



PROGRESS IN MOTION.

ENGINEERING STANDARDS

THE CITY OF FRISCO, TEXAS

Record of Revisions

JUNE 2012	Engineering Standards adopted by Council as Appendix to Subdivision Ordinance
JUNE 2017	Revisions made to the Engineering Standards include, but are not limited to, the following:
SECTION 1	GENERAL REQUIREMENTS
	1.11: Removed section regarding the use of Easement Use Agreements.
SECTION 2	THOROUGHFARE DESIGN REQUIREMENTS
	2.02.F: Made minor revisions to roundabout design requirements.
	2.02.K: Specified the orientation of head-in angled parking along a public street.
	2.03.B.4: Specified the location of the first median opening downstream of a roundabout.
	2.03.B.6: Clarified the distance between a median opening and the closest driveway that is not served by a median opening.
	2.03.D: Specified where deceleration lanes shall not be installed when in proximity to a roundabout.
	2.04.F: Clarified the pavement design for an alley that also serves as a fire lane.
	2.04.L: Created new standards and requirements for a mews, a special type of alley that serves homes that do not front onto a street.
	2.05.C: Reiterated prohibition of residential driveways connecting to roundabouts.
	2.05.D: Reduced minimum commercial driveway width on a Type C thoroughfare from 30 feet to 24 feet (Table 2.9).
	2.05.E: Reduced minimum curb radius for commercial driveways on a commercial or residential collector (Table 2.10).
	2.05.G.3: Specified driveway spacing from an arterial roundabout.
	2.06.B.7: Clarified that fences and walls are not allowed within sidewalk easements.
	2.07.C: Clarified the use of Table 2.13; clarified that a smaller sight distance can be used for driveways on a divided roadway that are not located at a median opening; specified the design speed for sight distance calculations on a fire lane; and clarified where the 150-foot sight distance can be applied (Table 2.13).
	2.07.E: Specified sight distance restrictions for street trees planted between the curb and the sidewalk.
	2.07.F: Specified sight distance requirements for fire lanes, including specific restrictions for dumpster enclosures and parking garage exits.
	2.08.C: Updated frontage road access restrictions near entrance and exit ramps.
	2.09.E.3: Clarified that funds escrowed for a future traffic signal may be used to construct a roundabout in lieu of a traffic signal.
	2.10: Updated street lighting standards to include the latest LED technology.
	2.10.D: Specified decorative street lighting standards in urban centers.
	2.11.F: Specified blue street name signs for public ways and the color combinations possible for street name signs within City-approved public or private special districts.
	2.12.C.5: Specified traffic study requirements for any proposed full service car wash.
	2.12.I.4: Specified that TIAs shall analyze roundabouts before traffic signals are considered along Type B thoroughfares or 4-lane Type A thoroughfares.
	2.13.B: Specified the stacking spaces required to be constructed at a proposed full service car wash.

2.13.C: Specified requirements for structured parking garages, including the number of driveway access points, a separate pedestrian entrance, the provision of sight distance at garage exits, and limitations on column and barrier cable encroachments into parking spaces within the garage.

SECTION 3

PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS

Reorganized Section 3 in its entirety.

3.01: Replaced the Pavement Design Catalog with Pavement and Subgrade Minimum Requirements (Table 3.1). Removed the geotextile/CTB option previously included in the Pavement Design Catalog. Increased the minimum depth from 2-ft to 4-ft when moisture conditioning is required. Reduced minimum lime thickness and application rate. Added jointing plan requirement for roundabouts.

3.02: Added re-evaluation requirement.

3.03: Added requirement to perform both Swell Test and TxDOT method, and to use more conservative value in evaluating swell potential.

3.04: Provided guidance on flexible base subgrade alternative.

3.05: Updated the Pavement Design Inputs (Table 3.2) to align with City's minimum pavement thicknesses.

Clarified Geotechnical Report for Roadways submittal requirements by including a checklist of items to address.

Created a Summary of Geotechnical Recommendations Form.

SECTION 5

UTILITY DESIGN REQUIREMENTS

5.01.2: Redefined depth of cover requirements for water mains.

5.01.3: Clarified separation distances between water and wastewater mains.

5.01.4: Updated Average Daily Water Demands (Table 5.1) based on new Master Plan.

5.02.3: Clarified separation distances between wastewater and water mains.

5.02.4: Updated Wastewater Flow Projections (Table 5.4) based on new Master Plan.

5.08.D: Requires steel encasement of wastewater mains when crossing concrete box storm sewers.

SECTION 6

LANDSCAPING DESIGN REQUIREMENTS

6.02 (Figure 6.1): Pavers or Stamped Concrete required in median when width is less than 8' (previous was 6').

6.02.F: Specified how far median trees should be planted from street lights.

6.02.M: Sod is required to cover entire median area instead of 4' behind curb.

6.02.R: Specified requirements for landscaping within a roundabout.

SECTION 7

IRRIGATION DESIGN REQUIREMENTS

7.01.E: Only irrigation piping and boxes currently connected to the Reclaimed Water system should be purple.

7.02.I: Clarification on the irrigation system requirements for backflow prevention.

SECTION 8

ENVIRONMENTAL REQUIREMENTS

8.04.I: Requires an erosion control plan for each major phase of a project.

SECTION 9 STRUCTURAL DESIGN REQUIREMENTS

9.10.B: Engineer of Record is permitted to act as third-party inspector to perform inspections and certify construction.

SECTION 11 WELL REQUIREMENTS

Section 11 added with this update.

GN GENERAL NOTES

All Construction Activities (#5): Contractors are required to pay for the cost of meters and water used on projects.

Paving (#3): Clarified when machine or hand finished pavement placement is allowed.

Storm Drain (#3): Added recommendation for inspection of existing storm drain lines prior to connection.

Storm Drain (#4): Added recommendation for inspection and cleaning of storm drain outfalls prior to final inspection.

Erosion Control & Stormwater (#3): Wire reinforcement of silt fence is required.

Water Wells: New section of General Notes added for water wells.

TS TECHNICAL SPECIFICATIONS

Refer to Technical Specifications Table of Contents for revisions dated June 2017.

AM APPROVED MATERIALS LIST

Updated list included.

SD STANDARD DETAILS

Refer to Standard Details Table of Contents for revisions dated June 2017.

AUGUST 2020 Revisions made to the Engineering Standards include, but are not limited to, the following:**SECTION 1 GENERAL REQUIREMENTS**

1.10.B: Revised plans submittal requirements. Merged former paragraph C with previous paragraph to create a single paragraph of instruction resulting in renumbering of 1.10.C through 1.10.G.

1.10.C: Updated language to include “(if requested)” as part of the paragraph and paragraph number for reference regarding survey requirements.

1.10.E: Reiterated the review and approval of plans by city does not remove responsibility for standards and accuracy from The Engineer of Record.

1.10.H: Inserted directions for obtaining a construction plan checklist for plan sets submitted at the pre-construction conference.

1.10 I: Added possible requirement of a condition assessment of existing infrastructure.

1.11 C: Removed language regarding payment of fee to the city within the process steps for acquiring an easement.

1.11.F: Added expectations of easement abandonment with regard to easements within a City ROW, Street easement, Public Way, FAUE, or general UE.

1.11.G: Updated language to include “private” as part of the paragraph related to the existing easement and added requirement for encroachment agreement when a public infrastructure crossed an existing easement.

SECTION 2

THOROUGHFARE DESIGN REQUIREMENTS

2.0: Various revisions and clarifications throughout Section 2.

2.02.K.4: Added requirement for a right-turn lane on a residential collector where it meets a major roadway.

2.02.N.5: Added requirements for installing privately maintained items in the ROW.

2.03.E.3: Added requirement for a right-turn lane on a commercial collector where it meets a major roadway.

2.04.L: Added various requirements for how mews alleys can intersect with other mews alleys and residential streets.

2.05.B.5.d: Added requirement for a right-turn lane on a high capacity driveway where it meets a major roadway and is a potential location for a traffic signal.

2.06.B.18: Added restrictions on vertical obstructions being installed or incorporated into a sidewalk.

2.07.A.6: Added requirements for a pedestrian visibility triangle where a divided roadway or driveway intersects a major roadway.

2.13.F: Added requirements for the design of off-street parking spaces.

SECTION 3

PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS

3.01.H: Revised geogrid requirements.

3.01.J: Revised moisture conditioning requirements.

3.03.C: Removed moisture conditioning for Eagle Ford and Austin Chalk soil characteristics.

SECTION 4

DRAINAGE DESIGN REQUIREMENTS

Complete rewrite.

4.08.E.4: Updated paragraph to exclude “wyes” from the head losses parameters.

4.08.E.6: Updated paragraph to include “wyes” to the head losses and gains to the parameters.

TABLE 4.5: Updated Manhole schematic column heading to include “wyes” in the description.

4.09.B.4: Added additional paragraph for parameters for the Detention Storage Calculation.

4.11.L: Complete paragraph rewrite to include additional requirements.

SECTION 5

UTILITY DESIGN REQUIREMENTS

5.01.D: Inserted new requirement for developments to connect to two independent water sources.

5.01.D: Renumbered to 5.01.E.

5.01.E.: Renumbered to 5.01.F.

5.01.1.E: Added prohibition of water mains in the center of roundabouts.

5.01.3: Replaced entire section with requirements pulled from DWU Water and Wastewater Procedures and Design Manual Section 2, pages 26 – 34 with various edits to meet City of Frisco needs.

5.01.3.E: Revised requirements for water mains in crossing under a wastewater main.

- 5.01.7: Added requirements for separate irrigation meters for non-single-family developments and increased fire service line requirement from 6" to 8".
- 5.01.7.I: Added requirement for a line size reducer to be installed on the stub out piping from the vault.
- 5.01.8: Added additional requirements for anchoring and location of isolation valves.
- 5.01.9: Revised splash pad specifications for fire hydrants located near parking or in open spaced landscaped areas.
- 5.01.9.P: Added requirement to prohibit removal and installation of fire hydrants older than 8 years and stipulate new fire hydrants be installed.
- 5.01.10: Revised requirements to use existing stub-outs when connection to existing water mains.
- 5.01.10.D: Added requirement for use of a tee and valve when connecting to a waterline at the branch of tee and defining parameter for allowance of direct tapping to a water line.
- 5.01.13: Revised water line abandonment requirements.
- 5.02.1: Added requirement that wastewater mains not be located within the center of roundabout.
- 5.02.7: Added requirement regarding plugging unused wastewater service laterals and main stub outs at the manhole.
- 5.02.8: Added polymer concrete as an accepted material for construction of manholes and requirements for opening size of modified manholes.
- 5.02.10: Revised requirements for location of lift station perimeter fence with regard to residential lot lines.
- 5.02.13: Inserted additional paragraph regarding specifics for Main Line and Manhole Abandonment.
- 5.03.D: Inserted new paragraph stipulating when a reclaimed water storage facility is permitted and the requirements to be met if permitted.
- 5.08.D: Added potential encasement of water and wastewater mains when crossing a storm sewer pipe.
- 5.08.E.2: Inserted new paragraph stipulating the requirement for hydrology and hydraulic studies for approved aerial crossings for water and wastewater mains.
- 5.08.F: Added specifications for franchise/dry utility crossings.

SECTION 6

LANDSCAPING DESIGN REQUIREMENTS

- 6.02.M: Inserted paragraphs 1 and 2 stipulating timing of planting of Buffalo Grass and exceptions must have written permission of the Director of Engineering Services.
- 6.03.B: Inserted stipulation that Buffalo Grass be used in median plantings.
- 6.03.C: Inserted stipulation that Bermuda Grass be used along parkways.

SECTION 8

ENVIRONMENTAL REQUIREMENTS

Complete rewrite.

- 8.04: Added stipulation that a copy of the SWP3 and NOI must be provided to the city prior to scheduling of preconstruction meeting.
- 8.04.A: Inserted a paragraph regarding parameters in which a sedimentation basin is required.

SECTION 9

STRUCTURAL DESIGN REQUIREMENTS

- 9.01.B: Added inlets as a defined structure within this section of the Engineering standards.

9.02.F: Inserted specifications for concrete that is exposed to sulfate containing solutions or soils.

9.02.F: Renumbered to 9.02.G.

9.02.G: Renumbered to 9.02.H.

9.02.H: Renumbered to 9.02.I.

9.02.I: Renumbered to 9.02.J.

9.05.H: Added parameters for privately owned retaining walls.

SECTION 10

SURVEY REQUIREMENTS

10.02.F: Deleted old paragraph and inserted new more detailed Electronic Submittal Requirements.

10.03: Updated section heading and rewrite of platting requirements including but not limited to monuments, property line amendments, right of way, easements, preliminary plats, and final plat acceptance.

10.03.A: Corrected incorrect reference.

10.03.A.1: Inserted the phrase “(with three-dimensional coordinates)” to the Surveyor requirements of providing two monument requirements.

10.03.A.8.a: Inserted new paragraph stipulating offsite easements adjacent to the boundary of the plat be shown.

10.03.A.11.a: Inserted new paragraph stipulating labeling of dedicating new easements.

10.03.A.22: Inserted new paragraph stipulating labeling of abandoned easements and rights-of-way.

10.03.A.23: Inserted new paragraph stipulating all information shall be the most current and proper scale on a plat.

GN

GENERAL NOTES

Landscaping (#18, 18.a and 18.b): Added requirements for median planting times, requirements outside of the planting time, and removal of temporary stabilization and installation of Buffalo Grass.

Water and Wastewater (#4): Added replacement requirements for fire hydrants exceeding age of 8 years and return of the replaced hydrant to the Public Works Department.

Water and Wastewater (#5): Added requirements regarding the modification of manhole covers smaller than 30”.

TS

TECHNICAL SPECIFICATIONS

Refer to Technical Specifications Table of Contents for revisions dated August 2020.

AM

APPROVED MATERIALS LIST

Updated list included.

SD

STANDARD DETAILS

Refer to Standard Details Table of Contents for revisions dated August 2020.

Table of Contents

Part A – Design Standards		Page
SECTION 1	GENERAL REQUIREMENTS	1-1
1.01	Short Title.....	1-2
1.02	Interpretation	1-2
1.03	Enforcement	1-3
1.04	Amendment	1-3
1.05	Variance Requests	1-3
1.06	Applicability	1-3
1.07	Other Local, State and Federal Environmental Regulations	1-3
1.08	Texas Accessibility Standards (TAS).....	1-4
1.09	Engineering Design Criteria – Section Descriptions.....	1-4
1.10	Submittal Requirements for Construction Plans	1-6
1.11	Easements.....	1-7
1.12	Fees.....	1-9
SECTION 2	THOROUGHFARE DESIGN REQUIREMENTS	2-1
2.01	General	2-2
2.02	Street Design	2-2
2.03	Median, Left-Turn Lane, Right-Turn Lane, Deceleration Lane, and Island Design	2-28
2.04	Alley Design.....	2-37
2.05	Driveway Design.....	2-43
2.06	Sidewalk Location and Design.....	2-52
2.07	Public Right-of-Way Visibility Requirements	2-57
2.08	Frontage Road Design.....	2-62
2.09	Traffic Signal Installation.....	2-62
2.10	Street Lighting.....	2-64
2.11	Street Name Signs	2-68
2.12	Traffic Impact Analysis and Mitigation	2-69
2.13	Internal Site Circulation Requirements	2-76
SECTION 3	PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS	3-1
3.01	General	3-2
3.02	Existing Surface/Subsurface Investigation.....	3-3
3.03	Subsurface Design.....	3-4
3.04	Subgrade Design	3-5
3.05	Pavement Design.....	3-6
	Geotechnical Report for Roadways Checklist.....	3-8
	Summary of Geotechnical Recommendations Form.....	3-10
SECTION 4	DRAINAGE DESIGN REQUIREMENTS	4-1
4.01	General	4-2
4.02	Determining Design Discharge	4-2
4.03	Downstream Assessment.....	4-7

4.04	Street Capacity	4-9
4.05	Alley Capacity	4-10
4.06	Valley Gutters	4-10
4.07	Inlet Location and Capacity	4-10
4.08	Design of Enclosed Storm Sewer System	4-17
4.09	Detention/Retention Facility Design	4-21
4.10	Miscellaneous Drainage Requirements	4-23
4.11	Open Channel Design.....	4-24
4.12	Hydraulic Design of Culverts.....	4-29
4.13	Bridge Design Hydraulics	4-30
4.14	Energy Dissipators	4-31
4.15	Floodplain Alterations.....	4-31
4.16	Erosion and Sedimentation Control	4-32
4.17	Drainage Easements	4-33
4.18	Storm Water Quality Treatment.....	4-34
4.19	Sustainable Development	4-39
SECTION 5	WATER & WASTEWATER DESIGN REQUIREMENTS	5-1
5.01	Water System – General.....	5-2
5.01.1	Water Main Location.....	5-2
5.01.2	Horizontal and Vertical Alignment	5-2
5.01.3	Separation Distance between Water and Wastewater Mains	5-3
5.01.4	Average Daily Water Demands.....	5-9
5.01.5	Water Main Sizing	5-10
5.01.6	Water Main Materials.....	5-11
5.01.7	Water Services.....	5-11
5.01.8	Valves.....	5-12
5.01.9	Fire Hydrants.....	5-13
5.01.10	Connections to Existing Water Mains.....	5-14
5.01.11	Backflow Prevention	5-14
5.01.12	Automatic Flushing Valve.....	5-15
5.01.13	Water Line Abandonment	5-15
5.02	Wastewater System – General.....	5-16
5.02.1	Wastewater Main Location	5-16
5.02.2	Horizontal and Vertical Alignment	5-16
5.02.3	Separation Distance between Wastewater and Water Mains	5-17
5.02.4	Wastewater Flows	5-17
5.02.5	Wastewater Main Sizing	5-18
5.02.6	Wastewater Main Materials.....	5-18
5.02.7	Wastewater Service Laterals	5-19
5.02.8	Manholes and Cleanouts	5-19
5.02.9	Inverted Siphons.....	5-20
5.02.10	Wastewater Lift Stations	5-21
5.02.11	Force Mains.....	5-22
5.02.12	Dumpster Enclosure Drains.....	5-22
5.02.13	Wastewater Abandonment	5-22
5.03	Reclaimed Water System – General.....	5-22
5.03.1	Reclaimed Water Main Location	5-23
5.03.2	Horizontal and Vertical Alignment	5-23
5.03.3	Separation Distance between Reclaimed Water and Other Systems.....	5-23

5.03.4	Reclaimed Water System Materials	5-23
5.04	Easements	5-24
5.05	Thrust Restraint	5-25
5.06	Pavement Cut and Repair	5-25
5.07	Trenchless Construction	5-25
5.08	Crossings	5-26
5.09	Corrosion Protection.....	5-28
SECTION 6	LANDSCAPING DESIGN REQUIREMENTS	6-1
6.01	General	6-2
6.02	Landscape Requirements within the Median	6-2
6.03	Approved Plant Materials.....	6-4
SECTION 7	IRRIGATION DESIGN REQUIREMENTS	7-1
7.01	General	7-2
7.02	Roadway Irrigation Requirements.....	7-2
7.03	Additional Irrigation Design Requirements within Roadway	7-3
SECTION 8	ENVIRONMENTAL REQUIREMENTS	8-1
8.01	General	8-2
8.02	Storm Water Management Plan (SWMP) – Permanent Controls	8-2
8.03	Texas Construction General Permit (CGP)	8-3
8.04	Storm Water Pollution Prevention Plan (SWP3).....	8-3
SECTION 9	STRUCTURAL DESIGN REQUIREMENTS	9-1
9.01	General	9-2
9.02	Code Requirements	9-2
9.03	Geotechnical Performance Specifications	9-4
9.04	Bridge Design.....	9-6
9.05	Retaining Wall Design	9-7
9.06	Slope Stability Design Criteria.....	9-9
9.07	Screening Wall Design Criteria.....	9-9
9.08	Excavation Support	9-9
9.09	Construction Plans.....	9-10
9.10	Construction Inspection and Certification.....	9-13
SECTION 10	SURVEY REQUIREMENTS	10-1
10.01	General	10-2
10.02	Survey Markers and Monumentation	10-2
10.03	Platting Requirements	10-4
SECTION 11	WATER WELL DESIGN REQUIREMENTS	11-1
11.01	General	11-2
11.02	References	11-2
11.03	Well Design Requirements.....	11-4
11.04	Casings	11-5



11.05	Well Screens.....	11-7
11.06	Gravel Pack	11-9
11.07	Sanitary Seal / Grout	11-9
11.08	Vertical Turbine Pumps.....	11-9
11.09	Low-Voltage AC Induction Motors	11-10
11.10	Well Verification.....	11-11

Part B – Construction Standards

GN – General Notes
TS – Technical Specifications
AM – Approved Materials List
SD – Standard Details
Appendix A – Definitions and Abbreviations



DS
DESIGN STANDARDS



SECTION 1 – GENERAL REQUIREMENTS

Section 1 – General Requirements

1.01 Short Title

These are hereby adopted as a part of the “Engineering Standards”, Sections 1 – 11 and Appendices, including Technical Specifications and Standard Construction Details which shall be in full force and effect from and after the effective date of adoption of the Engineering Standards.

1.02 Interpretation

In the interpretation and application of the provisions of these regulations, it is the intention of the City Council that the principles, standards and requirements provided for herein shall be minimum requirements for the design of both subdivisions and municipal capital projects in the City, and, where other City ordinances or regulations of the City are more restrictive in their requirements, such other ordinances or regulations shall govern.

The City has adopted various ordinances and master plans, which address various requirements not explicitly included in the Engineering Standards, including, but not limited to the following. The Engineer is responsible for understanding and complying with the City’s various ordinances and master plans.

- A. Building Code
- B. Water Capital Improvement Plan
- C. Wastewater Capital Improvement Plan
- D. Reclaimed Water Capital Improvement Plan
- E. Comprehensive Plan;
- F. Flood Damage Prevention Ordinance
- G. Hike and Bike Master Plan
- H. Impact Fee Ordinance
- I. International Fire Code (Including Oil and Gas Drilling)
- J. Parks, Recreation & Open Space Master Plan;
- K. Preston Corridor Access Management Plan;
- L. Right-of-Way Management Ordinance;
- M. Subdivision Ordinance;
- N. Tributary Study;
- O. Zoning Ordinance;

1.03 Enforcement

The City's Engineering Standards are issued by the Engineering Services and Public Works Departments, and are hereby authorized to enforce the provisions of these Engineering Standards. The standards and any updates will be available on the City's website.

These Engineering Standards shall be in full force and effect immediately upon adoption or revision. Projects will be required to comply with all requirements. The standards include the various design criteria, technical specifications, and standard construction details which are considered **minimum** requirements for the design and construction of adequate public facilities within the City. **The Engineer of record shall bear the sole responsibility for meeting the Engineering standard of care for all aspects of the design and providing a design that's required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City's design and construction requirements.**

1.04 Amendment

- A. The City may amend the Engineering Standards. In order to ensure that the Engineer has the City's latest design standards, they are directed to the City's website to acquire the City's most current design standards. The Engineering Standards will include a Record of Revisions to identify any revisions to the Engineering Standards.
- B. A formal request to modify current design criteria or add new design criteria can be submitted to the City for consideration in writing to the Director of Engineering Services.

1.05 Variance Requests

- A. All variances from the requirements included in the Engineering Standards shall be approved by the Director of Engineering Services. **A grant of an alternative material, design, or method of construction shall not affect nor relieve the Engineer of the obligation and responsibility of such material, design, or method of construction for the intended purposes.**
- B. In the event that specific circumstances dictate requirements not already included in the Engineering Standards, it shall be the responsibility of the Engineer to provide the additional information as deemed necessary by the Director of Engineering Services in writing for review.

1.06 Applicability

The Engineer shall be responsible for the applicability of the information contained in the Engineering Standards to the design of their particular project. The Engineer shall also be responsible for the applicability and accuracy of the information furnished in their design. Acceptance by the City of the plans for construction shall not be construed to relieve the Engineer of any responsibility.

1.07 Other Local, State and Federal Environmental Regulations (this is not intended to be a complete list and is provided for informational purposes only)

- Section 404 of the Clean Water Act (33 USC 1344)
- Water Rights (TCEQ)
- Migratory Bird Treaty Act

- Water Well Drilling
- Threatened and Endangered Species (TPWD)
- The Antiquities Code of Texas (THC)
- Air Quality (TCEQ)
- Dam Requirements (TCEQ)

1.08 Texas Accessibility Standards (TAS)

- A. All plans and specifications for the construction or alteration of public buildings and facilities, privately owned buildings and facilities leased or occupied by state agencies, places of public accommodation, pedestrian facilities within public right-of-way, and commercial facilities must be in compliance with the Texas Accessibility Standards (TAS) for individuals with disabilities and must conform to the standards required by regulations issued by the **Texas Department of Licensing and Regulation (TDLR)**, under the **Architectural Barriers Act, codified as Article 9102**, Texas Civil Statutes.
- B. Projects with a total estimated construction cost of \$50,000 or more are required to submit a full set of construction documents in accordance with Administrative Rule 68.20 to TDLR for registration and review. For Public Right-of-Way projects, the estimated cost for the project shall be based on pedestrian elements only in accordance with Administrative Rule 68.102. If a project's total estimated construction cost is less than \$50,000, it is not required to be submitted to TDLR for registration and review; however, the project is still required to comply with TAS. An architect, engineer, interior designer, or landscape architect with overall responsibility for the design of a building or facility subject to subsection 5(j) of the Architectural Barriers Act, shall mail, ship, or hand-deliver the project registration form, review and inspection fees, and construction documents to the TDLR, a registered accessibility specialist, or a contract provider not later than thirty (30) business days after the design professional seals and signs the construction documents. An Architectural Barriers [Project Registration Form](#) must be completed for each subject building or facility.

1.09 Engineering Criteria – Section Descriptions

The following is a brief description of the contents of each section.

A. Section 1 – General Requirements

This section includes an overview and definitions, abbreviations, and acronyms used in the manual. This section also includes general minimum requirements applicable to all projects, including submittal requirements to the City and to other agencies.

B. Section 2 – Thoroughfare Design Requirements

This section includes requirements associated with the City's thoroughfares, including roadway geometry, street lighting, signage and markings, and traffic signals, etc.

C. Section 3 – Subgrade and Pavement Design Requirements

This section includes requirements associated with pavement and subgrade design requirements (including geotechnical requirements) for roadways within the City.

D. Section 4 – Drainage Design Requirements

This section includes storm drainage design requirements to be followed in the design of storm drainage facilities, and demonstrates the design procedures to be used on drainage projects within the City. This section also addresses floodplains, bridge hydraulics, erosion control and sustainable development.

E. Section 5 – Utility Design Requirements

This section includes design requirements for public wastewater facilities, water distribution and transmission system facilities.

F. Section 6 – Landscaping Design Requirements

This section provides requirements and standards to address landscaping requirements within roadway right-of-way, specifically in the medians of arterial roadways.

G. Section 7– Irrigation Design Requirements

This section provides requirements and standards to address irrigation requirements within roadway right-of-way.

H. Section 8 – Environmental Requirements

This section provides requirements and standards to address environmental requirements, including stormwater best management practices.

I. Section 9 – Structural Design Requirements

This section establishes minimum structural design and geotechnical requirements for various items including bridges, concrete structures, retaining walls, and screening walls. This section also addresses slope stability analysis.

J. Section 10 – Survey Requirements

This section provides survey requirements.

K. Section 11 – Well Design Requirements

This section includes minimum design requirements for public water well facilities.

L. Appendix

1. General Notes – The latest version of general notes shall be included in the Construction Plans for all projects.
2. Standard Details – All projects shall be constructed in accordance with the City’s standard details which are available through the City website. It is the responsibility of the engineer to use the most current detail, as the details are subject to change. If a necessary standard detail is not available from the City, TxDOT details are generally acceptable, except for utility construction. For utility work, a standard detail may be selected from the most recent version of Public Works Construction Standards as issued by the North Central Texas Council of

Governments (NCTCOG). It is the responsibility of the Design Engineer to provide a detail in the plans if a standard detail is not available.

3. Approved Materials List – Products that have been pre-approved for use on projects are available in this listing on the City website. Products not shown on this list must be approved prior to installation.
4. Technical Specifications – All projects shall be constructed in accordance with the most recent version of the City specifications which are available through the City website or TxDOT specifications. It is the responsibility of the Design Engineer to use the most current specification, as the specifications are subject to change. If a necessary specification is not available from the City or TxDOT, then one may be selected from the most recent version of NCTCOG Public Works Construction Standards.
5. Plan Checklists – Common elements necessary on most plans that should be verified by designer prior to submittal of plans. These elements are routinely reviewed by staff and if missing can delay issuance of construction permits. The checklists can be found online in the Development Application Handbook at the City's website.

1.10 Submittal Requirements for Construction Plans

- A. All improvements shall be designed in accordance with the City design criteria, specifications, and standard details referenced as part of the Engineering Standards.
- B. Refer to the Construction Plan Checklist found within the Development Application Handbook for submittal requirements. Reference Section 3 of the Subdivision Ordinance for application submittal and processing procedure. Incomplete applications shall not be accepted for filing and shall not be considered officially filed. 24" x 36" sheets and a PDF copy of complete construction plans shall be submitted. Each sheet of the construction plans shall contain a title block, including space for the notation of revisions. This space is to be completed with each revision to the plan sheet and shall clearly note the nature of the revision and the date that the revision was made.
- C. One hard copy (if requested), a pdf and CAD files of the Record Drawings shall be submitted for public infrastructure projects. The CAD file shall include linework for property boundaries, right-of-way, easements, roadway, signals, lighting, drainage, water, and sewer facilities. Refer to Survey Requirements 10.02.F for additional electronic submittal requirements.
- D. Each construction plan sheet shall bear the seal and signature of the Licensed Professional Engineer in the State of Texas who prepared the plans (Engineer of Record). If standard details are included in the construction plan submittal, the Engineer shall provide the following certification on the title sheet of the plans:

The standard [City, TxDOT, etc.] details specifically identified in this set of construction plans [or specifically included in these bidding/contract documents] have been selected by me or under my direct responsible supervision as being applicable to this project. _____,
P.E., Firm Registration # _____

- E. By approval of the construction plans, the City has determined that the plans are in general compliance with the City's Ordinances, Master Plans and Engineering Standards. The City's review and approval of the construction plans does not represent that the City has re-engineered or verified the engineering of the proposed improvements. The Engineer of Record is responsible

for all engineering and recognizes that specific site circumstances or conditions may require improvements constructed to exceed minimum standards contained in the City's Engineering Standards and is responsible for the applicability and accuracy of the plans and specifications contained herein.

- F. Specific information required for submittals can be found within this document and in the plan checklists located on the City website. The City reserves the right to specify additional requirements as necessary to facilitate the review.

Submittals	Responsible Reviewing Department
Preliminary Site Plan - Private	
Overall Concept	Development Services
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Traffic
Utilities	Engineering
Preliminary Plans (30/60%) - Public	
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Traffic
Utilities	Engineering
Landscaping and Irrigation (Public)	Parks
Construction Plans (Final) - Public and Private	
Paving, Grading, Drainage	Engineering
Traffic (Signs, Markings, Signals, Lighting, TCP)	Traffic
Utilities	Engineering
Landscaping and Irrigation (Public)	Parks
Landscaping and Irrigation (Private)	Development Services
Project Manual (Public)	Engineering
Technical Specifications (Private)	Engineering

- G. Any projects requiring permits from agencies other than the City (such as railroad, TxDOT, NTTA, etc.) shall submit the required permit documents to the City for approval. City staff will review and submit permit requests to the agencies.

- H. A separate checklist is available for construction plan sets to be submitted at the pre-construction conference.

- I. Condition assessment of existing infrastructure may be required.

1.11 Easements

- A. General – Easements shall be provided for public facilities including roadway, water, wastewater, reclaimed water, drainage features, and traffic signal or lighting equipment that are located outside the public right of way. Storm drain lines are also considered public if they cross property lines and collect runoff from adjacent properties. For single-family residential developments, water, wastewater, reclaimed water and storm drain lines shall not cross residential

lots unless specifically approved by the Director of Engineering Services. Additional easement width may be required to accommodate future maintenance of the facilities.

- B. Acquisition of Easements – Easements that have not been dedicated on a plat may be acquired by separate instrument. The acquisition of any easement is the owner’s responsibility. If the owner cannot obtain a required offsite easement, the owner may request assistance from the City. Prior to requesting assistance, the owner shall provide a written offer to the property owner based on fair market value. The City’s assistance does not relieve the owner of the cost of purchasing the easement. In addition, the owner may be required to reimburse the City for any costs associated with the acquisition.
- C. The process for acquiring an easement by separate instrument is as follows:
- Submit a metes and bounds description, a drawing of the easement sealed, signed and dated by a licensed surveyor, and ownership information to Engineering Services.
 - Engineering Services will prepare the easement documents on City forms.
 - Person requesting the easement shall pay any document preparation and filing fees required by the City.
 - The easement documents will be sent to the person requesting the easement to obtain all necessary signatures (other than City’s).
 - Return all signed documents to the City for filing with the county.
 - City will send a copy of the filed easement to the person requesting the easement and the easement grantor, if needed.
- D. Abandonment of Right of Way and Easements - Right of way and easements that have not been abandoned by plat may be abandoned by separate instrument. Signatures are required from all the public utility companies, including franchise utilities and the adjacent affected property owners indicating either agreement or disagreement to the proposed abandonment. Right of way and easements proposed to be abandoned that do not contain improvements may be processed administratively. If improvements are present, the abandonment request will be forwarded to City Council for approval. Abandonments opposed by the affected property owners will also be forwarded to City Council for approval. Right of way and easements granted to entities other than the City shall be abandoned by that entity.

The following describes the process for abandoning right of way or easements:

- All property owners abutting the proposed abandonment shall be notified by the applicant by certified letter. A written response from each abutting property owner must be received by the City prior to staff review.
- All public utilities including franchise utilities must consent to the abandonment.
- The applicant shall provide a description as to how the City originally acquired the right of way or easement (i.e., by plat, by separate instrument, etc.).
- For right of way, the applicant may be required to provide a certified appraisal stating the value. In addition, the applicant shall provide an explanation that identifies why the proposed use of the right of way will benefit the community under private ownership, versus retention of the property as public right of way.
- For easements, the applicant shall describe why the easement is no longer needed.

- E. The right of way/easement abandonment application shall be submitted along with the supporting documentation to the Engineering Services Department for coordination and processing. The application form is available from the Engineering Department or the City's website.
- F. At the time of Final Plat, easements obtained by separate instrument for specific non-city utilities are expected to abandon portions of the easement that will be in a City ROW, Street easement, Public Way, FAUE or general UE.
- G. Any public infrastructure that crosses an existing private easement requires an encroachment agreement from the easement grantee.

1.12 Fees

A listing of the required fees is available on request.



SECTION 2 - THOROUGHFARE DESIGN REQUIREMENTS

Section 2 – Thoroughfare Design Requirements

2.01 General

- A. The arrangement, character, extent, width, alignment, and location of all streets, public ways, alleys, and driveways shall be in conformity with the City's Thoroughfare Plan and Comprehensive Plan and should be considered in their relation to existing and planned streets, alleys and driveways, topographical and environmental features, scenic views, and the land uses proposed to be served by such streets.
- B. All thoroughfare designs shall meet the guidelines in AASHTO's current *A Policy on Geometric Design of Highways and Streets*.
- C. All information shown on any type of development or construction submittal (including, but not limited to, preliminary site plans, site plans, preliminary plats, zoning exhibits, specific use permits, landscape plans, open space plans, construction plans, etc.) shall be correct, up-to-date, legible, easily understood, consistent, and shown to the proper scale.

2.02 Street Design

- A. Thoroughfare Definitions – The City recognizes five basic classifications of public roadways that include highways, major thoroughfares, minor thoroughfares, collectors, and local streets as identified in the transportation element of the Comprehensive Plan. Each class provides a certain degree of continuity, capacity, and accessibility to adjacent land uses. While differentiated by function, there is also a variance in geometric design. Table 2.1 summarizes the general design criteria of roadways within the City. The typical cross sections are depicted in Figure 2.1.
 - 1. Major Thoroughfares – Six-lane divided roadways defined herein as Type A thoroughfares. Type A thoroughfares are typically initially constructed as four-lane divided roadways with a wider median and then widened to six lanes at a later date. Frontage roads are also considered major thoroughfares.
 - 2. Minor Thoroughfares – Four-lane divided roadways defined herein as Type B thoroughfares.
 - 3. Collectors – Commercial collectors provide access from a Type A or B thoroughfare to non-residential properties and are defined herein as Type C thoroughfares. Residential collectors connect to a Type A or B thoroughfare, extend more than six hundred feet (600') into a residential neighborhood, and have no homes fronting onto them. A residential collector can also be a "ring road" within a neighborhood with no homes fronting onto it and which connects to Type A or B thoroughfares through one or more entrance streets. Residential collectors can be built with the cross section of a Type D, F, or G thoroughfare.
 - 4. Local Streets – Residential streets with homes fronting onto them are defined herein as Type D, E, F, and G thoroughfares, each with different design characteristics depending on whether the homes are front entry or alley served and whether or not the street is adjacent to a school or park. (A mews is a special type of alley that serves homes that do not front onto a street.)
 - 5. Private Streets – Private streets shall be designed and constructed to the same standards as public streets. Any gated entrances shall also meet the requirements of Section 2.05.K.

TABLE 2.1: General Roadway Design Criteria

<u>Criteria</u>	<u>Thoroughfare Class</u>						
	<u>Major Type A</u>	<u>Minor Type B</u>	<u>Commercial Collector Type C</u>	<u>Local Type D</u>	<u>Local Type E</u>	<u>Local Type F</u>	<u>Local Type G</u>
Right-of-Way (ROW)	120' ⁽¹⁾	90' ⁽²⁾	60'	60'	50'	60'	60'
Pavement Width ⁽³⁾ (face to face)	36' in each direction	24' in each direction	36'	36'	26'	30'	26'
Traffic Lanes	6	4	2	2	2	2	2
Left Turn-lane Width	2 @ 10'	1 @ 11'	N.A.	N.A.	N.A.	N.A.	N.A.
Right Turn-lane Width	11'	11'	N.A.	N.A.	N.A.	N.A.	N.A.
Median Width	24'	18'	N.A.	N.A.	N.A.	N.A.	N.A.
Parkway Width	12'	12'	12'	12'	12'	15'	17'
Design Speed, V (MPH)	45	45	30	30	25	25	25
Minimum Grade	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Maximum Grade	6%	6%	6%	6%	6%	6%	6%
Min. Horizontal Radii	See Table 2.2						
Min. Tangent Between Curves	100'	100'	100'	100'	N.A.	N.A.	N.A.
Min. Length of Vertical Curve	See Table 2.3 and Table 2.4						
Stopping Sight Distance	360'	360'	200'	200'	155'	155'	155'
Parking	Prohibited	Prohibited	Allowed ⁽⁴⁾	Allowed ⁽⁴⁾	Allowed ⁽⁴⁾	Allowed ⁽⁴⁾	Allowed ⁽⁴⁾
Volume Range (VPD)	36-45,000	20-28,000	12-18,000	6-12,000	N.A.	N.A.	N.A.

