



Water and Wastewater Design Manual

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1. Water and Wastewater Design Requirements

1.1. General

A. Governing Documents

1. All work and materials shall be in accordance with:
 - Current edition of City of Plano (City) Standard Construction Details (Standard Details), latest revision
 - North Central Texas Council of Governments (NCTCOG) Public Works Construction standards, latest edition.
 - American Water Works Association Standards (AWWA)
2. Should a conflict be found between the publications, the City Standard Details shall take precedence. In the event that an item is not covered by the City Standard Details, the North Texas Council of Governments (NCTCOG) Public Works Construction standards shall apply. Notification in writing by the contractor shall be made to the design engineer, City inspector, and the Director of Engineering of the issue. The Director of Engineering reserves the right to make the final decision on construction materials, methods, and procedures specified in construction plans.
3. Reference to all documents contained in the project specifications shall refer to the current edition of each document.

B. Separation Requirements

1. All water mains and wastewater mains shall be separated per TCEQ Rules and Regulations. Refer to Chapters 217 and 290.

C. Provisions for Future Development

1. Water and wastewater mains shall be sized and extended through the limits of a development to provide a connection for ultimate development of adjacent properties.

D. Record Drawings

1. Design engineer shall obtain available record drawings, and field investigations and verifications shall be required prior to construction. Record drawing requests may be submitted using the following link: <https://www.plano.gov/975/Record-Drawing-Requests>

1.2. Infrastructure Crossings

A. Highway

1. All proposed highway crossings must be coordinated with TXDOT, NTTA or other applicable stakeholder. Design engineer is responsible for securing all required permits. All proposed highway crossings shall be encased in steel within stakeholder right-of-way



in accordance with the City Standard Details.

B. Railroad

1. All railroad crossings must be designed per the stakeholder requirements, if applicable. In addition to the stakeholder's requirements, all designs must be in accordance with the most updated American Railway Engineering and Maintenance-of-Way (AREMA) standards. All proposed railroad crossings shall be encased in steel inside of railroad right-of-way.

C. Creek/Drainage Crossing

1. Concrete encasement is required at all creek crossings. Encasement shall extend from ten feet past top of bank to ten feet past top of bank.
2. Bank stabilization is required for all excavations adjacent to creek. Design engineer shall be responsible for performing hydraulic modeling to aid in design of required stabilization. Hydraulic analysis shall be in accordance with City's Storm Drainage manual.
3. Minimum cover at creek crossings shall be in accordance with City Standard Details. Where minimum cover cannot be achieved, design engineer shall provide erosion control measures such as gabion mattresses along creek bottom to prevent erosion. At the City's discretion, drilled piers may be required.

D. Storm Water

1. Steel or concrete encasement is required at storm water crossings where the water/wastewater mains cross under the storm water pipe and the City determines that the weight from the storm infrastructure may impact the proposed water/wastewater main.
2. Proposed water and wastewater mains crossing above a storm water pipe shall be a minimum of six inches clear edge-to-edge from storm water pipe.

E. Park

1. Installation of a new easement within City park property shall be subject to meeting the requirements of Chapter 26 of the Parks and Wildlife Code.

F. Private Utilities

1. Private utilities shall cross public utilities only at 90 degrees and not without approval from the Director of Engineering.



1.3. Pipe Embedment

A. General

1. Pipe embedment for water and wastewater mains shall be per the City Standard Details.
2. Trench dams may be required by the Director of Engineering depending on the ground water potential, pipe slope and length of sloped line segments.

1.4. Trenchless Construction Methods

A. Construction Requirements

1. All projects proposing trenchless construction methods shall show bore pit locations on the plans. Bore pit dimensions and offsets to adjacent structures shall be included.
2. "Level A" locating of existing major utilities that will be crossed by the bore shall be required. Locating shall be in accordance with ASCE Standard 38-02 Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data.
3. All casing pipe shall meet the requirements of the City Standard Details. All annular space between casing pipe and carrier pipe shall be grouted with a low-density cellular grout mix.
4. The following trenchless construction methods may be allowed by the City. The Director of Engineering shall have final discretion over the proposed use of trenchless construction methods:
 - a) Auger Boring - Proposed horizontal bores shall have a minimum vertical clearance distance from the casing pipe meeting the general clearance requirements of these Standards.
 - b) Pipe Jacking - Proposed pipe jacks shall have a minimum vertical clearance distance meeting the general clearance requirements of these Standards.
 - c) Hand Tunneling - Proposed hand tunnels shall have a minimum vertical clearance distance meeting the general clearance requirements of these Standards. Contact grouting shall be provided for the annular space between the tunnel and soil. Settlement monitoring shall be performed when tunneling beneath existing roadways.
 - d) Pipe Bursting - All proposed pipe bursts shall have a minimum clearance distance of 10-inches per 1- inch increase in pipe size to any existing underground crossing obstructions. Proposed pipe burst operations shall be designed to avoid soil heaving at the surface. TV inspection shall be performed prior to pipe bursting.
 - e) Horizontal Direction Drilling - Drilling shall be performed with a bore tracking system capable of accurately locating the position of the drill head in the x, y, and z axes. Record drawing of actual drill path shall be provided following construction.
 - f) Cured-in-Place Piping (CIPP) - TV inspection shall be performed prior to CIPP to ensure host pipe is suitable for CIPP installation.



- g) Bridge Crossings – Attaching water mains to bridge structure is not allowed unless otherwise approved by the Director of Engineering. When allowed, the following provisions apply:
- i. Structural design for attaching a pipeline to a bridge must account for both the pipeline supports and the bridge or structure itself. Structural calculations must account for the pipeline being full. Design shall be signed and sealed by a licensed Professional Engineer in the State of Texas with experience in structural engineering.
 - ii. Pipe utilized for bridge crossings shall be of a suitable material for long-term exposure to atmosphere, weather elements (rain, temperature extremes, etc.) and sunlight.
 - iii. Pipe utilized for bridge crossings shall have restrained joints over entire length of crossing.
 - iv. Bridge crossings shall include a designed slope stabilization plan. Slope stabilization shall extend a minimum of ten feet on both sides of the pipeline penetrating ground, on either side of the crossing.
- h) Aerial Crossings – Aerial crossings are not allowed unless otherwise approved by the Director of Engineering. When allowed, the following provisions apply:
- i. Aerial carrier pipe shall be installed in a casing pipe. Casing pipe shall be provided with internal and external coating system to protect the pipe. Internal coating shall protect against H₂S corrosion. Casing pipe shall extend a minimum of 15 feet into streambank including encasement and pipe collar.
 - ii. Aerial crossings shall include a designed slope stabilization plan. Slope stabilization shall extend a minimum of ten feet on both sides of the pipeline penetrating ground, on either side of the crossing.
 - iii. Piers shall be located to minimize impacts to creek. When possible, piers shall be located outside the main flow of the creek.
 - iv. A hydraulic analysis shall be performed to determine the impacts of the aerial crossing to storm events.
 - v. All aerial crossings shall be installed with pipe guards on each side to avoid pedestrian traffic from walking across the crossing. Pipe guards shall be made of stainless steel.
 - vi. A structural design for aerial crossings shall be submitted in conjunction with construction plans. Structural design for aerial crossings shall account for the following items and shall be based on a geotechnical report with design recommendations. Design shall be signed and sealed by a licensed Professional Engineer in the State of Texas with experience in structural engineering.
 - Impact load (pipe and pier)
 - Sag



