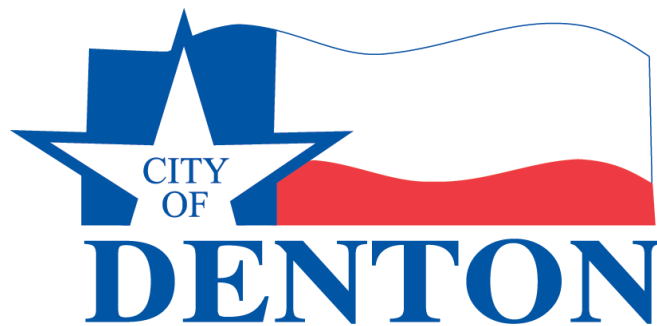


City of Denton

Water and Wastewater Criteria Manual



ADOPTED BY COUNCIL ORD. No. 2018-###

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Section 1 – Introduction

1.1 Purpose

The purpose of this Manual is to provide minimum guidelines for the design and construction of water distribution and wastewater collection systems within the City of Denton, Texas and its extra-territorial jurisdictions. The criteria established in this Manual have been developed from a review of various applicable publications, North Central Texas Council of Government (NCTCOG) Public Works Construction Standards (as amended by the City of Denton), regulatory requirements, and City of Denton offices which oversee the design, construction and maintenance of the water distribution and wastewater collection systems.

These guidelines are to be used by design engineers in the City of Denton Capital Projects Engineering Division, consulting engineers employed by the City, and engineers of subdivision and land development infrastructure projects proposed for construction and acceptance by the City within the City, within its extra-territorial jurisdictions and within its Certificate of Convenience and Necessity (CCN) area. The criteria established in this Design Manual provide basic guidance. However, full responsibility and liability for proper design remains with the design engineer. Users of this Manual should be knowledgeable and experienced in the theory and application of water and wastewater engineering. Alternative designs may be submitted for consideration. However, alternative designs will require additional time to evaluate, and the Director of Water Utilities or the Director of Wastewater Utilities, as applicable, must approve any deviations from criteria established in this Manual.

Along with this Manual, the Denton Development Code (DDC) should be consulted for additional criteria. The criteria established in this Manual do not supersede the criteria contained in the DDC. In the case of conflict among this Manual, NCTCOG Public Works Construction Standards as amended by the City of Denton (City of Denton PW Construction Standards), City of Denton Standard Details, or other cited regulations and standards, the more stringent requirement shall apply.

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Section 2 – Preliminary Design (Applicable Only to City Projects)

NOTE: This Section is applicable only to design for City administered projects; not development projects. However, this Section includes information development design engineers may find useful to ensure appropriate coordination for their development projects.

2.1 *General*

The success of any project can be attributed to the thoroughness of the initial investigations undertaken by the design engineer. This section describes the general steps that are essential when beginning a project to develop the vision required for preparing the final engineering plans and specifications.

2.2 *Project Folder*

The design engineer shall create and maintain an electronic project folder and appropriate subfolders in the current electronic document system for each project. The folder and subfolders shall contain all pertinent correspondence including, but not limited to the following items:

- A. Assignment memo for the project, if applicable.
- B. Copies of memos from other City Offices.
- C. Correspondence to and from the private sector, e.g., consulting engineers, developers, etc.
- D. Correspondence to and from other utilities, e.g., gas, electric, cable, telephone, etc.
- E. Engineering calculations used to determine the size of pipe, alignment, cost, etc. of the project.
- F. Notes to file concerning conversations with citizens, consultants, etc.

2.3 *Internal Coordination*

Internal coordination among departments within the City is necessary to prevent duplication of efforts, avoid conflicts and to inform other sections of activity in the project area. The internal coordination process shall be accomplished and documented via email.

The design engineer shall contact the following:

- Director of Capital Projects
- Executive Manager of Energy Delivery, DME
- Director of Water Utilities

- Director of Wastewater Utilities
- Director of Parks and Recreation
- City Engineer
- Manager of Streets and Traffic
- Manager of Drainage
- Manager of Engineering Development Review

Indicate that a water or wastewater project is planned for a specific area and request they identify, within 7 calendar days, any activities currently underway or planned by their Operation that might conflict with the proposed project; negative responses are to be requested to ensure proper coordination.

The email communication shall include a Concept Plan Fact Sheet with:

- Brief description of the project,
- Planned schedule,
- Approximate cost,
- Map highlighting the general area or location of the project, and
- General layout of the project with pipe sizes and direction of flow for wastewater.

2.4 Record Research

A thorough search for and review of existing records is required for all design projects. These include water and wastewater construction plans, record drawing information and online GIS interactive utility maps. Verification of main location and/or depth may be obtained by field trips by the design engineer and/or a qualified Subsurface Utility Engineering (SUE) firm. The design engineer should visit all sites of proposed construction prior to and during design.

2.5 Utility Coordination

The design engineer shall initiate the utility coordination process prior to survey or design. Subsurface Utility Engineering (SUE) firms should be considered for all projects. Level "A" SUE locations may be required by the City depending on the nature of the project and the magnitude of existing utility congestion along the project route.

- A. The design engineer will furnish for submittal to the utilities a description of the proposed project and the project location maps, highlighting in blue (for water) and green (for wastewater) the proposed route or location of the project. The following utility companies, along with any others operating within the area of the planned project, are to be contacted:
1. AT&T
 2. Atmos Energy
 3. Spectrum
 4. CoServ Gas & Electric
 5. Frontier Communications
 6. Grande Communications

7. Oncor Electric
8. Texas 811

The Public Works Inspection ROW Inspector should also be contacted to determine if other utilities should be contacted and if the City has any pending permits for work in the area of the planned project.

If the design engineer is in need of a specific location of a facility, a field determination shall be coordinated with the specific utility company. The requesting party shall be responsible for any excavation required to locate existing facilities, unless the owner of the existing facility desires to make the excavation, or as governed by the existing franchise law. In any case, the owner of the utility shall be contacted prior to excavation and shall be afforded the opportunity to have a representative on-site to ensure protection of the owner's interests.

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Section 3 – Water Design Guidelines

3.1 General

It is the responsibility of the design engineer to ensure the final design of a water main is in conformance with the most recent versions of the following documents:

- A. Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) – Rules, Ch. 290, “Public Drinking Water”
- B. Denton Development Code (DDC)
- C. This Manual and the City’s Standard Details
- D. North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction (“COG Specs.”), as amended by the City of Denton
- E. City of Denton Water Master Plan
- F. Appendix B of the 2012 International Fire Code
- G. American Water Works Association (AWWA) Standards

3.2 Water Main Separation from Wastewater Mains

Water mains shall be separated from wastewater mains as set forth in Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) [Rules - 30 TAC §290.44.e. Location of waterlines](#) and amended herein by the City of Denton (see also Section 4.3 of this Manual, where those requirements are listed).

NOTE: The City of Denton does not allow the use of cast iron for water or wastewater piping.

3.3 Size of Water Distribution Mains

Water mains shall be sized according to the City of Denton’s Water Distribution System Master Plan (Master Water Plan). Design engineers shall contact the City of Denton Water Utility to obtain the latest version of the water distribution system model and determine the size of water main required. For all residential, commercial, industrial, and any other development connecting to the City’s water distribution system, the following guidelines shall be used:

- A. The design engineer shall obtain the record drawing water maps from the Capital Projects Engineering Division and use the following criteria, based on the City’s Master Water Plan, for sizing the water lines.
 - Average daily demand in gallons per capita per day = 180 GPCD
 - Maximum daily demand / Average daily demand = 2.2
 - Peak hour demand / Maximum daily demand = 1.7
 - For Single-Family Residential – Use 3.2 people/unit
 - For Multi-Family Residential – Use 2.5 people/unit

- B. Water systems shall be provided with a sufficient number of connections to the City's existing water system and shall be of sufficient size to furnish adequate water supply to furnish fire protection to all lots and conform to the City Master Water Plan. Every new water system shall include two or more connections to the existing City water system, when feasible, to ensure an adequate and reliable water supply in the event of a water main break or routine system maintenance. The City may require two or more connections, particularly for larger developments. Good engineering judgement is required to ensure reliability is considered in design of all proposed water systems.

The City's standardized water service line sizes are:

Table 3.3-1

Service Size	Meter Size
1 in.	5/8 in. x 3/4 in., full 3/4 in., and 1 in.
2 in.	1-1/2 in. and 2 in.
4 in.	3 in. and 4 in.
6 in.	6 in.
8 in.	8 in.

Non-standard sized water services are not allowed. Refer to the water service connection drawings on the City Standard Details.

- C. Water pipe shall be a minimum of 8 in. diameter. The standard pipe sizes that shall be used for water main lines are 8", 12", 16", 20", 24", 30", 36" and 42". Pipe sizes of 6", 10", 14", 18", 21", and 33" are considered non-standard by the City and shall not be used for water main lines. Six (6) in. pipe may be used for fire hydrant connections and, with approval of the Director of Water Utilities, for short dead-end mains with a limited number of service connections.
- D. Every development shall provide adequate water capacity for fire protection purposes. Fire flow capacity requirements are in addition to daily demand requirements. The procedure for determining fire flow requirements for buildings or portions of buildings shall be in accordance with Appendix B of the 2012 International Fire Code. For any platted lot where the end use is not defined, the following standards shall apply:

Table 3.3-2

Area	GPM
One and two family dwellings less than 3,600 SF	1,000
Buildings other than one and two family dwellings less than 3,600 SF	1,500
Medium-intensity commercial and light industrial	3,000
High-intensity commercial and industrial	4,000

All fire flows to be calculated with twenty (20) pounds residual pressures.

In addition to the fire flow requirements specified above, all developments shall provide adequate water capacity to satisfy the greater of (1) Peak Hour demand for the Peak Day or (2) Average Hour demand plus fire flow for the Peak Day.

Mains are to be sized to ensure less than 1 foot of head loss per 1,000 feet of water main at Hazen Williams coefficients of $C = 100$, except for fire flow demands within the subdivision internal distribution system.

Special exceptions to the above standards may be made by the Director of Water Utilities for unique situations.

3.3.1 Public Fire Hydrants

Fire flow requirements shall be in accordance with Ch. 29 of the City of Denton Code of Ordinances and Appendix B of the 2012 International Fire Code.

3.3.2 Private Fire Mains

In addition to the requirements of 3.3.1, private fire protection water mains shall be installed in accordance with NFPA 24 and 2012 International Fire Code requirements. Private fire protection mains shall be permitted by the Fire Marshall's Office.

3.3.3 Fire Flow Tests

Fire flow tests are normally requested by the design engineer, the MEP engineer, and other engineers to determine available water system capacity at or near the point of interest. If a fire flow test on the existing water system is necessary, contact the Water Utilities Department directly.

3.4 Depth of Cover for Water Mains

The following guidelines apply to water main installations in public rights-of-way, easements, or unimproved areas without permanent paving surfaces with base (such as asphalt streets without permanent base, gravel or unimproved streets, or streets without curb and gutters):

Table 3.4-1

Pipe Size	Minimum Depth of cover to top of pipe
12" and smaller	5'
16" and larger	6'

For water main installation in proposed or existing permanent pavement (such as improved streets with curb and gutter), the following guidelines apply:

Table 3.4-2

Pipe Size	Minimum Depth of cover to top of pipe
12" and smaller	42"
16"	5'
20" and larger	6'

Additional depth of cover may be required for low lying areas where future drainage improvements are anticipated.

3.5 Pipe and Fittings

Specifying the appropriate pipe material is the responsibility of the design engineer, based on the analysis of specific site and loading conditions and pressure requirements. The minimum requirements in this Section are based on pipe size only and in no way relieve the design engineer of the responsibility of specifying the pipe material applicable to the particular project. Pipe gasket material shall be that recommended by the manufacturer for the specified pipe. Special attention shall be given by the design engineer for unique pipe fitting and pipe assembly situations.

See Table 3.5-1 for the City's minimum pipe materials, fittings, polywrap, thrust restraint, and embedment requirements, as a function of pipe size.

All fittings, including vertical and horizontal bends, shall have concrete thrust blocking. See Drawings W700N, W701, W702A, W702B, W702C, and W703 on Sheet 3 of the City Standard Details.

For water pipe lines 16 in. - 30 in., all fittings, including vertical and horizontal bends, shall have restrained joints, designed independently of concrete thrust blocking. For each particular fitting, the restrained joints may need to be installed beyond the fitting (i.e., may need to be installed on several pipe joints on each side of the fitting), depending on the required restrained length calculated. Restrained length calculations shall be included in the lay schedule in the material submittal package and shall use approved methods of joint restraint. See City Standard Details, specific product listings and Table 3.5-1.

