 Reference Schematic

- DWU Standard Drawing No. 224.

3.4 FLUSH POINT

3.4.1 General Requirements

- Flush points are to be installed primarily to flush water mains as needed
- Fire hydrants shall not be used in lieu of flush points
- Flush points shall not be designed to flush water to storm drains in order to prevent migration of chlorine residual in storm water system.
- The developer may need to extend a lateral to the end of the cul-de-sac so that it can be used to flush the water thru a flush point.

3.4.2 Type

Two types of Flush Points are typically used for water mains:

- Manually Operated Flush Point
- Automatic Flush Point
 - Automatic Flush Points can only be installed where frequent flushing may be required, contingent upon Distribution approval.

3.4.3 Size

- Typical size of Flush Points are shown in Table

Table 3.4.2: Typical Size of Flush Points

Main Size (in)	Flush Point (in)	
	Manual	Automatic
16 or Smaller	2	2
Larger Than 16	N/A	N/A

3.4.4 Location

- Deadend mains
- Backflow Preventer
- High/Low Valve Assembly

3.4.5 Reference Schematic

- Manually Operated Flush Point Assembly:
DWU Standard Drawing No. 207
- Automatic Flush Point Assembly
DWU Standard Drawing Nos. 207A

3.5 WATER METER

3.5.1 General Requirements

- As per City Code Chapter 49-9, all residential and non-residential, including but not limited to, commercial, industrial and wholesale customers are to be metered.
- Raw water will typically be metered at the lake intakes and point of entry of water treatment plants (WTP).
- Treated water will be metered at the exit or discharge side of water treatment plants (WTP) and pump stations.
- The designer is responsible for the location, selection, and sizing of water meters in accordance with the applicable criteria as specified in this section.

3.5.2 Definitions

- **Advanced Metering Infrastructure (AMI):**
This refers to an intelligent technology that interacts with water meters to measure, collect and analyze water usage through various communication media either on request (on-demand) or on pre-defined schedules. AMI typically encompasses several different components: meters, automatic meter reading (AMR) systems, communications technology, and data warehouses.
- **AMI Endpoint:**
This is a radio-based module that fit on meters. Endpoints encode consumption and tamper information from the meters and communicate the data via radio to AMI collection system (Handheld, Mobile AMR and Fixed Network).
- **AMI Meter Assembly:**
This is a combination of the meter assembly with AMI ready meter, AMI compatible lid, and end point.
- **Residential Meter:**
A residential meter is generally used in conjunction with a domestic water service of single-family home. These meters typically range from five-eighths (5/8) through two (2) in. in sizes.
- **Non-Residential Meter:**
Non-residential meters are generally used to serve non-residential water demand from commercial or industrial customers. These meters typically range from one (1) to ten (10) in. in sizes as required by the customer water demand while meeting all applicable plumbing code.
- **Irrigation Meter:**
A meter used in conjunction with an irrigation water service to measure the water flowing to a property that primarily services the needs of the property landscape. All irrigation meters must have a backflow prevention device.

- **Master Meter:**
A master meter is typically used to serve a cluster of residential or commercial developments located on a single lot. Master meters cannot be used to serve buildings on separate lots.
- **Sub-Meter:**
Privately owned meters that can be used to encourage effective conservation and efficient use of water by fairly allocating its cost among the ultimate users within a master metered apartment units, office building, or shopping center. The sub-meters are not to be read and billed by the City as they are considered private meters.
- **Deduct Meter (Private Meter):**
A deduct meter is installed on a specific water process inside of private property that subtracts the process flow from the metered water flow.
- **Temporary Meters (Fire Hydrant Meter):**
Temporary water meters are typically used by contractor to draw water for construction from fire hydrants. These meters are typically 3 in. with 2.5 in. hose and require backflow prevention devices.
- **Wholesale Meter (Customer City Meter):**
A wholesale meter is generally used to serve a wholesale municipal customer who purchases water for resale. This is typically a venturi-type meter and is sometimes referred to as a Customer City Meter. Wholesale meters are managed by DWU Wholesale Service in conjunction with DWU Meter Reading and Operations.

3.5.3 Design Data

Water meters shall be designed based on the peak water demand and type of application as necessary. All meters shall be adequately sized in order to avoid the following undesirable conditions:

- Volume, pressure and maintenance problem due to under sizing
- Unregistered water use in low flow conditions due to over sizing

A sample water meter sizing worksheet prepared in accordance with AWWA M22: Sizing Water Service Lines and Meters, latest Edition is included in **Appendix I**. Accordingly, all applicable water usage including domestic, irrigation, mechanical and fire demand shall be considered while sizing a water meter:

3.5.3.1 Domestic Water Demand:

In absence of actual demand profile, the following modified fixture count method can be used to estimate peak flow demand while meeting all applicable plumbing and fire codes:

3.5.3.1.1 Combined Fixture Value:

The following recommended fixture value shown in **Table 3.5.3.1.1** can be used to estimate the combined fixture value as necessary:

Table 3.5.3.1.1: Recommended Fixture Value

Fixture	Fixture Value @ 60 psi
Bathtub	8
Bedpan Washers	10
Bidet	2
Dental Unit	2
Drinking Fountain (public)	2
Faucet (kitchen sink)	2.2
Faucet (lavatory)	1.5
Shower Head (shower only)	2.5
Faucet (utility sink)	4
Urinal (flush valve)	35
Urinal (wall or stall)	16
Urinal Trough (2 ft. unit)	2
Toilet Flush Valve	35
Toilet Tank Type	4
Dishwasher	2
Clothes Washer	6
Hose (50 ft length wash down)	5
1/2" connection	9
5/8" connection	12
3/4" connection	

Source: AWWA M22: Sizing Water Service Lines and Meters, Second Edition

3.5.3.1.2 Peak Domestic Demand:

Figure 3.5.3.1.2A and **Figure 3.5.3.1.2B** can be used to determine low and high range of peak demands using the estimated combined fixture value:

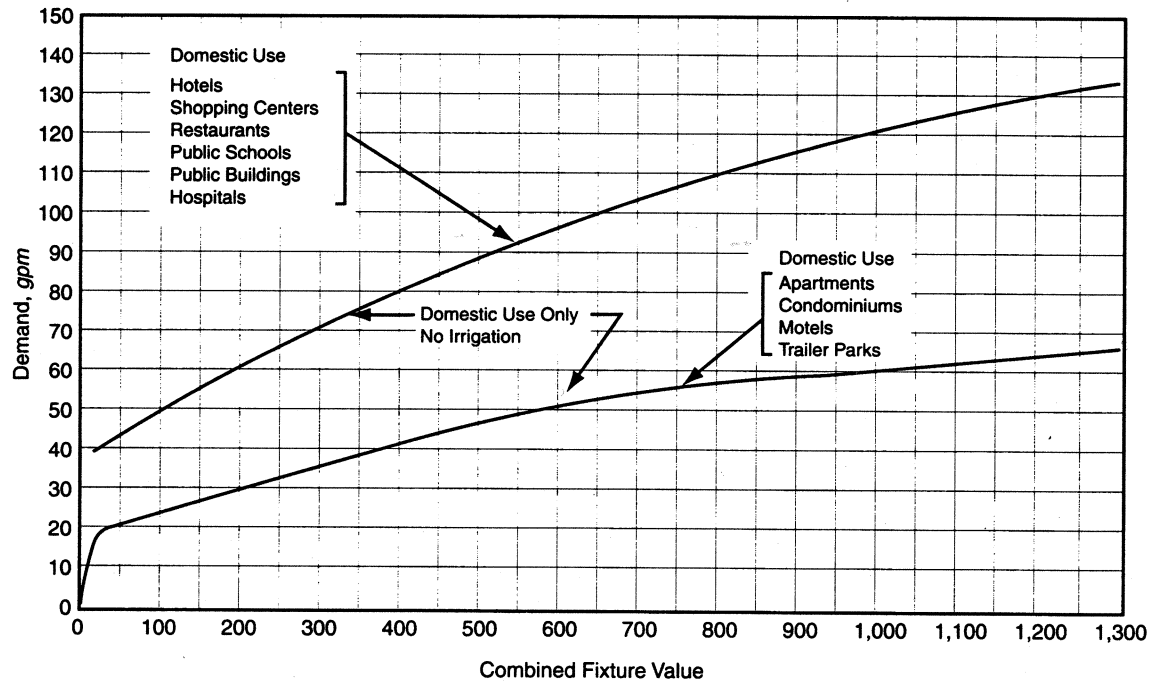


Figure 3.5.3.1.2A: Water Flow Demand per Fixture Value – Low Range

Source: AWWA M22: Sizing Water Service Lines and Meters, Second Edition

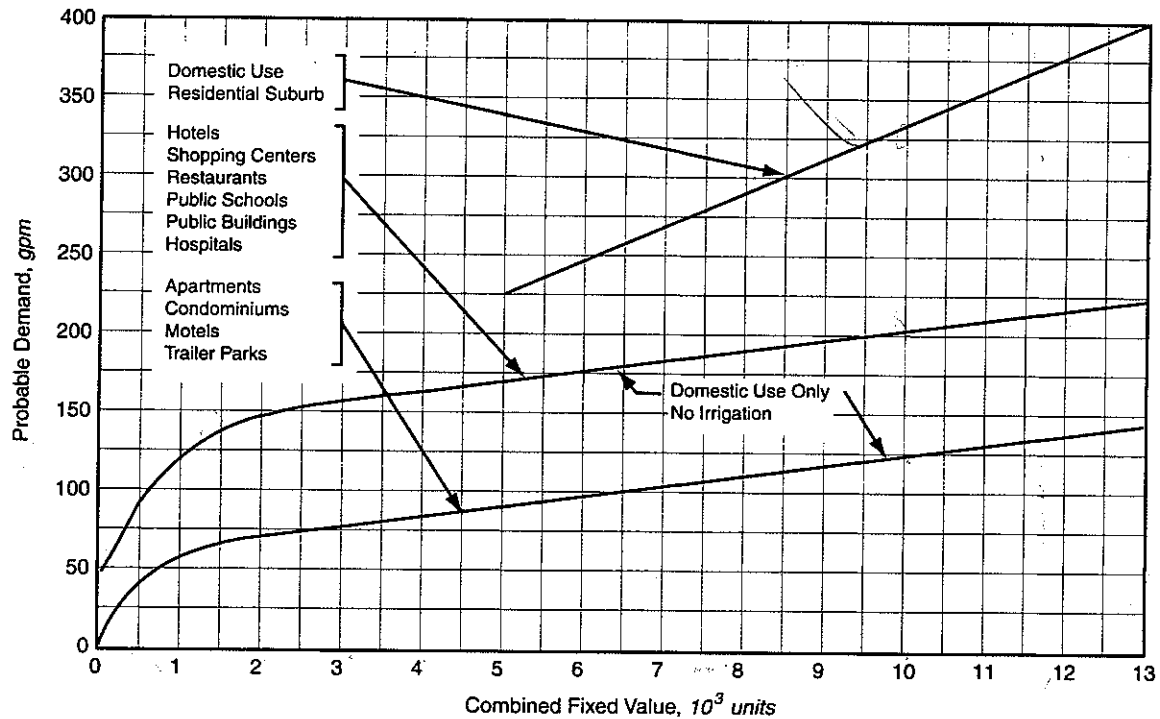


Figure 3.5.3.1.2B: Water Flow Demand per Fixture Value – High Range

Source: AWWA M22: Sizing Water Service Lines and Meters, Second Edition

3.5.3.1.3 Pressure Adjustment:

Estimated peak demand shall be adjusted to actual available pressure at proposed meter location (**Table 3.5.3.1.3**). Typically a fire hydrant test shall be requested to determine or verify the actual water pressure at the peak demand of the proposed meter location

Table 3.5.3.1.3: Pressure Adjustment Factors

Working Pressure at Meter Discharge (psi)	Pressure Adjustment Factor
35	0.74
40	0.80
50	0.90
60	1.00
70	1.09
80	1.17
90	1.25
100	1.34

Source: AWWA M22: Sizing Water Service Lines and Meters, Second Edition

Example: The total fixture count of a facility at assumed 60 psi is calculated to be 100
The modified fixture count at actual 80 psi will be $100 \times 1.17 = 117$

3.5.3.2 Irrigation Water Demand:

The irrigation water demand shall be estimated considering the following items:

- Area to be irrigated
- Type of irrigation System to be used (spray or rotary)
- Number of hose bib
- Pressure adjustment

3.5.3.3 Mechanical Demand:

Mechanical water demand shall typically be obtained from MEP Engineers considering the following items:

- Type of equipment to be used (cooling towers, AC or wash down systems)
- Type of usage (continuous or intermittent)

3.5.3.4 Fire Demand:

Fire demand shall meet the requirements of the International Building Code (IBC), the International Fire Code (IFC) and the National Fire Protection Agency (NFPA) and other regulations as applicable. Fire demand shall typically be obtained from Electrical, Mechanical and Plumbing (MEP) or Fire Engineer considering the following items:

- Type of Building or Construction (Type 1A, 1B, IIA, IIB, IV, IIIA, IIIB, VA, VB)
- Type of Occupancy (Residential or Non-Residential)
- Type of Sprinkler System (Wet Pipe, Dry Pipe, Pre-Action and Deluge System), if any
- Type of Fire Pump, if any

As per 2006 International Building Code, fire flow requirements for buildings are summarized in **Table 3.5.3.4**. A reduction in required fire flow up to 75% may be allowable if building is provided with approved automatic sprinkler system.

Table 3.5.3.4: Summary of Fire Flow Requirements for Building

Parameter	One-and-Two Family Dwelling		Building Other Than One-and-Two Family Dwelling
Floor Area (ft)	<3,600	>3600	As Required
Fire Flow (gpm)	1,000	1,500- 8,000	1,500- 8,000
Allowable Fire Flow Reduction (%)	0- 50	0- 50	0- 75
Fire Flow Duration (Hr)	—	2- 4	2- 4

Source: 2006 International Fire Code, Table B105.1, Appendix B

3.5.4 Meter Classification

The following types of water meters shall be considered:

- Positive Displacement (PD) Meter:
 - Positive displacement meters shall typically be used for low flow rates (<160 gpm) with wide range of flow fluctuations.
- Non-Displacement Meter:
 - Non-Displacement meters are typically used for high flow applications where accuracy at an extremely low range is not important.
 - If large capacity is of primary importance and the flows are usually above 10 or 15 percent of the maximum rating and low flow accuracy is secondary, Non-Displacement can be considered.
- Compound Meter:
 - Compound meters consist of integrally connected positive displacement and non-displacement meters and to be used to measure low and high flows. Low flows are measured through positive displacement while high flows are measured by non-displacement meters.
 - If close accuracy at low flows is important but large capacity is also needed, compound meters can be used.

General recommended uses of various types of meters are summarized in the following **Table 3.5.4:**

Table 3.5.4: Recommended Use of Various Water Meters

General Category	Sub-Category	Typical Use
Positive Displacement (PD) (Low Flow Application)	Nutating Disc Oscillating Piston	- Single Family Residential - Apartment Building with Less than 100 Units - Small Business - Schools and Other Public Buildings without Large Irrigation
Non-Displacement (High Flow Application where Accuracy is secondary)	Velocity Turbine Multijet Magnetic (Mag) Ultrasonic Propeller Proportional	- Large Hotels - Factories - Public Irrigation - Large Office Buildings - Pump Discharge - Hospitals
	Differential Pressure Fixed Opening: Variable Differential Orifice Venturi Variable Opening: Fixed Differential Rotameter	- Pump Discharge - Wholesale Water Purchasers - Research Applications - Subsystem Metering
	Mass Flow	
	Level Measurement Weir Parshall Flume	
Compound	Standard Compound Fire Service	- School with Irrigation - Laundries - Large Apartment Buildings - Fire Lines - Hospitals

Source: AWWA M22: Sizing Water Service Lines and Meters, Second Edition. *denotes meters not commonly used

3.5.5 Service Allocation and Meter Selection

Based on the estimated flow rate and type of service, designer shall determine the need for a single or multiple services as per §2.12.3 (Water Services) while considering the following criteria:

3.5.5.1 Domestic Service and Meter:

A single meter on a domestic service line shall be used primarily to measure domestic flow only.

3.5.5.1.1 Small Domestic Service and Meter:

- Typical size of small domestic meters are 5/8", 3/4", 1", 1-1/2" and 2" (See **Figure 3.5.5.1.1**).
- Domestic meters can also be used to supply irrigation and/or residential fire demand with the approved fire sprinkler systems as necessary.
- 5/8"- 2" Nutating disc positive displacement (PD) is commonly used in residential domestic and optional irrigation demand.
- Detail Reference Schematics: DWU Standard Drawing Nos. 201-206A.

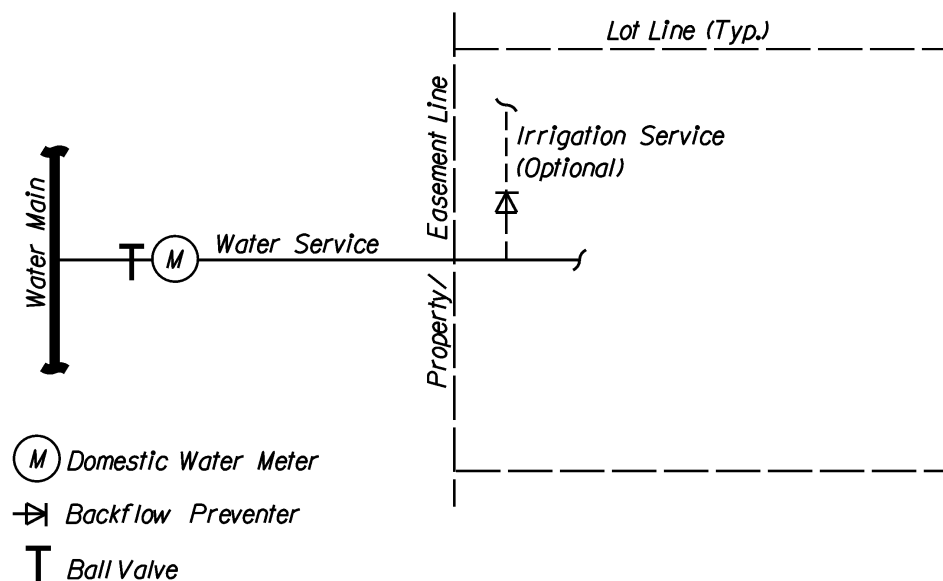


Figure 3.5.5.1.1: Typical Small Domestic Service and Meter Configuration

3.5.5.1.2 Large Domestic Service and Meter:

- Typical size of large domestic meters are 3", 4", 6", 8" and 10" (See **Figure 3.5.5.1.2**)
- Nutating disc positive displacement (PD), turbine or compound meter can be used for a large domestic meter as necessary
- Detail Reference Schematics: DWU Standard Drawing Nos. 513- 516.

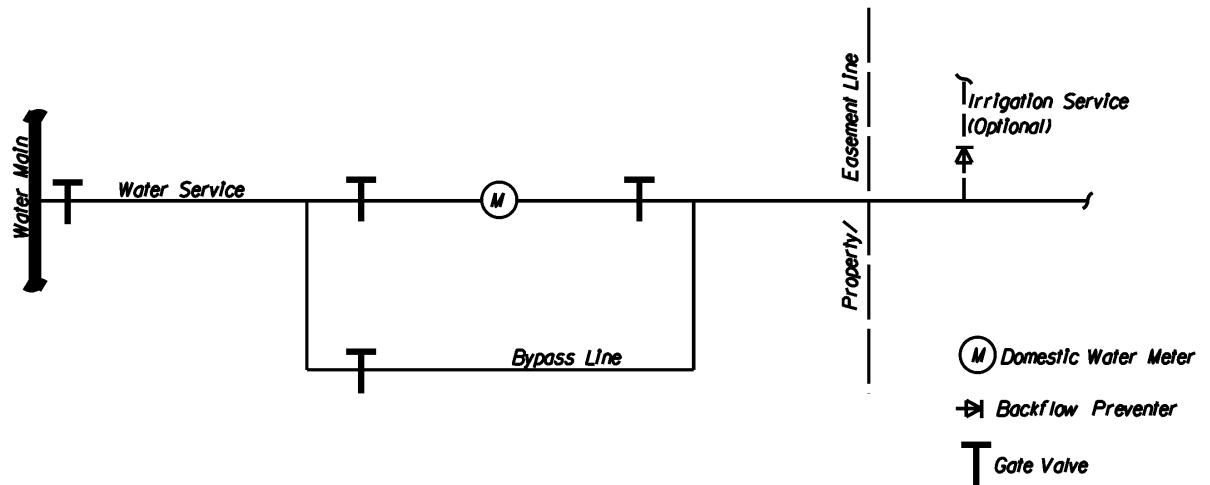


Figure 3.5.5.1.2: Typical Large Domestic Service and Meter Configuration

3.5.5.2 Fire Service and Detector Check Device:

- A single Detector Check (DC) on closed fire line shall typically be used to measure fire flow for approved automatic fire sprinkler only (See **Figure 3.5.5.1.3**).
- Typical size of a Detector Check (DC) is 4" (min.), 6", 8" and 10" as necessary. A 5/8"- 1" Nutating Disc Positive Displacement (PD) meter is also typically used in a bypass line conjunction with Detector Check (DC).
- Bypass line in a dedicated fire line should not be used for domestic use.
- Detail Reference Schematics: DWU Standard Drawing Nos. 517- 521.

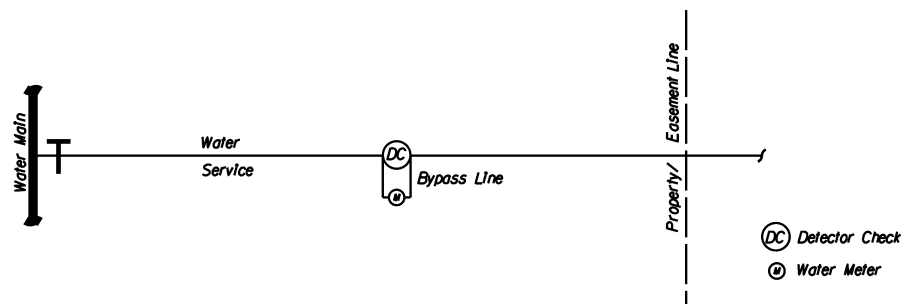


Figure 3.5.5.1.3: Typical Fire Service and Detector Check Configuration

3.5.5.3 Irrigation Service and Meter:

- A single meter on an irrigation service line shall typically be used to measure water required for irrigation or landscaping.
- Typical size of single irrigation meter is 1", 1 ½", 2", 3", 4" and 6" as necessary (See **Figure 3.5.5.3**).
- A backflow prevention device must be used on all irrigation service.

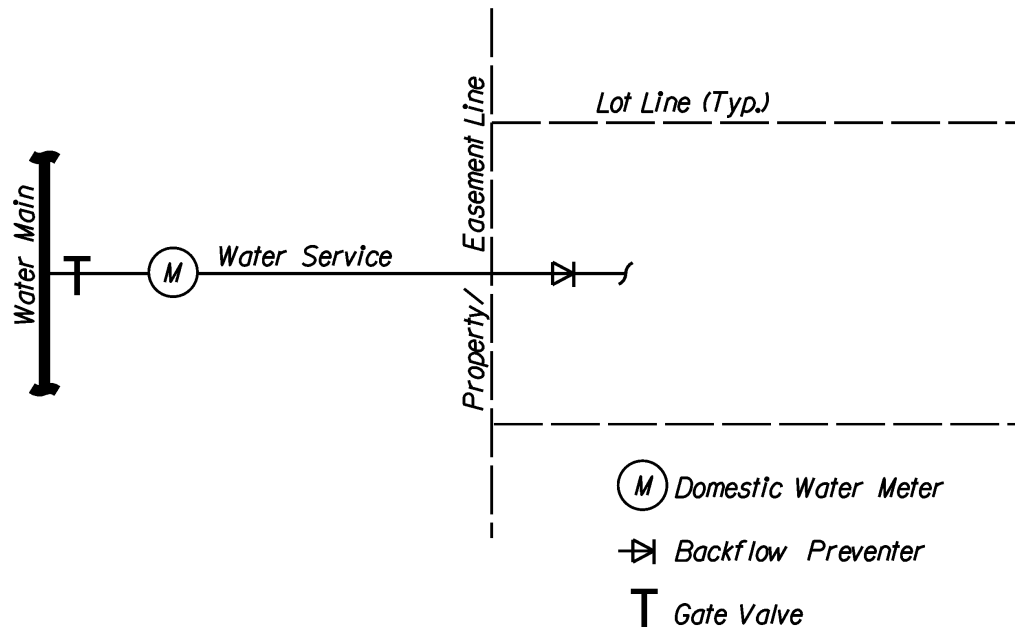


Figure 3.5.5.3: Typical Irrigation Service and Meter Configuration

3.5.5.4 Combined Water and Fire Services and Meters:

A single or a combination of meter(s) can be used to measure combined water, fire and/or irrigation services as required.

3.5.5.4.1 Small Combined Water and Fire Service and Meter(s)

- Typical size of a meter to measure small combined water and internal fire sprinkler is 1"-2" as necessary (**Figure 3.5.5.4.1**).
- Multijet turbine meter shall be used to measure residential domestic service with fire demand.
- One meter per house or building shall only be allowed for residential fire sprinklers as necessary.

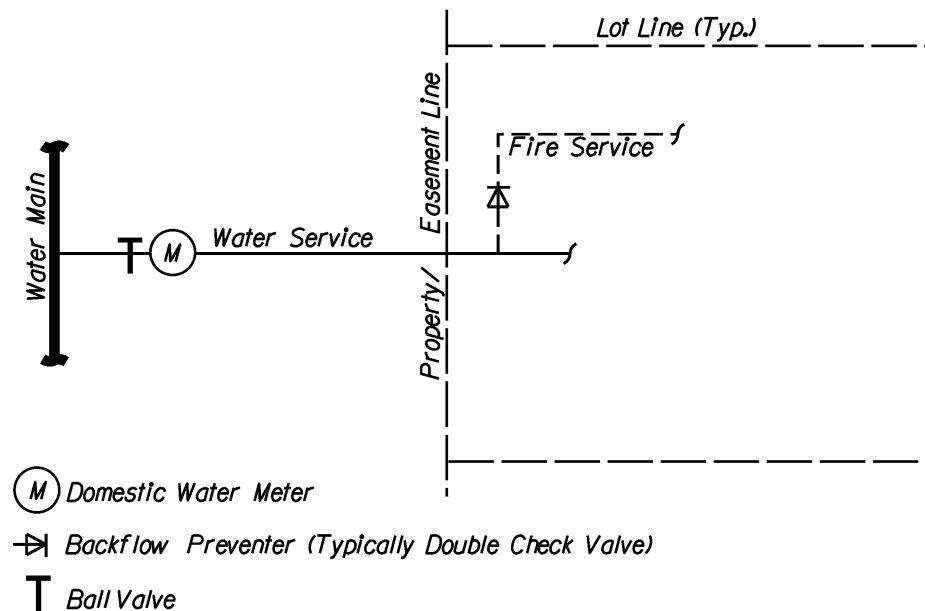


Figure 3.5.5.4.1: Typical Small Combined Water and Fire Service and Meter Configuration

3.5.5.4.2 Large Combined Water and Fire Service and Meter(s)

- Typical size of a fire meter on a combined service is 4" (min.), 6", 8" and 10" as necessary (See **Figure 3.5.5.4.2**)
- Typical size of a domestic meter on a combined service is 1", 1-1/2" and 2", 3", 4", 6" as necessary.
- Reference Schematics: DWU Standard Drawing Nos. 507- 512.

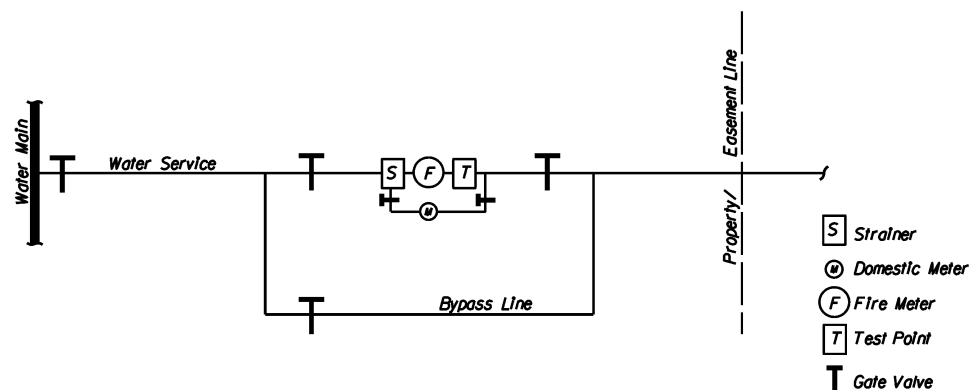


Figure 3.5.5.4.2: Typical Large Combined Water and Fire Service and Meter Configuration

3.5.6 Meter Reader and Advance Metering Infrastructure (AMI)

All new meters and related appurtenances shall be compatible with Advance Metering Infrastructure (AMI) as approved by DWU.

3.5.6.1 Meter Register:

- All meter registers must measure water consumption in gallons.
- Registers must record consumption to at least hundredths of a gallon.
- Registers must have no more than seven (7) digits when reading to hundredths of a gallon.
- Registers must be clearly marked to ensure ease of accurate readings by DWU meter readers.

3.5.6.2 Type of Reader:

The following types of meter readers are to be considered as approved by DWU:

- Manual Reads: Meter reader visually inspects meter and enters read on handheld computer device.
- Mobile Reads: Mobile reads requires an AMI endpoint. Meter reader typically walks or drives by and collects readings on handheld or laptop device from a signal generated by the endpoint.
- AMI Fixed Network: This requires AMI endpoints where the system is set to automatically collect data from meters or endpoints and uploads to DWU servers

3.5.6.3 Special Consideration:

The following items shall be considered on all new or replacement pipeline projects when directed by DWU:

- AMI Endpoint and AMI-ready meter shall be installed.
- Meter Box Radio Frequency (RF) lids shall be used.
- Vault metal lids that are to remain shall be drilled (if new must be pre-drilled) to accept a remote antenna that will attach to the endpoint to allow endpoint signals to be read by AMI system.
- If a meter(s) has AMI endpoints and AMI ready meters currently installed the contractor is responsible for maintaining the system.
- If the meter is to be replaced it shall be replaced with an AMI approved meter and the endpoint shall be reinstalled. If not, the endpoint shall be returned to DWU Materials Services for inventory control. If reinstalled the Meter Reading Operations Division will be contacted to reprogram the endpoint.

- Coordinate all new products with DWU Meters Division, Meter Reading Division and Materials Services Division for inventory control and activation of a new endpoint.

3.5.7 Location and Installation

A water meter shall typically be located at the property line (preferably at center of the sidewalk) in the public right-of-way or in an easement dedicated to DWU.

3.5.7.1 Accessibility:

- All meters must be placed in a location where they can be read and accessed by DWU meter reading personnel.
- The meter must be mounted in a way that allows for both easy access and reading of the counter display.
- Horizontal mounting is preferred for best access to the counter.
- The meter must be located to allow easy readability of the serial number when taking manual readings from the meter display unit.
- The meter must be accessible at all times and the surrounding area must be kept clear of vegetation and other obstructions.

3.5.7.2 Minimum Length of Unobstructed Pipe:

- The meter must be located in a straight clean pipe of uniform, circular cross section and without any fittings or obstructions.
- A minimum length of ten (10) diameters of straight rigid pipe must be fitted on the intake side of the meter and a minimum of five (5) diameters of straight rigid pipe on the discharge of the meter to minimize flow disturbance.
- Exception: Where this requirement cannot be met, it may be acceptable for the meter to be installed with a minimum of five (5) diameters of straight rigid pipe upstream of the meter and a minimum of two (2) diameters of straight rigid pipe immediately downstream. This will only be considered in those circumstances where the meter manufacturer warrants that the meter will operate to the required accuracy under the revised conditions.
- Minimum length of straight uninterrupted pipe is summarized in **Table 3.5.7.2**

**Table 3.5.7.2: Required Minimum Straight Unobstructed
Pipe Length for Water Meter**

Meter Size (in)	Min. Straight Unobstructed Length	
	Intake or Up Stream (U/S) Side (ft.)	Discharge or Down Stream (D/S) Side (ft.)
5/8	0.52	0.26
¾	0.63	0.31
1	0.83	0.42
1-1/2	1.25	0.63
2	1.67	0.83
3	2.5	1.25
4	3.33	1.67
6	5	2.5
8	6.67	3.33
10	8.33	4.17
12	10	5
>12	As Calculated	As Calculated

3.5.7.3 Miscellaneous Items:

- The meter must be installed so that at all flow rates there is a full pipe of water on both the intake and discharge sides of the meter.
- The meter must not be installed in a section of pipe where there may be air pockets or the pipe does not run full of water. If it is likely that air will become entrapped near the meter, an air valve must be installed.
- Any filtering equipment must be installed on the intake side of the meter.
- The meter must be installed in the correct direction to the flow.
- Where the meter has to be fitted to plastic or polyethylene pipelines, it must be supported by concrete thrust block or fabricated steel bracing to ensure stability.

3.5.8 Meter Box and Vault

3.5.8.1 General:

- No meter shall be installed deeper than 4.5 feet below ground level.
- Where a meter is installed underground, sufficient space must be provided to facilitate easy access for maintenance and reading at all times.
- Meter shall not be placed in low lying areas prone to flooding or natural drainage.
- Meter shall not be placed in a driveway approach.

3.5.8.2 Meter Box:

- All 2' or smaller meters located down to 1.5' below ground will require a suitable meter box to house the meter.
- All meter boxes are to be made of plastic with cast iron or AMI-Ready Radio Frequency (RF) lids as approved by DWU
- Reference Schematics: DWU Standard Drawing Nos. 201- 206

3.5.8.3 Meter Vault:

- All 3" or larger domestic, fire, irrigation or combined meters will require a meter vault.
- For meters located between 1.5 feet and 4.5 feet below ground, an access pit or meter vault will be required.
- Reference Schematics: DWU Standard Drawing Nos. 501- 526.

3.5.9 Meter Testing Frequency

- All privately owned meters must be tested prior to use for billing purposes. Certified test results from an independent party must be provided to DWU.
- Routine maintenance and testing must be performed according to the following schedule (**Table 3.5.9**)
- Any meter which falls outside registration accuracy guidelines found in the AWWA Standards must be replaced.