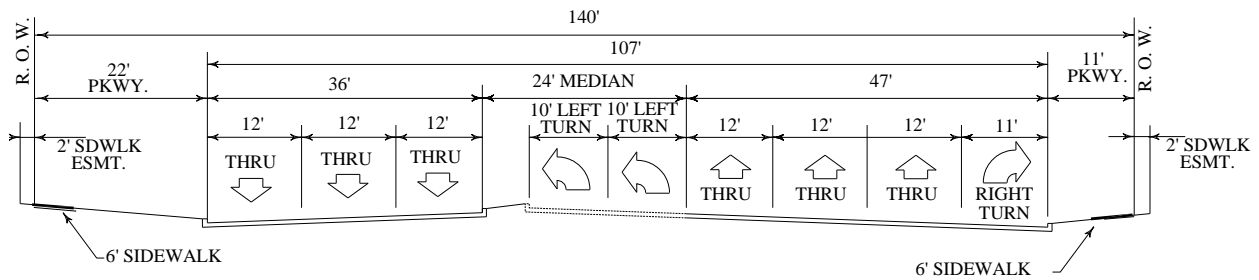
(1) 140' or 160' ROW at intersections (See Figures 2.2 and 2.4)

(2) 110' or 120' ROW at intersections (See Figures 2.3 and 2.5)

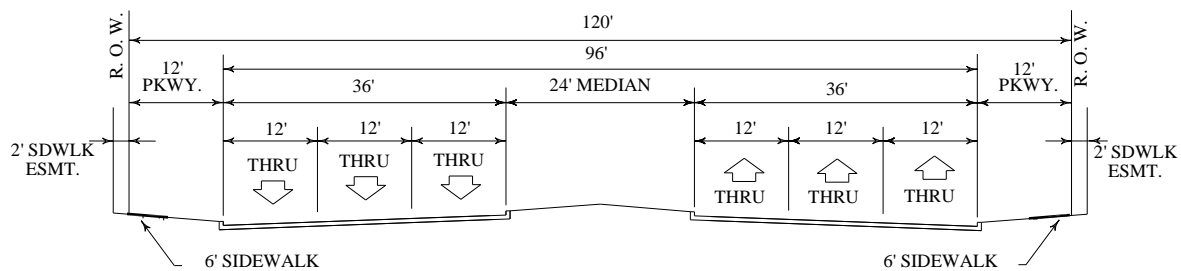
(3) Additional pavement width will be necessary at intersections with Type A or B thoroughfares, as described herein

(4) Parking is allowed unless otherwise prohibited by ordinance or by signs installed by the City

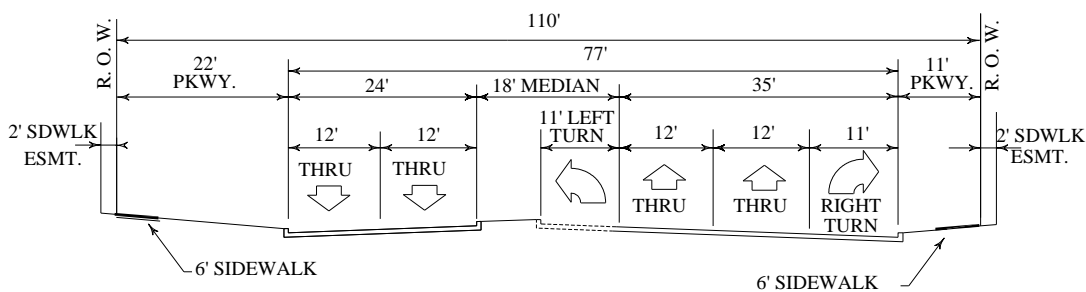
Major Thoroughfare Type A (Intersection)



Major Thoroughfare Type A (Midblock)



Minor Thoroughfare Type B (Intersection)



Minor Thoroughfare Type B (Midblock)

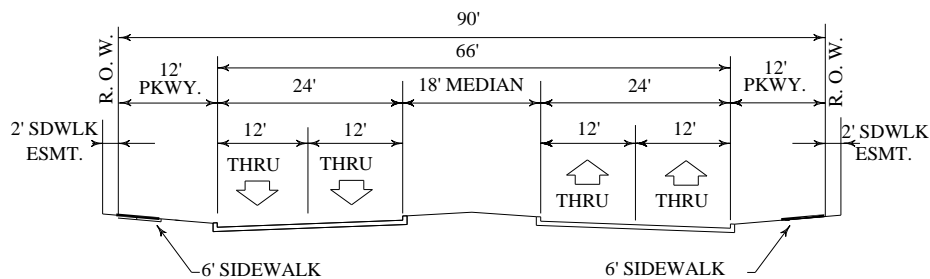
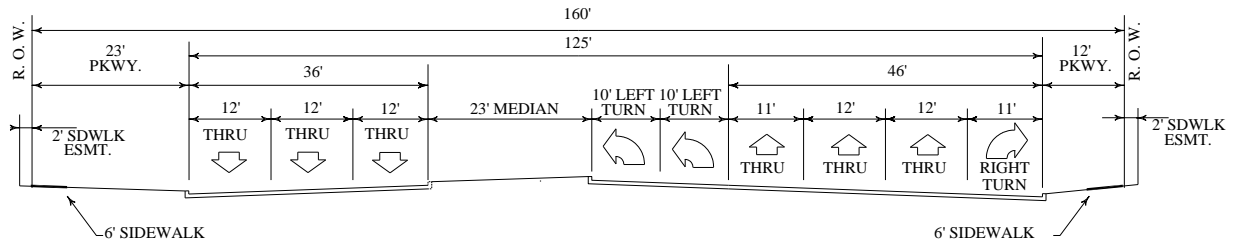
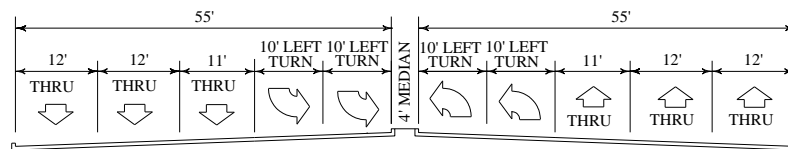


FIGURE 2.1: Typical Cross Sections

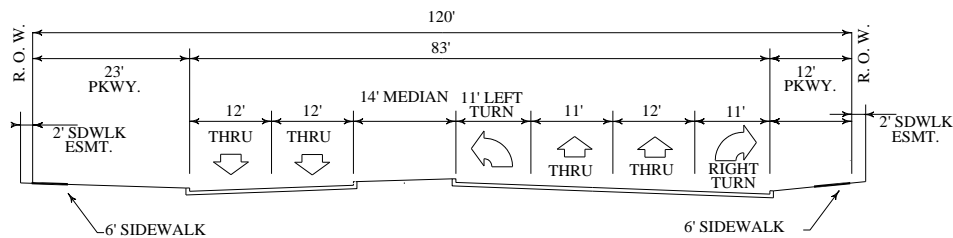
Major Thoroughfare Type A (At Frontage Road)



Major Thoroughfare Type A (Between Frontage Roads)



Minor Thoroughfare Type B (At Frontage Road)



Minor Thoroughfare Type B (Between Frontage Roads)

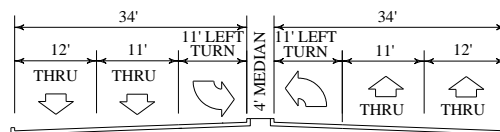
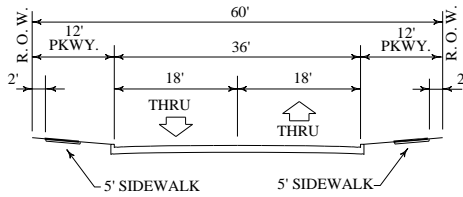
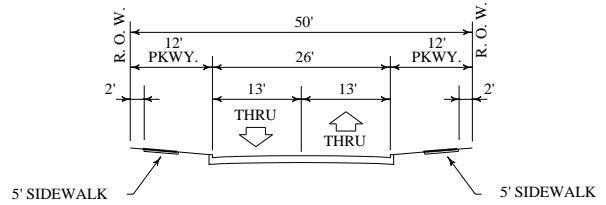


FIGURE 2.1 (Cont.): Typical Cross Sections

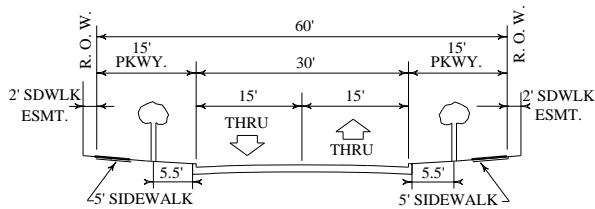
Commercial Collector Type C and Local Type D



Local Type E

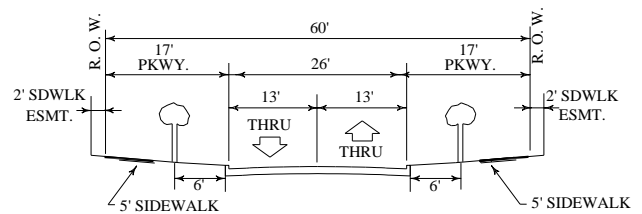


Local Type F - Front Entry



Refer to the Zoning Ordinance for street tree spacing, size, and species.

Local Type G - Rear Entry



Refer to the Zoning Ordinance for street tree spacing, size, and species.

Residential Collector Use the cross-section of Type D, F, or G

Divided Residential Subdivision Entrance

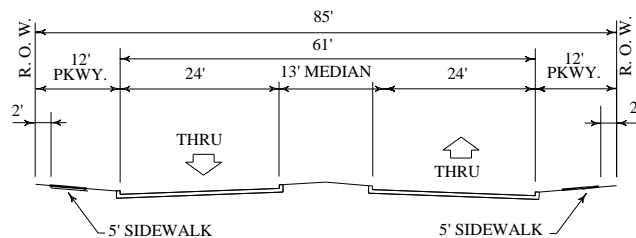


FIGURE 2.1 (Cont.): Typical Cross Sections

6. Public Ways – Public ways shall be designed and constructed to the same standards as public streets and shall meet the design criteria of a commercial collector (Type C thoroughfare) unless otherwise allowed under Subsection 6.a below. Public ways shall be privately maintained, shall be dedicated to public use, and shall not be gated.
 - a. A public way can be reduced to the design criteria of a Type F thoroughfare if the owner agrees to prohibit parking on the public way and to actively enforce such prohibition. The parking prohibition shall be recorded on the plat and shall be clearly posted along the public way.
 7. Alternate Cross Sections – If an alternate roadway cross section is proposed, it must provide the capacity, maneuverability, parking, and emergency access necessary to serve the adjacent land uses and is subject to approval by the Director of Engineering Services and the Fire Department. The right-of-way dedicated for such a roadway shall include a minimum of twelve feet (12') of right-of-way beyond the outermost face of curb on each side of the roadway.
- B. Roadway Geometrics – Geometrics of City streets shall be defined as the geometry of the pavement and curb areas that govern the movement of traffic within the confines of the right-of-way (ROW). Included in the geometrics are pavement width, horizontal curvature, width of traffic lanes, median nose radii, curb radii at street intersections, pavement cross-slope, crown height, pavement thickness, and geometric shapes of islands separating traffic movements and other features.
1. Design Speed – The design speed is a primary factor in the horizontal and vertical alignment of roadways. Design features such as curvature, super-elevation, turning movement radii, and sight distance affects roadway lane width, pavement width, pavement cross-slope, pavement crown, and clearances. Refer to Table 2.1.
 2. Grades – Roadway grades shall be a maximum of six percent (6%) and a minimum of eight-tenths percent (0.8%) in order to ensure proper flow of surface drainage toward inlets. Steeper grades are allowed on certain local residential streets, up to a maximum of ten percent (10%), provided that no homes front onto the steeper street and the Fire Department determines that they would not need to use the steeper street to protect any structure. Grades steeper than six percent (6%) may be permitted on Type A, B, or C thoroughfares where required by topographical and/or natural features, as approved by the Director of Engineering Services.
3. Roadway Centerline
- a. Roadways shall be placed in the center of the ROW. The centerline of curves shall be tangent to the centerline of street at each end of curve.
 - b. If offset, roadway centerlines for Type C, D, E, F, and G thoroughfares shall be offset a minimum of one hundred and twenty-five feet (125'). If a roundabout is located on one or both sides of the offset, the offset shall be measured from the closest edge of the circulatory roadway rather than the centerline of the roundabout.
 - c. If offset, Type A and B thoroughfares shall be offset to meet the median requirements in Section 2.03.B.

4. Cross-Slope/Crown Height – Type A and B thoroughfares shall have a two percent (2%) cross-slope. The cross-slope can vary where there is a transition into or out of a maximum two percent (2%) superelevation. Type C and D thoroughfares shall have six-inch (6”) parabolic crowns, Type E and G thoroughfares a four-inch (4”) parabolic crown, and Type F thoroughfares a five-inch (5”) parabolic crown
5. Pavement Thickness and Reinforcement – See Section 3 of the Engineering Standards for subgrade and pavement design requirements.
6. Transitions – A concrete transition shall be constructed where four (4) lanes of a thoroughfare connect to a two (2) lane thoroughfare. The transition occurs only in the direction in which traffic needs to be shifted laterally to join the thoroughfare with a different cross section.
 - a. Transitions from a four (4) lane to a two (2) lane thoroughfare shall be a minimum of sixteen feet (16’) wide, face-to-face, a minimum of three hundred feet (300’) long, and meet AASHTO’s current minimum design requirements based on a design speed of 25 mph.
 - b. A transition from a two (2) lane to a four (4) lane thoroughfare that occurs less than one thousand feet (1,000’) from a traffic signal, or from an intersecting Type A or B thoroughfare, shall be a two (2) lane transition twenty-four feet (24’) wide, a minimum of three hundred feet (300’) long, and meet AASHTO’s current minimum design requirements based on a design speed of 25 mph.
 - c. A transition from a two (2) lane thoroughfare to a four (4) lane thoroughfare that occurs more than one thousand feet (1,000’) from a traffic signal, and from an intersecting Type A or B thoroughfare, shall be a one (1) lane transition sixteen feet (16’) wide, face-to-face, a minimum of three hundred feet (300’) long, and meet AASHTO’s current minimum design requirements based on a design speed of 25 mph.
7. Dead-End Streets/Cul-de-Sacs/Stub Streets
 - a. All dead-end streets shall have a turnaround unless otherwise allowed in Subsection d below. Turnarounds (cul-de-sacs) at the end of dead-end streets shall have a circular driving surface that has a minimum radius of fifty feet (50’) and a street right-of-way that has a minimum radius of sixty feet (60’).
 - b. The maximum length of a dead-end street with a turnaround (cul-de-sac) shall be six hundred feet (600’), measured from the right-of-way line of the intersecting street to the center point of the turnaround. Where unusual topography exists, a dead-end residential street can exceed six hundred feet (600’) only if it has no more than twenty (20) lots fronting onto the street and the ultimate street length meets water line and Fire Department requirements. If a dead-end street has another dead-end street branching off of it, the total combined length of the main dead-end street and its branch(es) cannot exceed the maximum length described above and the total number of lots fronting onto the combined dead-end streets cannot exceed twenty (20).
 - c. If any residential lot fronts onto the dead-end portion of a street that will be extended in the future, that lot shall not be developed until the street is properly extended or a temporary turnaround that meets the standards described above is constructed at the end of the dead-end street within a temporary street easement. If no temporary turnaround is provided, the following note shall be placed on the plat: “Block X Lot Y shall not be

developed until (name of street) is extended (give direction) with future development of abutting property. An amending plat shall be required to remove the condition of this note.” If a temporary turnaround is provided on Lot Z to allow Lot Y to develop, the following note shall be placed on the plat: “Temporary street easement on Block X Lot Z is for a temporary turnaround which shall remain in place until (name of street) is extended (give direction) with future development of abutting property. Block X Lot Z shall not be developed until the street is extended and the temporary street easement is removed by an amending plat.”

- d. A stub street is an undivided dead-end street that will be extended in the future that does not have a turnaround, which is only allowed under the following conditions: No residential lots shall front onto a stub street. Non-residential lots adjacent to a stub street shall have access to another street. If the length of a residential stub street exceeds the depth of the adjacent residential lots, it shall be temporarily blocked at the rear edge of the lots (or alley) with barrel-mounted barricade. If a non-residential stub street extends more than one hundred feet (100') beyond the last driveway on the street, it shall be temporarily blocked at the last driveway with barrel-mounted barricade.
 - e. A stub street shall have a permanent Type III barricade or a row of object marker signs installed at its terminus (see Standard Details T05 and T05-A). A residential stub street shall also have a 24"x30" sign prominently posted at its terminus with black letters on a white background that state, "NOTICE – This street will be extended as part of a future development" (see Standard Detail T10). The installation and cost of these barricades and signs shall be the responsibility of the developer.
 - f. All permanent turnarounds (cul-de-sacs) shall be constructed at the end of a street with one of the standard pavement widths defined in Table 2.1. No permanent turnaround (cul-de-sac) shall be constructed on the side of a street or in a way that creates a wider than normal intersection with a street.
8. Merging and Shifting Tapers – Thoroughfares that add or drop lanes shall meet the merging and shifting taper requirements in the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) Tables 6C-3 and 6C-4. Merging tapers shall be used when lanes are dropped and shifting tapers shall be used when lanes are added.

C. Minimum Horizontal Design Radius

- 1. The minimum centerline radius is a function of design speed, superelevation, and the vehicle side friction factor. Side friction is the force that keeps a vehicle from sliding off of the roadway.
- 2. The minimum horizontal radii are shown in Table 2.2 and are in accordance with the guidelines in AASHTO's 2018 edition of *A Policy on Geometric Design of Highways and Streets*.

TABLE 2.2: Minimum Horizontal Centerline Radius

<u>Design Speed, V (MPH)</u>	<u>Friction Factor, F</u>	<u>Superelevation, e (ft/ft)</u>	<u>Radius, R (ft) (Rounded for Design)</u>
25	0.23	-0.02	250 ⁽¹⁾
30	0.20	-0.02	350
35	0.18	-0.02	525
40	0.16	-0.02	775
45	0.15	-0.02	1100
50	0.14	-0.02	1400

- (1) May be reduced to a radius of two hundred feet (200') at mid-block locations provided that it is shown that the general public safety is not compromised (e.g., stopping sight distance). A curve with a radius less than two hundred fifty feet (250') must be a minimum of three hundred feet (300') from a street or alley intersection.

D. Minimum Vertical Alignment

- Vertical curves are utilized in roadway design to affect gradual change between tangent grades and will result in a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide Stopping Sight Distance (SSD) in all cases. SSD is a function of design speed, perception-reaction time, and deceleration rate. The perception-reaction time is assumed to be 2.5 seconds and is in accordance with the guidelines in AASHTO's 2018 edition of *A Policy on Geometric Design of Highways and Streets*. The equation for SSD appears below:

$$SSD = 1.47Vt + 1.075 \frac{V^2}{a}$$

SSD = stopping Sight Distance (ft)

t = brake reaction time (2.5 sec.);
 V = vehicle design speed (MPH); and
 a = deceleration rate, (11.2 ft/s²)

- To determine the minimum acceptable length of Crest and Sag curves shown in Tables 2.3 and 2.4, it is assumed that approach grades are between -3% and 3% in the SSD calculation. The SSD for grades steeper than -3 % or 3% shall be in accordance with the guidelines in AASHTO's current *A Policy on Geometric Design of Highways and Streets*. Tables 2.3 and 2.4 also show values of K. K is defined as the rate of vertical curvature and is equivalent to the horizontal distance in feet required to make a one percent (1%) change in grade. The values of A are equivalent to the algebraic difference in grade between the two grades that are being joined together by the vertical curve.

TABLE 2.3: Minimum Acceptable Crest Curve Given Speed and Difference in Grade of Road

<u>Design Speed, V (MPH)</u>	<u>SSD (ft)</u>	<u>K</u>	<u>Length of Vertical Curve (L=KA)</u>									
			<u>A=1.6</u>	<u>A=2</u>	<u>A=3</u>	<u>A=4</u>	<u>A=5</u>	<u>A=6</u>	<u>A=7</u>	<u>A=8</u>	<u>A=9</u>	<u>A=10</u>
25	155	12	50	50	50	50	60	80	90	100	110	120
30	200	19	50	50	60	80	100	120	140	160	180	190
35	250	29	50	60	90	120	150	180	210	240	270	290
40	305	44	70	90	140	180	220	270	310	360	400	440
45	360	61	100	130	190	250	310	370	430	490	550	610
50	425	84	140	170	260	340	420	510	590	680	760	840

TABLE 2.4: Minimum Acceptable Sag Curve Given Speed and Difference in Grade of Road

<u>Design Speed, V (MPH)</u>	<u>SSD (ft)</u>	<u>K</u>	<u>Length of Vertical Curve (L=KA)</u>									
			<u>A=1.6</u>	<u>A=2</u>	<u>A=3</u>	<u>A=4</u>	<u>A=5</u>	<u>A=6</u>	<u>A=7</u>	<u>A=8</u>	<u>A=9</u>	<u>A=10</u>
25	155	26	50	60	80	110	130	160	190	210	240	260
30	200	37	60	80	120	150	190	230	260	300	340	370
35	250	49	80	100	150	200	250	300	350	400	450	490
40	305	64	110	140	200	260	320	390	450	520	580	640
45	360	79	130	160	240	320	400	480	560	640	720	790
50	425	96	160	200	290	390	480	580	680	770	870	960

E. Standard Intersection Layout

1. Street intersections shall intersect at ninety-degree (90°) angles. Intersection approaches for Type A and B thoroughfares shall remain perpendicular for a minimum distance equal to the corresponding design speed Stopping Sight Distance (SSD) identified in Table 2.1. For residential collector and/or local street intersections, up to a five-degree (5°) tolerance is allowable.
2. When the classification of a thoroughfare changes as it crosses an intersecting street, the design of both thoroughfare approaches shall maintain the characteristics of the higher-class thoroughfare for a minimum distance specified by the Director of Engineering Services.
3. The through lane(s) on one approach shall align with the receiving lane(s) on the other side of the intersection. If pre-existing physical encroachments make an offset necessary, a through lane can be offset no more than six feet (6') from its receiving lane when crossing a Type B or smaller thoroughfare and offset no more than eight feet (8') when crossing a Type A thoroughfare. These requirements apply to both public street and private driveway approaches to an intersection.
4. The curb radii shall be a minimum of twenty feet (20') where Type D, E, F, and G thoroughfares intersect with Type D, E, F, and G thoroughfares. The curb radii shall be a minimum of forty feet (40') where Type A, B, and C thoroughfares intersect with Type A and B thoroughfares. The curb radii at all other intersecting streets shall be a minimum of thirty feet (30'). Larger curb radii may be required to accommodate fire trucks and/or commercial trucks.

5. Type A-A, A-B, and B-B intersections shall maintain a maximum slope of two percent (2%) a minimum distance of two hundred feet (200') upstream and downstream of the intersection.
6. Roadway connections to a Type A or B thoroughfare shall maintain a maximum slope of two percent (2%) a minimum distance of one hundred feet (100') upstream and downstream of the intersection.
7. A separate grading plan shall be provided for Type A-A, A-B, and B-B intersections. Grading plans shall account for future extensions of Type A and Type B thoroughfares for a minimum distance of six hundred feet (600') beyond the curb return of the intersection in all directions.
8. At four-way intersections of parabolic streets, the reduction of the crown height shall occur on the thoroughfare with the through gutter.
 - a. For Type C and D thoroughfares, the crown height reduction from six inches (6") to three inches (3") shall occur through the intersection and transition from the curb return to a point fifty feet (50') past the curb return.
 - b. For Type E thoroughfares, the crown height reduction from four inches (4") to two inches (2") shall occur through the intersection and transition from curb return to a point thirty feet (30') past the curb return.
 - c. For Type F and G thoroughfares, the crown height reduction from five inches (5") to three inches (3") shall occur through the intersection and transition from curb return to a point thirty feet (30') past the curb return.
9. A minimum of nine and a half feet (9.5') of parkway shall be maintained from the back of the curb along the curb's radius.
10. ROW width for a Type A thoroughfare that intersects a Type A or Type B thoroughfare shall be one hundred forty feet (140') for a distance of two hundred feet (200') and then taper at a 15:1 ratio to the standard ROW width. See Figure 2.2.
11. ROW width for a Type B thoroughfare that intersects a Type A or Type B thoroughfare shall be one hundred ten feet (110') for a distance of one hundred fifty feet (150') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figure 2.3.

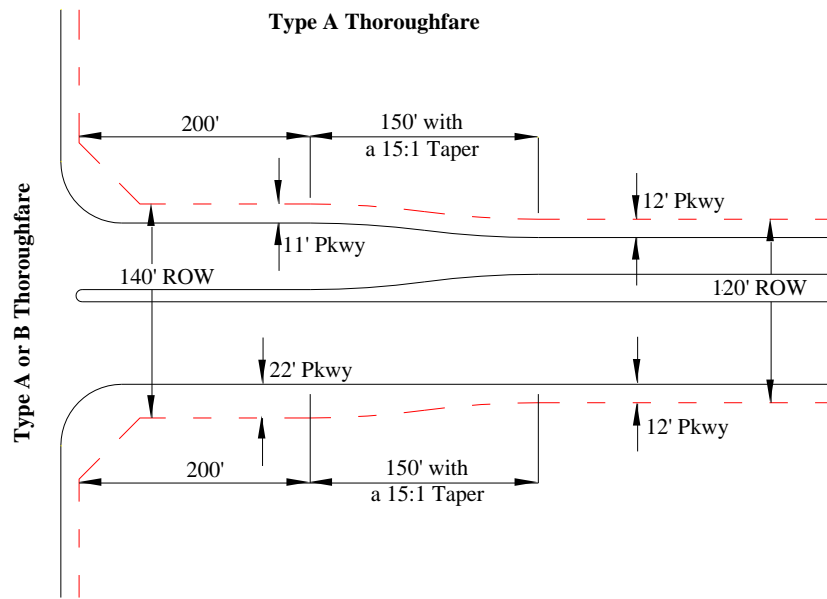


FIGURE 2.2: Type A Thoroughfare Intersection Detail

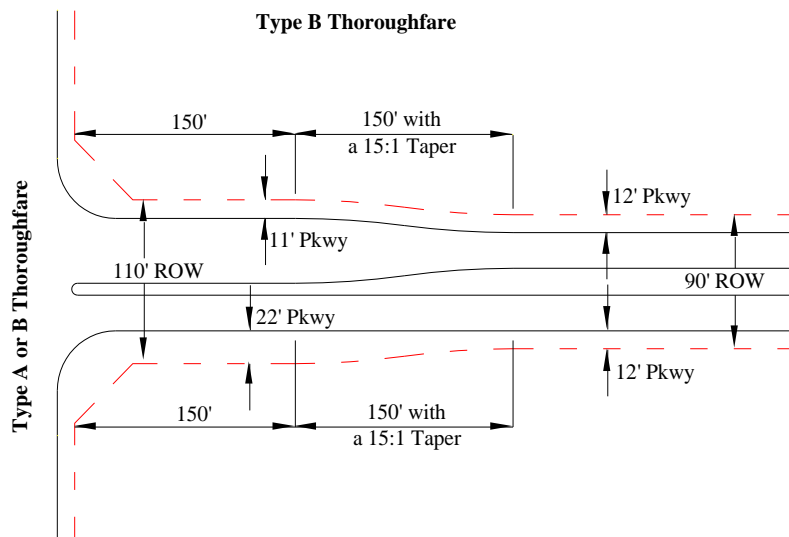


FIGURE 2.3: Type B Thoroughfare Intersection Detail

12. The ROW width for a Type A thoroughfare that intersects with a pair of highway frontage roads shall be one hundred sixty feet (160') for a distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. The ROW width for a Type B thoroughfare that intersects with a pair of highway frontage

roads shall be one hundred twenty feet (120') for a distance of three hundred feet (300') and then taper at a 15:1 ratio to the standard ROW width to allow build-out of the intersection. See Figures 2.4 and 2.5.

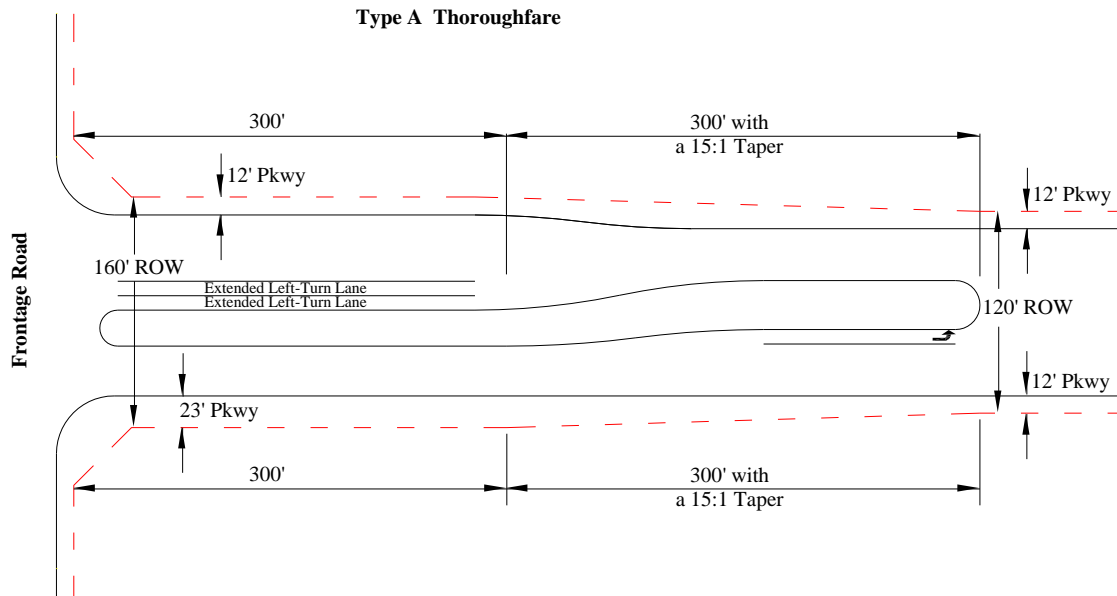


FIGURE 2.4: Type A Thoroughfare Intersection with Frontage Road

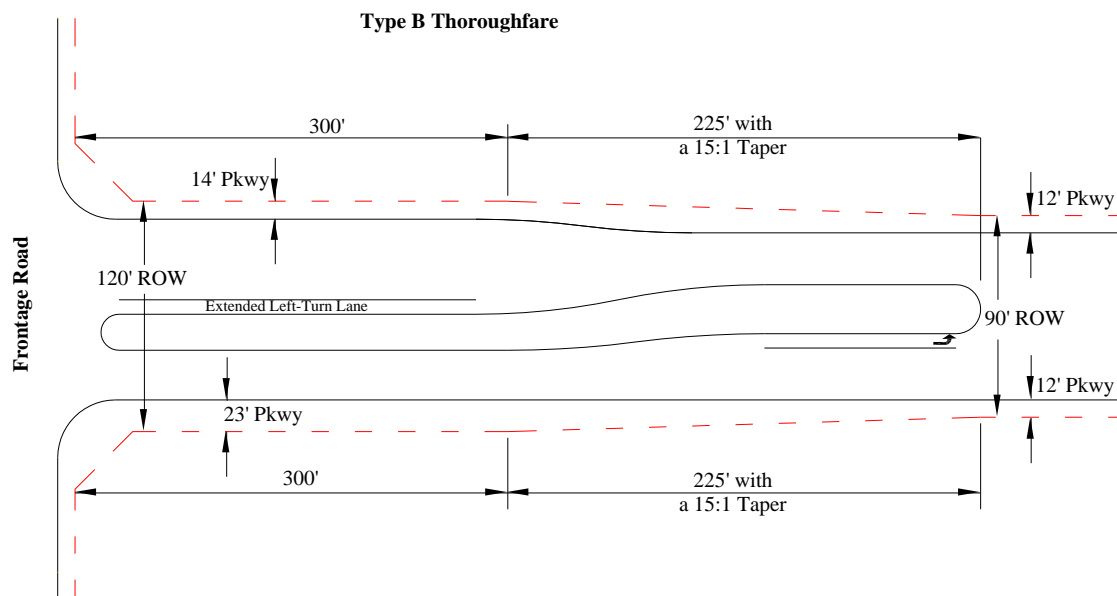


FIGURE 2.5: Type B Thoroughfare Intersection with Frontage Road

F. Roundabouts

1. Roundabouts may be considered for the intersection of Type B, C, D, E, F, or G thoroughfares with Type B, C, D, E, F, or G thoroughfares. Roundabouts may also be considered for intersections along Type A thoroughfares that have not yet been widened to six lanes. Roundabouts shall not be installed at a Type A-A, A-B, or B-B intersection without a detailed traffic simulation and cost-benefit analysis approved by the Director of Engineering Services. Roundabouts shall not be installed along a six-lane Type A thoroughfare.
2. Roundabouts on private property that connect to a private street or to a fire lane shall be designed to the standards in these design requirements.
3. Roundabouts shall be designed to accommodate a City fire truck making all possible entry and exit movements. A fire truck shall be able to make the “through” movement without traveling on a truck apron. Roundabouts located along a Type A, B, or C thoroughfare shall also accommodate a WB-67 design vehicle.
4. Roundabouts shall include the typical features of a modern roundabout shown in Figure 2.6 and described in these design requirements.
5. The curb surrounding the central island shall be six inch (6”) vertical curb if a truck apron is provided and six inch (6”) mountable curb if no truck apron is provided. The curb surrounding a truck apron shall be three inch (3”) mountable curb. The curb surrounding all faces of each splitter island shall be four inch (4”) mountable curb.
6. The inscribed circle radius shall be a minimum of fifty-five feet (55’) and a maximum of eighty feet (80’) for a single lane roundabout, and a minimum of seventy-five feet (75’) and a maximum of a hundred feet (100’) for a two-lane roundabout.
7. The circulatory roadway shall have a minimum width of sixteen feet (16’), face-to-face. The circulatory roadway shall be at least as wide as the maximum entry width at the roundabout. If the circulatory roadway is less than twenty-nine feet (29’) wide, face-to-face, a truck apron shall be provided. The combined width of the circulatory roadway and the truck apron shall be a minimum of twenty-nine feet (29’). Truck aprons shall provide a solid surface of concrete pavers that are a contrasting color compared to the pavement of the circulatory roadway and shall not give the appearance of being a sidewalk.
8. Single lane entries and exits shall be a minimum of sixteen feet (16’) wide, face to face. Two-lane entries and exits shall be a minimum of twenty-four feet (24’) wide, face to face.
9. Splitter islands shall provide a solid surface of concrete pavers unless the entry and exit on the same leg of the roundabout are both at least twenty-four feet (24’) wide, face-to-face. The pavers shall be a contrasting color compared to the street pavement and no signs shall be installed in the splitter island. If pavers are not required, the splitter island can contain City-approved landscaping provided it does not interfere with the necessary sight distance.
10. Crosswalks shall pass through or in advance of each splitter island. A crosswalk can only pass through a splitter island if the island is large enough to retain significant channelization features after the crosswalk is subtracted from it.

11. All streets, fire lanes, and approved driveways shall intersect radially with a roundabout. Residential driveways and alleys shall not intersect with a roundabout.

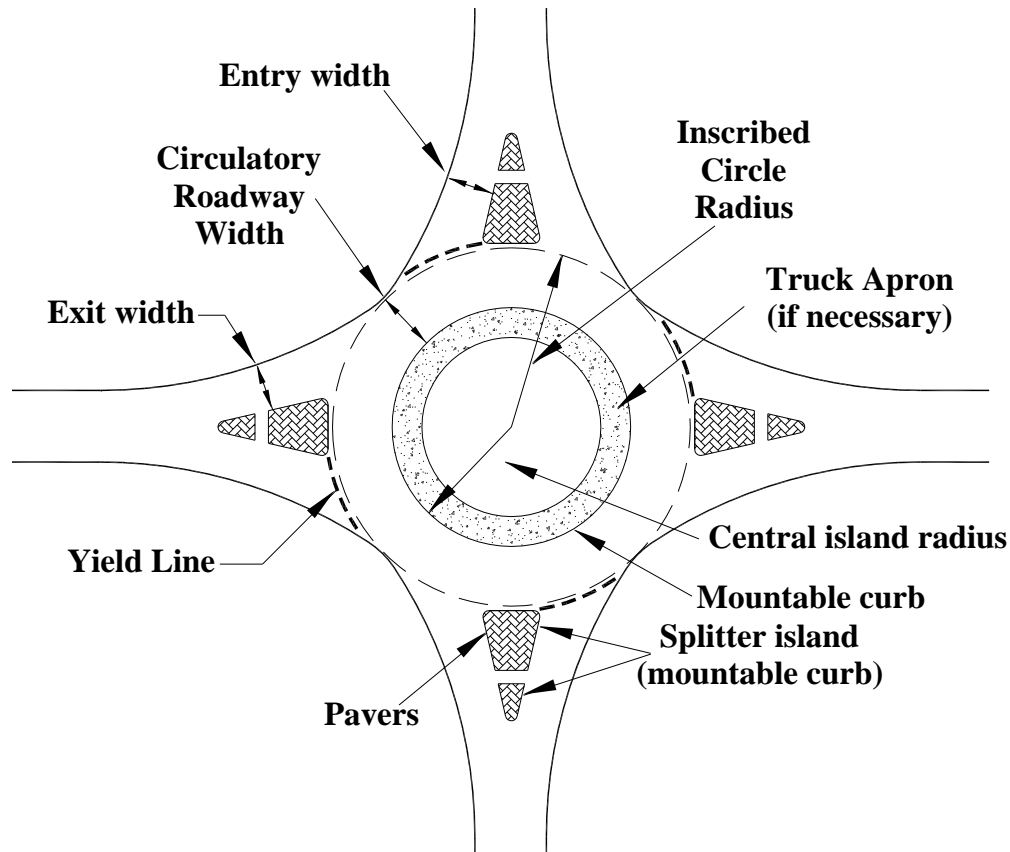


FIGURE 2.6: Typical Roundabout

12. The design of any roundabout located along a Type A, B, or C thoroughfare shall include calculations of the vehicle entry path deflection (fastest path) in each direction. Each critical radius along the fastest path must be shown to reduce speeds to the desirable levels shown in the latest edition of FHWA's *Roundabouts: An Informational Guide*.
13. Landscaping and/or monuments within the central island are encouraged, but shall be limited so that the minimum sight distances described in the latest edition of FHWA's *Roundabouts: An Informational Guide* are provided at the roundabout. For vehicles approaching the roundabout, this includes the approach stopping sight distance to the crosswalk or the yield line, the stopping sight distance to the crosswalk on the next exit, and the intersection sight distance to circulating vehicles and vehicles entering at the immediate upstream entry. For circulating vehicles, this includes the stopping sight distance on the circulatory roadway. (See Section 6.02.R for roundabout landscaping requirements.)
14. Parking is prohibited within a roundabout.
15. On any approach to a roundabout, driveways, alley connections, and on-street parking shall not be permitted between the crosswalk and the yield line nor along any portion of street that contains a splitter island.