- Pier spacing
- Pier structural design (including depth and diameter)
- Scour

1.5. Easements

A. Dedication

1. Water and wastewater easements serving a new on-site development or redevelopment shall be dedicated by plat. Water and wastewater easements dedicated to the City as part of a Community Investment Program (CIP) or off-site improvement may be dedicated by separate instrument. Dedication for separate instrument easements shall be noted on the plat.
2. Easements and associated plats shall be filed and recorded prior to final acceptance of public infrastructure.
3. Easements dedicated for water or wastewater shall be dedicated as “Water Easement” or “Wastewater Easement”. General easements such as “Utility Easement” will not be allowed without prior approval from the Director of Engineering.

B. Easement Widths

1. Minimum water and wastewater easement widths shall be determined by the depth to the bottom of pipe. Minimum easement widths shall be per the table below:

Depth to Bottom of Pipe (feet)	Minimum Easement Width (feet)
Less than 10	15
10-20	30
Greater than 20	Per City Direction

2. The City may require proposed water and/or wastewater easements to be wider than shown in this table based on, but not limited to, the following:
 - a) Pipe diameter
 - b) Adjacent structures
 - c) Adjacent roadways
 - d) Anticipated future development
 - e) Other maintenance concerns or considerations

C. Easement Requirements

1. The following obstructions are prohibited from being in water or wastewater easements:
 - a) Trees
 - b) Structures
 - c) Retaining and/or screening walls



- d) Fences
 - e) Landscaping
 - f) Light fixtures
 - g) Utilities or underground infrastructure not owned and maintained by the City, unless crossing at 90 degrees to the easement and approved by the City.
 - h) Other infrastructure determined on a case-by-case basis.
2. Proposed mains shall be encased when the main crosses the following infrastructure:
- a) TxDOT right-of-way
 - b) Box culverts or large diameter storm water
 - c) Wastewater crossings in accordance with TCEQ
 - d) Creek crossings (Ten feet beyond top of bank on each side)
 - e) Within five feet of structures
 - f) As required by Director of Engineering

D. Water Meter Easements

- 1. Water meters 2-inch or smaller shall have an accompanying 5-foot by 5-foot minimum water easement centered on the meter.
- 2. Easements for water meters 3-inch or greater shall be based on the required vault size shown in the City Standard Details. At a minimum, five feet shall be provided between edge of vault and edge of easement. Minimum water easement shall be 15' x 17'.
- 3. Larger easements may be required for special conditions such as protection bollards or situations the City considers to be unique.

1.6. Pavement Cut and Repair

A. General

- 1. Water and wastewater improvements shall be designed to minimize the impact to existing pavement, where feasible.
- 2. No pavement shall be cut unless approved in writing by the Director of Engineering. Pavement cut, excavation and repair shall be in accordance with City Standard Details.
- 3. If pavement cut is permitted, full panel concrete pavement replacement will be required. This requirement may be waived by the Director of Engineering if the roadway does not contain a centerline paving joint.

2. Water Design Standards

2.1. Water System - General

A. General

- 1. The intent of the water system design requirements is to list minimum requirements for public water distribution and transmission system facilities and appurtenances. Private



fire service mains shall also be designed according to these water system design requirements, the City's Fire Code, and the National Fire Protection Association (NFPA) 24, Standard for the Installation of Private Fire Service Mains and Appurtenances, latest revision.

2. Design criteria for all water systems shall comply with Texas Commission on Environmental Quality (TCEQ) Chapter 290, Subchapter D (Rules and Regulations for Public Water Systems), latest revision.

2.2. Water Main Locations

A. General

1. Water mains within right of way shall be located per the City Standard Details and Right-Of-Way Management Regulations.
2. The City shall have final discretion on water main alignments, and on the location and length of stub-outs for future water connections.
3. Water mains shall not be located in alleys.
4. Water mains shall be designed to minimize bends and fittings and follow right-of-way or centerline alignment curves at uniform distance from the right-of-way or centerline.
5. Water mains within easement shall be located in the center of the easement.
6. Water mains shall not be located underneath parking spaces, unless otherwise approved by the City.
7. Water mains shall not be located closer than five feet to adjacent trees or structures.
8. Where water mains are installed parallel to existing franchise utility infrastructure, water main shall be located a minimum of three feet horizontally clear between outside pipes from the franchise utility line.
9. Potable water distribution lines shall be installed in a separate trench from wastewater mains or parallel utility lines.

2.3. Water Main Horizontal and Vertical Design

A. Horizontal Design

1. 16-inch and larger water mains shall be designed in straight alignments if possible.
2. Horizontal curves will be allowed 12-inch and smaller water lines to minimize the use of the fittings.
3. The maximum joint deflection permitted shall be no greater than 80% of the manufacturer's recommended maximum joint deflection. Contractor will not be permitted to bend pipe to achieve pipe deflection. All deflection must take place at the pipe joints. The minimum curve radius due to maximum joint deflection can be calculated using the following equation:

$$\bullet \quad R = 57.3 * \frac{L}{\theta}$$



- o R = Minimum curve radius
- o L = Pipe spool length, ft
- o $\emptyset$ = Joint deflection angle, degree

B. Vertical Design

1. Water line minimum cover shall be in accordance with City Standard Details.
2. Water mains should be designed to avoid excessive number of high points and low points between cross street connections.
3. Vertical curves may be used on 12-inch and smaller water lines to minimize the use fittings. Vertical curves will not be allowed on 16-inch and larger water mains.
4. Vertical profile design shall be included in construction plans when any of the following situations apply:
 - a) Proposed water main size is 12-inch or larger
 - b) Proposed water main crosses existing or future infrastructure, including:
 - Franchise utilities
 - Private and public utilities
 - Existing divided thoroughfares
 - Future roadway pavement
 - Storm water pipes
 - Drainage swales
 - Creek crossings
 - Highway crossings
 - Proposed trenchless construction
 - The Director of Engineering shall have final discretion to determine where vertical profile information is required.