3.6 Meters and Meter Cans/Vaults

The City allows the following water meters, depending on the volume and nature of the customer flow demands:

Table 3.6-1

Meter Size	Type	Manufacturer
5/8" x 3/4"	Positive Displacement	Neptune/Badger
3/4" x 3/4"	Positive Displacement	Neptune/Badger
1"	Positive Displacement	Neptune/Badger
1-1/2"	Positive Displacement	Neptune/Badger
2"	Positive Displacement	Neptune/Badger
Spectrum 175 (3")	Venturi Inlet (Single Jet	Metron-Farnier
Spectrum 500D (3" or 4")	Venturi Inlet (Single Jet	Metron-Farnier
3" Tru/Flo	Compound	Neptune/Badger
4" Tru/Flo	Compound	Neptune Badger
6" Tru/Flo	Compound	Neptune/Badger
6" Protectus III Fire Service	Compound	Neptune/Badger
8" Protectus III Fire Service	Compound	Neptune/Badger

Turbine meters are only allowed for irrigation meters; not for domestic meters.

Venturi meters are only allowed on a case-by-case basis, when recommended by City Water Utilities.

Vaults are required for all meters greater than 2 in.

See Section 3.6.3 for Furnishing and Installing meters.

**Table 3.5-1
Minimum Requirements for Pipe and Fittings**

Pipe Size	Pipe Material	Ductile Iron Fittings	Polywrap (Pipe & Fittings)	Thrust Restraint (IN ADDITION TO AND DESIGNED INDEPENDENTLY OF THRUST BLOCKING)	Embedment
8 in. - 12 in.	PVC (AWWA C900, DR-14)	Mechanical joint; Compact or Full-Body	8-mil V-Bio Enhanced Polywrap (fitting only)	Wedge-action mechanical joint restraint glands, at fittings.	See drawings U201, U202, U203A, U203C in City Standard Details
16 in. - 20 in.	Ductile Iron, AWWA C151, Special Thickness Class 52, push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	See drawings U201, U202, U203A, U203C in City Standard Details
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint	Contact Water Utilities Dept.
24 in.	Ductile Iron, AWWA C151, Special Thickness Class 52, push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	Crushed Stone
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint.	Contact Water Utilities Dept.
30 in. and larger	Ductile Iron, Pressure Class 350; push-on joints (where unrestrained; example: American Flex-Ring joint)	Mechanical joint; Full-Body	8-mil V-Bio Enhanced Polywrap (inner layer), plus 4-mil cross-linked (outer layer)	Wedge-action mechanical joint restraint glands, at fittings. Boltless Restrained connections (Example: American Flex-Ring joint), at several pipe joints either side of each fitting, depending on the required restrained length calculated.	Crushed Stone
	Reinforced Concrete Steel Cylinder, AWWA C303 Bar Wrapped	N/A	Bonded joint and Cathodic Protection (CP) System required	Full Circle Welded Joints required for thrust restraint.	Contact Water Utilities Dept.

3.6.1 Sizing

In commercial and industrial projects, the design engineer shall consult with the owner or the Mechanical, Electrical and Plumbing (MEP) engineer to identify proposed sizes and locations for domestic water meters, fire sprinkler connections and irrigation meters.

During Building Permit review, the City evaluates adequacy of meter size using Table E201.1, "Minimum Size of Water Meters, Mains and Distribution Piping Based on Water Supply Fixture Unit Values (w.s.f.u.)" of the 2012 International Plumbing Code (copy included herein as Table 3.6.1-1). The City's Building Permit Plans Review uses the 2012 International Residential Code, Table P2903.6, "Water-Supply Fixture-Unit Values for Various Plumbing Fixture and Fixture Groups" (see Table 3.6.1-2) to estimate water supply fixture units (w.s.f.u.). To facilitate review of the proposed meter size, the design engineer shall submit a tabulation of water supply fixture units (w.s.f.u.); a sample tabulation is provided herein in Table 3.6.1-3.

Contact the Water Utilities Dept. regarding criteria for sizing fire-rated master meters.

When sizing water meters, the design engineer should be aware that, per City Code, water and wastewater Impact Fees are based on water meter size, with the following exceptions:

- A. For multifamily developments of 8 or more units, Impact Fees are based on bedroom count.
- B. For fire-rated master meters, Impact Fees are based on the equivalent meter size the City would require for domestic demands (except for multifamily developments of 8 or more units, in which case Impact Fees are based on bedroom counts).

Refer to Table 3.6.1-4, "Land Use and Service Unit/SFE Equivalencies." Impact Fees are based on Single Family Equivalent (SFE's). For example, Impact Fees for a 1-1/2" meter would be twice those for a 1" meter.

TABLE 3.6.1-1

**2012 International Plumbing Code - TABLE E201.1
MINIMUM SIZE OF WATER METERS, MAINS AND DISTRIBUTION PIPING
BASED ON WATER SUPPLY FIXTURE UNIT VALUES (w.s.f.u.)**

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
		Pressure Range 30 to 39 psi		40	60	80	100	150	200	250	300
3/4	1/2a	2.5	2	1.5	1.5	1	1	0.5	0.5	0	0
3/4	3/4	9.5	7.5	6	5.5	4	3.5	3	2.5	2	1.5
3/4	1	32	25	20	16.5	11	9	7.8	6.5	5.5	4.5
1	1	32	32	27	21	13.5	10	8	7	5.5	5
3/4	1-1/4	32	32	32	32	30	24	20	17	13	10.5
1	1-1/4	80	80	70	61	45	34	27	22	16	12
1-1/2	1-1/4	80	80	80	75	54	40	31	25	17.5	13
1	1-1/2	87	87	87	87	84	73	64	56	45	36
1-1/2	1-1/2	151	151	151	151	117	92	79	69	54	43
2	1-1/2	151	151	151	151	128	99	83	72	56	45
1	2	87	87	87	87	87	87	87	87	87	86
1-1/2	2	275	275	275	275	258	223	196	174	144	122
2	2	365	365	365	365	318	266	229	201	160	134
2	2-1/2	533	533	533	533	533	495	448	409	353	311

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.1-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
		Pressure Range 40 to 49 psi									
		40	60	80	100	150	200	250	300	400	500
3/4	1/2a	3	2.5	2	1.5	1.5	1	1	0.5	0.5	0.5
3/4	3/4	9.5	9.5	8.5	7	5.5	4.5	3.5	3	2.5	2
3/4	1	32	32	32	26	18	13.5	10.5	9	7.5	6
1	1	32	32	32	32	21	15	11.5	9.5	7.5	6.5
3/4	1-1/4	32	32	32	32	32	32	32	27	21	16.5
1	1-1/4	80	80	80	80	65	52	42	35	26	20
1-1/2	1-1/4	80	80	80	80	75	59	48	39	28	21
1	1-1/2	87	87	87	87	87	87	87	78	65	55
1-1/2	1-1/2	151	151	151	151	151	130	109	93	75	63
2	1-1/2	151	151	151	151	151	139	115	98	77	64
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	264	238	198	169
2	2	365	365	365	365	365	349	304	270	220	185
2	2-1/2	533	533	533	533	533	533	533	528	456	403

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.1-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
		Pressure Range 50 to 60 psi		40	60	80	100	150	200	250	300
3/4	1/2a	3	3	2.5	2	1.5	1	1	1	0.5	0.5
3/4	3/4	9.5	9.5	9.5	8.5	6.5	5	4.5	4	3	2.5
3/4	1	32	32	32	32	25	18.5	14.5	12	9.5	8
1	1	32	32	32	32	30	22	16.5	13	10	8
3/4	1-1/4	32	32	32	32	32	32	32	32	29	24
1	1-1/4	80	80	80	80	80	68	57	48	35	28
1-1/2	1-1/4	80	80	80	80	80	75	63	53	39	29
1	1-1/2	87	87	87	87	87	87	87	87	82	70
1-1/2	1-1/2	151	151	151	151	151	151	139	120	94	79
2	1-1/2	151	151	151	151	151	151	146	126	97	81
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	275	275	247	213
2	2	365	365	365	365	365	365	365	329	272	232
2	2-1/2	533	533	533	533	533	533	533	533	533	486

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.1-1 (continued)

METER AND SERVICE PIPE (inches)	DISTRIBUTION PIPE (inches)	MAXIMUM DEVELOPMENT LENGTH (feet)									
		Pressure Range Over 60	40	60	80	100	150	200	250	300	400
3/4	1/2a	3	3	3	2.5	2	1.5	1.5	1	1	0.5
3/4	3/4	9.5	9.5	9.5	9.5	7.5	6	5	4.5	3.5	3
3/4	1	32	32	32	32	32	24	19.5	15.5	11.5	9.5
1	1	32	32	32	32	32	28	28	17	12	9.5
3/4	1-1/4	32	32	32	32	32	32	32	32	32	30
1	1-1/4	80	80	80	80	80	80	69	60	46	36
1-1/2	1-1/4	80	80	80	80	80	80	76	65	50	38
1	1-1/2	87	87	87	87	87	87	87	87	87	84
1-1/2	1-1/2	151	151	151	151	151	151	151	144	114	94
2	1-1/2	151	151	151	151	151	151	151	151	118	97
1	2	87	87	87	87	87	87	87	87	87	87
1-1/2	2	275	275	275	275	275	275	275	275	275	252
2	2	365	368	368	368	368	368	368	368	318	273
2	2-1/2	533	533	533	533	533	533	533	533	533	533

Note a: Minimum size for building supply is 3/4-inch pipe.

TABLE 3.6.1-2**2012 International Residential Code****P2903.6 Determining Water-Supply Fixture Units**

Supply loads in the building water-distribution system shall be determined by total load on the pipe being sized, in terms of water-supply fixture units (w.s.f.u.), as shown in Table P2903.6, and gallon per minute (gpm) flow rates [see Table P2903.6(1)]. For fixtures not listed, choose a w.s.f.u. value of a fixture with similar flow characteristics.

TABLE P2903.6**WATER-SUPPLY FIXTURE-UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS**

TYPE OF FIXTURES OR GROUP OF FIXTURES	WATER-SUPPLY FIXTURE-UNIT VALUE (w.s.f.u.)		
	Hot	Cold	Combined
Bathtub (with/without overhead shower head)	1.0	1.0	1.4
Clothes washer	1.0	1.0	1.4
Dishwasher	1.4	—	1.4
Full-bath group with bathtub (with/without shower head) or shower stall	1.5	2.7	3.6
Half-bath group (water closet and lavatory)	0.5	2.5	2.6
Hose bibb (sillcock) ^a	—	2.5	2.5
Kitchen group (dishwasher and sink with/without garbage grinder)	1.9	1.0	2.5
Kitchen sink	1.0	1.0	1.4
Laundry group (clothes washer standpipe and laundry tub)	1.8	1.8	2.5
Laundry tub	1.0	1.0	1.4
Lavatory	0.5	0.5	0.7
Shower stall	1.0	1.0	1.4
Water closet (tank type)	—	2.2	2.2

For SI: 1 gallon per minute = 3.785 L/m.

- a. The fixture unit value 2.5 assumes a flow demand of 2.5 gpm, such as for an individual lawn sprinkler device. If a hose bibb/sill cock will be required to furnish a greater flow, the equivalent fixture-unit value may be obtained from this table or Table P2903.6(1).

Table 3.6.1-3

SAMPLE W.S.F.U. TABULATION			
Quantity	Fixture	Load Values, in Total Water Supply Fixture Units (Each)	Total Fixture Units
9	Water Closet (Public; Flush Valve)	10.0	90
3	Water Closet (Public; Flush Tank)	5.0	15
5	Urinal (Public; 3/4-inch Flush Valve)	5.0	25
10	Lavatory (Public)	2.0	20
2	Kitchen Sink (Hotel, Restaurant)	4.0	8
1	Service Sink	3.0	3
1	Shower Head (Private)	1.4	1.4
		Total	162.4

Table 3.6.1-4

EXHIBIT F LAND USE AND SERVICE UNIT/SFE EQUIVALENCIES WATER AND WASTEWATER FACILITIES From Section 26-218 of City of Denton Code of Ordinances			
Meter Type	Meter Size	Typical Land Use	Single Family Equivalents (SFEs)
Positive Displacement	5/8" X 3/4"	Residential - Single Family (Building less than 1,300 sq. ft./ lot size less than 6,000 sq. ft.)	0.5
Positive Displacement	5/8" X 3/4"	Residential - Single Family	1.0
Positive Displacement	3/4" X 3/4"	Residential / Commercial	1.5
Positive Displacement	1"	Residential / Commercial	2.5
Positive Displacement	1-1/2"	Commercial	5.0
Positive Displacement	2"	Commercial	8.0
Single Jet	3" Metron Spectrum 175	Commercial / Industrial	17.5
Compound	3"	Commercial / Industrial	22.5
Single Jet	3" or 4" Metron Spectrum 500D	Commercial / Industrial	35.0
Compound	4"	Commercial / Industrial	50.0
Source: City of Denton Approved Meter Manufacturer's Specifications			
NOTE: The total service units for multi-family apartment projects with eight or more units shall be determined by multiplying the total number of bedrooms in the multi-family apartment project by 0.26 Single Family Equivalents (SFEs).			