16. No building (e.g., a home, amenity center, school, business, sports facility, etc.) shall front onto a roundabout or have a pedestrian entrance facing the roundabout in a way that would encourage motorists to park, stop, or stand in the roundabout. No building shall be located adjacent to a roundabout in a way that would have the roundabout serve as its primary fire protection and/or emergency response staging area.
17. The ROW for a roundabout shall extend a minimum of twelve feet (12') beyond the back of its outer curb. The ROW for any street entering the roundabout will flare out as the street flares so that a minimum of twelve feet (12') is provided beyond the back of curb on each side of the street.
18. The roundabout entries and exits and the pavement contained within the inscribed circle radius shall be constructed on a uniform plane of the same grade, which shall not exceed two percent (2%). Roadway approaches to the roundabout shall have a maximum slope of two percent (2%) for a distance of at least two hundred feet (200') for Type B thoroughfares and at least one hundred feet (100') for Type C, D, E, F, and G thoroughfares.
19. Roundabouts shall be illuminated by street lights as described in the latest edition of FHWA's *Roundabouts: An Informational Guide*.

G. Residential Frontage

1. Residential lots shall not front onto a Type A, B, or C thoroughfare or a residential collector unless the residential lots front onto a parallel access road. The minimum distance between adjacent curbs of the thoroughfare and the access road shall be twenty feet (20'). Access road ROW shall be in addition to the thoroughfare ROW and access roads shall not connect to the adjacent thoroughfare.
2. Residential lots shall not front onto a Type D, E, F, or G thoroughfare within one hundred feet (100') of the ROW line of the nearest Type A or B thoroughfare.
3. Residential lots shall not front onto any portion of a Type D, E, F, or G thoroughfare that is part of a residential collector, which is defined in Sections 2.02.A.3 and 2.02.I.5.
4. Residential lots shall not front onto a roundabout. Residential lots adjacent to roundabouts shall be oriented so that their homes do not face the roundabout and their driveways do not intersect with the roundabout or along any section of street with a splitter island.
5. Residential lots that front onto open space rather than onto a residential street shall back to a mews, a special type of alley described in Section 2.04.L. When such open space is adjacent to a Type A, B, or C thoroughfare or a residential collector, the distance between the front of the residential lot and the ROW line of the thoroughfare shall be a minimum of fifty feet (50'). In addition, the sidewalk from the front door of each home shall be prohibited from connecting directly to the public sidewalk along that thoroughfare. Instead, each home's sidewalk shall connect to a privately maintained, communal sidewalk that is separated from the parallel public sidewalk by at least fifty feet (50').
6. If the use of a mews makes it appear that a residential lot fronts onto a Type A, B, or C thoroughfare or a residential collector, as determined by the Director of Engineering Services, a fence or wall that meets City standards shall be installed between the front yard of the home and the public sidewalk along the thoroughfare. No gates shall be installed in the fence or

wall that would provide resident access to the thoroughfare other than communal access points located at street corners or authorized mid-block locations.

7. Residential lots are allowed to front onto a divided residential street that has twenty-four feet (24') of pavement, face to face, on each side of the median. In that case, on-street parking shall be prohibited adjacent to the median.

H. Partial Streets

1. Longitudinal partial dedications of Type A and B thoroughfares shall be permitted when only one side of a future thoroughfare is being developed. In such a case, one-half of the total right-of-way shall be dedicated and a minimum of twenty-four feet (24') of pavement, face-to-face, shall be constructed.
2. Longitudinal partial dedications of Type C, D, E, F, or G thoroughfares shall be prohibited, except when essential to the reasonable development of a property in conforming with the requirements of the Subdivision Ordinance, and where the Planning & Zoning Commission finds that it will be practical to require the dedication of the other portion of the street when the adjoining property is developed. Whenever a partial street exists along a common property line, the other portion of the street shall be dedicated when the adjoining property is subdivided or developed. Where a partial street is being dedicated along a common property line and the ultimate planned ROW width is sixty feet (60'), the first ROW dedication will be thirty-five feet (35').
 - a. The developer shall construct a minimum of twenty-four feet (24') of pavement, face-to-face, for all Type C or D thoroughfares that are partial streets at the time of development.
 - b. The developer shall construct the full width of pavement face-to-face for all Type E, F, or G thoroughfares that are partial street dedications at the time of development.

I. Street Lengths

1. Type A, B, and C thoroughfares have no street length restrictions. Residential streets (Type D, E, F, and G thoroughfares in a single-family, duplex, or townhome neighborhood) shall have street length restrictions to discourage speeding and cut-through traffic. All street length restrictions shall be measured from the ROW line of the intersecting street on each end of the street being measured.
2. A residential street that intersects with a Type A or Type B thoroughfare and has residential lots fronting onto any portion of the street shall not exceed a maximum length of six hundred feet (600') measured from the Type A or Type B thoroughfare ROW line. Such an entrance street shall also meet the requirements of Subsection K below.
3. Residential streets that do not intersect with a Type A or Type B thoroughfare shall not exceed one thousand two hundred feet (1,200') in length before changing direction. A change in direction occurs when one of the following elements is used:
 - a. A horizontal curve radius of three hundred fifty feet (350') for a Type D thoroughfare or of two hundred fifty feet (250') for a Type E, F, or G thoroughfare that changes the course of the street between ninety (90°) and one hundred twenty degrees (120°) (see Figure 2.8). A tangent that is a minimum of one hundred feet (100') long shall be provided between reverse curves.

- b. A street offset using two elbow intersections, each between ninety (90°) and one hundred twenty degrees (120°). The minimum distance between reverse elbows shall be one hundred fifty feet ($150'$). See Figure 2.9.
- c. A roundabout is used to start a new section of roadway which is angled or curved away from the alignment of the preceding street. If roundabouts are used to create a continuous route through a neighborhood that would otherwise be considered a residential collector, no homes shall front any part of that route.

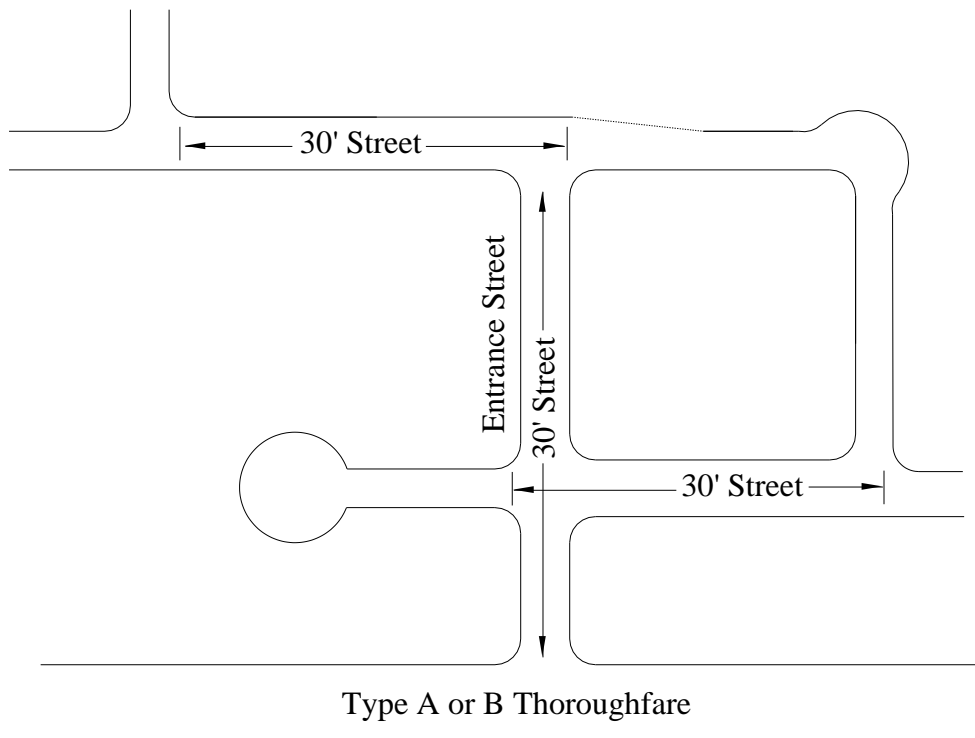


FIGURE 2.7: Example of 30' Entrance Street Requirements

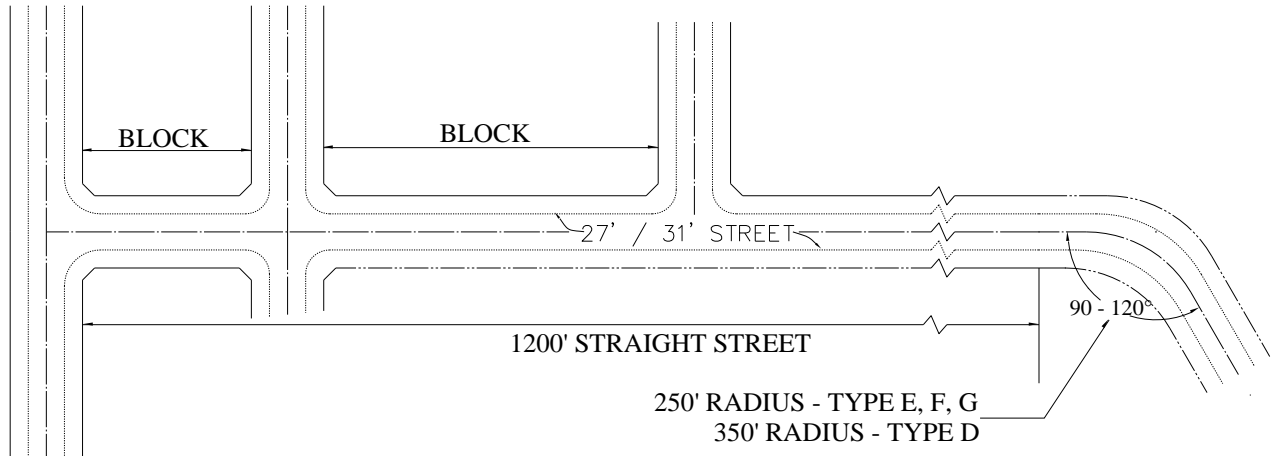


FIGURE 2.8: Change in Street Direction: Curve

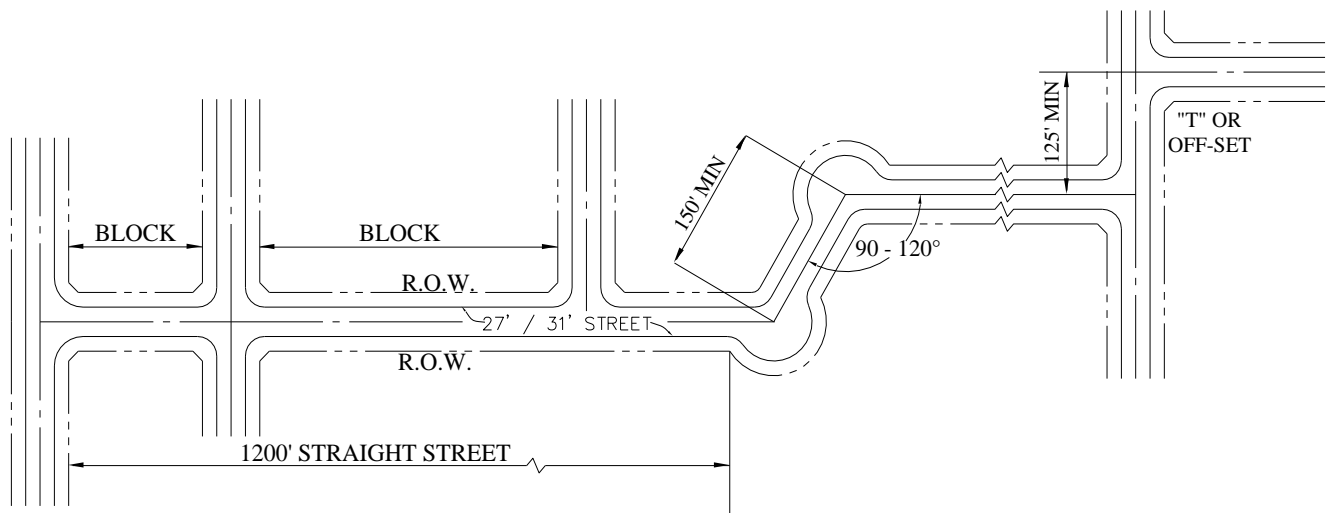


FIGURE 2.9: Change in Street Direction: Offset

4. Residential streets that do not intersect with a Type A or B thoroughfare may extend to a length of one thousand eight hundred feet (1,800') without a change in direction when one of the following is provided:
 - a. A curvilinear Type G residential street with street trees, block lengths that do not exceed seven hundred feet (700'), and at least one four-leg intersection. Front entry homes are prohibited on this type of street. See Figure 2.10.
 - b. A roundabout installed at one or more of the intersections along the street which divides the street into segments that are less than one thousand two hundred feet (1,200') long.
5. A residential collector shall have no street length restriction provided that no residential lots front onto any part of the collector and the collector shall not have any straight sections exceeding one thousand feet (1,000'). A residential collector is a "ring road" within a

neighborhood or a street that connects to a Type A or B thoroughfare and extends into a neighborhood for more than six hundred feet (600') without changing direction. A residential collector shall be constructed with the cross section of a Type D, F, or G thoroughfare.

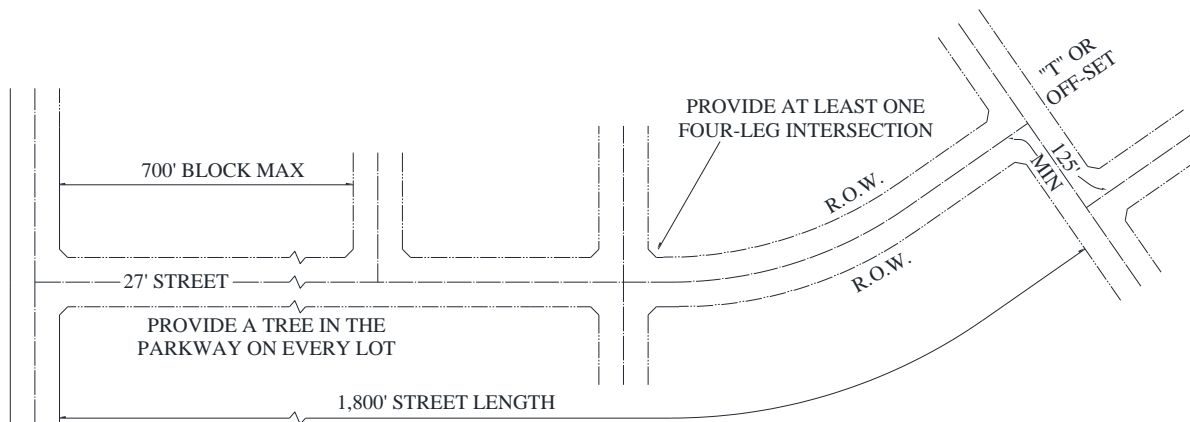


FIGURE 2.10: Maximum Street Length: Curvilinear, Short Blocks and a Four-Leg Intersection

J. Block Requirements

1. **Block Length** – Residential blocks shall not exceed one thousand two hundred feet (1,200') in length, measured from street ROW line to street ROW line. In the case of non-rectangular blocks, each side of the block with lots fronting onto it shall not exceed one thousand two hundred feet (1,200'), measured between the vertices formed by the extension of ROW lines at each corner of the block. Residential blocks shall be further restricted so that they shall contain no more than twenty (20) lots on one side. Residential blocks with a continuous series of lots longer than one thousand two hundred feet (1,200'), measured along one or more sides, may be required to be bisected by a pedestrian easement and a sidewalk (see Section 2.06.B.15).
2. **Block Width** – Residential blocks shall be wide enough to allow two (2) tiers of lots and shall have a block width no less than two hundred feet (200'), except when only one tier of lots is possible due to the size of the property or the need to back up to a Type A or B thoroughfare.

K. Entrance Streets – A residential street that connects to a Type A or B thoroughfare shall meet the following requirements:

1. Unless approved as a cul-de-sac, all neighborhoods shall have a minimum of two entrance streets.
2. A neighborhood with public residential streets shall have a minimum of two public entrance streets regardless of any connections it may have to a private neighborhood. A public entrance street cannot be removed or converted to a private entrance street unless the public portion of the neighborhood retains at least two other public entrance streets.
3. An entrance street shall be a minimum of thirty feet (30') wide, face to face, or be divided according to Section 2.03.B.7 and then transition to a thirty foot (30') wide street. On each

side of the entrance street, at least one cross street shall have a minimum width of thirty feet (30'), face to face, between the entrance street and the first intersection that provides access deeper into the subdivision. The entrance street shall remain thirty feet (30') wide at least until it has reached a thirty foot (30') wide side street on both sides. See Figure 2.7 for an example.

4. An entrance street that is a potential location for a traffic signal shall be a minimum of thirty-six feet (36') wide, face to face, or be divided according to Section 2.03.B.7, for a minimum distance of one hundred twenty-five feet (125') in advance of the curb return. It also shall align with the street on the other side of the Type A or B thoroughfare so that the through lanes align across the intersection. In addition, if the entrance street serves a residential collector, the pavement on the outbound side of the street shall be thirty-six feet (36') wide (or the ROW shall be dedicated in a way so that a right-turn lane can be added to the entrance street when the traffic signal is constructed) unless the approach will never have a through movement.
5. Each neighborhood shall have at least one entrance street designated as a primary entrance street (see Subsection 7 below). Regardless of phased construction, neighborhoods that will ultimately be larger than one hundred (100) acres in size, including any parks, schools, or floodplain areas, shall have one primary entrance street on each Type A or B thoroughfare bounding the neighborhood. Individual neighborhoods that will connect to other neighborhoods to eventually form a larger combined neighborhood surrounded by Type A or B thoroughfares shall each have a primary entrance so that the combined neighborhood will eventually have at least one primary entrance on each Type A or B thoroughfare.
6. All other entrance streets shall be considered secondary entrance streets. However, it is permissible for any secondary entrance street to be constructed to the same enhanced standards as a primary entrance street.
7. A primary entrance street shall meet the following requirements:
 - a. A primary entrance street shall be located so that it is likely to serve more traffic than a secondary entrance street.
 - b. A primary entrance street shall have a minimum street length of two hundred feet (200') or twice the depth of the nearby residential lots, whichever is greater. The maximum street length is described in Subsection I.2 above.
 - c. A primary entrance street shall have an enhanced appearance by incorporating one or more of the following design features: a boulevard street, a curvilinear street, or an entry roundabout. (See Subsection L below for the requirements of a curvilinear street.)
 - d. If a primary entrance street does not incorporate a curvilinear street or a roundabout, it shall be a boulevard street and shall be divided for a minimum distance of two hundred feet (200') or twice the depth of the nearby residential lots, whichever is greater.
 - e. If a primary entrance street incorporates a roundabout or a curvilinear street, the entrance street is not required to be divided. However, it can be divided if the developer so chooses. If so, the divided portion only needs to meet the minimum length described in Section 2.03.B.7.

- f. A primary entrance street shall not terminate at a “T” intersection unless the lot adjacent to the intersection contains open space, an amenity center, or the side of a home with proper screening as required by the Zoning Ordinance. A primary entrance street shall not lead to the front of a home.
 - g. An entry roundabout shall be located a minimum of one hundred twenty feet (120’) from the Type A or B thoroughfare, measured from the curb of the Type A or B thoroughfare to the yield line of the roundabout.
 - h. If a neighborhood is to be built in phases, a primary entrance street must be built in the first phase.
- 8. A secondary entrance street shall, at a minimum, meet the following requirements:
 - a. A secondary entrance street shall have a minimum street length equal to the depth of a residential lot. The maximum street length is described in Subsection I.2 above.
 - b. A secondary entrance street is not required to be divided. If it is divided, it must meet the standards described in Section 2.03.B.7.
 - c. A secondary entrance street shall not terminate at a “T” intersection unless the lot adjacent to the intersection contains open space, an amenity center, or the side of a home with proper screening as required by the Zoning Ordinance. The secondary entrance street shall not lead to the front of a home.
- L. Curvilinear Streets – The majority of residential streets within a neighborhood shall be curvilinear, as defined by the following requirements:
 - 1. The centerline of a curvilinear street shall consist of one or more horizontal curves or a combination of straight lines and horizontal curves. Each curve shall meet the minimum radius requirements described in Section 2.02.C and shall have a minimum arc length of one hundred twenty-five feet (125’).
 - 2. A straight line drawn between the two ends of the centerline of a curvilinear street shall cross over a curb in at least two locations along the length of the street. This straight line shall be offset from the curb a minimum of thirty feet (30’) in at least one location along the street so that a motorist on one end of the street cannot see the other end. See Figure 2.11A.
 - 3. The closest residential street parallel to a Type A or B thoroughfare is not required to be curvilinear, but the design of the neighborhood shall become more curvilinear as the distance from the Type A or B thoroughfare increases.
 - 4. The use of a street that is primarily straight with a short curve at one end of the street shall be limited to streets whose straight end is perpendicular to the straight edge of the neighborhood and is separated from that straight edge by no more than one lot. However, a primarily straight street with a larger curve at one end of the street that changes the direction of the street by ninety degrees (90°) can be used in any location. See Figure 2.11B.
 - 5. A short residential street that connects between two curvilinear streets is not required to be curvilinear if it has no homes fronting onto it and its length is no more than two hundred seventy feet (270’) measured from the ROW lines of the intersecting streets. See Figure 2.11B.

6. Curvilinear streets should follow the natural features of a site so that the leveling and/or filling of the natural topography is minimized.
7. Curvilinear streets shall be designed so that the sight distance requirements in Section 2.07 are maintained.

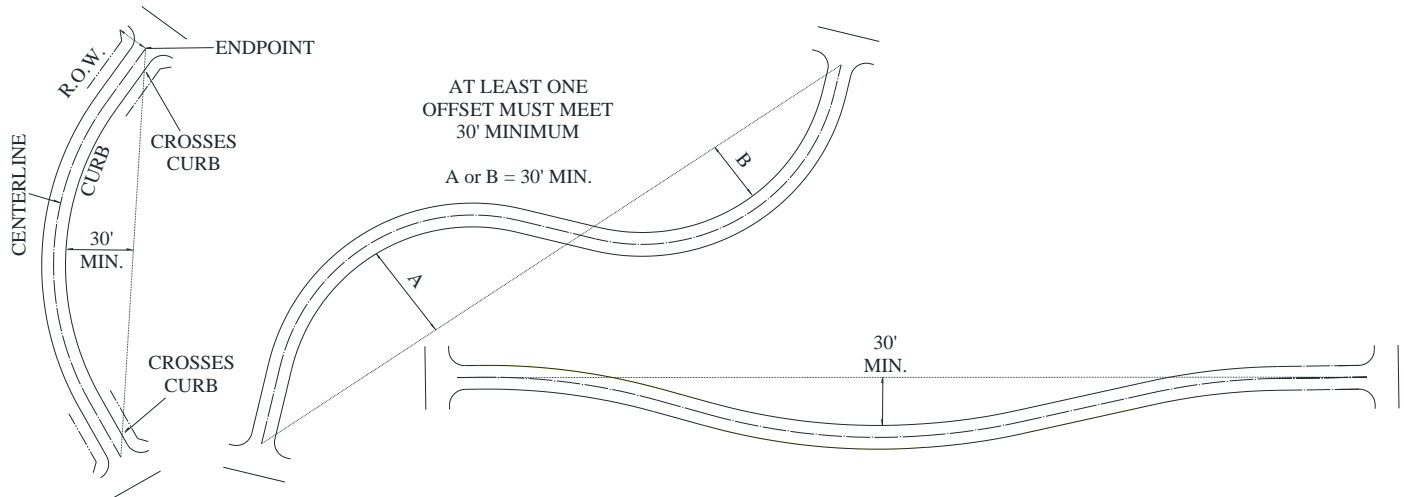


FIGURE 2.11A: Curvilinear Street Centerline Requirement

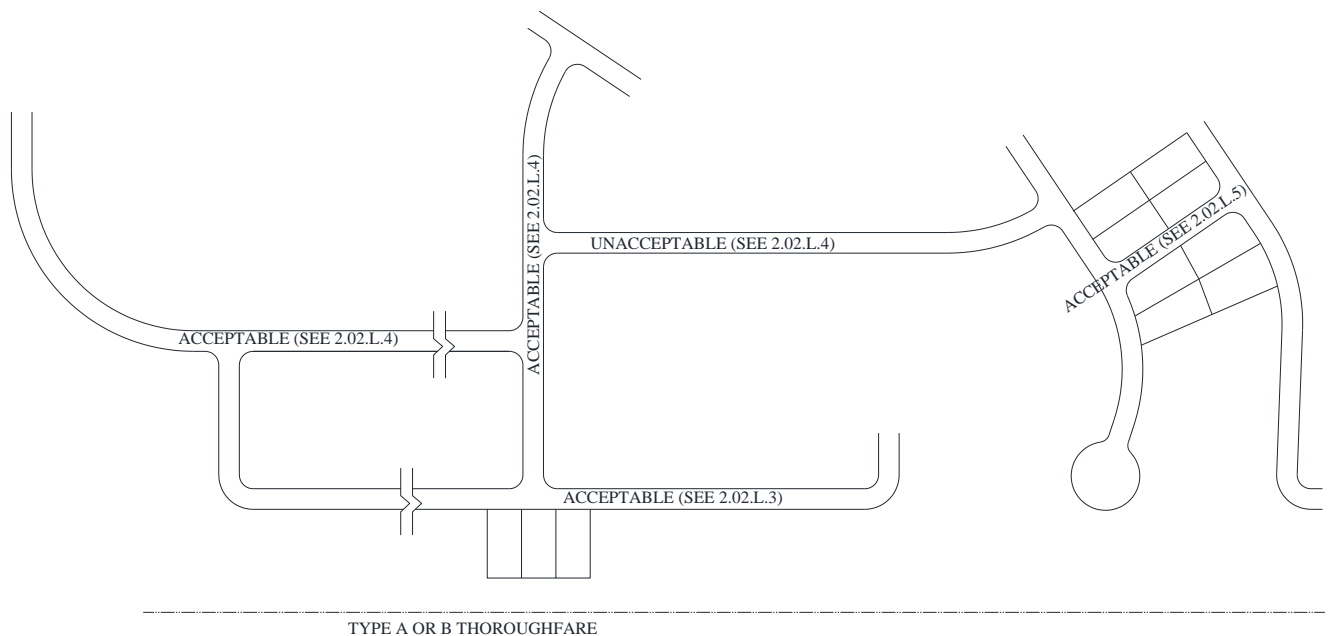


FIGURE 2.11B: Curvilinear Street Exceptions

8. The designer of a new neighborhood should use the existing Frisco neighborhood of Hunters Creek as a good example of a curvilinear neighborhood. This neighborhood is located south of Rolater Road between Independence Parkway and Custer Road (see Figure 2.11C). However, any new neighborhood shall meet all current City standards regardless of what exists within the Hunters Creek neighborhood.

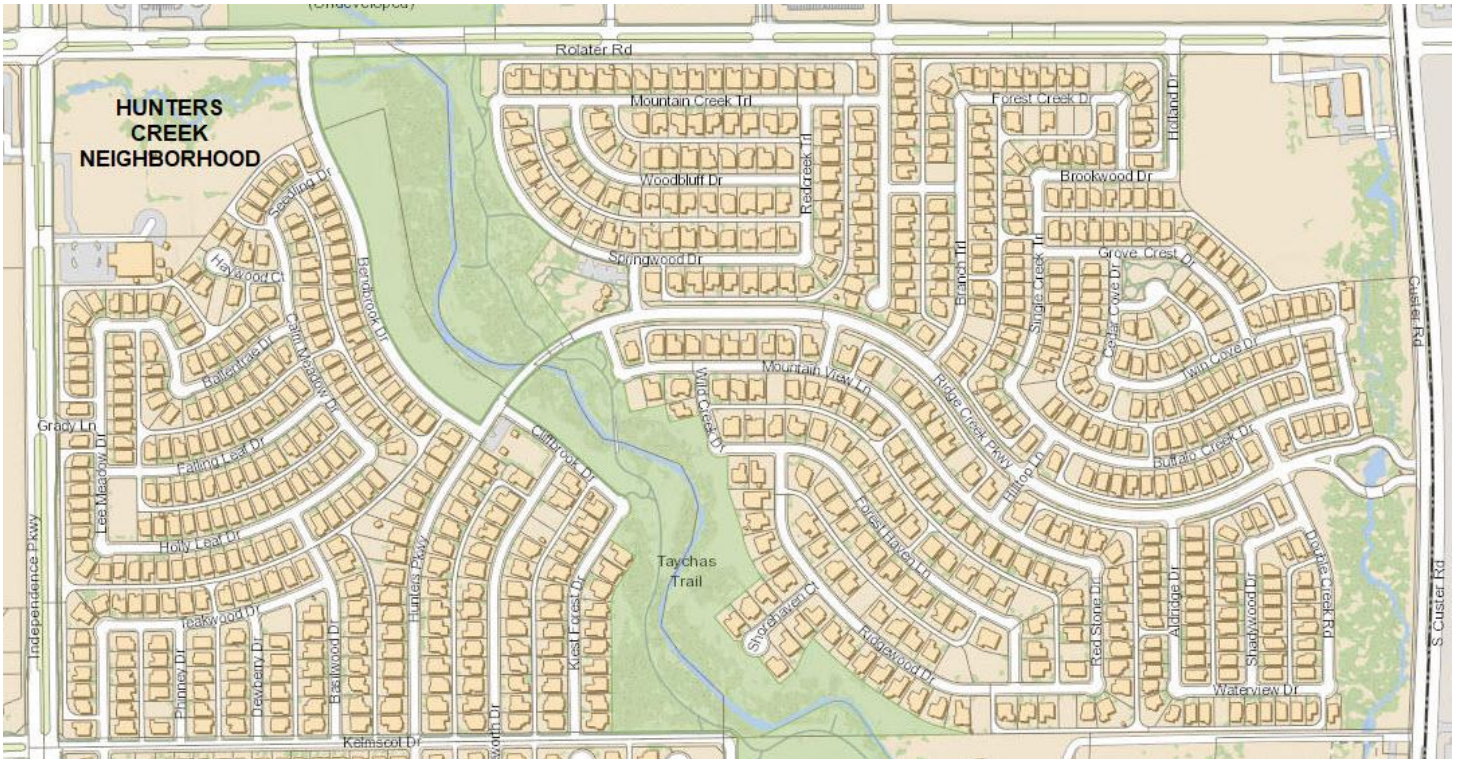


FIGURE 2.11C: Curvilinear Streets: Hunters Creek Neighborhood

- M. Circuitous Streets – Neighborhood streets shall be laid out in a pattern that discourages cut-through traffic and speeding; but shall not be too circuitous, as defined by the following restrictions:
1. The layout of a new neighborhood shall not require a motorist to make more than four turns in order to reach a home from its closest entrance street. All homes in a new neighborhood shall be reachable by no more than four turns from at least one entrance street. See Figure 2.11D.
 2. Turning off of a Type A, B or C thoroughfare into a neighborhood entrance street shall not be counted towards the turn limitation.
 3. The turning route will be measured from the entrance street to an on-street parking space in front of the home, regardless of whether or not it is alley served. Alleys shall not be used to measure the turning route. Turning into the home's driveway shall not be counted towards the turn limitation.

N. Other Street Designs and Requirements

1. Any segment of a residential street that is adjacent to a school shall be constructed with the Type D cross section. Chokers and pedestrian bulb-outs shall not be used adjacent to a school.
2. Any segment of a residential street that is adjacent to a park, or adjacent to an HOA open space that has sufficient level space for one or more practice fields, shall be constructed with the Type D cross section. If the Type D cross section will extend for more than eight hundred feet (800'), midblock chokers and pedestrian bulb-outs at intersections shall be used for traffic calming (see Subsection 3 below).
3. A choker is a midblock location where a residential street is narrowed to twenty-two feet (22') wide, face to face. A choker shall be twenty-five feet (25') long, not counting the taper on either end. Pedestrian bulb-outs are used at an intersection to narrow the residential street to twenty-four feet (24') wide, face to face, at the location where pedestrians cross the street. Pedestrian bulb outs shall consist of a fifteen-foot (15') tangent extending from the curb return. Chokers and pedestrian bulb-outs shall contain landscaping or a sign to increase their visibility to motorists; however, trees shall not be planted in them.
4. In mixed-use and urban developments, a zipper street may be used to reduce vehicular speeds and create a pedestrian-friendly environment. A zipper street has a twenty-four foot (24') wide travel section with parking cut outs on each side that are eight feet (8') wide and forty-four feet (44') to eighty-eight feet (88') long and a tree island between the parking cut-outs that is a minimum of twenty feet (20') long and eight feet (8') wide. A tree shall be planted in each tree island per the requirements in the Zoning Ordinance. See Figure 2.11E.

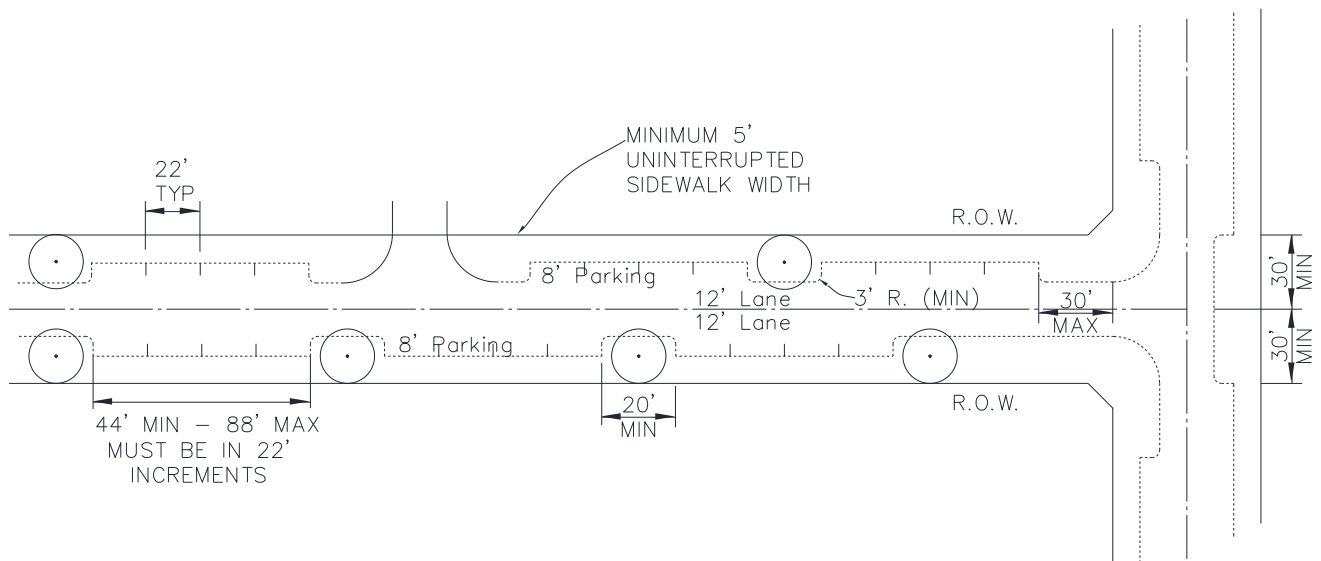


FIGURE 2.11E: Urban Developments: Zipper Street

5. Nothing shall be installed temporarily or permanently in the public right-of-way without permission from the Director of Engineering Services. If approved, decorative pavement

installed in the right-of-way shall be maintained by the adjacent landowner or property owners' association and shall require the execution of an encroachment agreement. If approved, vertical items (such as signs, columns, stoops, etc.) installed in the right-of-way shall meet all visibility requirements described in Section 2.07, shall not interfere with ADA requirements, shall be maintained by the adjacent landowner, shall require the execution of an encroachment agreement, and shall meet federal breakaway safety requirements if installed within eight feet (8') of a roadway's curb.

- O. On-Street Parking – Where on-street parking is allowed by the standards in Section 2.02, it shall operate as parallel parking unless otherwise approved by the Director of Engineering Services. Where head-in parking is approved by the Director of Engineering Services, the parking spaces shall be angled in the direction of traffic flow on each side of the street, assuming a vehicle pulls forward into a parking space. Where on-street angled parking is used, the street shall provide a travel section that is no less than twenty-four feet (24') wide, the angled parking shall be no closer than twenty feet (20') from the curb return of an upstream or downstream intersection (measured along the curb of the street), and the angled parking shall be no closer than twenty feet (20') from the downstream edge of a pedestrian crossing (regardless of whether it is striped with a crosswalk).

2.03 Median, Left-Turn Lane, Right-Turn Lane, Deceleration Lane, and Island Design

A. Required Median Openings and Left-Turn Lanes

1. Median openings on divided thoroughfares shall be required at all public street, private residential street, and public way intersections. Median openings may be constructed to serve non-residential driveways provided that the minimum spacing requirements herein are met. Left-turn lanes are required for each street or driveway that connects to a median opening. The design of median openings and left-turn lanes shall accommodate potential future left-turn lanes that might serve undeveloped land.
2. All non-residential lots on a divided thoroughfare shall have direct or indirect access to a median opening. Indirect access shall be provided through a series of fire lane and access easements.
3. Multi-family developments on a divided thoroughfare shall have direct access to a median opening.
4. The City can modify, relocate, or remove any existing or planned median opening to facilitate traffic flow and/or preserve the health, safety and welfare of the Public, as reasonably determined by the Director of Engineering Services utilizing recognized industry standards as they exist, may be amended, or in the future arising.

B. Minimum Left-Turn Storage, Taper Length, and Median Opening Width, Location, and Spacing Requirements

1. Left-Turn Lane Storage

- a. All single left-turn lanes constructed on divided thoroughfares of ultimate cross section width shall be a minimum of eleven feet (11') wide. Where double left-turn lanes are provided, each left-turn lane shall be a minimum of ten feet (10') wide.

- b. All left-turn lanes constructed as future through lanes on divided thoroughfares shall be twelve feet (12') wide for the entire storage and taper length requirements as listed in Table 2.5.
 - c. Minimum storage requirements are listed in Table 2.5. Storage requirements may be increased by the City based upon actual and projected traffic demands of the properties that will be served by the left-turn lane.
 - d. Left-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
 - e. Concrete pavers shall be required in the median where the median width is eight feet (8') or less, back of curb to back of curb (see Figure 2.12). If the median width is greater than eight feet (8'), concrete pavers shall be required for a minimum distance of ten feet (10') from the median nose. See City's current standard details for median noses.
2. Taper Length – The taper specifications for left-turn lane entrance areas are specified in Table 2.5. The variables used for the specifications are shown in Figure 2.12.

TABLE 2.5: Minimum Left-Turn Lane Design Requirements

<u>Type of Thoroughfare On</u>	<u>Type of Thoroughfare At</u>	<u>Turn Lane Width(s) (ft)</u>	<u>Length of Full-Width Storage(ft)</u>	<u>Taper Specifications</u>		
				<u>Length(ft)</u>	<u>R₁(ft)</u>	<u>R₂(ft)</u>
A	A, B	10 ⁽¹⁾⁽⁴⁾	150,250 ⁽²⁾	200	505	505
B	A, B	11	150	100	250	250
A, B	C, Residential Collector	11 ⁽⁴⁾	150	100	250	250
A, B	D, E, F, G	11 ⁽⁴⁾	100 ⁽³⁾	100	250	250
A, B	Non-Residential Driveway	11 ⁽⁴⁾	150	100	250	250
TxDOT Road	A, B	Apply Type A Thoroughfare specifications ⁽⁵⁾				
TxDOT Road	C,D,E,F,G and Non-Residential Driveway	See TxDOT's <i>Roadway Design Guide</i> and Specifications utilizing the design speed and a 20 mph differential				
Frontage Road	A,B,C,D,E,F,G and Non-Residential Driveway	Apply Type A Thoroughfare specifications to Dallas Pkwy Apply "TxDOT Road" specifications to SH 121 and US 380				

1. Double left-turn lanes
2. 150 feet for the inside left-turn lane; 250 feet for the outside left-turn lane
3. 150 feet of storage shall be required for gated communities.
4. Left-turn lanes that will become a future through lane shall be twelve feet (12') in width and be square at the end and incorporate a street header.
5. Turn lane designs on Preston Road (SH 289) shall also meet the requirements set forth in the Preston Corridor Access Management Plan.