2.4. Water Main Materials

A. PVC Pipe

1. PVC water mains from 4-inch to 6-inch in diameter shall be AWWA C900 DR14.
2. PVC water mains 8-inch to 12-inch in diameter shall be AWWA C900 DR18.

B. C303 Pipe

1. Water mains 16-inch in diameter and greater shall be Concrete Pressure Pipe, Bar Wrapped, Steel-Cylinder Type, designed in accordance with AWWA C303 and AWWA M9.
2. Allowable joint types are push-on gasketed, flanged or welded.

C. Fittings

1. Water mains shall be designed to minimize the use of fittings
2. All fittings on PVC piping shall be ductile iron and have mechanical restraints.



3. 11.25-degree bends will not be permitted unless otherwise directed by the Director of Engineering.

D. Thrust Restraint

1. Piping within casing shall have restrained joints.
2. Thrust restraint for 12-inch and smaller water mains shall be provided using concrete thrust blocks.
3. Thrust restraint for 16-inch and larger water mains shall be provided by both concrete thrust blocks and joint restraint. Joint restraint shall be provided by welded joints.
4. Restraint length calculations shall be signed and sealed by a professional engineer registered in the state of Texas. For the purposes of thrust calculations, in-line valves shall be evaluated as a dead end thrust condition.

2.5. Water Service Connections

A. Services

1. Domestic water services shall be 1-inch or 2-inch in size.
2. 1-inch and 2-inch water services shall be either HDPE or copper. 4-inch, 6-inch and 8-inch water services shall be C900 PVC. No other materials will be allowed unless otherwise approved by the City.
3. Domestic service connections shall not connect to fire hydrant leads.
4. Water services on existing water lines already in service are to be installed by the City Water Department at the owner's expense unless otherwise approved by Director of Public Works. The use of manifold water service connections will be allowed only in the case of using two 2-inch meters in lieu of a 3-inch meter. All other manifold water service connections will not be permitted without Director of Engineering approval.
5. Bullhead services are not permitted unless approved by Director of Engineering.
6. A domestic or irrigation service connection shall be located as close to the water main as possible and shall not contain fittings.
7. All non-single-family developments shall have a separate irrigation meter.

B. Meters

1. The water meter sizing schedule is required on the project's Site Plan and Utility/Water Plan. A list of water meters to be replaced and/or reconnected shall be included on City CIP projects. A sample meter sizing schedule is shown below:

**Sample Water Meter Schedule**

WATER METER SCHEDULE					
I.D.	TYPE	SIZE	NO.	WASTEWATER	REMARKS
①	DOMESTIC	4"	1	6"	EXISTING
②	IRRIGATION	2"	1	-	EXISTING
③	DOMESTIC	2"	1	6"	RELOCATED

2. All water meters and meter boxes shall be protected during construction. Meters shall be protected by curb or bollard only unless otherwise approved by the City. Contractor is responsible for the replacement of damaged water meters and meter boxes.
3. Multi-family or commercial sites with multiple buildings shall be required to have separate water meters for each building.
4. Design engineer shall provide sizing calculations for meters 3-inch and larger. Concrete meter vaults will be required for meter sizes 3-inch and larger and shall be provided by the owner.
5. 3-inch and larger meters shall not be installed in the right-of-way.
6. Meter boxes shall be placed within the right-of-way or in a dedicated water easement.
7. Water meters shall be installed in front of or immediately adjacent to the building it serves in the middle of the lot. Banking of water meters or otherwise grouping water meters in such a way that it is unclear which building is served by an individual meter will not be permitted. City staff shall have final authority to determine meter location.
8. Water meters cannot be placed in sidewalk or driveway.
9. Water meter vaults shall not be installed parallel to water main. Service connections to the water main shall be generally perpendicular to the main.
10. All water meters for domestic lines shall be connected to a looped water line.
11. Refer to Approved Material List for acceptable products.

2.6. Fire Protection and Fire Hydrants

A. Location

1. Fire hydrants shall be installed a minimum of ten feet from the curb return on Thoroughfare Types A, B, C, C1 and D.
2. Fire hydrants shall be installed at a minimum of four feet and a maximum of seven feet from the edge of pavement on Thoroughfare Types E, F and fire lanes.
3. Fire hydrants shall not be located in the sidewalk.
4. Additional requirements for fire hydrant installation adjacent to, and along fire lanes in occupancies other than 1 and 2 family dwellings is as follows:
 - a) Fire hydrants shall be located at least 35' from all buildings.
 - b) A minimum of two fire hydrants shall be located within 500' of the front of any building as measured along the route that a fire hose is laid by a fire apparatus.



B. Spacing

1. Fire hydrants shall be spaced per the table below, meeting City Fire Code requirements:

OCCUPANCY	SPRINKLERED	NOT SPRINKLERED
Residential (1 & 2 Family)	600 feet	500 feet
Residential (Multi Family)	400 feet	300 feet
All Other	500 feet	300 feet

2. Fire hydrants must be located on each side of a divided roadway and shall meet minimum spacing requirements on both sides.
3. Fire hydrants on private property shall be located within easements and protected by 6-inch curb or bollards, the maintenance of which shall be the responsibility of the property owner. The property owner is responsible for keeping the curb or bollards in place.
4. Fire hydrants on private property shall be accessible to the Fire Department at all times.
5. The location of all fire hydrants is subject to approval of the Fire Department.

C. Fire Hydrant Leads

1. Fire hydrant lead size shall be 6-inch for leads 50 feet and shorter.
2. Fire hydrant lead size shall be 8-inch for leads longer than 50 feet.
3. Fire hydrant lead valves shall be installed in accordance with City Standard Details. Irrigation lines may tap fire hydrant leads with approval from the Director of Engineering.

D. Fire Service Lines

1. Horizontal separation between a fire service line and any other private services (water, wastewater, etc.) shall be a minimum of ten feet, per City Fire Code.
2. Fire service lines shall be 8-inch minimum unless design is approved by the City's Fire Department.
3. A main line valve is required on the water main between a fire hydrant and any fire service connection.