3.6.2 Location

Water meters and meter cans and vaults shall be placed within a City Right-of-Way, Public Utility Easement or Public Water Easement. Placement shall also satisfy the following requirements:

- A. Located as close as possible to the public water main.
- B. Easily accessible to City of Denton employees.
- C. Located in an unpaved area that does not conflict with vehicular or pedestrian traffic.

3.6.3 Furnishing and Installing

All meters 2" and smaller shall be furnished and installed by City Water Utilities for fees per current Fee Schedule. All meter assemblies 3" and larger and their associated vaults shall be furnished and installed by Contractor at their expense and inspected by Public Works Inspection or City water Utilities.

3.6.4 Details

Details of the meter can assemblies for meter sizes 2" and smaller are shown in Drawings W501A, W501B, W501C, and W502 on Sheet 2 of the City Standard Details.

Details of the meter vault assemblies for meter sizes 3" and larger are shown in Drawings W100, W101, W102, and W103 on Sheet 1 of the City Standard Details.

3.7 *Water Main Horizontal and Vertical Alignment*

The following guidelines should be followed by the design engineer in placement of water lines:

- A. In existing streets, water lines shall be placed in the pavement 2 feet inside of the curb and gutter line intersection. For new residential development, water lines shall be placed on the north and east sides of the streets, where possible, 2 feet inside of the curb and gutter line intersection. See Drawing U101 on Sheet 7 of the City Standard Details. For commercial and industrial development, water mains shall be placed outside of pavement areas.
- B. All water lines shall be laid as straight as possible. Avoid excessive number of high points and low points between cross street connections, as they trap air pockets. See Section 3.15.2 for placement of air release valves.
- C. Minimum radius of curve and maximum deflection angle of pipe joints will be restricted to 80% of manufacturer's recommendation, after which the use of horizontal or vertical bends will be required.
- D. Vertical bends shall be no greater than 45 degrees.
- E. Except for pipe crossings, no other utility shall be installed over, under or within 5 ft. horizontally of a water line.

- F. Provide at least 2 feet of vertical separation between a water line and any utility or stormdrain crossing it.

3.8 Highway Crossings

The design engineer shall, prior to the design of any highway crossing, contact the appropriate regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent than those of any applicable agency, the City's standards shall apply.

3.8.1 State Highway Alignment Criteria

Refer to Section 4.12.1.

3.9 Railroad Crossings

The design engineer shall, prior to the design of any railroad crossing, contact the appropriate railroad company and regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent than those of the Railroad Company or regulatory agency, the City's standards shall apply. See Section 6.4.A for processing of railroad permits.

3.10 Creek Crossings

Where water mains are laid under any flowing stream or semi-permanent body of water, such as a marsh or pond, the water main shall be installed in a separate watertight encasement pipe, with valves on each side of the crossing to allow the isolation and testing of that portion of the water main to determine if there are any leaks and to facilitate future repairs.

A primary consideration in the design of creek crossings is the prevention of soil erosion in the areas of trench backfill. The design engineer shall determine the need and limits of any special embedment and determine and specify the limits for specialized backfills.

3.11 Tunneling, Boring, Jacking and Casing

Tunneling, boring, jacking and Casing are methods used for water line placement under restrictive conditions when open-cut construction is not allowed. Only straight pipe alignments for both horizontal and vertical alignment are allowed.

Design engineers should consider the location, size and depth of boring and receiving pits when choosing the beginning and ending stations for boring. A typical bore pit is over 20 ft. in length to accommodate one joint of pipe. Width of the bore pit can vary depending on the depth and size of pipe, with the narrowest width being approximately 5 ft. The preferred location for the bore pit is the lower elevation end of the bore; allowing any groundwater and/or boring slurry to drain from the tunnel into the bore pit. The water can then be removed by pumping.

Steel casing pipe, where required for open-cut or other than open cut installation shall have an inside diameter (ID) large enough to accommodate a carrier pipe of at least two (2) to three (3) standard sizes above the pipe being installed and shall meet the minimum ID listed in Table 3.11-1. The casing pipe wall thickness design shall be based on the requirements of the agency whose facility is being crossed and shall conform to the minimum criteria listed in Table 3.11-1. Casing pipe shall be provided with interior and exterior coal-tar protective coating in accordance with AWWA C203. Field welds shall be coated with an equivalent coating.

Table 3.11-1

Nominal Carrier Pipe Size	Minimum Casing Pipe ID	Minimum Casing Pipe Wall Thickness
8 in.	12 in.	3/8 in.
12 in.	20 in.	1/2 in.
16 in.	24 in.	1/2 in.
20 in.	30 in.	1/2 in.
24 in.	36 in.	5/8 in.
30 in.	42 in.	5/8 in.
>30 in.	a	b

- a. Consult with Water Utilities Department
- b. Project specific design, sealed and signed by a Professional Engineer licensed by the State of Texas

Carrier pipes may be PVC with external harness restrained joints (requires larger casing than for pipe alone) or ductile iron with restrained joints. All carrier pipes shall be installed in accordance with the pipe manufacturer's recommendations, properly restrained and supported with approved spacers and casing end seals. Use of Fast Grip Gaskets is not allowed for pipe joint restraint. Pipe joint restraint shall be achieved using approved pipe manufacturer restrained joint systems or approved external harnesses. Refer to Standard Detail U208A.

3.12 Elevated Crossings

Two acceptable methods of elevated crossings for consideration by the design engineer are 1) hanging the water main on a roadway bridge or 2) designing a specific utility bridge for the support of the water main crossing. The following basic criteria must be addressed by the design engineer for all elevated crossings:

- A. Provisions for thrust restraints at the points of transition from a buried conduit to an elevated conduit and for all elevated changes of alignments and fittings.
- B. Increased loading effects on the bridge created by a full main and its supports.
- C. Access to main for maintenance purposes.
- D. Coatings or methods of corrosion control for elevated pipe sections and pipe supports.

- E. PVC pipe is not to be used for any exposed sections of elevated crossing, due to deterioration caused by the ultraviolet rays present in direct sunlight.
- F. Evaluate and address the freeze potential of small diameter or low flow mains.
- G. Each joint of pipe is to have two support straps, to ensure positive restraint in all directions. Spacing of pipe supports is to be in accordance with the length of pipe joints specified; one of the supports should be placed near the bell end of the pipe.
- H. Air relief provisions are required where high points are created in the main. See Section 3.15.2.
- I. A minimum of one expansion joint fitting is recommended for a water main crossing on a roadway bridge. Expansion joint locations should coincide with the expansion joints of the road way bridge.
- J. Valves should be placed on each side of the crossing to facilitate pressure testing of the crossing and future repairs.

3.12.1 Specific Utility Bridge

In addition to the guidelines for all elevated crossings, the following criteria must be addressed for the designs of specific utility bridges for elevated crossings:

- A. Height required for specific crossing types (Example: 2 ft. above 100 year flood elevation for creeks).
- B. Required length of spans and spacing of bridge piers to clear desired physical crossing.
- C. Soil conditions affecting design of the piers.
- D. Lateral loadings created by winds or flowing water.
- E. Potential hazards of facility to the general public, both pedestrian and vehicular.

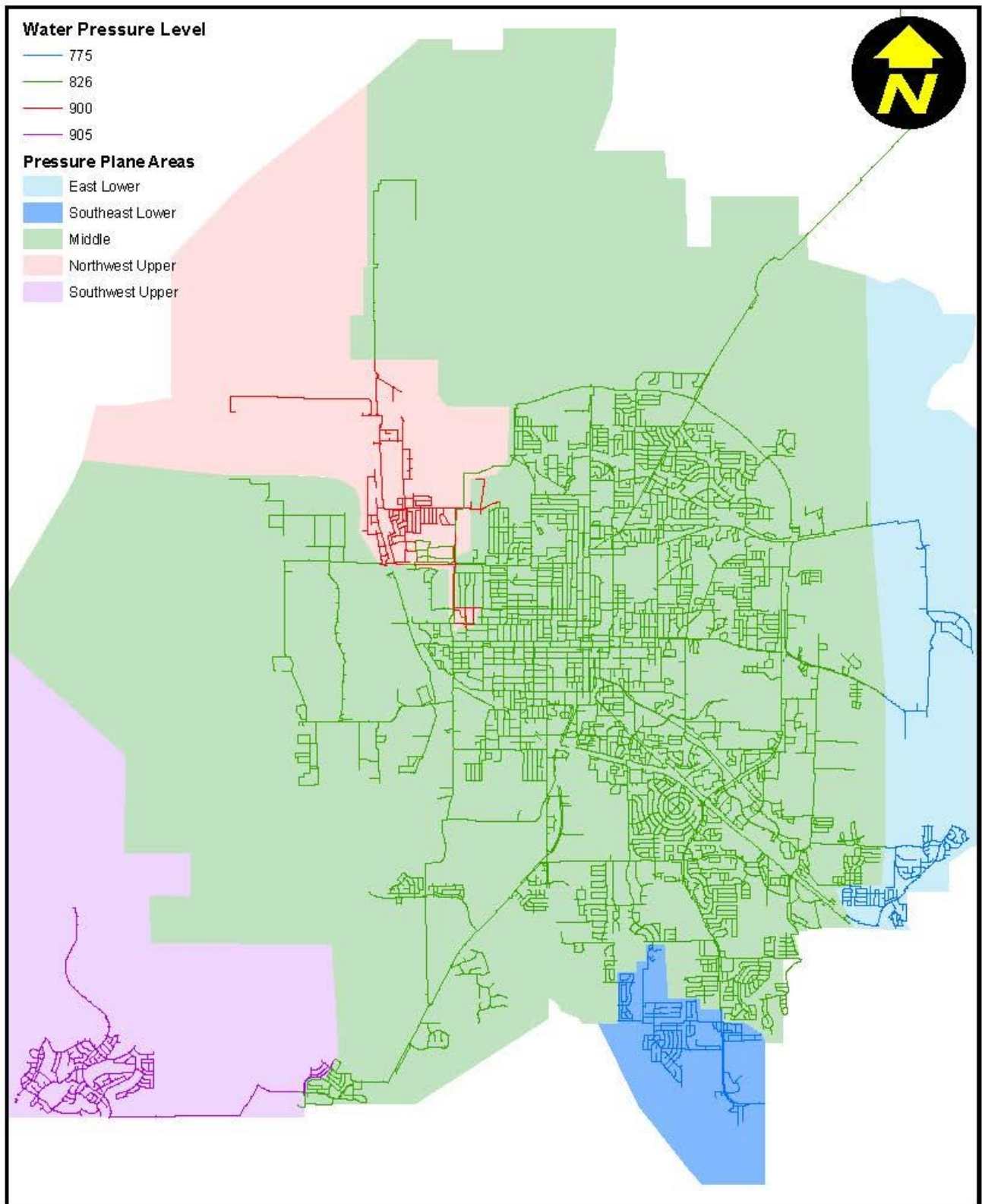
3.13 Existing Water Main Replacement

To replace an existing main, the new main should be designed parallel to and two (2) to three (3) ft. away from the main being replaced and at least five (5) ft. away from existing curbing to avoid damaging the curbing during installation of the proposed main, where appropriate and feasible. The design engineer shall perform field investigations to determine pavement condition over the existing main. The pavement may have been patched due to breaks in the existing main over the years. Based on field investigations, the design engineer shall include additional quantities for pavement replacement, if necessary.

3.14 Methods of Connection

3.14.1 Pressure Zones

The City of Denton's Water Distribution System is divided into several water pressure zones to ensure even water pressure gradients. Prior to the design of connection points between a proposed main and any existing main, the design engineer shall investigate and determine if the proposed water main crosses the boundary between different pressure zones. Even though physical connections of water pipes exist between pressure zones, they are designed with valves which are closed at the boundary points so that each pressure zone is isolated. Proposed mains that approach pressure zone boundaries should be designed to loop within their designated pressure zones and with no or minimum lengths of dead-end mains. Connections between pressure zones may require pressure reducing valve stations. The design engineer can determine the pressure zone boundaries by consulting the record drawing water maps which show the designated closed valves between pressure zones and by contacting the Capital Projects Engineering Division. See Figure 3.14.1-1 for a Pressure Zone Map.



3.14.2 Tapping Sleeve and Valve

Tapping sleeves with tapping valves should be used whenever possible for connections to existing mains in order to avoid interruption of water services. See Figure 3.1 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.

- A. Size on size taps are allowed up to 12.”
(Example: 12” X 12”)
- B. Taps on 16” and larger pipes must be at least one standard pipe size smaller than the pipe being tapped. See Figure 3.2 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.
(Example: 16” X 12”, 16” X 8” and 16” X 6” taps are allowed).

3.14.3 Type “D” Connection

When two mains 12” and larger are designed such that they cross each other, they should be connected by means of a Type “D” connection, instead of the installation of a cross. See Figure 3.3 in Drawing PIAZ13 on Sheet 2 of the City Standard Details.

3.14.4 Cut-In Connection

On occasions when connecting to an existing main, it may be desirable to have an additional valve on the existing main. In this situation, the design engineer should consider using a cut-in connection with a tee and valve being cut into the existing main. See Figure 3.4 in Drawing PIAZ14 on Sheet 2 of the City Standard Details.