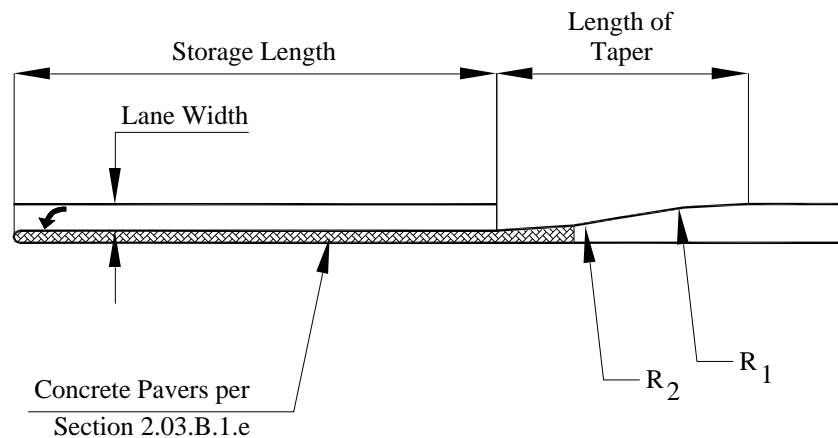


FIGURE 2.12: Typical Left Turn Lane Dimensions

3. Median Openings
 - a. Median openings shall accommodate all turning paths and crosswalks.
 - b. The width of mid-block median openings shall not be less than sixty feet (60'). They may be greater than sixty feet (60') where necessary to accommodate turning paths and crosswalks subject to approval by the Director of Engineering Services.
 - c. Median openings shall not be less than seventy feet (70') wide at divided high capacity driveways (see Section 2.05.B.5).
4. The minimum distance to the first mid-block median opening along a Type A or B thoroughfare that is immediately downstream from a Type A or B thoroughfare is shown in Figure 2.13. This distance varies from three hundred fifty feet (350') to six hundred feet (600'), measured nose to nose, depending on the thoroughfare type and the type of mid-block opening. If the first median opening is downstream of a roundabout, the median opening shall be located so that the taper for its left-turn lane begins no less than fifty feet (50') downstream from the crosswalk on the roundabout's departure.
5. The minimum distance between median openings on a Type A or B thoroughfare where left-turn storage is provided in both directions for Types C, D, E, F, and G intersecting thoroughfares and driveways is shown in Figure 2.14. The distances shown are measured nose to nose. Refer to Table 2.11 for driveway design requirements.

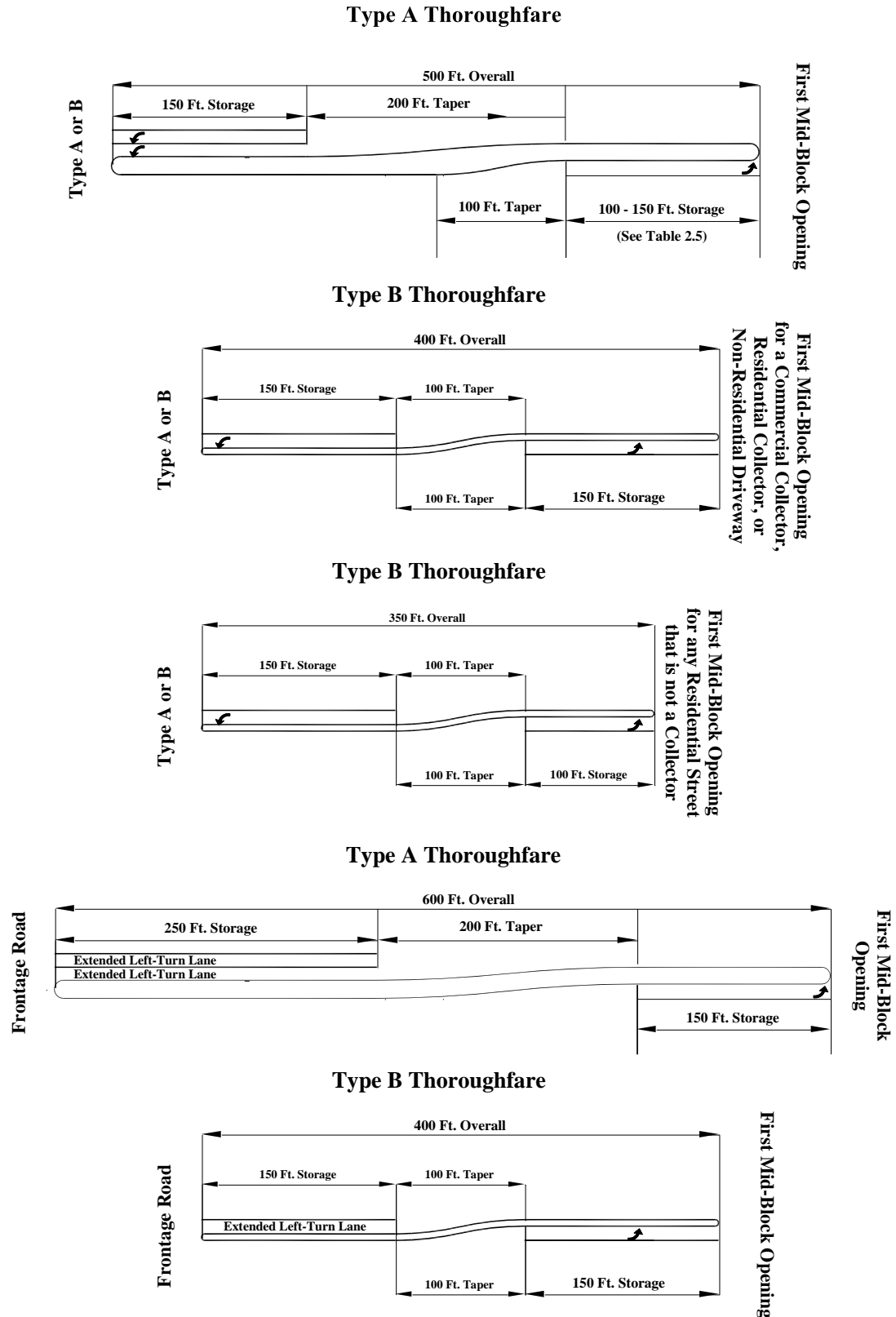


FIGURE 2.13: Minimum Spacing between Type A or B Thoroughfares and First Mid-Block Median Opening on a Type A or B Thoroughfare

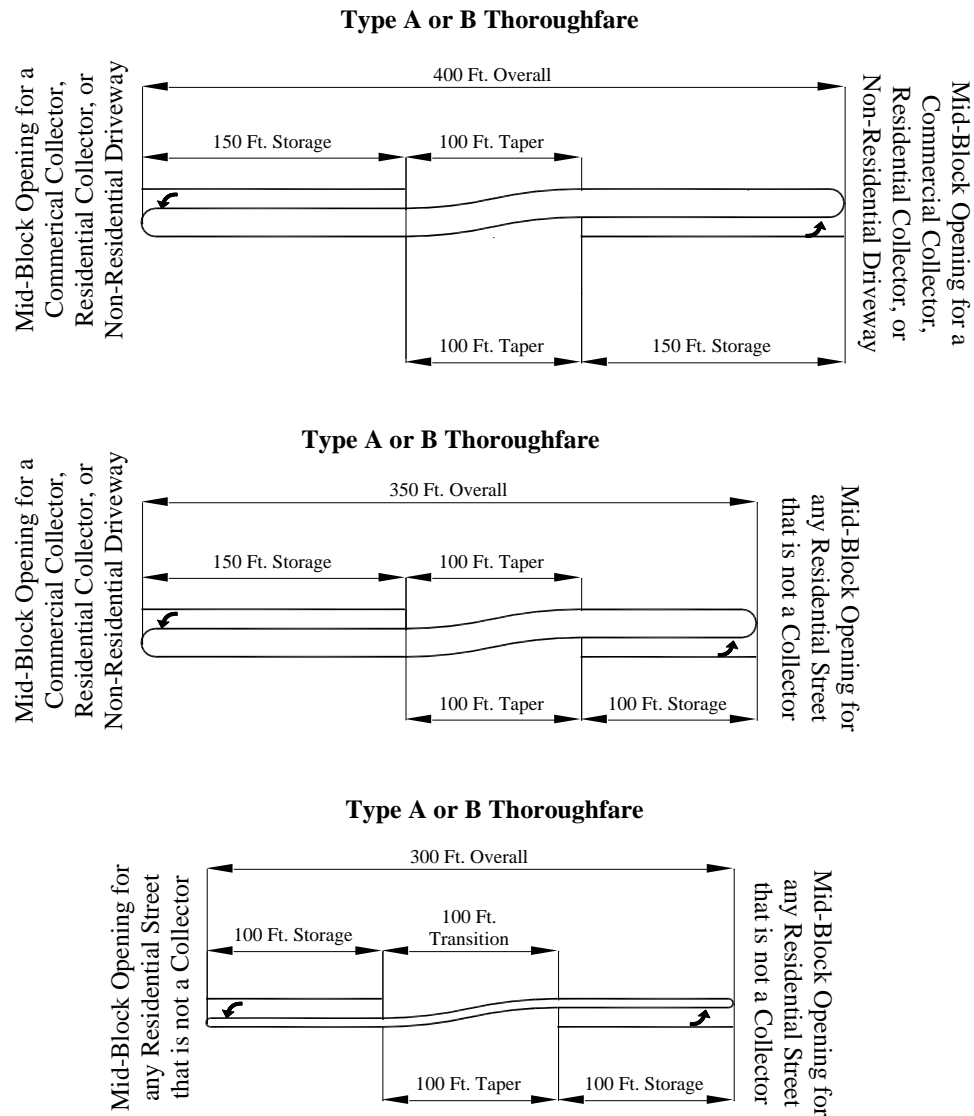


FIGURE 2.14: Minimum Distance between Mid-Block Median Openings on a Type A or B Thoroughfare

6. Medians without Left-Turn Lanes in Both Directions

- a. If a left-turn lane is required in only one direction, the minimum length of the median shall be the sum of the required left-turn storage, taper length, fifty-foot (50') tangent, and length of median nose. This requirement is reflected in Figure 2.15. This median design is only allowed if access is not compromised for vacant property on the opposite side of the thoroughfare.

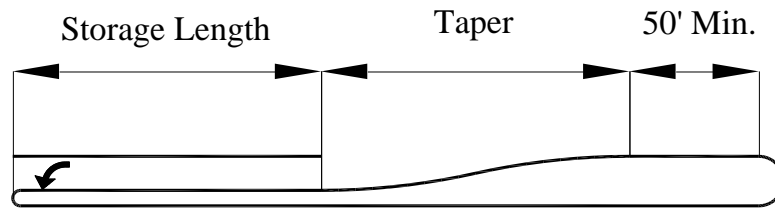


FIGURE 2.15: Minimum Length of Median Where A Left-Turn Lane is Needed in Only One Direction

- b. If the left-turn storage is not required in either direction and the median is simply a spacer between two median openings, the minimum length of the spacer must be one hundred feet (100') (see Figure 2.16).

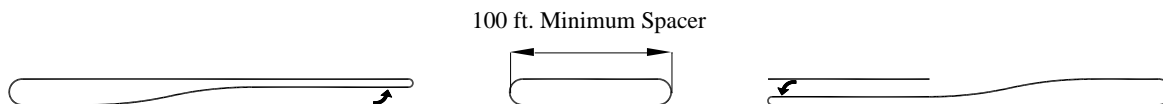


FIGURE 2.16: Minimum Spacer Length

- c. If a driveway is not served by a median opening, at least one hundred feet (100') of separation shall be provided between the edge of the driveway and the edge of the median opening.
7. Medians on Public Street Entrances to Developments
 - a. Medians installed on undivided thoroughfares at entrances to subdivisions for aesthetics or any other purpose shall be a minimum of thirteen feet (13') wide and one hundred feet (100') long (see Figure 2.1 for Divided Residential Subdivision Entrance cross section). The median shall have a maximum width of twenty feet (20') at the intersection with a Type A or B thoroughfare, but can be wider as the median extends into the neighborhood. The pavement on either side of the median shall be a minimum of twenty-four feet (24') wide, face-to-face. If the entrance street is a potential location for a traffic signal, the median shall be offset from any median on the other side of the Type A or B thoroughfare in order to minimize the offset between opposing left-turn movements.
 - b. A divided residential subdivision entrance shall transition to the normal residential street width upstream or downstream of the first street intersection. No part of the transition shall occur within an intersection.
 - c. If an entrance street is designated as a primary entrance, additional design standards may be required as described in Section 2.02.K.

C. Minimum Right-Turn Storage and Taper Length

1. Right-Turn Lane Storage

- a. Right-turn lanes are required on Type A and B thoroughfares at all public street, private residential street, and public way intersections and shall be constructed at the time of development.
 - b. All right-turn storage areas shall be eleven feet (11') wide.
 - c. Additional ROW shall be required adjacent to right-turn lanes so that there is a minimum of ten feet (10') of ROW from the back of curb.
 - d. Right-turn lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
 - e. Minimum storage requirements are listed in Table 2.6. Storage requirements may increase based upon actual and projected traffic demands.
 - f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveway or cross street curb return and the taper of a right-turn lane.
2. Taper Length – The taper specifications for right-turn lane entrance areas are specified in Table 2.6. The variables used for the specification are shown in Figure 2.17.

TABLE 2.6: Minimum Right-Turn Lane Design Requirements

<u>Type of Thoroughfare On</u>	<u>Type of Thoroughfare At</u>	<u>Turn Lane Width(s) (ft)</u>	<u>Length of Full-Width Storage(ft)⁽¹⁾</u>	<u>Taper Specifications⁽²⁾</u>		
				<u>Length(ft)</u>	<u>R₁(ft)</u>	<u>R₂(ft)</u>
A	A, B	11	225	150	515	515
B	A, B	11	175	150	515	515
A, B	C, Residential Collector	11	150	110	280	280
A, B	D, E, F, G	11	100	110	280	280
C, Residential Collector	A, B	11	100	50	Varies	Varies
TxDOT Road	A, B	Apply Type A Thoroughfare specifications				
TxDOT Road	C,D,E,F,G	See TxDOT's <i>Roadway Design Guide</i> and Specifications utilizing the design speed and a 20 mph differential				
Frontage Road	A,B,C,D,E,F,G	Apply Type A Thoroughfare specifications to Dallas Pkwy Apply "TxDOT Road" specifications to SH 121 and US 380				

1. Measured from the intersecting thoroughfare face of curb.

2. No driveways are permitted within the taper area.

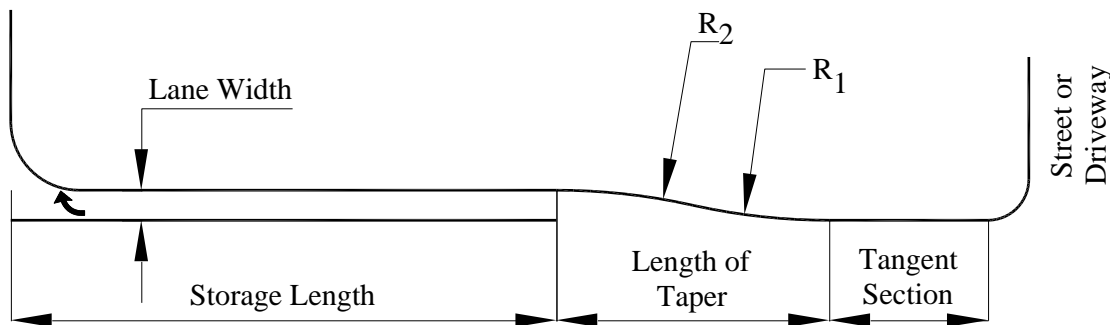


FIGURE 2.17: Typical Right-Turn / Deceleration Lane Dimensions

3. A right-turn lane is required on a commercial collector (Type C thoroughfare) where it intersects with a Type A or B thoroughfare. Unless the approach will never have a through movement, this right-turn lane shall be in addition to the typical thirty-six-foot (36') width of the street so that a left-turn lane, through lane, and right-turn lane will be provided at the intersection. See Table 2.6 for design requirements.
4. If a right-turn lane is required on a residential collector where it intersects with a Type A or B thoroughfare under the requirements of Section 2.02.K.4, see Table 2.6 for design requirements.

D. Minimum Deceleration Lane Storage and Taper Length

1. Deceleration Lane Storage
 - a. Deceleration lanes are required on Type A and B thoroughfares at all non-residential and multi-family driveways, except where precluded by the proximity of a roundabout (see Subsection h below).
 - b. All deceleration lane storage areas shall be eleven feet (11') wide.
 - c. In locations where there will be less than ten feet (10') of ROW adjacent to the deceleration lane, a street easement shall be dedicated such that the combination of ROW and street easement extends at least ten feet (10') from the back of curb of the deceleration lane. Street easements shall extend along the street a minimum of forty feet (40') beyond the far edge of the driveway to allow for utility connections.
 - d. Deceleration lanes will be delineated by using the City's current Pavement Markings and Markers standard details.
 - e. Minimum storage requirements are listed in Table 2.7. Storage requirements may increase based upon actual and projected traffic demands.
 - f. A minimum tangent section of thirty feet (30') shall be provided between the preceding driveway or cross street curb return and the taper of a deceleration lane.

- g. A tangent section is not required when a deceleration lane is immediately downstream from an intersecting Type A or Type B thoroughfare.
 - h. Roundabout Exceptions – On an approach to a roundabout, a deceleration lane shall not be installed for a driveway whose edge is less than two hundred eighty feet (280') upstream from the roundabout's yield line. On a departure from a roundabout, a deceleration lane shall not be installed for a driveway whose edge is less than two hundred twenty feet (220') downstream from the roundabout's crosswalk. If the driveway's edge is between two hundred twenty feet (220') and two hundred seventy feet (270') downstream from the roundabout's crosswalk, a deceleration lane shall be installed with a storage of one hundred feet (100') and a taper of seventy feet (70').
2. Taper Length – The taper specifications for deceleration lane entrance areas are specified in Table 2.7. The variables used for the specification are shown in Figure 2.17.

TABLE 2.7: Minimum Deceleration Lane Design Requirements

<u>Type of Thoroughfare On</u>	<u>Type of Thoroughfare At</u>	<u>Turn Lane Width(s) (ft)</u>	<u>Length of Full-Width Storage(ft)⁽¹⁾</u>	<u>Taper Specifications</u>		
				<u>Length(ft)</u>	<u>R₁(ft)</u>	<u>R₂(ft)</u>
A	Non-Residential Driveway	11	110 ⁽²⁾	110 ⁽²⁾	280	280
B	Non-Residential Driveway	11	90	110 ⁽²⁾	280	280
TxDOT Road	Non-Residential Driveway	See TxDOT's <i>Roadway Design Guide</i> and Specifications utilizing the design speed and a 20 mph differential				
Frontage Road	Non-Residential Driveway	Apply Type A Thoroughfare specifications to Dallas Pkwy Apply TxDOT specifications to SH 121 and US 380				

1. Measured from the edge of the driveway.
2. When a deceleration lane is immediately downstream from an intersecting Type A or B thoroughfare (or a roundabout), its storage can be reduced to 100 feet and its taper can be reduced to 70 feet (see Figure 2.23).

E. Cost of Median Openings and Turn Lanes

1. Median openings, left-turn lanes, and right-turn lanes constructed for residential streets and/or subdivision entrances not referenced on the Thoroughfare Plan shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.
2. Median openings, left-turn lanes and deceleration lanes for multi-family and non-residential developments shall be the responsibility of the developer and shall be constructed to City (or TxDOT) standards and inspected by the governing entity.
3. If median openings, left-turn lanes, deceleration lanes or right-turn lanes are not constructed at the time of development, the developer shall escrow funds for such future improvements prior to final acceptance. The escrow amount shall include all costs for engineering, inspection, and construction.

2.04 Alley Design

A. Alley Intersections

1. Alleys shall not intersect any Type A, B, or C thoroughfare nor any residential collector.
2. Alleys that are parallel to and share a common ROW line with a Type A, B, or C thoroughfare or a residential collector shall turn away from that thoroughfare not less than forty feet (40') or one subdivision lot width (whichever is greater) from the cross street ROW as shown in Figure 2.18.
3. Alleys shall intersect with a residential street so that the alley ROW line is not less than forty feet (40') or one subdivision lot width (whichever is greater) from the ROW of the nearest cross street as shown in Figure 2.18.

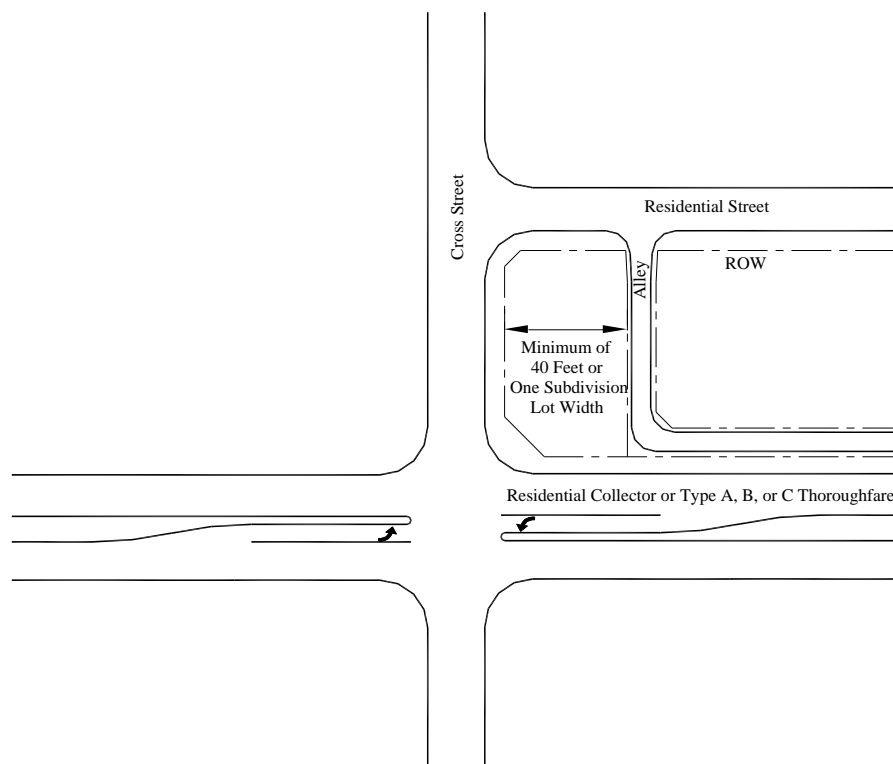


FIGURE 2.18: Minimum Distance from Intersection for Parallel Alley

4. All alley intersections with streets shall be perpendicular or radial, within a five-degree (5°) tolerance, at the intersection of the ROW lines.
5. The offset between alleys on opposite sides of a residential street shall be less than fifteen feet (15') or greater than ninety feet (90') measured from centerline to centerline.
6. Alleys shall not align with existing or future streets or driveways on the opposite side of a street. Alleys shall be offset from such a street or driveway by a minimum of seventy-five feet (75') measured from edge of alley to edge of street or driveway.

7. Alleys that intersect at “elbow” street intersections shall not intersect within thirty degrees (30°) of the centerline of the adjacent streets. See Figure 2.19.
8. Alleys shall not intersect with a roundabout.

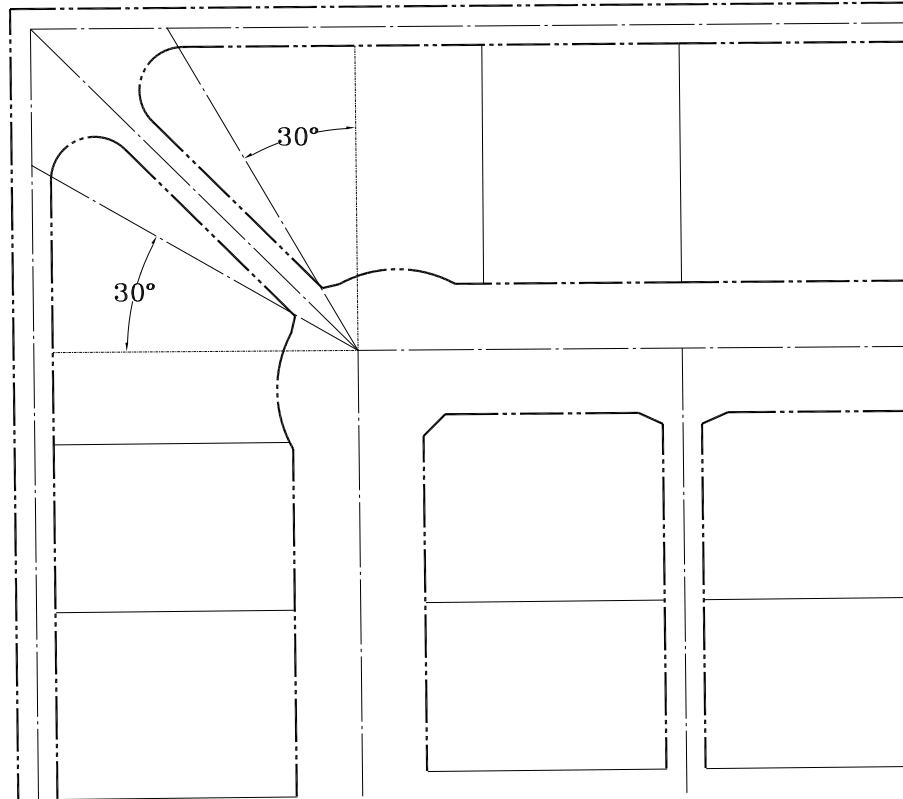


FIGURE 2.19: Alley Intersecting an Elbow

9. Internal alley intersections shall consist of no more than three alley approaches.
10. The offset between alleys on the opposite side of an intersecting alley shall be a minimum of one hundred feet (100') measured from centerline to centerline.
11. As an alley approaches an intersection with another alley, the pavement width shall increase to fourteen feet (14') using a taper twenty feet (20') long. The wider pavement shall be maintained for a distance of fifteen feet (15') prior to the radius of the intersection. Two feet (2') of parkway shall be maintained between the pavement and the ROW line at all times. See Figure 2.20.
12. No permanent dead end alley shall be permitted in new subdivisions. Alleys shall connect and/or be aligned with alleys in adjacent subdivisions.

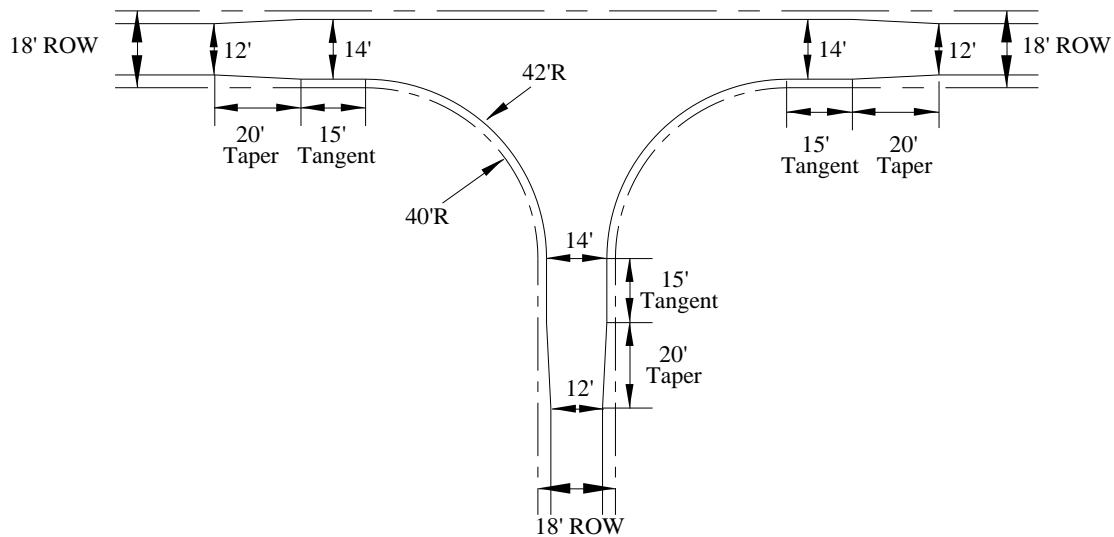


FIGURE 2.20: Alley to Alley Intersection

13. The radius of alley pavement at street intersections shall not be less than fifteen feet (15'). At the intersection of two alleys, the radius of the alley ROW is dependent upon the alley ROW intersection angle as listed in Table 2.8. At the intersection of two alleys, the radius of the alley pavement shall be two feet (2') greater than the radius of the alley ROW.

TABLE 2.8: Alley Intersecting Alley Radius

Alley ROW Intersection Angle	Minimum Required ROW Radius (ft)
1°-40°	70
41° -70°	50
71° -90°	40
> 90°	50

- B. Alley ROW Width – Alley ROW shall be eighteen feet (18') wide except for certain townhome developments that are required by the Zoning Ordinance to follow the design standards in the Form-Based Code Manual. Where an alley intersects a street, ROW corner clips shall be provided as shown in Figure 2.21.
- C. Alley Pavement Width – Alley pavement shall be twelve feet (12') wide except near alley intersections, as shown in Figure 2.20, and except near street intersections as shown in Figure 2.21. Parking is prohibited within the pavement of an alley.

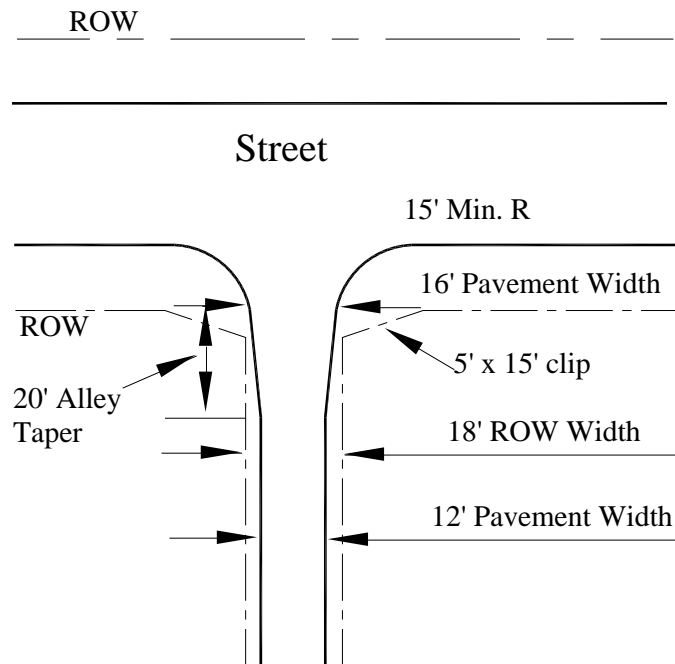


FIGURE 2.21: Alley to Street Intersection

- D. Alley Length – Alleys shall not exceed eight hundred feet (800') in length without an intermediate connection to a residential street.
- E. Alley Pavement Thickness – See Section 3 of the Engineering Standards for alley subgrade and pavement design requirements.
- F. Alley as Fire Lane – An alley that also serves the purpose of a fire lane shall be constructed to the standards of a fire lane as required by the Fire Department. These standards include, but are not limited to, a minimum pavement width of twenty-four feet (24'), a minimum pavement thickness of six inches (6"), fire lane striping painted on its edges, and a minimum pavement edge radius of twenty feet (20') at street intersections. The pavement design for an alley that also serves as a fire lane is shown in the City's current standard detail entitled "Typical Mews Section." (A mews is a special type of alley that serves as a fire lane and has other requirements as described in Subsection L below.)
- G. Rear Alley Frontage – The minimum alley rear frontage shall be twenty feet (20').
- H. Alley Visibility Obstructions
 - 1. No fence, wall, screen, sign, structure, landscaping rock greater than four inches (4") in height, or foliage of hedges, trees, bushes, or shrubs shall be erected, planted or maintained in any alley ROW, including the ROW corner clips shown in Figure 2.21.
 - 2. Foliage of hedges, trees, bushes, and shrubs planted adjacent to the alley ROW shall be maintained by the property owner such that the overhang or encroachment shall be no less

than fourteen feet (14') above the alley surface and no less than one foot (1') outside the edge of the pavement.

I. Alley Grade

1. Alleys shall have a maximum grade of six percent (6%). Steeper grades may be permitted where required by topographical and/or natural features, as approved by the Director of Engineering Services.
2. Alleys shall maintain a maximum cross-slope of two percent (2%) at the intersection of the adjacent sidewalk.

J. Vertical Curves in Alleys – Vertical curves in alleys shall be used in order to provide a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide stopping sight distance in all cases based on a design speed of 20 mph.

K. Alley Screening Walls – The area between screening walls and alleys shall be paved and graded to drain to the invert.

L. Mews Alleys – Residential lots that front onto open space rather than onto a residential street shall back to a mews. A mews is a special type of alley that serves as the only vehicular access and emergency access for these homes. The residential lots shall meet the requirements of Section 2.02.G and the mews shall conform to the following standards:

1. A mews shall have a pavement width of twenty-four feet (24') centered within thirty feet (30') of ROW. Parking is prohibited within the pavement of the mews.
2. The pavement of a mews shall be built in a similar manner as a typical alley, including having an invert and no curbs. The pavement design for a mews is shown in the City's current standard detail entitled "Typical Mews Section."
3. A mews shall have fire lane striping painted on its edges.
4. Every intersection along a mews shall have a pavement edge radius of twenty feet (20').
5. Each end of a mews shall connect to a residential street. A mews shall not connect directly to a Type A, B, or C thoroughfare. A mews shall not terminate into an alley and no dead-end mews shall be allowed. A mews shall not intersect with another mews unless the resulting layout of the neighborhood meets the other requirements of this Subsection L, as determined by the Director of Engineering Services.
6. The maximum length of a mews shall be five hundred feet (500'). The length of a mews may be limited further depending on the amount of public parking that is constructed nearby, as described in Subsection 7 below.
7. If a mews is proposed, adequate parking shall be provided along nearby public streets to serve the mews homes. Such parking shall be convenient to the mews homes and accessible by the public. Such parking shall be in addition to the typical on-street parking spaces provided in front of homes that front onto any nearby public streets. The length of any mews and/or the use of multiple mews alleys in a neighborhood shall be limited by the amount of

- nearby parking spaces that are provided to serve the mews homes, as determined by the Director of Engineering Services.
8. A mews shall have a street name and the homes that back to the mews shall be addressed to that mews. The street name shall have the suffix “Mews” so emergency responders will know the special home orientation they will encounter when they arrive. The suffix “Mews” shall not be used with the name of any other type of street.
 9. Where a home fronts onto open space and backs to a mews, the design of its back door(s), back yard, and fence, shall conform to the requirements of the Fire Department to ensure adequate emergency access from the back of the home.
 10. Homes shall not front onto a mews. If a home fronts onto a street while also backing to a mews, the home shall be addressed to the street, the mews will be considered its alley, and the home will not be required to conform to the requirements described in Subsection 9 above.
 11. Where a mews intersects with a street, corner visibility triangles (ROW corner clips) shall be provided. The corner clip on the inbound side of the mews shall be a triangle with one side measuring fifteen feet (15') along the street and the other side five feet (5') along the alley. The corner clip on the outbound side of the mews shall be a triangle with one side measuring ten feet (10') along the street and the other ten feet (10') along the alley.
 12. A mews shall, at a minimum, have the same restrictions on visibility obstructions as a typical alley as described in Subsection H above.
 13. A mews is not considered a public pedestrian route from a public sidewalk to a mews home. A sidewalk connection shall be provided between the front of each mews home and the public sidewalk along a nearby street. Typically, a privately maintained, communal sidewalk will connect multiple mews homes to a public sidewalk. This sidewalk route shall meet all state and federal ADA requirements for accessibility. See Section 2.02.G.5 and 6 for additional requirements.
 14. Where a mews intersects with a street or another mews, the mews shall have a stop sign with street name signs. No fence, wall, screen, sign, structure, or foliage of hedges, trees, bushes, or shrubs shall be erected, planted or maintained in or adjacent to the mews ROW in a way that obstructs the visibility of the stop sign for motorists traveling on the mews. At a minimum, no obstruction shall be placed within thirty-five feet (35') of the face of the stop sign.
 15. If a mews is allowed to intersect with another mews, corner visibility triangles (ROW corner clips) and sight line triangles shall be provided. The ROW corner clip on each corner of the intersection shall be a triangle with a twenty-foot (20') side along each mews (see Figure 2.28). Sight line triangles shall be dedicated as Visibility, Access, and Maintenance (VAM) easements according to the procedure described in Section 2.07.C using a 20 mph design speed. These visibility requirements will preclude a home or a fenced yard from being located directly adjacent to the corner of two mews alleys.
 16. A street light that meets the requirements of Section 2.10.C shall be installed on each end of a row of homes that back to a mews so as to be visible to pedestrians walking on the communal sidewalk described in Subsection 13 above and shall not be more than six hundred feet (600')

apart. Depending on the orientation of the mews, these street lights may not necessarily be adjacent to a street.

2.05 Driveway Design

- A. Introduction – Driveway design standards are needed to provide safe and efficient vehicular access to and from the public street system, to provide public street capacity for accommodating peak traffic volumes of public streets, to maintain smooth traffic flow, and to maintain street ROW and drainage. The intent of driveway design standards is to achieve the following:
1. Prohibit the indiscriminate location and spacing of driveways while maintaining reasonable vehicular access to and from the public street system.
 2. Reduce conflicting turning movements and congestion thereby reducing vehicular crashes.
- B. Definition of Driveway Types
1. Residential Driveway – Provides access to a single-family residence, duplex, or multi-family building containing four or fewer dwelling units. Residential driveways shall intersect Type D, E, F, and G thoroughfares only (according to the restrictions described below).
 2. Non-Residential Driveway
 - a. Commercial Driveway – Provides direct access to an office, retail or institutional building, or multi-family building having more than four dwelling units. It is anticipated that such buildings will have incidental truck service. Commercial driveways shall typically access Type A, B, or C thoroughfares only, with a maximum of one (1) driveway accessing a residential entrance street or residential collector (unless prohibited by the Comprehensive Plan or the Zoning Ordinance). In the case of multi-family developments, the primary driveway shall access a Type A or B thoroughfare.
 - b. Industrial Driveway – Serves truck movements to and from loading areas of an industrial facility, manufacturing, warehouse, or truck terminal. A retail development may have one or more driveways specially designed, signed, and located to provide access for trucks, which shall be considered industrial driveways. Industrial plant driveways whose principle function is to serve administrative or employee parking lots shall be considered commercial driveways. Industrial drives shall access Type A, B, and C thoroughfares only.
 3. Standard Driveway – Provides two-way access at a single, undivided curb opening. The minimum width of a standard driveway depends on land use and is shown in Table 2.9.
 4. One-Way Driveway – Provides only inbound or outbound access and can only be permitted when the orientation of on-site circulation and parking layout clearly utilize the driveway for one-way movements. The minimum width for a one-way driveway depends on land use and is shown in Table 2.9.
 5. High Capacity Driveways – Intended to provide two-way access with geometric provisions which more adequately respond to greater driveway volumes and/or access limitations than standard driveways. These provisions include increased width, increased internal storage and a median divider. See Table 2.9 for median width and driveway width requirements.