E. Miscellaneous

1. Removal and re-installation of fire hydrants eight years and older is not allowed and will have to be replaced with a new fire hydrant.
2. The Fire Marshal shall approve the construction plans for the vault, fittings, valves, and double detector check and shall issue a separate permit for fire sprinkler systems.
3. Splash pads should be provided when fire hydrants are located in open spaces or non-sodded landscaped areas. Splash pads should be per City Standard Details. For redevelopment locations, splash pads must be installed on existing fire hydrants regardless of replacement.
4. Fire Hydrant Color



c) Fire hydrant coloring shall be based on water main size as follows:

- 6-inch – Silver
- 8-inch – Blue
- 12-inch or Larger – Yellow

2.7. Water Valves and Appurtenances

A. Valves

1. Valves 12-inch and smaller shall be resilient seated gate valves.
2. Valves 16-inch and larger shall be butterfly valves.
3. Valves are to be located at street intersections at or near side property lines, unless a specific construction issue requires the placement of the valve at a nonstandard point of connection
4. Valve spacing for 12-inch and smaller valves shall match fire hydrant spacing requirements. Valve spacing for 16-inch and larger valves shall be located as directed by Director of Engineering.
5. A minimum of two valves shall be provide at each tee intersection and three valves shall be provided at each cross. When a valve is located on a stub out for a future extension, valve shall be flanged to tee.
 - a) Where a tee connection is installed and the branch line is a dead-end water line into a cul-de-sac, three valves shall be provided at the tee.
6. Valves shall not be located in walkways, including barrier-free ramps, sidewalks or trails. Main line valves shall be located adjacent to all fire hydrants and fire service lines.
7. The City has final discretion on location of valves and number of valves.
8. Mechanical joint restraints or flange joints are required for all valves.
9. Pressure testing of water mains shall be conducted against existing valves where applicable. Existing valves that do not hold a watertight seal shall be replaced at the Developer's expense.

B. Air Release Valves

1. Air release valves shall be designed on a case-by-case basis in accordance with manufacturer's recommendations.
2. Air release valves shall be located on mains 16-inch or larger where the water main profile creates the possibility for air entrapment or where air release valves are located adjacent to valves and the closure of the valve results in temporary high point on the line.
3. Additional installation locations may be requested by the Director of Engineering.

C. Blowoff Valves

1. Blowoff valves shall be designed on a case-by-case basis. Blowoff valve sizing shall take



into account the amount of time required to dewater the entire water main, bounded by the adjacent valves on either side of the proposed blowoff valve. Allowable dewatering time shall be coordinated with Director of Engineering.

2. The City may require the placement of additional blowoff valves.
3. Blowoff valves shall be required on lines 16-inch or larger, where topography and water main profile creates a low point in the pipeline profile or where temporary closure of an adjacent valve results in a temporary low point on the line.
4. Blow off valves shall be designed to discharge within City right-of-way or easement. Blowoff valve discharge piping configuration must be approved by the Director of Engineering.
5. Residential blowoff valves shall be per City Standard Details.

D. Backflow Preventer Locations

1. Backflow preventers shall be designed and located per the City's Building Code, Code of Ordinances and Cross Connection Control Program.

2.8. Water Main Connections

A. General

1. New water mains shall have a minimum of two connections to the City's water distribution system unless otherwise approved by the Director of Engineering. All connections must come from the same pressure zone.
2. Connections to 12-inch and larger water mains shall be subject to approval by Director of Engineering.
3. Only 12-inch or larger connections are permitted on 24-inch diameter and larger transmission mains. Smaller diameter connections less than 12-inch diameter shall be made on internal or parallel development lines.
4. Size-on-size tapping is not allowed for 12-inch water mains and larger. The largest allowable tapping sleeve shall be the main line size less one standard pipe size.
5. Allowable methods of connection, such as tapping sleeve, cut-in connection, etc. will be at the discretion of the Director of Engineering.
6. Proposed service taps on existing water mains shall be a minimum of two nominal sizes smaller than the existing main.
7. Connections to substandard mains shall not be allowed. Substandard mains shall be determined by the Director of Engineering based on criteria including, but not limited to: size, material, condition, pressure, flow rate, etc. Offsite improvements may be necessary to provide adequate water service to the site.
8. When connecting a new line into an existing ductile iron or cast-iron water line, provisions shall be made to facilitate future replacement of the existing cast iron/ductile iron water lines. See detail below:

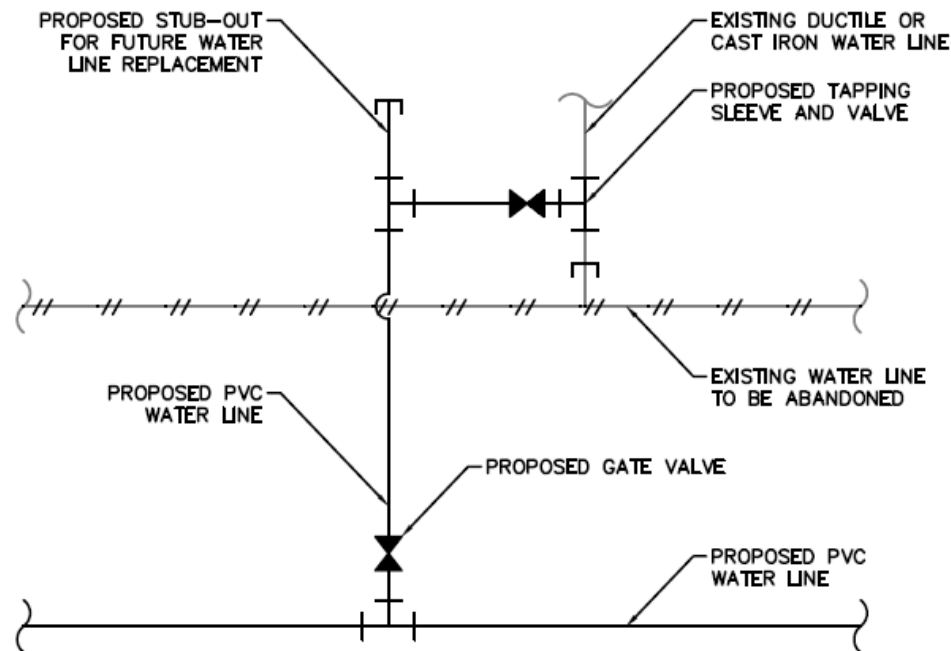


Figure 1 - Provisions for Future Iron Water Line Replacement

9. Water mains to be abandoned shall be cut, plugged, and abandoned in place. Valves along abandoned water mains shall be closed, the valve box and concrete pad removed, and the valve extension stem grouted. Water mains may be required to be grout-filled at the City's request.
10. The Director of Engineering shall have sole authority in determining to which pressure plane a development may connect.

2.9. Dead-End Main Provisions

A. General

1. Dead-end water mains are not allowed unless approved in writing by the Director of Engineering.
 - a) All dead-end water mains shall have a City-approved automatic flushing valve and 2-inch meter located at or near the termination of the water main. Flushing valve shall be located at extension of the property line in accordance with the City Standard Details.
2. All dead-end water mains located in a cul-de-sac shall have a fire hydrant located within 250 feet of each building. If no building exists, fire hydrant shall be located within 250 feet of front building line.
3. When a dead-end main won't extended in the future, it shall reduce after the last fire hydrant if the water main extends past the last fire hydrant for less than 50 feet.