Table 3.5.9: Meter Testing Frequency

Meter Size (in)	Testing Intervals (Yrs)
5/8	10
¾	8
1	6
1-1/2	4
2	4
3	3
4	2
6	1
>6	As Per DWU

3.5.10 Special Design Consideration:

3.5.10.1 Deduct Meter

- General

Deduct meters can be considered for any facility where the water either evaporates or is consumed in a specific process including, but not limited to, cooling towers, bottling plants or similar applications as approved by DWU.

- Typical Configurations:

The following are the most common configurations currently approved for use by DWU. Other configurations may be submitted but must be reviewed on an individual basis.

- **Wastewater Meter:** Wastewater meter is used to measure total discharge into the wastewater collection system. If the customer has more than one wastewater lateral, a meter will be required for each lateral.
- **Deduct Water Meter:** Deduct water meter(s) can be used to measure water which does not return to the wastewater collection system. Volume measured on the deduct meter is subtracted from the total water volume for the calculation of wastewater charges. Deduct meters shall typically be at both the supply side and the return side of the process as approved by DWU.
- An example would include water to be consumed in a manufacturing process (**Figure 3.5.10.1**)

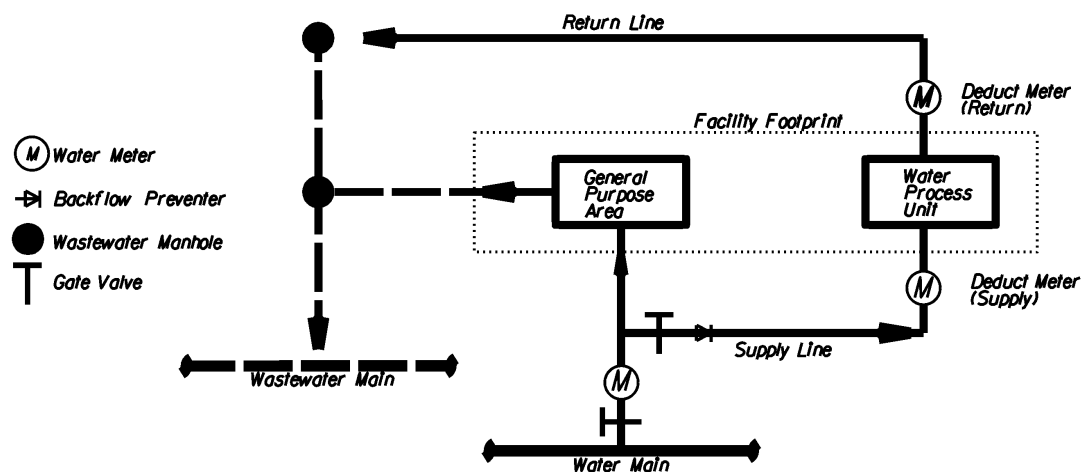


Figure 3.5.10.1: Typical Configuration of Deduct Water Meter

3.5.10.2 Wholesale Meter

- General
 - Wholesale customer meters are coordinated through DWU Wholesale Services.
 - Wholesale customer meters are typically designed and constructed by the party requesting the service from DWU.
 - DWU Pumping Division operates and maintains the wholesale meters
- Typical Configurations:
 - A wholesale customer meter assembly typically consists of a primary and a secondary flow meter.
 - Primary flow meter shall be sized based on the estimated flow of the whole customer. Venturi tube or a similar meter as approved by DWU shall be used as primary flow meter.
 - A secondary flow meter shall be sized to measure any flow through the bypass line.
- Standard Schematic
See **Figure 3.5.10.2.**

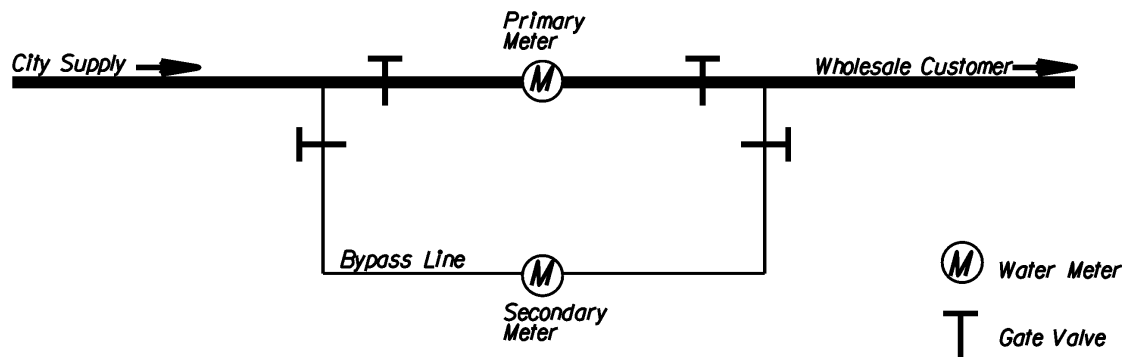


Figure 3.5.10.2: Typical Configuration of Wholesale Meter

3.6 AIR VALVE

3.6.1 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.

3.6.2 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)

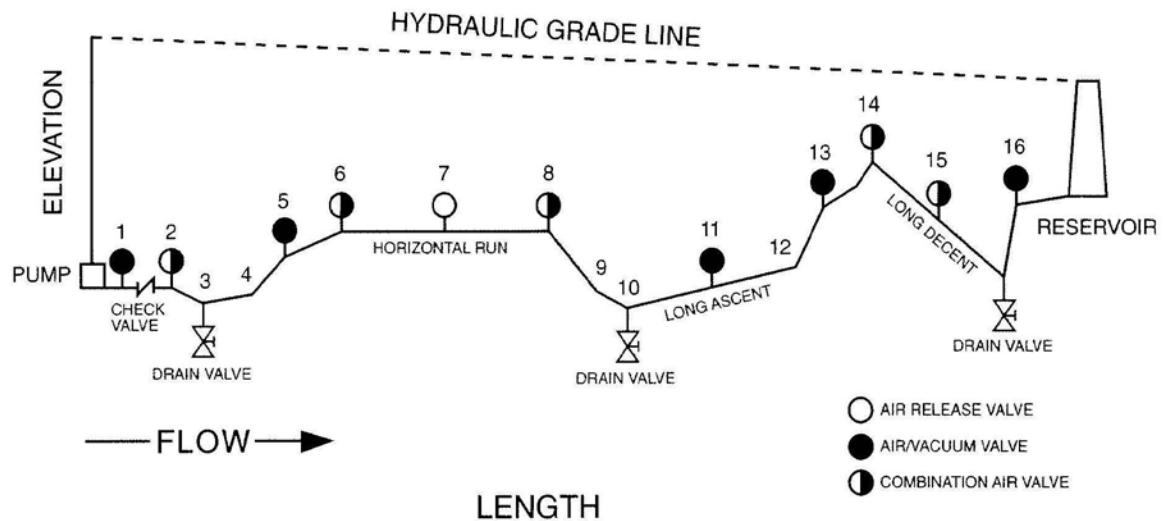
3.6.3 Locations

The 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 follow the terrain. In addition, the height of the air vent riser shall be evaluated on a case-by-case basis in order to be well above 100-year flood plain.

The following **Figure: 3.6.3** illustrates various locations of air valves:



NO.	DESCRIPTION	RECOMMENDED TYPES	NO.	DESCRIPTION	RECOMMENDED TYPES
1	Pump Discharge	Air/Vacuum for Pumps	9	Decrease Downslope	No Valve Required
2	Incr. Downslope	Combination	10	Low Point	No Valve Required
3	Low Point	No Valve Required	11	Long Ascent	Air/Vac or Combination
4	Increase Upslope	No Valve Required	12	Increase Upslope	No Valve Required
5	Decrease Upslope	Air/Vac or Combination	13	Decrease Upslope	Air/Vac or Combination
6	Beginning Horizontal	Combination	14	High Point	Combination
7	Horizontal	Air/Rel or Combination	15	Long Descent	Air Release or Combination
8	End Horizontal	Combination	16	Decrease Upslope	Air/Vac or Combination

Figure: 3.6.3:

Sample Pipeline Profile Illustrating Air Valve Locations

*Source: Manual of Water Supply Practice, M51: Air-Release, Air/Vacuum & Combination Air Valve
By AWWA, First Edition, 2001*

3.6.4 Sizing

Air valves 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.

3.6.5 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

3.7 PITOT OUTLET

3.7.1 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 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.

3.7.2 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 the 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.

3.7.3 Minimum Spacing

The following tables show suggested minimum spacing between pitot outlets:

**Table 3.7.3:
Spacing between Pitot Outlets**

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

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.

3.7.4 Reference Schematic

- DWU Standard Drawing. No. 220

3.8 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.

3.9 ACCESS MANHOLE

Access manhole shall be considered for the water transmission mains of 48" or larger in diameter under the 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.

3.10 BACKFLOW PREVENTION DEVICE

Backflow prevention device 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

3.11 HIGH/ LOW VALVE

The DWU water distribution network shall be 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.

A typical High-Low valve assembly is shown in **Figure 3.11:**

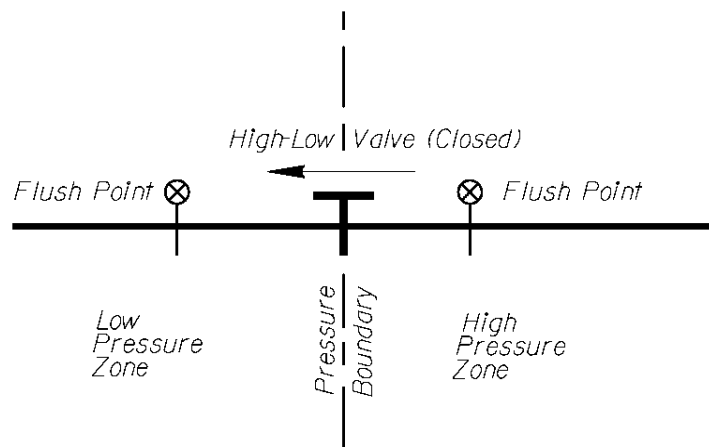


Figure: 3.11: High/Low Valve Assembly

3.12 PRESSURE REDUCING VALVE

3.12.1 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.

3.12.2 Configurations

PRV can be designed with the following configurations:

3.12.2.1 Single PRV Assembly:

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

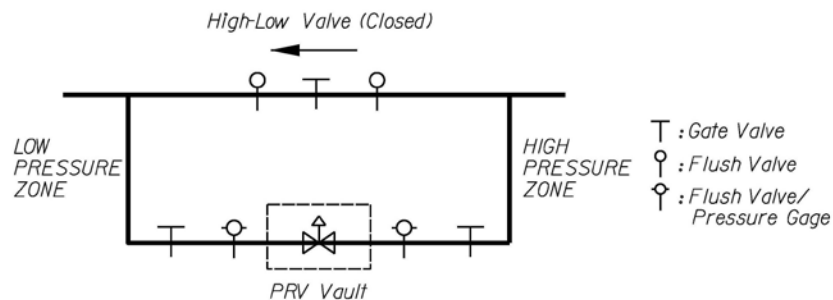


Figure 3.12.2.1: Single PRV Assembly

3.12.2.2 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.

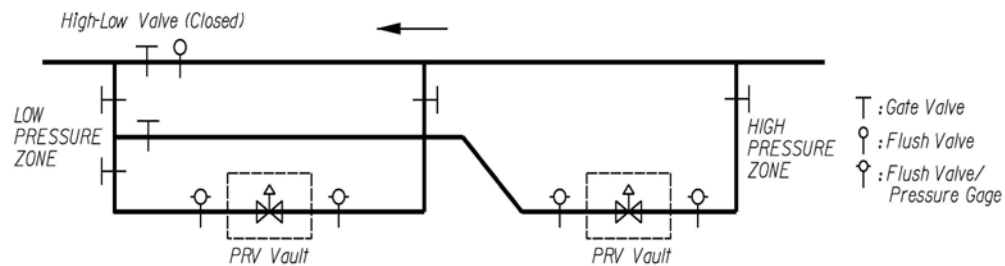


Figure 3.12.2.2: Two Parallel PRV Assembly

3.12.2.3 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.

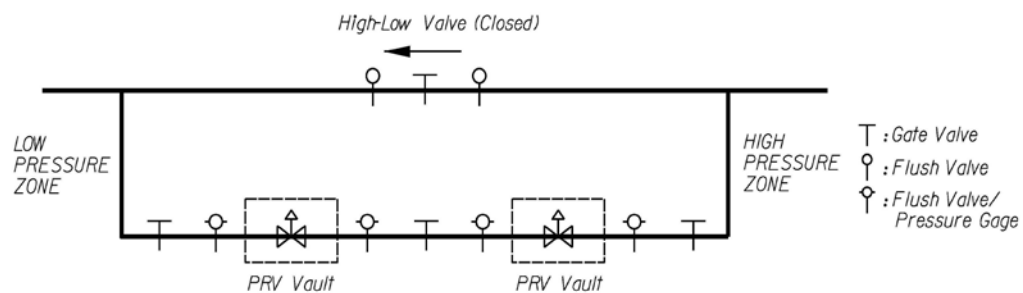


Figure 3.12.2.3: Two Staged Series PRV Assembly

3.12.2.3 Reference Schematic

- DWU Standard Drawing Nos. 239- 245.

3.13 CORROSION PROTECTION SYSTEM

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.

3.13.1 Terminology

3.13.1.1 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 involves two half-cell reactions:

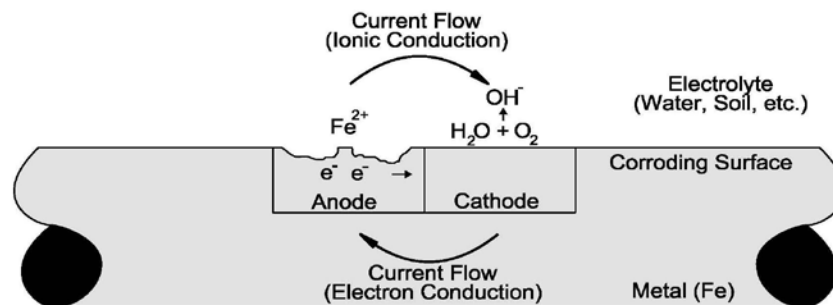
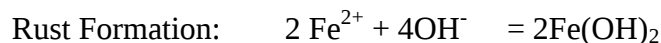
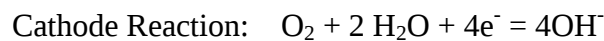


Figure 3.13.1.1: Corrosion Principle

3.13.1.2 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.

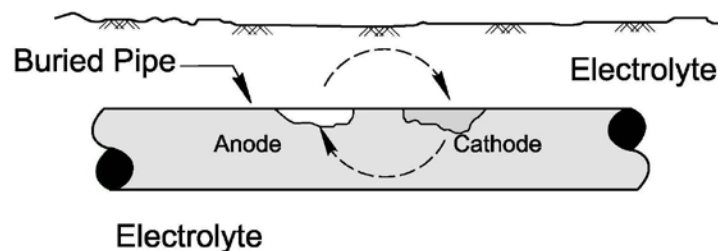


Figure 3.13.1.2: Galvanic Corrosion

3.13.1.3 Electrolytic Corrosion:

Electrolytic corrosion occurs due to an 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 3.13.1.3**).

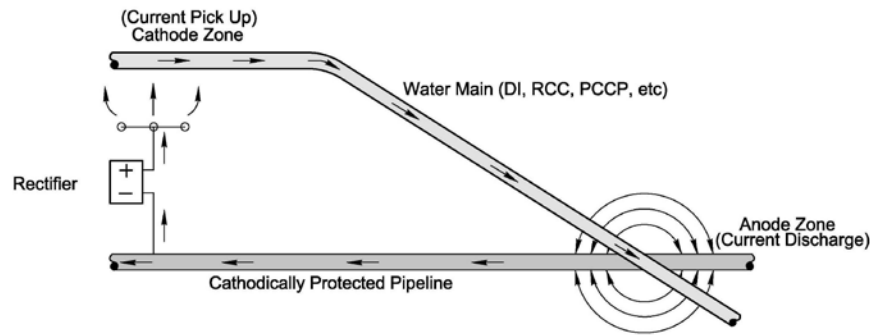


Figure 3.13.1.3: Electrolytic Corrosion

3.13.2 Preventive Requirements

3.13.2.1 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.

3.13.2.2 Dielectric Coating:

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

3.13.2.3 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

3.13.2.4 Polyethylene Encasement:

- All DI pipe and fittings shall be poly wrapped.

3.13.3 Monitoring Requirements

3.13.3.1 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.

3.13.3.2 Electrical Continuity:

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

3.13.4 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.

3.13.4.1 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

3.13.4.2 Data Evaluation:

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

3.13.4.3 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:

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

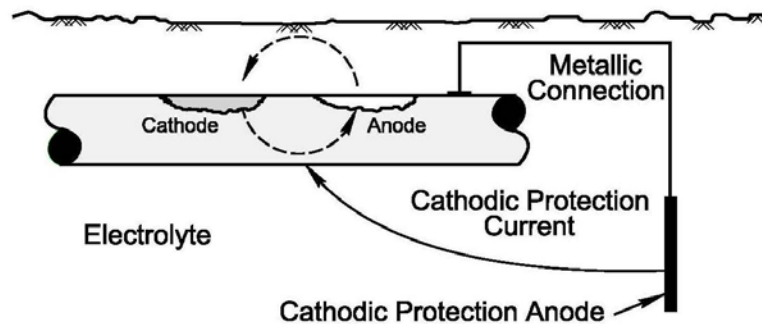


Figure 3.13.4.3.1: Galvanic Protection (GP) System

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

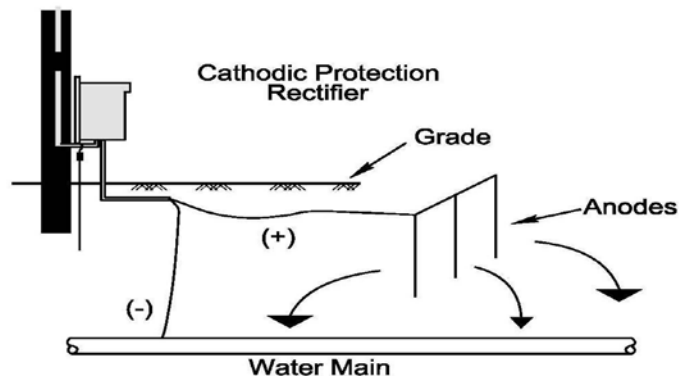


Figure 3.13.4.3.2: Impressed Current Cathodic Protection (ICCP) System

3.14 ABANDONMENT OF WATER APPURTENANCES

3.14.1 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.

3.14.2 Valves

3.14.2.1 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.

3.14.2.2 Large Valve

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

3.14.3.3 Reference Schematics

- DWU Drawing No. 219 for 4"- 16" Gate Valve Abandonment

CHAPTER 4

WASTEWATER MAIN DESIGN

4.1 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.

4.2 DWU WASTEWATER INFRASTRUCTURE:

4.2.1 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 4.2** 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 4.2** and summarized in **Table 4.2**.

Table 4.2: DWU Wastewater Sheds/Basins

Basin Name/ Wastewater Shed No.	Wastewater Shed Name	Basin Name/ Wastewater Shed No.	Wastewater Shed Name
White Rock Basin		South Dallas Basin	
1	North White Rock	29	Oak Cliff
2	McKamy Branch	East Bank Basin	
3	Upper White Rock Relief	30	Shady Trail
4	Cottonwood Branch	31	Joe's Creek
5	Central Branch	32	Bachman Relief #2
6	Central White Rock	33	Bachman Relief #3
7	Ferris Branch	34	Bachman Creek Shorecrest
8			Bachman Relief #1
9	Lower West White Rock	36	Nobles Branch
10	Lower White Rock Relief #1	37	Knights Branch
11	Ash Creek	38	East Bank
12	Lower White Rock Relief #2	39	Cedar Springs Branch
13	Lower East White Rock Relief	40	Turtle Creek
14	South White Rock	41	Upper North Interceptor
15	Southside Diversion	42	Lower North Interceptor
16	Sludge Force Mains 1	43	Mill Creek
Elam Creek Basin		44	South Interceptor
17	Elam Creek	45	Lower East Bank 1
Prairie Creek		Warren Avenue Basin	
18	Prairie Creek	46	
Hickory Creek Basin		47	
19	Hickory Creek Interceptor	48	
Pleasant Grove Basin		TRA Basin	
20	Pleasant Grove Interceptor	U1	Upper TRA 1
Five Mile Basin		U2	Upper TRA 2
21	Lower Five Mile	L1	Lower TRA
22	Woody Branch	Garland Basin	
23	Upper Five Mile	G1	Garland
West Bank Basin			
24	West Bank		
25	Upper Coombs Creek		
26	Lower Coombs Creek		
27	Elmwood Branch		
28	Cedar Creek		

Source: DWU Comprehensive Wastewater Collection System Assessment, Oct 22, 2007

4.2.2 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.

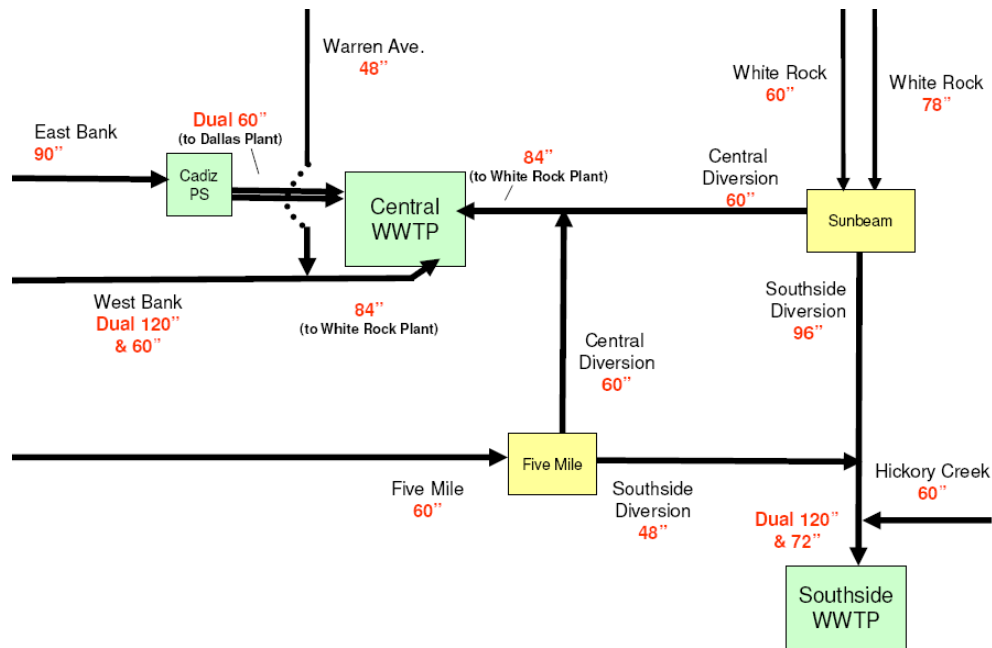


Figure 4.2.2: DWU Wastewater Treatment Plants (WTP)

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.

4.3 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 4.3: Wastewater Main for Replacement Criteria

Criteria	DWU Measures
Structural Integrity	Pipe Age: 40 years or older mains, but age shall not be the lone factor Inflow/Infiltration (I/I): 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.
Capacity Analysis	Substandard Mains: Smaller mains (< 8") due to difficulties in maintenance and cleaning System Wide Growth: Wastewater main serving areas which is subjected to further growth
Regulatory	Sanitary Sewer Overflow (SSO): Wastewater mains subjected to backups and surcharge at adjacent manholes
Project Coordination	Wastewater Main Condition Check: Existing deteriorated wastewater mains in the vicinity of a proposed water main Minimize Pavement Cut: Existing mains shall be replaced if future maintenance of the main requires cutting of new pavement within next 10 years Wastewater Master Plan: Compliance to any specific recommendations as per current wastewater master plans

4.4 WASTEWATER MAIN SIZING

4.4.1 DWU Wastewater Collection System

Table 4.4.1: Wastewater Mains Classifications

Type of Main	Size Range (in)	Direct Service Connection
Collection	Less than 18"	Permitted
Interceptor	18" to 30"	*Not Permitted
	Larger than 30"	Not Permitted

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

4.4.2 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:

4.4.2.1 Average Daily Flow (ADF):

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.

4.4.2.2 Peak Hourly Flow (PHF):

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.

4.4.2.3 Peak Daily Flow (PDF):

Each wastewater main shall be sized with peaking factor to appropriately handle infiltration and inflow. The peaking factor shall be evaluated by the designer 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 4.4.2.3: Wastewater Peaking Factor*

Pipe Size	Peaking Factor	Depth of Flow
Less than 18"	4.0	Full
18" thru 30"	3.5	Full
Larger Than 30"	3.0	Full

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

4.4.3 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 shall use the most conservative data while meeting or exceeding the following criteria for sizing wastewater mains:

- **Velocity:** The velocity of gravity wastewater main shall be maintained between 2 and 10 ft/sec. Velocity shall be determined by the Manning formula:

$$V = (1.486/n)R^{2/3} S^{1/2}$$

Where, n = Co-efficient of Roughness
S = Slope, ft/ft
R = Hydraulic Radius, ft.

Where, velocities greater than 10 ft/sec are attained, drop manholes shall be considered to reduce steep slopes so as to limit the velocities in pipes between manholes.

- **Size:** The size of the wastewater main shall be sufficient to carry the peak daily flow without pressurizing the pipe. The pipe size shall be calculated using the following equation:

$$Q = VA, \text{ where}$$

Q = Peak Daily Flow, ft³/sec
A = Required Cross-Sectional Area of conduit, ft²
V = Velocity, ft/sec

- **Service:** The size of the services must be at least one standard size smaller than the proposed and existing wastewater main.
- Comply with **Tables 4.4.2.2, 4.4.3.1 and 4.4.3.2** as applicable.

Table 4.4.3.1:
Wastewater Design Flow Estimation with Limited Available Data

Source	Remarks	Average Daily Wastewater Flow (gals/person)
Municipality	Residential	125
Subdivision	Residential	125
Trailer Park (Transient)	2½ Persons per Trailer	60
Mobile Home Park	3 Persons per Trailer	75
School	Cafeteria & Showers	20
	Cafeteria/No Showers	15
Recreational Parks	Overnight User	30
	Day User	5
Office Building Factory	A facility must be designed for the largest shift	25
		20
Hotel/Motel	Per Bed	75
Restaurant	Per Meal	10
Restaurant with bar or cocktail lounge	Per Meal	12
Hospital	Per Bed	250
Nursing Home	Per Bed	125
Apartments	Per Unit	300

Source (Modified): 30 TAC §217.32(a)(3): Design Organic Loading

Table 4.4.3.2: Criteria-2: Design Flow Estimation with Available Zoning/Property Data

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
		A(A)	Agricultural (Agricultural, Single Family)	1 per 3 acre	3.25	140	455
RESIDENTIAL	Single Family	R-1ac(A)	Single Family	1 per 1 acre	3.25	140	455
		R-1/2ac(A)	Single Family	2 per 1 acre	3.25	140	455
		R-16(A)	Single Family	1 per 16000 sq. ft.	3.25	140	455
		R-13(A)	Single Family	1 per 13,000 sq. ft.	3.25	140	455
		R-10(A)	Single Family	1 per 10,000 sq. ft.	3.25	125	406
		R-7.5(A)	Single Family	1 per 7,500 sq. ft.	3.25	125	406
		R-5(A)	Single Family	1 per 5,000 sq. ft.	3.25	125	406
	Duplex/ Townhome	D(A)	Duplex	1 per 3,000 sq. ft.	2.5	125	313
		TH-1(A)	Townhouse	6 per acre	2.25	125	281
		TH-2(A)	Townhouse	9 per acre	2.25	125	281
		TH-3(A)	Townhouse	12 per acre	2.25	125	281
	Clustered Housing/ Multifamily	CH	Clustered Housing (Multi/Single Family)	18 per acre	2.0	125	281
		MF-1(A)	Multifamily	Min. Lot: 3,000 1,000 sq ft- E 1,400 sq ft- 1 BR 1,800 sq ft- 2 BR +200 sq ft each add BR	2.00 2.25 2.50	125	250 281 313
		MF-2(A)	Multifamily	Min. Lot: 1,000 8,00 sq ft- E 1,000 sq ft- 1 BR 1,200 sq ft- 2 BR +150 sq ft each add BR	2.00 2.25 2.50	125	250 281 313
		MF-3(A)	Multifamily	Min. Lot: 6,000 450 sq ft- E 500 sq ft- 1 BR 550 sq ft- 2 BR +50 sq ft each add BR	2.00 2.25 2.50	125	250 281 313
		MF-4(4)	Multifamily	Min. Lot: 6,000 225 sq ft- E 275 sq ft- 1 BR 325 sq ft- 2 BR +50 sq ft each add BR	2.00 2.25 2.50	125	250 281 313
		MH(A)	Mobile Home	1 per 4000 sq. ft.	2.50	125	313

Table 4.4.3.2 contd.
4

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
NONRESIDENTIAL	Office	NO(A)	Neighborhood Office	0.5 FAR	1 per 400 sf	25	25 per 400 sf
		LO-1	Limited Office	1.0 FAR	1 per 400 sf	25	25 per 400 sf
		LO-2	Limited Office	1.5 FAR	1 per 400 sf	25	25 per 400 sf
		LO-3	Limited Office (Office, Lodge)	1.75 FAR	1 per 400 sf	25	25 per 400 sf
		MO-1	Mid-Range Office (Office, Lodging)	2.0 FAR	1 per 400 sf	25	25 per 400 sf
		MO-2	Mid-Range Office (Office, Lodging)	3.0 FAR	1 per 400 sf	25	25 per 400 sf
		GO(A)	General Office (Office, Lodging)	4.0 FAR	1 per 400 sf	25	25 per 400 sf
	Retail	NS(A)	Neighborhood Service	0.5 FAR	1 per 400 sf	25	25 per 400 sf
		CR	Community Retail	0.75 FAR overall 0.5 office	1 per 400 sf	25	25 per 400 sf
		RR	Regional Retail	1.5 FAR overall 0.5 Office	1 per 400 sf	25	25 per 400 sf
	Commercial/ Industrial	CS	Community Service	0.75 FAR overall 0.5 office/lodging/retail	1 per 400 sf	25	25 per 400 sf
		LI	Light Industrial	1.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	25	25 per 400 sf
		IR	Industrial Research	2.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	25	25 per 400 sf
		IM	Industrial Manufacturing	2.0 FAR overall 0.75 office/retail 0.5 retail	1 per 400 sf	25	25 per 400 sf
	Central Area	CA-1(A)	Central Area	20.0 FAR	1 per 400 sf	25	25 per 400 sf
		CA-2(A)	Central Area	20.0 FAR	1 per 400 sf	25	25 per 400 sf
	Mixed Use	MU-1	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	25	25 per 400 sf
		MU-2	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	25	25 per 400 sf
		MU-3	Mixed Use	0.8 FAR base 1.0 FAR max. + bonus for residential	1 per 400 sf	25	25 per 400 sf

Table 4.4.3.2 contd.

4

		Zoning District	Land Use	Unit per Area*	Pop. per Unit**	Ave. Daily Demand per Capita (gpcd)	Ave. Daily Demand Per Unit (gpd)**
NONRESIDENTIAL	Multiple Commercial	MC-1	Multiple Commercial	0.8 FAR base 1.0 max.	1 per 400 sf	18	18 per 400 sf
		MC-2	Multiple Commercial	0.8 FAR base 1.0 max.	1 per 400 sf	18	18 per 400 sf
		MC-3	Multiple Commercial	1.2 FAR base 1.5 max.	1 per 400 sf	18	18 per 400 sf
		MC-4	Multiple Commercial	1.6 FAR base 2.0 max.	1 per 400 sf	18	18 per 400 sf
	Urban Corridor	UC-1	Urban Corridor	10 DU/ acre 0.6 FAR base 2.0 max.	1 per 400 sf	18	18 per 400 sf
		UC-2	Urban Corridor	35 DU/acre 0.85 FAR base 3.6 max.	1 per 400 sf	18	18 per 400 sf
		UC-3	Urban Corridor	45 DU/acre 1.0 FAR base 4.5 max.	1 per 400 sf	18	18 per 400 sf
	Parking	P(A)	Parking	-	-	-	

Note: *FAR denotes to Floor Area Ratio and DU denotes to Dwelling Unit.

** Average daily demands for non-residential units are based on the assumption of 1 person per unit and 400 square feet (sf) per unit. Actual estimation shall be based on the designed floor area, FAR and DU as necessary.

Wastewater flow for any **Planned Developments (PD)**, as defined by City Code 51A.472, shall be estimated using the most conservative adjacent zoning unless otherwise written in the ordinance for the specific PD as approved by the City of Dallas.

4.4.4 Minimum Pipe Sizes

- The minimum pipe diameter for any public gravity wastewater collection main shall be 8 inches for maintenance and easy cleaning.
- 6" Pipe is not allowed for new wastewater mains.

4.4.5 Minimum and Maximum Slope

As per 30 TAC §217.53(l), the 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 to 10 ft/sec when flowing full.

Accordingly, as per 30 TAC §217.53(2)(A), using a “n factor” of 0.013 DWU acceptable slopes are calculated are as follows:

Table 4.4.4: Allowable Wastewater Main Slope

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

* 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

4.5 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.

4.5.1 Terminology

4.5.1.1 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.

4.5.1.2 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.

4.5.2 Minimum Cover

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

**Table 4.5.2:
Minimum Depth of Cover for Wastewater Main**

Size of Main		Min. Depth (ft)*	
	Unimproved	Improved	Highway/Railroad Crossing**
12" and Smaller	6	4	6
16"	6	5	6
20" and Larger	7	6	6

*** *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.*

4.6 WASTEWATER PIPE MATERIALS AND EMBEDMENT

4.6.1 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 (25) are preferred for small diameter (<18") pressure and gravity mains, as applicable.

4.6.2 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 embedment.