- a. Divided high capacity driveways are required at the first median opening downstream of a Type A-A, A-B, or B-B intersection.
- b. The primary multi-family driveway shall be a divided high capacity driveway at a median opening.
- c. Divided high capacity driveways are required on Type A or Type B thoroughfares when the number of parking spaces per driveway exceeds two hundred (200), except along a frontage road.
- d. If a divided high capacity driveway is a potential location for a traffic signal, the median shall be offset from any median on the other side of the Type A or B thoroughfare in order to minimize the offset between opposing left-turn movements and the width of the median shall be designed to ensure the alignment of a through lane in each direction across the Type A or B thoroughfare. In addition, the outbound side of the driveway shall provide a minimum of three lanes so that a left, through, and right-turn lane can be provided.

C. Driveway General Design Parameters

1. The centerline angle for a driveway approach shall be ninety degrees (90°) to the street curb line for all driveways.
2. Driveways shall not be permitted in the taper area of any right-turn lane or deceleration lane.
3. Driveways that intersect at a mid-block median opening shall have the driveway centerline intersect with the midpoint of the median opening (measured nose-to-nose) unless alignment requirements for the operation of a traffic signal dictate otherwise.
4. Driveway connections can be required by the Director of Engineering Services to ensure adequate circulation.
5. Driveway elevations at the ROW line of a public street shall be a minimum of six inches (6") above the street gutter. A residential driveway that intersects an alley shall be a minimum of three inches (3") above the edge of the alley pavement at the ROW line and shall be high enough to maintain gutter capacity.
6. Cross access is required between adjacent non-residential properties so that each property can share the use of the driveway(s) on the adjacent property. A shared driveway that is centered on the common property line is also encouraged. When one non-residential property develops before the adjacent property develops, the full width of the shared driveway shall be constructed at that time.
7. Driveway grades in a fire lane shall not exceed six percent (6%). Steeper grades may be permitted in areas where buildings are not present, as approved by the Director of Engineering Services and the Fire Department.
8. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.
9. Differential grades on driveways shall not exceed ten percent (10%).

10. Any sidewalk access across a driveway shall meet all state and federal ADA requirements for accessibility.
11. Residential driveways shall be prohibited:
 - a. Along a Type D, E, F, or G thoroughfare within one hundred feet (100') of an intersection with a Type A or Type B thoroughfare measured from the ROW line.
 - b. Along any part of a Type A, B, or C thoroughfare or a residential collector.
 - c. Within a signalized intersection or a roundabout.
12. Residential driveways shall provide access to an alley or an eligible public street according to the following restrictions:
 - a. A residential lot shall be allowed a maximum of one (1) driveway onto a public street, except in the case of a circular driveway approved by the Director of Engineering Services.
 - b. A residential driveway that provides access to a garage shall connect to an alley or shall connect to a residential street that is at least thirty feet (30') wide, face-to-face.
 - c. A residential lot bordered by an alley and a residential street that is at least thirty feet (30') wide shall provide a driveway to the alley if trash pick-up services cannot be easily provided on the residential street, as determined by the Environmental Services Division. Factors that will be considered include, but are not limited to, trash truck routing and whether existing or planned homes on the block already connect to the alley.
 - d. A residential lot shall be prohibited from having multiple driveway connections in a configuration that would create the possibility of a cut-through route between a public street and an alley that do not intersect or between two public streets that do not intersect, as determined by the Director of Engineering Services.
 - e. If a residential driveway is shared between two properties, the driveway shall be centered on the common property line unless otherwise approved by the Director of Engineering Services.
 - f. A residential driveway connecting to an alley shall not be located within twenty feet (20') of the ROW line of a public street so as to prevent the driveway from being located in the alley taper
 - g. A residential driveway connecting to a public street shall be located so its upstream flare is no closer than fifteen feet (15') from the curb return of an upstream intersection and so its downstream flare is no closer than five feet (5') from the curb return of a downstream intersection.
 - h. A residential driveway that changes in width as it extends onto the property shall do so with a curved transition or an angled transition that does not exceed a taper of one to one (1:1) within ten feet (10') of the ROW line.
 - i. Residential lots adjacent to a roundabout shall be oriented so that their homes do not face the roundabout and their driveways do not intersect with the roundabout or along any section of street with a splitter island.

- j. Paired driveways along a street shall be encouraged in neighborhoods with SF-8.5 zoning or smaller. When paired driveways are used, the block shall be divided into two-lot pairs whose driveways must be located adjacent to their shared property line. Each driveway shall be located five feet (5') from the shared property line so that the paired driveways are ten feet (10') apart.
13. Driveways shall be located so that they meet the required spacing from other driveways and streets, as described in Subsections F, G, and H below. The spacing and location of driveways shall be related to existing driveways and streets and to future driveways and streets that are shown on approved preliminary site plans and/or site plans that have not expired.
- D. Driveway Width – The width of a driveway refers to the width of pavement at the property line and is measured where the curb return radii ends perpendicular to the street curb or edge of pavement. The minimum and maximum widths of driveways are listed in Table 2.9. A driveway may transition to a different width as it extends onto the property, but its width shall not change abruptly at the property line. A non-residential driveway shall maintain its minimum width for the entire length of the driveway storage (throat length) required in Subsection J below.

TABLE 2.9: Minimum and Maximum Driveway Widths⁽¹⁾

<u>Driveway Type</u>	<u>Land Use</u>	<u>Width in Feet (face to face)⁽²⁾</u>	
		<u>Minimum (ft)</u>	<u>Maximum(ft)</u>
Standard Driveway	Residential	10	22 to a street 32 to an alley ⁽³⁾
	Commercial	30 to a Type A or B 24 to a Type C (36 if to be signalized)	36 (40 at a gas station) (48 if to be signalized)
	Industrial	30 (36 if to be signalized)	40 (48 if to be signalized)
One-Way Driveway	Residential (circular)	10	16
	Commercial	24	24
	Industrial	24	24
Divided High Capacity Driveway	Entrance	24	24
	Two Lane Exit	24	24
	Three Lane Exit	30 (36 if to be signalized)	36
Driveway Medians		4	20 ⁽⁴⁾

1. Driveway width at the property line. A driveway may transition to a different width as it extends onto the property.
2. Driveways that serve as a fire lane shall be a minimum of twenty-four feet (24') in width.
3. A residential driveway connecting to an alley may have a width up to a maximum of thirty-two feet (32') if the garage faces onto the alley; otherwise, its width is limited to twenty-two feet (22').
4. If the driveway is a potential location for a traffic signal, the design of the median shall take into account the operation of the traffic signal (see Section 2.05.B.5.d).

E. Driveway Radius

1. All driveways intersecting dedicated streets shall be built with a circular curb radius connecting the six-inch (6") raised curb of the roadway to the design width pavement of the driveway.
2. Driveway radii shall fall entirely within the subject property so as to begin at the street curb at the extension of the property line.
3. Table 2.10 presents the minimum and/or maximum standards to be applied in designing and locating driveways on public streets.

TABLE 2.10: Driveway Design Requirements

<u>Criteria</u>	<u>Thoroughfare Classification</u>	<u>Residential Driveway (ft)</u>	<u>Commercial or Multi-family Driveway (ft)</u>	<u>Industrial Driveway (ft)</u>
Driveway Curb Radius	Type A	N.A.	30	40
	Type B	N.A.	30	40
	Commercial Collector Type C	N.A.	25	40
	Residential Collector	N.A.	20	N.A.
	Local D, E, F, G	5-10	N.A.	N.A.
Minimum Driveway Spacing Along Roadway (edge to edge)	Type A	N.A.	280	280
	Type B	N.A.	260	260
	Commercial Collector Type C	N.A.	90	90
	Residential Collector	N.A.	max. of 1 drive	N.A.
	Local D, E, F, G	20 (10 when enclosing both mailboxes) ⁽²⁾	N.A.	N.A.
Minimum Distance to Intersection Along Roadway (edge to ROW line of intersecting street) ⁽¹⁾	Type A	N.A.	75 / 200	75 / 200
	Type B	N.A.	75 / 200	75 / 200
	Commercial Collector Type C	N.A.	100 / 100	100 / 100
	Residential Collector	N.A.	100 / 100	N.A.
	Local D, E, F, G	15 / 5 from curb return to edge of drive	N.A.	N.A.
	Arterial Roundabout ⁽³⁾	N.A.	120 / 100	120 / 100

1. Upstream / downstream distance to intersection. See Figure 2.23.
2. If both mailboxes are located between two driveways, those driveways can be exactly 10 feet apart. If they are more than 10 feet apart, they must be 20 feet apart or more.
3. Applies to a roundabout on a Type A, B, or C thoroughfare. Distances are measured upstream of yield line and downstream from crosswalk (see Section 2.05.G.3).

F. Driveway Spacing

1. Spacing between driveways is measured along the property line from the edge of one driveway to the closest edge of the next driveway.
2. Table 2.10 defines minimum driveway spacing as a function of thoroughfare classification.
3. In the vicinity of a railroad crossing, the closest edge of a driveway shall be a minimum of one hundred feet (100') from the railroad ROW line.
4. Non-residential and multi-family driveways on opposite sides of an undivided street shall align with each other or be spaced a minimum of seventy-five feet (75') apart, measured edge to edge, to ensure that conflicting movements do not overlap. This spacing shall also apply to a driveway that is on the opposite side of an undivided street from an intersecting street. See Figure 2.22.

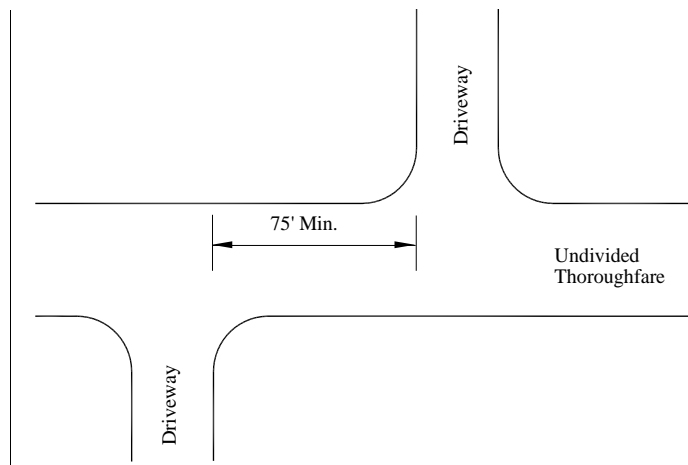


FIGURE 2.22: Driveway Spacing on Opposite Sides of an Undivided Street

G. Distance between Driveway and Intersection

1. Adequate distance between cross street intersections and access driveways shall be provided to ensure intersection/driveway conflict areas are minimized.
2. Table 2.10 defines the upstream and downstream distance from an intersection as a function of thoroughfare classification. The distances required from an intersection along a Type A or B thoroughfare are shown in Figure 2.23.
3. Driveways located near a roundabout on a Type A, B, or C thoroughfare shall conform to the following spacing standards: On the approach to a roundabout, the closest driveway shall be located so the edge of the driveway is a minimum of one hundred twenty feet (120') upstream of the roundabout's yield line. On the departure from a roundabout, the closest driveway shall be located so the edge of the driveway is a minimum of one hundred feet (100') downstream of the roundabout's crosswalk. However, if a driveway is to align with a median opening, the location of the median opening must meet the requirements of Section 2.03.B.4.

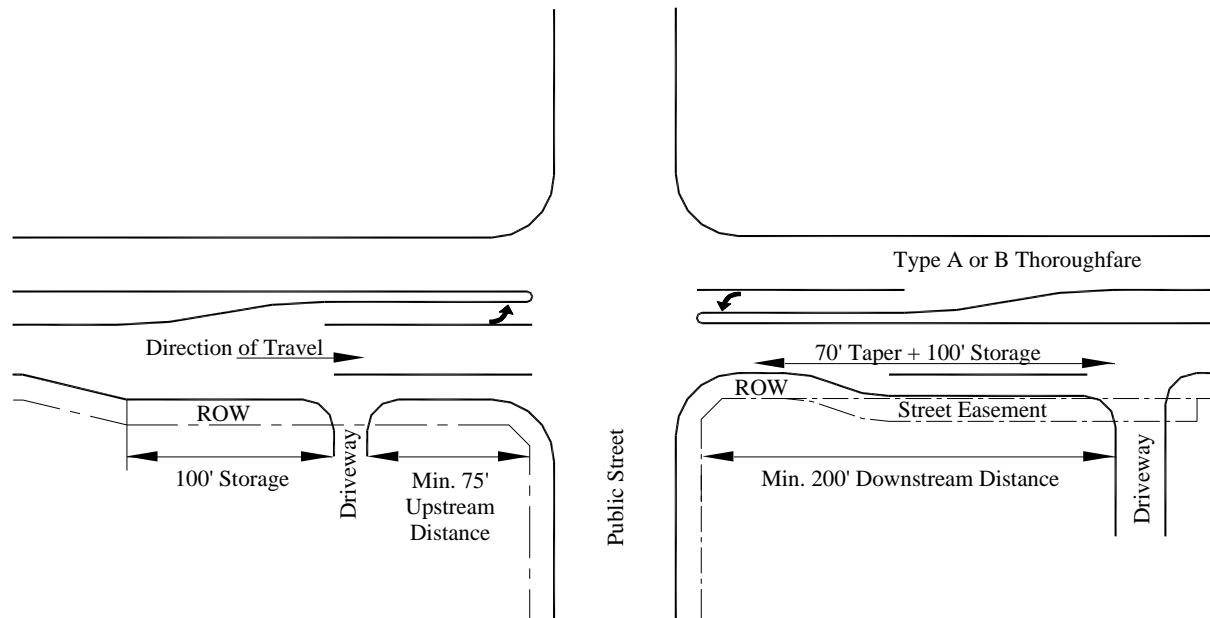


FIGURE 2.23: Distance Between Driveway and Intersection

H. Driveways Located in Right-Turn Lanes

1. A driveway located within the right-turn lane of a public street intersection shall be spaced so that its closest edge will be a minimum of seventy-five feet (75') in advance of the ROW line of the intersecting street. See Figure 2.23.
2. If a driveway is located within the right-turn lane of a public street intersection, the storage length of the right-turn lane shall extend a minimum of one hundred feet (100') beyond the upstream edge of the driveway (see Figure 2.23). No driveway shall be permitted within the taper area of a right-turn or deceleration lane.

I. Driveway Deceleration Lanes - Deceleration lanes are required on Type A and B thoroughfares at all non-residential and multi-family driveways and shall meet the requirements of Section 2.03.D.

J. Driveway Storage Lengths (Throat Lengths)

1. On-site internal storage shall be provided at all non-residential and multi-family driveways for queuing of vehicles off-street, to minimize congestion, and increase safety both on the public street and within the driveway.
2. Internal storage (throat length) requirements shall be based on the number of parking spaces accessible by the affected driveway. Divide the total number of parking spaces by the number of driveways and then use Table 2.11 to determine the amount of internal storage required. This calculation shall be based on the preliminary site plan for an overall development or the site plan for a specific lot, whichever produces the largest ratio of parking spaces per driveway.
3. Internal storage length shall be measured from the ROW line to the first intersecting aisle, internal driveway, or parking stall.

4. A circulation study will be required for all multi-story parking garages with a driveway that connects directly to a public street. Driveway storage requirements will be determined as a result of the study.

TABLE 2.11: Minimum Driveway Storage Lengths (Throat Lengths)

<u>Parking Spaces per Driveway</u>	<u>Storage Required (ft)</u>			
	<u>Multi-family or Commercial Uses</u>		<u>Industrial Land Uses</u>	
	<u>No Median Opening⁽¹⁾</u>	<u>Median Opening⁽²⁾</u>	<u>No Median Opening⁽¹⁾</u>	<u>Median Opening⁽²⁾</u>
Less than 25	25	25	25	25
25-50	25	40	25	40
51-100	25	40	40	40
101-200	40	80	40	60
More than 200	100	150	40	100

1. Includes driveways that connect to one-way frontage roads.
2. Includes any driveway where a left-turn exit can be made, including driveways that connect to undivided roadways.

K. Entrance Streets and Driveways for Gated Developments

1. To ensure that the minimum dimensions are adequate, a traffic study is required with the submission of a Specific Use Permit application for all gated communities.
2. Residential/Multi-family Developments
 - a. Gated developments shall have a median divided street or driveway that will allow for a vehicular turnaround prior to the gate in the event that access is denied. A turnaround is not required on the public side of an exit-only gate provided that the exit is designed to prevent traffic from approaching it.
 - b. The turnaround shall be a minimum of eighteen feet (18') in width.
 - c. Entry gates shall be set back from the ROW line a minimum of one hundred thirty-five feet (135') or as indicated in the traffic study. The card reader, or first stop, shall be set back from the ROW line a minimum of one hundred feet (100'), or as indicated in the traffic study, to provide storage for the longest queue of vehicles expected to access the gate. See Figure 2.24.
 - d. Each direction of the divided street or driveway shall be a minimum of twenty-four feet (24') in width with curb radii of thirty feet (30'). See Figure 2.24.
 - e. The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb. The gate shall open to twenty-four inches (24") behind back of curb.
 - f. Gates shall open sideways or swing open in the direction of travel on each side of the divided street.
 - g. Gates shall be equipped with emergency access devices as required by the Fire Department.

-
- The diagram illustrates a typical residential driveway layout with the following dimensions and features:
- Top Section:** A 100' ROW (Right-of-Way) width. A 15' R (Radius) is indicated for the top curve. A 20' R is indicated for the side curves. A 10' x 10' ROW Clip is shown on the right side.
 - Building Line:** A dashed line indicating the building setback. A 12' setback is shown on the left side.
 - Driveway Entrance:** A 10' x 10' ROW Clip is shown on the left side. A 10' x 10' ROW Clip is shown on the right side. A 10' x 10' ROW Clip is shown on the left side.
 - Driveway Width:** A 18' width is indicated for the main driveway section.
 - Reader/Keypad 1st Stop:** A location marked on the left side of the driveway.
 - Minimum Centerline Radius:** A 250' Minimum Centerline Radius is indicated for the left side of the driveway.
 - 25' x 25' ROW Clip:** A 25' x 25' ROW Clip is shown on the left side of the driveway.
 - Minimum Stacking Distance:** A 100' - Residential / Multi-Family Stacking Distance (40' - Other Non-Residential) is indicated for the right side of the driveway.
 - Minimum Gate Distance:** A 135' - Res. (75' - Other) Minimum Gate Distance is indicated for the right side of the driveway.
 - Storage and Transition:** A 11' Storage area and a 11' Transition area are indicated on the right side of the driveway.
 - Bottom Section:** A 70' width is indicated for the bottom section. A 30' R is indicated for the bottom curve. A 24' width is indicated for the bottom section.
 - Landscape ROW:** A 12' Landscape ROW is indicated on the left side.
 - Right Side:** A 12' Landscape ROW is indicated on the right side.

FIGURE 2.24: Gated Entrance Detail

- d. Each direction of the driveway shall be a minimum of twenty-four feet (24') in width with curb radii of thirty feet (30'). See Figure 2.24.
 - e. The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb. The gate shall open to twenty-four inches (24") behind back of curb.
 - f. Gates shall open sideways or swing open in the direction of travel on each side of the divided entrance.
 - g. Gates shall be equipped with emergency access devices as required by the Fire Department.
 - h. All gates shall provide pedestrian access. The movement of the gates shall not encroach on sidewalks.
4. Individual gated single-family residences shall have a minimum setback of twenty feet (20') from the property line. The movement of the gate(s) shall not encroach on a sidewalk, alley, or street.

L. Non-Conforming Driveways

- 1. All nonconforming driveways on a lot, tract, parcel or site shall be allowed to remain in use until the occurrence of one or more of the following events:
 - a. A change in use, or an increase in intensity of use, occurs such that the site requires a ten percent (10%) increase in required parking spaces.
 - b. Addition or expansion of required stacking spaces.
 - c. Any modification that changes the design or function of the existing driveway (including, but not limited to, any change to the internal circulation of the site that would increase the amount of traffic using the driveway).
 - d. The addition of a median opening on the public street by a developer. All driveways that are served by the new median opening shall comply with the requirements of these standards.
- 2. Upon the occurrence of the events described above, the nonconforming driveway shall either be reconstructed in accordance with these design requirements or eliminated.

2.06 Sidewalk Location and Design

- A. Definition of Sidewalk – A sidewalk is defined as the paved area designated for pedestrian use which is generally located between the curb of the roadway and the adjacent property line. The

inside edge of the sidewalk is the edge closest to the street while the outside edge of the sidewalk is farthest from the street.

B. Sidewalk Design – Sidewalks shall conform to the most current federal, state, and local ADA requirements and to the following standards:

1. Sidewalk Grade – The maximum grade of the sidewalk shall be five percent (5%) or the grade of the adjacent street, whichever is greater. The maximum cross-slope of the sidewalk shall be two percent (2%).
2. Zoning Classification Requiring Sidewalks – Concrete sidewalks designed and located according to City standards shall be constructed along all streets in all zoning classifications except agriculture uses in agricultural zoned areas. Prior to developing any single-family, duplex, or townhome residential lots, residential developers shall build sidewalks along all streets adjacent to the subdivision and along the portions of any street within the subdivision where residential lots do not front or side onto the street. Sidewalks along residential lots shall be constructed by the homebuilder at the time each lot develops. Sidewalks adjacent to non-residential and multi-family land uses shall be built at the time of lot development.
3. Hike and Bike Master Plan – Sidewalks shall be constructed with the width specified in the Hike and Bike Master Plan along thoroughfares that are designated as off-street hike and bike trail routes.
4. Type A and B Thoroughfares – A concrete sidewalk, a minimum six feet (6') in width, shall be located along all Type A and B thoroughfares. The sidewalk should typically be located within the street ROW, but may extend into a sidewalk easement. The inside edge of the sidewalk shall be no closer than five feet (5') from the back-of-curb.
5. Type C, D, E, F, and G Thoroughfares – A concrete sidewalk, a minimum five feet (5') in width, shall be located along all Type C, D, E, F, and G thoroughfares. The sidewalk shall be located within the street ROW unless pre-existing physical encroachments (e.g., utility infrastructure or trees) dictate otherwise. The outside edge of the sidewalk shall be located two feet (2') inside the ROW line on Type C, D, and E thoroughfares. On Type F and G thoroughfares, the outside edge of the sidewalk may be on the ROW line and a two-foot (2') sidewalk easement shall be provided adjacent to the ROW line.
6. See Section 3 of the Engineering Standards for sidewalk thickness requirements.
7. Sidewalk Easements – A minimum of two feet (2') of ROW or sidewalk easement shall be provided adjacent to the outside edge of the sidewalk for maintenance purposes. Any portion of sidewalk extending outside the ROW shall be contained within a sidewalk easement, the inside edge of which extends to the ROW line and the outside edge of which extends a minimum of two feet (2') beyond the outside edge of the sidewalk. No fence, wall, building, or other type of structure shall be located within the sidewalk easement.
8. Parkways – The area between the curb and ROW line shall be graded at two percent (2%) above the top of street curb. If the area between the curb and the sidewalk is at least three feet (3') wide, it shall contain grass that is maintained by the adjacent property owner. If the area between the curb and sidewalk is less than three feet (3') wide, it shall be paved with concrete for a minimum length of fifteen feet (15'). If a parkway is adjacent to a non-residential or multi-family land use, the area between the curb and the sidewalk may be paved with concrete or concrete pavers in lieu of grass.

9. **Meandering Sidewalks** – Sidewalks along Type A, B, and C thoroughfares and residential collectors may meander for aesthetics and/or to avoid pre-existing physical encroachments. Between thoroughfare intersections, these sidewalks shall meander with smooth undulation and shall have no sharp angles or abrupt changes in direction. Sidewalk easements adjacent to the standard ROW line will be required to contain any portion of the meandering sidewalk that extends beyond the ROW. Sidewalk easements shall provide a minimum clearance of two feet (2') beyond the outside edge of the sidewalk. The inside edge of a meandering sidewalk shall never be less than five feet (5') from the back-of-curb. A tangent calculated at any point along the centerline of a meandering sidewalk shall not be less than thirty degrees (30°) from perpendicular to the street. These requirements are shown in Figure 2.25.

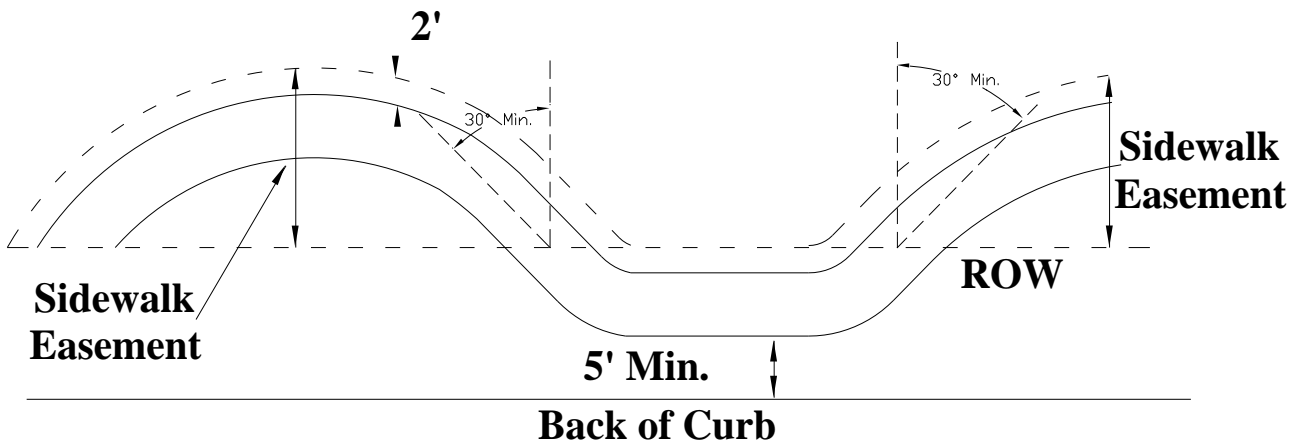


FIGURE 2.25: Meandering Sidewalk Detail

10. **Sidewalks Adjacent to Screening Walls** – In areas where a screening wall is provided along a thoroughfare, the outside edge of the sidewalk shall either remain a minimum of two feet (2') from the wall or the sidewalk shall be paved up to the wall.
11. **Access Ramps** – Barrier-free ADA access ramps shall be provided at all street intersection corners, at all crosswalks, and across any non-residential or multi-family driveway. The side of a residential T-intersection that has no corner shall have a minimum of one access ramp leading to one of the two corners. The number and location of ADA crossings across Type A, B, and C thoroughfares and residential collectors shall be determined by the Director of Engineering Services. Access ramps on each side of a crossing shall align with each other.
12. **Sidewalks on Bridges**
- All street bridges shall have a sidewalk constructed on each side of the bridge. The sidewalk shall have a minimum width of six feet (6') with a parapet wall that is separated from the travel lane by an eighteen-inch (18") shoulder. See Figure 2.26.
 - A standard pedestrian bridge rail protecting the sidewalk shall be provided on the outside edge of the bridge. See Figure 2.26.

- c. When an eight-foot (8') sidewalk is required on the bridge as part of a hike and bike trail, the center lane may be reduced to eleven feet (11') and the shoulders may be reduced to twelve inches (12").
13. Sidewalks Under Bridges – When new bridges are built as a part of the construction of a roadway or the reconstruction of a roadway and a pedestrian crossing is needed beneath the bridge, a sidewalk shall be built as a part of the embankment design underneath the structure for future hike and bike trails. The Hike and Bike Master Plan will designate whether a sidewalk is built on one or both sides of the waterway and whether the sidewalk shall be ten feet (10') or twelve feet (12') wide.
14. Sidewalks on Culverts – All culvert crossings shall have a sidewalk, a minimum of six feet (6') wide, constructed on each side of the culvert. A standard pedestrian hand rail as shown in Figure 2.27 shall be provided on the outside edge of the culvert. A parapet wall may be required by the Director of Engineering Services.

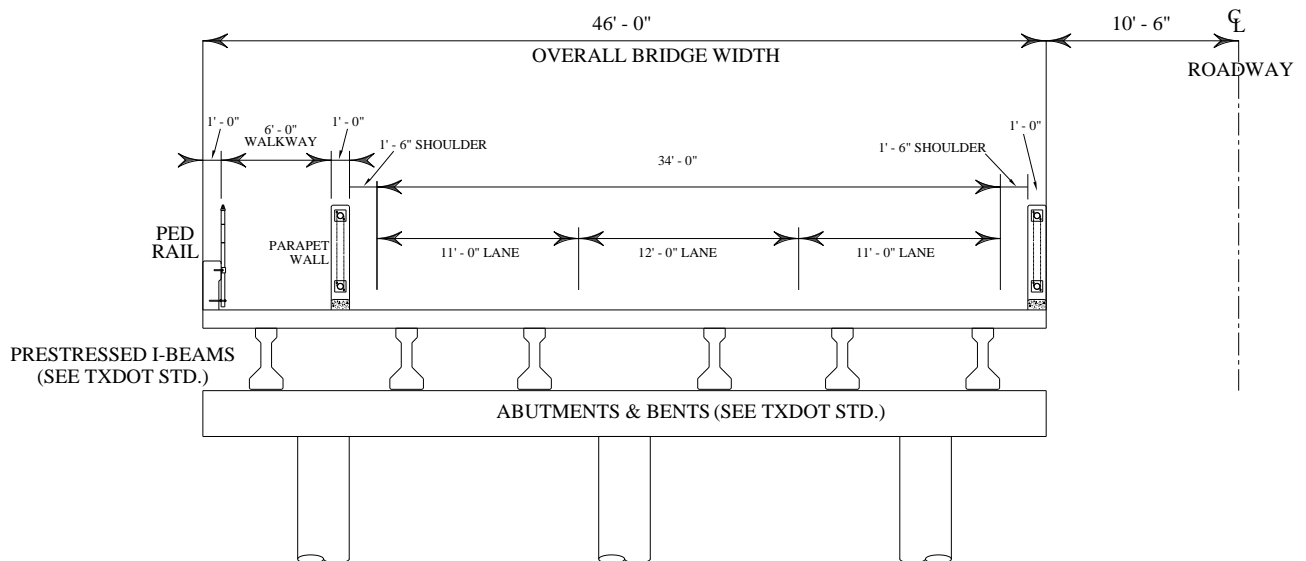


FIGURE 2.26: Typical Sidewalk on Bridge Section

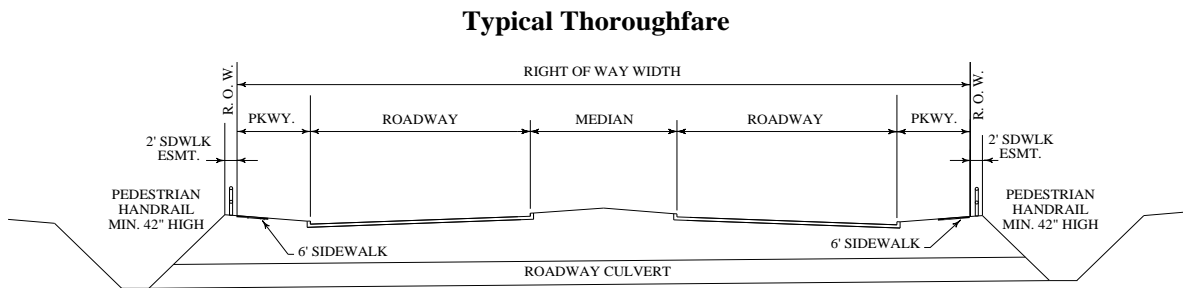


FIGURE 2.27: Typical Pedestrian Handrail Over Culvert

15. Sidewalks between Residential Lots

- a. Where deemed necessary by the Director of Engineering Services, a block with a continuous series of lots longer than one thousand two hundred feet (1,200'), measured along one or more sides, shall be bisected by a fifty foot (50') wide pedestrian easement containing a sidewalk that is a minimum of five feet (5') wide. Such a mid-block pedestrian connection will be necessary where it would be beneficial to create a short-cut to walk to a school, park, trail, or group of homes on the other side of the long block.
- b. Pedestrian easements and sidewalk connections shall be provided between cul-de-sacs and adjacent streets as required by the Subdivision Ordinance.

16. Sidewalk Escrow – When the delay of sidewalk construction is deemed appropriate by the City due to future right-of-way improvements, escrow funds in lieu of the construction of sidewalks may be approved by the Director of Engineering Services. Such funds shall be escrowed with the City prior to final acceptance of the development. The escrow amount shall be determined by the square footage of sidewalk to be constructed, as estimated by the developer, and approved by the Director of Engineering Services.

17. Sidewalk Reimbursement – If the City constructs the sidewalk along any street before the adjacent property develops, the owner of that property shall reimburse the City for its construction costs when the property is to be subdivided or developed. This amount shall be determined by multiplying the City's square foot cost of constructing the sidewalk by the square footage of sidewalk that is required along the property, subtracting out the square footage of sidewalk the developer will remove or replace while developing the site, and adding any cost associated with City-installed ADA access ramps, retaining walls, and protective railing. The reimbursement shall be paid before any plat may be filed for the property. If the property has already been platted or a plat is not required, the reimbursement shall be paid prior to final acceptance or Certificate of Occupancy, whichever occurs first.

18. Sidewalk Obstructions – No vertical obstructions (including, but not limited to, power poles, street lights, fire hydrants, trees, service pedestals, etc.) shall be installed on or incorporated into a sidewalk unless in an urban center with wider than normal sidewalks, as approved by the Director of Engineering Services. Any allowed obstructions shall be located next to one edge of the sidewalk. When multiple obstructions are present, they shall be installed in line with each other on the same edge of the sidewalk.

- C. Sidewalks within Non-Residential and Multi-family Developments – All sidewalks within non-residential and multi-family developments shall be a minimum of four feet (4') wide and shall maintain a continuous walking path a minimum of four feet (4') wide exclusive of any tree wells or vertical obstructions. At least one ADA accessible pedestrian route shall be provided between each building and the public sidewalk. All accessible routes shall comply with the most current federal, state, and local ADA requirements. At each pedestrian crossing, the barrier-free ADA ramps shall align directly with each other.

2.07 Public Right-of-Way Visibility Requirements

- A. Adequate sight distance at the intersection of a thoroughfare and a proposed thoroughfare, driveway, or alley must be ensured. This sight distance is provided through the use of Corner Visibility Triangles and/or Sight Line Triangles. Corner Visibility Triangles are also known as ROW Corner Clips. Sight Line Triangles are also known as Visibility, Access and Maintenance (VAM) Easements. All intersection visibility requirements shall meet the guidelines for sight triangles in AASHTO's current *A Policy on Geometric Design of Highways and Streets*.
1. Corner Visibility Triangles shall be provided on all corners of an intersection between two thoroughfares or an intersection between an alley and a thoroughfare.
 2. Sight Line Triangles shall be provided where a driveway, an alley, or a stop-controlled thoroughfare intersects an uncontrolled thoroughfare and on any signalized intersection approach where right turn on red operation is permitted.
 3. No fence, wall, screen, sign, structure, utility box, foliage, hedge, tree, bush, shrub, berm, driveways, parking, drive aisles, or any other item, either man-made or natural shall be erected, planted, or maintained in a position that will obstruct or interfere with a driver's clear line of sight within a corner visibility triangle or a sight line triangle (i.e., a VAM easement). Tree foliage within a corner visibility triangle or a sight line triangle shall be trimmed to the level specified in Subsection B.2 below.
 4. The City has the right to prune or remove any vegetation within City right-of-way, including within the corner visibility triangle, and within sight line triangle easements (including VAM easements), to abate a safety hazard and/or a nuisance.
 5. Tree foliage shall be trimmed to a minimum of seven feet (7') above any sidewalk and a minimum of fourteen feet (14') above any roadway, alley, or mews. However, an exception is granted for young trees along a residential street that is wider than twenty four feet (24'), face to face: In areas where on-street parking is allowed along such a residential street, any tree foliage that extends up to five feet (5') beyond the face of the curb shall be trimmed to a minimum of seven feet (7') above the curb and any tree foliage extending more than five feet (5') beyond the face of curb shall be trimmed to a minimum of fourteen feet (14') above the roadway.
 6. Pedestrian Visibility Triangle – Where a divided, stop-controlled thoroughfare or driveway intersects an uncontrolled thoroughfare, nothing shall be planted or constructed in the median that would obstruct or interfere with a driver's clear view of the entire path a pedestrian would take to cross the full width of the thoroughfare or driveway in front of the vehicle while the vehicle is stopped at the stop bar. The pedestrian visibility triangle is formed by connecting a line from the nearest corner of truncated domes within each ADA ramp to a point ten feet (10') in advance of the stop bar (or the stop sign) located in the center of the outbound side of the thoroughfare or driveway.

B. Corner Visibility Triangles

1. The corner visibility triangle is defined at an intersection of two thoroughfares by extending the two ROW lines from their point of intersection to a distance as shown on Table 2.12. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 2.28. This corner visibility triangle shall be dedicated as ROW.

TABLE 2.12: Corner Visibility Triangle Distances

<u>Type of Thoroughfare On</u>	<u>Type of Thoroughfare At</u>	<u>Distance⁽¹⁾ (X)</u>
A, B, C	A, B, C, D, or any residential street that potentially will be signalized	40'
A, B, C	E, F, G that will remain unsignalized	25'
D, E, F, G	D, E, F, G	10'
TxDOT Road, Frontage Road	Use the specifications for a Type A Thoroughfare	
Unimproved Road	D, E, F, G	30'

1. The corner visibility triangle shall have the same dimension on all corners of the intersection.

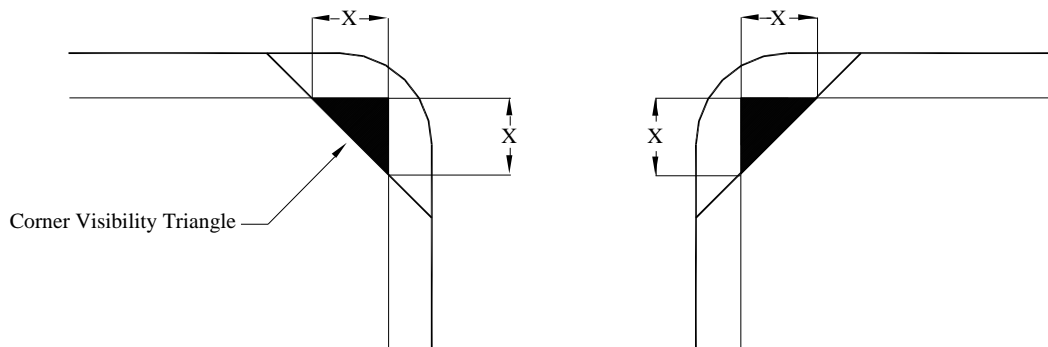


FIGURE 2.28: Corner Visibility Triangle for an Intersection

2. Vision at all intersections of thoroughfares shall be clear at elevations between thirty inches (30") and nine feet (9') above the average gutter elevation within the corner visibility triangle and meet AASHTO's current minimum requirements.
3. Where alleys intersect residential Type E, F, and G thoroughfares, the corner visibility triangle is measured as fifteen feet (15') along the residential street ROW and five feet (5') along the alley ROW from the point of intersection. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 2.29. The alley corner visibility triangle shall be dedicated as ROW.