2.10. Water Demand and Main Sizing

A. Demand Development

1. Residential development submittals shall include the total number of units and the total acres of the proposed development. Non-residential development submittals shall include estimated water use records showing the minimum hourly demand, maximum hourly demand, maximum daily demand, total building square footage, and the total acres for the proposed development.

Average Daily Water Demands

Land Use	Design	Calculation
Apartment	2.0 persons/unit	250 gpd/unit
	125 gallons per person per day	
Residential/ Town Home/Patio Home	3.0 persons/unit	375 gpd/unit
	125 gallons per person per day	
Hospital (Beds)	125 gallons per day per bed	125 gpd/bed
Nursing Home or Other Institution (Beds)	125 gallons per day per bed	125 gpd/bed
Commercial/ Industrial/Office	1 person per parking space, or	75 gpd/person
	1 person per 400 SF of building	

B. Water Peaking Factors

1. Minimum peaking factors used for projecting maximum daily demand (MDD) and peak hourly demand (PHD) shall be as follows or per TCEQ, whichever is greater:
 - a) 2.4 for peaking from average daily demand (ADD) to MDD
 - b) 1.25 for peaking from MDD to PHD

C. Main Sizing

1. Water main sizes shall comply with the Water Master Plan.
2. Water mains shall be sized and extended through the limits of a development to serve adjacent properties.
3. Water mains may be required to be upsized at the direction of the Director of Engineering.
4. Water mains shall be of the City's standard diameter sizes. City standard diameter sizes are as follows:

8"	12"	16"	20"	24"	30"	36"	42"	48"
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5. 4-inch and 6-inch water mains may be utilized in dead end line and fire hydrant leads as



discussed in this document.

6. Any other size diameters, such as 10-inch, 14-inch, 18-inch, etc., will not be allowed without approval from the Director of Engineering.
7. Single Family Residential – 12-inch mains shall be required along all collector streets and other areas as determined by the Director of Engineering. 8-inch mains are required along smaller residential streets. Water mains shall be extended to provide service to adjacent properties.
8. Multi-Family Residential – Multi-family water mains shall be no less than 8-inch. Mains over 600 feet in length between intersecting mains or mains supplying more than one fire hydrant/fire service line shall be 12-inch diameter unless approved by Director of Engineering. Any modeling efforts to reduce size to 8-inch shall be at expense of the Developer.
9. Non-Residential – Mains over 1,000-ft in length between intersecting mains or mains supplying more than two fire hydrants/fire service lines shall be 12-inch diameter unless approved by Director of Engineering. Any modeling efforts to reduce size to 8-inch shall be at expense of the Developer.

2.11. Cathodic Protection

A. General

1. Cathodic protection is required on all AWWA C303 pipelines.
2. Cathodic protection must be designed by a National Association of Corrosion Engineers (NACE) certified licensed Professional Engineer.

3. Wastewater Design Standards

3.1. Wastewater System – General

A. General

1. Design criteria for all wastewater systems shall comply with Texas Commission on Environmental Quality (TCEQ) Chapter 217, (Design Criteria for Domestic Wastewater Systems), latest revision.
2. Private wastewater infrastructure shall be designed and constructed meeting the public wastewater requirements.
3. Wastewater systems shall be designed to be gravity systems. If the use of a wastewater lift station is approved by the Director of Engineering, it shall be designed in accordance with Section 3.7.
4. Connections to substandard mains and manholes shall not be allowed. Substandard mains shall be determined by the Director of Engineering based on criteria including, but not limited to: size, material, condition, flow rate, capacity, etc. Offsite improvements may be necessary to provide adequate wastewater service to the site.



3.2. Wastewater Main Locations

A. General

1. Wastewater mains within right of way shall be located per the City Standard Details and Right-Of-Way Management Regulations.
2. Wastewater mains shall not be located in alleys.
3. Wastewater mains shall not be located underneath parking spaces, unless otherwise approved by the City.
4. Wastewater mains shall not be located inside storm water.
5. Wastewater mains within easement shall be located in the center of the easement.
6. Wastewater mains will not be allowed in right-of-way or easements less than 15 feet wide, or within five feet of trees or structures.
7. Separation between water mains and wastewater mains shall meet TCEQ requirements.
8. Wastewater mains crossing water mains shall be at an angle of 90 degrees, unless approved by Director of Engineering.
9. Wastewater mains shall be installed in a separate trench from water mains or parallel utility lines.
10. The Director of Engineering shall have final discretion on wastewater main alignments, and on the location and length of stub-outs for future wastewater connections.

3.3. Wastewater Main Horizontal and Vertical Design

A. Horizontal Design

1. Wastewater mains shall be designed as straight as possible between manholes.
2. Alignment should follow the centerline of ROW and/or easements.
3. When streets have horizontal curvature, curved wastewater mains are acceptable to maintain parallel alignment.
4. Contractor will not be permitted to bend pipe to achieve pipe deflection. All deflection must take place at the pipe joints. The maximum joint deflection permitted shall be no more than 80% of the manufacturer's recommended maximum joint deflection. The minimum curve radius due to maximum joint deflection can be calculated using the following equation:
 - $R = 57.3 * \frac{L}{\theta}$
 - R = Minimum curve radius
 - L = Pipe spool length, ft
 - θ = Joint deflection angle, degree



B. Vertical Design

1. Larger lines shall not flow into smaller lines.
2. Vertical curves are not allowed.
3. Inverted siphons are not allowed
4. Minimum cover for wastewater main shall be 4 feet. When beneath pavement, cover shall be measured from bottom of pavement section.
5. The minimum depth for wastewater mains to serve a given property with a 4-inch lateral shall be three feet plus 2% times the length of the service lateral (the distance from the main to the center of the building).
6. Wastewater lines at water infrastructure crossings shall be steel encased for 20 feet when the vertical clearance between lines is less than nine feet. This applies to wastewater crossings both above and below the water line.
7. Separation between water mains and wastewater mains shall meet TCEQ requirements.
8. Wastewater mains shall be designed to cross underneath water mains whenever possible. Separation between water and wastewater mains shall be two feet clear edge to edge from casing pipe when possible. Minimum separation may be approved by City staff on a case-by-case basis.
9. Where wastewater mains cross existing franchise utility infrastructure, wastewater main shall be located a minimum of two feet clear edge-to-edge vertically from the franchise utility line.

3.4. Wastewater Main Materials

A. General

1. Pipe material shall be consistent from manhole to manhole.
2. Where depth of cover requires a change in material between manholes, the more conservative pipe class shall be used for the entire pipe run between manholes. The Director of Engineering may waive this requirement in situations where a single length of pipe is required to be replaced due to utility crossings.