General terminology of a typical pipe trench is as follows:

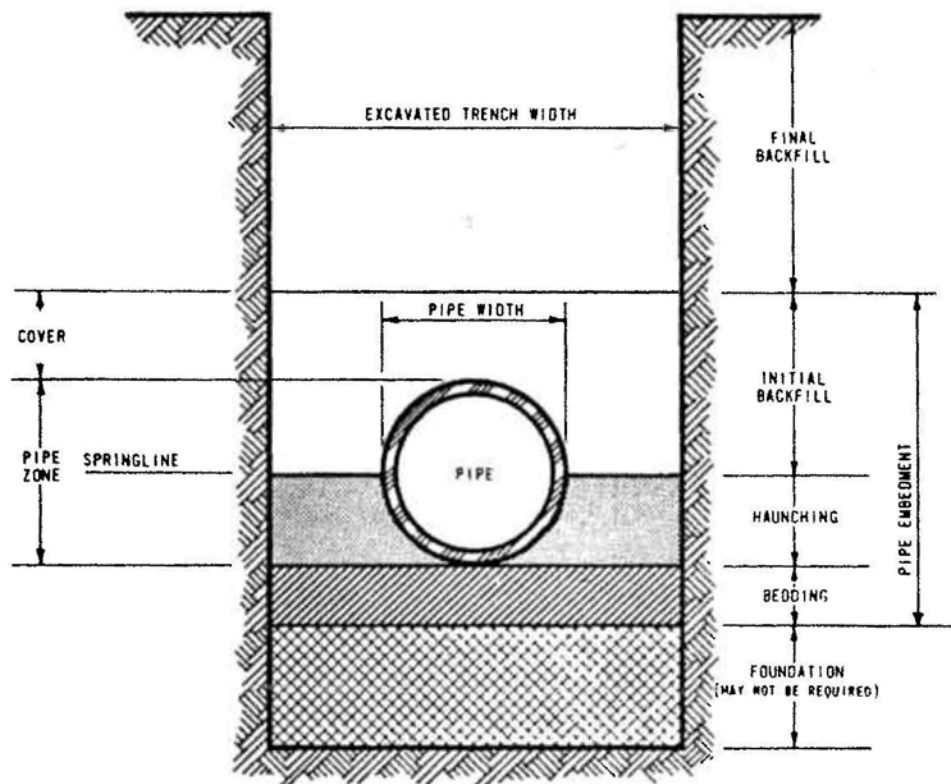


Figure 4.6.2: Typical Pipe Trench

Source: 30 TAC §217.54: Criteria for Laying Pipe

4.6.3 Recommended Pipe Material and Embedment

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

Table 4.6.3: Recommended Wastewater Pipe Materials and Embedments

Pipe & Material Specification	Min. Pipe Stiffness (PS) (psi)	Allowable Size (in)	Joint Specification	Embedment Class Per Depth Of Cover (ft)
PVC ASTM D 3034 (SDR 35) (Solid Wall)	PS= 46	6"– 15"	Bell & Spigot ASTM D 3212	< 8' : B-1 8'- 25' : B-2 >25' : B-5 < 25' : Modified Flowable Backfill within Easement Engineering Evaluation Required
PVC ASTM F 679 (SDR 35) (Solid Wall)	PS= 46	18"– 48"		
PVC ASTM F 794 (Open Profile/ Dual Wall Corrugated Profile)	PS= 46	15"–48"		
PVC ASTM F 949 (Dual Wall Corrugated Profile)	PS= 46	6"–36"		
PVC ASTM F 1803 (Closed Profile)	PS= 46	21"–54"		
PVC- Pressure Rated* ASTM D 2241 (SDR 26)	PS= 160	6"–12"	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477	< 8' : B-1a 8'-25': B-2a < 25' : Modified Flowable Backfill within Easement >25' : Engineering Evaluation Required
PVC- Pressure Rated* AWWA C 905 (DR 25)	PR= 165	14"– 30"	Bell & Spigot ASTM D 3139 AWWA C 905	

*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 4.6.3: Recommended Materials for Wastewater Pipe and Embedment
(Contd.)

Pipe & Material Specification	Min. Pipe Stiffness (PS) / Stiffness No. (SN)	Allowable Size (in)	Joint Specification	Embedment Class Per Depth Of Cover (ft)
RCP*** ASTM C 76 Specify Class I, II, III, IV, V		54" – 120"	Bell & Spigot ASTM C 361	< 3.5' : G
RCP*** ASTM C 361 Specify Class A, B, C, D		54" – 102"		3.5'-10' : C > 10' : B
PCCP-Embedded Cylinder AWWA C 301		54" – 144"	Bell & Spigot AWWA C 301	< 10' : C > 10' : B
HDPE ASTM F 894	PS= 46 psi	18" – 96"	Bell & Spigot Joints: ASTM D3212 Gasket: ASTM F477	< 8' : B-1 8'-25': B-2
HDPE ASTM F714 (DR 17) <i>Specify DIPS Only</i>	PS= 125 psi	6" - 30"	Fusion ASTM F2620	< 25' : Modified Flowable Backfill Within Easement
HDPE- Pressure Rated ASTM F714 (DR 11) <i>Specify DIPS Only</i>	PS= 200 psi	6" - 30"	Fusion ASTM F2620	> 25' : B-5 Engineering Evaluation Required

*** RCP Pipe shall only be installed with plastic or sprayable liner as approved by Wastewater Collection Division

Table 4.6.3: Recommended Materials for Wastewater Pipe and Embedment

(Contd.)

Pipe & Material Specification	Min. Pipe Stiffness (PS) / Stiffness No. (SN)	Allowable Size (in)	Joint Specification	Embedment Class Per Depth Of Cover (ft)
RTRP^a & RPMP^b ASTM D 3262 (Fiberglass)	PN $\geq$ 50 SN $\geq$ 46	HOBAS 18" – 102" Flowtite $\geq$ 24"	Bell & Spigot Joints: ASTM D4161 Gasket: ASTM F477	< 8' : B-1 8'-25': B-2 < 25' : Modified Flowable Backfill within Easement >25' : Engineering Evaluation Required
Pressure-Rated RTRP^a & Pressure-Rated- RPMP^b ASTM D 3754 (Fiberglass)	PN $\geq$ 150 SN $\geq$ 46	HOBAS 18"–102" Flowtite $\geq$ 24"	Bell & Spigot Joints: ASTM D4161 Gasket: ASTM F477	< 8' : B-1a 8'-25': B-2a < 25' : Modified Flowable Backfill within Easement >25': Engineering Evaluation Required
VCP^c ASTM C 700		6"–24"	Bell & Spigot Joints: ASTM C425 Gasket: ASTM C425	< 3 ½' : G 3 ½'-10': C >10' : B

^a RTRP denotes to Reinforced Thermosetting Resin Pipe

^b RPMP denotes to Reinforced Polymer Mortar Pipe

^c VCP denotes to Vitrified Clay Pipe

Any pipe material not listed in this table shall use the manufacturers recommended embedment and will require approval from DWU.

4.7 LOCATION

4.7.1 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.

4.7.2 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.

4.8 HORIZONTAL ALIGNMENT

- All mains should be laid as straight as possible between street 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).

4.9 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 typically allowed unless otherwise approved by DWU Wastewater Collection.
- 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).

4.10 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.

4.10.1 Pipe Trench

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

4.10.2 Ideal Case

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

4.10.3 Variances

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

4.10.3.1 New Wastewater Installation- Parallel Lines:

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

4.10.3.1.1 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.

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

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

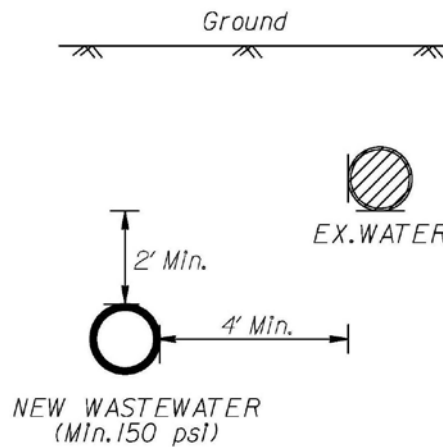


Figure 4.10.3.1:
New Wastewater Main Parallel to Existing Water Main

4.10.3.2 New Wastewater Installation- Crossing Lines:

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

4.10.3.2 .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:

4.10.3.2 .1.1 *A minimum separation distance is six inches between outside diameters of the pipes.*

4.10.3.2 .1.2 *A collection system pipe must be below a public water supply pipe.*

4.10.3.2 .1.3 *Collection system pipe joints must be located as far as possible from an intersection with a public water supply line.*

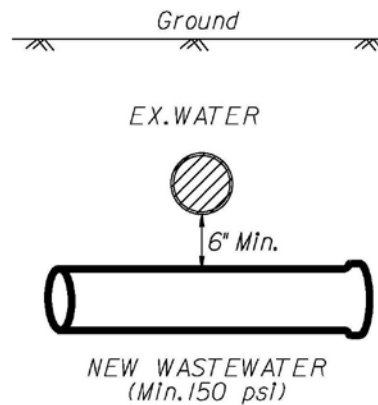


Figure 4.10.3.2.1:
Criteria for Pressure-Rated Wastewater Pipe Material

4.10.3.2 .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:

4.10.3.2 .2.1 *A minimum separation distance is two feet.*

4.10.3.2 .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:*

4.10.3.2 .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.*

- 4.10.3.2 .2.2.2 *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.*

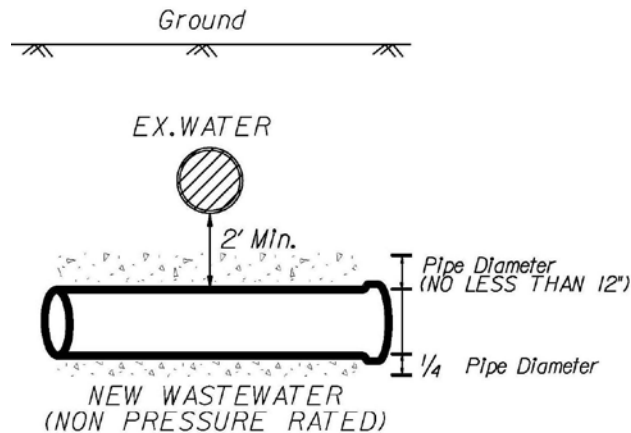


Figure 4.10.3.2.2:
Criteria for Non-Pressure-Rated Wastewater Pipe Material

- 4.10.3.2 .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:
- 4.10.3.2 .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.*
- 4.10.3.2 .3.2 *A collection system pipe must be encased in a joint of at least 150 psi pressure class pipe that is:*
- 4.10.3.2 .3.2.1 *Centered on the crossing;*
 - 4.10.3.2 .3.2.2 *Sealed at both ends with cement grout or manufactured seal;*
 - 4.10.3.2 .3.2.3 *At least 18 feet long;*
 - 4.10.3.2 .3.2.4 *At least two nominal sizes larger than the wastewater collection pipe; and*

- 4.10.3.2 .3.2.5 *Supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.*

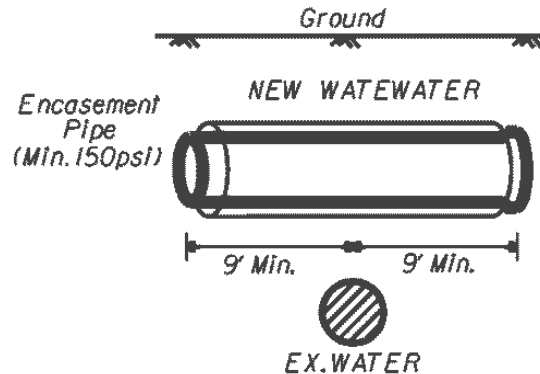


Figure 4.10.3.2.3.2:
Criteria for New Wastewater Pipe over Existing Water Pipe

4.10.4 Manhole Separation

4.10.4.1 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.

4.10.4.2 Variance:

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

4.10.5 Building Laterals and Taps

Building laterals and taps on an installation must:

- 4.10.5.1 Include a manufactured fitting that limits infiltration
- 4.10.5.2 Prevent protruding service lines; and
- 4.10.5.3 Protect the mechanical and structural integrity of a wastewater collection system

4.10.6 Reclaimed Water Mains

Wastewater mains located adjacent to reclaimed water mains shall comply with the separation criteria established in §4.10 regarding separation distance between reclaimed water and water/wastewater mains.

4.10.7 Wastewater, Storm Drain and Gas Main Separation

- The horizontal separation distance from a wastewater main of 20" diameter or smaller to a storm drain shall be 4 feet (preferred) and 3 feet (minimum).
- The horizontal separation distance from a wastewater main of 20" diameter or smaller to a gas main shall be 4 feet (minimum).
- The separation distance for a wastewater main of larger than 20" diameter to a storm drain or gas main shall be considered on a case-by-case basis.

4.10.8 Proximity of Piers, Foundations and Vertical Structures

- The minimum horizontal separation distance between proposed wastewater main and existing/proposed piers, foundations or vertical structures shall be 10 feet from outside edge to outside edge as applicable.
- If 10 feet horizontal separation is not available, then each situation should be evaluated on case-by-case basis to allow adequate space for future maintenances.

4.10.9 Foreign Line Crossing DWU Wastewater Easements

See § 7.6.1 and § 7.6.3

4.11 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.

4.12 WASTEWATER SERVICE LATERAL

4.12.1 General Requirements

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

4.12.2 Location

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

4.12.3 Size

- The size of the wastewater service lateral 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 4.12.3:
Wastewater Lateral Sizing Criteria**

Fixtures	Flow (gpm)	Size (in)
0- 720	0- 180	6
720- 2640	180- 4000	8
2640- 4680	4000- 7000	10
4680- 8200	7000- 11600	12

4.12.4 Depth

- The wastewater service lateral should be at a depth sufficient to insure the dwelling to be connected, will be served using a preferred lateral grade of 2 % (min. 1%) 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 **Figure 4.12.4**.

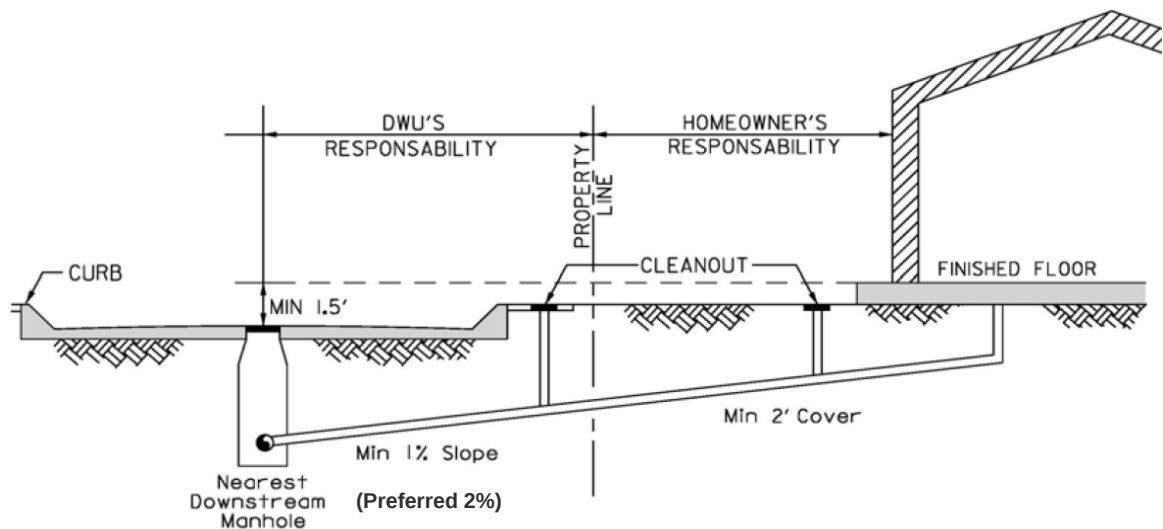


Figure 4.12.4: Typical Wastewater Service Lateral

4.13 ABANDONMENT OF 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.

CHAPTER 5

WASTEWATER APPURTENANCES AND FACILITIES DESIGN

5.1 REFERENCES

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

5.2 MANHOLE (MH)

5.2.1 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.

5.2.2 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.

5.2.3 Corrosion Protection

Following minimum preventive measures shall be considered for all manholes in order to minimize microbiological induced corrosion (MIC):

- Protective lining
- Precast concrete additive

5.2.4 Spacing

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

**Table 5.2.4:
Manhole Spacing Criteria**

Pipe Diameter (in)	Max. Manhole Spacing (ft)
6- 15	500
18- 30	800
36- 48	1000
54 or Larger	2000

- 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).

5.2.5 Type

5.2.5.1 Standard Manholes

- Pre Cast, Cast in Place, or Fiberglass
- Fiberglass is used on a case by case basis as approved by DWU

5.2.5.2 Drop Manholes

- This can be used where the incoming pipe(s) is 2' or higher than the outgoing pipe:
- Manhole with 2- 10 ft. Drop: External (preferred) or internal drop connection shall be used
- Manhole with > 10 ft. Drop: Shall be evaluated on case-by case basis
- Reference Schematics: DWU Standard Drawing 307-308

5.2.5.3 Pressure Type Manholes

- This can be used where the manhole is placed in a creek or 100 year flood plain area.
- Reference Schematics: DWU Standard Drawing Nos. 304, 313-315.

5.2.5.4 Vortex Control Manholes

- Vortex Manholes are not typically allowed unless otherwise approved by DWU Wastewater Collection.
- In instances where a vortex manhole exists, the designer should determine ways to eliminate the manhole and replace with a drop connection or other approved manhole.

5.2.5.3 Manholes with Odor Control Insert

- This can be used only where a known odor issue exists contingent upon approval by DWU Wastewater Collection.
- The following criteria may be applicable prior to considering odor control insert:
 - Flow in must be greater than 9 ft/s
 - Minimum daily flow in is 0.3 MGD
 - Drop is greater than 20 feet

5.2.6 Size

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

**Table 5.2.6:
Manhole Sizing Criteria**

Pipe Diameter (in)	Min. Manhole Diameter (ft)
8- 18	4
21- 30	5
33- 48	6
48 or Larger*	As Approved by DWU

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

5.2.7 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.
- 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.

5.2.8 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 in 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 in 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 in 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 5.2.8**).

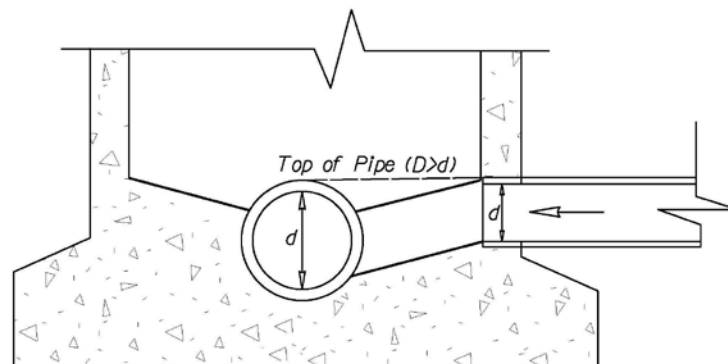


Figure 5.2.8:
Crown Elevation of Different Pipe Sizes within a Manhole

- 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.
- A minimum of 12 inches of separation measured from the outside of each pipe should be maintained among pipes at a manhole.

5.2.9 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.

5.2.10 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 the following requirements:

- Vent design must minimize inflow.
- Vents must be located above a 100-year flood elevation
- Tunnel must be vented as needed

5.3 WASTEWATER JUNCTION STRUCTURE

A wastewater junction structure is generally required where two or more wastewater pipelines cannot be connected at a manhole due to inadequate separation distance between the outer diameters of the mains (**Figure 3.12.2**). The following items, but not limited to, must be considered for designing a wastewater Junction structure:

5.3.1 General

- Junction structures are used typically where a standard 8' diameter pre-cast manhole is not adequate.
- The separation distance between pipes must be at a minimum of 1 foot inside junction structure.
- All pipes entering a junction structure must be at right angle at the junction wall.

5.3.2 Structural Consideration

- Roofs of junction structures must be structurally designed for HS-20 loading
- Non-shrink grout shall be used between the junction structure and wastewater mains along structure wall

5.3.3 Corrosion Protection

- Corrosion protection provisions shall be considered for all junction structures
- All moving components of structure must be Stainless Steel 316 unless otherwise approved by DWU

5.3.4 Flow Bypass

- A wastewater flow bypass plan must be prepared

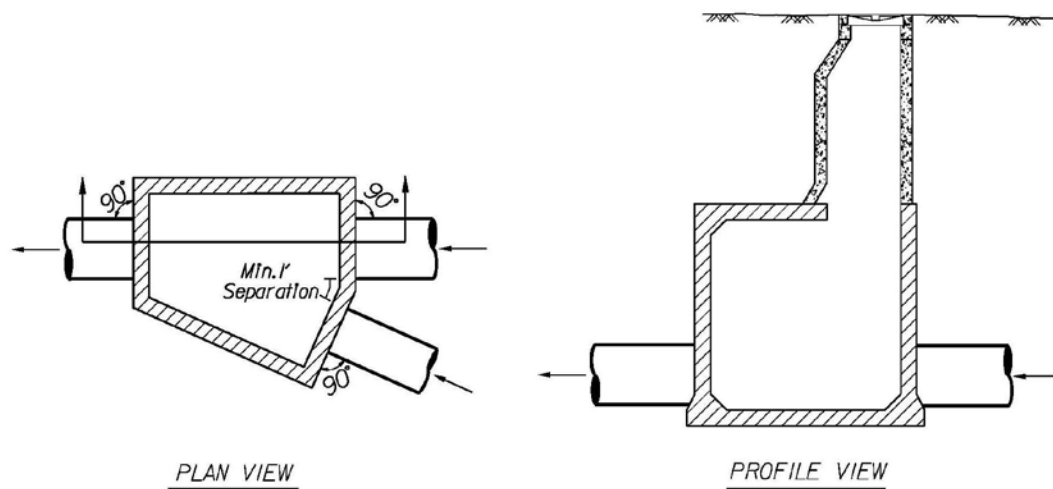


Figure 5.3.4: Typical Wastewater Junction Structure

5.4 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

5.4.1 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.
- WWAD may be installed in lieu of a manhole at the end of wastewater collection system pipe if no extensions are anticipated.

5.4.2 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.

5.4.3 Reference Schematics

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

5.5 INVERTED SIPHON

An inverted siphon can be designed to a portion of a wastewater main which dips below the hydraulic grade line to avoid any obstructions including, but not limited to a drainage structure, utility, tunnel or stream. It shall only be considered where avoidance or adjustment of the obstructing utility or structure is not practical. All siphons shall be designed in accordance to the following criteria:

5.5.1 General

- Useful design life shall be 50 years.
- Design flow shall be the hydraulic capacity of the upstream flow or the future projected flow as per latest DWU Wastewater Master Plan, whichever is greater.
- Design for minimum headloss. Convergence, divergence and bend losses may be considered to be insignificant as applicable.
- All siphons shall be completely buried with a minimum of 48" of cover when going across a natural or man-made depression,
- Maximum slope of the downstream (rising) leg of the siphon shall be 15%.
- Because an inverted siphon includes slopes of zero and adverse values, head losses through the structure shall be calculated by hydraulic grade analysis.
- The total computed head loss should be increased by 10% as a factor of safety.
- Additional criteria for Inverted Siphon is also included in §7.8 (Creek Crossing).

5.5.2 Components

A typical siphon consists of the following components as shown in **Figure 5.5.2**:

5.5.2.1 Conduits:

- Typically, the conduit size through the inverted siphon shall be the same size as either the approaching or exiting conduit.
- The siphon shall consist of two or more conduits with a minimum pipe diameter of 8 inches.
- The siphon pipes must be sized and designed with sufficient heads to achieve a velocity of at least 3 ft/sec at initial and design flows in order for the siphon to be self-cleansing and to minimize siltation.
- The arrangement of inlet and outlet details must divert the normal flow to one conduit and allow overflow into the second conduit. Usually, the conduit taking the overflow will be right above the point where the approaching conduit is carrying the flow that the first conduit is able to carry at full flow.

- When multiple conduits are to be used, all conduits should be arranged so that additional conduits can be brought in service as wastewater flows increase.
- Pressure rated pipes and fittings shall be used.

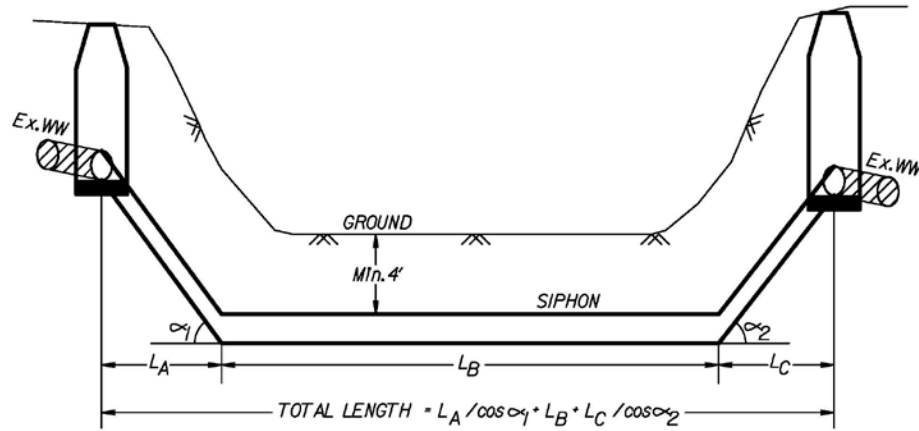


Figure 5.5.2: A Typical Inverted Siphon

5.5.2.2 Inlet and Outlet Structures

- Two manholes or junction structure must be designed including one upstream and one downstream with adequate clearance for cleaning equipment, inspection, and flushing.
- The design must allow any conduit to be taken out of service for cleaning.
- Siphon pipes, manholes and junction structures must be designed to minimize nuisance odors. Provisions must be made to allow cleaning across each bend with equipment available to Wastewater Collection Division.

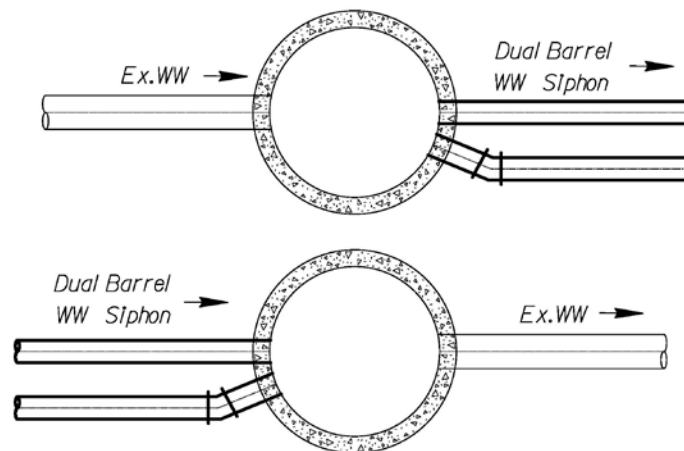


Figure 5.5.2.2: Typical Siphon Inlet and Outlet Manholes

5.5.3 Design Approach

The following design steps may be used to adequately size a typical siphon as applicable:

- Step 1: Preliminary Sizing

Determine approximate location, size and type of conduits, inlet and outlet structures or manholes as needed. Conduits size(s) to the carry maximum design flows may be determined as follows:

$$d_1 = \sqrt{\frac{4Q_1}{\pi V}} \quad \text{and} \quad d_2 = \sqrt{\frac{4Q_2}{\pi V}}$$

Where, d_1 = Diameter of Primary Conduit, ft.
 d_2 = Diameter of Secondary Conduit, ft.
 Q_1 = Max. Daily Flow, ft³/sec
 Q_2 = Peak Daily Flow – Max. Daily Flow, ft³/sec
 V = Velocity (Min. 3ft/sec)

- Step 2: Preliminary Layout

Prepare a preliminary layout of the siphon profile to include the siphon, required inlet and outlet structures, existing or proposed ground line, and elevations at the siphon ends. This layout should provide the required cover, slope and bend angles.

- Step 3: Headloss Calculation

Compute the siphon head losses using the preliminary layout and trial inlet and outlet geometry. Total headloss may be calculated as follows:

$$H_f = (L_T)(S_f)$$

Where,

H_f = Total head loss due to friction
 L_T = Total length of siphon
 S_f = Friction slope, $S_f = (n^2 V^2) / (2.2R^{4/3})$

The total computed head loss should be increased by 10% as a factor of safety as needed:

$1.1H_f < \text{Head/Fall for Each Conduit or Barrel.}$

If $1.1H_f > \text{Head/Fall}$, then V and d shall be adjusted to achieve a minimum velocity of 3 fps if available.

- Step 4: Hydraulic Slope Verification

Hydraulic slope across siphon shall meet the minimum slope required for wastewater mains as per **Table 3.4.4**. Hydraulic slope can be calculated as follows:

$$S_h = \left(\frac{0.785d^2 Vn}{1.49AR^{2/3}} \right)^2$$

Where,

- S_h = Hydraulic slope
- d = Diameter of pipe, ft.
- n = Coefficient of Roughness
- V = Velocity, ft/sec
- A = Cross-sectional area of conduit, ft²
- R = Hydraulic Radius, ft.

- Step 5: Finalize Calculations

All computed siphon dimensions and angles on the final siphon layout. The final transition geometry and actual head losses shall be calculated. If the actual head loss exceeds the available head, more trials may be needed by return to Step 2.

5.6 ON-SITE SEWAGE FACILITIES (OSSF)

5.6.1 General

- All On-Site Sewage Facilities (OSSF) shall be designed strictly in accordance with 30 TAC §285: On-Site Sewage Facilities as approved by the appropriate permitting authority on a case-by-case basis.

5.6.2 Eligibility

- Nearest Wastewater Mains:
OSSF may be considered when a property cannot be served by gravity wastewater main within a distance of 200 feet of a platted boundary.
- Wastewater flow:
Produce no more than 5,000 gallons of waste each day, and used only for disposal of sewage produced on the site where the system is located
- Minimum Lot Size
 - Platted or unplatted subdivisions of single family dwellings served by a public water supply and using individual OSSFs for sewage disposal, shall have lots of at least one (1) acre.
 - Platted or unplatted subdivisions of single family dwellings not served by a public water supply and using individual OSSFs, shall have lots of at least one acre (1).
 - A platted or unplatted subdivision where one tract is divided into four or fewer parts; where each tract is five acres or larger; and each tract is to be sold, given, or otherwise transferred to an individual who is related to the owner within the third degree by consanguinity or affinity.

5.6.3 Facility Planning and Design

- **Site Evaluation:**
A complete site evaluation consisting of soil analysis, groundwater evaluation, and surface drainage analysis shall be performed.
- **Selection Criteria for Treatment and Disposal System:**
The type and size of an OSSF shall be determined on the basis of the soil and site information.
- **Criteria for Sewage Treatment System:**
All pipe materials, septic tanks and appurtenances shall be designed in accordance with applicable TCEQ requirements with the following considerations:
 - The pipe from the sewer stub out to the treatment system shall be constructed of cast iron, ductile iron, polyvinyl chloride (PVC) Schedule 40, standard dimension ratio (SDR) 26.
 - The pipe shall be watertight
 - The slope of the pipe shall be no less than 1/8 inch fall per foot of pipe.
 - The pipe shall have a minimum inside diameter of three inches.
 - Liquid depth of septic tanks shall not be less 30 inches
- **Criteria for Effluent Disposal System**
Standard, propriety or nonstandard systems may be considered as applicable.
- **Other Requirements**
Pump tanks may be necessary when the septic tank outlet is at a lower elevation than the disposal field or for systems that require pressure disposal.

5.6.4 Approval and Permit for Construction

- The property owner or owner's agent must obtain an authorization to construct from the appropriate permitting authority before construction may begin on an OSSF.
- Before an authorization to construct can be issued, the permitting authority will require submittal of the following from the owner or owner's agent:
 - Permit Application
 - Planning Materials
 - Site Evaluation
 - Application Fee

5.7 WASTEWATER LIFT STATION AND FORCE MAIN

5.7.1 General

- All wastewater lift stations shall be designed strictly in accordance with 30 TAC §217.59-63 while meeting or exceeding the following design criteria.
- Lift stations will only be considered a viable option if the cost analysis clearly shows that the gravity wastewater mains are not economically feasible.
- All public lift station designs shall consider the potential for future expansion. The design of lift station shall incorporate a wet well sized for the final capacity of the lift station.
- A lift station application shall meet the submittal requirements as specified on §5.3.16. All design information shall be signed, sealed, and dated by a Texas Licensed Professional Engineer.
- All public lift stations shall be reviewed and approved by DWU Wastewater Collection Division and other divisions or entities under jurisdiction prior to any construction.

5.7.2 Type and Locations

5.7.2.1 Private Lift Station:

- Private lift station may be considered to serve a single property where gravity sewer cannot be used.
- Private lift stations may only be allowed where gravity sewer exists adjacent to a property, but is not deep enough to serve the property.
- Multiple platted properties cannot be served through a single private lift station.
- A wastewater backflow prevention device or assembly may also be required to protect from wastewater backups at the dwelling.
- A private manhole will also be required at the downstream end of the force main prior to gravity flow to the nearby wastewater main. The manhole shall be located within the property limit and to be maintained by the property owner.
- DWU does not maintain private lift stations. Any maintenance of these assets are the sole responsibility of the private owner.
- A typical layout of a private lift station is shown under **Figure 5.7.2.1**.