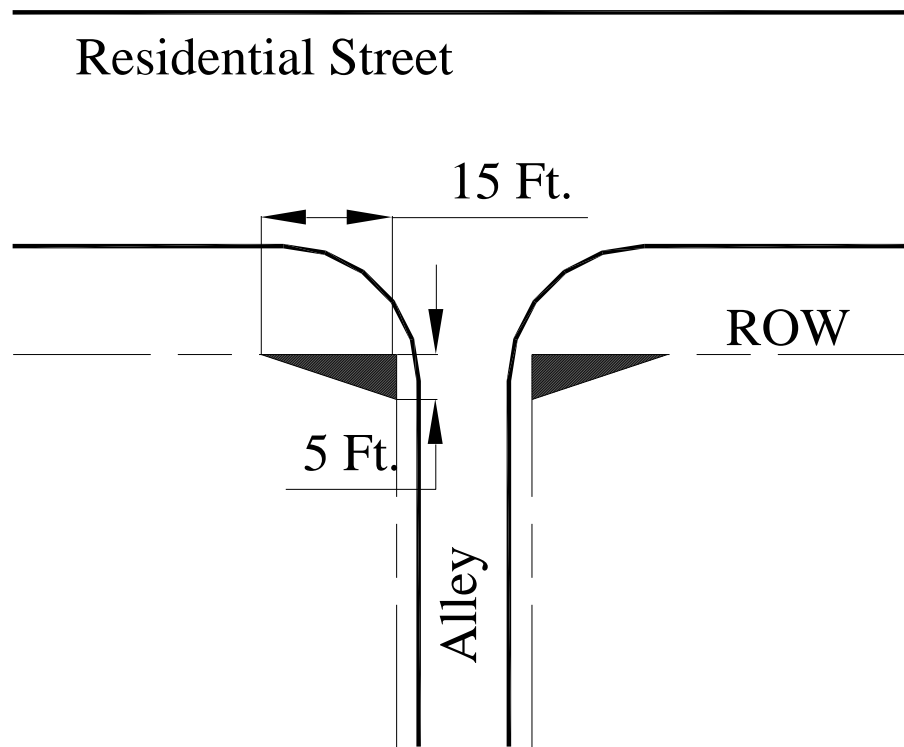


FIGURE 2.29: Corner Visibility Triangle for an Alley

C. Sight Line Triangles

1. The sight line triangle is formed by first extending a line along the center line of the proposed thoroughfare or driveway that begins at the tangent curb of the intersecting thoroughfare and extends to its endpoint fifteen feet (15') into the proposed thoroughfare or driveway. For the sight line triangle to the left, construct a second imaginary line that is parallel to and five feet (5') out from the intersecting thoroughfare's curb that begins at the centerline of the side street and continues to the left for a distance L (see Table 2.13) to its endpoint. To complete the sight line triangle, connect the endpoints of the first two lines as shown in Figures 2.30 and 2.31. In the case of the sight line triangle to the right, the second imaginary line is parallel and five feet (5') out from the nearest edge of the conflicting traffic flow (or adjacent median in the event of a divided thoroughfare). It begins at the centerline of the side street and continues to the right for a distance R (see Table 2.13) to its endpoint. See Figures 2.30 and 2.31.
2. Distance to driver's eye for driveways that intersect a street is fifteen feet (15') from the intersecting curb line that is adjacent to the through lane as shown in Figures 2.30 and 2.31.
3. In the case where the thoroughfare contains existing horizontal curvature, the distances L and R must be measured along the horizontal curve.

4. Sight Line Triangles that extend outside of the ROW shall be identified and dedicated as Visibility, Access and Maintenance (VAM) Easements on the plat using City-approved VAM language.

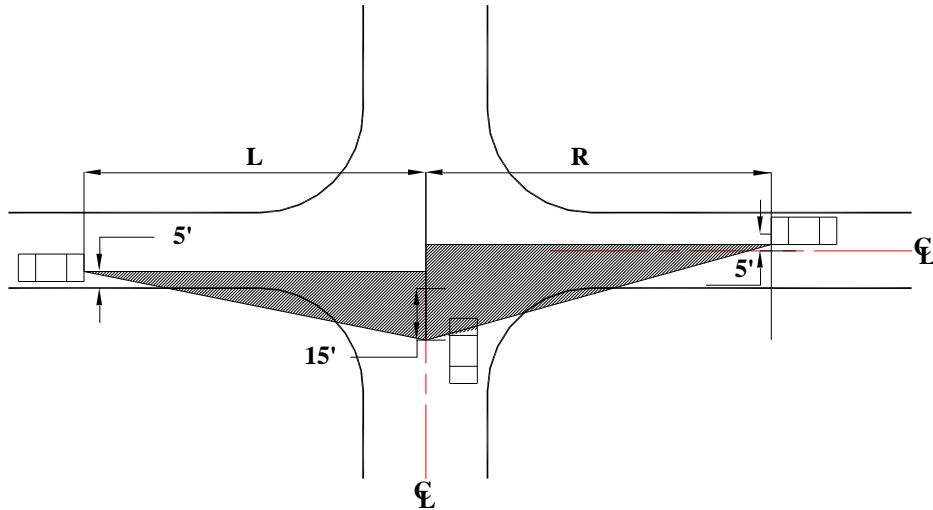


FIGURE 2.30: Sight Line Triangle for Undivided Thoroughfare

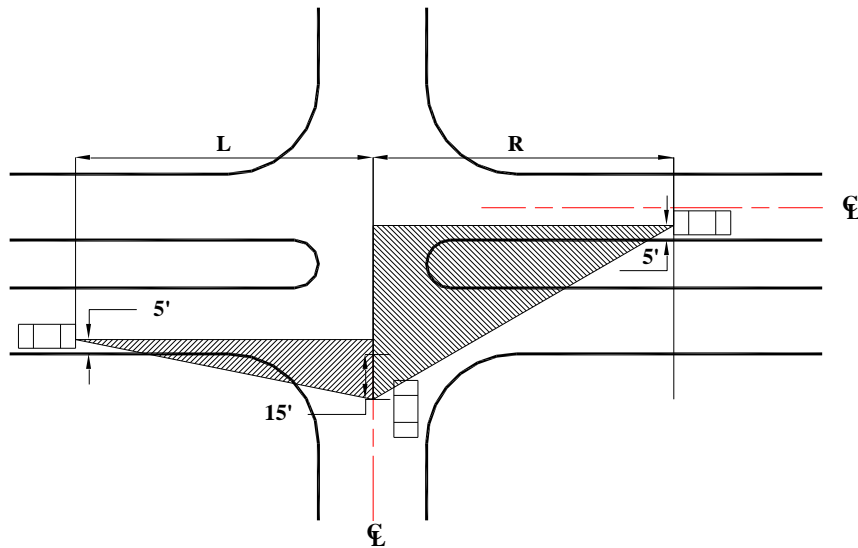


FIGURE 2.31: Sight Line Triangle for Divided Thoroughfare

TABLE 2.13: Sight Line Triangle Distances⁽¹⁾

Design Speed V (MPH)	<u>Sight Distance by Lanes in Cross Section (ft)⁽²⁾</u>			
	<u>Dimensions L and R (Where Left-Turns Are Allowed)</u>			<u>Dimension L (Right-Turns Only)</u>
	<u>2</u>	<u>4</u>	<u>6</u>	<u>All Cross Sections</u>
20 ⁽⁴⁾	225	N/A	N/A	195
25	280 ⁽³⁾	N/A	N/A	240 ⁽³⁾
30	335	N/A	N/A	290
35	390	N/A	N/A	335
40	445	N/A	N/A	415
45	500	530	565	500
50	555	590	625	555

(1) Source: AASHTO's 2018 *A Policy on Geometric Design of Highways and Streets* – Chapter 9.

(2) Number of lanes in the ultimate configuration of roadway (e.g., use 6 lanes for a Type A thoroughfare)

(3) 150 feet with approval by the Director of Engineering Services (applicable only to an all-way stop intersection or where an intersection has an approach that is less than 175 feet long).

(4) Design speed for fire lanes and mews alleys.

- D. Traffic Control Devices – Any tree or landscape requirements in the Engineering Standards, the Subdivision Ordinance, the Zoning Ordinance, or any other City ordinance shall not interfere with the placement, visibility or maintenance of traffic control devices under governmental authority and control.
- E. Street Trees – Street trees that are planted between the curb and the sidewalk shall be restricted so they will not interfere with the visibility of traffic control devices or pedestrians preparing to cross a street:
1. At a minimum, a street tree shall be planted no closer than thirty-five feet (35') upstream from the curb return of an intersection and no closer than twenty feet (20') downstream from the curb return of an intersection.
 2. If a curb return is not present on an approach to an intersection, a street tree shall be planted no closer than thirty-five feet (35') upstream from a stop sign installation or the location that a stop sign might be installed in the future.
 3. At a minimum, a street tree shall be planted no closer than thirty-five feet (35') upstream from a pedestrian crossing, measured from the upstream edge of the ADA ramp. This restriction applies regardless of whether or not there is a striped crosswalk.
 4. At a minimum, a street tree shall be planted no closer than thirty-five feet (35') upstream from any traffic control device on a Type D, E, F, or G thoroughfare and no closer than fifty feet (50') upstream from any traffic control device on a Type A, B, or C thoroughfare.

- F. Fire Lanes – Adequate sight distance shall be provided at each intersection along a fire lane which is dedicated for public access using a design speed of 20 mph. This includes, but is not limited to, the following considerations:
1. Dumpster enclosures shall be located and/or oriented so that the dumpster door(s) can never swing or slide into a position that would interfere with the required sight distance.
 2. Where vehicles exit a parking garage, the fire lane shall be located at least fifteen feet (15') away from the exterior wall or column of the parking garage exit so adequate sight distance is provided for exiting vehicles.

2.08 Frontage Road Design

- A. Frontage roads are typically a pair of one-way roadways found adjacent to existing or planned freeway or tollway facilities.
- B. Frontage roads are considered Type A thoroughfares. Frontage roads for the Dallas North Tollway shall be designed to the Type A standards set forth in this document. Frontage roads along state highways shall follow TxDOT design guidelines (see Tables 2.5, 2.6, and 2.7).
- C. Access to frontage roads shall also conform to the standards set forth for Type A thoroughfares. In addition, the following access restrictions apply to frontage road design:
1. Exit Ramp Restrictions:
 - a. No driveway shall be located less than fifty feet (50') in advance of the concrete curb gore of an exit ramp, measured from the edge of the driveway.
 - b. No driveway shall be located less than four hundred feet (400') beyond the striped gore of an exit ramp (designated as the point where the striping of the exit ramp lane and the through lane converge), measured from the edge of the driveway.
 2. Entrance Ramp Restrictions:
 - a. No driveway shall be located less than two hundred feet (200') in advance of the striped gore of an entrance ramp (designated as the point where the striping of the entrance ramp lane and the through lane diverge), measured from the edge of the driveway.
 - b. No driveway shall be located less than fifty feet (50') beyond the concrete curb gore of an entrance ramp, measured from the edge of the driveway.

2.09 Traffic Signal Installation

- A. Introduction – According to the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD), traffic control signals should not be installed unless one or more of the signal warrants in the manual are met. The satisfaction of a warrant or warrants is not in itself justification for a signal. Information should be obtained by means of engineering studies and compared with the requirements set forth in the warrants. The engineering study should indicate the installation of a traffic signal will improve the overall safety and/or operation of the intersection. If these

requirements are not met, a traffic signal should neither be put into operation nor continued in operation (if already installed).

B. Warrant Criteria

1. To justify the installation of a traffic signal, Part IV in the TMUTCD shall be followed. Part IV describes the warrants for a traffic signal installation and provides guidelines and requirements for the actual design and operation of a traffic signal.
2. Engineering studies must be conducted in order to assess whether a particular location satisfies the warrant criteria listed in the TMUTCD. These studies may include one or more of the following:
 - a. Traffic volume counts
 - b. Pedestrian volume counts
 - c. Delay studies
 - d. Speed studies
 - e. Gap studies
 - f. Diagram of physical conditions
 - g. Accident studies

- C. Traffic Signal Spacing – Signal spacing is an important factor in being able to provide progressive flow for a platoon of traffic. Traffic signal spacing shall be determined by the Director of Engineering Services and may preclude some locations from ever being signalized. In general, traffic signals at Type A-A, A-B, and B-B intersections shall dictate the spacing that is acceptable for traffic signals to be installed at other intersections along a Type A or B thoroughfare. A new traffic signal should not be located in the area between one thousand feet (1,000') and two thousand feet (2,000') from a Type A-A, A-B, or B-B intersection (measured from the center of each intersection).

- D. Traffic Signal Design and Installation – The design and installation of traffic signals shall follow the City's Technical Specifications.

E. Cost of Traffic Signal Installation

1. Traffic signals where a private driveway or a residential street intersects with a Type A or B thoroughfare – The developer is responsible for the total cost of designing and constructing a traffic signal that would only be warranted based on the traffic generated by the development. The developer shall escrow funds for the cost of the traffic signal and the City shall construct the traffic signal at the time of development or when the development reaches a certain level of activity, as determined by the Director of Engineering Services. If a future traffic signal will equally serve a development on each side of the thoroughfare, each development shall be responsible for half the cost of the traffic signal.
2. Traffic signals at Type A-A, A-B, and B-B intersections – The developer on each corner of a Type A-A, A-B, or B-B intersection is responsible for a portion of the cost of designing and constructing a future traffic signal at the intersection and shall escrow such funds with the

- City at the time of development. Seventy-five percent (75%) of the total cost of designing and constructing the traffic signal shall be divided equally among each of the four corners of the intersection and then proportionally assessed to each lot within a fifteen (15) acre area at each corner, measured eight hundred eight feet (808') in each direction from the corner. In the case of a three-leg intersection, a hypothetical fourth leg shall be assumed for the purposes of creating four corners. As each lot develops as a portion of each corner, the trips generated by that land use shall be calculated and compared to the trips that would be generated by the total fifteen (15) acre area, the ratio of which determines the proportion of the traffic signal escrow that shall be assessed to that lot. If a preliminary site plan has not been approved for the whole fifteen (15) acre area, the land uses of a typical shopping center shall be assumed. If there are less than fifteen (15) acres that can be developed on a corner, the trips generated by a developing lot will be compared to a hypothetical fifteen (15) acre shopping center.
3. Roundabouts in lieu of traffic signals – The City reserves the right to install a roundabout in lieu of a traffic signal at any location referenced in Subsections 1 and 2 above. In that case, any funds escrowed for a traffic signal according to Subsections 1 and 2 above shall be used for the roundabout.
 4. Modification of an existing traffic signal – If a developer adds an additional leg or a turn lane to an existing signalized intersection, the developer shall be responsible for the total cost of designing and constructing the necessary modifications to the existing traffic signal.

2.10 Street Lighting

- A. The following standards shall apply to all Type A and Type B Thoroughfares:
 1. Street lighting shall be placed in the medians, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred forty-five feet (145') depending on median breaks and intersections.
 2. Unless a photometric analysis suggests the use of a different type of luminaire, street lighting shall use a City-approved, standard 250-watt equivalent LED.
 3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt equivalent LED single or double head with davit arm(s) traffic black (RAL9017-traffic black) in color, or the equivalent approved by the Director of Engineering Services shall be used.
 4. Street lighting shall be installed prior to final acceptance of the construction of a thoroughfare. When partial thoroughfares are constructed, the Director of Engineering Services may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect thoroughfares, each Owner (Developer) is responsible for one-half the total cost of fully developed street lighting along that segment of the thoroughfare.
 5. When development occurs along a Type A or Type B thoroughfare, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the thoroughfare.
 6. Poles are to be round and tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details and specifications.

7. Type C ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.
8. Street lighting foundations shall be thirty inches by ninety-six inches (30" x 96") in accordance with the City's Standard Details and specifications.
9. Street lighting conduit shall be two-inch (2") Schedule 40 PVC.
10. Street lighting shall use #10 AWG stranded wiring inside the poles.
11. Electrical service pedestals shall be 240V/480V single phase, 3 wire, and meet the local service provider's specifications.
12. Conduit shall be installed as shown in Section 6.02, Landscape Requirements in the Median.

B. The following standards shall apply to all Type C commercial collectors:

1. Street lighting shall be placed in the parkway between the curb and the sidewalk, with spacing not to exceed one hundred eighty feet (180') and no closer than one hundred forty-five feet (145').
2. Unless a photometric analysis suggests the use of a different type of luminaire, street lighting shall be a City-approved, standard 250-watt equivalent LED.
3. Die cast aluminum or extruded aluminum with segmented internal reflector, 250-watt equivalent LED single head with davit arm traffic black (RAL-9017 traffic black) in color, or equivalent approved by the Director of Engineering Services shall be used.
4. Street lighting shall be installed prior to final acceptance of the construction of a commercial collector. When the delay of installing street lighting is deemed appropriate by the Director of Engineering Services, the Director may allow the payment of a street light fee in lieu of installing the required lighting. Where property lines bisect collectors, each owner (Developer) is responsible for one-half of the total cost of fully developed street lighting along that segment of the collector.
5. When development occurs along a Type C commercial collector, the Owner (Developer) shall pay a street light fee to reimburse the City for the future or past installation of street lighting. The fee shall be paid prior to final acceptance of the development and the amount shall be determined by multiplying the then current fee rate by the amount of linear frontage the developing lot has along one or both sides of the collector.
6. Poles are to be round tapered with a maximum height of thirty feet (30') in accordance with the City's Standard Details and specifications.
7. Type C ground boxes with concrete aprons are required in accordance with the City's Standard Details and specifications.
8. Street lighting foundations shall be thirty inches by ninety-six inches (30" x 96") in accordance with the City's Standard Details and specifications.
9. Street lighting conduit shall be two-inch (2") Schedule 40 PVC.
10. Street lighting shall use #10 AWG stranded wiring inside the poles.

11. Electrical service pedestals shall be 240V/480V single phase, 3 wire, and meet the local service provider's specifications.

C. The following standards shall apply to all Type D, E, F, and G residential streets:

1. Poles are to be round tapered, American style with Barrington base, black in color. Pole height shall be twelve feet (12') for Type D, E, F, and G local streets and fourteen feet (14') for residential collectors. Where a residential street intersects a Type A or B thoroughfare, the pole height shall be fourteen feet (14').
2. Lamps shall be 100 watts High Pressure Sodium or an LED equivalent.
3. Luminares shall be Acorn with refractive globes, metal cap and finial.
4. The Developer may install additional banding and/or medallions with prior approval from the Director of Engineering Services. The cost for maintenance and/or replacement of the banding and/or medallions shall be the responsibility of the developer or Homeowners' Association.
5. Street lights shall be installed without multiple luminares.
6. Street lights shall typically be located at intersections and at mid-block locations if the block length is greater than six hundred feet (600'). (This includes an intersection with a mews but does not include an intersection with a driveway or an alley.) Cul-de-sac streets over two hundred twenty-five feet (225') in length, measured from centerline of cross street to center point of cul-de-sac, shall, at a minimum, have a street light installed at the street intersection and on the perimeter of the cul-de-sac bulb. Other locations may be required as deemed necessary by the Director of Engineering Services. Street lights shall not be greater than six hundred feet (600') apart and shall not be closer than one hundred fifty feet (150') apart except when located at two closely-spaced intersections or at a roundabout (see Subsection 7 below).
7. A minimum of two street lights shall be provided at a single-lane roundabout in a residential neighborhood. Additional street lights may be required as deemed necessary by the Director of Engineering Services.
8. Subdivisions bounded by Type A or Type B thoroughfares shall have a common type of luminaire throughout. Street lighting shall be installed prior to acceptance by the Director of Engineering Services.
9. Fire hydrants shall not be installed on the same corner of a residential intersection that contains a street light or a sign post. The fire hydrant shall be located away from the corner (beyond the curb return) or be located on a different corner of the intersection.

D. The following standards shall apply to streets in urban centers or where multi-family buildings face a street:

1. Poles are to be round tapered, American style with Barrington base, black in color. Pole height shall be fourteen feet (14'). Poles shall have banner arms when installed in areas so designated by the Director of Engineering Services.
2. Lamps shall be 100 watts High Pressure Sodium or an LED equivalent.

3. Luminaires shall be Acorn with refractive globes, metal cap and finial.
 4. The Developer may install additional banding and/or medallions with prior approval from the Director of Engineering Services. The cost for maintenance and/or replacement of the banding and/or medallions shall be the responsibility of the developer or Homeowners' Association.
 5. Street lights shall be installed without multiple luminaires.
 6. Street lights shall typically be located at intersections and at mid-block locations. Street lights shall not be closer than fifty feet (50') apart nor greater than ninety feet (90') apart.
 7. The electrical service for any street lights installed along a public street shall be kept separate from the service to any adjacent building and the street light service pedestal shall be installed in the public right-of-way.
- E. A lighting plan shall be required anytime street lighting is proposed or modified. The lighting plan shall be submitted to the Director of Engineering Services for a construction permit. A certified engineer, architect, landscape architect, lighting engineer or designer shall prepare the plan. The plan shall also contain a certification by the property owner or agent and the preparer of the plan that the street lighting depicted on the plan complies with these requirements. The submission shall contain but shall not necessarily be limited to the following:
1. Plans indicating the location of the lighting, and the type of illuminating devices, fixtures, lamps, supports, reflectors, and other devices;
 2. Description of the illuminating devices, fixtures, lamps, supports, reflectors, and other devices and the description may include, but is not limited to, catalog cuts by manufacturers and drawings (including sections where required) and height of the luminaires;
 3. Photometric plan and data sheets, such as that furnished by manufacturers, or similar to that furnished by manufacturers or the lighting designer, showing the angle of cut off or light emissions; and
 4. Water and sewer locations along with any other existing utilities lightly shaded on plans showing any possible location conflicts with proposed lighting.
- F. The following are exempt from these requirements:
1. "Cobra head" type lighting fixtures having dished or "drop" lenses or refractors which house other than incandescent light sources in undeveloped areas.
 2. Temporary lighting approved in writing by the Director of Engineering Services.
 3. Where existing or phased subdivisions are currently under construction, the continued use of previously approved street lighting will be permitted. When a new phase of a subdivision is divided by a residential collector, the street lighting standards contained in these requirements shall be required.
 4. City Council may vary from these requirements as part of the approval of public street and sidewalk projects in overlay districts and Planned Developments.

5. Lighting luminaires in existence on the effective date of these requirements shall be exempt from these standards and shall be considered legally non-conforming. Such fixtures may be repaired, maintained and/or replaced. If an identical replacement of non-conforming luminaires is not available, the new luminaires shall comply with these requirements.
- G. Notwithstanding anything to the contrary in this Section 2.10 (Street Lighting), where street lighting is proposed to be placed within the Network Node Overlay District, the Preston Road Overlay Design District, the Tollway Overlay Design District or any other design district or historic district designated under the Zoning Ordinance pursuant to Chapter 284 of the Texas Local Government Code, as it exists or may be amended, the street lighting shall be installed on decorative poles as approved by the City.

2.11 Street Name Signs

- A. Street name signs shall be installed at all intersections of public streets, private streets, and public ways in accordance with the City's Standard Details, Technical Specifications and requirements. The City shall fabricate all street name signs for new developments at the cost of the developer.
- B. Street name signs shall be nine inch (9") tall flat aluminum.
- C. The street name shall be left justified, with block numbers located in the upper right-hand corner. Abbreviated street designations shall be located in the lower right-hand corner and right-justified.
- D. The lettering of the street name shall be Clear View 2W, six inches (6") tall and upper/lower case. Letters of abbreviated street designations shall be three inches (3") tall and all uppercase (i.e., LN, PKWY, DR, CT, etc.). Block numbers shall be 3" tall.
- E. A street name shall be limited to sixteen (16) characters, not including the street designation. A street name shall either consist of one word no longer than sixteen (16) letters or two words separated by one space where the two words have no more than fifteen (15) letters combined.
- F. Sign sheeting shall be diamond grade intensity. Signs designating a public street shall have a green background and a white legend. Signs designating a public way or a named fire lane shall have a blue background and white legend. Signs designating a public or private street within a City-approved special district (such as a private neighborhood or an urban center) shall be limited to one of the background and legend color combinations allowed by the latest edition of the *Texas Manual on Uniform Traffic Control Devices*. Where a special district street intersects with a Type A or B thoroughfare, the sign designating that street shall have a green background and a white legend.
- G. Where an intersection leads to a cul-de-sac, a standard W14-2a sign shall be mounted over the street name sign. Where an intersection leads to two cul-de-sacs, two standard W14-2a signs shall be mounted over the street name sign in the appropriate directions. The words "NO OUTLET" on a yellow background can be incorporated into the appropriate end of the street name sign in lieu of a W14-2a sign if such use will not create an overlong street name sign.
- H. Block numbers are required on all street name signs, even if no homes or buildings front onto the street.

2.12 Traffic Impact Analysis and Mitigation

- A. Purpose – The purpose of a Traffic Impact Analysis (TIA) is to assess the effects of specific development activity on the existing and planned thoroughfare system. Development activity may include, but is not limited to, rezoning, preliminary site plans, site plans, preliminary plats, driveway permits, certificates of occupancy, and Thoroughfare Plan amendments.
- B. Pre-submission Meeting – Prior to the commencement of a TIA, an initial or pre-submission meeting with City staff is required to establish a base of communication between the City and the applicant. This meeting will define the requirements and scope relative to conducting a TIA and ensure that any questions by the applicant are addressed.
- C. Applicability of TIA Requirements
 - 1. Zoning – These TIA requirements shall apply to all zoning requests for land uses which will generate 2,500 or more vehicle trips per day or contain a density of 0.75 Floor Area Ratio (FAR) or greater. Applicable requests include zoning requests and Thoroughfare Plan amendments, if no previous traffic assessment was performed. Special circumstances including, but not limited to, development with no case history, which do not meet the daily trip generation threshold, may also require a TIA. Such circumstances, as determined by the Director of Engineering Services may include, but are not limited to, impacts to residential neighborhoods from non-residential development, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the proposed land use differs significantly from that contemplated in the Comprehensive Plan, or the internal street or access is not anticipated to accommodate the expected traffic generation.
 - 2. Development – These TIA requirements shall apply to all development requests for land uses, except single-family residential development, which will generate over 100 total trips during the AM or PM peak hour. Applicable development requests include concept plans, preliminary site plans, specific use permits, site plans and preliminary plats. Special cases, in which site generated peak hour trip activity is different from that of the adjacent street (weekdays 7:00-9:00 a.m. and 4:00-6:00 p.m.), may require an additional separate analysis as determined by the Director of Engineering Services. Such circumstances may include, but are not limited to, commercial/retail, entertainment or institutional activity. The Director of Engineering Services may waive the TIA for a development request if a TIA was performed previously with the Zoning request and conditions listed in the report are still current.
 - 3. Single-Family Residential Exception – A TIA for single-family residential development will not be required if the development contains fewer than six dwelling units unless special circumstances exist, as determined by the Director of Engineering Services. These special circumstances may include, but are not limited to, impacts to other residential development from cut-through traffic, inadequate site accessibility, the implementation of the surrounding Thoroughfare Plan is not anticipated during the estimated time period of the proposed development, the internal street or access system is not anticipated to accommodate the expected traffic generation, or the development is outside the urban core of the community
 - 4. Daycares and Schools – All development requests and/or specific use permit requests for a daycare, Montessori school, private school, charter school, or public school shall include, at a minimum, a traffic circulation and queuing study. This study shall include the estimated maximum peak hour trip generation of the facility, the planned circulation of inbound and outbound traffic during drop-off and pick-up operations, and the estimated length of the

- queue of cars waiting to pick up students. The design of the site and the circulation plan shall ensure that school traffic does not back up onto any public street. The traffic circulation study shall include a statement that the owner and/or operator of the daycare or school agrees to operate the facility in accordance with the approved circulation plan. The circulation plan must be approved by the Director of Engineering Services before the development request or the specific use permit can be approved.
5. Car Washes – All development requests and/or specific use permit requests for a full-service car wash shall include, at a minimum, a traffic circulation and queuing study. This study shall state the rate at which the car wash tunnel can process cars (per lane and total) and the rate at which the pay station can process cars (per lane and total), the smaller of which shall be the constraining service rate for the facility. The stacking spaces required in Section 2.13.B will be determined by a queuing analysis. The design of the site and the circulation plan shall ensure that car wash traffic does not back up onto any public street. The study shall provide two circulation plans that show how cars will enter, circulate, and leave the site (including the use of any detailing or vacuum stations). One circulation plan will be created for normal operations and another circulation plan will be created for peak operations when vehicles begin to stack up in a fire lane. The traffic circulation study shall include a statement that the owner and/or operator of the car wash agrees to operate the facility in accordance with the approved circulation plans. The circulation plans must be approved by the Director of Engineering Services before the development request or the specific use permit can be approved.
 6. Determination of Applicability – The need for a TIA shall be determined by the Director of Engineering Services based upon the results and recommendation from a pre-submission meeting. It shall be the responsibility of the applicant to demonstrate that a TIA should not be required. If a TIA is required, the level of effort for a TIA submission shall be determined based on the criteria set forth in Table 2.14. Depending upon the specific site characteristics of the proposed development, one or more of the following elements may also be required as part of the TIA: an accident analysis, sight distance survey, traffic simulation, roundabout analysis, traffic signal warrant analysis, queuing analysis, turn lane analysis, and/or traffic circulation plan.

TABLE 2.14: Criteria for Determining TIA Study Requirements

<u>Analysis Category</u>	<u>Site Trips Generated at Full Build-Out</u>	<u>TIA Analysis Periods⁽¹⁾</u>	<u>Minimum Study Area⁽³⁾</u>
I	>50 peak hour driveway trips; or 100-500 total peak hour trips	1. Existing year 2. Opening year ⁽²⁾ 3. Five years after opening 4. Twenty years after opening for roundabouts	1. All site access drives 2. All signalized intersections, roundabouts, and major unsignalized intersections within 0.5 mile to 1 mile of site boundary
II	>500 total peak hour trips	1. Existing year 2. Opening year of each phase 3. Five years after initial opening 4. Ten years after final opening with full build-out 5. Twenty years after opening for roundabouts	1. All site access drives 2. All signalized intersections, roundabouts, and major unsignalized intersections within 1.5 miles of site boundary

1. Analysis periods shall include build and no-build scenarios. Assume full occupancy when each phase opens.
2. Assume full build-out.
3. For certain projects, the City may require an enlarged study area. Land uses within the study area should include recently approved or pending development adjacent to the site.

- D. Requirements for TIA Updates – A TIA shall be updated when time or circumstances of the original study fall within the parameters presented in Table 2.15. The applicant is responsible for preparation and submittal of appropriate documentation in order for City staff to process the zoning or development application. A TIA for site development requests must be updated if two years have passed since the original submittal, or if existing or assumed conditions have changed within the defined study area. The Director of Engineering Services shall make the final determination as to the extent of a TIA update.

TABLE 2.15: Criteria for Determining TIA Update Requirements

<u>Original TIA Report was based on:</u>	<u>Changes to the Originally Proposed Development:</u>	
	<u>Access Changed⁽¹⁾ or Trip Generation Increased by more than 10%</u>	<u>Access Not Changed and Trip Generation Increased by less than 10%</u>
Zoning; or Preliminary Site Plan or Site Plan that is less than 2 years old	Letter Amendment Required: Identify and report only analysis conditions that have changed	Letter Documenting Change (No analysis is required)
Preliminary Site Plan or Site Plan that is more than 2 years old	Prepare New Study. Must meet all current TIA requirements	Prepare New Study. Must meet all current TIA requirements.

1. Changed access includes proposed new access or refinement of general access locations not specifically addressed in original proposed development.

E. Responsibility of TIA Preparation and Review

1. A TIA shall be prepared in accordance with all of the guidelines in this section and submitted in accordance with the Development Review Schedule set by the City. The responsibility for TIA preparation shall rest with the applicant and must be performed by a Professional Engineer (P.E.) licensed in the State of Texas with experience in traffic and transportation engineering. The final TIA report must be signed and sealed by the P.E. responsible for the analysis to be considered for review by the City. Application and review fees are due at the time of each submittal. City staff shall serve primarily in a review and advisory capacity and will only provide data to the applicant when available.
2. It shall be the responsibility of the applicant to submit four (4) draft TIA reports and executive summaries with the zoning and/or development request submission. The proper number of reports, the timing for submission, and the review of these reports shall be based on standard City development review procedures. Incomplete TIAs or failure to submit a TIA with the submission shall delay consideration of zoning and development requests. Should it be determined during the review of any zoning and/or development plans that a TIA is required, consideration shall be deferred until the applicant submits a completed TIA and the City has reviewed the assessment.
3. The City shall review the TIA and provide comments to the applicant. It shall be the responsibility of the applicant to submit four (4) finalized TIA reports and executive summaries once all review comments have been addressed.

F. TIA Standards

1. Design Level of Service – The minimum acceptable level of service (LOS) within the City shall be defined as LOS “D” in the peak hour for all critical movements and links. All development impacts on both thoroughfare and intersection operations must be measured against this standard.
2. Trip Generation Resources – The City’s standard for trip generation rates for various land use categories shall be those found in the latest edition of *Trip Generation* published by the

- Institute of Transportation Engineers (ITE) or other published or recognized sources applicable to the region. Alternate trip generation rates may be accepted on a case-by-case basis if the applicant can provide current supporting data substantiating that their development significantly differs from the ITE rates. The Director of Engineering Services must approve alternative trip generation rates in writing in advance of the TIA submission.
3. Trip Reductions – Trip reductions for passer-by trips and mixed-use developments will be permitted, subject to analytical support provided by the applicant and approval by the Director of Engineering Services on a case-by-case basis. Assumptions relative to automobile occupancy, transit mode share, or percentage of daily traffic to occur in the peak hour must be documented and will be considered subject to analytical support provided by the applicant.
 4. Study Horizon Years – The TIA must evaluate the impact of the proposed development on both existing traffic conditions and future traffic conditions for the horizon year(s) as specified in Table 2.14. However, applications for densities of 0.75 Floor Area Ratio (FAR) or greater within the Dallas North Tollway, SH 121, US 380 or Preston Road corridors (throughout the City Limits) shall require that the horizon year land use assumptions be updated to reflect full development based on all proposed zoning. These applications should also assume full development of the Master Thoroughfare Plan or pending amendments.

G. TIA Methodology

1. Site Location/Study Area – A brief description of the size, general features, and location of the site, including a map of the site in relation to the study area and surrounding vicinity.
2. Existing Zoning – A description of the existing zoning for the site and adjacent property, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate);
3. Existing Development – A description of any existing development on the site and adjacent to the site and how it would be affected by the development proposal;
4. Proposed Zoning / Site Development – A description of the proposed zoning/development for the site, including land area by zoning classification and density by FAR, square footage, number of hotel rooms, and dwelling units (as appropriate); identify other adjacent land uses that have similar peaking characteristics as the proposed land use; identify recently approved or pending land uses within the area;
5. Thoroughfare System – A description and map of existing planned or proposed thoroughfares, roundabouts, and traffic signals for horizon year(s) within the study area;
6. Existing Traffic Volumes – Recent traffic counts for existing thoroughfares and major intersections within the study area;
7. Projected Traffic Volumes – Background traffic projections for the planned thoroughfare system within the study area for the horizon year(s). Background traffic projections shall include the growth in regional traffic as well as the traffic that will be generated by the undeveloped land adjacent to the site and/or within the study area that is likely to develop by the horizon year(s), as determined by the Director of Engineering Services. These traffic projections shall be based upon recently approved development applications, the current zoning on the undeveloped land, or the City's Future Land Use Plan;

8. Density of Development – A table displaying the amount of development assumed for existing zoning and/or the proposed development (using gross floor area, dwelling units, occupied beds, etc., as required by the trip generation methodology);
9. Existing Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy based on existing zoning (if applicable), and including all appropriate trip reductions (as approved by the Director of Engineering Services);
10. Proposed Site Trip Generation – A table displaying trip generation rates and total trips generated by land use category for the AM and PM peak hours and on a daily basis, assuming full development and occupancy for the proposed development, and including all appropriate trip reductions (as approved by the Director of Engineering Services);
11. Net Change in Trip Generation (for rezoning cases) – Proposed trip generation minus existing trip generation (if applicable); the net increase in trips to be added to base volumes for the design year;
12. Trip Distribution and Traffic Assignment – Tables and figures of trips generated by the proposed development (or net change in trips, if applicable) added to the existing and projected volumes, as appropriate, with distribution and assignment assumptions, unless computer modeling has been performed;
13. Level of Service Evaluations – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for both existing conditions and horizon year projections for intersections, thoroughfare links, median openings and turn lanes associated with the site, as applicable;
14. Roundabout and Traffic Signal Evaluations – The need for new roundabouts and/or traffic signals based on warrants and their impact on the performance of the transportation system (see Section 2.12.I.4);
15. Evaluation of Proposed/Necessary Mitigation – Capacity analyses for weekday AM and PM peak hours of the roadway and peak hour of the site, if different from the roadway, for intersections, thoroughfare links, median openings and turn lanes associated with the site under proposed/necessary traffic mitigation measures;
16. Conclusions – Identification of all thoroughfares, driveways, intersections, and individual movements that exceed LOS D or degrade by one or more LOS, the percentage of roadway volume change produced by the proposed development, and any operational problems likely to occur;
17. Recommendations – Proposed impact mitigation measures consistent with Subsection I below; and
18. Other information required for proper review – As requested by the Director of Engineering Services.

H. TIA Report Format

1. The TIA report must be prepared on 8½" x 11" sheets of paper. However, it may contain figures on larger sheets, provided they are folded to this size. All text and map products shall

be computer-based and provided in both published format and computer file format (PDF). In addition, all electronic files used as part of the traffic analysis (i.e., Synchro, HCS, Passer II/III, CORSIM, VISSIM, ARCADY, etc.) shall be provided.