B. Polyvinyl Chloride (PVC) Wastewater Pipe

1. Non-pressure rated, gravity wastewater mains between 6-inch to 15-inch diameter shall be SDR 35 if top of pipe is less than 12 feet below ground surface or SDR 26 if top of pipe is deeper than 12 feet below ground surface (ASTM D3034).
2. Non-pressure rated gravity wastewater mains 18-inch diameter and greater shall have a minimum pipe stiffness of 46 psi if top of pipe is less than 12 feet below ground surface or 115 psi if the top of pipe is deeper than 12 feet below ground surface and shall be manufactured in accordance with ASTM F679 (solid wall).
3. Pressure rated gravity wastewater mains and force mains from 6-inch to 12-inch diameter shall be SDR 26 (ASTM D2241) with a minimum pressure rating of 160 psi.
4. Pressure rated gravity wastewater mains and force mains greater than 12-inch diameter



shall be AWWA C900 DR25 with a minimum pressure rating of 165 psi.

5. PVC profile wall pipe is not allowed.

C. Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe

1. Non-pressure-rated gravity wastewater mains 18-inch diameter and greater shall be in accordance with ASTM D3262 with a minimum pipe stiffness of 46 psi.
2. Pressure rated gravity wastewater mains and force mains 18-inch diameter and greater shall be in accordance with ASTM D3754 with a minimum pressure rating of 150 psi.

D. Vitrified Clay Pipe

1. Vitrified clay pipe will not be allowed.

3.5. Wastewater Laterals

A. General

1. All wastewater service laterals crossing water mains shall conform to the requirements of the TCEQ Chapter 217, Subchapter C, Rule 217.53(d), latest revision, or Section 3.2 of this standard.
2. Wastewater service laterals for single-family residential shall be a minimum of 4-inch diameter. Laterals shall be installed ten feet downstream from the center of the lot and have a minimum separation distance of ten feet separation from the water service.
3. Wastewater service laterals for multiple units, apartments, local retail and commercial developments shall be a minimum of 6-inch diameter.
4. Wastewater service laterals for manufacturing and industrial shall be a minimum of 8-inches.
5. Manholes are required on 6-inch and larger wastewater service laterals where they connect to the main line. No more than three services may connect to a single manhole.
6. Wastewater laterals shall be PVC SDR-35
7. Wastewater service laterals shall not be attached to wastewater mains that are deeper than 12 feet without City approval. Deep cut or drop connections are not be permitted.
 - a) Wastewater mains deeper than 12 feet shall have a parallel wastewater main for connection to wastewater laterals.
8. Each residential building shall have only one wastewater service lateral, except duplexes, condominiums and townhomes which shall have one wastewater service lateral per unit independently attached to the wastewater main.
9. All mains installed for future developable areas shall include wastewater service laterals; the use of boots will not be permitted.
10. Wastewater laterals shall connect with the main in the direction of flow with a maximum connection angle of 90 degrees.
11. Sites being redeveloped shall confirm that existing laterals meet the requirements of



these Standards. If existing laterals are undersized per these Standards, they shall be upsized.

12. Unused wastewater service laterals and main stubouts shall be abandoned and plugged at the manhole.
13. Grease traps shall not be located within fire lane or other easements or right-of-way.

3.6. Manholes and Cleanouts

A. Spacing

1. Manholes shall be installed at all changes in grade, horizontal direction, and pipe size. Additionally, maximum spacing shall meet the requirements of TCEQ or the spacing shown below, whichever is less:

Manhole Spacing

Pipe Diameter (inch)	Maximum Manhole Spacing (feet)
6-15	500
18-30	800
36-48	1,000
54+	2,000

2. Manholes on curved wastewater mains shall be located at the P.C. or P.T. of the curve and have a maximum spacing of 300 feet along the curve.
3. Manholes shall be located at each end of a wastewater main aerial crossing and/or wastewater main creek crossing. Manhole shall be located within 20 feet to 30 feet of top of bank.
4. Manholes shall be located at the end of any public wastewater main.
5. Manholes shall not be located in parking spaces or residential lots.
6. Cleanouts shall be installed at the dead end of proposed wastewater mains. Cleanouts shall be located no more than 250 feet away from the nearest downstream manhole. Main line cleanouts will only be allowed in residential areas and at the approval of the City.
7. Double cleanouts shall be located on all wastewater lateral connections to wastewater mains per City Standard Details. Cleanout shall be located between the sidewalk and property line and per City Standard Details.

B. Material

1. Manholes on wastewater mains greater than 24-inches shall be polymer concrete manholes only.
2. Manholes on wastewater mains 15-inches to 24-inches may be either polymer concrete manholes or Portland cement manholes lined with CIPP.



3. Manholes on wastewater mains 12-inch and smaller shall be Portland cement.
4. Existing brick manholes shall be replaced with a new manhole where the following conditions apply:
 - a) Proposed wastewater mains or laterals connect to an existing brick manhole.
 - b) Pavement improvements over an existing brick manhole.
 - c) Excavations exposing an existing brick manhole.

C. Sizing

1. Manholes shall be sized as follows:
 - a) 4-foot diameter for 6-inch, 8-inch, and 10-inch pipe.
 - b) 5-foot diameter for 12-inch, 15-inch, 18-inch, 21-inch, 24-inch and 27-inch pipe.
 - c) 6-foot diameter for 30-inch, 33-inch and 36-inch pipe.
 - d) Manholes deeper than 15 feet shall be a minimum of 5 feet diameter and require structural design.
 - e) Manholes deeper than 20 feet require approval from the Director of Engineering. Manhole diameter may increase due to pipe geometry, excessive depths, and multiple pipes connected to the manhole.

D. Frame and Cover

1. Manhole lids and rims shall meet requirements of City Standard Details.
2. Manhole rim shall typically be flush with existing ground or pavement as shown in the City Standards. Manholes shall utilize standard manhole cones unless the manhole extends above grade more than 12 inches, in which case a flat top manhole shall be used.
3. Watertight manhole rings and bolt-down manhole lids are required on wastewater manholes located in the 100-year floodplain. Manhole vents along the wastewater system shall be provided at a spacing of no more than 1,500 feet. Manhole vents shall be located above the 100-year floodplain and have mechanical provisions to prevent inflow.
4. Existing manholes with an opening smaller than 30 inches in diameter being connected to shall have the cone section, ring, and cover replaced to provide a minimum of a 30 inch diameter opening.

E. Miscellaneous

1. On a collector line, drop manholes are required when the inlet pipe flow line elevation is 18 inches or more above the outlet pipe flow line elevation, per the City's Standard Details. Drops shall be outside the manhole unless otherwise approved by the Director of Engineering.
2. When a collector line connects to an interceptor line, a drop manhole shall be utilized if the flow line of the collector line is 18 inches or more above the crown of the interceptor line.
3. A minimum 0.1 foot drop is required through wastewater manholes located on a collector



main.