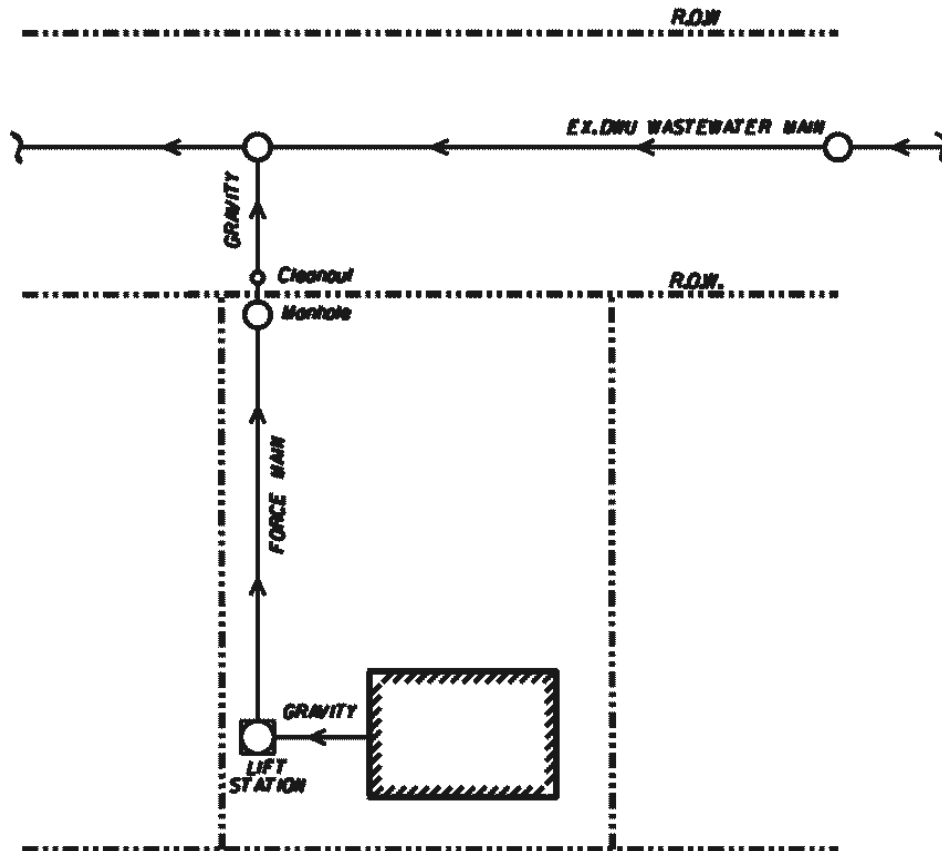


Figure 5.7.2.1: Typical Layout of a Private Lift Station

5.7.2.2 Public Lift Station

- Public lift stations may be considered to serve multiple properties where gravity wastewater cannot be used.
- The lift station must be located and sized so it may serve as much of the entire wastewater drainage basin as possible. This may require that the station be located off-site of the development if necessary.
- The site shall be located as remotely as possible from any residential developments.
- The site shall not be located within 100 feet from a residential lot or 150 feet of an existing or proposed residential dwelling.
- The site and its access shall be dedicated to the City as a wastewater easement if applicable.
- A typical layout of a public lift station is shown under **Figure 5.7.2.2.**

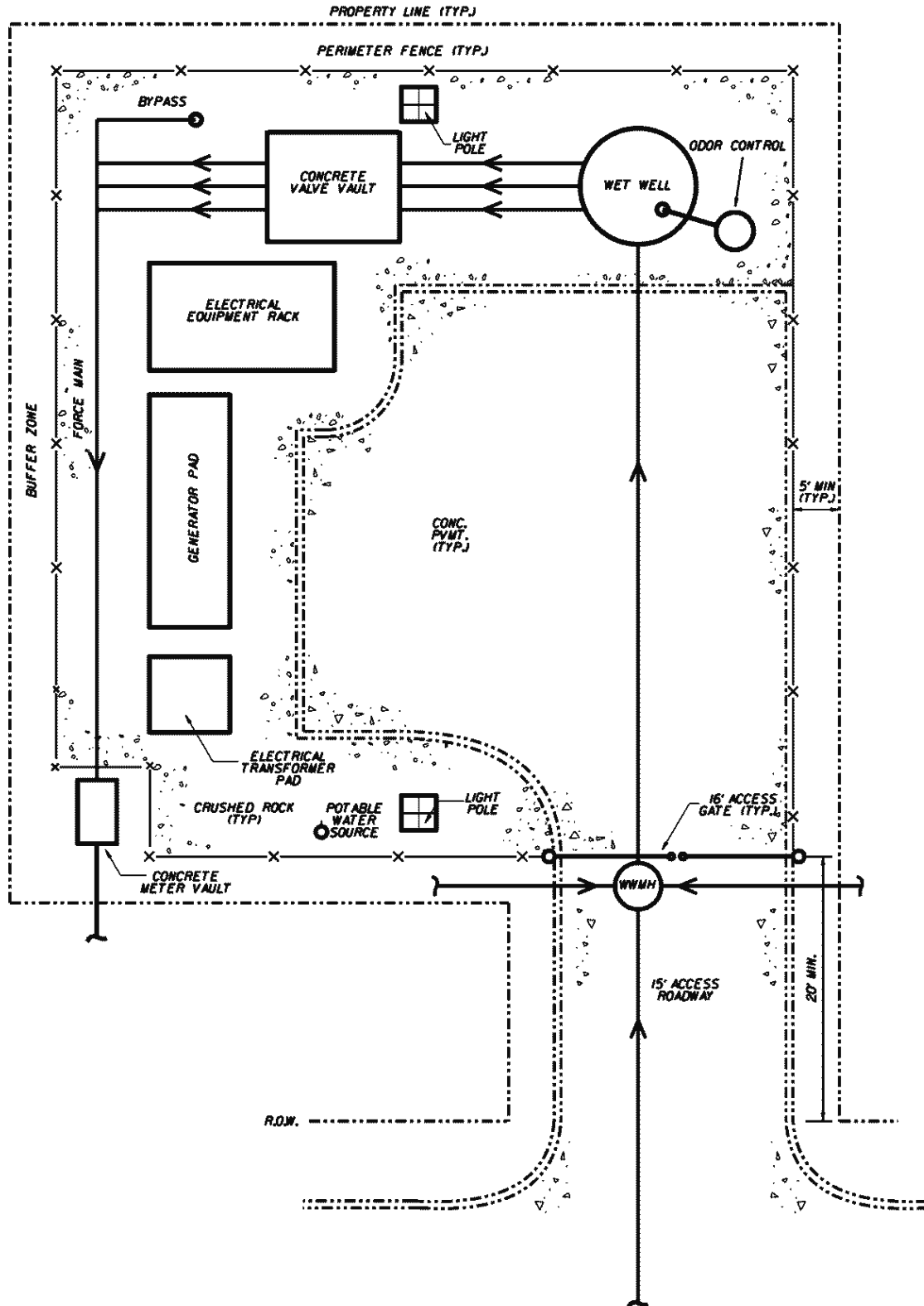


Figure 5.7.2.2: Typical Layout of a Public Lift Station

5.7.3 Site Requirements

5.7.3.1 Site Access

- All public lift station shall have a permanent access road located in a dedicated right-of-way or a permanent easement.
- The road surface must have a minimum width of 16 feet and must be constructed for use in all weather conditions.
- The road shall be constructed of minimum 6" asphalt or concrete depending on adjacent road type. Gravel, rock or other surfaces are not acceptable
- The road surface must be above the water level caused by a 25-year rainfall event.

5.7.3.2 Security

- The design of a lift station, including all mechanical and electrical equipment, must restrict access by any unauthorized personnel.
- The lift station must include an intruder-resistant fence, enclosure, or a lockable structure.
- An intruder-resistant fence must use a minimum of a 6.0 feet high chain link, masonry, or wrought iron fence with at least three strands of barbed wire or 8.0 feet high chain link, masonry, or wrought iron fence with at least one strand of barbed wire as approved by DWU. The fencing set back shall be minimum 5 feet from the property line to allow for a landscape and drainage buffer.
- A double 8-foot or single 15-foot sliding gate shall be provided for easy access by large equipment. The gate setback shall be at least 20 feet from the main road to allow safe entry and exit.

5.7.3.3 Flood Protection and Site Grading

- The elevation of the site shall be a minimum of 2 feet above 100-year flood plain.
- The design of a lift station, including all electrical and mechanical equipment, must be designed to withstand and operate during a 100-year flood event, including wave action.
- The finished grade of the lift station shall be designed so that storm water drainage will not collect on or flow across the finished grade of the lift station.
- The adjacent ground surrounding the station shall be graded so that storm water will not wash dirt and/or any other debris on top of the station during rain storms.
- The concrete slabs of top of wet well, electrical rack, tower foundation and generator shall be minimum 6" higher than the adjacent pavement.
- The station site within the fenced area shall be constructed with concrete, asphalt or crushed rock for easy maintenances as approved by DWU Wastewater Collection.

5.7.3.4 Potable Water Source

- A potable water source must be made available for washing down pumps and general cleaning of the lift station.
- A ¾-inch minimum freeze proof water service with a hose bib with a vacuum breaker shall be used.
- The hose bib shall be at least 2 feet higher than the adjacent ground and to be located outside 20-foot of radius of wet well.

5.7.3.5 Odor Control

- The design of a lift station must minimize potential odor.
- Odor control ventilation or other device shall be considered for the wet well as required.
- Odor control equipment shall be located in an area where it can be easily serviceable.

5.7.3.6 Protective Coating, Corrosion Control and Fall Protection

- Interior of concrete wet well shall be coated with protective coating.
- All pump discharge pipe and fittings within wet well, except SS 316 and PVC, shall receive after installation, protective coating.
- All accessory hardware in wet well including but not limited to chains, cables, bolts, nuts, fasteners, brackets, anchor bolts, washers, cable holders and slide rails, shall be minimum 316 stainless steel.
- All exposed pipe, valves, and fittings outside the wet well shall receive after installation a gray protective coating as approved by DWU Wastewater Collection.
- Any ladders and hatches that provide access to below-ground confined spaces shall incorporate fall protection cages and grates as necessary.
- All hatches without ladder shall incorporate fall protection system as applicable.

5.7.3.7 Pump Control

- A lift station pump must operate automatically, based on the water level in a wet well.
- The location of a wet well level mechanism must ensure that the mechanism is unaffected by currents, rags, grease, or other floating materials. Typically stilling wells are not allowed.
- A level mechanism must be accessible without entering the wet well.
- Wet well controls with a bubbler system require a backup level sensor system.
- Motor control centers must be mounted at least 4.0 inches above grade to prevent water intrusion and corrosion from standing water in the enclosure.
- Electrical equipment and electrical connections in a wet well or a dry well must meet National Fire Prevention Association 70 National Electric Code explosion prevention requirements, unless continuous ventilation is provided.
- Motor control center, SCADA and telemetry systems must be sheltered under a grounded metal canopy for all weather operations.

5.7.8 Design Flows

Design flow shall be estimated for initial and final periods in accordance with §3.4.2 as needed:

- Average Daily Flow (ADF)
- Peak Daily Flow (PDF)

5.7.9 Wet Well Design

A wet well shall be sized to accommodate submersible pumping equipment, piping, supports, emergency storage volume for adequate response time and to support pump cycle times as needed. In addition, wet well shall meet the following:

5.7.9.1 General:

- A wet well must be enclosed by watertight and gas tight walls.
- A penetration through a wall of a wet well must be gas tight.
- A wet well must not contain equipment requiring regular or routine inspection or maintenance, unless inspection and maintenance can be done without staff entering the wet well.
- A gravity pipe discharging to a wet well must be located so that the invert elevation is above the liquid level of a pump's "on" setting.
- Gate valves and check valves are prohibited in a wet well.
- Gate valves and check valves may be located in a valve vault next to a wet well or in a dry well.

5.7.9.2 Volume:

The wet well volume shall be calculated based on the projected final peak flows. Service reliability as specified in §5.7.17.3 shall also be considered while sizing wet well volume. The minimum operating volume of a wet well can be determined by the following method:

$$V = (T * Q) / (4 * 7.48)$$

Where:

V = Active Volume, cu. ft.

Q = Pump Capacity, gpm

T = Cycle Times, minutes

7.48 = Conversion Factor (gallons/cu.ft)

5.7.9.3 Cycle Time:

Pump cycle time, based on peak flow, must equal or exceed those in the following table:

Table 5.7.9.3: Minimum Cycle Time

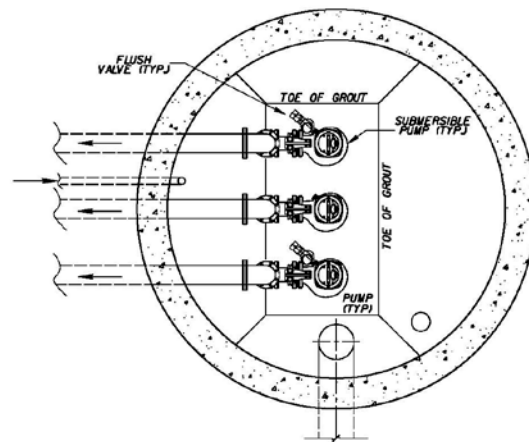
Pump Horsepower	Minimum Cycle Times (Minutes)
< 50	6
50-100	10
> 100	15

5.7.9.4 Materials and Wet Well Slopes:

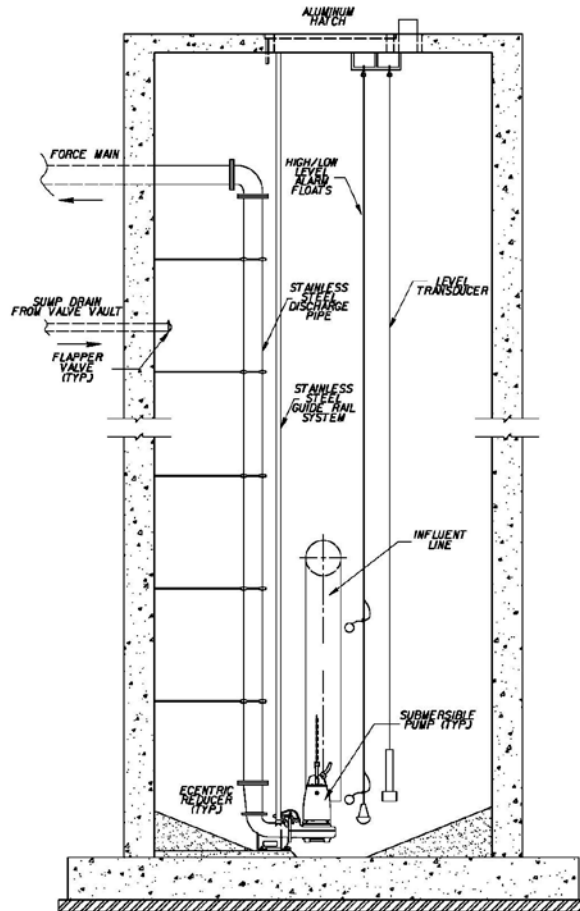
- The wet well shall be constructed with full monolithic concrete structure or a precast structure with monolithic base.
- A wet well floor must have a smooth finish and minimum slope of 10% to a pump intake.
- A wet well design must prevent deposition of solids under normal operating conditions.
- A lift station with greater than 5.0 mgd firm pumping capacity must have anti-vortex baffling.

5.7.9.5 Reference Schematic:

A schematic of a typical wet well is shown in **Figure 5.7.9**.



PLAN VIEW



SECTION VIEW

Figure 5.7.9: A Typical Wet Well Configuration

5.7.10 Dry Well

If approved by DWU, a dry well shall meet the following criteria:

- An underground dry well must be accessible.
- A stairway in a dry well must use non-slip steps and conform to Occupational Safety and Health Administration regulations with respect to rise and run.
- A ladder in a dry well must be made of non-conductive material and rated for the load necessary for staff and equipment to descend and ascend.

5.7.10 Lift Station Ventilation

5.7.10.1 Passive Ventilation for Wet Wells:

- Passive ventilation structures must include screening to prevent the entry of birds and insects to a wet well.
- All mechanical and electrical equipment in a wet well with passive ventilation must be constructed in compliance with explosion requirements in the National Fire Protection Association 70 National Electric Code.
- A passive ventilation system must be sized to vent at a rate equal to the maximum pumping rate of a lift station, but not to exceed 600 feet per minute through a vent pipe.
- The minimum acceptable diameter for an air vent is 4.0 inches.
- A vent outlet must be at least 1.0 foot above a 100-year flood plain elevation.

5.7.10.2 Mechanical Ventilation in Lift Stations:

5.7.10.2.1 Dry Wells.

- A dry well must use mechanical ventilation.
- Ventilation equipment under continuous operation must have a minimum capacity of six air exchanges per hour.
- Ventilation equipment under intermittent operations must have a minimum capacity of 30 air exchanges per hour and be connected to a lift station's lighting system.

5.7.10.2.2 Wet Wells.

- A wet well must use continuous mechanical ventilation.
- The ventilation equipment must have a minimum capacity of 12 air exchanges per hour and be constructed of corrosion resistant material.
- The design of a wet well must reduce odor potential in a populated area.

5.7.11 Hoisting Equipment

- A lift station must have permanent hoisting equipment or be easily accessible to portable hoisting equipment for removal of pumps, motors, valves, pipes, and other similar equipment.

5.7.12 Valve Vault Drains

- A floor drain from a valve vault to a wet well must prevent gas from entering a valve vault by including flap valves, "P" traps, submerged outlets, or a combination of these devices.

5.7.13 Dry Well Sump Pumps

If approved by DWU, a dry well shall meet the following criteria as applicable:

5.7.13.2 Sump Pumps:

- A dry well must use dual sump pumps, each with a minimum capacity of 1,000 gallons per hour and capable of handling the volume of liquid generated during peak operations.
- Sump pump must have a submersible motor and watertight wiring.
- A dry well floor must slope toward a sump sized for proper drainage.
- The minimum sump depth is 6.0 inches and must prevent standing water on a dry well floor under normal operation.
- A sump pump must operate automatically by the use of a float switch or other level-detecting device.
- The sump pump must discharge into the wet well as necessary.

5.7.13.3 Pipes:

- A sump pump must use separate pipes capable of discharging more than the maximum liquid level of an associated wet well.
- A sump pump outlet pipe must be at least 1.5 inches in diameter and have at least two check valves in series.

5.7.14 Pump Design

5.7.14.1 General Requirements:

- All lift stations shall contain a minimum of two pumps and shall be capable of handling peak flows with one pump out of service.
- Each pump should have its own discharge pipe feeding into one common header.
- If additional flow is anticipated in the future, provision for additional pump (s) shall be considered during initial design.

5.7.14.2 Submersible and Non-Submersible Pumps

A raw wastewater pump, with the exception of a grinder pump, must meet the following conditions:

- Pumps shall be designed to prevent clogging.
- Pumps shall be capable of passing a sphere of 2.5 inches in diameter or greater.
- Pumps shall have greater than 3.0 inch diameter suction and discharge openings.
- A non-submersible pump must have inspection and cleanout plates on both the suction and discharge sides of each pumping unit that facilitate locating and removing blockage-causing materials, unless the pump design accommodates easy removal of the rotation elements.
- A pump support must prevent movement and vibration during operation.
- A submersible pump must use a rail-type pump support system with manufacturer-approved mechanisms designed to allow personnel to remove and replace any single pump without entering or dewatering the wet well.
- Submersible pump rails and lifting chains must be constructed of a material that performs to at least the standard of Series 316 stainless steel.

5.7.14.3 Pumping Capacity

- The firm pumping capacity of a lift station must handle the expected peak flow. Typically the firm capacity is defined as the capacity of the lift station with the largest pump out of service. Lead pump shall alternate at each pump cycle.
- The following pump configuration may be used as applicable:

Table 5.7.14.3: Pump Configuration

Peak Daily Flow (gpm)	Minimum No. of Pumps
500 or less	2 Pumps: 1 Lead, 1 Standby
501- 1200	3 Pumps: 1 Lead, 1 Lag, 1 Standby
1201- 3000	4 Pumps: 1 Lead, 1 Lag, 2 Standby
Over 3001	5 Pumps: 1 Lead, 2 Lag, 2 Standby

5.7.14.4 Pump Head Calculations

- General
 - A pump shall be selected based upon analysis of the system head and pump capacity curves that determine the pumping capacities alone and with other pumps as the total dynamic-head (TDH) increases due to additional flows pumped through a force main.
 - The pipe head loss calculations, using the Hydraulic Institute Standards, pertaining to head losses through pipes, valves, and fittings, must be considered.
 - The selected friction coefficient (Hazen-Williams "C" value) used in friction head loss calculations must be based on the pipe material selected.
 - For a lift station with more than two pumps, a force main in excess of one-half mile, or firm pumping capacity of 100 gpm or greater, system curves must be provided for both the normal and peak operating conditions at C values for proposed and existing pipe.
- System Head Curve
 - A family of system head curves shall be developed to indicate the operating envelope of the pumps throughout the life of the facility. These curves shall be constructed by using varying friction factors (C) and wet well levels. At a minimum, curves will be established for both the "pump off" level and the "pump on" level using "C" values of 100 and 140 or equivalent friction factors.
- Pump Curves
 - Once the system curve is developed, various pumps shall be analyzed to determine which pump curves best fit the system curve. Multiple pumps may be required to produce the necessary flow at the required head.
 - Upon selecting the pump, the motor rating (horsepower) and impeller size shall be established. In the case where Variable Frequency Drives (VFDs) are used, the designer shall prepare reduced speed curves as necessary.

- Pump Selection
 - The most efficient pumps shall be selected for the given head-capacity situation as approved by DWU. The selected pumps have a Net Positive Suction Head Required (NPSHR) that is less than the system's Net Positive Suction Head Available (NPSHA) under the worst case scenario.
 - The use of constant speed pumps is typically preferred for a lift stations with a design capacity of 5 MGD or less unless otherwise necessary. Lift stations designed for a capacity greater than 5 MGD may consider variable speed drive (VFD) motor if the hydraulic analysis shows them to be more efficient.
 - A typical system-head curve is shown in **Figure 5.7.14.4**.

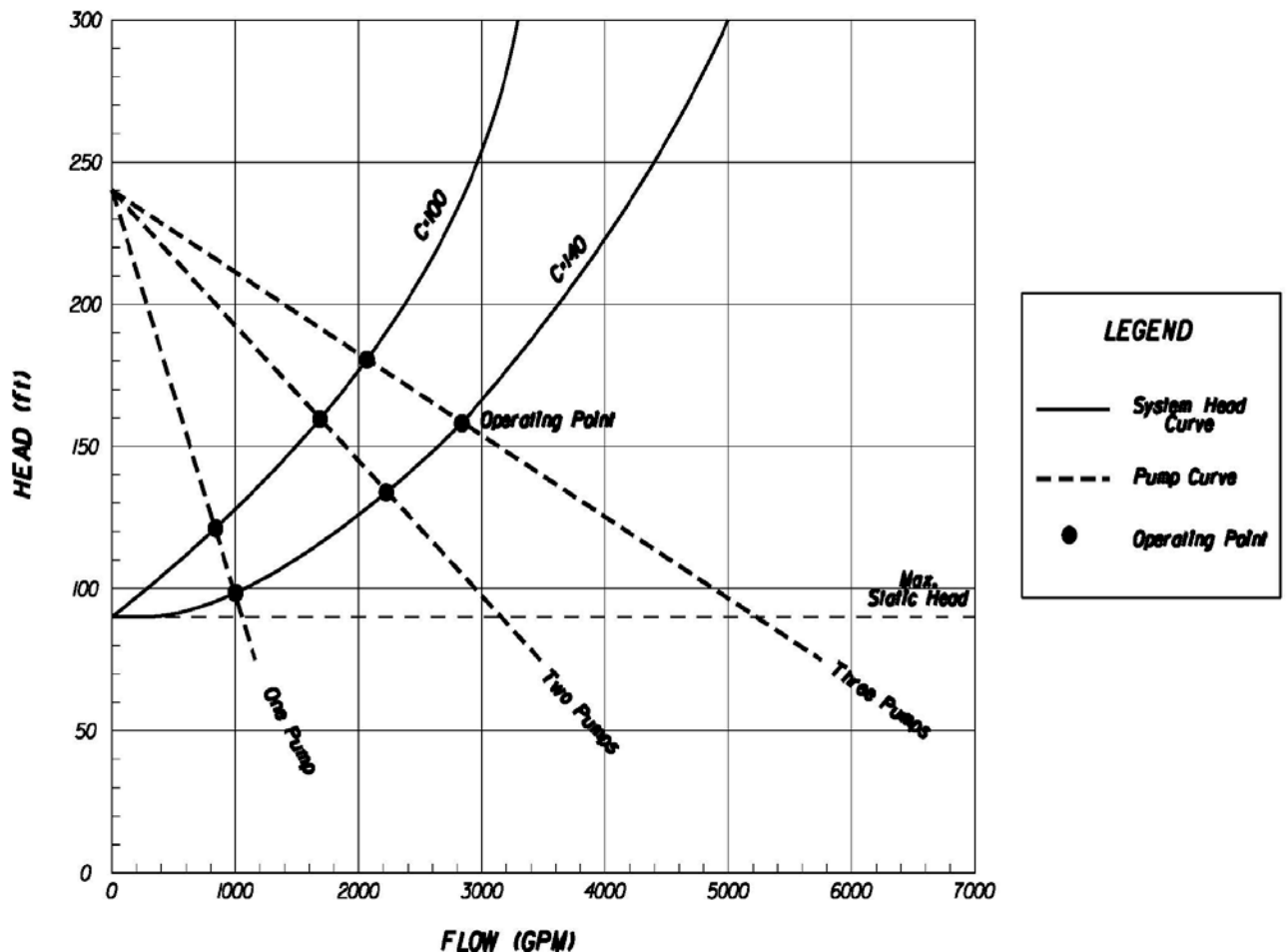


Figure 5.7.14.4:
Typical Construction of Multiple Pump Operating Curves

5.7.14.5 Alternate Pump Selection

The following type of pumps may also be considered as approved by DWU.

- Flow Control
 - A lift station or a transfer pumping station located at or discharging directly to a wastewater treatment system must have a peak pump capacity equal to or less than the peak design flow, unless equalization is provided.
 - A wastewater treatment system with a peak flow that is greater than 300,000 gpd must use three or more pumps, unless duplex, automatically controlled, variable capacity pumps are provided.
- Self-Priming Pumps
 - A self-priming pump must be capable of priming without reliance upon a separate priming system, an internal flap valve, or any external means for priming.
 - A self-priming pump must use a suction pipe velocity of at least 3.0 feet per second, but not more than 7.0 feet per second, and must incorporate its own suction pipe.
 - A self-priming pump must vent air back into the wet well during priming.
- Vacuum-Priming Pumps
 - A vacuum-primed pump must be capable of priming by using a separate positive priming system with a dedicated vacuum pump for each main wastewater pump.
 - A vacuum-priming pump must use a suction pipe velocity of at least 3.0 feet per second but less than 7.0 feet per second and must have its own suction pipe.
- Vertical Positioning of Pumps
 - A raw wastewater pump must have positive static suction head during normal on-off cycling, except a submersible pump with "no suction" pipes, a vacuum-primed pump, or a self-priming unit capable of satisfactory operation under any negative suction head anticipated for the lift station.
 - Individual Grinder Pumps: A grinder pump serving only one residential or commercial structure that is privately owned, maintained, and operated is not subject to the rules of this chapter.
- Pump for Low-Flow Lift Station
 - A pump used for a lift station with a peak flow of less than 120 gallons per minute must be submersible and include a grinder.

5.7.15 Lift Station Piping, Valves and Other Accessories

5.7.15.1 Horizontal Pump Suctions:

- Each pump must have a separate suction pipe that uses an eccentric reducer.
- Pipes in a wet well must have a turndown type flared intake.

5.7.15.2 Valves:

Valves shall not be placed in a wet well. Isolation valves, check valves, and air release/vacuum valves shall be located in the valve vault (**Figure 5.3.12.2**). A butterfly valve, tilting-disc check valve, or any other valve using a tilting-disc in a flow pipe is prohibited.

5.7.15.2.1 Air Release/Vacuum Valves

- Air release valves of a type suitable for wastewater service shall be installed along the force main where the force main would be prone to trapped air.
- Air valve at the lift station may also need to be vented into odor control system as necessary.

5.7.15.2.2 Check Valves

- Check valves shall be located upstream of the isolation valve.
- A check valve must be a swing type valve with an external lever.
- A valve must include a position indicator to show its opened and closed positions, unless a full-closing valve is a rising-stem gate valve.
- A grinder pump installation may use a rubber-ball check valve or a swing-type check valve.

5.7.15.2.2 Isolation Valves

- Each pump shall have one isolation valve downstream of the pump and check valve.
- Isolation valves shall be plug valves as approved by DWU.

5.7.15.3 Yard Piping

- A lift station pipe must have flanged or flexible connections to allow for removal of pumps and valves without interruption of the lift station's operations.
- Wall penetrations must allow for pipe flexure while excluding exfiltration or infiltration.
- Pipe suction velocities must be at least 3.0 feet per second but not more than 7.0 feet per second.

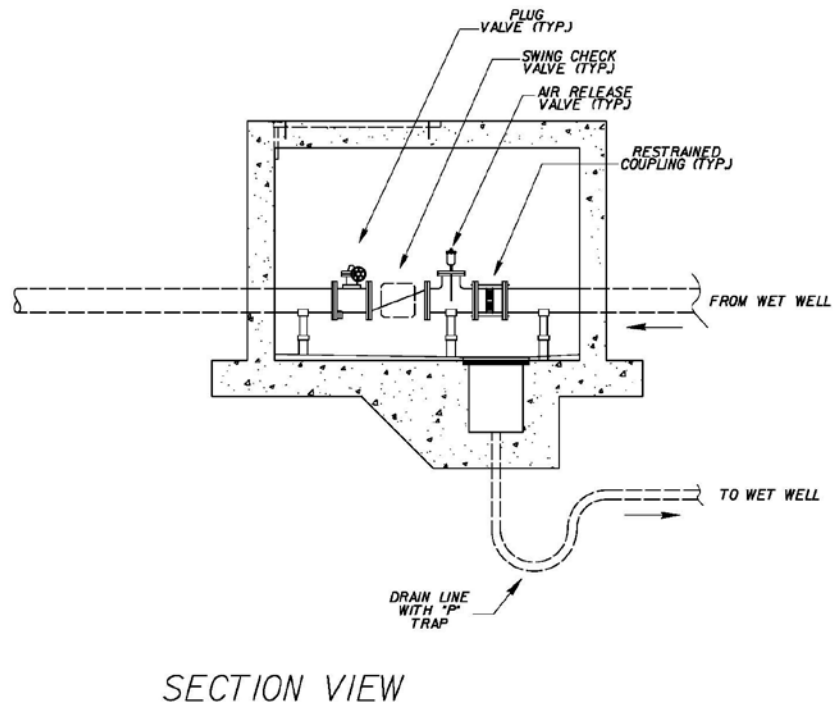
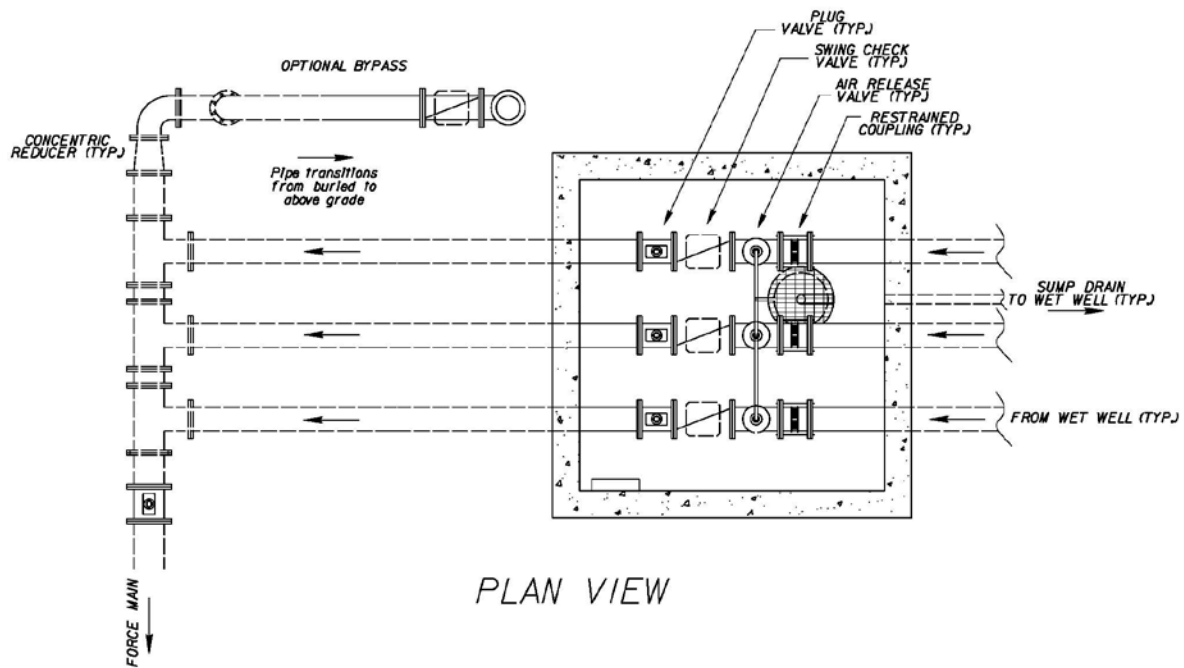


Figure 5.7.15.3: A Typical Valve Assembly

5.7.16 Flow Meter

- Wastewater flow meter shall be located in separate valve vault.
- Flow meter shall be located outside the fence unless otherwise approved.

5.7.17 Emergency Provisions for Lift Stations

5.7.17.1 Alternate Power Source

- A full capacity backup generator with an automatic transfer switch shall be installed in all lift stations.
- Lift stations must be equipped with a tested quick-connect mechanism or a transfer switch properly sized to connect to a portable generator, if not equipped with an onsite generator.
- Double feed electrical backup from two separate sources may also be considered, if available.

5.7.17.2 Audiovisual Alarm

- Lift stations must include an audiovisual alarm system and the system must transmit all alarm conditions through use of an auto-dialer system, Supervisory Control and Data Acquisition (SCADA) system, or telemetering system connected to a continuously monitored location.
- An alarm system must self-activate for a power outage, pump failure, or a high wet well water level.

5.7.17.3 Service Reliability

A lift station constructed to pump raw wastewater must have service reliability based on:

- Retention Capacity
 - The retention capacity in a lift station's wet well and incoming gravity pipes must prevent discharges of untreated wastewater at the lift station or any point upstream for a period of time equal to the longest electrical outage recorded during the past 24 months, but not less than 20 minutes.
 - For calculation purposes, the outage period begins when a lift station pump finished its last normal cycle, excluding a standby pump.
- On-Site Generators
 - A lift station may be provided emergency power by on-site, automatic electrical generators sized to operate the lift station at its firm pumping capacity or at the average daily flow, if the peak flow can be stored in the collection system.

- Portable Generators and Pumps
 - A lift station may use portable generators and pumps to guarantee service if the report includes:
 - (i) the storage location of each generator and pump;
 - (ii) the amount of time that will be needed to transport each generator or pump to a lift station;
 - (iii) the number of lift stations for which each generator or pump is dedicated as a backup; and
 - (iv) the type of routine maintenance and upkeep planned for each portable generator and pump to ensure that they will be operational when needed.
 - An operator that is knowledgeable in operation of the portable generators and pumps shall be on call 24 hours per day every day.
 - The size of a portable generator must handle the firm pumping capacity of the lift station.