3.14.5 Main Extensions

It is recommended and good practice, though not required, that a new valve be installed at the point of connection for water main extensions. This will facilitate the testing and chlorination of the new main prior to its placement into service. See Figure 3.5 in Drawing PIAZ14 on Sheet 2 of the City Standard Details.

3.15 Valves

3.15.1 Isolation Valves

3.15.1.1 Location

Isolation valves shall be provided to allow for the proper operation and maintenance of the water distribution system, and ensure water quality can be maintained to each individual water customer connected to the system.

The location of valves needs to properly address the ability of the Water Utilities Department to remove a water line from service to perform necessary repairs, while minimizing the interruption of service to the least number of customers and to fire protection. Isolation of any given section of water line should generally be able to be accomplished by closure of the least number of valves, as would generally be expected under good engineering design practices and utility engineering standards. The Water Utilities Department reserves the right to require changes to proposed designs to satisfy these objectives.

The design engineer shall place valves on proposed water mains so they may be easily located in the future by operations and maintenance crews.

The following guidelines should be used by the design engineer in placement of isolation valves on proposed water mains:

- A. Valves are to be located at street intersections at the projection of property lines, except when the main connection is by the tapping sleeve and valve method. This specific type of construction requires the placement of the valve at the point of connection. See Figure 3.6 in Drawing PIAZ15 on Sheet 2 of the City Standard Details.
- B. Valves for line sizes 12" in diameter or less should not be spaced any farther apart than 1,000 feet. For city blocks that are longer than 1,000 feet between street intersections, placement of a valve will be required between street intersections.
- C. Valves should be generally located so that no more than four (4) valves are required to isolate a section of main. See Figure 3.7 in Drawing PIAZ15 on Sheet 2 of the City Standard Details. For mains larger than 12" in diameter, valve spacing and placement shall be subject to alternate criteria approved by the Director of Water Utilities.
- D. All fire hydrant leads are to be designed with a valve that is positively anchored to the main line.

3.15.1.2 Specifications

Refer to Table 3.15.1.2-1.

**Table 3.15.1.2-1
Isolation Valve Requirements**

Size	4 in. - 12 in.	16 in. - 20 in.	24 in.	30 in.	36 in. or larger
Type	Gate Valve (AWWA C509 resilient-seat)	Gate Valve (AWWA C515 resilient-seat)	Gate Valve (AWWA C515 resilient-seat)	Gate Valve (AWWA C515 resilient seat)	Gate Valve (AWWA C515 resilient-seat) or butterfly, to be determined by City on a case-by-case basis
Orientation	Vertical	Vertical	Vertical	Vertical or horizontal; to be determined by City on a case-by-case basis	Vertical or horizontal; to be determined by City on a case-by-case basis
Gear Operator Required	No	No	Yes	Yes	Yes
Vault Required	No	No	Yes	Yes	Yes
Bypass Required	No	No	No	Yes	Yes

3.15.1.3 Details

Refer to Drawings W104, W105, W106A, W106B, and W601 on Sheets 1 and 2 of the City Standard Details.

3.15.2 Air Release Valves and Air / Vacuum-Air Release Valves

For 12" mains, City may require air release valves at local high points to facilitate automatic release of accumulated air.

For 16" and larger mains, City requires air / vacuum air release valves at local high points to facilitate automatic release of accumulated air and to facilitate automatic prevention of vacuum conditions within the line. See Drawings W801 and W802 on Sheet 3 of the City Standard Details.

3.16 Dead-end Mains

Dead-end main situations should be avoided whenever possible. These situations create a stagnant water condition that can cause taste and odor problems as well as low chlorine residuals. These mains create maintenance problems, because they must be routinely flushed. In addition, dead end mains result in a waste of water resources due to required flushing to ensure water quality.

In lieu of dead-end mains, the design should loop, within a Home Owners Association (HOA) pedestrian easement or common area (with adequate assurance of access and fencing prohibited), or a dedicated public utility easement (with adequate assurance of access and fencing prohibited) to another nearby water main using the same size pipe as an alternate size, on a case-by-case basis. The "loop main" shall be constructed with pipe of at least one standard pressure class higher than normally required, e.g., Class 200 in lieu of Class 150.

If a dead-end main situation is unavoidable, it should be designed so that it may be periodically flushed of stagnant water by locating a fire hydrant near the main's end.

It is recommended that a dead-end main should have no more than one blow-off fire hydrant connected to it. If the length of the dead-end main is such that a fire hydrant is required along it, then the design engineer should consider if any additional fire hydrants need to be placed on the cross feed mains. See Figure 3.8 in Drawing PIA Z16 on Sheet 2 of the City Standard Details.

3.17 Fire Hydrant Locations and Coverage

The design engineer should locate fire hydrants as close as possible to street intersections, but outside of the curb radius. This positioning of fire hydrants provides coverage along several streets. When spacing requirements necessitate the installation of fire hydrants between street intersections, they should be placed at the projection of lot lines between property owners. For main replacement projects in established neighborhoods, fire hydrants should be designed as close as possible to the old fire hydrant location, provided coverage is adequate. Neighborhood residents are familiar with the fire hydrant being at that location and normally expect a replacement fire

hydrant to be placed at the same location. Fire hydrants are not to be installed closer than nine (9) feet to any wastewater main or any wastewater appurtenance.

As a general guideline, fire hydrants shall be placed at a maximum of 600 feet apart in residential areas and a maximum of 300 feet apart in commercial (including apartments) and industrial areas.

3.18 Requirements for Abandoning Water Mains

The design engineer should note the limits and appropriate conditions for the abandoning of existing water mains which are to be replaced by the construction of any proposed water mains.

The design engineer should also make allowances in the design to provide for the existing and proposed mains to be in service simultaneously until all customer services are transferred from the old main to the new main with minimum interruption of service. If the construction of a proposed main necessitates the abandoning of the existing main prior to the new main's placement into service, then provisions for a temporary water main with services must be addressed by the design.

The City may require special abandonment actions including, but not limited to, filling the abandoned water main with grout, removal and proper disposal of all above ground appurtenances, and removal and proper disposal of the abandoned pipe.

3.18.1 Replacement Mains

On mains being abandoned, the design engineer should note and locate points of cut and plug as close as possible to the main that remains in service. (See Figure 3.9 in Drawing PIAZ16 on Sheet 2 of the City Standard Details).

3.18.2 Extension Mains

If a design requires an existing main to be cut by a connection with a proposed main, then no cut and plug is to be specified. (See Figure 3.10 in Drawing PIAZ16 on Sheet 2 of the City Standard Details).

3.18.3 Fire Hydrants

Fire hydrants, located on mains being abandoned, shall be removed and delivered to the City of Denton Water Utilities Department.

3.18.4 Valves

Sixteen (16) in. and larger valves located on mains being abandoned shall be removed and delivered to the City of Denton Water Utilities Department.

3.19 Flushing and Disinfection

Prior to making permanent connections to the distribution system, water distribution mains, valves and appurtenances shall be adequately flushed and disinfected in accordance with the most current revision to AWWA C651, and bacteriological testing shall be completed to meet the standards established by the Water Utilities Department and Chapter 290 of the Texas Administrative Code (30 TAC §290). Additionally, heavily

chlorinated water shall be flushed from all segments of the newly constructed mains before final connections are made.

Before commencement of construction of water distribution infrastructure, the Contractor or engineer shall submit a flushing and disinfection plan to the Water Utilities Department for review. At a minimum the plan shall describe:

- A. Flushing procedures
- B. Hydraulic calculations to demonstrate adequate flushing velocities, or demonstrate conformance with the conditions outlined in AWWA C651 Table 3.
- C. The method of chlorination
- D. Bacteriological sampling plan
- E. Dechlorinating procedures (Ref. AWWA C655)
- F. Disposal of chlorinated water

NOTE: Water Drawings have been removed from this update, because they are contained in the City Standard Details. This Manual now references the applicable Standard Detail Sheets for those Drawings.

Section 4 – Wastewater Design Guidelines

4.1 *General*

It is the responsibility of the design engineer to ensure the final design of a sewer main is in conformance with the following:

- A. Texas Administrative Code (TAC) Title 30, Part 1, Texas Commission on Environmental Quality (TCEQ) – Rules, Ch. 217, [“Design Criteria for Domestic Wastewater Systems”](#)
- B. Denton Development Code (DDC)
- C. This Manual and the City’s Standard Detail Drawings
- D. North Central Texas Council of Governments (NCTCOG) Standard Specifications for Public Works Construction (“COG Specs.”), as amended by the City of Denton
- E. City of Denton Wastewater Master Plan

4.2 *Estimated Wastewater Flows*

- A. For sewers in new developments, sewer lines and lift stations shall be designed for the estimated future population to be served, plus adequate allowance for institutional and commercial flows. Figure: 30 TAC §217.32(a)(3) Table B.1. - Design Organic Loadings and Flows for a New Wastewater Treatment Facility (see excerpted information in Table 4.2-1) shall be used as a guide to generate wastewater flows. However, minimum flow capacity for sizing of sewers for peak flow condition shall not be less than the results of the following calculations:
 - 1. Delineate the proposed development that will drain into the sewer main and lift station. Add drainage areas from up-stream sub-basins.
 - 2. To calculate sewer flows, use the following design parameters:
 - a. Use 4 houses per acre for off-site area and add the number of proposed lots for the development to establish total number of lots.
 - b. Use 3.2 capita per lot.
 - c. Use average daily flow of 100 gal/capita/day.
 - d. Apply a 4.0 multiplier to the average daily flow to determine the peak flow.

For replacement of existing sewers and construction of parallel sewers for additional capacity, wastewater flow data will be provided by the City from data generated by City sewer shed computer models.

TABLE 4.2-1

Excerpt of Table B.1 - Design Flows for a New Wastewater Treatment Facility (reproduced from TCEQ Rules - 30 TAC §217.32(a)(3), Table B.1)		
Source	Remarks	Daily Wastewater Flow (Gal. Per Person)*
Municipality	Residential	75-100
Subdivision	Residential	75-100
Trailer Park (Transient)	2½ Persons per Trailer	50-60
Mobile Home Park	3 Persons per Trailer	50-75
School	Cafeteria & Showers	20
	Cafeteria/ No Showers	15
Recreational Parks	Overnight User	30
	Day User	5
Office Building or Factory	A facility must be designed for the largest shift	20
Hotel/Motel	Per Bed	50-75
Restaurant	Per Meal	7-10
Restaurant with bar or cocktail lounge	Per Meal	9-12
Hospital	Per Bed	200
Nursing Home	Per Bed	75-100
Alternative Collection Systems e.g., septic tanks	Per Capita	75

*** City of Denton requires usage of the highest number of the TECQ ranges.**

4.3 Separation Distances between Wastewater Collection System Pipes and Manholes and Public Water Supply Pipes (excerpted from TCEQ Rules - 30 TAC §217.53.d and amended for City of Denton Standards)

NOTE: The City of Denton does not allow the use of cast iron for water or wastewater piping.

- A. Wastewater collection system pipes must be installed in trenches separate from water supply pipe trenches.
- B. Wherever possible, a wastewater collection system pipe must be located below a water supply pipe. If a collection system pipe cannot be located below a water supply pipe, the design engineer must justify in the engineering report why it is not possible to locate the collection system pipe below the public water supply pipe.
- C. Wherever possible, wastewater collection system pipes and manholes must be located at least nine (9) feet from all water supply pipes. If a collection system pipe or manhole cannot be located at least nine (9) feet away from a water supply pipe, the

- design engineer must justify in the engineering report why it is not possible to provide at least nine (9) feet of separation. Table 4.3-1 (Table C.1. in Figure: 30 TAC §217.53(d)(3)) provides a reference to paragraphs in this subsection that apply if a collection system pipe or manhole cannot be located at least nine (9) feet away from a water supply pipe.
- D. If a wastewater collection system pipe is located above a water supply pipe and runs parallel to the water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must be encased. The casing pipe must be steel casing pipe, with minimum wall thickness as shown in Section 3.11, that:
1. Encases the entire length of wastewater collection system pipe that is within nine (9) feet of the water supply pipe;
 2. Is sealed at both ends with cement grout or a manufactured seal;
 3. Is at least two nominal sizes larger than the wastewater collection pipe; and
 4. Is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.
- E. If a wastewater collection system pipe crosses above a water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be encased in a steel casing pipe according to subparagraph E.1 of this paragraph, or must be constructed using at least 150 psi pressure class pipe according to subparagraph E.2 of this paragraph.
1. A casing pipe for a wastewater collection system pipe that crosses above a water supply pipe must be constructed of steel pipe, with minimum wall thickness as shown in section 3.11, that:
 - (a) Is sealed at both ends with cement grout or a manufactured seal;
 - (b) Is at least two nominal sizes larger than the wastewater collection pipe;
 - (c) Is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals; and
 2. A wastewater collection system pipe that crosses above a water supply pipe must be constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe and must use manufacturer-approved adapters. Gasketed joints, compression joints, and other non-bonded joints must be designed to seal at atmospheric pressure.
- F. If a wastewater collection system pipe is located below a water supply pipe and runs parallel to the water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be constructed using at least 150 psi pressure class pipe according to subparagraph F.1 of this paragraph, or must be encased in a steel casing pipe, with minimum wall thickness as shown in section 3.11, according to subparagraph F.2 of this paragraph.