2. The sections of the TIA report should be categorized according to the outline shown below:

Executive Summary

- I. Introduction
 - A. Purpose
 - B. Methodology
- II. Existing And Proposed Land Use
 - A. Site Location/Study Area
 - B. Existing Zoning
 - C. Existing Development
 - D. Proposed Zoning (if applicable)
- III. Existing And Proposed Transportation System
 - A. Thoroughfare System
 - B. Existing Traffic Volumes
 - C. Projected Traffic Volumes
- IV. Site Traffic Characteristics
 - A. Existing Site Trip Generation (if applicable)
 - B. Proposed Site Trip Generation
 - C. Net Change in Trip Generation (if applicable)
 - D. Trip Distribution and Traffic Assignment
- V. Traffic Analysis
 - A. Level of Service Evaluations
 - B. Roundabout and Traffic Signal Evaluations
- VI. Mitigation
- VII. Conclusions
- VIII. Recommendations

Appendices

- I. Traffic Impact Mitigation

1. Mitigation of traffic impacts shall be required if the proposed development would cause a facility or traffic movement to exceed LOS D, or where it already exceeds LOS D and the development would contribute five percent (5%) or more of the total traffic during any projected horizon year. If mitigation is required, the applicant must only mitigate the impact of the proposed development, and would not be responsible for alleviating any deficiencies in the thoroughfare system that may occur without the proposed development.
2. Acceptable mitigation measures shall include:
 - a. Staging of development in order to relate site development to the construction of the required thoroughfare system;
 - b. Staging of development so that the site contributes less than five percent (5%) of the total traffic to the affected facility or traffic movement during the projected horizon year;

- c. Off-site improvements, including the provision of right-of-way and/or the participation in funding for needed thoroughfare and intersection improvement projects (including, but not limited to, through lanes, turn lanes, roundabouts, or traffic signals); and
 - d. On-site improvements, including access controls and site circulation adjustments.
- 3. Mitigation is not required if it can be shown that the traffic impacts of the project are fully mitigated ten (10) years after the final opening with any improvements that are already programmed to be implemented within five (5) years of the initial opening.
- 4. Any intersection under consideration for a higher form of traffic control that is located along a Type B thoroughfare, or along a Type A thoroughfare that is not expected to be widened to six lanes by the horizon year(s), must be analyzed for the implementation of a multi-lane roundabout. The roundabout must be shown to fail in the horizon year(s) or be proven infeasible before a traffic signal will be considered at that location.
- J. Administration of the TIA – Based on the results of the TIA and actions recommended by the Director of Engineering Services, the Planning & Zoning Commission and/or the City Council, as appropriate, shall take one or more of the following actions:
 - 1. Approve the zoning or development request, if the project has been determined to have no significant impact or where the impacts can be adequately mitigated;
 - 2. Approve the development request, subject to a phasing plan;
 - 3. Recommend study of the City Thoroughfare Plan to determine amendments required to increase capacity;
 - 4. Recommend amendment of the Capital Improvement Program (CIP) to expedite construction of needed improvements; or
 - 5. Deny the zoning or development request, where the impacts cannot be adequately mitigated.
- K. Cost of TIA Review by City – The cost for review of TIA submittals shall be based on the parameters set forth in the City's Development Fee Schedule and paid in full at time of submission.

2.13 Internal Site Circulation Requirements

- A. All internal site circulation shall be designed and constructed in a way that preserves the health, safety, and welfare of the Public, as determined by the Director of Engineering Services. This applies to all private and public infrastructure intended for the movement of pedestrians and all types of vehicles (including, but not limited to, cars, trucks, buses, trains, golf carts, bicycles, scooters, etc.).
 - 1. Proper internal site circulation includes, but is not limited to, proper channelization and alignment of intersections, turning radii, fire truck access and maneuverability, sight distance, traffic control devices, traffic queue management, loading dock access, delivery truck activity, loading zones, trash pickup location and procedures, parking lot circulation, crosswalk alignment, crosswalk location, ADA access routes, etc.

2. The curvature and alignment of a driveway, as well as the way in which other fire lanes and drive aisles intersect with it, shall not cause confusion for motorists, create unusual conflict points, nor create difficult geometry for fire trucks to navigate.
 3. The curvature and/or alignment of a fire lane within a site shall not create difficult geometry for fire trucks to navigate, as determined by the Fire Department. Some specific requirements include:
 - a. Parallel fire lanes shall be forty feet (40') apart when they both intersect a third fire lane so that a continuous twenty-foot (20') radius is maintained when turning from one lane onto the parallel fire lane.
 - b. When a fire lane contains a reverse curve (or S-curve) in its alignment, there must be a tangent at least twenty feet (20') long between the reverse curve and the next curve in the alignment or the next curb return of a fire lane intersection.
 4. Drive-through restaurants and businesses shall be designed so that the drive-through lane never ends with its traffic traveling parallel to traffic traveling in the opposite direction. The end of the escape lane (see Zoning Ordinance Section 4.04.08(B)(7)) and the end of the drive-through lane shall merge with a one-way drive aisle running in the same direction as the drive-through lane, or shall intersect perpendicularly with a one-way or two-way drive aisle.
 5. Drive-through restaurants and businesses shall be designed so that traffic queued up to use the business shall not block a fire lane, block required parking spaces, interfere with traffic circulation for other businesses, block a driveway entrance to the shopping center, nor back up into a public street.
- B. Car Washes – Full-service car washes shall provide the number of stacking spaces required by this subsection or by Section 4.04.08(B) of the Zoning Ordinance, whichever is greater. If the car wash can serve between 100 and 250 cars per hour (total) based on the traffic circulation and queuing study required under Section 2.12.C.5, the car wash shall provide at least twenty (20) stacking spaces in advance of the constrained service location (e.g., the tunnel entrance or the pay station). If the car wash can serve less than 100 cars per hour (total) or more than 250 cars per hour (total), the number of stacking spaces required will be based on a detailed queuing analysis. The stacking spaces required herein shall not be located within a fire lane.
- C. Structured Parking Garages
1. Parking garages containing five hundred (500) or more parking spaces shall have at least two driveway access points, each with a minimum of two lanes. If a parking garage is allowed to have only one driveway access point, that driveway shall have a minimum of one (1) inbound lane and two (2) outbound lanes
 2. Parking garages shall have at least one pedestrian entrance which does not require pedestrians to walk in a driveway access point to enter the garage. This pedestrian entrance shall be served by a sidewalk connection that complies with the most current federal, state, and local ADA requirements. Additional pedestrian entrances may be required as deemed necessary by the Director of Engineering Services.
 3. Where vehicles exit a parking garage, the fire lane shall be located at least fifteen feet (15') away from the exterior wall or column of the parking garage exit so adequate sight distance is provided for exiting vehicles.

4. The size of parking spaces within a parking garage is dictated by the Zoning Ordinance. If the parking spaces are eighteen feet (18') deep, no column or barrier cable is allowed to encroach into a parking space beyond an area measuring fourteen inches (14") by fourteen inches (14") in one front corner of that parking space. If the parking spaces are deeper than eighteen feet (18'), the encroachment area shall be no wider than fourteen inches (14") and no deeper than twenty-six inches (26") in one front corner of that parking space. If barrier cables are installed across the entire width of a parking space, the required parking space depth must be measured from the face of the barrier cable(s).
- D. Daycares and Schools – All development requests and/or specific use permit requests for a daycare, child-care, Kindergarten, Montessori school, or similar child training establishment shall provide the parking spaces required by Section 4.04.08(A) of the Zoning Ordinance and the stacking spaces required by Section 4.04.08(B) of the Zoning Ordinance unless the following alternative is approved by the Director of Engineering Services. A daycare or similar facility can provide additional parking in lieu of the required stacking spaces provided that the traffic queuing and circulation study required in Section 2.12.C.4 includes the following statements: First, that all parents will be required to park and walk into the facility to drop-off and pick-up their child. Second, that the child-care facility cannot change its drop-off and pick-up operations without obtaining permission from the City by submitting a new traffic study to determine if any physical changes to the campus are necessary. If these conditions are met, the child-care facility must provide at least one (1) parking space per six (6) students plus one (1) parking space per employee in order to eliminate the stacking space requirement.
- E. Loading Zones – Loading zones shall be provided within a commercial development so that deliveries are never made by stopping, standing, or parking in a fire lane. One or more loading zones can be shared among businesses but must be convenient to each business. Required parking spaces cannot be counted as loading zones. Multi-family apartment buildings that have parking garages rather than surface parking lots must be designed so that one or more loading zones are designated on the public street adjacent to the building that are convenient to the freight elevator(s) so that moving trucks do not double park in the public streets.
- F. Off-Street Parking Spaces
1. Off-street parking spaces are governed by the requirements described in Section 4.04 of the Zoning Ordinance. The basic dimensional requirements are repeated below but shall not supersede the requirements in the Zoning Ordinance.
 2. Each standard (head-in) off-street parking space shall be a minimum of nine feet (9') wide and twenty feet (20') deep. A minimum drive aisle twenty-four feet (24') wide shall be provided adjacent to these standard parking spaces, regardless of whether the drive aisle is one-way or two-way. These requirements are summarized in Figure 9.01.01.12 of the Zoning Ordinance.
 3. A standard (head-in) parking space may be reduced to eighteen feet (18') deep provided the front of the vehicle overhangs a paved, mulched, or grassed area which is not part of a required sidewalk, right-of-way, or landscape area. A two-foot (2') overhang measured from the face of the curb shall be shown on the development plan.
 4. Where a standard twenty-foot (20') parking space is adjacent to a sidewalk or landscape area, a two-foot (2') overhang shall be shown on the development plan unless a wheel stop is provided within the parking space to prevent the vehicle from hanging over the end of the parking space.

5. Where a sidewalk is flush with the adjacent parking spaces, wheel stops shall be used to prevent vehicles from parking on the sidewalk.
6. Where a parking space allows the front of a vehicle to hang over a sidewalk, that sidewalk shall be a minimum of six feet (6') wide so that the minimum four-foot (4') sidewalk width required in Section 2.06.C shall be provided when a car is parked. However, vehicles shall not be allowed to hang over the public sidewalk adjacent to a thoroughfare.
7. When used, wheel stops shall be installed so that all surface parking spaces are a minimum of eighteen feet (18') deep measured from the face of the wheel stop. Any vertical obstruction in front of a surface parking space shall be located a minimum of twenty feet (20') from the back of the parking space.
8. Parallel off-street parking spaces shall be a minimum of eight feet (8') wide and twenty-two feet (22') deep. Angled off-street parking spaces shall be a minimum of nine feet (9') wide. The dimensions and permissible layouts of parallel and angled off-street parking spaces are shown in Figure 9.01.01.10 of the Zoning Ordinance.

SECTION 3 – PAVEMENT AND SUBGRADE DESIGN REQUIREMENTS

Section 3 – Pavement and Subgrade Design Requirements

3.01 General

- A. The following specifies minimum standards required for the pavement and subgrade design for roadways and alleys within the City. These minimum standards are not intended to replace the professional judgment of the Geotechnical Engineer for any specific project. The standards may need to be expanded or modified on a case by case basis as determined necessary and appropriate by the Geotechnical Engineer, and as approved by the Director of Engineering Services.
- B. Table 3.1 lists the City's minimum pavement and subgrade thicknesses and dimensions. In no case shall the pavement and subgrade be less than the minimums.

TABLE 3.1: Pavement and Subgrade Minimum Standards

Criteria	Thoroughfare Classification									
	Type A		Type B		Type C		Type D-G		Alley	
	Eagle Ford	Austin Chalk	Eagle Ford	Austin Chalk	Eagle Ford	Austin Chalk	Eagle Ford	Austin Chalk	Eagle Ford	Austin Chalk
Concrete* Thickness	9"	9"	8"	8"	7"	7"	6"	6"	See SD	See SD
Lime Thickness	8"	6"	8"	6"	8"	6"	8"	6"	8"	6"
Lime Application Rate	8%	8%	8%	8%	8%	6%	8%	6%	8%	6%
MC Depth										
Avg. Swell < 2%	48"	N/A	48"	N/A	48"	N/A	48"	N/A	48"	N/A
2% ≤ Avg. Swell < 6%	60"	N/A	60"	N/A	60"	N/A	60"	N/A	60"	N/A
6% ≤ Avg. Swell < 8%	72"	N/A	72"	N/A	72"	N/A	72"	N/A	72"	N/A
8% ≤ Avg. Swell < 10%	84"	N/A	84"	N/A	84"	N/A	84"	N/A	84"	N/A
Avg. Swell ≥ 10%	96"	N/A	96"	N/A	96"	N/A	96"	N/A	96"	N/A
SG Behind BOC	4-ft	2-ft	4-ft	2-ft	4-ft	2-ft	4-ft	2-ft	4-ft	2-ft
MB Behind BOC	6-ft	N/A	6-ft	N/A	6-ft	N/A	6-ft	N/A	6-ft	N/A

*Note all concrete shall be Class P1 or P2.

MC = Moisture Conditioning

SG = Subgrade

BOC = Back of Curb

MB = Moisture Barrier

SD = Standard Detail

- C. All roadways and alleys shall have a geotechnical investigation and pavement and subgrade design performed. Results of the geotechnical investigations, engineering analyses, and recommendations shall be presented in a Geotechnical Report for Roadways ("Report"). The Report and any subsequent re-evaluations or supplemental reports shall be signed and sealed by a Licensed Professional Engineer in the State of Texas trained and qualified to provide geotechnical engineering analysis and pavement and subgrade design recommendations.
- D. The Report shall address all items listed in the *Geotechnical Report for Roadways Checklist* ("Checklist"). The Checklist shall be filled out completely and submitted with the Report. Any "N/A" response on the Checklist shall include a written explanation and adequate justification as deemed necessary by the Director of Engineering Services.
- E. The *Summary of Geotechnical Recommendations Form* ("Form") shall be filled out completely and submitted with the Report.

- F. City review of the Report will be conducted as a means to verify if the pavement and subgrade design has been performed in general conformance to the City's requirements and shall not be considered a detailed technical review of the pavement and subgrade design for adequacy, accuracy, or completeness. The Geotechnical Engineer performing the pavement and subgrade design shall remain responsible for the technical adequacy, accuracy, and completeness of the pavement and subgrade design and shall not be relieved of any responsibility for such as a result of the City's review.
- G. The information and recommendations contained in the Report and any subsequent re-evaluation and/or supplement reports shall be accepted by the Director of Engineering Services in writing prior to Construction Plan Approval.
- H. Fire lane paving shall be designed in accordance with the Standard Paving Construction Details or Letter of Recommendation from the Geotechnical Engineer or Engineer of Record. At a minimum the standards shall include, but are not limited to, a minimum pavement thickness of six inches (6"), #4 rebar at 18" on center each way, and a 28-day break of 3600 psi concrete.
- I. The Engineer shall prepare a site-specific jointing plan for any roundabout. This includes, but is not necessarily limited to, expansion and contraction/sawed joints. Refer to Section 2 – Thoroughfare Design Requirements and Standard Details for more information on Roundabouts.
- J. All driveway approaches shall match the street pavement thickness, subgrade, and moisture conditioning depth. Steel reinforcement shall meet current street standards.
- K. Refer to the Standard Details and Technical Specifications for additional specific requirements related to pavement and subgrade.

3.02 Existing Surface/Subsurface Investigation

- A. Field Investigation elements include:
 - 1. Borings shall be drilled on center of roadway at 250' spacing (or less), alternating between each roadway direction or on a 200' grid throughout a subdivision to a depth of at least 20' below finished subgrade.
 - 2. Borings shall be sampled at 3' intervals or less to a depth of 10', and at 5' intervals or less thereafter.
 - 3. Bulk samples of each soil type encountered in the upper 5' shall be taken for Laboratory Investigation.
- B. Laboratory Investigation elements include:
 - 1. Moisture Content Tests (ASTM D 2216) shall be performed. When the samples are wetter than normally expected due to seasonal variability, the samples shall be air dried such that the samples represent the drier portion of the year. Average all swell test results to determine the mean maximum swell percentage and the standard deviation.
 - a. For samples taken during the months of June through September, use the mean swell percentage.

- b. For samples taken during the months of October through May, use the mean plus one standard deviation to determine the design swell percentage.
- 2. Soil types in each boring shall be classified as follows:
 - a. Atterberg limits (ASTM D 4318)
 - b. Percent Passing the No. 200 sieve (ASTM D 1140)
 - c. Moisture/Density
- C. Weathered Eagle Ford shale (classified as either shale, shaley clay, or clayey shale and not rock) encountered within 8' below finished subgrade shall be excavated to a depth of at least the depth of required moisture treatment and replaced with on-site light brown or dark brown clays or other approved material. Weathered Eagle Ford shale is not suitable for stabilization without appropriate detailed design and acceptance by the City.
- D. A geotechnical re-evaluation will be required if more than two (2) months occur between the end of moisture conditioning and beginning of liming operations; when conditions have changed significantly between moisture conditioning and liming operations; when Contractor and/or Owner have not properly maintained moisture content; or as deemed necessary by the City. The re-evaluation shall include additional field and laboratory testing to confirm moisture conditioning is still acceptable, or how to rectify the substandard condition prior to liming operations as necessary. Borings for the re-evaluation will be required on center of roadway at 500' spacing (or less) or on a 400' grid throughout a subdivision to a depth of at least 20' below finished grade.

3.03 Subsurface Design

- A. Laboratory investigation elements for both Eagle Ford and Austin Chalk formations include determining swell characteristics and movement potential using the Swell Test **AND** the calculated Potential Vertical Rise (PVR) – TxDOT Tex-124-E methods for a 20' depth of moisture penetration. The results of both tests shall be included in the Report. **The Geotechnical Engineer shall use the more conservative value in determining swell potential and depths of moisture treatment.**
 - 1. Swell Test: Test for swell potential using swell test (ASTM D 4546) at 200 psf stress at least two samples per boring at varying depths from 0' to 10' to determine the average swell potential of the subgrade. Use Table 3.1 to determine the minimum depth of moisture treatment based on average swell potential.
 - 2. PVR-TxDOT Tex-124-E: Test for swell potential using swell test (ASTM D 4546) and/or soil suction tests (ASTM D 5298) necessary to calculate PVR for a 20' moisture penetration. The PVR shall be calculated based upon 20' moisture penetration and shall provide moisture treatment depth to limit PVR to 4.5".
- B. The Geotechnical Engineer shall address transitions between zones of varying depths of moisture treatment. Zones shall remain at the most conservative depth 150-feet from the location of the boring resulting in the greatest depth, prior to transitioning to a zone with less moisture conditioning depth. In no case shall the transitions be greater than 1H:1V.

- C. For areas that have soil characteristics of both Eagle Ford and Austin Chalk, any portion of the street that is moisture conditioned will require the entire length of the street to be moisture conditioned to the depth specified in the geotechnical report unless rock is encountered.
- D. If street trees are proposed and within the limits of the moisture treated subgrade and moisture barriers, the Geotechnical Engineer shall address this condition in the Report and propose an alternate moisture barrier for the City's review.
- E. All subsurface improvements shall be in accordance with the Technical Specifications unless otherwise approved by the Director of Engineering Services.

3.04 Subgrade Design

- A. Laboratory Investigation elements for both Eagle Ford and Austin Chalk formations include:
 - 1. Lime stabilization series for each soil type expected to be in the upper 12" of the subgrade. The Eades-Grimm method of pH testing shall be used to obtain a beginning point. Additional testing shall be performed for each soil type to determine lime content. Minimum design criteria are:

pH = 12.4 (or maximum pH) after mellowing (ASTM D 2976)

Swell potential <1.0 percent under 200 psf stress test (ASTM D 4546)

The minimum lime content shall be the percentage, by weight, of hydrated lime as determined by lime stabilization series plus 1.0%, and in no case be less than the City's minimum requirements as listed in Table 3.1.
 - 2. Test for sulfates in the upper 3' of the subgrade in each boring using EPA 9038 or EPA 375.4 with 10:1 dilution ratio. Provide testing to determine the levels of sulfate present in all soil types in the upper 3'.
- B. Eagle Ford or Austin Chalk formations having over 6,000 ppm (0.6%) sulfates shall be lime stabilized using a double application method. Refer to Technical Specifications for lime application methods.
- C. Alternative subgrade options may be proposed by the Geotechnical Engineer, and may be approved by the Director of Engineering Services in writing.
- D. Flexible base, if proposed as an alternative subgrade, shall have a minimum depth of 12 inches and shall extend a minimum of 2 feet behind the back of curb. Flexible base shall meet TxDOT Specifications, Item 247, Type D, Grade 1 or 2 with Geogrid per TxDOT Special Specification 5001 under the flexible base.
- E. All subgrade improvements shall be in accordance with the Technical Specifications unless otherwise approved by the Director of Engineering Services.

3.05 Pavement Design

- A. All concrete pavement shall be in accordance with Technical Specification 321313 unless otherwise approved by the Director of Engineering Services.
- B. The minimum pavement sections listed in Table 3.1 are based on the Pavement Design Input Values contained in Table 3.2. It is the Geotechnical Engineer's responsibility to ensure those input values are applicable. In no case shall the pavement sections be less than the City's minimum. A pavement design shall be required when any of the input values deviate from the City's input values listed in Table 3.2. When a pavement design is required, it shall be based on the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures, current edition, utilizing WinPAS, Pavement Analysis Software. A printout from the software program will be required.

TABLE 3.2: Pavement Design Input Values

Input	Thoroughfare Classification			
	Type A	Type B	Type C	Types D-G, and Alley
Design Period	20 years	20 years	20 years	20 years
Initial Serviceability	4.5	4.5	4.5	4.5
Terminal Serviceability	2.5	2.3	2.3	2.0
Concrete MOR @ 28 days	620 psi	620 psi	620 psi	620 psi
Concrete E @ 28 days	5,000,000 psi	5,000,000 psi	5,000,000 psi	5,000,000 psi
Modulus of Subgrade Reaction (Eagle Ford Shale Formation)	300 psi/in	300 psi/in	300 psi/in	300 psi/in
Modulus of Subgrade Reaction (Austin Chalk Formation)	420 psi/in	420 psi/in	420 psi/in	420 psi/in
Reliability	90%	90%	85%	85%
Standard Deviation	0.35	0.35	0.35	0.35
Load Transfer Coefficient	2.9	2.9	2.9	2.9
Drainage Coefficient	1.0	1.0	1.0	1.0
Design Average Daily Traffic (ADT)	60,000	30,000	20,000	12,000
Traffic Growth Rate	0%	0%	0%	0%
Percent Trucks	2%	2%	1%	1%
Lanes	6	4	2	2
Lane Distribution Factor	0.7	1	1	1

Geotechnical Report for Roadways Checklist

Project Name: _____

Geotechnical Engineer/Firm: _____

Report Date: _____ Date Received: _____

Note: Any N/A response shall include a written explanation with adequate justification, as deemed necessary by the Director of Engineering Services.

COMPLETE	N/A	1. SECTION 3.01 GENERAL <div style="margin-left: 20px;"> <input type="checkbox"/> A. Include the <i>Summary of Recommendations Form</i> <input type="checkbox"/> B. Description of Project <input type="checkbox"/> C. Location of Project <input type="checkbox"/> D. Roadway type and classification <input type="checkbox"/> E. Grading plan and summary <input type="checkbox"/> F. Discussion of underground utilities within the Project limits </div>
COMPLETE	N/A	2. SECTION 3.02 EXISTING SURFACE/SUBSURFACE <div style="margin-left: 20px;"> <input type="checkbox"/> A. Discussion of existing surface/subsurface conditions that may affect subgrade and pavement design or performance (i.e. vegetation, terrain, existing structures, existing pavement, etc.) <input type="checkbox"/> B. Discussion of geological conditions that may impact subgrade and pavement design or performance. Specify formation. <input type="checkbox"/> C. Surface/subsurface conditions with logs <div style="margin-left: 20px;"> - Sampling techniques - Description of soil and rock encountered, including lab test details - Discussion of water and groundwater conditions - Discussion of seasonal variations in moisture content - Atterberg limits (ASTM D 4318) - Percent Passing the No. 200 sieve (ASTM D 1140) </div> <input type="checkbox"/> D. All standards used in field and laboratory testing shall be identified. Any deviations to standard procedures shall be discussed. </div>
COMPLETE	N/A	3. SECTION 3.03 SUBSURFACE RECOMMENDATIONS <div style="margin-left: 20px;"> <input type="checkbox"/> A. Expansive Soils Evaluation <div style="margin-left: 20px;"> - Percent swell calculation and test results - Effect of cut/fills (i.e. long-term soil uplift in cut areas; settlement overburden pressure effects in fill areas) - Identify soil movement estimates at each boring location - Explanation of anomalous variations within the soil profile and between borings (i.e Atterberg limits, PI, sulfates, clay to rock, etc.) </div> <input type="checkbox"/> B. Soil Moisture Conditioning <div style="margin-left: 20px;"> - Discussion of swell test results summary - Recommended depth of moisture conditioning - Address transition between zones of varying depth - Discussion of possible variations during construction and mitigation thereof - Discussion of techniques to maintain moisture in soil </div> </div>

- Discussion of methods to test soil moisture conditioning during construction (i.e. a second geotechnical investigation/re-evaluation may be required to specifically address soil moisture prior to lime operations)
- Address street trees

COMPLETE
☐
N/A
☐
4. SECTION 3.04 SUBGRADE RECOMMENDATIONS
A. Subgrade Stabilization

- Typical subgrade type
- Explanation of anomalous soil conditions anticipated and discussion of potential variations to consider
- Construction techniques to implement
- Effects of rock/rock fragments encountered during construction and recommendations to abate

☐
☐
B. Soluble Sulfates

- Identify soluble sulfate test results; summarize results and discuss variations
- Discussion of techniques during construction to mitigate sulfate-induced heaving
- Sulfate retesting during construction

COMPLETE
☐
☐
☐
N/A
☐
☐
☐
5. SECTION 3.05 PAVEMENT RECOMMENDATIONS
A. Identify roadway type(s) and classifications(s)
B. Identify deviations from Pavement Design Input Values (re: Table 3.2)
C. Identify recommended pavement section
COMPLETE
☐
☐
☐
☐
☐
☐
☐
☐
N/A
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☐
6. APPENDIX
A. Geological Map
B. Boring Locations
C. Boring Logs
D. Grading Plan (for non-linear projects)
E. Cut vs. fill by station number (for linear projects)
F. Printout from WinPAS pavement design software program
G. Proposed typical section with dimensions showing pavement thickness, subgrade type and thickness, moisture conditioning depth, and location of moisture barrier. If applicable, location of proposed trees and root barriers shall be shown.
Geotechnical Engineer Signature: _____

Date: _____

**Summary of Geotechnical Recommendations Form**

Project Name: _____

Geotechnical Engineer/Firm: _____

Report Date: _____ Date Received: _____

Geotechnical must fill out this form completely, and submit with the Report. A proposed typical section detail must be provided.

1. DESIGN INPUT VALUES:

Thoroughfare Classification(s): _____

Eagle Ford or Austin Chalk: _____

PI Range: _____

Pavement Design Input Value Deviation(s): _____

2. DESIGN RECOMMENDATIONS:Moisture Conditioning Depth (inches): _____ *If yes, include plan layout depicting limits*

Lime Thickness (inches): _____

Lime Application Rate (calculated): _____ + 1% = _____
lab value *minimum required*

Lime Application Rate (design value): _____

Alternate Subgrade (Y/N): _____ *If yes, describe*Sulfates over 6,000 ppm (Y/N): _____ *If yes, double lime application required*

Concrete Thickness (inches): _____

Miscellaneous Items and Notes:

Geotechnical Engineer Signature: _____ Date: _____



SECTION 4 – DRAINAGE DESIGN REQUIREMENTS

Section 4 – Drainage Design Requirements

4.01 General

- A. This section contains the minimum storm drainage design criteria to be followed in the design of storm drainage facilities and demonstrates the design procedures to be used on drainage projects in the City of Frisco.
- B. The design factors, formulas, graphs and procedures described are intended to serve as guidelines. Responsibility for the actual design remains with the Engineer. Deviation from the requirements of these standards may be approved by the Director of Engineering Services.
- C. The Engineer shall prepare the construction plans in accordance with the Section 5 of the Subdivision Ordinance.
- D. It is the responsibility of the Engineer to provide all necessary calculations and designs described herein. The Engineer shall provide the City the data, calculations, and designs necessary to demonstrate the design does not adversely impact the surrounding or downstream property and meet local, state, and federal rules, regulations, and requirements.
- E. The Engineer shall use the city's base models for development along floodplain areas. If a model is not available, the Engineer shall be required to provide a floodplain model in accordance with city standards and guidelines.

4.02 Determining Design Discharge

The Rational Method may be used to determine the runoff generated from a property when a contributing drainage area is less than 200 acres. A unit hydrograph method shall be used to determine the runoff generated from a property with a contributing drainage area greater than or equal to 200 acres. The Director of Engineering Services may require developments with contributing drainage areas less than 200 acres to use a unit hydrograph method if the hydrologic results of the contributing drainage area or components within the drainage area more accurately reflect a unit hydrograph.

- A. Rational Formula (Drainage Areas < 200 acres)

The Rational Formula for computing peak runoff rates is as follows:

$$Q = C * I * A$$

- Q = runoff rate (cfs)
- C = runoff coefficient (dimensionless)
- I = rainfall intensity (in/hr)
- A = drainage area (ac)

- B. Runoff Coefficient (C)

- 1. Runoff coefficients shall be based on the future land use plan, which is included in the City's Comprehensive Plan. Runoff coefficients reflecting other conditions may be used based on the guidelines set forth in Section 4.02.F.

2. Table 4.1 provides guidelines for runoff coefficients for typical land use within the city; however, a weighted runoff coefficient may be used for the design if it is more representative of the site conditions.
3. A lower runoff coefficient may be used if sustainable or low impact development elements are included in the design. The Engineer shall notify Engineering Services of the design intent and provide the necessary data, calculations and design to support the desired runoff coefficient. All sustainable designs are subject to approval by Engineering Services.

Table 4.1 Runoff Coefficients and Inlet Time Guidelines

Land Use	Runoff Coefficient “C”	Inlet Time (Minutes)
Single Family Residential	0.55	15
Two Family, Patio Home, Town Home	0.70	10
Multiple Family (Max 60% Impervious)	0.80	10
Multiple Family (Greater than 60% Impervious)	0.90	10
Non-Residential Uses	0.90	10
Park Area	0.35	20
School	0.70	15
Church	0.80	10
Undeveloped	0.30	20
Hospital	0.90	10
Streets	0.90	10

C. Time of Concentration (T_c)

SCS methodology shall be used to determine the time of concentration (T_c). This method separates the flow through the drainage area into sheet flow, shallow concentrated flow, and open channel flow. The T_c is the sum of travel times for sheet flow, shallow flow and open channel flow. The time of concentration flow path and sheet flow path shall be made available to the City upon request.

1. Sheet Flow: The maximum allowable length for sheet flow is 300-ft for undeveloped drainage areas and 100-ft for developed areas. When selecting n for sheet flow, consider cover to a height of about 0.1-ft. This is the only part of the plant cover that will obstruct sheet flow. The T_t in hours for sheet flow is determined using the following equation:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

- T_t = travel time (hr)
 n = Manning’s roughness coefficient (Table 4.2)
 L = flow length (ft)
 P₂ = 2-year, 24-hour rainfall, 3.6in
 S = slope of hydraulic grade line (land slope, ft/ft)

Table 4.2 Sheet Flow 'n' Values

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils	
Residue cover less than 20%	0.06
Residue cover greater than 20%	0.17
Grass:	
Short Prairie Grass	0.15
Dense grasses	0.24
Range (natural)	0.13
Woods:	
Light underbrush	0.40
Dense underbrush	0.80

2. Shallow Concentrated Flow

Shallow concentrated flow begins where sheet flow ends. A projected slope should be established along the flow line for the shallow concentrated flow length. The T_t in hours for shallow concentrated flow is determined by the following equation:

$$T_t = \frac{L}{3600V}$$

- T_t = travel time (hr)
 L = flow length (ft)
 V = velocity (fps)
 Unpaved = $16.1345 \cdot (S)^{0.5}$
 Paved = $20.3282 \cdot (S)^{0.5}$

3. Open Channel Flow

Open Channel Flow is where the runoff is located within a defined channel or in some cases, closed storm systems. The T_t for open channel flow is determined using the following equation:

$$T_t = \frac{L}{3600V}$$

$$V = \frac{1.49 r^{\frac{2}{3}} s^{\frac{1}{2}}}{n}$$

- T_t = travel time (hr)
 V = average velocity (ft/s)
 r = hydraulic radius (ft)
 A = cross sectional flow (ft²)
 P = wetted perimeter (ft)
 s = slope of the hydraulic grade line (channel slope, ft/ft)
 n = Manning's roughness coefficient

The Engineer shall compare the calculated time to the time listed in Table 4.1. If the calculated T_c differs from the value in Table 4.1, the Engineer shall provide information to justify the T_c calculations.

D. Rainfall Intensity (I)

The rainfall intensity (I), shall be based on the National Weather Service Rainfall Frequency Data presented in Technical Memorandum NWS Hydro-35, dated June 1977 (2 to 100 year) and U.S. Geologic Survey Frequency Data presented in Water Resources Investigations Report 98-4044, dated 1998 (500 year). The intensity for a particular duration can be obtained using the coefficients from Table 4.3. If the calculated inlet time differs from the value in Table 4.1, the Engineer shall provide information to justify the inlet time calculations. The equation used to determine the intensity values for various storm events and durations is provided below.

$$I = \frac{b}{(T_c + d)^e}$$

I = Rainfall Intensity (in/hr)
 T_c = Time of Concentration (minutes)

Refer to the following table for b, d, and e.

Table 4.3 Intensity Coefficient Table

	2-year	5-year	25 year	100- year
B	81.319	82.686	106.665	112.783
D	15.788	15.497	18.069	17.572
E	0.864	0.820	0.806	0.771

E. Unit Hydrograph Method (Drainage Areas \geq 200 acres)

1. The use of the unit hydrograph method shall be based upon standard and accepted engineering principles normally used in the profession. United States Army Corps of Engineers HEC-HMS model is the preferred method in developing hydrologic models. A request to use another type of hydrologic model must be submitted to Engineering Services for approval.
2. Circumstances that may require the use of a unit hydrograph method include open channels, reclaiming floodplains, creating lakes, regional detention/retention facilities or building other types of drainage related facilities on major drainage courses. The city requires fully developed watershed conditions be used for all modeling. FEMA's flows shall not be used as the flows are generally based upon existing watershed conditions.

3. Coincident peak flows can also be considered using Table 4.4. Provide calculations for each coincidental occurrence in the construction plans. The more restrictive results based on the area ratio shall be used.

Table 4.4: Frequencies for Coincidental Occurrences

Area Ratio	100-year design	
	Main Stream	Tributary
10000:1	2	100
	100	2
1000:1	10	100
	100	10
100:1	25	100
	100	25
10:1	50	100
	100	50
1:1	100	100
	100	100

4. Modeling Requirements

HEC-HMS shall be used in developing all hydrologic models. Other hydrologic models may be used upon approval from Engineering Services. The following criteria should be used:

- a. 24-hour storm duration using a frequency distribution.
- b. Rainfall values shall be consistent with the City's Watershed Master Drainage Plans. If no Watershed Master Plan is available for the study area, rainfall values shall be calculated using coefficients provided in Table 4.3.
- c. The SCS Curve Number (CN) method shall be used to determine the loss rate. CN values shall be taken from TR-55.
- d. T_c values shall be calculated as shown in Section 4.02.C.
- e. Modified Puls method shall be used for routing of the Unit Hydrograph through the drainage system. If Modified Puls is not feasible, other methods may be proposed to Engineering Services, such as the Muskingum-Cunge.

F. Runoff from Off-Site Developments

1. Off-site Flows for Developed Upstream Watershed

The Engineer may take the effects of upstream detention into account if the hydrologic and hydraulic information for the existing upstream ponds are shown on the construction plans and the information can be verified by record drawings or a record survey. An emergency overflow path between the existing detention ponds and the proposed site shall be identified and clearly indicated on the construction plans. The Engineer shall confirm the hydrologic and hydraulic effects of upstream facilities in accordance with Section 4.09.

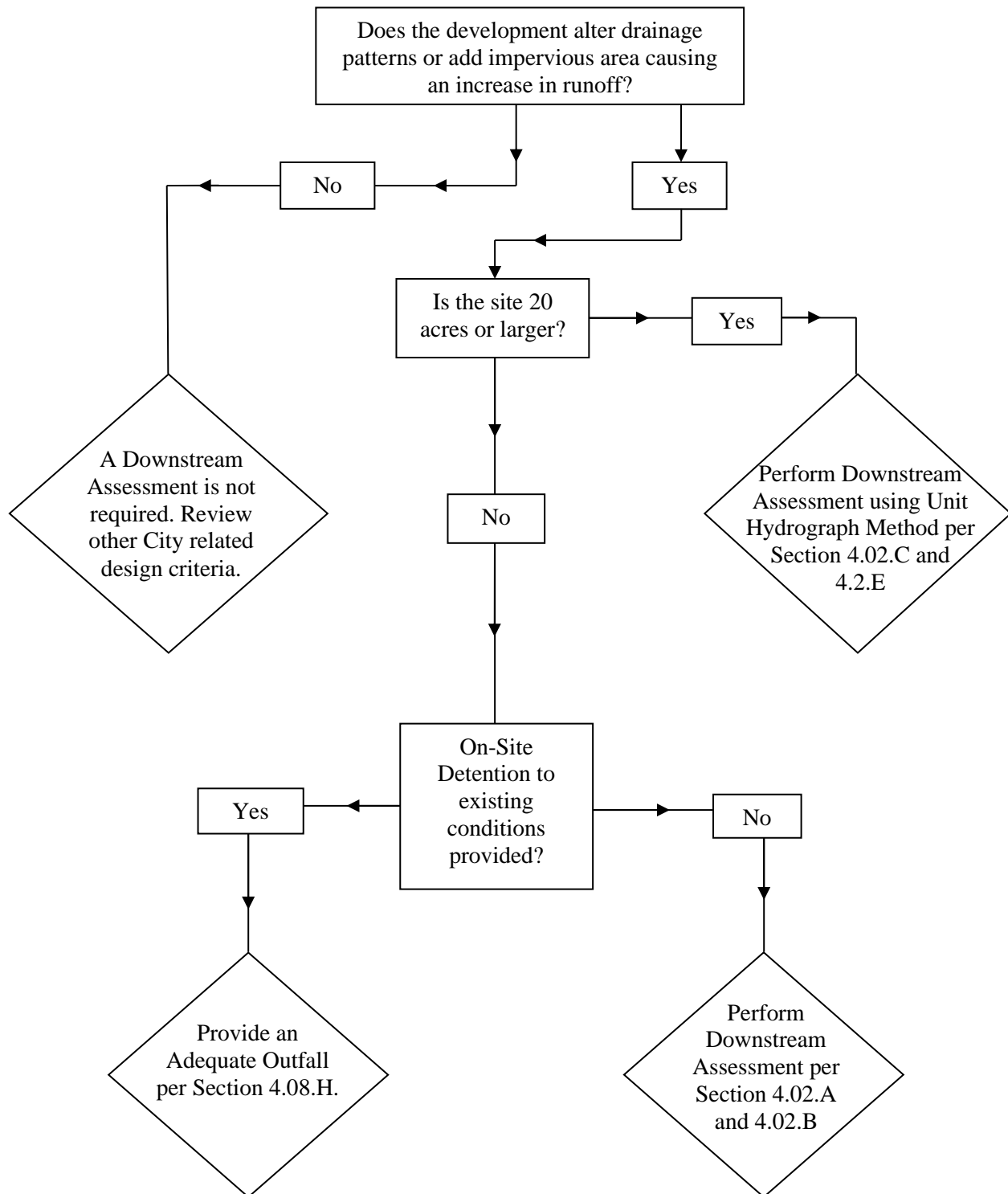
2. Off-site Flows for Undeveloped Upstream Watershed

If an undeveloped upstream property exists, the Engineer shall assume fully developed conditions without detention for the off-site area. If a Downstream Assessment shows the downstream facilities cannot convey the fully developed peak flows, anticipate equivalent detention for all upstream properties and subject property.