4. Wastewater mains shall connect to a manhole in the direction of flow with a maximum connection angle of 90 degrees.
5. Both public and private manholes will be required to be vacuum, air and mandrel tested following installation of all connections.

3.7. Wastewater Lift Stations

A. General

1. Any proposed use of a wastewater lift station must be approved by the Director of Engineering.
2. Lift stations shall be designed in accordance with TCEQ Chapter 217, Subchapter C.
3. Design engineer shall submit a signed and sealed design report detailing the basis of lift station design. At a minimum, the design report shall include:
 - a) Flow projections in accordance with these Standards
 - Lift station may be required to be sized to handle off-site flow within the wastewater drainage basin at the direction of the City.
 - b) Hydraulic analysis
 - Pump and system curve
 - Force main sizing
 - Wet well sizing
 - c) Site design assumptions
 - d) Electrical and instrumentation provisions
 - e) Odor control provisions
4. Lift station property shall be located on a dedicated fee simple property to the City. Site area requirements shall be determined on a case-by-case basis by the City.

B. Site Design

1. Site shall be enclosed with a minimum 8-foot steel tube fence with 16-foot manual swing gate for vehicular access. Lift station perimeter fence shall be a minimum of 150 feet from residential lot lines.
2. Site shall have a concrete access drive minimum 6-inches thick, 4,000 psi reinforced concrete pavement. Drive shall be a minimum 15 feet wide with 15 foot turning radius. Alignment of access drive to be coordinated and agreed upon with the City.
3. Access drives shall be “T” shaped with applicable turning radii when located on existing and future thoroughfares and all other locations when pulling out becomes a safety hazard. The alignment of the drive shall allow maintenance vehicles the ability to back up straight to the wet well.
4. Site shall be graded to drain away from the station to prevent storm water inflow or infiltration into the wet well. The wet well top elevation shall be a minimum of 6 inches higher than concrete pavement to provide wheel stop for maintenance vehicles.



5. Provide a 1-inch potable freeze-proof water service with a 1-inch angle stop and double check valve shall be installed in an appropriately sized meter box.
6. Lift stations shall include a landscaping and irrigation plan approved by the City.

C. Pump, Mechanical, and Yard Piping Design

1. Lift station shall be a wet well and dry pit configuration and shall utilize non-clog submersible centrifugal pumps. Design engineer shall design the station to meet peak wet weather flows. Station shall be designed with 1 redundant pump.
2. All wastewater lift stations shall be equipped with a quick connection to the discharge force main and equipped with an on-site generator that is capable of providing power to the lift station for a period no less than two hours or the longest power outage on record for the previous five years.
3. Discharge piping shall be equipped with electromagnetic flow meter and check valves shall be provided on each pump discharge header.
4. Within wet well, all piping shall be stainless steel. All other yard piping and mechanical piping shall be ductile iron with Protecto 401 lining.
5. Lift stations are required to have an odor control system designed by the design engineer.

D. Electrical, Instrumentation and Control

1. All lift stations shall be wired to connect with the City's fiber network, if applicable. If the City's fiber network is not available, the lift station shall be connected to the City Supervisory Control and Data Acquisition (SCADA) system. The Developer shall pay all costs associated with the SCADA including all labor, equipment, materials, and programming of the City's computer and testing. The design engineer shall consult with Building Inspections Department for the latest NEC code requirements. The SCADA equipment installed shall conform to the City's standard specifications for Computerized Monitoring and Control Specifications for Wastewater Lift Stations. At a minimum, instrumentation shall include:
 - a) Wet well levels
 - b) High and low-level alarms
 - c) Intrusion alarms
 - d) Pump information
 - e) Generator information
 - f) Water level sensor information shall utilize a bubbler sensor
2. A 15-foot-high halogen area light with photometric cell on an aluminum pole shall be placed within 10 feet of wet well and control panel without obstructing daily operations.

3.8. Force Mains

A. General

1. Force main design criteria shall meet the minimum requirements from TCEQ Chapter 217



- (Design Criteria for Sewerage Systems).
2. Force main capacity shall be sized to meet the peak hour flows for the proposed development as well as the remainder of the drainage basin that may drain to the lift station.
 - a) The force main may be designed to handle a portion of the basin with the ability to expand for the ultimate basin capacity with the approval from the Director of Engineering.
 3. The minimum force main size shall be 4-inch diameter except for grinder pump lift stations.
 4. The following are allowable force main pipe materials:
 - a) PVC
 - b) HDPE
 - c) Fiberglass
 5. Force mains shall be designed to minimize the required number of air release valves. Air release valves shall be placed at high points along the pipeline. Vent piping shall be provided with odor control.
 6. Force main minimum cover shall meet the requirements stipulated for potable water lines in the City Standard Details.
 7. All force main contractors shall furnish and install non-metallic pipe detector tape. The detector tape must be located above and parallel to the force main and bear the label "PRESSURIZED WASTEWATER" continuously repeated in at least 1-1/2 inch letters.
 8. All visible access points (valves, manholes, etc.) shall have cover/lids labeled "wastewater".
 9. Force main shall transition to gravity prior to discharging into City manhole. If the manhole downstream of the force main connection is existing, it shall be CIPP lined in accordance with these Standards. If the manhole downstream of the force main connection is proposed, it shall be a polymer concrete manhole.
 10. Plans shall include plan and profile for the force main.

B. Thrust Restraint

1. Thrust blocking is required on all pressurized mains and shall be in accordance with the City Standard Details.
2. Thrust restraint for 12-inch and smaller force mains shall be provided using concrete thrust blocks.
3. Thrust restraint for 16-inch and larger force mains shall be provided by both concrete thrust blocks and joint restraint. Joint restraint shall be provided by welded joints.
4. A minimum of one pipe segment shall be restrained on each side adjacent to all fittings.



3.9. Wastewater Flows and Main Sizing

A. Flow Development

1. The table below should be used to calculate the average daily wastewater flow. The collection system shall be designed based on peak flow calculations.
2. For replacement of existing wastewater mains and construction of parallel wastewater mains for additional capacity, wastewater flow data will be provided by from the City's Wastewater Master Plan computer model.