1. A wastewater collection system pipe that runs parallel to and below a water supply pipe must be constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe that:
 - (a) Is located at least two (2) vertical feet below the water supply pipe;
 - (b) Is located at least four (4) horizontal feet away from the water supply pipe; and
 - (c) Includes joints that are designed to seal at atmospheric pressure.
 2. A casing pipe for a wastewater collection system pipe that runs parallel to and below a water supply pipe must be constructed of steel pipe, with minimum wall thickness as shown in section 3.11, that:
 - (a) Is sealed at both ends with cement grout or a manufactured seal;
 - (b) Is at least two nominal sizes larger than the wastewater collection pipe; and
 - (c) Is supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.
- G. If a wastewater collection system pipe crosses below a water supply pipe, each portion of the collection system pipe within nine (9) feet of the water supply pipe must either be constructed using at least 150 psi pressure class pipe according to subparagraph G.1 of this paragraph, or must be encased in cement-stabilized sand according to subparagraph G.2 of this paragraph, or must be encased in a steel casing pipe according to subparagraph G.3 of this paragraph.
1. A wastewater collection system pipe that crosses below a water supply pipe and is constructed of at least 150 psi pressure class, corrosion-resistant, non-brittle pipe must:
 - (a) Have at least six (6) inches of separation between the outsides of the pipes;
 - (b) Be centered on the crossing;
 - (c) Be at least 18 feet long; and
 - (d) Terminate at joints that are designed to seal at atmospheric pressure.
 2. A wastewater collection system pipe that crosses below a water supply pipe and is constructed of any material other than at least 150 psi pressure class, corrosion-resistant, non-brittle pipe must:
 - (a) Have at least two feet of separation between the outsides of the pipes; and
 - (b) Be encased in cement-stabilized sand backfill that meets the requirements of subparagraph G.4 of this paragraph.
 3. A casing pipe for a wastewater collection system pipe that crosses below a water supply pipe must be constructed of steel pipe, with minimum wall thickness as shown in section 3.11, that is:
 - (a) Sealed at both ends with cement grout or a manufactured seal;
 - (b) At least two nominal sizes larger than the wastewater collection pipe; and
 - (c) Supported by spacers between the collection system pipe and the encasing pipe at a maximum of five-foot intervals.
 4. Cement-stabilized sand for encasing wastewater collection system pipes must:
 - (a) Include at least 160 pounds of cement for every cubic yard of sand;
 - (b) Be installed beginning one-quarter pipe diameter below the centerline of the collection system pipe; and

- (c) Be installed ending one full pipe diameter above the top of the collection system pipe, or 12 inches above the top of the collection system pipe, whichever is greater.
- H. If a nine-foot separation distance between a manhole and a water supply pipe cannot be achieved, the manhole must either:
1. Have no measurable leakage during a leakage test conducted according to the requirements in 30 TAC §217.58 of the TECQ Rules (relating to Testing Requirements for Manholes); or
 2. Have all portions of the manhole within nine (9) feet of a water supply pipe encased in at least one foot of cement stabilized sand that meets the requirements of paragraph G.4.(a) and (b) of this subsection.

Table 4.3
Separation Distance between Wastewater Pipes
and Water Supply Pipes

Figure: 30 TAC §217.53(d)(3) Table C.1.

Case	Protection Requirement
Parallel pipes within nine feet, where the collection system pipe is above the water supply pipe	Encased in a casing pipe according to Section 4.3.D
Crossing pipes within nine feet, where the collection system pipe is above the water supply pipe	Encased in a casing pipe according to Section 4.3.E.1 -or- Constructed using 150 per square inch (psi) pressure class pipe according to Section 4.3.E.2
Parallel pipes within nine feet, where the collection system pipe is below the water supply pipe	Constructed using 150 psi pressure class pipe according to Section 4.3.F.1 -or- Encased in a casing pipe according to Section 4.3.F.2
Crossing pipes within nine feet, where the collection system pipe is below the water supply pipe	Constructed using 150 psi pressure class pipe according to Section 4.3.G.1 -or- Encased in cement-stabilized sand according to Section 4.3.G.2 -or- Encased in a casing pipe according to Section 4.3.G.3
Manhole within nine feet of a water supply pipe	No measurable leakage according to Section 4.3.H.1 -or- Encased in cement-stabilized sand according to Section 4.3.H.2

4.4 Size and Slope of Sewers

After the design engineer has determined the wastewater flows per Section 4.2, the sewer size can be determined using the following criteria. However, no sewer, other than service laterals and force mains, shall be less than 8 inches in diameter.

The size and grade of the proposed sewer shall be evaluated by Manning's Equation.

$$V = \frac{1.49}{n} (R)^{0.67} (S)^{0.50}$$

Where:

- V = velocity (feet per second)
- n = Manning's coefficient of roughness;
minimum 0.013
- R = hydraulic radius (feet)
- S = slope of energy grade line (feet per foot)

Proposed sewers shall be designed with slopes sufficient to provide a minimum velocity of 2.0 feet per second (fps). It is desirable to design for 3.0 fps velocity in the sewer. The minimum acceptable Manning's "n" factor for design shall be 0.013. This "n" value takes into consideration the slime, grit and grease layers that will affect hydraulics or hinder flow as the pipe matures. The sewer pipe grades shown in Table 4.4-1 are based on an "n" value of 0.013 and are the minimum acceptable slope for sewer lines.

**Table 4.4-1
Minimum and Maximum Pipe Slopes**

Size of Pipe in Inches I.D.	Minimum Slope In Percent	Maximum Slope in Percent	Capacity Flowing Full at Min. Slope (MGD)
8	0.335	8.40	0.45
10	0.25	6.23	0.71
12	0.20	4.88	1.03
15	0.15	3.62	1.62
18	0.115	2.83	2.25
21	0.095	2.30	3.07
24	0.08	1.93	4.14
27	0.07	1.65	4.91
30	0.06	1.43	6.23
33	0.055	1.26	7.66
36	0.045	1.12	9.17

The capacity of the sewer pipe flowing full shall be computed by the following equation:

$$C = \frac{0.299 (D)^{2.67} (S)^{0.50}}{n}$$

Where C = capacity (million gallons per day)

n = Manning's coefficient of roughness; minimum 0.013

D = inside diameter (feet)

S = slope of the energy grade line (feet per foot)

4.4.1 High Velocity Protection

Where velocities greater than 10 fps will occur when a pipe flows full, based on Manning's Equation and an "n" value of 0.013, special provisions must be made to protect the pipe against pipe and bedding displacement.

4.5 Sewer Main Depth

Minimum depth for the design of sewer mains shall be determined by providing a two percent grade for the lateral from the center of the house or building to the center of the proposed main and including an additional two foot drop. Therefore, for a house 100 feet from the proposed sewer main, the designed depth of the main shall be at least 4.0 feet below the finished floor elevation of the house since:

$$2 \text{ feet} + (2\% \text{ of } 100 \text{ feet}) = 4.0 \text{ feet}$$

The lateral also must have at least two (2) feet of cover at its shallowest point. The design engineer is responsible for ensuring sufficient depth and grade is maintained to serve all building sites in the sewer shed.

4.6 Recommended Cover

Recommended cover for all sewer mains is four (4) feet to six (6) feet. Minimum cover shall be 3.5 feet. Any main with less than minimum cover shall be encased in Class "G" embedment. See Drawing U204 on Sheet 7 of the City Standard Details.

When establishing depth for proposed wastewater mains, design engineers should be aware of proposed street grades in unimproved areas. This information can be obtained from the Capital Projects Engineering Division. Design engineers should also anticipate the size of proposed storm sewers that will be installed in unimproved streets. To do this, calculate the cross-sectional area of both drainage ditches and convert that area into a circular area of equivalent storm sewer pipe, thus determining the anticipated size of the future storm sewer. Future storm sewers should be at least 2.5 feet below the top of the curb. The top of the proposed sewer main should be at least two (2) feet below the bottom of the future storm sewer.

4.7 Sewer Alignment

Design engineers should be guided by the following in the alignment of wastewater lines:

- A. For new construction in areas not served, sewer mains shall be laid straight between manholes at the center of the pavement. No horizontal or vertical bends are allowed between manholes.

- B. Avoid shifting mains from one side of the ROW to the other side of the ROW between street intersections.
- C. When existing flow permits, it is recommended that 8 in. and 10 in. replacement mains be constructed horizontally in the same trench.

4.8 Sewer Laterals

Minimum lateral sizes from the sewer main to the public cleanout are:

- A. 4" minimum for single family
- B. 6" minimum for residential duplex and triplex
- C. 6" minimum for local retail, light commercial, apartment, manufacturing and industrial

Clean-outs shall be provided on laterals at the public easement or Right-of-Way line. See Drawings S403 and S404 of Sheet 5 of the City Standard Details.

Manholes shall be provided for lateral connections when the lateral pipe diameter is equal to the main sewer pipe diameter or the lateral is 8-inch diameter or larger.

Laterals shall be constructed to the property line and shall be located at a point five (5) feet downstream from the center of the lot on unimproved property. For improved property, design engineers should use technical judgement in lateral placement.

Preferred grade for lateral construction is 2%. It is recommended that laterals not be designed with less than 1% grade.

4.9 Gravity and Force Main Sewer Pipe Material

Gravity sewer pipe shall meet the following criteria, unless special circumstances require an alternative and the alternative is approved by the Director of Wastewater Utilities.

Table 4.9-1

Size	Pipe Material
6 in. through 15 in.	PVC – ASTM D3034, SDR 35 (for pipe depths 15 ft. or greater, use SDR-26 pipe)
18 in. through 24 in.	PVC – ASTM F 679, PS46 or PS115 Fiberglass Reinforced Plastic – ASTM D3262

For gravity sewer pipe sizes over 24" in diameter, design calculations and pipe selection shall be submitted by the development design engineer to Engineering Development Review for review; approvals will be provided on a project specific basis.

Force main sewer pipe shall be designed to meet the working and surge pressure requirements of the particular application. Design calculations and pipe selection shall be submitted by the development design engineer to Engineering Development Review.

Different pipe materials shall not be mixed between manholes. If it is anticipated that a mixing of materials will occur, the design engineer shall design a manhole at the point of transition of pipe materials. For previously placed stub-out of a material other than PVC pipe, design engineer shall add a note to the plans calling for removal of the stub out or change the material of the proposed pipe for that section of pipe between manholes.

4.10 Sewer Pipe Embedment

The types of embedment and backfill for sewer mains are shown in Drawings U201, U202, U203A and U203C of Sheet 7 of the City Standard Details. Embedment requirements shall be based on sewer mains under proposed pavement, unpaved areas and existing pavement.

Embedment and backfill up to six (6) in. above the top of the pipe will be based on materials as specified by North Central Texas Council of Governments (NCTCOG) Standard 504.2.2.1(a). Crushed stone embedment – Aggregate Grade 4.

Table 4.10-1

Standard Crushed Rock Aggregate Grade 4	Percent
Retained on 1 - ½ inch sieve	0 %
Retained on 1 inch sieve	0 – 5 %
Retained on ½ inch sieve	40 – 75 %
Retained on No. 4 sieve	90 – 100 %
Retained on No. 8 sieve	95 – 100 %

4.11 Manholes

Manholes constructed on existing or proposed sewer lines shall be sized as follows:

Table 4.11-1

Pipe Diameter	Manhole Diameter
8" through 12"	4.0 ft. (For depths greater than 12 ft., use 5.0 ft.)
15" through 27"	5.0 ft.
30" through 36"	6.0 ft.

Special manholes shall be designed for mains larger than 36" diameter pipe.

The types of manholes allowed by the City are shown in Drawings S101, S102, S103 and S107B of Sheet 4 of the City Standard Details and are listed below:

- A. Cast-in-place
- B. Pre-cast with pre-cast base with lining as noted in Drawing S101 on Sheet 4 of the City Wastewater Standard Details
- C. Fiberglass
- D. Drop connection

Generally, manholes shall be stationed on the main run, and where known, the stations of the side mains should also be indicated. When connecting a proposed main to an existing main at a manhole, the preferred connection should have the top inside elevation of the outfall main level with the top inside elevation of the proposed main.