5.7.17.4 Spill Containment Structures

- The use of a spill containment structure as a sole means of providing service reliability is prohibited.
- A lift station may use a spill containment structure in addition to one of the service reliability options detailed in §5.3.13.1.
- A detailed management plan for cleaning and maintaining each spill containment structure is needed, if applicable.
- A spill containment structure must have a locked gate and be surrounded by an intruder resistant fence that is 6.0 feet high chain link, masonry, or wrought iron fence with at least three strands of barbed wire or 8.0 feet high chain link, masonry, or board fence with at least one strand of barbed wire.

5.7.17.5 System Control

- Lift station system controls must prevent over-pumping upon resumption of normal power after a power failure. Backup or standby units must be electrically interlocked to prevent operation at the same time that other lift stations pumps are operating only on the resumption of normal power after a power failure.

5.7.18 Electrical Equipment

- All electrical and electronic lift station equipment must be located above ground level so that a confined space entry permit is not required to service the lift station controls and telemetry equipment.
- The control panel should be ready to accommodate additional controls for a third pump if a triplex lift station is required.

5.7.19 Supervisory Control and Data Acquisition (SCADA)

- The lift station must incorporate a telemetry system such as radio communications or an approved auto-dialer unit and a phone line to provide failsafe notification of alarms and failures.
- Designer shall coordinate with telephone company for installation of phone line and design alignment of phone line.
- DWU will typically coordinate with phone company for phone number and other communication issues.
- All electrical conduit, fittings and supports must be installed as per latest Electrical Code as approved by DWU.

5.7.20 Force Main Design

5.7.20.1 Pipe Materials:

- Force main pipe material must withstand the pressure generated by instantaneous pump stoppage due to power failure under maximum pumping conditions.
- The use of pipe or fittings rated at a working pressure of less than 150 psi is prohibited.
- Pipe must be identified in the technical specifications with the appropriate specification number for both quality control and installation from the American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), or American Water Works Association (AWWA).
- Pipe material specified for a force main must have an expected life equal to or longer than that of the lift station and must be suitable for the material being pumped.
- **Table 4.6.3** may be used for selecting appropriate pipe materials and embedment as applicable.

5.7.20.2 Pipe Joints:

- An underground force main pipe joint must include either push-on rubber gaskets or mechanical joints with a pressure rating equal or greater than the force main pipe material.
- Exposed force main pipe joints must be flanged or flexible and adequately secured to prevent movement due to surges.
- ASTM, AWWA or other widely accepted national reference standard for the joints must be considered for pipe specifications.

5.7.20.3 Identification of Force Main Pipes:

- A detector tape must be laid in the same trench as a force main pipe. The detector tape must be located above and parallel to the force main.
- The detector tape must bear the label "**PRESSURIZED WASTEWATER**" continuously repeated in at least 1.5 inch letters.

5.7.20.4 Velocities:

- A force main must be a minimum of 4.0 inches in diameter, unless it is used in conjunction with a grinder pump station.
- For a duplex pump station, the minimum velocity is 3.0 ft/s per second with one pump in operation.
- For a pump station with three or more pumps:
 - The minimum velocity in a force main is 2.0 ft/s with only the smallest pump in operation; and
 - A minimum flushing velocity of 5.0 ft/s or greater must occur in a force main at least once daily.
- The force main with a velocity greater than 6.0 ft/s shall be designed to withstand high and low negative surge pressures in an event of sudden pump failure.

5.7.20.5 Detention Time:

- A force main detention time must be calculated.
- The force main detention time calculations must be performed using a range of flow rates that represent the flows expected to be delivered to a force main by an upstream pump station during any 24-hour period.

5.7.20.6 Water Hammer:

- A force main design must include surge control measures to manage pressure due to a water hammer that may exceed the working strength of a force main pipe.

5.7.20.7 Connection to Gravity Main:

- A force main must terminate in an appropriate structure and either at a manhole on the wastewater collection system or at a wastewater treatment facility.
- The discharge end of a force main inside a manhole must remain steady and produce non-turbulent flow.
- A receiving wastewater collection system must accept the maximum pump discharge without surcharging.

5.7.20.8 Pipe Separation:

- A separation distance between a force main and any water supply water pipe must meet the minimum separation requirements established in §2.10 as applicable.

5.7.20.9 Odor Control:

- A force main must terminate below a manhole invert with the top of the pipe matching the water level in the manhole at design flow.
- A force main must be designed to abate any anticipated odor.

5.7.20.10 Air Release Valves in Force Mains:

- Any high point along the vertical force main alignment must include an air release valve or a combination of air release and air vacuum valves.
- An air release valve must have an isolation valve between the air release valve and the force main.
- An air release valve must be inside of a vault that is at least 48 inches in diameter and has a vented access opening of at least 30 inches in diameter.

5.7.17.11 Valves:

- A force main must have isolation valves spaced at no more than 2,000 foot intervals to facilitate initial testing and subsequent maintenance and repairs.

5.7.17.12 Force Main Testing

- The final plans and specifications must include the pressure testing procedures.
- A pressure test must use 50 psi above the normal operating pressure of a force main.
- A temporary valve for pressure testing may be installed near the discharge point of a force main and removed after a test is successfully completed.
- A pump isolation valve may be used as an opposite termination point.
- A test must involve filling a force main with water.

- A pipe must hold the designated test pressure for a minimum of 4.0 hours.
- The leakage rate must not exceed 10.0 gallons per inch diameter per mile of pipe per day.

5.7.18 Submittal Requirements for Public Lift Stations

5.7.18.1 Preliminary Design Report

A preliminary design report, as prepared and sealed by a Texas Professional Engineer, shall be submitted to DWU for review and approval by DWU and other entities with jurisdiction prior to any construction. This report shall include, but not limited to, the following items:

- Scope:
 - Location, type and size of development
 - Size of lot or building to be serviced
- Evaluation of Existing Wastewater Collection System:
 - Location, type and size of gravity system the force main will discharge into.
- Design Data:
 - i. Design Flow
 - Average Daily Flow (ADF), gpm of initial and final phase
 - Peak Daily Flow (PDF), gpm of initial and final phase
 - ii. Storage Requirements
 - Wet Well Size
 - Cycle Time
 - ii. Pump Head Calculation
 - Total Dynamic Head (TDH)
 - Selected Pump Curve
 - Net Positive Suction Head Available (NPSHA) and Net Positive Suction Head Required (NPSHR), if available
 - Static and Total Suction Lift, if applicable
 - iii. Pump, Motor and Generator Data, if available
 - iv. Lift Station Piping, Valves and Other Accessories

v. Force Main Data

- Length
- Material, Class and Rated Pressure
- Size, Inside Diameter
- Velocity in Force Main

vi. Other Pertinent Calculations

- Bouncy Check
- Water Hammer Calculation
- Force Main Flush Time Calculation

- Estimated Construction Cost

5.7.18.2 Plan and Specifications

Final Plan and Specifications shall be sealed and signed by a Texas Professional Engineer

5.17.18.3 O & M Manual

The Design Engineer shall ensure the specifications require the Contractor to submit minimum 3 hard copies and one electronic copy (in pdf) of the Operation and Maintenance (O&M) manuals of all equipment to DWU. O&M manual shall include, but not limited to the followings:

- Technical data, system head curve, performance levels, specifications, parts description, installation, operation and maintenance of electrical, mechanical, and instrumentation components.

5.8 ABANDONMENT OF WASTEWATER APPURTENANCES:

5.8.1 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).

5.8.2 Reference Schematics:

- DWU Drawing No. 316: Abandonment of manhole in and out of Pavement

CHAPTER 6

RECLAIMED WATER MAIN AND APPURTENANCES DESIGN

6.1 REFERENCES

Reclaimed water main shall be designed in conformance with “30 TAC §210: Use of Reclaimed Water” along with all applicable laws, regulations, codes and standards.

6.2 DEFINITIONS

- **Reclaimed Water**

Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use pursuant to the provisions of applicable TCEQ rules and permits is commonly known as reclaimed, recycled or reuse water.

- **Type I Reclaimed Water Use**

Use of reclaimed water where contact between humans and the reclaimed water is likely and which, therefore requires more stringent water quality.

- **Type II Reclaimed Water Use**

Use of reclaimed water where contact between humans and the reclaimed water is unlikely and thus does not require the stringent water quality of Type I.

6.3 DWU RECLAIMED WATER SYSTEM

- Dallas Water Utilities is currently evaluating closely at opportunities to use highly treated effluent or recycled water to augment other sources of water in meeting current and future water demands. A reclaimed water master plan entitled “Recycled Water Implementation Plan, dated August 30, 2005” was developed consisting of the evaluation of two options for the use of reclaimed water: direct, non-potable reuse and indirect potable reuse through the augmentation of raw water supplies.
- A preliminary design report consisting of project scope, supporting data, evaluation of various alignment alternatives and recommendation must be prepared and submitted to DWU for approval prior to any detail design of reclaimed water main (Ref: §1.6.4).

6.4 RECLAIMED WATER MAIN SIZING

The reclaimed 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 main must be based on engineering analysis of initial and future demand of the reclaimed water user(s). The designer shall meet or exceed the following minimum criteria for sizing reclaimed water mains:

- **Velocity:** The velocity of a reclaimed water main shall be maintained between 2 and 10 feet per second.
- **Service:** The size of the services must be at least one standard size smaller than the proposed and existing raw water main.

6.4.1 Pressurized Main:

Reclaimed water pressure mains shall be designed with the same criteria as potable water mains as outlined in Chapter 2 relating to water main design guideline unless otherwise specified in this Chapter. The designer shall consider methods to prevent or maintain lines to mitigate the effect of the deposition of solids in such lines.

6.4.2 Gravity Main:

Reclaimed water gravity mains shall be designed with the same criteria as gravity wastewater mains as outlined in Chapter 3 relating to wastewater main design guideline unless otherwise specified in this Chapter. The designer shall consider methods to prevent high velocity scour or maintain line fluid velocity to mitigate the effects of the deposition of solids in the gravity conveyance.

6.5 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.

6.5.1 Terminology:

6.5.1.1 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.

6.5.1.2 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.

6.5.2 Minimum Cover:

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

Table 6.5.2: Minimum Depth of Cover for Reclaimed Water Main

Size of Main (in)	Min. Depth* (ft)		
	Unimproved Area	Improved Area	Highway/Railroad Crossing**
12" and Smaller	6	4	6
16"	6	5	6
20" and Larger	7	6	6

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

** Reclaimed water mains under highway and railroad right-of-ways must meet all additional criteria as required.

6.6 RECLAIMED WATER PIPE MATERIALS & EMBEDMENTS

6.6.1 Pipe Material Selection:

Designers are responsible for specifying the type of pipe to be used in any design. Typically all reclaimed water pipes shall be pressure rated with a minimum working pressure rating of 150 psi unless otherwise approved by DWU. For smaller pipe sizes ($\leq 16''$ diameter) PVC is the material preferred by DWU. For larger pipe sizes ($> 16''$) DWU prefers reinforced concrete cylinder pipe (RCCP). Other materials such as ductile iron and steel may be specified contingent 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 pipes 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. In addition, all reclaimed water mains must be designated with a purple coloration. They may be fabricated from purple base materials, painted purple, or encased in a purple polyethylene sleeve. In addition to the purple color or purple sleeve all pipe materials shall have the words “Non-Potable” painted on them in 2” high letters every two feet.

6.6.2 Fittings:

All PVC and ductile iron pipe shall use ductile iron fittings with a minimum working pressure rating of 150 psi. Compact fittings are not allowed. All 90 degree bends shall be avoided in the system, if possible.

6.6.3 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 113-119C for the various classes of embedment.

6.6.4 Recommended Pipe Material and Embedment:

The following table summarizes recommended pipe material and embedment for different reclaimed water mains:

Table: 6.6.4: Recommended Reclaimed Water Pipe Materials & Embedments*

Pipe & Material Specification	Allowable Size (in)	Joint Specification	Embedment Class Per Depth of Cover** (ft)
Purple PVC AWWA C900 (DR-14)	6 – 12	Bell & Spigot Joints: ASTM D3139 Gasket: ASTM F477	< 8' : C+
Purple PVC AWWA C905 (DR-14)	16	Fusible Fusible C 900 ^(R) Fusible C 900 ^(R) Certa-Lok Certa-Lok C900/RJ ^(TM) Certa-Lok C905/RJ ^(TM)	8'-16' : B+
Ductile Iron (DI) w/Seal Coat Purple Polyethylene PolyWrap, 8-mil ANSI/AWWA C151/A21.51 Class 52 or Class 54	6 – 60	Bell & Spigot/ Push On ANSI/AWWA C111/A21.11 Mechanical ANSI/AWWA C111/A21.11 Flanged ANSI/AWWA C115/A21.15	≤16-in Dia: >16-in Dia: < 8' (Rock): C < 8' (Earth): D+ <8" : B 8'-16' : C 8'- 16' : B > 16' : B >16' : B
RCCP- Bar Wrapped Cement Mortar w/Purple Dye ANSI/AWWA C303 Class 150	16 – 42	Bell & Spigot ANSI/AWWA C303	16-in Dia: >18-in Dia: < 16' : C <16' : B > 16' : B >16' : B

Table: 6.6.4: Recommended Reclaimed Water Pipe Materials & Embedments*
(Contd.)

Pipe & Material Specification	Allowable Size (in)	Joint Specification	Embedment Class Per Depth of Cover** (ft)
PCCP- Lined Cylinder Cement Mortar w/Purple Dye ANSI/AWWA C301 Class 150	20 – 60	Bell & Spigot ANSI/AWWA C301	< 16' : C > 16' : B
PCCP- Embedded Cylinder Cement Mortar w/Purple Dye ANSI/AWWA C301 Class 150	54 – 144	Bell & Spigot ANSI/AWWA C301	< 16' : C > 16' : B
Steel Cement Mortar w/Purple Tape Coating** ANSI/AWWA C200	24 – 156	Welded Joints or Bell & Spigot ANSI/AWWA C200	< 8' : C > 8' : C

* 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

6.7 LOCATION

- Location of all new reclaimed water mains shall be considered on case-by-case basis while meeting the criteria of this chapter.
- New reclaimed water mains within highway or railroad right-of-ways must be coordinated with appropriate agency while meeting DWU criteria.

6.8 HORIZONTAL ALIGNMENT

Horizontal alignment of reclaimed water mains shall be conducted in accordance with §2.8 of this manual relating to horizontal alignment of water main.

6.9 VERTICAL ALIGNMENT

Vertical alignment of reclaimed water mains shall be conducted in accordance with §2.9 of this manual relating to vertical alignment of water main with the following exception:

- All 6" or larger reclaimed water main designs must have a vertical profile.

6.10 SEPARATION DISTANCE BETWEEN RECLAIMED WATER AND WATER/WASTEWATER MAINS

- When a reclaimed water main is built near an existing water/wastewater facility, conveyance, or appurtenance, 30TAC §210.25(c)-(e) as enforced by TCEQ, governs the minimum separation distances:

6.10.1 Ideal Case:

- Reclaimed water piping shall be separated from potable water piping by a horizontal distance of at least nine (9) feet. All separation distances shall be measured from the outside surface of each of the respective pieces.
- Where a reclaimed water main parallels a wastewater main, the horizontal separation distance shall be three (3) feet (outside to outside) with the reclaimed water main at the level of or above the sewer line.

6.10.2 Pipe Trench:

- Reclaimed water main and potable water distribution mains or laterals from parallel utility lines shall be installed in separate trenches.
- Reclaimed water lines, which parallel wastewater lines may be placed in the same benched trench contingent upon approval by DWU.

6.10.3 Cross Connection:

No physical connection shall be made between a reclaimed water line and potable water or wastewater line. Any appurtenance shall be designed and constructed so as to prevent any possibility of cross contamination.

6.10.4 Variances:

- Where the nine (9) foot separation distance from water main cannot be achieved, the reclaimed water piping must meet the line separation requirements of 30TAC §290.44(e) as specified in §2.10 of this manual.
- Where a reclaimed water line crosses a wastewater main, the requirements of §2.10.5 relating to “New Waterline Installation- Crossing Lines” shall be followed, with “reclaimed water line” substituted in §2.10.5 of this title (relating to Location of Water Line) for “water line”.

6.11 CONNECTION TO EXISTING MAINS

Typically service lines from individual properties are not allowed to be connected to a reclaimed water main unless otherwise approved by DWU Distribution.

6.12 RECLAIMED WATER MAIN APPURTENANCES

Any appurtenance connected to the reclaimed water main that is accessible from the surface shall have a sign affixed to it that says “Non Potable” in both English and Spanish. If the appurtenance is inside a manhole, vault or meter box the sign may be affixed to the inside wall. Any appurtenance that has a lid or cover shall have the label “Non Potable” cast into the outside surface or permanently inscribed with the same label in some other manner.

6.12.1 Isolation Valves

Isolation valves on reclaimed water lines shall typically be standard double-disk gate valves, but shall open in the clockwise direction.

6.12.2 Hose Bib and Faucet

- All hose bibs and faucets shall be painted purple and designed to prevent connection to a standard water hose.
- Hose bibs shall be located in locked, below grade vaults which shall be clearly labeled as being of non-potable quality. As an alternative to the use of locked, below grade vaults with standard hose bibs services, hose bibs may be placed in a non-lockable service box which can only be operated by a special tool so long as the hose bib is clearly labeled as non-potable water. One of the following requirements must be met by the user or provider, for any area where reclaimed water is stored or where there exist hose bibs or faucets:
 - Signs having a minimum size of eight inches by eight inches, as shown in **Figure 6.12.2** shall be posted at all storage areas and on all hose bibs and faucets reading, in both English and Spanish, "Reclaimed Water, Do Not Drink" or similar warning.
 - The area shall be secured to prevent access by the public.



DO NOT DRINK THE WATER
NO TOMAR EL AGUA

**Figure 6.12.2
Reclaimed Water Warning Sign**

6.12.3 Backflow Prevention Device

Backflow prevention Device shall be installed at each delivery point in order to protect reclaimed water system from potential cross contamination.

6.12.4 Exposed Piping

All exposed piping and piping within a building shall be manufactured in purple, painted purple, taped with purple metallic tape, or bagged in purple. All exposed piping should be stenciled in white with a warning reading "Non-Potable Water." All exposed or buried reclaimed water piping constructed at a wastewater treatment facility is exempt from the color coding requirements of this section

6.12.5 Storage Tanks

All ground level and elevated storage tanks shall be designed, installed and constructed in accordance with current AWWA standards with reference to materials to be used and construction practices to be followed, except for health-based standards strictly related to potable water storage and contact practices, where appropriately less standards may be applied contingent upon approval by DWU.

In the event that a storage tank, basin, or other water storage facility for reclaimed water will also have a potable water connection, the potable water connection must always have a twelve (12) inch minimum air gap between the potable water outlet and the maximum surface elevation of the stored reclaimed water.

6.13 HYDROSTATIC TESTING

- All reclaimed water mains shall be hydrostatically tested in accordance with §2.15 of this manual before being put in service. However, no chlorination will be required unless otherwise requested by DWU.
- Hydrostatic testing of all reclaimed water mains must also be in accordance with Addendum to the NCTCOG Standards by DWU, Latest Edition.

CHAPTER 7

CRITICAL ACCESS AND CROSSING CRITERIA

7.1 GENERAL

This chapter addresses water and wastewater main design criteria for various critical accesses and crossings.

7.2 ROADWAY ACCESS, PAVEMENT CUT AND REPAIR CRITERIA

7.2.1 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). The following reference must be reviewed in conjunction with this manual:

- Pavement Cut and Repair Standards Manual by PW&T, Latest Edition.

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.

7.2.2 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.

7.2.2.1 Concrete Pavement:

The 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 7.2.2.1.1).

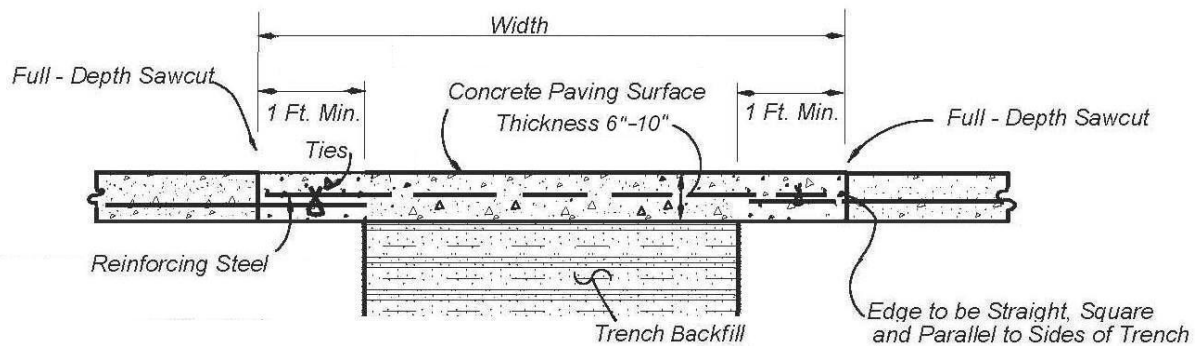


Figure 7.2.2.1.1:
Full Depth Concrete Pavement

Source: Pavement Cut and Repair Standards Manual by PW&T, 2003

- Asphalt Concrete Pavement with Concrete Base: Pavement consists of 6- 10" of concrete base with 2" asphaltic concrete surface course (Figure 7.2.2.1.2)

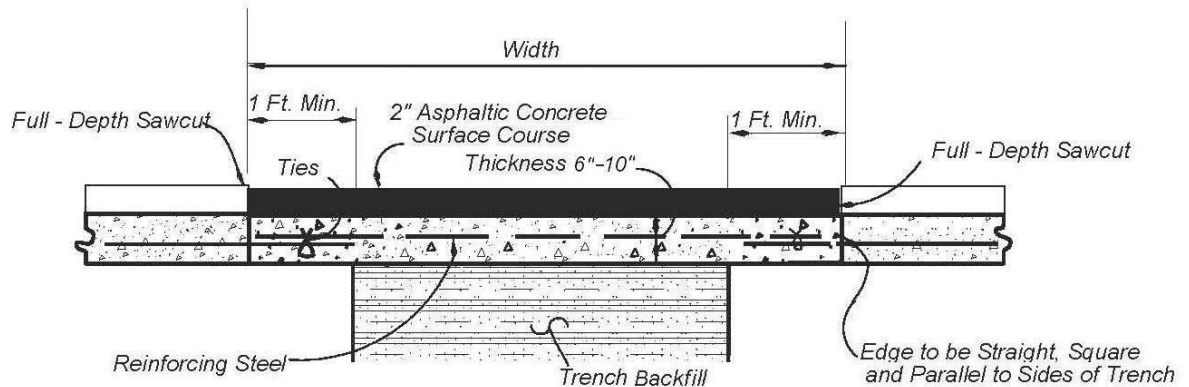


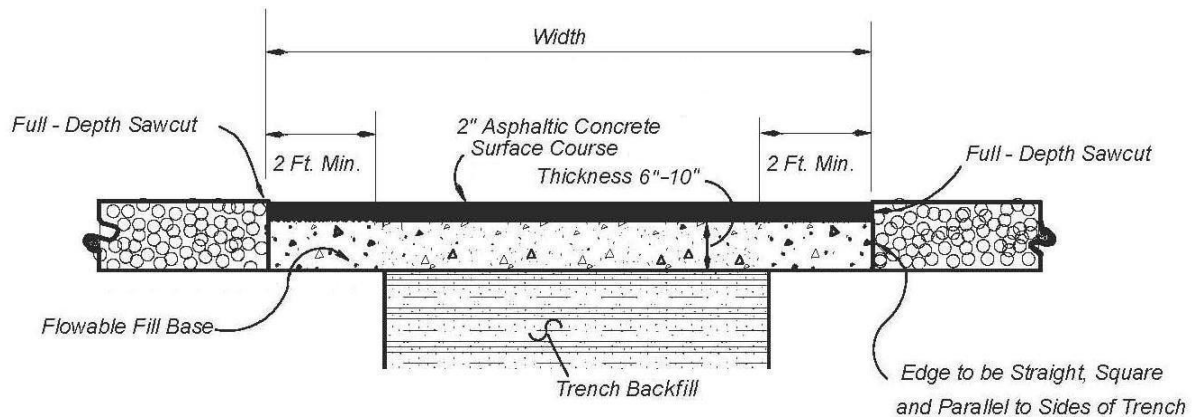
Figure 7.2.2.1.2:
Asphalt Concrete Pavement with Concrete Base

Source: Pavement Cut and Repair Standards Manual by PW&T, 2003

7.2.2.2 Asphalt Pavement:

The 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 7.2.2.2.1**)



**Figure 7.2.2.2.1:
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 7.2.2.2.1**).

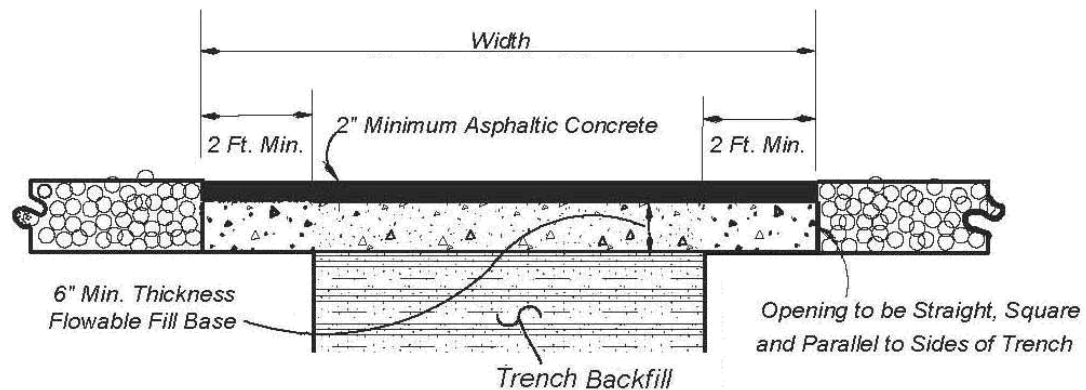


Figure 7.2.2.2.2: Asphalt Concrete on Flexible Base

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 7.2.2.2.3**).

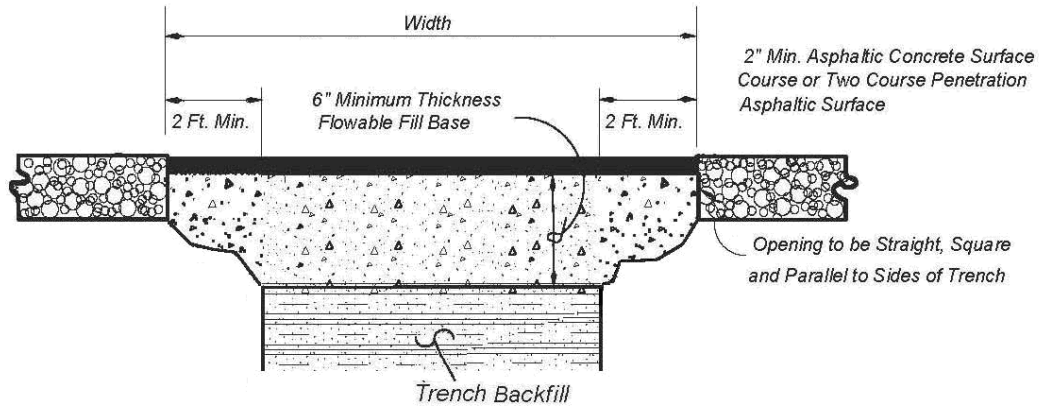


Figure 7.2.2.3:
Penetration Type Pavement on Flexible Base

Source: Pavement Cut and Repair Standards Manual by PW&T, 2003

7.2.2.3 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 7.2.2.3**).

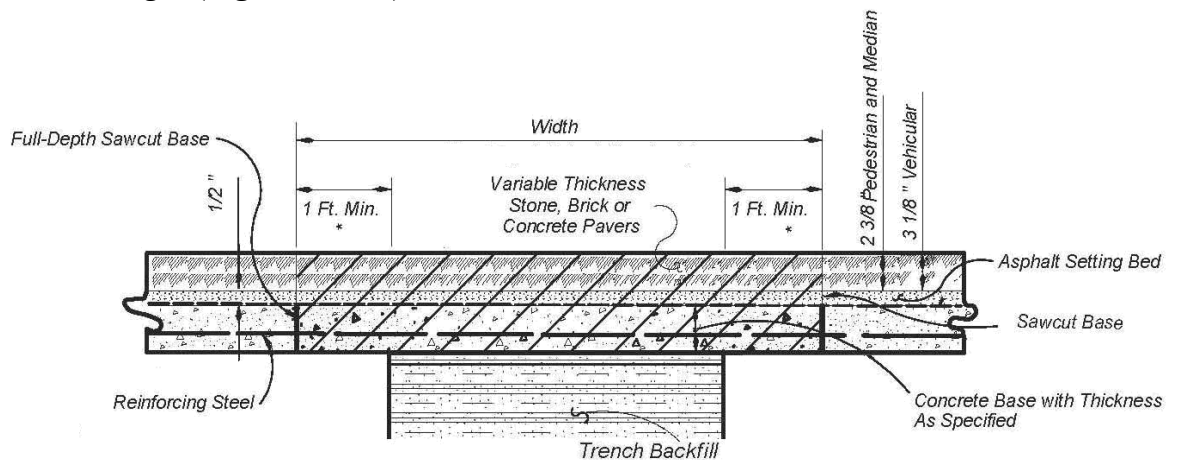


Figure 7.2.2.3:
Special Pavement

Source: Pavement Cut and Repair Standards Manual by PW&T, 2003

The 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.

7.2.3 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.

7.2.4 Repair Criteria for Streets of More Than 5 Years Old:

7.2.4.1 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.