Wastewater Flow Projections

Land Use	Design	Average Daily Wastewater Flows	Peak Wastewater Flows
Apartment	2.0 persons/unit	200 gpd/unit	800 gpd/unit
	100 gallons per person per day		
Residential/ Town Home/Patio Home	3.0 persons/unit	300 gpd/unit	1200 gpd/unit
	100 gallons per person per day		
Hospital (Beds)	200 gallons per day per bed	200 gpd/bed	800 gpd/bed
Nursing Home or Other Institution (Beds)	100 gallons per day per bed	100 gpd/bed	400 gpd/bed
Commercial/ Industrial/Office	1 person per parking space, or	60 gpd/person	240 gpd/person
	1 person per 400 SF of building		
	60 gallons per day/person		

B. Wastewater Peaking Factor

1. Wastewater peaking factor shall be four (4). Peaking factor accounts for inflow and infiltration.

C. Main Sizing

1. Wastewater main sizes shall comply with the Wastewater Master Plan.
2. Wastewater mains shall be sized and extended through the limits of a development to serve adjacent properties.
3. Wastewater mains should not be upsized in order to lay the line at a shallower slope.
4. Wastewater mains with direct connections to service lines shall be designed to be no more than 70% full and interceptors shall be designed to be 100% full.
5. Proposed parallel wastewater mains adjacent to existing wastewater mains shall be sized to eliminate surcharge in the existing lines.
6. Wastewater mains shall be of the City's standard diameter sizes. City standard diameter sizes are as follows:

8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	42"
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7. At the discretion of the Director of Engineering, 6" wastewater mains may be utilized for collector mains that possess low flows.
8. Wastewater mains shall be placed on such a grade that the velocity is not less two feet per second (fps) or more than ten fps at design peak flow. Minimum and maximum wastewater main slopes are shown in the table below:

Minimum and Maximum Grades for Wastewater Mains*

Pipe Diameter (inches)	Minimum Slope (percent)	Maximum Slope (percent)
8	0.335	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.115	2.83
21	0.095	2.30
24	0.08	1.93
27	0.07	1.65
30	0.06	1.43
33	0.055	1.26
36	0.045	1.12
>36	**	**

* The slopes were calculated using Manning's Equation and roughness coefficient of 0.013.

** For pipes larger than 36-inch diameter, the slope can be determined by Manning's formula. Manning's formula is as follows:

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

Where:

V = flow velocity (feet per second)

n = Manning's roughness coefficient (dimensionless)

R = hydraulic radius ($R = A/P$) (feet)

A = flow area (square feet)

P = wetted perimeter (feet)

S = pipe slope (feet per foot)



4. Administrative Items

4.1. City Submittals

A. Engineering

1. An overview of the City's Engineering Department permit review process can be found on the City's website at the following link: <https://www.plano.gov/299/Engineering-Permits>.

B. Planning

1. Submittals to the Planning Department shall meet the requirements of the City's Planning website, found at the following link: <https://www.plano.gov/965/Plan-Plat-Checklists>.
2. The submittal schedule for plan and/or plat review by the Planning and Zoning Commission may be found on the Department website at the following link: <https://www.plano.gov/906/Planning>.

C. City Variance Process

1. Any proposed variances from the requirements of these standards shall be requested in writing at time of submittal and shall include:
 - a) The section in which the applicant is requesting a variance
 - b) Justification for not complying with the Standard
 - c) Alternate criteria being proposed and an explanation for how it will comply with the intent of the City's Standard
 - d) Supporting documentation (calculations, manufacturer information, reference material, etc.) to evaluate the acceptability of the variance request
2. A variance request may be approved at the City's discretion if the City determines that the variance meets the intent of the City's standards. At a minimum, proposed variances shall:
 - a) Not be detrimental to the public welfare
 - b) Not be of lesser quality or adversely impact the infrastructure in question
 - c) Be signed and submitted by a licensed Professional Engineer in the State of Texas
3. Financial hardship shall not be used as grounds for requesting a variance. Additionally, previous variance approvals shall not be considered as a precedent for future variance requests.
4. Variances will be considered on a case-by-case basis.

4.2. TCEQ Submittals

A. General

1. All water and wastewater infrastructure shall be designed in accordance with TCEQ requirements. All construction improvements associated with a public wastewater system shall be reviewed by City staff for compliance with TCEQ requirements.



4.3. North Texas Municipal Water District (NTMWD) Submittals

A. General

1. Proposed water and wastewater mains crossing or connecting to NTMWD infrastructure must have design reviewed and approved by NTMWD.
2. All connections to NTMWD infrastructure shall meet the requirements of NTMWD's "Request for Wastewater Connections and Point of Entry Protocol".
3. All water and wastewater main crossings of NTMWD infrastructure shall meet the requirements of NTMWD's "Pipeline Crossing Application".

4.4. Drafting Standards

A. General

1. Plans submitted to the City shall be:
 - a) Clear and legible
 - b) Sheet size of 22" x 34" (so that 50% scale can be utilized at 11" x 17")
 - c) Signed and sealed (preliminary or final) by a licensed Professional Engineer in the State of Texas
 - d) Provided with a title block containing the following:
 - e) Project Name
 - f) Design engineer's Name, Address and Telephone Number
 - g) Firm's registration number
 - h) City's project number
 - i) North Arrow pointing up or to the left
 - j) Of a horizontal scale as follows: 1"=20', 1"=30' or 1"=40'
 - k) Of a vertical scale at 5:1 horizontal to vertical exaggeration maximum, unless topography doesn't allow.
 - l) Generated directly from computer-aided design software and shall be vectorized (snappable). Rasterized images will not be allowed.
2. Plans submitted to the City shall have:
 - a) Sizes shown for all lines
 - b) All lines numbered or lettered on both plan and profile sheets
 - c) Flow direction arrows, where applicable
 - d) Match lines located such that sheets cuts are not located near or at roadway intersections or at fittings along the alignment
 - e) All existing and proposed infrastructure shown
 - f) Black and grayscale lines, colored lines will not be allowed
 - g) Appropriate lineweight and shading showing bold for proposed infrastructure and lighter weighting for existing infrastructure
 - h) Stationing for each alignment starting at 0+00 and shown to the nearest 0.01'
 - i) Callouts in plan view identifying critical design elements. Keynote legends with



numbers referring to a reference table will not be allowed.

j) The meter schedule shall be shown on the site plan and utility plan sheets

k) Station callouts for the following:

- Manholes
- Points of Curvature
- Points of Tangency
- Points of Intersection
- Bends
- Wyes
- Cleanouts

3. Elevation callouts for the following:

- Manhole inverts
- Vertical points of Curvature
- Vertical points of Tangency
- Vertical points of Intersection
- Vertical bends

4.5. Pro-Rata Requirements

A. General

City-required improvements may be subject to Pro-Rata requirements and standards. Pro-Rata requirements shall be per Chapter 21, Article V of the City's Municipal Code and in accordance with Section 6.4 of the City's Subdivision Ordinance. Pro-Rata agreements shall be approved and in place before any corresponding project plans are approved.