No manhole may contain more than one outlet unless approved by

4.11.1 Manhole Locations

Manholes shall be provided at the following locations to facilitate maintenance, cleaning, and inspection:

- A. At the location of lateral connections that are 8" in diameter or larger.
- B. At 500 feet intervals on sewer mains 15" diameter or smaller; at 800 feet intervals on mains 18" diameter through 30" diameter; at 1,000 feet intervals on mains 36" diameter through 48" diameter; and at 2,000 feet for 54" diameter and larger.
- C. At all locations where pipe diameter or pipe material changes.
- D. At all locations where the horizontal or vertical alignment of the sewer main changes.
- E. At the ends of all mains. Two ends of a main may not be combined in one manhole. If the main line is less than 150 ft. long, then a Sanitary Sewer Mainline Cleanout may be used. See Drawing S402 on Sheet 5 of the City Standard Details.
- F. At the end of a sewer line planned for extension in the near future, where a manhole and stub-out shall be provided.

4.12 Highway Crossings

The design engineer shall, prior to the design of any highway crossing, contact the appropriate regulatory agency and determine if there are any special requirements.

4.12.1 State Highway Alignment Criteria

Some of the design parameters that affect water and sewer line construction and that have been established by TxDOT are listed below. Design engineers are directed to TxDOT's "Use of Right of Way by Others Manual" for additional information and references

(<http://onlinemanuals.txdot.gov/txdotmanuals/use/use.pdf>).

A. Utility Accommodation Zone

On most state highways the Utility Accommodation Zone is within 10 feet of the ROW line, with the outside 3 feet being reserved for overhead utilities. TxDOT does not permit its pavement to be cut. The City of Denton requires that all of its water and sewer lines be constructed in an easement outside of the TxDOT ROW, unless specifically approved by the Director of Water or Director of Wastewater Utilities (as

applicable), there is adequate space within the TxDOT highway utility accommodation zone, and authorization is provided by TxDOT to accommodate the water or sewer line within its accommodation zone.

B. Accommodation of Utilities on Controlled Access Highways

On all interstate highways there are control of access lines along the outer ROW limits. Accommodation of utility facilities longitudinally inside control of access lines is normally not permitted. Variances to this prohibition can sometimes be granted. However, a variance usually entails approval from the TxDOT Dallas District office, the TxDOT State Office, and FHWA. A variance would require the four tests below be met.

1. The accommodation will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway
2. The accommodation will not be constructed and/or serviced by direct access from through traffic roadways or connecting ramps
3. The accommodation will not interfere with or impair the present use or future expansion of the freeway
4. Any alternative location would be contrary to the public interest. This determination would include an evaluation of direct and indirect environmental and economic effects that would result from the disapproval of the use of such right-of-way for the accommodation of such utility.

4.13 Railroad Crossings

The design engineer shall, prior to the design of any railroad crossing, contact the appropriate railroad company and regulatory agency and determine if there are any special requirements. In the event City of Denton Design Criteria are more stringent than those of the Railroad Company or regulatory agency, the City's standards shall apply. See Section 6.4.A for processing of railroad permits.

4.14 Tunneling, Boring, Jacking and Casing

Tunneling, boring, jacking and casing are methods used for sewer line placement under restrictive conditions when open cut construction is not allowed. Only straight pipe alignments for both horizontal and vertical alignments are allowed.

Design engineers should consider the location, size and depth of boring and receiving pits when choosing the beginning and ending stations for boring. A typical bore pit is over 20 ft. in length to accommodate one joint of pipe. Width of the bore pit can vary depending on the depth and size of pipe, with the narrowest width being approximately 5 ft. The preferred location for the bore pit is the lower elevation end of the bore; allowing any groundwater and/or boring slurry to drain from the tunnel into the bore pit. The water can then be removed by pumping.

Steel casing pipe, where required for open-cut or other than open cut installation shall have an inside diameter (ID) large enough to accommodate a carrier pipe of at least two (2) to three (3) standard sizes above the pipe being installed and shall meet the minimum ID listed in Table 4.14-1. The casing pipe wall thickness design shall be based on the requirements of the agency whose facility is being crossed and shall conform to the minimum criteria listed in Table 4.14-1. Casing pipe shall be provided with interior and exterior coal-tar protective coating in accordance with AWWA C203. Field welds shall be coated with an equivalent coating.

Table 4.14-1

Nominal Carrier Pipe Size ^a	Minimum Casing Pipe ID	Minimum Casing Pipe Wall Thickness
8 in.	12 in.	3/8 in.
12 in.	20 in.	1/2 in.
16 in.	24 in.	1/2 in.
20 in.	30 in.	1/2 in.
24 in.	36 in.	5/8 in.
30 in.	42 in.	5/8 in.
>30 in.	a	b

- a. Minimum depth of bore shall be 42 inches.
- b. Consult with Water Utilities Department
- c. Project specific design, sealed and signed by a Professional Engineer licensed by the State of Texas

4.15 Storm Drain Crossings

When a sewer main crosses beneath a 24 in. or larger diameter storm drain, the sewer main shall be encased within a 10 ft. long casing centered on the centerline of the storm drain, to allow future removal and replacement of the sewer main without removal or shoring of the storm drain.

4.16 Creek Crossings

When a sewer main crosses a creek or channel, the design engineer must evaluate the condition of the creek bed and ensure erosion control is provided. Backfill material and minimum construction criteria are shown in Low Water Channel Crossing Drawings S701 and S702 on Sheet 6 of the City Standard Details. These criteria include creek bed soil and condition, as well as presence of exposed rock.

4.17 Siphons

For creek or channel crossings and under special design conditions, design of inverted siphons should be undertaken only as a last resort, when all other alternatives have been evaluated and rejected. Inverted siphons shall not have less than two (2) barrels, with a minimum pipe size of eight (8) in., and shall be provided with necessary

appurtenances for convenient flushing and maintenance. Manholes are required at each end of the siphon with adequate clearance for rodding.

4.18 Abandonment of Sewer Mains

When an existing sewer line is replaced with a new sewer line, often it is necessary to abandon the old line, especially if the replacement is not in the same ditch. The design engineer shall ensure the laterals tying into the existing sewer line are transferred to the new main, so that a live sewer main is not abandoned. If a manhole on the sewer main being abandoned is to remain in service because other sewer mains are entering this manhole, the sewer main to be abandoned shall be plugged inside the manhole. A note is required on the plans, showing which sewer main is to be plugged inside the manhole. "Cut and plug" method resulting in excavation outside the manhole and a cut in the main with attendant excessive costs shall be avoided.

4.19 Abandonment of Manholes

If a manhole as well as the sewer main is to be abandoned, the method described in Section 4.18 above, along with the minimum guidelines shown in Drawing S105 on Sheet 4 of the City Standard Details, shall be used.

4.20 Lift Stations

The need to construct a lift station should be determined only after a thorough analysis of the physical and economic factors involved. A Preliminary Engineering Report is required, which lists all factors and adheres to current state regulations. The City reserves the right to review each proposal and determine whether there is enough merit to justify a lift station.

4.20.1 Preliminary Design Submittal

A preliminary design submittal will be required for each lift station proposed. The submittal shall include a written report and a map prepared by a Professional Engineer licensed by the State of Texas.

- A. The plans submitted shall contain the following information, as a minimum:
1. Be to scale, with the scale indicated.
 2. A north arrow.
 3. A location map.
 4. Delineation of the boundary of the proposed development.
 5. Delineation of the boundary of the sewer shed in which the development lies.
 6. The area in acres of the development.
 7. The area in acres of the sewer shed contributing to the Lift Station.
 8. The proposed land use or uses for the development.
 9. The proposed land use or uses for the sewer basin.
 10. The proposed lift station site.
 11. The proposed force main routing and size.
 12. Delineation of the one hundred year flood plain and Environmentally Sensitive Areas (ESAs).
 13. Location and size of the existing collection system at the tie-in point.
 14. Contour lines (2-foot intervals).

15. Property lines.

- B. The written report shall include the following information:
1. The general narrative about the proposed development and the circumstances that warrant a lift station.
 2. Influent hydraulic calculations showing:
 - a. Area in acres of the sewer basin and the development.
 - b. The area of each proposed land use for the development and for the projected land use(s) for the basin.
 - c. The design flow for the basin and the development.
 - d. The maximum flow for the basin and the development.
 - e. Elevation of the proposed lift station site.
 - f. The elevation of the proposed discharge point of the force main.
 3. Preliminary wet well volume calculations.
 4. Preliminary force main size.
 5. Cost estimates for proposed lift station(s) and force main(s), and cost estimates for a gravity line in lieu of the lift station if possible.
 6. Ground water levels in proposed site areas.

4.20.2 Site Layout

- A. Station Siting. The following are the minimum criteria for station sites.
1. The station shall be protected from the 100-year flood and shall be accessible during a 25-year flood.
 2. The station should be located as remotely as possible from populated areas. The station shall be a minimum of 200 ft. from a residential or commercial building. If the lift station is placed closer than 200 ft., the entire station site shall be completely enclosed with an eight (8) ft. high, opaque concrete or masonry wall, and opaque gate, of an architectural style and colors blending with the development architecture, and an approved odor control system provided.
 3. The station site and its access shall be dedicated to the City.
 4. The station site shall be located so it may serve as much of the entire sewer basin as possible. This may require the station to be located off-site of the development. When it is required the station serve a larger area than the proposed development, the developer may enter into a pro-rata contract with the City to be reimbursed the cost of excess capacity as other developments tie to the system.
- B. Wet Well/Dry Well Arrangement
1. Orientation shall consider the routing of incoming sewers and force main.
 2. Orientation shall allow a two-ton vehicle to directly access the wet well or the dry well, forwards and backwards.
 3. Wet wells and dry wells shall be separated by at least a water and gas tight wall with separate entrances.

4. Wet wells shall have sloped bottoms to avoid excess sludge deposits.
5. The wet well shall have a lockable aluminum door with an aluminum frame. The minimum opening size shall be 4' x 6' with two doors large enough to adequately maintain the wet well. Door and frame shall be Bilco Type K, KD or an approved equal.
6. The dry well or valve vault shall have a lockable aluminum door with an aluminum frame. The minimum opening size shall be 2'x 3' or large enough to adequately maintain the dry well or meter vault. Door and frame shall be Bilco Type K, KD or an approved equal.
7. The wet well, dry well, valve vault and meter vault shall be cast in place concrete or pre-cast with watertight joint meeting ASTM C478-90. Steel, fiberglass, HDPE and RCP are not acceptable materials. The tops may be pre-cast with the doors built-in. The coating for the wet well exterior and interior walls shall be as specified in 4.20.2.C and D below, respectively.
8. The wet well shall be hydrostatically tested to the top of the wet well for 48-hours prior to placing the lift station into service. Only losses due to evaporation will be acceptable.
9. Provisions shall be made to remove water from the dry well, valve vault or meter vault without allowing gas or water from the wet well into these structures.

C. Exterior Walls (below grade, to be backfilled)

Table 4.20-1

Surface Preparation	Coating System
Clean and Dry	Tnemec Series 46H-413 Polyamide Epoxy - Coal Tar 8 - 10 mils in two coats for a total of 16.0 to 20.0 dry mils

D. Interior Walls (Thick Film System)

Table 4.20-2

Surface Preparation	Coating System	
	Primer	Finish
Brush-off Blast Cleaning	Tnemec Series 218 Mortarclad 0.25 in.	Tnemec Series 436 Perma-Shield 100 - 125 dry mils

In addition to this coating system, the lining products listed in Drawing S101 of the City Wastewater Standard Details are acceptable.

E. Site Access

1. Access will be provided by an all-weather surface of flex-base or better from a public street to the station site.
2. Access shall be functional during a 25-year flood. The road surface shall be above the water level caused by a 25-year return period storm.
3. If the station is greater than 100 feet from a public street, a hammerhead type turn-around to accommodate a Single Unit (SU) type vehicle shall be provided on the station site.

F. Fencing

Fence shall be seven (7) feet above grade, using six (6) feet high chain link fabric surmounted by three strands of barbed wire.

G. Electrical and Instrumentation Panels

Panels shall generally be located where they do not obstruct vehicle access to the wet well or the dry well. The panels shall be placed at an elevation to be easily accessible.

H. Site inside the fence shall be an all-weather surface, such as $\frac{3}{4}$ in. crushed rock or flex-base.

I. Passive ventilation shall be screened to prevent insect access to the wet well. Minimum air vent shall be 4-inch diameter. Vent outlet shall be at least 1 foot above the 100-year flood elevation.

4.20.3 Hydraulic Design

A. Influent Flow

The preliminary design report shall include the design flow and the maximum flow for the development and the sewer basin. The design flow shall be calculated in accordance with TCEQ rules. Refer to Section 4.2 Estimated Wastewater Flows herein for maximum flow calculations.

B. Pump Capacity

1. Definition

Firm pumping capacity is the pumping capacity of the station with the largest pump out of service.

2. The firm pumping capacity shall be greater than the maximum flow for the entire sewer basin. If the sewer basin is significantly larger than the proposed development and it is not feasible to design for this flow, the firm pumping capacity may be designed to handle a portion of the basin with approval from the Director of Wastewater Utilities.

- The pump curves shall be selected so the pumps will run near the best efficiency point during normal operating conditions. The selected curves shall also be such that the pumps do not approach shut-off head when they are running simultaneously.