7.2.4.2 Residential Street of 30' or Greater:

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

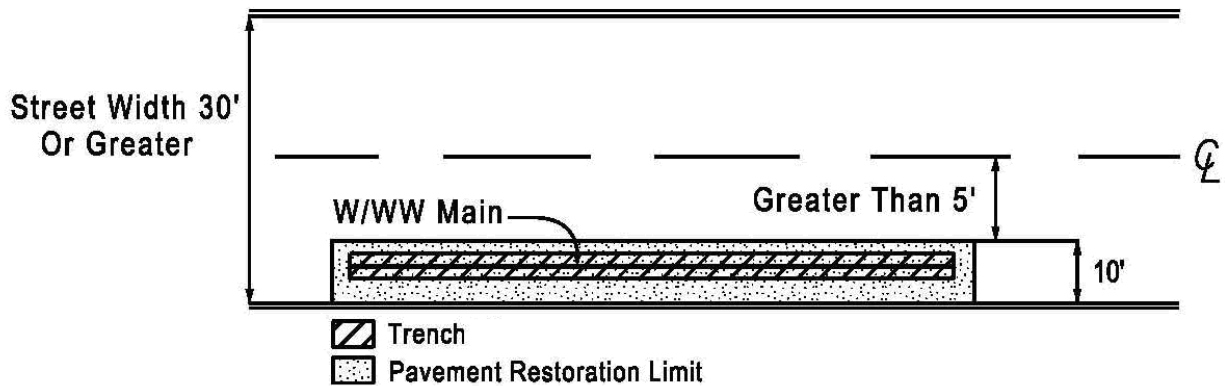


Figure 7.2.4.2.1:
Option 1: Pavement Cut and Repair Extent for Residential Street of 30 Feet or Greater

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

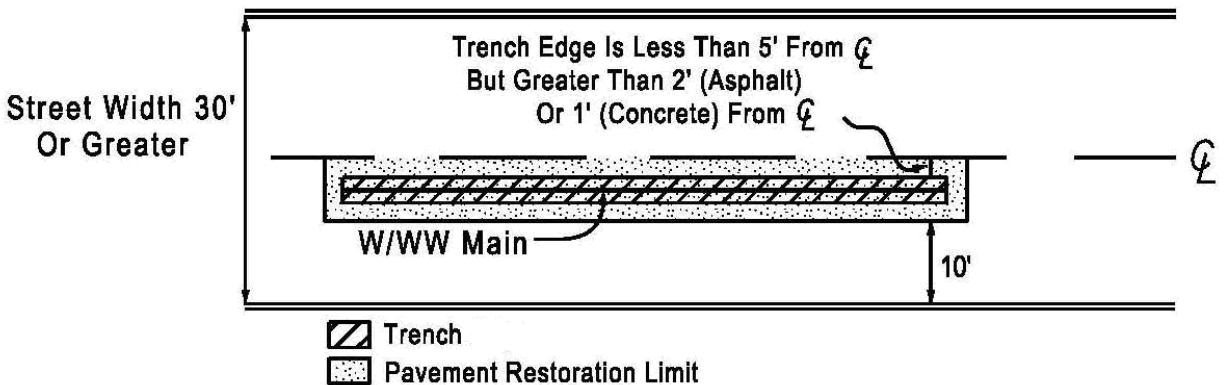


Figure 7.2.4.2.2:
Option 2: Pavement Cut and Repair Extent for Residential Street of 30 Feet or Greater

7.2.4.3 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:

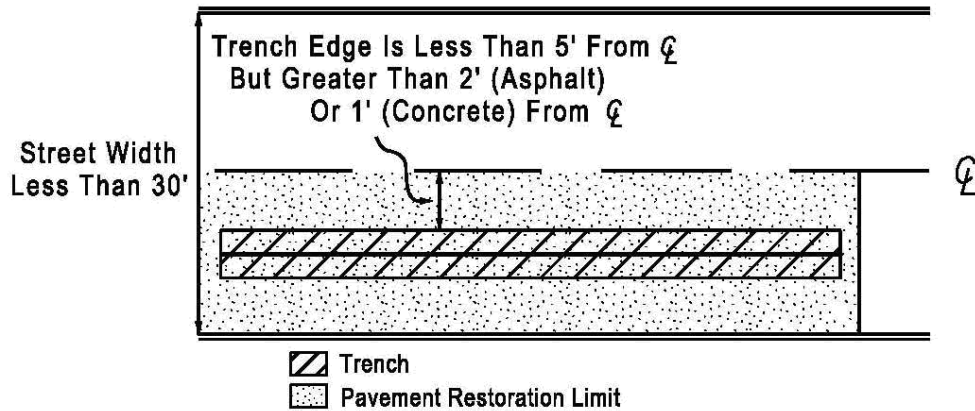


Figure 7.2.4.3:
Pavement Cut and Repair Extent for Residential Street of Less Than 30 Feet

7.2.4.4 All Residential Streets:

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

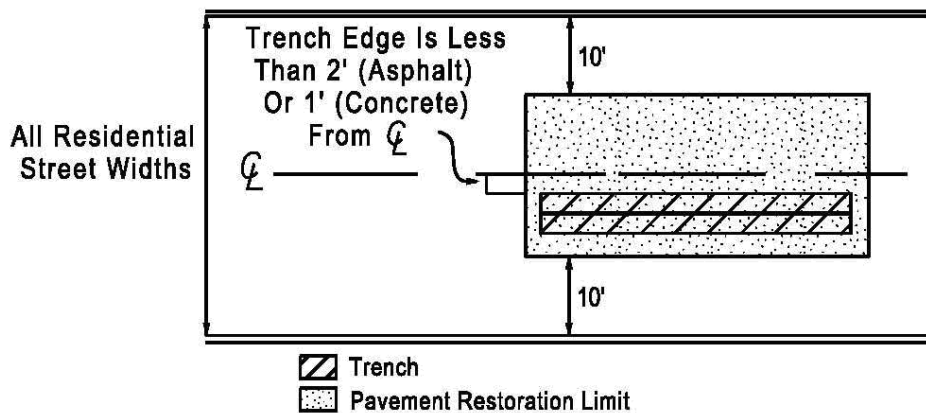


Figure 7.2.4.4:
Pavement Cut and Repair Extent for All Residential Streets

7.2.4.5 All Service Laterals:

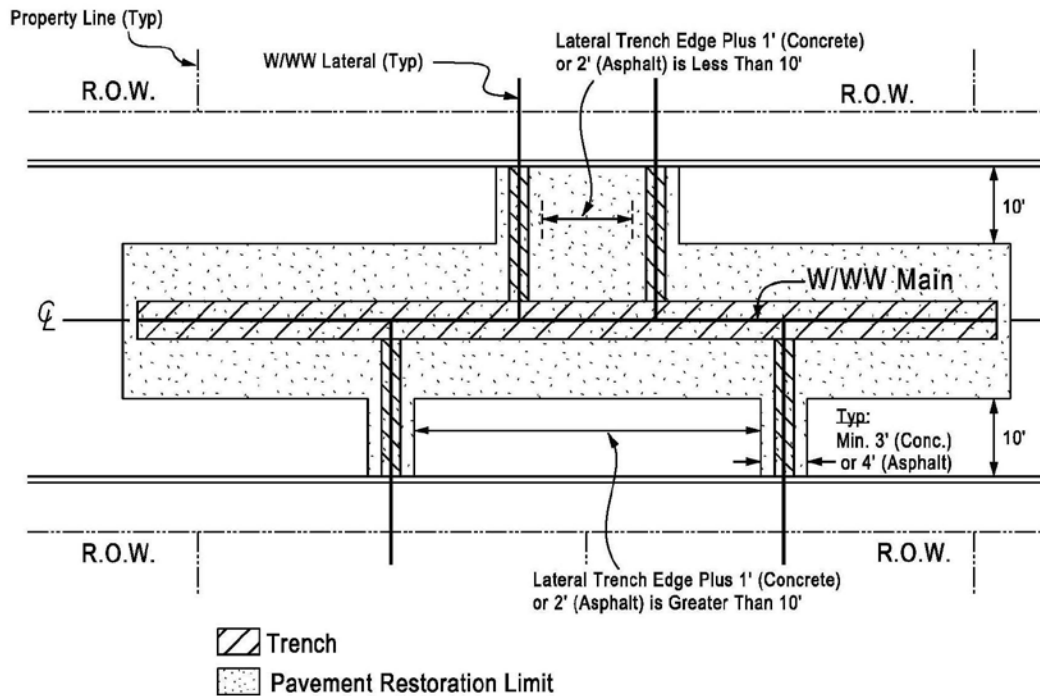


Figure 7.2.4.5:
Pavement Cut and Repair Extent for Service Laterals

7.2.4.6 Multiple Lane Concrete Street:

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

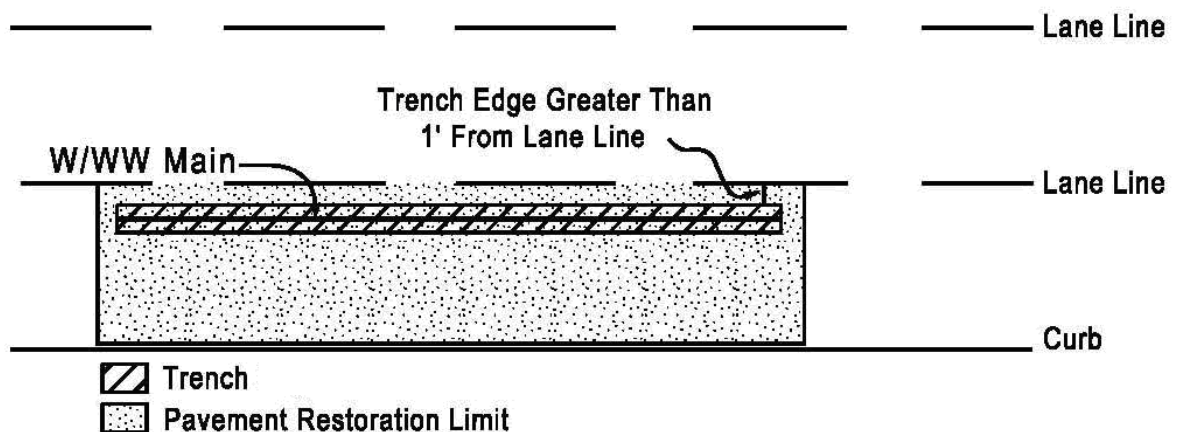


Figure 7.2.4.6.1:
Option 1: Pavement Cut and Repair Extent for Multiple Lane Concrete Streets

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

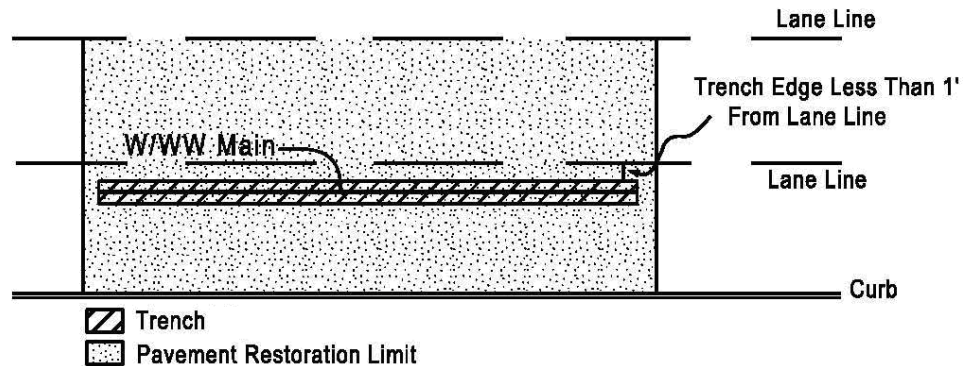


Figure 7.2.4.6.2:
Option 2: Pavement Cut and Repair Extent for Multiple Lane Concrete Streets

7.2.4.7 Multiple Lane Asphalt Street:

- Option 1: Trench edge plus 2 feet is less than $\frac{1}{2}$ lane width:

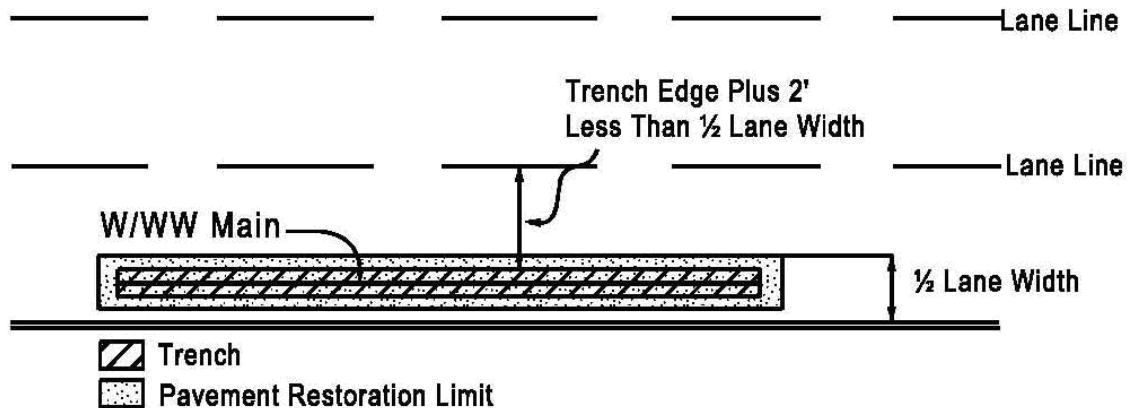


Figure 7.2.4.7.1:
Option 1: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets

- Option 2: Trench edge is less than $\frac{1}{2}$ lane width but greater than 2 feet from lane line:

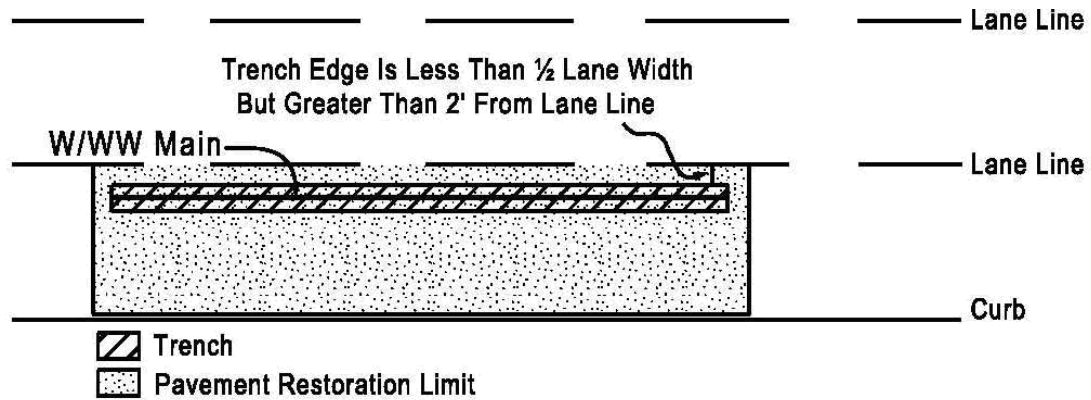


Figure 7.2.4.7.2:

Option 2: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets

- Option 3: Trench edge is less than 2 feet from lane line:

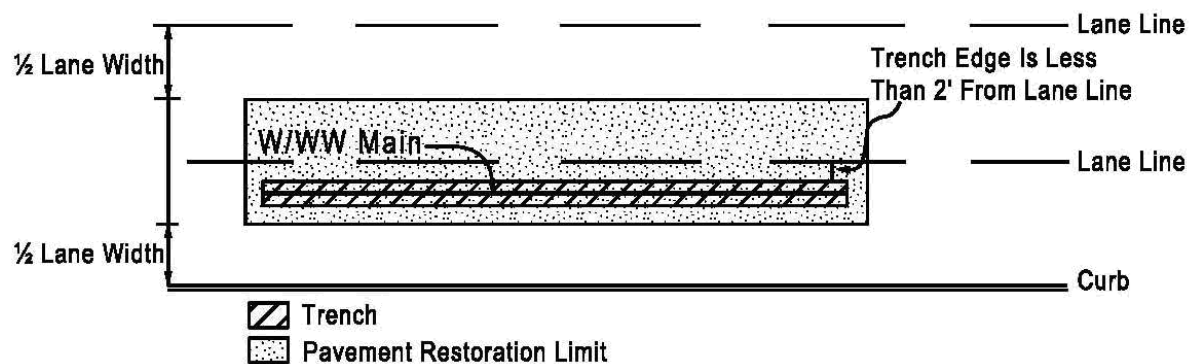


Figure 7.2.4.7.3:

Option 3: Pavement Cut and Repair Extent for Multiple Lane Asphalt Streets

7.2.5 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.

7.2.5.1 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 foot ledge to undisturbed soil on both sides of the trench excavation.

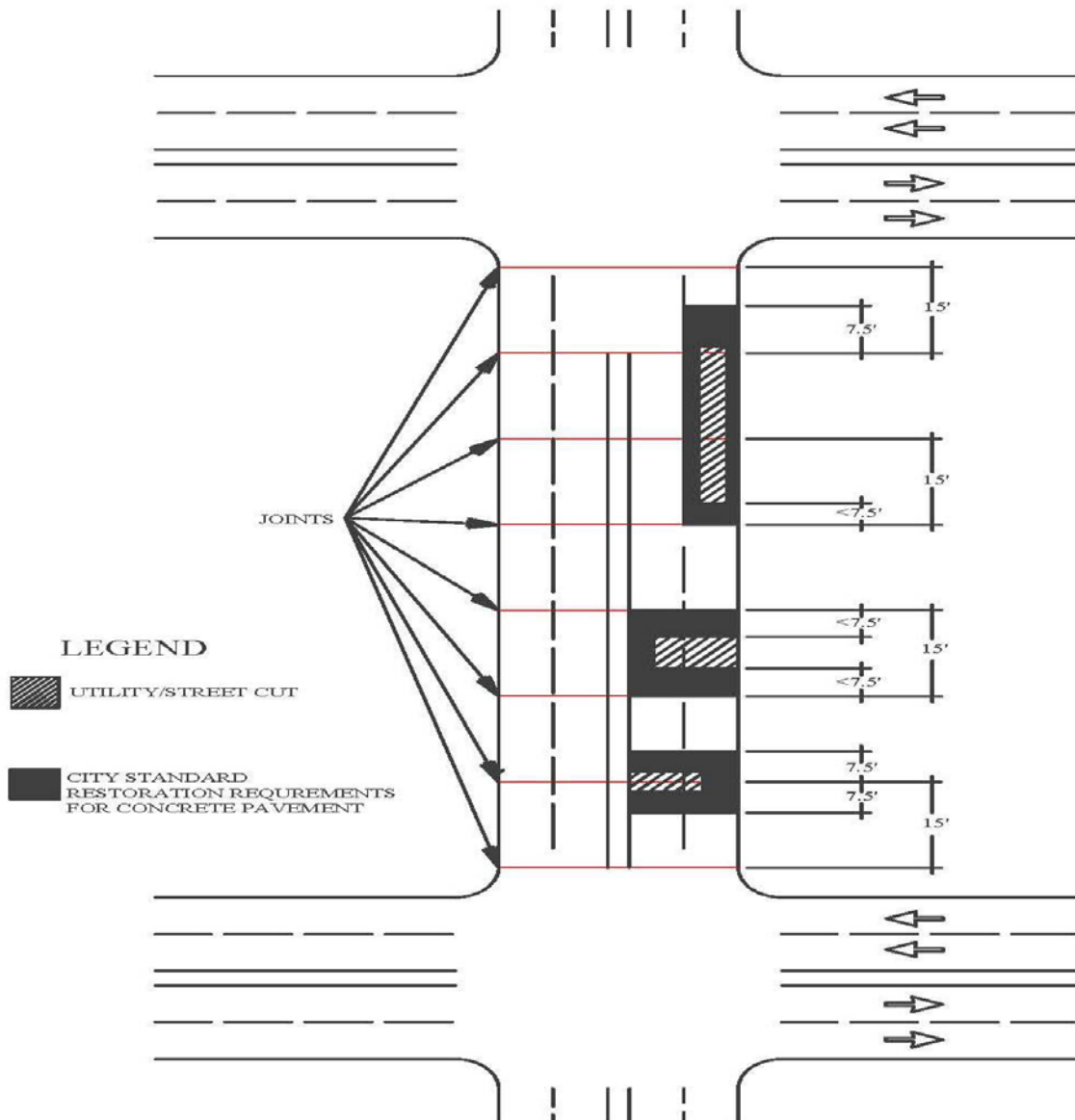


Figure 7.2.5.1:
Pavement Cut and Repair Extent for Concrete Streets of Less Than 5 years Old

7.2.5.2 Asphalt Street:

If approved by PW&T, the restoration limit for asphalt streets will be no less than one lane width and extend to 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.

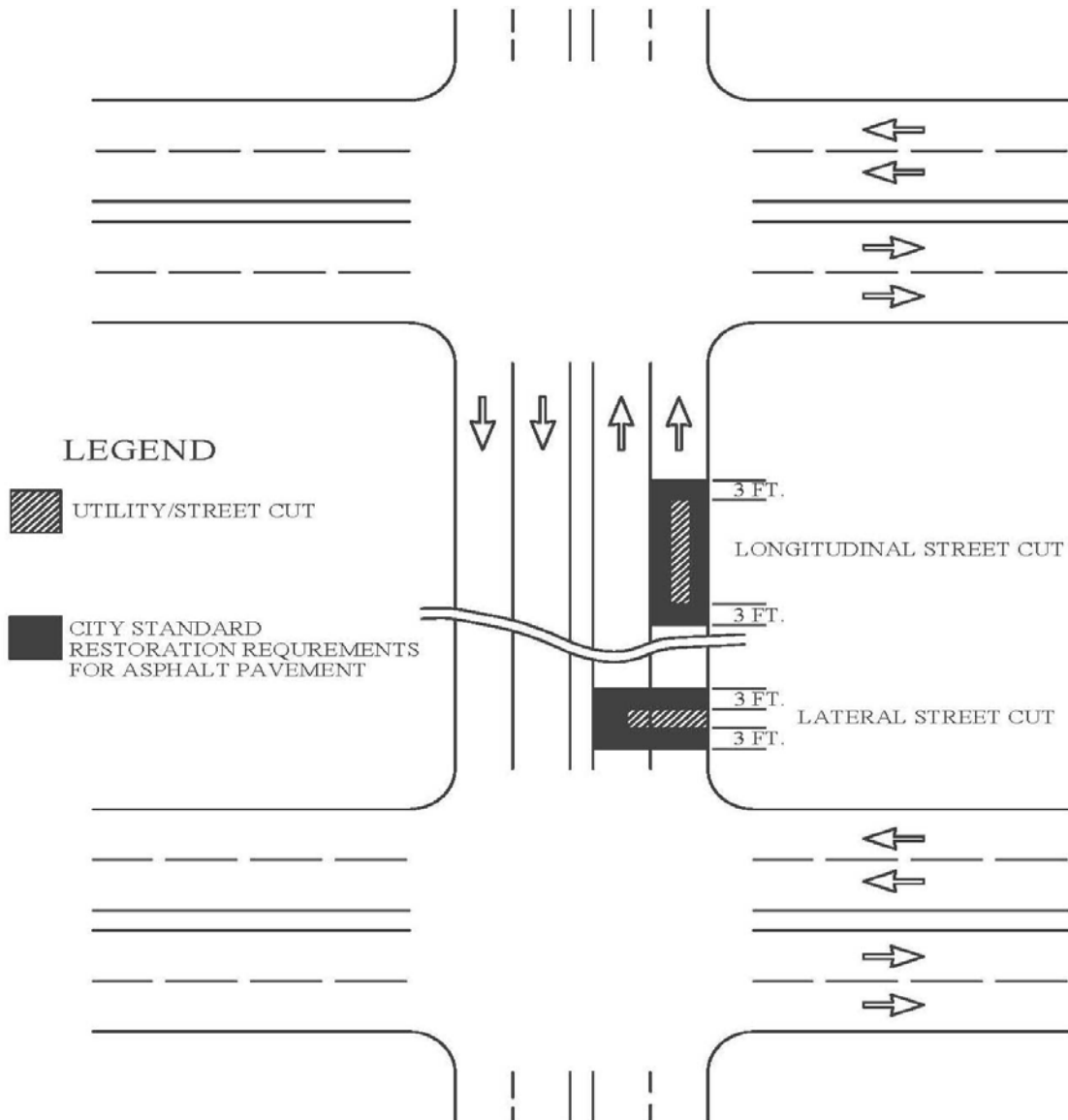


Figure 7.2.5.2:
Pavement Cut and Repair Extent for Asphalt Multilane Streets of Less Than 5 years Old

7.3 HIGHWAY ACCESS CRITERIA

7.3.1 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:

- 43 Texas Administrative Code §21-Subchapter C: Utilities Accommodation by Texas Department of Transportation, Latest Edition.

7.3.2 Location

7.3.2.1 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.

7.3.2.2 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.

7.3.2.3 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.

7.3.3 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.

7.3.4 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.

7.3.5 Encasement

7.3.5.1 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.

7.3.5.2 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.

7.3.5.3 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

7.3.5.4 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.

7.3.5.5 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.

7.3.5.6 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.

7.3.5.7 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.

7.4 RAILROAD ACCESS CRITERIA

7.4.1 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:

- Utility Accommodation Policy by Burlington Northern Santa Fe (BNSF), Latest Edition.
- Dallas Area Rapid Transit (DART) Design Criteria Manual, Latest edition.
- American Railway Engineering & Maintenance Association (AREMA), Latest edition

7.4.2 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.

7.4.2.1 Transverse Crossing:

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

7.4.2.2 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.

7.4.3 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.

7.4.4 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.

7.4.5 Encasement

7.4.5.1 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.

7.4.5.2 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.

7.4.6 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 back slope or within 25 feet of the centerline of track, and shall not protrude above surrounding ground without approval from railroad authority.

7.4.7 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.

7.4.8 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.

7.5 STREETCAR TRACK ACCESS CRITERIA

7.5.1 Authority

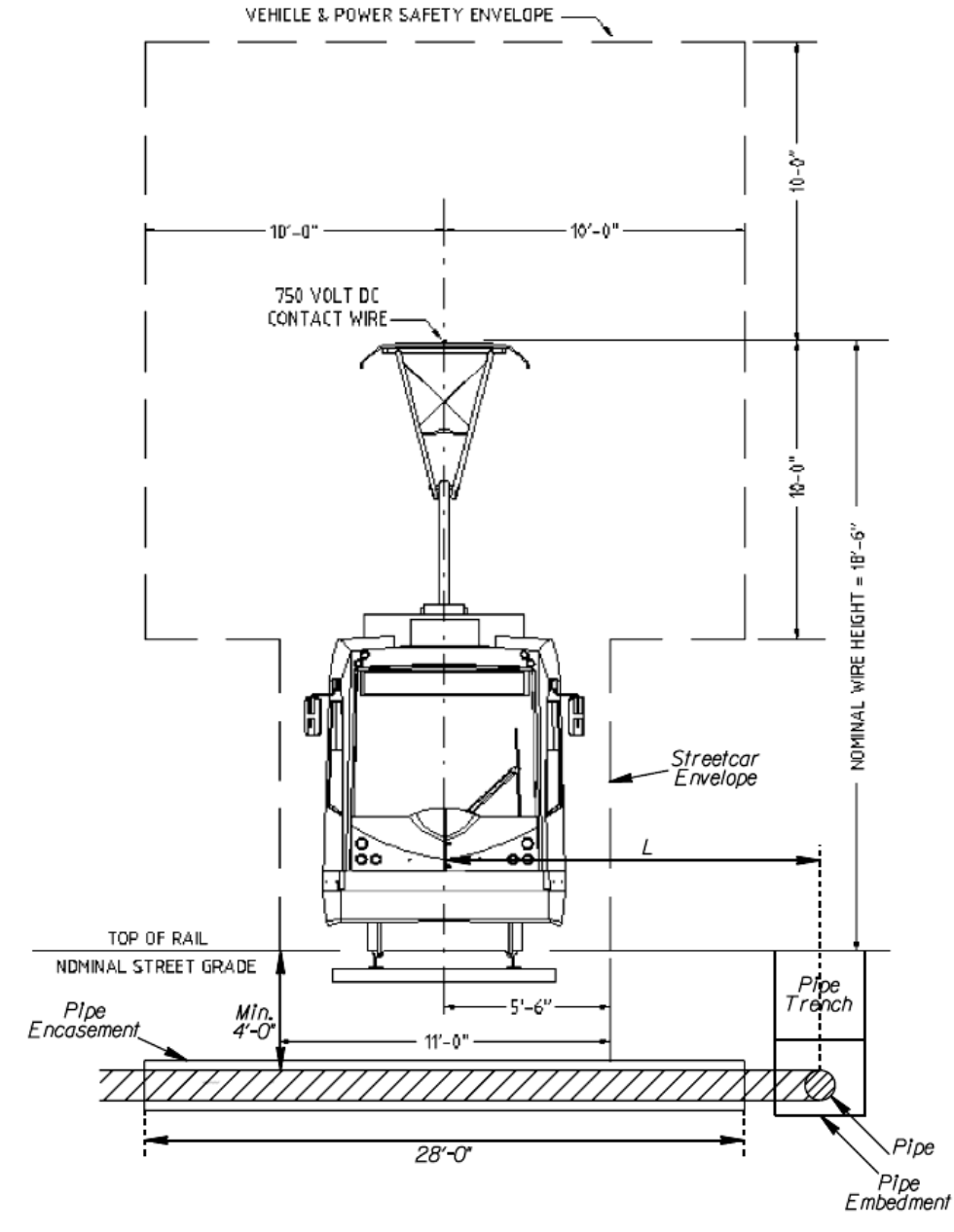
This section addresses special design and relocation criteria for water and wastewater assets near existing streetcar tracks or a proposed streetcar project. This criteria includes utilities that cross or parallel the area affected by the construction of a streetcar project, including but not limited to tracks, pavement and amenities related to the project.

- Preliminary plans of the water and wastewater relocations and streetcar design shall be submitted to DWU for review along with the specifications of the cars to be put in service. Revisions to the streetcar design shall be submitted to DWU for review.

7.5.2 Clearance Requirements

A “streetcar envelope” has been established by the Department of Street Services to allow operation of the streetcar system and to accommodate operation and maintenance of utilities. Water and wastewater mains near street car track shall meet following criteria:

- Water and wastewater mains and appurtenances must be kept clear of the streetcar envelope and allow for future operation and maintenance.
- All mains 24-inch in diameter and smaller must keep a distance “L” from the centerline of the streetcar envelope as shown in **Figure 7.5.2**. Special considerations may be needed for larger pipe sizes.
- The depth of the mains shall comply with DWU standards as specified in §2.5 and §4.5.
- Alternative design criteria proposed by the design engineer must be submitted to Relocations Section for each specific main crossing or paralleling the streetcar project. It shall include a detailed engineering explanation of the alternate option, engineering calculations, life cycle costs and preliminary drawings. The request will be reviewed by DWU personnel for approval.



Pipe Size (in)	L-Distance (feet)
<16	17.0
16	18.0
20	20.0
24	21.0

Figure 7.5.2: Streetcar Clearance Requirements

7.5.3 Criteria for Replacement or Relocation

- Water and wastewater mains parallel to the proposed track slab and not meeting the clearance requirements must be relocated.
- Mains crossing the proposed track slab without minimum encasement must be replaced and encased.
- Mains outside the streetcar clearance, but under proposed paving must be replaced if any of the DWU's standard replacement criteria is met (substandard size, material, age, depth of cover, condition check and other criteria) or at the direction of Water Distribution or Wastewater Collections sections.
- All active water and wastewater services, including irrigation services that cross under the proposed streetcar tracks shall be replaced from the main to the meter or clean out. They shall be encased following the standards explained in this section.
- Main appurtenances including but not limited to manholes, wastewater access devices and fire hydrants within the streetcar clearance area must be relocated.

7.5.4 Design Standards

- Mains crossing the streetcar project must be perpendicular to the streetcar tracks in order to minimize the length of pipe under the streetcar envelope.
- Carrier pipes within the streetcar clearance area must be non-metallic.
- Encasement is required for mains crossing the clearance area. Acceptable encasement pipes shall be two nominal sizes larger than the carrier pipe or service (minimum 2 inches greater than the largest outside diameter of the carrier pipe). Encasement pipe material shall be Ductile Iron Pipe Class 52, PVC Pipe (meets or exceeds carrier pipe pressure rating), or Steel Encasement Pipe meeting the minimum thickness requirements shown on DWU Standard Drawing #104.
- Split encasement is not allowed.
- The carrier pipe shall be held by casing spacers (see DWU Standard Drawing 109) and the encasement pipe plugged at both ends with a minimum slope of 0.1%. The void between the carrier pipe and the encasement pipe shall not be grouted.
- The length of the encasement for mains with 24-inch and smaller diameters shall be 28 feet centered on the track centerline as shown in the figure in the previous page.
- Corrosion test stations are required for metal encasement pipes.

7.6 DWU EASEMENT ACCESS CRITERIA BY FOREIGN MAINS

7.6.1 General

DWU owns water mains that extend into other adjacent cities and counties. These are either raw water supply mains or customer city treated water mains which may be crossed by foreign mains under following conditions:

- Foreign mains are typically defined as water, wastewater, telephone, electric, cable, fiber optic, storm drain, petroleum and any other franchise or public utility own and/or operated by outside entities (Non-COD).
- The crossing utility will have to acquire an easement where DWU owns the property fee simple and an encroachment letter where DWU owns the easement.
- Crossing DWU mains with levee, retaining wall or other critical infrastructures requires special coordination with DWU Engineering, Distribution, Wastewater Collection Divisions or other entities as applicable.

7.6.2 Foreign Mains Crossing DWU Water Easements

- All foreign lines crossing DWU water mains and associated easements shall be at 90 degree (preferable) or 60 degree (minimum) as shown in **Figure 7.6.2**.
- The vertical separation between proposed foreign main and existing DWU water shall be in accordance with **Table 7.6.2** while meeting all applicable DWU, state and federal requirements.

Table 7.6.2:
Typical Minimum Vertical Separation Distance Between Proposed Foreign Main and Existing DWU Water Main

		Foreign Pipe (in)			
		8- 12	16- 24	30- 66	72 & Large
DWU Water (in)	8- 12	2	2.5	3	3.5
	16- 24	2.5	3	3.5	4
	30- 66	3	3.5	4	4.5
	72 & Larger	3.5	4	4.5	5+

Note: All dimensions shall be measured from outside diameter (O.D.) to outside diameter (O.D.)

- All foreign wastewater lines crossing over DWU water mains shall be encased with 150 psi pressure-rated pipe as needed. The length of encasement shall be minimum 18 feet centered at the DWU water main.
- Any proposed foreign mains intended to cross DWU main shall submit preliminary plans to Engineering Services and DWU Distribution for final approval.

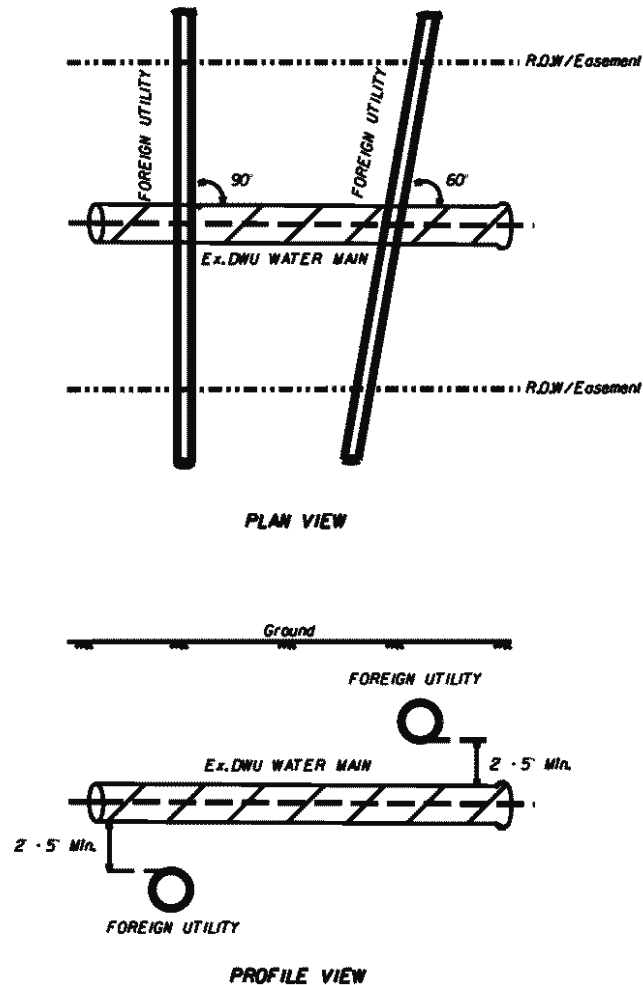


Figure 7.6.2: Typical Foreign Line Crossing DWU Water Main

7.6.3 Foreign Line Crossing DWU Wastewater Easements

- All foreign lines crossing DWU wastewater mains and associated easements shall be at 90 degree (preferable) or 60 degree (minimum) as shown on **Figure 7.6.3**.
- The vertical separation between proposed foreign main and existing DWU wastewater shall be in accordance with **Table 7.6.3** while meeting all applicable DWU, state and federal requirements.
- Any proposed foreign mains intended to cross DWU wastewater main shall submit preliminary plans to DWU Engineering Services and Wastewater Collection (WWC) for final approval.

Table 7.6.3:
Typical Minimum Vertical Separation Distance Between Proposed Foreign Main and Existing DWU Wastewater Main

		Foreign Pipe (in)			
		8- 12	16- 24	30- 66	72 & Large
DWU Wastewater (in)	8- 12	2	2.5	3	3.5
	16- 24	2.5	3	3.5	4
	30- 66	3	3.5	4	4.5
	72 & Larger	3.5	4	4.5	5+

Note: All dimensions shall be measured from outside diameter (O.D.) to outside diameter (O.D.)