System head curves, pump curves and head calculations shall be submitted. Calculations and pump curves at both minimum (all pumps off) and maximum (last normal operating pump on) static heads, for a C value of both 100 and 140, must be provided for each pump and for the combination of pumps with modified pump curves.

C. Wet Well Volume

- Wet well volume for a submersible pump station is the volume contained above the top of the motor, or as specified by the pump manufacturer.
- Wet well volume for all other non-submersible pump stations is the volume contained in an area from a minimum of two (2) feet above or distance at which vortexing does not occur above the top of the intake of the pump.
- High level alarm elevation shall be a minimum of 48 inches below the top of the wet well or 48 inches below the flow line elevation of the lowest influent pipe, whichever elevation is lower. Wet well volume shall be calculated by the following method:

$$T = \frac{V}{D-Q} + \frac{V}{Q}$$

Where:

T = Total time between successive pump starts in minutes (operating cycle)

D = Rated pump capacity in GPM

V = Storage volume between lead pump on and pump off elevations in gallons

Q = Inflow to wet well in GPM

The operation cycle 'T' shall not be less than 10 minutes for Average Flow and not more than 60 minutes for Minimum Flow conditions.

- Per TCEQ Rules, 30 TAC § 217.63:

(g) Systems for preventing the discharge of wastewater must operate for a duration at least equal to the longest power outage on record for the past 60 months, or at least 20 minutes, whichever is longer. The design must be based on peak flows, inflow, and infiltration. If the longest power outage on record for the past 60 consecutive months is greater than 48 hours and generators will be used to provide backup power, then the owner must have a contract in place that

guarantees fuel supply during an emergency. The owner must also have sufficient storage capacity at the wastewater treatment facility for the fuel for the duration of the emergency.

(h) For calculation purposes, the owner must assume that the lift station wet well is full to the pump activation level when the power outage period begins.

D. Force Main Capacity

Force main capacity shall be sized to meet the capacity of the entire sewer basin. The force main may be designed to handle a portion of the basin with approval from the Director of Wastewater Utilities. The minimum force main size shall be four (4) inches in diameter, except for Grinder Pump lift stations. The minimum recommended velocity is 3 feet per second (3 fps), and the velocity shall not be less than 2 feet per second (2 fps) when only the smallest pump is in operation.

4.20.4 Pumps

Acceptable pumps are listed in the City of Denton Approved Products and Materials List.

4.20.5 Mechanical

A. Force Main

1. Force mains 6-inches through 12-inches shall be polyvinyl chloride (PVC) meeting AWWA C-900 with a minimum working pressure of 150 psi and a minimum thickness of DR 18. Pipe larger than 12-inch diameter shall meet AWWA C-905 and minimum thickness of DR 18, 235 psi pressure class.

Force mains smaller than 6-inches may be approved with proper design justification, by the Director of Wastewater Utilities.

2. All fittings shall be ductile iron meeting AWWA C-110 or C-153. Interior of the pipe and fittings shall be lined with American Polybond Plus, which consists of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyethylene, or approved equal.
3. Force mains shall be laid to Denton Standard Construction Specifications for potable waterline.
4. Plans shall include plan and profile for the force main.
5. All force main contractors shall furnish and install non-metallic pipe detection tape. The pipe tape shall be green, 6-inch wide, 4 mils thick with 1-inch black continuous lettering "Caution Sewer Line Buried Below." The pipe tape shall be terra tape, extra stretch, or approved equal, and shall be installed on top of the sewer pipe embedment along the centerline of the pipe line.

B. Lift Station Interior Piping

1. Piping inside the lift station shall be ductile iron meeting AWWA C-150 and C-151. All fittings shall be ductile iron meeting AWWA C-110 or C-150. Interior of the pipe and fittings shall be lined with American Polybond Plus, which consists

of a primer layer of 5 mils thick fusion bonded epoxy and 55 mils thick of modified DuPont Fusabond Polyethylene, or approved equal.

2. All nut and bolt assemblies inside the wet well shall be ASTM 316 stainless steel, unless otherwise allowed.

C. Isolation Valves

1. Each pump shall have one isolation valve downstream of the pump.
2. Isolation valves shall be resilient seat gate valves or plug valves meeting the City of Denton Standard Construction Specification.
3. Isolation valves shall not be located inside the wet well. They shall be located in the building for self-priming stations and in a separate vault for submersible stations.

D. Check Valves

1. Check valves shall be controlled closing swing check valves with a lever arm or a ball check. There must be at least 15 feet of vertical head downstream in order to use a ball check valve.
2. A check valve shall be located upstream of the isolation valve.
3. If the station is submersible, then a check valve shall be located with the isolation valve in a separate vault. For self-priming stations, a check valve shall be located in the building. Under no circumstance shall the check valve be allowed in the wet well.
4. All external nuts and bolts shall be stainless steel.

E. Air Release/Vacuum Valves

1. 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.
2. The type of valve shall be air release or a combination of air release and vacuum breaker (see Drawing S803 on Sheet 6 of the City Standard Details). The design engineer shall determine the type and location, subject to approval of the Director of Wastewater Utilities.
3. Calculations for valve type and valve sizing shall be provided to the City.
4. Locations of the air release/vacuum valves shall be shown on the plan and profile sheets for the force main.
5. Isolation valves for 3 inches and smaller air release valves shall be all bronze or brass. Isolation valves 4 inches and larger shall meet City of Denton Standard Construction Specification for resilient seat gate valve.

6. Air release valves shall be fitted with blow off valves, quick disconnect coupling and hose to permit back flushing after installation without dismantling the valve.
7. Air release valves must be located in a vault as shown in Standard Details.

4.20.6 Electrical, Instrumentation and Supervisory Control and Data Acquisition (SCADA) Requirements

Due to rapid advances in technology and equipment in this area, contact the Director of Wastewater Utilities for the latest requirements.

4.21 Low Pressure Collection Systems

Low pressure collection systems may be allowed with specific approval by the Director of Wastewater Utilities.

4.22 On-Site Sewage Facilities

4.22.1 General

Planning, design and operation of on-site sewage facilities within the City of Denton must comply with the current Texas Administrative Code (TAC) Title 30, Part 1 TCEQ Rules, Ch. 285 for On-Site Sewage Facilities, as amended by the City of Denton. The property owner proposing to use an on-site sewage facility shall comply with the criteria listed in this Section, and Sections 35.11 and 35.12 of the City of Denton Development Code.

4.22.2 Permits Required

Any owner of a residential, commercial or institutional building who utilizes an on-site sewage facility is required to secure a permit from the City of Denton to construct, alter, repair or extend an on-site sewage facility regardless of the size of the lot or tract of land. Contact the Environmental Services Division at the Pecan Creek Water Reclamation Plant for details on permit fees and maintenance requirements.

4.22.3 Site Evaluations

A professional engineer or a professional sanitarian, licensed by the State of Texas, must perform site evaluations.

4.22.4 Planning Requirements

A professional engineer or a professional sanitarian, licensed by the State of Texas, must prepare on-site sewage facility plans.

4.22.5 On-Site Sewage Facility Land Use Requirements

Lots or tracts of land where an on-site sewage facility is proposed must have the following minimum area size.

- A minimum of 1 acre when a public water system serves the tract or lot.
- A minimum of 2 acres when a private water well is located on the tract or lot.

NOTE: Wastewater Drawings have been removed from this update, because they are contained in the City Standard Details. This Manual now references the applicable Standard Detail Sheet for those Drawings.

Section 5 – Construction Plans

5.1 General

Before any public works construction relative to a development may begin, City staff will verify the construction plans have been approved. Construction may not begin until the construction plans have been approved, all fees (including review and inspection fees) have been paid, all necessary agreements and bonds have been provided, and a Pre-Construction Conference has been held by the City.

5.2 Responsibility

The project engineer is responsible for the accuracy, completeness, and conformance of the submitted plans to City standards. The purpose of the City review is to ensure conformance to City policies and standards. The City review is limited to facts as presented on the plans submitted. The City has no project engineering design or design review responsibility. The engineer certifying the plans is responsible for the accuracy and completeness of the plan documents. The City reserves the right to require plan corrections to fit actual field conditions, which are found to be contrary to or omitted from the plans.

5.3 Format

Construction plans shall be digitally drawn on 24 in. by 36 in. size sheets; with borders of 22 in. x 34 in. so half-size reproduced plans will be to half-scale fitting 11 in. x 17 in. sheets. Each sheet shall be legible when reduced to half-size.

5.4 Plan Requirements

Construction Plans must contain, as a minimum, information listed in the following sections before they can be approved:

5.4.1 General

North arrow, scale, date and mean sea level elevations of all improvements, based on North America Vertical Datum 1988 (NAVD 88). Only NAVD 88 shall be used for plan elevations; no assumed or NGVD 29 elevations. Plans shall be drawn with a horizontal scale of one (1) inch equals forty (40) feet as a minimum, and appropriate corresponding

vertical scale. The plans shall provide a reference to the elevation benchmark or monument used in the development of the plans. Show all crossings of existing and proposed underground utilities. The construction plans shall be signed and sealed by a professional engineer, licensed by the State of Texas, prior to bidding the project for construction.

5.4.2 Water Systems

Horizontal alignment of the proposed water system within street rights-of-way and easements, with horizontal control points for location of the rights-of-way and easements and for location of the water system within the rights-of-way and easements. Plan and profile for water mains 12 inches in diameter or larger, showing pipe sizes, material and slopes and the location and stationing of valves, fire hydrants, fittings and other appurtenances, with a section showing pipe embedment or a note specifying the appropriate City Standard Detail. Show all service lines up to and including the meter can/vault. Adequate detail of other planned and existing improvements shall be shown to indicate planned crossings of utilities, stormdrains, and stormwater facilities and potential conflict points.

5.4.3 Sanitary Sewer Systems

Horizontal alignment of the proposed sanitary sewer system within street rights-of-way and easements, with horizontal control points for location of the rights-of-way and easements and for location of the sanitary sewer system within the rights-of-way and easements. Plan and profile for each sanitary sewer line showing existing and proposed ground level elevation at center line of pipe, pipe size, pipe slope, pipe material, manhole size, manhole rim elevation, flow line elevation and size for each "in" and "out" manhole pipe, and station numbers at 50 ft. intervals, with a section showing pipe embedment or a note specifying the appropriate City Standard Detail. The plan view shall include arrows indicating direction of flow in pipe. Show all service lines to and including the public cleanout. Adequate detail of other planned and existing improvements shall be shown to indicate planned crossings of utilities, stormdrains, and stormwater facilities and potential conflict points.

5.4.4 Grading

For situations involving proposed grading over existing water or sanitary sewer systems, provide a grading plan and profile showing the existing and proposed topography in two-foot contours. The grading plan shall consist of contours and spot elevations with water directional arrows to define the flow patterns.

Section 6 – Rights-of-Way and Easements

6.1 *Right-of-Way Requests and Approvals prior to Contract/Work Order*

Prior to release of any project for construction contract or work order, right-of-way (ROW) must be cleared. This means all highway, railroad, Park Department approvals, easements, releases, agreements, covenants, etc. required for the project must be properly executed. Documents used must be City “approved as to form” documents. All executed documents are to be provided to the appropriate City Office and recorded with the County Clerk’s office (if applicable).

6.2 *Within Existing City ROW and Easements*

When planning to utilize an easement for utility extensions, the design engineer should review the rights provided by that easement to ensure the easement can be used for the planned utility, e.g., some easements may grant permission for an underground water line, but not include permission for placement of wastewater lines.

If the project falls entirely within an existing City ROW or water, wastewater or utility easement, the design engineer must request and obtain approval of a Permit to Construct within City ROW from the Public Works Inspection Division. This request must be made on the permit application form available from Public Works Inspection.

If the easement is a Denton Municipal Electric (DME) easement, and the design engineer wishes to cross a section of that easement, a letter or permission from DME will be required in addition to an easement from the property owner.

6.3 *City Easement and ROW Acquisition*

For a City project, the design engineer is to involve the Real Estate Division in the project from the planning stage to assist in selecting routings which will alleviate ROW costs to the lowest practical level. Real Estate will perform all ROW acquisition duties required by the project plans and delivery schedule, under the direction of the Project Manager.

If easements, rights-of-way or railroad approvals must be acquired for a development project, the development design engineer must submit a request to the Real Estate Division, using the appropriate forms available from Real Estate. Acquisitions can be time consuming; often requiring 6 - 12 months. In the case of an application for a private development, the development design engineer should plan for this activity and duration and submit the appropriate forms and permit applications Real Estate as early as possible.