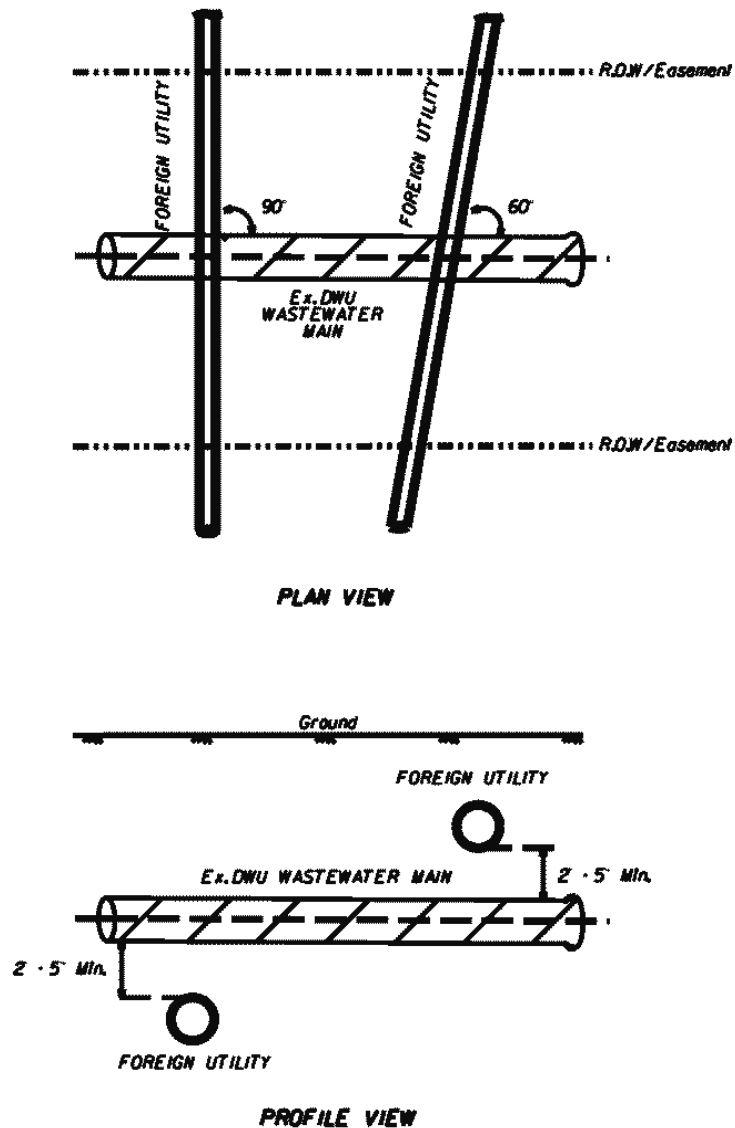


Figure 7.6.3: Typical Foreign Line Crossing DWU Wastewater Main

7.6.4 Outside Assets on DWU Easements

- Construction of outside assets including billboards, sidewalks, driveways, parking lots and features are not typically permitted within 10 feet of the outside diameter of DWU mains.
- Temporary features outside 10 feet may be allowed on case-by-case basis contingent upon approval by DWU Engineering Services, Distribution and Wastewater Collection Division as applicable.

7.7 LEVEE ACCESS CRITERIA

7.7.1 Authority

The design and construction of water and wastewater mains within a levee template must be in compliance with all applicable DWU standards and required criteria or variance as approved by the US Army Corp of Engineers (USACE) or other agencies with jurisdiction. The following references shall be reviewed in conjunction with this section:

- 33 United States Code (USC), §408, Latest Edition
- Clean Water Act (CWA), §404, Latest Edition
- Design and Construction Levees- Engineer Manual by USACE, Latest Edition

7.7.2 General Considerations:

- Water and wastewater mains shall be located so as to avoid or minimize the impact on levee template while allowing easy access to DWU utilities for their operation and maintenance. Typically, a levee template is defined as the projection of levee sloped to its intersection with bedrock as shown in **Figure 7.7.2**.

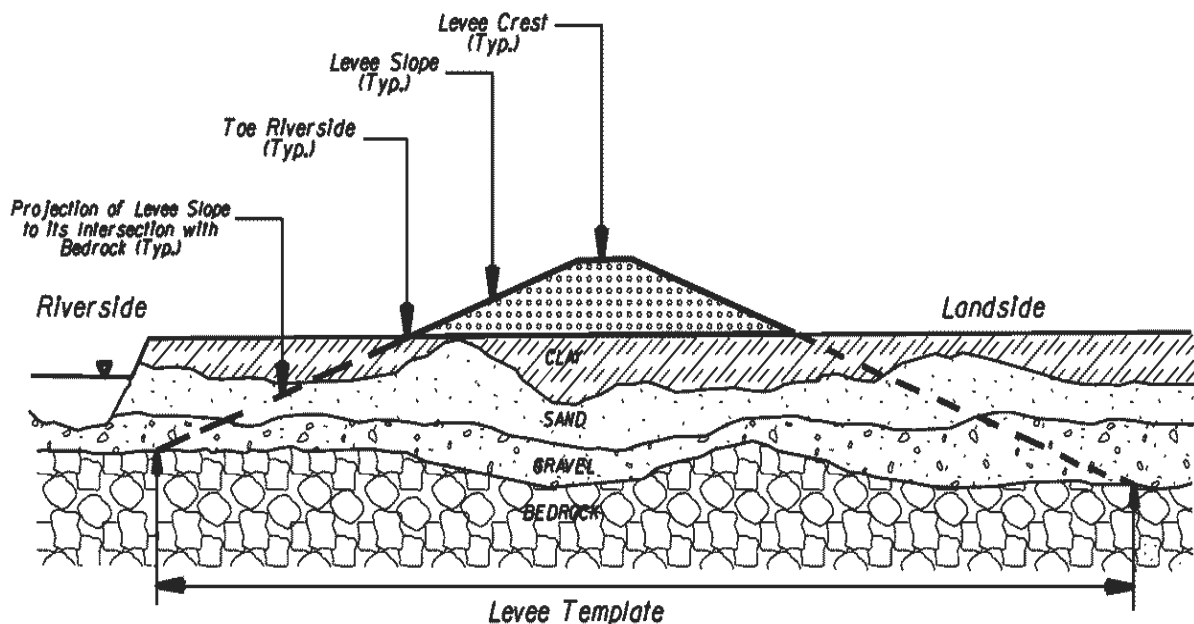


Figure 7.7.2: Typical Levee Template

- Penetration to install pipelines under levee may cause preferential seepage paths which may cause breaching of levee. USACE preference is for all pipes to cross over a levee unless supported by engineering study.
- General criteria for water and wastewater mains crossing levees are summarized in Table 7.7.2:

Table 7.7.2: Typical Criteria for Water and Wastewater Mains Crossing Levees

Criteria	Water and Wastewater Mains	Existing Mains	New Mains	
		Mains Under Proposed Levees	Mains Through Levees	Mains Over Levees
Condition of Main	Must be known to be in good condition	X		
Levee Loading	Must have adequate strength to withstand levee loading	X	X	
Depth of Cover	Must have adequate cover as needed to prevent damage by vehicular traffic or heavy equipment			X
Frost Protection	Must have adequate cover for frost protection	X	X	X
Settlement of Main	Must have sufficient flexibility in joints to adjust under expected settlement and stretching of pipe	X	X	X
Isolation of Main	Pressure lines must have provisions for rapid closure in event of leakage or rupture	X		
Emergency Closure	Gravity discharge pipes must have provisions for emergency closure in event of inoperative flap valves on riverside end	X		
Gravel/Pervious Backfill	Must have pervious backfill under landside third of levee where:			
	a. Foundation materials are susceptible to piping	X		
	b. Levee materials are susceptible to piping		X	

Ref: Design and Construction Levees- Engineer Manual by USACE, April 30, 2000.

7.7.3 Condition for Mains Crossing Through or Under Levees

- Existing Mains:
 - All existing mains must be located prior to initiation of embankment construction.
 - All abandoned mains shall be removed and the voids backfilled as feasible. If this is not feasible and removal is not practical, they should be sealed, preferably by completely filling them with concrete to prevent any potential seepage problems.
 - Existing pressure main may be relocated over the proposed new levee if feasible.
 - Existing mains must be carefully evaluated to determine their supporting capacity before allowing their use in conjunction with the new levee.
- New Mains:
 - Typically the only new pipelines allowed to penetrate the foundation or embankment of the levee are gravity drainage mains.

7.7.3 Condition for Mains Crossing Over Levees

USACE prefers all pipes to cross over a levee unless supported by an engineering study as needed. Mains crossing levees shall meet following the conditions:

- Pipes must be designed to prevent flotation if submerged.
- No scouring or erosion of the embankment slopes from any potential leakage will be allowed.
- Special design consideration may be required to prevent damage from debris carried by currents.

7.7.3 Location

7.7.3.1 Transverse Installation:

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

7.7.3.2 Longitudinal Installation:

- Longitudinal installations within the levee are not typically allowed, unless otherwise approved by DWU and USACE.

7.7.4 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 USACE and/or other agencies with jurisdiction.

7.7.5 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 USACE and/or other agencies with jurisdiction.

7.7.6 Concrete Encasement

- All main crossing under a levee may be encased in concrete to prevent preferential seepage paths as approved by USACE (**Figure 5.3.5**). Concrete encasement may be sloped at the sides to facilitate proper compaction as needed.

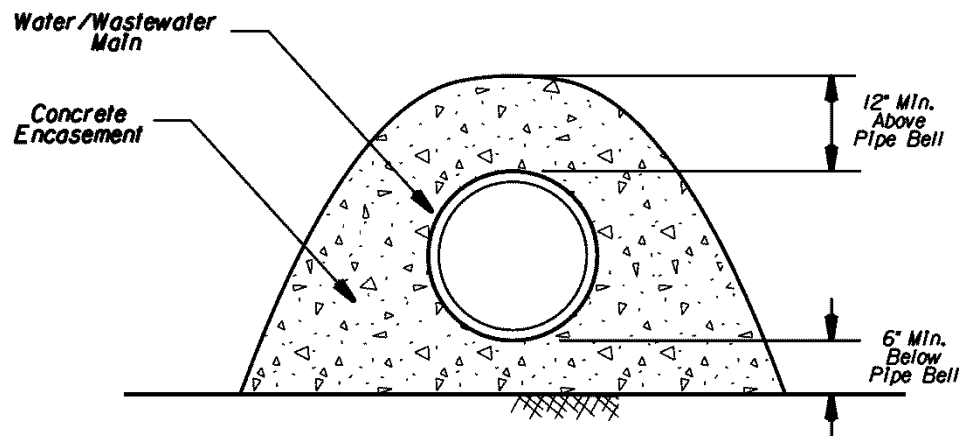


Figure 7.7.6: Typical Concrete Encased Pipe Under a Levee

7.7.7 Appurtenances

Due to the difficulty in maintenance, all new water and wastewater manholes, valves and other appurtenances shall be located outside the levee template if possible.

- All mains crossing a levee shall be provided with devices to assure positive closures as needed.
- All water mains crossing a levee shall include isolation valves on both sides of the levee.
- All gravity wastewater main crossing a levee shall include manhole or junction structures on both sides of the levee.

7.7.8 Permits

Dallas Floodway levee along Trinity River is mostly owned, operated and maintained by City of Dallas with Federal oversight though USACE. All water and wastewater mains installed within levees are subjected to approval by USACE. All necessary permit applications shall be coordinated through the City of Dallas Trinity Watershed Management (TWM) prior to submitting the permit to USACE.

7.7.8.1 USACE 404 Permit:

- *Applicability:*
 - USACE 404 permit is typically required as per CWA §404 for any construction involving possible discharge of dredged or fill materials into water of the U.S. including but not limited to wetlands, rivers, streams, creeks and lakes.
 - This permit contains general and special conditions, which clarify activities that are allowed and/or restricted for a particular project.
 - A 401 certification is typically issued when the USACE issues a 404 permit.
- *Types:*
 - Nationwide Permit

Nationwide permits are issued for projects that have minimal environmental impacts. They provide a simplified, expedited process that eliminates lengthy review by the regulatory agencies and allows certain activities to proceed with little or no delay. DWU water and wastewater projects are normally covered by Nationwide permits.
 - Regional Permit

Regional Permits may be issued if impacts from a project exceed the limits for Nationwide permits but are not large enough to require an Individual permit.

- Individual Permit

Individual permits are required for projects with potentially significant environmental impacts or impacts to rare or special aquatic types.

- *Processing Time:*

- The length of the 404 permit process is dependent on the size and complexity of the project.
- For projects authorized by Nationwide or Regional permits, the timeframe is typically 1-2 months.
- For Individual permits, the timeframe is typically 6-8 months.

7.7.8.2 USACE 408 Permit:

- *Applicability:*

- USACE permit is typically required as per 33 USC §408 for any design and construction of new structures on or adjacent to existing levees constructed by the US government whereby the proposed structures or modifications could impair human lives and cause property damage.

- *Type:*

- Minor 408 Permit

Minor 408 permits are issued for small construction activities including, but limited to, pipeline repairs where the hydrological, hydraulic, geotechnical, structural, mechanical, and other pertinent properties of the river and levee system are not changed or impacted. Minor 408 permits are typically reviewed by the USACE at a district level.

- Major Permit

Major 408 permits are issued for projects involving a potential impact or modification of the physical characteristics or the hydraulic capacity of the levee. Major permits are also submitted to the appropriate District for initial review and approval. This will require quality assurance review by the assigned Division prior to being forwarded to USACE Headquarter for final approval by the Chief of Engineers.

- *Documentations and Submittal:*

- Minor 408 Permit

Sufficient technical information of the proposed project must be submitted to the USACE for evaluation. Potential impacts of the proposed project to flood conveyance, structural integrity, operation and maintenance, and flood fighting capabilities shall be submitted. Construction plans and specifications must also be submitted to the District for review and approval.

- Major 408 Permit

Detail technical information of the proposed project must be submitted to the USACE for evaluation. Impacts of the proposed project to flood conveyance, structural integrity, operation and maintenance, and flood fighting capabilities must also be presented. Construction plans and specifications must be submitted to the District as part of the technical data requirements.

The major projects may also be required to evaluate for National Environmental Policy Act (NEPA) compliance and risk assessment. The risk analysis may include, but not limited to, the followings:

Hydrology and Hydraulic (H&H) Study

The Hydrology and Hydraulic (H&H) study typically consists of determination of the Standard Project Flood (SPF) level, the 100-year flood level, the river levels during spring, summer, fall, and winter seasons, as well as the upstream reservoir releases and their corresponding levels at the proposed project location.

Geotechnical Investigation:

The geotechnical investigation consists of a field investigation, a laboratory investigation, and the performance of geotechnical analysis as needed.

Environmental Investigation

The project may be evaluated for potential environmental issues. This may include Environmental Assessment (EA) or Environmental Impact Statement (EIS) may also be required.

- *Processing Time:*

- The length of the 408 permit process is dependent on the size and complexity of the project.
- The civil design must be advanced to a 60 percent completion stage, while the H&H, geotechnical and environmental analyses shall be advanced to 90 percent completion prior to submitting designs to USACE.
- One (1) to two (2) years are typically required for review, meetings, and time to address concerns prior to advancing design to 100%.

7.8 CREEK CROSSING

The 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:

7.8.1 Material and Appurtenances

- A watertight encasement pipe with a manhole on each side of the crossing should be used for wastewater mains. Additional criteria for wastewater inverted siphon is also included under §5.5.
- Watertight encasement pipe for water main with a valve on each side of the crossing should be used.

7.8.2 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.

7.8.3 Reference Schematic

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

7.9 ELEVATED CROSSING

7.9.1 General Option

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

7.9.2 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.

CHAPTER 8

SPECIAL DESIGN CRITERIA

8.1 GENERAL

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

8.2 PIPE ENCASEMENT

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

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

8.2.1 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 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.

8.2.2 Encasement Materials

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

8.2.2.1 PVC Casing Pipe:

8.2.2.1.1 Applicability:

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

8.2.2.1.2 Minimum Specifications:

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

8.2.2.2 Reinforced Concrete Casing Pipe:

8.2.2.2.1 Applicability:

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

8.2.2.2.2 Minimum Specifications:

- Reinforced Concrete Pipe C76, Class IV

8.2.2.3 Ductile Iron Casing Pipe:

8.2.2.3.1 Applicability:

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

8.2.2.3.2 Minimum Specifications:

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

8.2.2.4 Steel Casing Pipe:

8.2.2.4.1 Applicability:

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

8.2.2.4.2 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 35,0000 psi
- Minimum thicknesses of steel encasement pipe for different diameters are shown under **Table 8.2.2.4.2**, 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 8.2.2.4.2: Minimum Thickness of Steel Encasement Pipe

Encasement Pipe I.D. (in)	DWU*	AREMA**	
	Minimum Thickness (in)	Minimum Thickness (in)	
	(Coated)	(Coated or Cathodically Protected)	(Non-Coated or Not Cathodically Protected)
12 or Under	0.188	0.188	0.188
14	-	0.188	0.250
15	0.25	-	-
16	-	0.219	0.281
18	0.25	0.250	0.312
20	-	0.281	0.344
21	0.312	-	-
22	-	0.281	0.375
24	0.375	0.312	0.375
26	-	0.344	0.406
27	0.438	-	-
28	-	0.375	0.438
30	0.438	0.406	0.469
32	-	0.438	0.500
34- 36	0.50	0.469	0.531
38	0.50	0.500	0.562
40	0.50	0.531	0.594
42	0.50	0.562	0.625
44- 46	-	0.594	0.656
48	-	0.625	0.688
50	-	0.656	0.719
52	-	0.688	0.750
54	-	0.719	0.781
56- 58	-	0.750	0.812
60	-	0.781	0.844
62	-	0.812	0.875
64	-	0.844	0.906
66- 68	-	0.875	0.938
70	-	0.906	0.969
72	-	0.938	1.000

* Minimum thickness as acceptable by DWU must be verified by designer for any specific application

** Minimum thickness as per AREMA Manual for Railway Engineering, 2003. Latest updates and local railroad requirements must be verified as applicable.

8.2.2.5 Liner Plate:

8.2.2.5.1 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

8.2.2.5.2 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 8.2.2.5.2.1: Factor of Safety for Liner Plate Design

Criteria	Factor of Safety (AASHTO)
Seam/Joint Strength	3
Installation Stiffness	3
Critical Bucking	2
Allowable Deflection	3%

- Minimum thicknesses of tunnel liner plate for different diameters are shown under **Table 8.2.2.5.2.2**, 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 8.2.2.5.2.2: Minimum Thickness of Liner Plates*

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

* 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.

8.3 THRUST RESTRAINT

8.3.1 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.

8.3.2 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

8.3.3 Horizontal Thrust Block

8.3.3.1 Applicability:

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

8.3.3.2 Design Consideration:

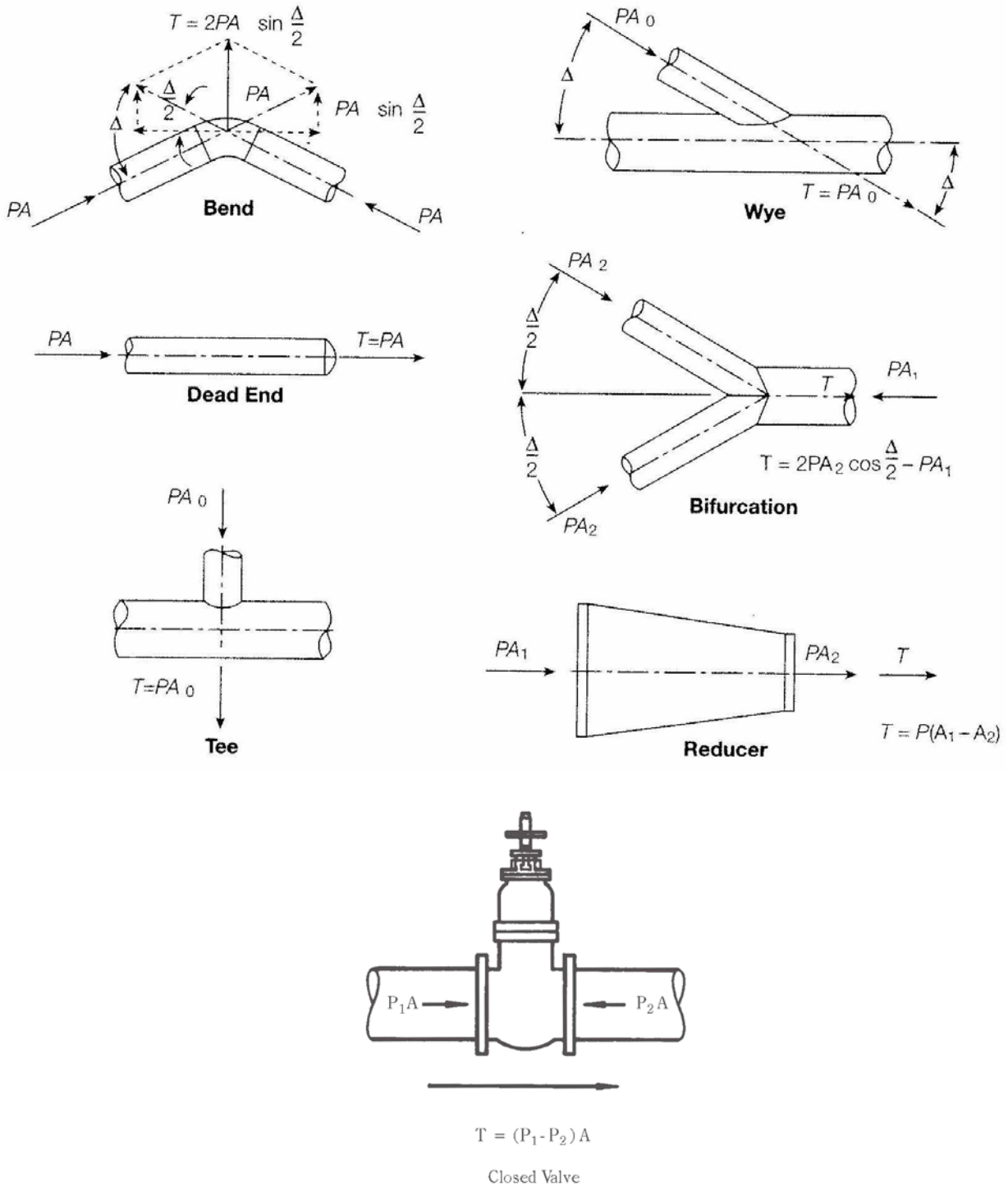
8.3.3.2.1 Design Pressure (P):

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.

8.3.3.2.2 Thrust Force (T):

Unbalanced thrust force occurs at the following configurations shall be restraint as needed (**Figure 8.3.3.2.2**):

- Bend
- Wye
- Deadend
- Bifurcation
- Tee
- Reducer
- Closed Valve



Where, T = Hydrostatic Thrust (lb)
A= Cross-Sectional Area of Pipe (in²)

P= Internal Pressure (psi)
Δ= Deflection Angle (degree)

Figure 8.3.3.2.2: Unbalanced Thrust Force at Various Configurations

Source: Thrust Restraint Design for Ductile Iron Pipe, by DIPRA, 2002

8.3.3.2.3 Bearing Area (A_b):

Thrust bearing area can be calculated as follows:

$$A_b = S_f T / S_b$$

Where,

A_b = Bearing Area

S_f = Factor of Safety, Typically 1.5

S_b = Horizontal Bearing Strength

T = Hydrostatic Thrust

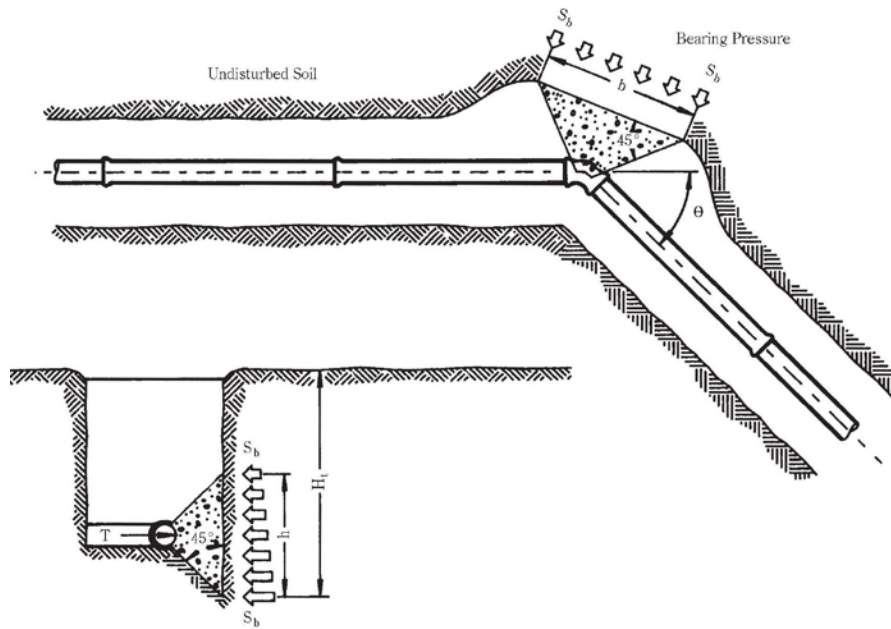


Figure 8.3.3.2.3: Horizontal Thrust Bearing Area

Source: *Thrust Restraint Design for Ductile Iron Pipe*, by DIPRA., 2002

In absence of actual Horizontal Bearing Strength, **Table 8.3.3.2.3** can be used to estimate bearing strength:

Table 8.3.3.2.3

Soil	Bearing Strength (lb/ft ²)
Muck	0
Soft Clay	1,000
Silt	1,500
Sandy Silt	3,000
Sand	4,000
Sandy Clay	6,000
Hard Clay	9,000

Source: *Thrust Restraint Design for Ductile Iron Pipe*, by DIPRA., 2000

8.3.3.2.4 Block Dimension:

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

$$b = A_b / h$$

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.
 - $h = b \sim 2b$

8.3.3.2.5 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

8.3.3.2.6 Reference Schematics:

For general application see DWU Standard Drawing Nos. 229- 232

8.3.4 Vertical Thrust Block/Anchor Block

8.3.4.1 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.

8.3.4.2 Design Consideration:

8.3.4.2.1 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.

8.3.4.2.2 Thrust Force (T)

Unbalanced thrust force occurs at the configuration shown in **Figure 8.3.4.2.2:**

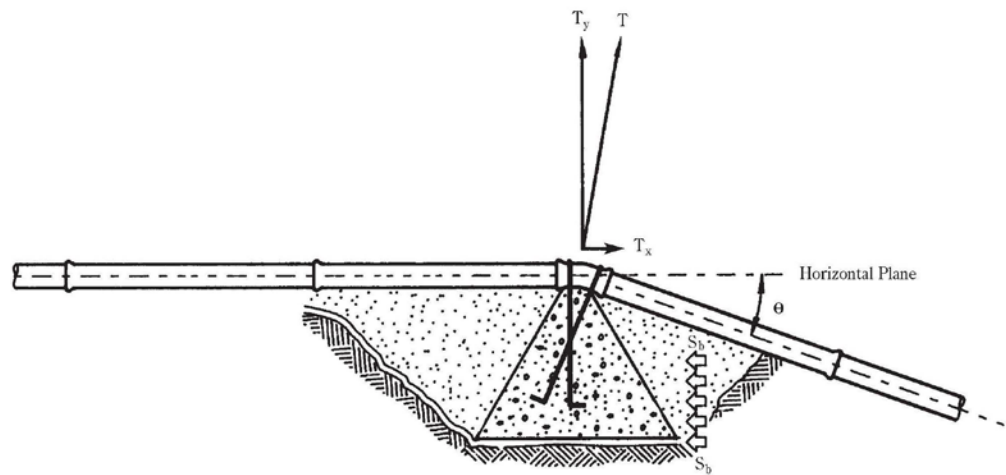


Figure 8.3.4.2.2: Vertical Thrust Block

Horizontal Hydrostatic Thrust, $T_y = PA \sin \Delta$

Horizontal Hydrostatic Thrust, $T_x = PA \sin \Delta$

Where,

P = Internal Pressure (psi)

A = Bearing Area

Δ = Deflection Angle (degree)

8.3.4.2.3 Volume of Vertical Thrust Block (V):

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

Required Volume, V

$$V = S_f T_y / W_m$$

$$= S_f P A \sin \Delta / W_m$$

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

8.3.4.3 Reference Schematics:

For general application see DWU Standard Drawing No. 233

8.3.5 Restraint Pipe Joint

8.3.5.1 Applicability:

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

8.3.5.2 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.

8.3.5.3 Reference:

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

- AWWA M9: Concrete Pressure Pipe by AWWA, Latest Edition
- AWWA M11: Steel Pipe- A Guide for Design and Installation, Latest Edition
- Thrust Restraint Design for Ductile Iron Pipe, 2002, or Latest Edition.

8.4 TRENCHLESS TECHNOLOGY

8.4.1 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 technologies. 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.

8.4.2 Technical References

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

- Trenchless Technology Pipeline and Utility Design, Construction, and Renewal by Mohammad Najafi and Sanjiv Gokhale, 2004.

8.4.3 Selection Criteria

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

8.4.3.1 Pipe Data

- Type and Size: Type and size of pipe shall be evaluated.
- Material: Pipe material shall be evaluated. Asbestos pipe shall not be replaced by destructive trenchless technologies.
- Appurtenances: Pipe with minimum appurtenances or services shall be considered.
- Condition: Condition of existing pipe shall be reviewed. Point repairs may be needed in advance of trenchless method.
- Depth: Minimum depth of pipe shall be 4 feet in order to avoid potential surface movement.
- Length: Minimum length of pipe shall be 500 LF, preferably 1000 LF for trenchless rehabilitation projects.
- Alignment: Pipeline with minimum bends shall be considered.

8.4.3.2 Site Data

- **Pavement Type:** Any place where pavement is concrete or asphalt on concrete, trenchless technologies shall be considered. In addition, if the pavement is greater than 6" of concrete or less than 5 years old additional focus should be on trenchless technology.
- **Traffic:** Pipeline shall be considered for trenchless to avoid major traffic disruptions during construction.
- **Bore Pit:** Availability of bore pit locations shall be evaluated. Bore pit must be sized based on the technology proposed.
- **Bypass Pumping:** Existing flow and requirement for bypass pumping shall be evaluated for wastewater lines.
- **Temp Services** Water main evaluations should consider the need for temporary services during the construction of the project.
- **Potential Impacts:** Pipeline shall be considered for trenchless to minimize potential environmental, social and traffic impacts.
- **Nearby Utility** Where a water and wastewater line are in close proximity to each other (<9') it is recommended not to consider trenchless technology unless both lines are at an excessive depth.

8.4.3.3 Construction Cost

Estimated construction shall be evaluated along with other factors. Critical Trench Ration (CTR) can be used as primary tool to economically justify trenchless projects. Typically, CTR is defined as the ratio of total number of services, fittings and appurtenances per linear feet of pipe to be replaced or rehabilitated.

Accordingly, CTR for water and wastewater mains are as follows:

Water CTR = (Services + Valves + Fittings+ Fire Hydrant)/ (Total LF of Pipe)

Wastewater CTR = (Laterals + Manholes + Cleanouts + Wastewater Access Device)/ (Total LF of Pipe)

Based on the current practices and cost schedules, trenchless project are typically more feasible under the following conditions while meeting other applicable criteria:

- **Water Main (<12"):** If CTR < 0.04
- **Wastewater Main (<12"):** If CTR < 0.04

Water and wastewater mains larger than 12" shall be considered on case-by-case basis.

8.4.4 Survey for Trenchless Design

A field survey shall be required prior to design and construction of any water and wastewater mains by trenchless technology. The survey shall be in accordance with DWU topographic survey requirement as specified in this manual with the following consideration:

- Width of topographic survey can be minimum 20 feet instead of typical 45 feet as required.
- All boundary information shall be shown as needed within the right-of-way or easement.
- All the typical subsurface data including manhole flow lines shall be collected

8.4.5 Design Plans for Trenchless Projects:

All water and wastewater main shall be designed in accordance with applicable standards as specified in this manual.

8.4.5.1 General Notes:

The following General Notes apply to all trenchless construction projects

- Contractor shall review existing data and information for pipeline alignment.
- Contractor shall coordinate with DWU the location of all bore pits.
- Contractor is responsible for all bypass pumping during the construction of this wastewater line.
- Contractor is responsible for maintaining all temporary water service during the construction of the water line.
- Contractor shall provide all material warranties to DWU following construction.

8.4.5.2 Water Plans:

- Detail plan view showing proposed alignment, stations, P.I. and all the necessary appurtenances shall be shown as needed.
- Proposed water main profile is not required unless existing profile is available from record drawing, if available.

8.4.5.3 Wastewater Plans

- Detail plan view showing proposed alignment, stations, P.I. and all the necessary appurtenances shall be shown as needed.
- Proposed wastewater main profile shall be shown utilizing existing profile data from record drawing, if available.

8.4.6 Acceptable Trenchless Technologies

Most commonly acceptable Trenchless Technologies utilized by DWU are summarized in **Figure 8.5.6**. 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. Currently, there are more acceptable options for wastewater than water trenchless rehabilitation.

Other technologies may be used on case-by-case basis upon approval by DWU:

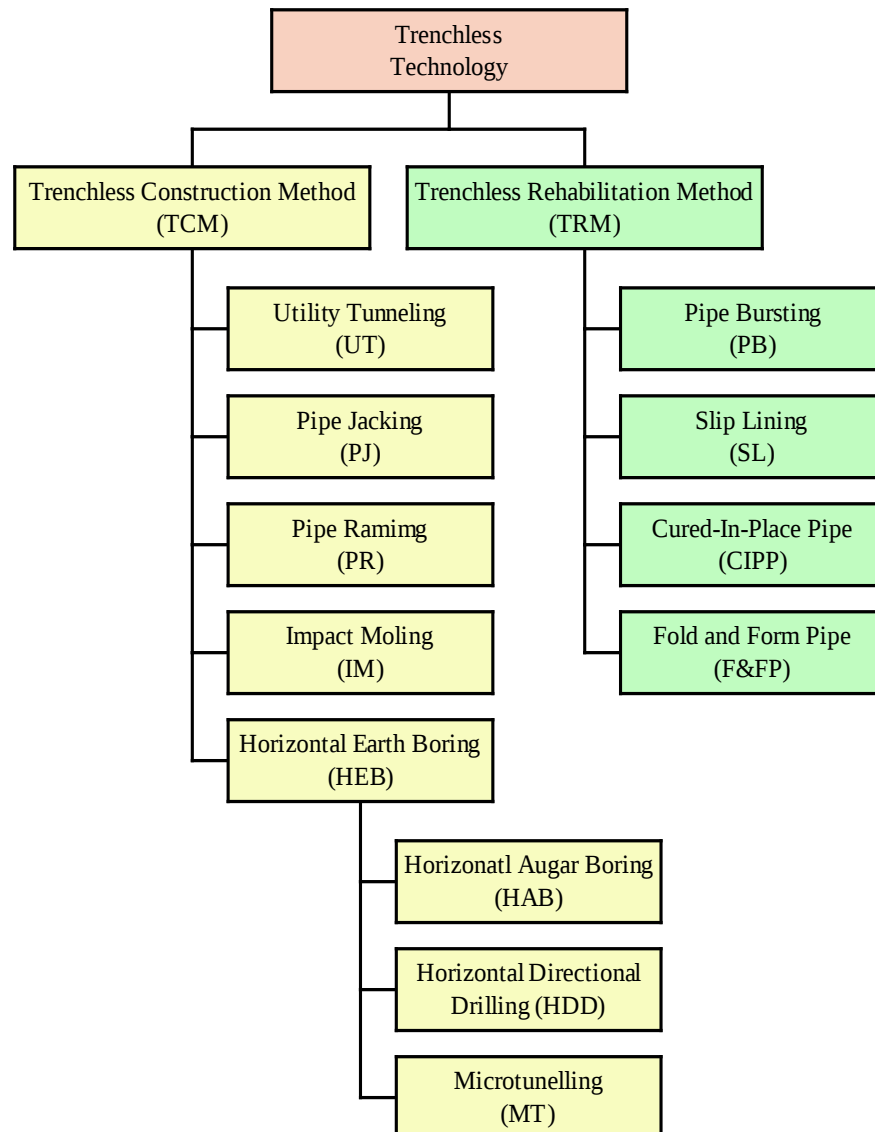


Figure 8.4.6:
DWU Acceptable Trenchless Technologies

8.4.7 Utility Tunneling (UT)

8.5.7.1 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.