For development projects, the document preparation and acquisition procedures for easements or street rights-of-way are outlined in the following paragraphs:

-
- A. The design engineer shall provide the Real Estate Division the following documents, so the proper land rights conveyance instruments can be prepared by Real Estate staff, under the direction of the City Attorney:
1. A copy of the current affected landowner's deed.
 2. A written metes and bounds description of the limits of the easement required by the approved design plans, labeled with a conspicuous header titled "EXHIBIT A", and successive page numbering such as "Page 1 of 3, Page 2 of 3,..." prepared, signed and sealed by a licensed land surveyor.
 3. A survey plat drawing depicting the limits of the easement required by the design plans, labeled with a conspicuous header titled "EXHIBIT B", and successive sheet numbering such as "Sheet 1 of 3, Sheet 2 of 3, ..." prepared, signed and sealed by a licensed land surveyor.
- B. Upon receipt of the documents cited in Paragraph A above, Real Estate will:
1. Perform a cursory review of the documents submitted and coordinate with the appropriate Engineering Development Review Committee engineer(s) to ensure the survey documents submitted conform and match the easement requirements of the approved design plans.
 2. Upon an endorsement by development review engineer(s), verify the current landowner by research of public records and prepare the appropriate land rights conveyance instrument(s), as approved to form by the City Attorney, with the respective boundary survey document attachments provided by the development design engineer.
 3. Calculate the fee cost necessary to record the given land rights conveyance instrument in the Real Property Records of Denton County, Texas and provide that fee information to the applicant and/or design engineer, along with the final form land rights conveyance instrument packet.
- C. After receipt of the land rights conveyance instrument form(s) from Real Estate by the developer or design engineer, it is the sole responsibility of the applicant or design engineer to negotiate for and acquire the necessary land rights of the project as evidenced by the notarized execution of the "approved to form" land rights conveyance instrument(s) by the affected landowner. Any monetary consideration, payments, special terms, conditions, inducements, promises and other considerations shall be addressed by separate agreement(s) between the affected landowner and developer; no duties or obligations shall be assigned to the City of Denton, outside of the language provided in the "approved to form" land rights conveyance instrument(s). Real Estate will only accept properly executed and notarized "approved to form" documents.
- D. After proper execution and notarization, the original executed land rights conveyance instrument(s) shall be delivered to Real Estate for further processing and recordation in the Real Property Records of Denton County, Texas. A check must also be provided, payable to "Denton County Clerk", in the amount of the recordation fee

- amount previously identified by Real Estate for the document(s). NOTE: THE CHECK FOR THE RECORDATION FEE MUST BE DRAWN ON A BUSINESS ACCOUNT.
- E. Upon receipt of the conveyance document(s) and recording fee check by Real Estate, a cursory review will be performed and, if all is found to be correct, the instrument will be executed for City acceptance by the Real Estate Manager. Real Estate will then record the documents in the Real Property Records of Denton County, Texas.
 - F. Upon receipt of the recorded land rights conveyance instrument from the Denton County Clerk, Real Estate will provide the applicant or design engineer with a copy of the recorded instrument and a copy of the recordation receipt.

6.4 Non-City ROW Permits and Approvals

A. Railroad Permits

Railroad permit approvals require considerable time. Therefore, the design engineer should coordinate and submit railroad permit requests to the Real Estate Division as early as possible. In some instances, it may be desirable to perform the railroad crossing under a separate contract or work order. When making a request, the request form shall be accompanied by four (4) sets of prints with the railroad crossing highlighted. Real Estate will notify the design engineer when the railroad permit approval has been received and provide a copy of the approved permit.

B. Texas Department of Transportation (TxDOT) Utility Permit Approvals

All water and wastewater utility work within TxDOT rights-of-way require TxDOT Utility Permit approval. TxDOT's requirements and procedures for Utility Permits are included in TxDOT's "Use of Right-of-Way by Others Manual," which can be found online at:

<http://onlinemanuals.txdot.gov/txdotmanuals/use/use.pdf> .

Development design engineers should coordinate with and submit their TxDOT Utility Permit applications through Engineering Development Review for any City utility work associated with land development. TxDOT requires the utility owner to submit the permit for any utilities within TxDOT ROW.

City design engineers will process TxDOT Utility Permits as part of their project work.

In addition to the proposed utility construction plans, a traffic control plan must be submitted with the TxDOT Utility Permit application by the design engineer. The traffic control plan must conform to the latest version of the "Texas Manual of Uniform Traffic Control Devices."

C. Denton County Utility Permit Approvals

All water and wastewater utility work within Denton County rights-of-way require Denton County Utility Permit approval. Denton County's requirements and

procedures for Utility Permits are included in their “Utility Installation Requirements” publication, which can be found online at:

<https://dentoncounty.com/-/media/Departments/Public-Works-Engineering/Forms/Utility-Installation-Requirements.pdf?la=en>

A “Utility Installation Permit Request” must be completed and submitted, which can be found online at:

<https://dentoncounty.com/-/media/Departments/Public-Works-Engineering/Forms/Utility-Installation-Permit-Request.pdf?la=en>

Design engineers should submit their Denton County Utility Permit applications directly to the Denton County Engineering Division for any City utility work. A copy of the approved Denton County Utility Permit shall be provided to City Public Works Inspection prior to commencing work on the project.

D. Private and Non-City Utility Easement Use Approval

When a proposed water or wastewater main crosses a non-City utility that has its own easement, a letter of permission or encroachment agreement from the affected utility is required in addition to an easement from the affected property owner.

An example of this would be a wastewater main crossing privately held oil or gas pipeline in designated private easement. In those instances, a wastewater easement should be obtained from the underlying property owner for the entire width of the private easement, and a separate letter of permission or encroachment agreement obtained from the non-City utility owner for the area of the wastewater main crossing easement.

Section 7 – Addenda, Plan Revisions and Change Orders

7.1 *General*

This section provides direction to the design engineer to ensure plan modifications are properly incorporated into the project. Occasionally, after the design engineer has submitted and received approval of the final plans and specifications and bid advertising has begun or a work order has been initiated, the design must be altered due to receipt of additional information requiring a design modification. The importance of the time factor for performing any required modification cannot be over-emphasized. The design engineer must make the modifications quickly and coordinate those changes with the appropriate parties (the approving and bidding authorities).

7.1.1 *Development Projects*

The development design engineer must submit any proposed design changes to Engineering Development Review for review and approval as soon as practically possible.

7.1.2 *City Projects*

The City's design engineer is not to attempt to contact contractors at any time concerning addenda, plan revisions or change orders. All contact must be through Capital Projects Engineering for issuance of addenda prior to bid opening or through Public Works Inspection for plan revisions and change orders after bid award.

7.2 *Addenda*

An addendum is required when there is a change in plans or specifications during advertisement, but prior to the receipt of bids. The change may be initiated by the design engineer or by an external party.

7.2.1 *Development Projects*

After the development design engineer has received approval from Engineering Development Review for a design change, the design engineer is responsible for preparing and issuing the appropriate addendum to the affected parties.

7.2.2 *City Projects*

After the City's design engineer has identified the required design changes, he is responsible for immediately notifying the City's Project Manager. After approval of the design changes by the Project Manager and consultation with the Purchasing Department to determine if the advertising schedule permits an addendum, the required changes in plans and specifications and resulting addendum must be prepared quickly by the design engineer. All revisions by addendum must be submitted by Capital Projects Engineering to Purchasing no later than 10 calendar days prior to the bid opening date in order to allow Purchasing to adequately notify all plan holders of any contract modifications prior to receipt of bids.

7.3 Plan Revisions

A plan revision is a modification in design after award of the contract. A plan revision is usually a minor change in alignment horizontally or vertically where little or no quantity change or additional bid item is involved. This type of modification may also be initiated by the design engineer or by an external party, during construction of the project. Timely modifications and communications must also be made in this situation to ensure construction is not delayed.

7.4 Change Orders

A change order is required when there is a modification in the plans or specifications that involves a quantity change, an additional bid item not previously bid by the contractor, or any other change which involves a change (increase or decrease) in the contract dollar amount or time.

7.4.1 Development Projects

After approval of the design changes by Engineering Development Review, change orders will be handled by the development design engineer, with appropriate notification to Engineering Development Review and Public Works Inspection. Change orders increasing the cost of public infrastructure items require an increase in the maintenance bond and may require an increase in the performance and payment bonds. The increase in costs will also require additional City inspection fees.

7.4.2 City Projects

All change order negotiations will be conducted by Capital Projects Engineering. Change orders totaling \$50,000.00 or less may be approved by "Administrative Action" and do not require City Council approval. Change orders greater than \$50,000 over the original contract dollar amount require Public Utilities Board (PUB) approval recommendation (in the case of utilities) and City Council approval. In all cases, a change order increase cannot exceed 25% of the original contract award amount. Change order decreases that exceed 25% of the original contract award amount must have the consent of the contractor and require Administrative, or PUB and Council approval. Additionally, the design engineer is responsible for providing written justification and notification to Capital Projects Engineering on all ongoing change orders.

7.5 Method of Plan Modification

The design engineer is responsible for making all required modifications to the plans. Several changes may be made under a single addendum, plan revision, or change order. Regardless of which type of change is being implemented, each plan modification made as a "group" under these processes is to be designated with a number within a triangle, and this designation is to be placed by each note, or other item being changed. Subsequent modifications to the design should be designated sequentially, e.g., 1, 2, 3, etc. The original design is not to be erased; it must be crossed out or otherwise indicated as void.

The design engineer is to furnish Public Works Inspection with at least six (6) sets of prints of the modified plan sheets. More prints may be required if an addendum is being processed. Public Works Inspection will determine the exact number of prints required of the design engineer.

7.6 *Distribution of Modified Plans or Specifications for City Projects*

The Capital Projects Engineering Division is responsible for distributing the modified plans or specifications to all affected parties and initiating City Council agenda items, if required.

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Section 8 – Submittals

8.1 *General*

If a specialized project requires unique construction methods or materials, control of the quality of those methods or materials must be assured. A contractor has a multitude of options that can be employed on any project and still fall within the guidelines outlined in the specifications of that project, yet the end result may not be exactly what the design engineer desired. Some control of the quality methods or materials can be obtained by requiring the contractor to furnish submittals for approval by the design engineer prior to construction.

8.2 *Material and Shop Drawing Submittals*

A material submittal is a proposal by a manufacturer through the contractor to the City of Denton Public Works Inspection Division for an item or material or an approved equal to the item or material that is acceptable to the City of Denton and that has been specified by the design engineer. A shop drawing is a drawing, diagram, schedule or other data specially prepared by the contractor or subcontractor, manufacturer, supplier or distributor to illustrate some portion of the work. A shop drawing may be required of a contractor when specific construction phases, methods or procedures require analysis to determine their conformance to approved performance, quality or safety, e.g., Trench Safety, a structural fabrication or assembly, or mechanical and electrical/electronic assemblages.

Submittals on specific items usually consist of the manufacturer's technical specifications which state materials, components, performance tests as noted by an approved laboratory, dimensions, finishes, and limitations or operational ranges of items. Submittals on specialized construction methods should state steps, procedures and construction sequences that the contractor proposes to follow. These items can be submitted as "catalog cut sheets", letters of certification by the manufacturer or notarized letters by the contractor. These items can be submitted for review either as a package or separately.

One (1) set of submittals (preferably in digital format) is required of the contractor. All submittals are to be submitted to Public Works Inspection prior to review by the design engineer for City construction contracts. For development contracts, the submittals are to be provided to the development design engineer for review, who is to submit the approved submittals to Public Works Inspection for review and final approval by the City. Two submittals, accompanied by a City transmittal letter, are to be returned to the contractor through Public Works Inspection.

8.3 *Standards for Pipe*

Pipe and related fittings should conform to or have a designation of certification by the American Water Works Association (AWWA) or the American National Standards Institute (ANSI). Other materials should conform to American Society for Testing and Materials (ASTM).

8.4 Submittal Review

The design engineer shall review the materials submittals, within 3 working days, for conformance to the item specified, including kind, type, size, operational limits, component materials, etc., and submit the approved materials listing to Public Works Inspection, who will also review the materials submittals and carefully check for conformance to the City of Denton Approved Materials Listing, City of Denton Construction Standards, and the contract plans and specifications.

After review and approval, within 3 working days, by the development design engineer, Engineering Development Review will review and approve shop drawings for development projects. For City construction projects, the design engineer will review and approve shop drawings, within 3 working days, and submit the approved drawings to the appropriate Project Manager and Public Works Inspector.

8.5 Nonconformance of Submittal

After review, if the submittal does not conform, the appropriate reviewing authority will stamp the submittal accordingly and return them to the design engineer and contractor, with a letter stating which item(s) were not acceptable and why.

8.6 Submittal Acceptable with Minor Exceptions

If the submittal is acceptable with minor exceptions, the plans are to be stamped accordingly and the minor exceptions noted in the submittal. A letter from the appropriate reviewing party stating the minor exceptions will accompany the return of the submittal to the contractor.

8.7 Acceptable Submittal

If the submittal is acceptable without exception, the plans are to be stamped accordingly, and a letter by the appropriate reviewing authority stating the acceptance will be returned to the contractor with the submittal.

8.8 Submittal Records

The design engineer and Public Works Inspector are to maintain a "Submittal Log" and keep copies of all submittals whether approved or disapproved in the project file.