8.4.7.2 Applicability:

**Table 8.4.7.2:
Utility Tunneling (UT) Criteria**

Items	Acceptable Parameter
Typical Application	Water Main Wastewater Main- Gravity & Pressure
Encasement Size	42" or Larger
Encasement Material	Steel Pipe , Liner Plate, Rib & Lagging*
Carrier Pipe Size	30" or Larger
Carrier Pipe Material	RCP, Steel, RTRP
Maximum Installation	1500 LF
Special Consideration	- Suitable for almost all types of soil - Requires worker entry

**Rib & lagging to be used for wastewater main with prior approval*

8.4.8 Pipe Jacking (PJ)

8.4.8.1 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.

8.4.8.2 Applicability:

**Table 8.4.8.2:
Pipe Jacking (PJ) Criteria**

Items	Acceptable Parameter
Typical Application	Water Main Wastewater Main- Gravity & Pressure
Encasement Size	Not Used
Encasement Material	N/A
Carrier Pipe Size	42" or Larger
Carrier Pipe Material	RCP, Steel, RTRP
Maximum Installation	1500 LF
Special Considerations	- Suitable for almost all types of soil - Requires worker entry - Directional changes only possible at the shafts.

8.4.9 Pipe Ramming (PR)

8.4.9.1 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.

8.4.9.2 Applicability:

Table 8.4.9.2:
Pipe Ramming (PR) Criteria

Items	Acceptable Parameter
Typical Application	Water Main Wastewater Main- Pressure
Encasement Size	N/A
Encasement Material	N/A
Carrier Pipe Size	4- 60"
Carrier Pipe Material	Concrete, Steel, DI
Maximum Installation	200' - 400'
Special Considerations	- Not suitable for gravity application or pipeline with grade - High Noise level, ground vibration, surface disruptions

8.4.10 Impact Moling (IM)

8.5.10.1 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.

8.4.10.2 Applicability:

Table 8.4.10.2:
Impact Moling (IM) Criteria

Items	Acceptable Parameter
Typical Application	Small Water Main Water Service Lateral
Encasement Size	N/A
Encasement Material	N/A
Carrier Pipe Size	3/8" - 6"
Carrier Pipe Material	PVC, Steel, Copper
Maximum Installation	Non-Steerable Mole: 35 LF Steerable Mole: 200 LF
Special Considerations	- May cause surface damage for too shallow installation - Most conservative depth for installation of a pipe is 4 feet or 10 times diameter of the pipe - High Noise level, ground vibration, surface disruptions

8.4.11 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).

8.4.11.1 Horizontal Auger Boring (HAB):

8.4.11.1.1 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.

8.4.11.1.2 Applicability

**Table: 8.4.11.1.2:
Horizontal Auger Boring (HAB) Criteria**

Items	Acceptable Parameter
Typical Application	Water Main Wastewater Main- Gravity & Pressure
Encasement Size	4"- 60"
Encasement Material	Steel
Carrier Pipe Size	2"- 48"
Carrier Pipe Material	PVC, RCP, Steel, RTRP, RPMP, HDPE
Maximum Installation	600 LF
Special Considerations	- Does not require worker entry - May require dewatering under water table

8.4.11.2 Horizontal Direction Drilling (HDD):

8.4.11.2.1 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.

8.4.11.2.2 Applicability

**Table 8.4.11.2.2:
Horizontal Direction Drilling (HDD) Criteria**

Items	Acceptable Parameter
Typical Application	Water Wastewater Main- Pressure
Encasement Size	Not Used
Encasement Material	N/A
Carrier Pipe Size	2"- 48"
Carrier Pipe Material	PVC- Fusible, PVC-Certa-Lok, HDPE, Steel, DI
Maximum Installation	600- 6000 LF
Special Considerations	- May cause significant ground movement especially for shallow ground cover. - Disposal of drilling fluid may be required - May cause community problem due to surfacing of drilling fluid known as "Frack Outs" - May be considered for new water or wastewater forcemain installation where pipe grade is not critical. - Engineer must be diligent in locating nearby gas lines.

8.4.12 Microtunneling (MT)

8.4.12.1 General 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.

8.4.12.2 Applicability:

**Table 8.4.12.2:
Microtunneling Criteria**

Items	Acceptable Parameter
Typical Application	Wastewater Main- Gravity
Encasement Size	10- 136"
Encasement Material	N/A
Carrier Pipe Size	4"- 108"
Carrier Pipe Material	RCP, Steel, DI, RTRP, RPMP
Maximum Installation	600 LF
Special Considerations:	- Does not require worker entry

8.4.13 Pipe Bursting (PB)

8.4.13.1 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.

8.4.13.2 Applicability:

**Table 8.4.13.2:
Pipe Bursting (PB) Criteria**

Items	Acceptable Parameter
Typical Application	Water Main Wastewater Main- Gravity/Pressure
Host Pipe Size	4" - 48"
Host Pipe Material	PVC, Clay, DI, RTRP*, RPMP**
New Pipe Size	4"-48"
New Material	HDPE
Maximum Installation	750 LF
Special Considerations	- Upsize allowable up to 1.5 times of the diameter of the host pipe - Bypass or diversion of flow required - Insertion pit required - Percussive action can cause significant ground movement - Point repair may be required - There shall be no gas, electrical or other sensitive utilities within a close proximity of the existing main in order to avoid potential construction risk. Typically minimum 4 feet horizontal or 2 feet vertical clearance is recommended.

* RTRP denotes Reinforced Thermosetting Resin Pipe

** RPMP denotes Reinforced Polymer Motar Pipe

8.4.14 Slip Lining (SL)

8.4.14.1 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.

8.4.14.2 Applicability:

**Table 8.4.14.2:
Slip Lining (SL) Criteria**

Items	Acceptable Parameter
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 - Not recommended - Not recommended for 12' or smaller main unless proposed is to be at least one size smaller the existing main.

*Reference: ASTM F585: Practice for Insertion of Flexible Polyethylene pipe into Existing Sewers

8.4.15 Cured-In-Place Pipe (CIPP)

8.4.15.1 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.

8.4.15.2 Applicability:

**Table 8.4.15.2:
Cured-In-Place Pipe (CIPP) Criteria**

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

**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)

8.4.16 Fold & Form Pipe (F&FP)

8.4.16.1 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.

8.4.16.2 Applicability:

**Table 8.4.16.2:
Fold & Form (F&FP) Criteria**

Items	Acceptable Parameter
Typical Application	Wastewater Main- Pressure/Gravity
Host Pipe Size	8' - 15"
Host Pipe Material	PVC, Clay, DI
Liner Pipe Size	<15"
Liner Material*	PVC, HDPE
Max. Installation	350- 600 LF
Special Considerations	It was not used on line segments which had broken or collapsed

*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

PRELIMINARY DESIGN REPORT CHECKLIST DALLAS WATER UTILITIES

PRELIMINARY DESIGN REPORT CHECKLIST		
DALLAS WATER UTILITIES		
PROJECT TYPE*		ITEMS
Minor	Major	
☐	☐	1.0 GENERAL - General project description along with location and limit. Project description typically be based on PID number (Manhole to manhole for wastewater and street/alley intersection to street/alley intersection for water) - Purpose of the project - General location map with Mapsco, and PID Number(s)
☐	☐	2.0 DESIGN DATA 2.1 Record Search - Water/Wastewater Mains: - Size, type and age of existing water/wastewater main to be replaced - List of map references (685W, 411Q etc) - Adjacent Utilities: - Proposed/Existing adjacent water/wastewater mains, storm drains and franchise utilities 2.2 Water/Wastewater Condition Check, if Available: - Water condition check including water break index - Wastewater condition check including TV inspection summary report - Other field data as available 2.3 Pavement Data: - Street classification (M-2-U, R-2-U, etc) - Street material (asphalt, concrete, etc) - Pavement thickness, in inches, if available - Approximate age of existing pavement along with linear feet less than 5 years old and linear feet greater than 5 years old if available
	☐	3.0 EVALUATION OF ALTERNATIVES, IF APPLICABLE - Evaluation of various alignment and/or design alternatives along with drawing and photographs as necessary - A table showing comparison of various options including cost estimate.
		4.0 RECOMMENDATION
☐	☐	4.1 General - Selection of the preferred alternative/proposed alignment including drawing and photograph(s) as necessary - Proposed pipe size and material - Proposed construction method (Open cut or trenchless)

PRELIMINARY DESIGN REPORT CHECKLIST DALLAS WATER UTILITIES		
PROJECT TYPE*		ITEMS
Minor	Major	
☐	☐	4.2 Project Coordination: Proposed projects by others to include project Scope, agency, project schedule, and impact to DWU
☐	☐	4.3 Possible Impacts to Customers: This may include an analysis of inconvenience factors, alternate routes, lost business, etc.
☐	☐	4.5 Permits Requirements: Identification of potential permit(s) from following entities: - Corps of Engineers Permit - DART Permit - TXDOT Permit - TCEQ Permit - Railroad Permit - City of Dallas Street Cut Permit - NTTA - Customer Cities - Other Cities where the DWU utilities may be in non-City of Dallas public right of way or public owned easements.
☐	☐	4.6 Rights of Ways or Easements Requirement(s): Identification of potential right-of-ways easement requirement(s): Approximate area of new easement(s) or new property to be purchased in fee simple that is required to complete this project.
	☐	4.7 Field Investigation: Identification of following investigative requirement(s) - Geotechnical Investigation: Soil Boring - Subsurface Utility Investigation (S.U.E) - Evaluating Potential for Contamination : File Search, Phase I or Phase II Environmental Site Assessment (ESA)
	☐	4.8 Hydraulic Modeling: Any recommended modeling scenarios that might be needed to see how this pipe might impact the DWU systems.
☐	☐	4.9 Cost Estimate:

* Minor Project typically refers to the following:

- Project consisting of less than 2000 LF of 12' or smaller water and/or wastewater main basic replacement.

*Major Project typically refers to the following:

- Project consisting of greater than 2000 LF of water or/and wastewater main replacement

- Projects consist of typically larger than 12" in diameter

- New development projects

- Capacity improvement projects

- Other special projects as applicable.

APPENDIX B

SUBSURFACE UTILITY ENGINEERING (SUE) QUALITY LEVEL B REQUIREMENTS DALLAS WATER UTILITIES

**SUBSURFACE UTILITY ENGINEERING (SUE)
QUALITY LEVEL B REQUIREMENTS
DALLAS WATER UTILITIES**

1.0 GENERAL REQUIREMENTS

- All firms selected to provide Subsurface Utility Engineering (SUE) services to the Dallas Water Utilities (DWU) shall have a minimum of three (3) years of verifiable experience involving work of similar nature.
- SUE provider must have in-house crew, equipment and other resources in order to perform appropriate function in the field.
- All personnel involved in SUE project must have completed 40 hour OSHA safety training and have the proper equipment including, but not limited to blower, gas tester, tripod and other equipment as necessary.
- SUE provider must have a safety plan and submit a copy for each project.

2.0 REFERENCES

2.1 General

Following references shall be applicable in conjunction with SUE services:

- Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02 BY American Society of Civil Engineers, Latest Edition.

2.2 Standard Terminology

- 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.

3.0 SCOPE OF SERVICES

3.1 Utility Coordination

The SUE provider at a minimum shall conduct the following utility coordination to locate existing utilities prior to initiating any field works:

- DIG-TESS Center (800-344-8377 or 214-670-5111)
- DWU Water Distribution/Wastewater Collection Division Hotline (311)
- Coordinate with non DWU utilities as needed
- Coordinate with outside property owners as needed (Right of Entry)
- Comply with applicable City, State, and Local standards for utility coordination

3.2 Tasks

- Perform or verify tasks described for Quality Levels “C” and “D” (**Section 2.0**). In most instances, DWU Engineer has already performed level “C” and “D” and will provide that information to SUE provider prior to commencement of work.
- Select an appropriate suite of surface geophysical methods to search for utilities within project limits.
- Apply appropriate surface geophysics to search for utilities within project limits
- Interpret the surface geophysics. Depending on the methods this may be performed in the field or in the office.
- Mark the indications of utilities on the ground for subsequent survey.
 - Local utility owners, agencies, and/or one-call statues may dictate or recommend the markings color, sizes, or labeling.
 - Care shall be taken to differentiate markings placed on ground for design purposes from those placed on ground for damage prevention
 - A non-water base paint, must be used on all surface markings of underground utilities.

- Survey all markings that indicate the presence of a subsurface utility.
- Depict all designated utilities using MicroStation
- Correlate the designated utilities' depictions with utility record as necessary
- Resolve differences between designated utilities and utility records and surveyed appurtenances as necessary.
- Recommend additional measures to resolve differences if they still exists.

4.0 DELIVERABLES

All final deliverables shall be sealed and signed by a Texas Professional Engineer. Electronic and hard copy deliverables shall include, but not be limited to the following:

4.1 SUE Location Map

A preliminary drawing showing all designated utilities at 1:1 scale in MicroStation format shall be submitted with the following criteria:

- All utility information must clearly designated in plan-view for quality levels B, C, and D.
- A Line Code, shall be used to differentiate between the quality levels
- Color is used to indicate a utility pipe
- Layers or Levels are used to isolate utilities by owner and or quality level
- Approximate utility depth(s) and size(s) at critical locations along pipeline alignment shall be shown as available.

APPENDIX C

SUBSURFACE UTILITY ENGINEERING (SUE) QUALITY LEVEL A REQUIREMENTS DALLAS WATER UTILITIES

**SUBSURFACE UTILITY ENGINEERING (SUE)
QUALITY LEVEL A REQUIREMENTS
DALLAS WATER UTILITIES**

1.0 GENERAL REQUIREMENTS

- All firms selected to provide Subsurface Utility Engineering (SUE) services to the Dallas Water Utilities (DWU) shall have a minimum of three (3) years of verifiable experience involving work of similar nature.
- SUE provider must have in-house crew, equipment and resources in order to perform appropriate function in the field.
- SUE provider must have air lance capability along with other state-of-the-art non-destructive locating equipment and software systems, as necessary.
- All personnel involved in SUE project must have completed 40 hour OSHA safety training and have the proper equipment including, but not limited to blower, gas tester, tripod and other equipment as necessary.
- SUE provider must have a safety plan and submit a copy for each project.

2.0 REFERENCES

2.1 General

Following references shall be applicable in conjunction with SUE services:

- Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02 BY American Society of Civil Engineers, Latest Edition.

2.2 Standard Terminology

- 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.

3.0 SCOPE OF SERVICES

3.1 Utility Coordination:

The SUE provider at a minimum shall conduct the following utility coordination to locate existing utilities prior to initiating any field works:

- DIG-TESS Center (800-344-8377 or 214-670-5111)
- DWU Water Distribution/Wastewater Collection Division Hotline (311)
- Coordinate with non DWU utilities for marking existing utilities as needed
- Coordinate with outside property owners as needed (Right of Entry)
- Comply with applicable City, State, and Local standards for utility coordination

3.2.1 Task

- Perform or verify tasks designated for Quality Levels “B”, “C” and “D” (**Section 2.0**). In most instances, DWU Engineer has already performed level “C” and “D” and will provide that information to SUE provider prior to commencement of work.
- Select an appropriate method of gathering data that will achieve the accuracies and precision required by the project.
- Excavate test holes in such a manner that protects the integrity of the utilities to be measured:
 - Neatly cut and remove existing pavement material, such that the cut does not exceed 0.10 square meters (1.076 square feet) unless unusual circumstances exist.
 - Coordinate cut with City of Dallas Cut Permit Process, if in public ROW.

- Expose the utility using a minimally intrusive excavation (i.e. vacuum excavation). To eliminate the possibility of damaging the utility or its protective coating, air lance should be the first choice of nondestructive excavation. Comply with applicable damage prevention laws, permits and specifications, and coordinate with utilities and inspectors, as required.
- Determine the following items:
 - Horizontal and vertical location of the top and/or bottom of the utility referenced to the project survey datum.
 - The elevation of the existing grade over the utility at a test hole referenced to the project survey datum.
 - The outside diameter of the utility and configuration of non-encased, multiconduit systems
 - The utility structure material composition, when reasonably ascertainable
 - the benchmarks and/or project survey datum used to determine elevations
 - The paving thickness and type, where applicable
 - The general soil type and site conditions from visual or physical observation
 - Groundwater elevation, if applicable
 - Observed condition of outside utilities
 - Other pertinent information as is reasonably ascertainable from each test hole site.
- Resolve any differences between depicted Quality Level A data and other quality levels. This may take the form of additional surface geophysical searches or depiction of adjacent or nearby data points at a lower quality level.

4.0 DELIVERABLES:

All final deliverables shall be sealed and signed by a Texas Professional Engineer. Electronic and hard copy SUE deliverables shall include, but not be limited to the followings:

4.1 Test Hole Data Sheet:

Submit Test Hole data sheet(s) for each test hole containing following information:

- Date of Work
- Digital sketch of Test Hole with northing and easting in State Plane Coordinates (in grid)
- Digital Sketch Cross Section of pipe as it relates to the existing ground
- Photograph of Test Hole

4.2 SUE Location Map:

A preliminary drawing showing all Test Holes at 1:1 scale in MicroStation format shall be submitted. All utility information must clearly designated in plan-view for quality levels A, B, C, and D

- A Line Code, shall be used to differentiate between the quality levels
- Color is used to indicate a utility pipe
- Layers or Levels are used to isolate utilities by owner and or quality level
- Quality level “A” must be depicted in a profile or separate data sheet

APPENDIX D

TOPOGRAPHIC SURVEY REQUIREMENTS FOR WATER/WASTEWATER MAIN PROJECTS DALLAS WATER UTILITIES

TOPOGRAPHIC SURVEY REQUIREMENTS FOR WATER/WASTEWATER MAIN PROJECTS DALLAS WATER UTILITIES

1.0 GENERAL REQUIREMENTS

- All firms selected to provide surveying services to the Dallas Water Utilities (DWU) shall have a Registered Professional Land Surveyor (RPLS) as a full time employee to act as the Surveyor of Record. The Surveyor of Record will hold a current RPLS license issued by the State of Texas.
- All surveying must be performed under the direct supervision of the designated Surveyor of Record. Should the Surveyor of Record become unable to perform the required duties, work on the project will cease immediately and the DWU Project Manager shall be notified. Any work performed on the project when the Surveyor of Record is unavailable to perform the required duties will be deemed unacceptable and be rejected.

2.0 REFERENCES

Following references shall be applicable in conjunction with surveying services:

- Texas Professional Land Surveying Practices Act by Texas Board of Professional Land Surveying (TBPLS), latest edition as available at:
http://www.txls.state.tx.us/04_act_rules/2009_act.pdf
- General Rules of Procedures and Practices by TBPLS, latest edition as available at:
http://www.txls.state.tx.us/04_act_rules/rules2010.pdf
- Paving Design Manual by the City of Dallas Public Works and Transportation (PW&T), latest edition as available at:
<http://www.dallascityhall.com/pwt/pdf/PavingDesignManual-searchable.pdf>
- Water and Wastewater Procedures and Design Manual by DWU, latest edition as available at: http://www.dallascityhall.org/dwu/dwu_design_standards.html
- Drafting Standards for Water/Wastewater Pipeline Projects by DWU, latest edition as available at: http://www.dallascityhall.org/dwu/dwu_design_standards.html

3.0 SCOPE OF SERVICES

3.1 Purpose:

The purpose of the topographic survey is to locate and document all information that is pertinent to the design and construction of water/wastewater main projects.

3.2 Record Search:

The Surveyor of Record shall research all boundaries, subdivision plats, right-of-ways, easements and other available survey elements, which may affect the physical boundaries of the project. All the easements with volume and page numbers shall be identified and labeled on the survey submittal. Research shall include all public record resources, including but not limited to, the followings:

- City of Dallas Survey Records Vault
- Dallas, Denton and Collin County Records as applicable
- Texas Department of Transportation (TXDOT) Right-of-Way Records
- Private Utility Providers Records for gas, telephone, electric, cable, fiber optics and other utilities
- Ownership or Easement Records as available

3.3 Utility Coordination:

The Surveyor of Record at a minimum shall conduct following, but not limited to, utility coordination to locate existing utilities prior to initiating any field works:

- DIG-TESS Center (800-344-8377 or 214-670-5111)
- DWU Water Distribution/Wastewater Collection Division Hotline (311)

3.4 Width of Topographic Survey:

3.4.1 Non-Street/Alley Survey:

The typical survey along a non-street or alley area shall encompass 10 ft beyond the minimum required water/wastewater easement along the proposed alignment as specified in §1.8.3 of Water & Wastewater Pipeline Design Manual by DWU, latest Edition. Unless otherwise specified, the width of a typical survey along a typical non-street/alley shall be as per **Table 1**:

Table 1: Width of Typical Topographic Non-Street/Alley Survey

Size of Main (inch)	Min. Easement Width (ft)	Min. Survey Width (ft)
8" through 12"	25	45
16" through 24"	35	55
30" through 66"	50	70
72" and Larger	70	90

3.4.2 Street Survey:

Unless otherwise specified, the typical survey shall encompass 10 ft beyond the right-of-way as shown in **Figure 1**:

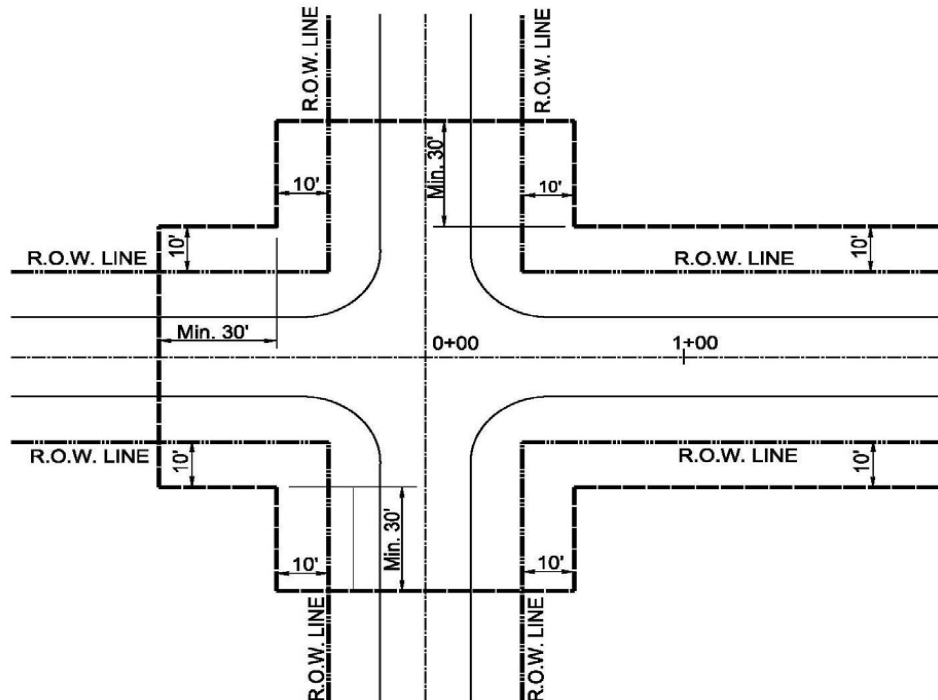


Figure 1: Width of Typical Topographic Street Survey

4.0 SURVEY CONTROLS

4.1 Horizontal Control

- Horizontal control datum for City of Dallas shall be the North American Datum of 1983 (NAD83) as defined by National Geodetic Survey (NGS).
- The applicable State Plane Coordinate (SPC) zone for City of Dallas is Texas North Central Zone (Code 4202).

If requested, a survey baseline or street/right-of-way centerline shall be established and monumented with following criteria:

- Monumentation shall be set at 100-foot stations at the beginning and end of the project along with all points of curvature (PC), points of tangency (PT), and points of intersection (PI).

- Monumentation shall be “PK” or “MAG” nails set through stainless steel washers imprinted with the registration number of the designated Surveyor of Record and the wording: “Survey Baseline/Centerline”.
- Monumentation shall be located sufficiently away from the possible construction areas so as not to be disturbed by the contractors or utilities.

4.3 Vertical Control

- Vertical control datum for City of Dallas shall be based on National Geodetic Vertical Datum of 1929 (NGVD29), as defined by National Geodetic Survey (NGS).
- Vertical control for DWU project shall be determined from the network of DWU established benchmarks (BM).
- Benchmarks (BMs) or Control Points (CPs) are to be established at each end of the project, with intermediate locations spaced about every 500 feet and at a sufficient distance outside the limits of construction so as not to be disturbed. A minimum of two BMs or CPs are to be provided on each project with the northing, easting, elevation and description.
- A closed loop consisting of at least two (2) DWU BMs shall be required to verify existing benchmark datum. Loops are to be established using level/ level rod and must have with an accuracy of plus or minus 0.05 foot times the square root of the distance in miles looped.
- When running the benchmark loop, additional BMs used on other projects in the immediate area should be turned through to provide a check. However, BMs from different projects should not be assumed to on the same datum.
- Turning points should be sufficiently stable to maintain desired accuracy. Backsights and foresights should be balanced in distance and shots should not exceed 300 feet. Care should be taken to ensure level rod is properly extended and "waved or rocked" to ensure lowest reading.
- BMs shall be referred to as found or set. Set BMs (also known as CPs) shall include the date set in the description. Found BMs shall include record elevation and refer to source of benchmark, such as DWU BM Book number, or plan number such as 411Q1321, sh. 21 etc.
- Set BMs or CPs points established shall be reasonably permanent and substantial (avoid using R/R spikes, 60-D nails, crosses on top of fire hydrants, etc). They shall be easily identified and afforded reasonable protection against damage or destruction. A description of the BMs or CPs shall be written in a clear and concise manner so that it can be easily recovered (specify distance to nearest cross street when applicable).

4.4 Special Considerations for GPS Survey

When instruments employing Global Positioning System (GPS) survey technology are used, 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.
- 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 0.07 feet is required.
- GPS survey instrument technology and procedures will not be approved for use in establishing vertical control for project benchmarks.

5.0 FIELD DATA COLLECTION

Field data collection shall include, but not be limited to, the followings:

5.1 Right-of-Way and Property:

- Locate and tie all existing rights-of-way, property lines and easements including type, size, bearing, volume and page, as necessary.
- Show lot, block, abstract number and dimensions with adjacent street names.
- Identify corporation lines with involved cities listed.

5.2 Topographic Features:

5.2.1 Roadways and Railways:

- Identify roadways, driveways, alleys and sidewalks with pavement type.
- Show centerlines and angles of intersection of the side street(s) with main roadway centerline, as necessary.
- Show all mail boxes, road signs and signal posts.
- Identify all existing or abandoned railways with company names, if available.

5.2.2 Trees, Shrubs and Landscaping:

- Locate all trees, vegetation lines and special landscaping.
- Locate and describe any trees, bushes, shrubs or other landscaping plants.
- Provide tree caliper (at 1 foot above ground), type of tree, and drip line location for all trees over 2 inches in diameter.
- Provide locations of other landscaping materials such as grass lawns, rock structures, sculptures, etc.
- Provide the type, locations and elevations of sprinkler heads, sprinkler control boxes, and other sprinkler devices that may become a design consideration

5.2.3 Fence and Retaining Wall

- Provide the location and type of fence (wooden, wrought iron, barbed wire etc.) within limits of the survey.
- Show retaining walls with detailed description.

5.2.4 Creek and Drainage Features:

- Show high and low banks of creeks.
- Locate toe and top of slopes within a drainage features.

5.2.5 Bridges

- Locate and fully describe all bridges.
- Show elevations along the centerline and of edge the structure.
- Show elevations and locations of sides and bottom of any channel, creek or drainage structure the structure bridge passes over.
- Show the bottom elevation of any beams or other physical restrictions.
- Show edges of bridge abutments, columns and wing wall if available.

5.3 Utilities:

Locate and confirm all existing utilities and appurtenances along with type, size and materials, as possible:

5.3.1 Water Mains and Appurtenances:

- Size and material type of water main
- Size and type of manhole, meter and fire hydrant (specify color)
- Size and type of valve with operating nut elevation

5.3.2 Wastewater Mains and Appurtenances:

- Size and material type of wastewater main with flow direction
- Size and type of manhole (brick, concrete, fiberglass, drop manhole etc.)
 - Rim elevations
 - Flowline elevations of all lines entering and exiting manhole
- Wastewater Access Device, Cleanout and other appurtenances

5.3.3 Stormdrains, Open Channels, and Culverts

- Size and material type of storm drains with flow direction
- Size and type of appurtenances including inlet, manhole, junction box etc.
- Indicate all open channels and culverts with material and elevations
- Provide the width and height of all box culverts as well as the entry and exit elevations
- Provide elevations, widths and locations of any headwalls, retaining walls, aprons or other objects within the limits of the survey.

5.3.4 Gas Mains :

- Size and material type of gas main, if available
- Indicate owner's name and pressure rating of the gas main if available
- Size and type of appurtenances including meter, manhole, valve etc.

5.3.5 Underground Telephone

- Size and material type, if known
- Indicate owner's name, if available
- Size and type appurtenances (manhole, telephone pole, guy wire etc.)

- 5.3.6 Underground Electric (Size, Material, Appurtenances- Manhole etc)
- Size and material type, if known
 - Indicate owner's name, and contact information, voltage, if available
 - Size and type appurtenances (manhole, vault, power pole, guy wire etc.)
- 5.3.7 Underground Cable (Size, Material, Appurtenances- Manhole etc.)
- Size and material type, if known
 - Indicate owner's name, and contact information, if available
 - Size and type appurtenances (manhole, vault etc.)
- 5.3.8 Underground Fiber Optic (Size, Appurtenances- Manhole etc.)
- Size and material type, if known
 - Indicate owner's name, and contact information, if available
 - Size and type appurtenances (manhole, vault etc.)

6.0 DATA IMPORT AND DIGITAL TERRAIN MODEL:

The latest version of InRoads or equivalent software(s) as approved by DWU, shall be used to perform survey data import, surface modeling, horizontal and vertical alignment, and related tasks as necessary. In addition, all drawings produced by a CADD system with electronic file format must be compatible with MicroStation V8 XM or the latest edition.

7.0 DELIVERABLES

- All survey data shall be furnished in **Read Only** compact disc (CD-R) labeled as "Survey Data" along with PID, Location/Limit and Consultant Name.
- All submittals of survey drawings must be in a surface projection, with any scale factor used clearly identified in the general notes for each drawing.
- Survey data submittals in coordinate format (Northing – Easting) which are State Plane Coordinates **must be Grid Values**. Generally, State Plane Coordinates would only be submitted for major horizontal control elements (Survey Baseline, Controlling Monuments).
- Any coordinate data submittals in coordinate format (Northing – Easting) which represent a local projection, **must** have the coordinate data modified so that the

data will not be mistaken for State Plane Coordinates. For example the coordinate pair N: 6989501.386, E: 2477443.932; by truncating those numbers which repeat within the project, would be changed to N: 9501.386, E: 7443.932.

Survey deliverables shall include, but not be limited to, the following data:

7.1 List of Horizontal/Vertical Controls:

A list of horizontal and vertical controls along with pertinent calculations shall be furnished in both electronic and hard copy. Hard copy shall be sealed and dated by Surveyor of Record containing a statement as “All field data is based on the horizontal and vertical controls as shown in this document(s)”.

7.2 Point File:

A list showing point numbers, northings/eastings, elevations, and description shall be furnished.

7.3 Field Sketch:

Field sketches and notes depicting any special field information shall be furnished, if available.

7.4 Preliminary Base Map:

A preliminary base map at 1:1 scale containing all pertinent survey data shall be prepared as per the latest edition of “Drafting Standards for Water/Wastewater Pipeline Projects” by DWU to incorporate following criteria:

- **File Format:** This map shall be based on the latest version of “**DWUSeed3D-xx.dgn**” as available in City of Dallas website. This file shall be re-named as per DWU standard naming convention:

“Basemap3D-xx.dgn”

Where, “xx” refers to project identification number (PID), street or project area name.

Examples:

Basemap3D-PID763_764_789.dgn

Basemap3D-MainSt.dgn

Basemap3D-ParkMainAlley.dgn

- **Global Origin:** The default Global Origin (GO) for a 3D file in MicroStation is set to the center of the design plane with coordinate values of 0,0,0.
- **Working Units:** The default working units (1:12:1000) and related parameters as set for DWU3D Seed file shall not be altered in 3D basemap.
- **Level Designation:** All designated levels in DWU3D Seed file with predefined attributes consisting of specific color, line style, and line weight must be used
- **Standard Symbol:** All standard symbols as available shall be used
- **Digital Terrain Model/Contour Data:** Digital terrain model (DTM) and contours shall be included. Contours shall be at 1-ft minor and 5-ft major intervals.

7.5 Profile Drawing:

If requested, a drawing showing centerline alignment and profile shall be furnished

7.6 Supplementary Files:

All computational files necessary for the production of the drawings including geometry files, survey data collector files (in both internal and ASCII formats), digital terrain model files and supplementary files shall be furnished as necessary.