4.03 Downstream Assessment

Storm water discharge from a development shall not cause adverse impacts to adjacent, upstream, or downstream properties or facilities. The design of a storm drain facility must account for the offsite flows that are routed through the development, flows generated by the development, and the impacts of the development and the drainage system on downstream facilities. Figure 4.1 below summarizes the process for determining if a Downstream Assessment will be required.

Figure 4.1: Downstream Assessment Flow Chart



Downstream Assessments shall be prepared and submitted in accordance with the Development Application Handbook. The study shall evaluate the capacity of the downstream system within the Zone of Influence. If the downstream system has less than fully developed capacity, the study shall demonstrate the development will produce no adverse impacts during the 2, 5, 25 and 100-year storm events. No adverse impacts may include, but are not limited to:

- a. No new or increased flooding of existing structures.
- b. No increases in water surface elevations unless contained within the banks of an existing channel including 1-ft freeboard. Dry lane and gutter capacity requirements set forth in Section 4.04.A shall also be met.
- c. Post-development channel velocities above 5-fps shall not be increased by more than 5% above pre-development velocities. Exceptions to these criteria require a certified geotechnical/geomorphologic study that provides documentation that a higher velocity will not increase erosion.
- d. No increases in downstream discharges caused by the proposed development that, in combination with existing discharges, exceeds the existing capacity of the downstream storm drainage system.
- e. The Downstream Assessment shall extend to a point downstream, known as the Zone of Influence, where the proposed development creates no adverse impacts. For properties less than 20 acres, the Downstream Assessment may use the 10% Rule to determine the Zone of Influence, which ends at the point where the total drainage area is 10 times greater than the total drainage area for the site. As an example, if a structural control drains 10 acres, the Zone of Influence ends at a point where the total drainage area is at least 100 acres.
- f. For all other properties, the Zone of Influence will be defined by a detailed hydrologic and hydraulic modeling analysis. The Director of Engineering Services may require analysis beyond the ZOI established by the Engineer.
- g. If the subject development is part of a larger development, the Downstream Assessment must include the larger development, and the Zone of Influence shall be determined based on the entire property.

4.04 Street Capacity

A. Straight Crown Streets:

1. All straight crown street capacities shall be hydraulically designed using Manning's equation:

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

- Q = Gutter flow (cfs)
 n = Manning's roughness coefficient, (0.0175 for concrete street)
 A = Cross section flow area (ft²)
 R = Hydraulic radius of the conduit in feet, which is the area of the flow divided by the wetted perimeter (R=A/P)
 P = Wetted perimeter (ft)

S = Slope of the hydraulic gradient (ft/ft)

2. The City requires a minimum of nine feet of dry lane in each direction during the 100-year event for Type A and B thoroughfares. The dry lane criteria shall be met in both the interim and future conditions.

B. Parabolic Crown Streets

1. All parabolic crown street capacities shall be hydraulically designed using Manning's equation.
2. During a 100-year storm event, the gutter depth on Type C, D, E, F, and G thoroughfares are required by the City not to exceed 6" or top of curb, whichever is less. Refer to Section 2.02 for thoroughfare descriptions.
3. The City requires a minimum of nine feet of dry lane in each direction during the 100-year event for Type C and D thoroughfares. The dry lane criteria shall be met in both the interim and future conditions.

4.05 Alley Capacity

- A. All alley capacities shall be hydraulically designed using Manning's equation.
- B. The 100-year storm event shall be contained within the edge of pavement.
- C. In residential areas where the standard alley section capacity is exceeded, storm sewer systems with inlets shall be provided.
- D. Grate combination inlets shall be located in alleys upstream from an intersection and where necessary to prevent water from entering intersections in amounts exceeding allowed street capacity.

4.06 Valley Gutters

- A. The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:
 1. Valley gutters shall not cross Type A, B, C, and D thoroughfares.
 2. At any intersection, valley gutters perpendicular to the main street will not be permitted and valley gutters parallel to the main street may only cross a lower classified street for Types C through F.

4.07 Inlet Location and Capacity

A. Gutter Flow

Curb inlets shall be placed to ensure that the 100-year flow in a street does not exceed the dry lane requirements for Type A, B, C and D thoroughfares and top-of-curb elevation for parabolic crown streets as per Sections 4.04. The following form of the Manning's equation should be used to evaluate gutter flow hydraulics:

$$Q = \left[\frac{0.56}{n} \right] S_x^{5/3} S^{1/2} T^{8/3}$$

- Q = Gutter flow rate (cfs)
 S_x = Pavement cross slope (ft/ft)
 S = Longitudinal slope (ft/ft)
 T = Width of flow in roadway (ft)
 n = Manning's roughness coefficient

Depth of flow in the gutter can be calculated using the following modified form of the equation above:

$$y_o = z \left(\frac{QnS_x}{S^{1/2}} \right)^{3/8}$$

- y_o = depth of water in the curb and gutter cross section (ft or m)
 Z = 1.24

If the flow in the gutter is still excessive, the storm sewer shall be extended to a point where the gutter flow can be effectively intercepted by curb inlets.

B. Capacity of Curb Inlet on Grade

To determine the capacity of a curb inlet on grade, first determine the ratio of the flow in the locally depressed gutter section to the total flow in the road.

$$E_0 = 1 / \left\{ 1 + \frac{S_w}{S_x} \left[\left(1 + \frac{S_w/S_x}{(T/W) - 1} \right)^{2.67} - 1 \right]^{-1} \right\}$$

- E₀ = Ratio of flow in the depressed gutter to the total flow
 S_w = Gutter cross slope (ft/ft)
 S_x = Roadway cross slope (ft/ft)
 T = Width of flow in roadway (ft)
 W = Width of depressed gutter section (ft)

Then calculate the equivalent cross slope at the depressed curb inlet opening.

$$S_e = S_x + \frac{a}{W} E_0$$

- S_e = Equivalent cross slope (ft/ft)
 S_x = Roadway cross slope (ft/ft)
 a = Gutter Depression Depth (ft)
 W = Width of depressed gutter section (ft)
 E₀ = Ratio of flow in the depressed gutter to the total flow

Then calculate the inlet length required to capture 100% of the gutter flow.

$$L_T = 0.60Q^{0.42}S^{0.3}\left(\frac{1}{nS_e}\right)^{0.6}$$

- L_T = Required length of inlet (ft)
 Q = Total flow in the roadway (cfs)
 S = Roadway longitudinal slope (ft/ft)
 n = Manning's roughness coefficient
 S_e = Equivalent cross slope (ft/ft)

The efficiency of a curb inlet opening shorter than L_T is:

$$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8}$$

- E = Inlet efficiency
 L = Length of the curb inlet opening (ft)
 L_T = Required length of inlet to capture 100% of the roadway flow (ft)

The total flow captured by the curb inlet is:

$$Q_i = EQ$$

- Q_i = Flow capture by inlet (cfs)
 E = Inlet efficiency
 Q = Total flow in the roadway (cfs)

C. Capacity of Curb Inlets in Sag

The capacity of a curb inlet in sag depends on the water depth at the curb opening and the height of the curb opening. The inlet operates as a weir to a depth equal to the curb opening height and as an orifice at depths greater than 1.4 times the opening height. At depths between 1.0 and 1.4 times the opening height, flow is in a transition stage and the capacity should be based on the lesser of the computed weir and orifice capacities.

1. If the depth of flow in the gutter (d) is less than or equal to 1.4 times the inlet opening height (h), ($d \leq 1.4H$), determine the length of inlet required considering weir control. Calculate the capacity of the inlet when operating under weir conditions with the following equation:

$$Q = C_w(L + 1.8W)d^{1.5}$$

2. Rearrange above equation to produce the following relation for curb inlet length required:

$$L = \left(\frac{Q}{C_w y_o^{1.5}}\right) - 1.8W$$

- Q = total flow reaching inlet (cfs)
 C_w = weir coefficient (3.0)
 y_o = head at inlet opening (ft)
 L = length of curb inlet opening (ft)

W = lateral width of depression (ft)

$$y_o = z \left(\frac{QnS_x}{S^{1/2}} \right)^{3/8}$$

y_o = depth of water in the curb and gutter cross section (ft or m)
 Q = gutter flow rate (cfs)
 n = Manning's roughness coefficient
 S = longitudinal slope (ft/ft)
 S_x = pavement cross slope (ft/ft)
 Z = 1.24

3. If the depth of flow in the gutter is greater than the inlet opening height ($d > h$), determine the length of inlet required considering orifice control. The equation for interception capacity of a curb opening as an orifice follows:

$$Q = C_o h L \sqrt{2g d_e}$$

Q = total flow reaching inlet (cfs)
 C_o = orifice coefficient = 0.70
 h = depth of opening (ft) (this depth will vary slightly with the inlet detail used)
 L = length of curb opening inlet (ft.)
 g = acceleration due to gravity = 32.2 ft/s²
 d_e = effective head at the centroid of the orifice (ft) $d_e = d - h/2$

Rearranging equation allows a direct solution for required length:

$$L = \frac{Q}{C_o h \sqrt{2g d_e}}$$

4. If both steps 1 and 2 were performed (i.e., $h < d \leq 1.4h$), choose the larger of the two computed lengths as being the required length.
5. Select a standard inlet length that is greater than the required length.

D. Capacity of Wye Inlets

$$\frac{Q}{P} = 3.1y^{3/2}$$

Q = flow (cfs)
 P = perimeter of opening (ft)
 y = head/depth (ft)

Wye (drop) inlets shall be located to collect water on non-paved areas where it is not practical to use a headwall. No double Wye inlets shall be allowed.

E. Curb Inlet Placement

1. Placing several curb inlets at a single location is only permitted in areas with steep grades (4% or greater) to prevent flooding and avoid exceeding street capacity in flatter reaches downstream.
2. No more than 20-ft of inlet shall be constructed at one location along one curb line.
3. Curb inlets shall be placed upstream from right angle turns and street intersections.
4. An emergency overflow path shall be provided on the plans for sag locations. An emergency overflow path is the path the storm water will take if the drainage facility becomes clogged or ceases to function as designed. The emergency overflow path must be located within public right-of-way or within a drainage easement and shown on the construction plans.
5. Curb inlet depth shall not be less than 4.5-ft from top of curb for all public improvements.
6. Inlets are required at the low point of a superelevation to prevent flow across the roadway.
7. On-grade curb inlets shall bypass to only one downstream inlet.
8. Multiple sag inlets shall be located no closer than 300-ft on Type A and B thoroughfares.
9. Grate inlets shall not be within a paved area or drain undeveloped areas.
10. Inlets shall not be connected in series.
11. Recessed curb inlets shall not be within a turn lane

F. The Engineer shall include a completed Inlet Calculations Table in the construction plans. All key design calculation columns shall be included. At a minimum this will include:

- Inlet number or name
- Location of inlet by storm drain station number
- Drainage area designation
- Drainage area size (acres)
- Runoff coefficient (C)
- Time of concentration (minutes)
- 100-year intensity (in/hr)
- 100-year runoff, $Q=CIA$ (cfs)
- 100-year carryover flow from upstream inlet (cfs)
- 100-year total gutter flow (cfs)
- Percentage of flow traveling from lower station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- Percentage of flow traveling from higher station side of sag inlet based on percentage of drainage area and carryover flow from that side (cfs)
- 100-year total gutter flow reaching the lower station side of the sag inlet (cfs)
- 100-year total gutter flow reaching the higher station side of the sag inlet (cfs)
- Longitudinal slope of the approach gutter.
- For sag inlets, half the longitudinal slope of the approach gutter on the lower station side of the inlet(ft/ft)
- For sag inlets, half the longitudinal slope of the approach gutter on the higher station side of the inlet (ft/ft)
- Street crown section type (straight crown ["rooftop"] or parabolic)
- Roadway cross slope (%)
- Manning's roughness coefficient (n) for pavement (0.0175 for concrete pavement)
- Street capacity based on Manning's equation. For sag inlets calculate the street capacity for both the lower and higher station sides of the inlet and use the greater of the two. (cfs)
- Total right-of-way capacity as a function of the cross-sectional area of the right-of-way at the inlet. For sag inlets, the total right of way capacity on the lower station side of the inlet. (cfs)
- For sag inlets, the total right of way capacity on the higher station side of the inlet. (cfs)
- Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the lower station side of the inlet. (ft)
- Depth of gutter flow "yo" in approach gutter from spread of water or from direct solution of Manning's equation for gutter capacity. For sag inlets, the depth of gutter flow on the higher station side of the inlet. (ft)
- Spread of water (T) or width of ponding in the gutter measured from the face of curb.
- Gutter cross slope (%)
- Width of depressed gutter section (ft)
- 100-year ratio of flow in the depressed gutter to the total flow (E0)
- Gutter depression depth (ft)

- Equivalent cross slope (%)
- 100-year inlet length required to capture 100% of the gutter flow (ft)
- Actual length in feet of inlet which is to be provided (10-ft, 16-ft or 20-ft). For wye inlets the length provided is equal to the perimeter of the opening intercepting flow. The length for wye inlets may be less than the total perimeter if the wye is not located in a sag location.
- Efficiency of a curb inlet where the length provided is shorter than the length required.
- Discharge in cubic feet per second which the inlet in question actually intercepts.
- Discharge capacity of the inlet (cfs)
- Bypass flow is the amount of water which passes the inlet in a 100-year storm. A substantial portion of the 100-year flow should be picked up by the inlet. The bypass flow should be accounted for in the next downstream inlet and should be reflected in the inlet bypass flow in the Storm Drain Hydraulics Table (minor variances may occur due to travel time routing in the Hydraulics Table).
- Downstream inlet receiving bypass flow
- Important comments relating to inlet

4.08 Design of Enclosed Storm Sewer System

A. Design Flow

All enclosed systems shall be hydraulically designed, and all required calculations shall be provided in the construction plans. The hydraulic gradient and full-flow velocity shall be calculated using the design flow, appropriate pipe size, and Manning's equation:

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

Q	=	Runoff rate (cfs)
A	=	Cross sectional area of the conduit (ft ²)
n	=	Manning's roughness coefficient (0.013 for concrete)
R	=	Hydraulic radius (ft) (Area of conduit divided by wetted perimeter (R=A/P))
S	=	Slope of the hydraulic gradient (ft/ft)

B. Hydraulic Gradient

1. The City requires that all hydraulic gradient calculations begin at the outfall of the system.
2. The starting hydraulic grade line (HGL) shall be the higher of the top of pipe or the 100-yr fully developed water surface elevation. See Section 4.02 E 3. for details on coincidental peak.
3. When a proposed storm sewer is to connect to an undersized existing storm sewer system, calculation of the hydraulic gradient for the proposed storm sewer shall start at the outfall of the existing storm sewer system.

C. Hydraulic Design

1. The hydraulic grade line (HGL) must be calculated for all storm drain mains and laterals using appropriate head loss equations. In all cases, the storm drain HGL must be at least one foot below top of curb at each inlet.
2. In partial flow conditions, the HGL represents the actual water surface within the pipe. The velocity of the flow should be calculated based on actual area of flow, not the full flow area of the pipe or box.

D. Lateral Design

1. HGL calculations are not required for laterals smaller than 12 inches in diameter.
2. Laterals shall intersect the storm drain at standard angles when not connecting at a manhole.

E. Velocity Head Losses (H_L)

1. Adjustments are made in the HGL whenever the velocity in the storm sewer system changes due to conduit size changes or discharge changes. Laterals in partial flow must be designed appropriately and the partial flow velocity shall be used in the calculations.

2. In determining the HGL for the lateral, begin with the hydraulic grade of the trunk line at the junction plus the head loss due to the velocity change. Where the lateral is in full flow, the hydraulic grade is projected along the friction slope calculated using Manning's Equation.
3. Minimum head loss at all junctions, inlets, and bends shall be a minimum 0.10 feet.
4. Head losses or gains for pipe size changes and other velocity changes will be calculated by the following formulas:

$$H_L = \left[\frac{(V_2)^2}{2g} \right] - \left[\frac{(V_1)^2}{2g} \right]$$

- H_L = Head loss or gain (ft)
 v_1 = Upstream velocity (fps)
 v_2 = Downstream velocity (fps)
 g = Gravity constant (32.2 ft/s²)

5. Head losses for pipe in full flow at manholes, bends, and inlets, where the flow quantity remains the same, shall be calculated as follows:

$$H_L = K_j \left[\frac{V^2}{2g} \right]$$

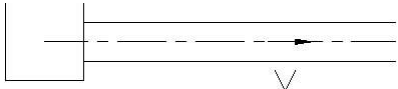
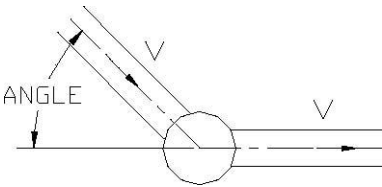
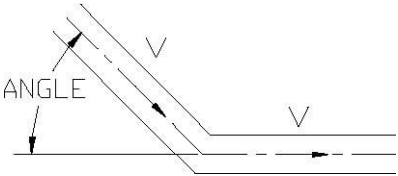
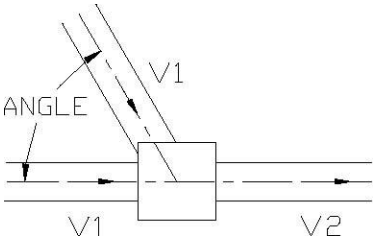
- H_L = Head loss or gain (ft)
 v = Velocity in the lateral (fps)
 g = Gravity constant (32.2 ft/s²)
 K_j = Coefficient of loss per Table 4.5

6. Head losses or gains at manholes, wyes, and junction boxes where there is an increase in flow quantity shall be calculated as follows:

$$H_L = \left[\frac{(V_2)^2}{2g} \right] - K_j \left[\frac{(V_1)^2}{2g} \right]$$

- H_L = Head loss or gain (ft)
 v_1 = Upstream velocity (fps)
 v_2 = Downstream velocity (fps)
 g = Gravity constant (32.2 ft/s²)
 K_j = Coefficient of loss per Table 4.5

Table 4.5 Velocity Head Loss in Closed Conduits

Inlet		
Schematic		Kj
		1.25
Manhole at Change in Pipe Direction		
Schematic	Angle	Kj
	90°	0.55
	60°	0.48
	45°	0.42
	30°	0.30
	0°	0.05
Bend in Pipe		
Schematic	Angle	Kj
	60°	0.43
	45°	0.35
	30°	0.20
Manhole and Wye		
Schematic	Angle	Kj
	0°	1.00
	22 1/2°	0.75
	45°	0.50
	60°	0.35
	90°	0.25

7. The Engineer shall include a completed Storm Drain Calculations Table in the construction plans. All key design calculation columns shall be included. This will at a minimum include:
 - Inlet, bend, lateral, or pipe size change identifier
 - Downstream storm drain station number.
 - Upstream storm drain station number. This is the design point. Design should start at the farthest upstream point.
 - The distance (in feet) between the storm drain stations.
 - Designation of the drainage area(s) that correspond with the provided drainage area map.
 - Area in acres for the drainage area.
 - Runoff coefficient “C” for the drainage area shown in Column 5.
 - Accumulated total “CA” for the drainage system
 - Time of concentration.
 - Intensity of rainfall in inches per hour corresponding with time of concentration.
 - Frequency of the storm event
 - Runoff in cfs.
 - Slope of the hydraulic gradient
 - Pipe size for circular pipe.
 - Width for box pipe.
 - Height for box pipe.
 - Manning’s roughness coefficient “n” (0.013 for concrete pipe and box culverts).
 - Velocity Head Loss Coefficient Junction & Minor Losses
 - Downstream, Post Friction Loss, and Upstream Hydraulic Grade Line Elevations
 - Head Loss for Junction and Minor Losses
 - Top of curb elevation or inlet elevation
 - Distance between hydraulic grade line and top of curb or inlet elevation.

F. Storm Drain

1. Alignments of proposed storm drain systems shall use existing easements and rights-of-way. If located within an easement, the storm sewer shall be centered within the easement. If located within rights-of-way, the centerline of the storm sewer shall be located under paving 7-ft from the back of curb. No part of the storm sewer is to be designed within the lime-treated subgrade of a proposed pavement.
2. Horizontal and vertical curve design for storm sewers shall take into account joint closure.
3. A minimum full flow velocity of 2.5 fps and a minimum slope of 0.5% shall be maintained in the pipe.
4. Only standard sizes shall be used. The minimum allowable pipe size is 18”. Pipe sizes shall not be decreased in the downstream direction.
5. In situations where only the lower portion of an enclosed storm sewer system is being built, stub-outs for future connections must be included.

6. The required storm drain capacity to meet existing and future needs, if applicable, shall be provided.
7. Energy dissipation is required at all outfalls.

G. Manhole Placement

The following is a list of guidelines governing the placement of storm sewer manholes to ensure adequate accessibility of storm drainage system:

1. Storm sewer lines shall have points of access no more than 500-ft apart. A manhole shall be provided where this condition is not met.
2. A manhole shall be required where two or more pipes connect into a main at the same joint.

H. Outfall Design

The Engineer shall demonstrate the drainage from the site is conveyed to an adequate outfall. An adequate outfall is a structure or location that is adequately designed as to not cause adverse flooding conditions, erosion, or any other adverse impacts. An adequate outfall shall also have capacity to convey the increased fully-developed runoff.

4.09 Detention/Retention Facility Design

A. Detention facilities shall be designed based upon the following minimum criteria:

1. Detention shall be provided for the 2, 5, 25, and 100-year design storms based on the results of a downstream assessment. Sites without a downstream assessment will be required to provide detention to undeveloped runoff rates.
2. The minimum bottom slope for above-ground detention facilities shall be 1%.
3. The Engineer shall provide an operations and maintenance plan for the detention/retention facility as part of the design. The operations and maintenance plan shall indicate the ingress and egress locations to enter and maintain the pond, maintenance roles and responsibilities, contact information for the party responsible for the maintenance, and a maintenance schedule. Plan shall be recorded at the County.
4. Criteria established by the State of Texas for dam safety (TAC Title 30, Part 1, Chapter 299) and impoundment of state waters (Texas Water Code Chapter 11) shall apply where required by the state, and where, in the Engineer's judgment, the potential hazard requires these more stringent criteria.
5. All detention/retention facilities shall demonstrate and provide an adequate outfall in accordance with City Requirements. An adequate outfall is a structure or location that is adequately designed as to not cause adverse flooding conditions, erosion, or any other adverse impacts. An adequate outfall shall also have capacity to convey the increased fully-developed runoff.

B. Detention Storage Calculation

1. Detention facilities without upstream detention areas and with drainage areas of 20 acres or less can be designed using the Modified Rational Method otherwise the Unit Hydrograph Method shall be used. Refer to Section 4.02 A and Section 4.02 E.
2. If the Unit Hydrograph Method is used, the model shall extend through the Zone of Influence (see Section 4.03) and include existing detention facilities within the Zone of Influence watershed.
3. No required parking space or fire lane may be located within a surface drainage pond. A maximum depth of 6 inches of ponded water is allowed in the parking lot.
4. If detention storage is located within a floodplain, the storage amount lost to the floodplain elevation must be modeled with unit hydrograph or the detention storage raised above the floodplain elevation.

C. Pond and Spillway Geometry

1. Detention/retention facilities shall be designed with an emergency bypass/spillway in case the primary outfall ceases to function as designed. The emergency bypass/spillway shall be designed to pass a minimum of the 100-year pond inflow.
2. Detention/retention facilities shall have a minimum of 1-ft of freeboard above the 100-year water surface elevation.
3. Where embankments are used to temporarily impound detention, the effective crest of the embankment will be a minimum of 1-ft above the 100-year water surface elevation.
4. The minimum finish floor elevation for any lot adjacent to a detention/retention facility shall be 2 feet above the adjacent 100-yr fully-developed water surface elevation.
5. The steepest side slope permitted for a vegetated embankment is 4:1.
6. Earth embankments used to temporarily or permanently impound surface water must be constructed according to specifications as required based on geotechnical investigations of the site and all regulatory requirements.
7. Access shall be provided to the banks and bottom of a detention facility for maintenance.
 - a. Engineer shall provide an operations and maintenance plan that will detail access.
 - b. Retention facilities shall address dewatering procedures.
8. It is the responsibility of the Engineer to consider pedestrian and vehicular safety in the design of detention facilities. Perimeter rails or fencing may be required.
9. Underground detention facilities shall be designed with reinforced concrete if located under fire lane or within city right of way.

D. Texas Commission Environmental Quality Requirements for Dams

The Texas Commission on Environmental Quality (TCEQ) provides design and review criteria for construction plans and specifications, construction, operation and maintenance, inspection, repair, removal, emergency management, site security, and enforcement of dams.

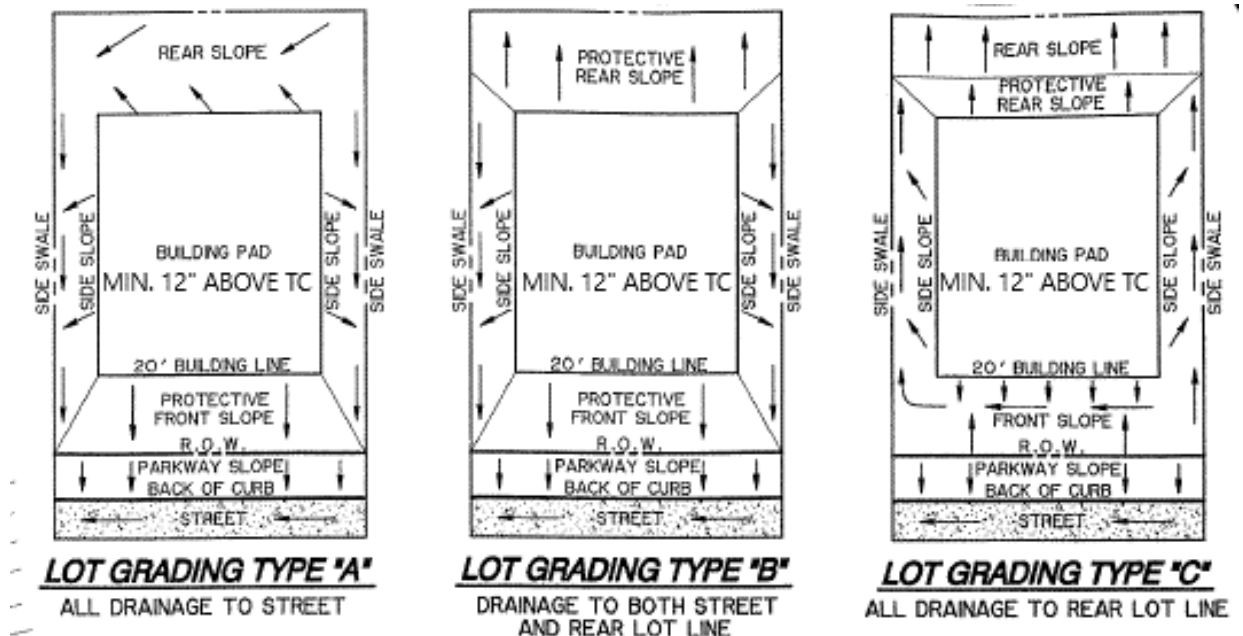
The design engineer shall refer to the [Texas Administrative Code, Title 30, Part 1, Chapter 299](#) Dams and Reservoirs for current dam safety criteria. All proposed construction or modification of dams are required to adhere to TCEQ dam safety criteria. Should the design engineer desire to utilize an existing facility that would qualify under these criteria and the use of the facility changes from an agricultural use to another use, the existing facility may need to be brought into compliance with the TCEQ dam safety criteria. If dams that fall under the TCEQ dam safety criteria, the City will require review and approval from TCEQ prior to authorizing construction.

Retention facilities must obtain a TCEQ water rights permit if applicable. [Refer to TCEQ for water rights regulations](#). For retention facilities without a water rights permit, the Engineer shall provide a signed statement to the City stating the water rights permit is not required.

4.10 Miscellaneous Drainage Requirements

- A. Lot Drainage - Lot to lot surface drainage is prohibited. Pad elevations shall be no less than 12" above curb elevation. Figure 4.4.2 is provided below for reference when performing lot grading designs. Lot grading type and finished floor elevations shall be shown on the construction plans. Type B and Type C Lot Grading must back to alleys, open space, or drainage easement. Type C Lot Grading may only be used with approval of Director of Engineering Services. Refer to the International Residential Building Code (IRC) Section 401.3 (latest version) for additional requirements.

Figure 4.4.2
Typical Lot Grading Patterns



B. Storm Drain Materials

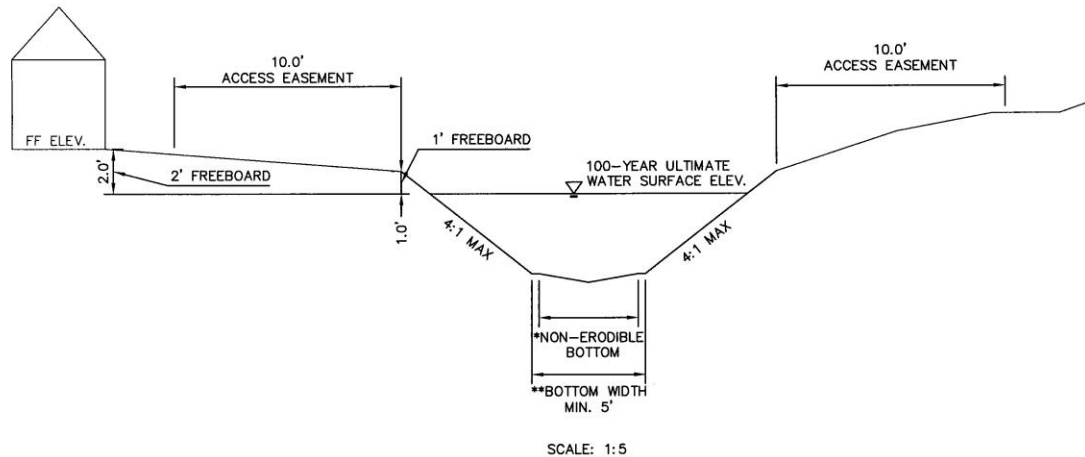
1. All public storm sewers shall be reinforced concrete.
2. All storm sewers under a roadway shall be reinforced concrete. Any structure under a fire lane must be designed to withstand applicable loadings, including loading of a fire apparatus.
3. Polypropylene Dual Wall Storm Sewer Pipe may be allowed for private storm water facilities, including under fire lanes, with the following stipulations:
 - a. The manufacturer and design engineer shall ensure the plans have the appropriate installation details.
 - b. The construction plans shall include the following note:

“Third party inspection of Polypropylene Dual Wall Storm Sewer Pipe under the fire lane is required. Prior to final acceptance, a letter shall be provided by the design engineer, or manufacturer that Polypropylene Dual Wall Storm Sewer Pipe under the fire lane has been constructed in accordance with the manufacturer’s recommendations and the construction plans.”

- C. The minimum finished floor elevation for any lot adjacent to a drainage feature shall be 2-ft above the adjacent 100-year fully developed water surface elevation and shall be shown on the final plat.
- D. Provide cross sections to demonstrate how proposed grading ties into adjacent properties. Include floodplain limits and erosion hazard setback lines within the cross sections if applicable.
- E. Should mitigation be required under Section 404 of the Clean Water Act, the areas shall be identified on the engineering construction plans.
- F. Refer to Section 4.15 for floodplain reclamation requirements.

4.11 Open Channel Design

Excavated open channels may be used to convey storm waters where the construction costs and/or long-term maintenance cost involved with a closed storm sewer system is not justified economically. Open channels shall be designed to convey the full design discharge. The allowable excavated channel cross section is shown on Figure 4.3. The maximum velocity allowed for unlined, vegetated excavated channels is 5-ft/s.

FIGURE 4.3: Open Channels -Excavated

*NON-ERODIBLE BOTTOM SHALL BE DESIGNED BY THE ENGINEER AND DOCUMENTATION AND CALCULATIONS SHALL BE PROVIDED TO CITY STAFF FOR REVIEW. GRADES SHALL ENSURE POSITIVE DRAINAGE THROUGHOUT THE CHANNEL.

**MINIMUM BOTTOM WIDTH SHALL BE BASED UPON PROJECT SPECIFIC CHANNEL MAINTENANCE NEEDS. BOTTOM WIDTHS SMALLER THAN WHAT IS SHOWN SHALL BE APPROVED BY THE DIRECTOR OF ENGINEERING SERVICES.

THE DIRECTOR OF ENGINEERING SERVICES MAY REQUIRE HYDRAULIC MODELING OF THE CONSTRUCTED CHANNEL TO CONSIDER A MANNINGS VALUE THAT REFLECTS A "MAINTAINED CHANNEL (0.25-0.35)" AND A "NON-MAINTAINED CHANNEL (0.35-0.055)".

- A. Unlined unvegetated excavated channels are not allowed. Construction of excavated channels will not be considered complete until the channel banks are stabilized. Vegetation selected for channel cover must conform with allowable vegetation from the Approved Material List.
- B. Supercritical flow shall not be allowed in channels except at drop structures and other energy dissipators.
- C. At transitions in channel characteristics, velocities must be reduced to the maximum velocity per the downstream assessment in accordance with Section 4.03.B. Velocities must be reduced before the flow reaches the natural channel using either energy dissipators and/or wider less steep channel.
- D. Channel armoring for erosion control shall be provided where deemed necessary by the Director of Engineering Services.
- E. If the channel cannot be maintained from the top of the bank, a maintenance access ramp shall be provided and included within the drainage easement.
- F. Minimum channel bottom widths are recommended to be equal to twice the depth of the channel. Any permanent open channel shall have a minimum bottom width of 5-ft.

- G. All open channels require a minimum freeboard of 1-ft freeboard.
- H. The minimum slope for an excavated improved channel is 1%.

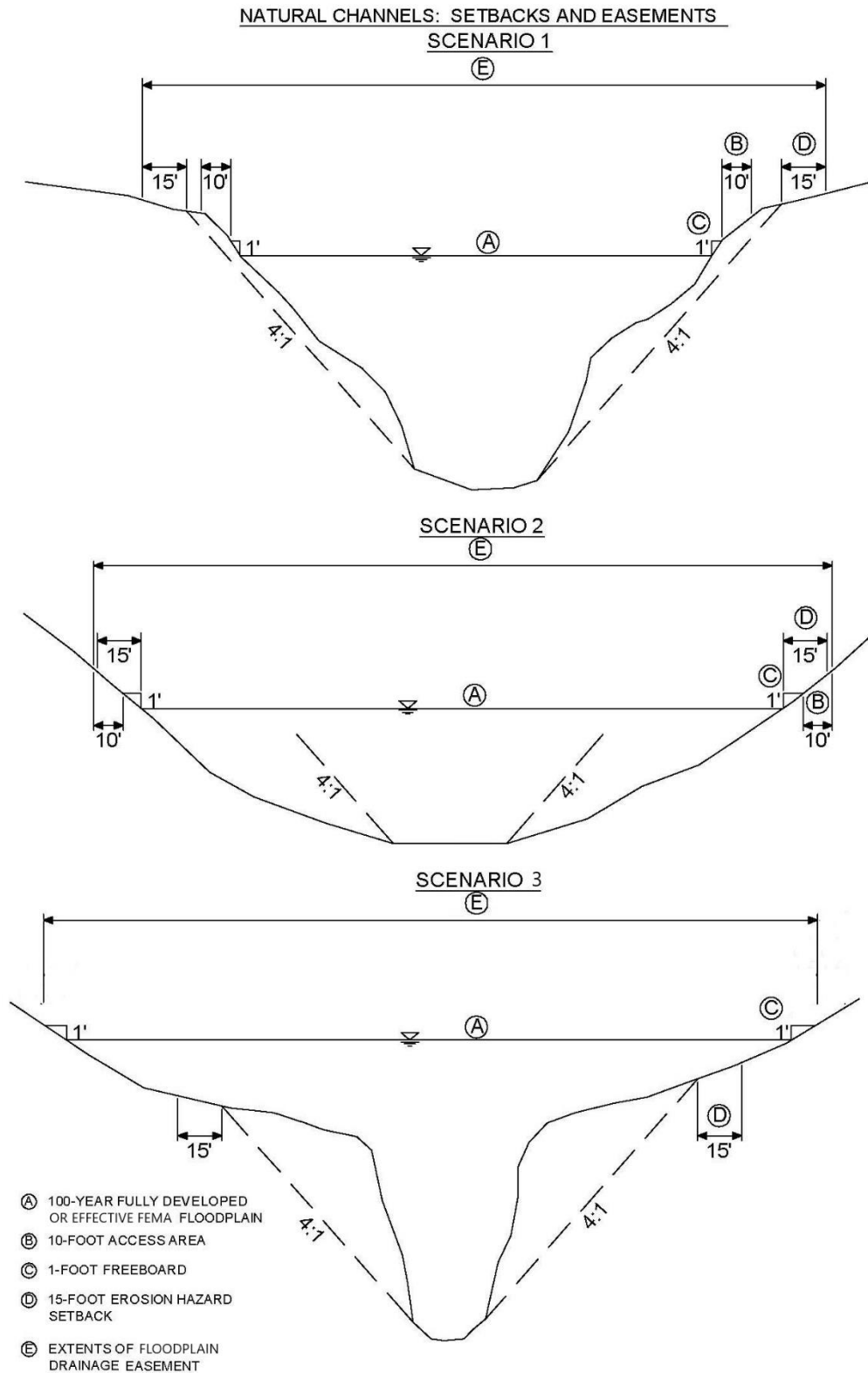
Table 4.6 provides allowable ranges for roughness coefficients of open channels.

Table 4.6 Channel Roughness Coefficients

Channel Description	Roughness Coefficient		
	Minimum	Normal	Maximum
Minor Natural Streams			
Moderately Well-Defined Channel			
-grass and weeds, little brush	0.025	0.030	0.033
-dense weeds, little brush	0.030	0.035	0.040
-weeds, light brush on banks	0.030	0.035	0.040
-weeds, heavy brush on banks	0.035	0.050	0.060
-weeds, dense willows on banks	0.040	0.060	0.080
Irregular Channel with Pools and Meanders			
-grass and weeds, little brush	0.030	0.036	0.042
-dense weeds, little brush	0.036	0.042	0.048
-weeds, light brush on banks	0.036	0.042	0.048
-weeds, heavy brush on banks	0.042	0.060	0.072
-weeds, dense willows on banks	0.048	0.072	0.096
Flood Plain, Pasture			
-short grass, no brush	0.025	0.030	0.035
-tall grass, no brush	0.030	0.035	0.050
Flood Plain, Cultivated			
-no crops	0.025	0.030	0.035
-mature crops	0.030	0.040	0.050
Flood Plain, Uncleared			
-heavy weeds, light brush	0.035	0.050	0.070
-medium to dense brush	0.070	0.100	0.160
-trees with flood stage below branches	0.080	0.100	0.120
Major Natural Streams			
Moderately Well-Defined Channel	0.025	-----	0.060
Irregular Channel	0.035	-----	0.100
Unlined Vegetated Channels			
Mowed Grass, Clay Soil	0.025	0.030	0.035
Mowed Grass, Sandy Soil	0.025	0.030	0.035
Unlined Unvegetated Channels			
Clean Gravel Section	0.022	0.025	0.030
Shale	0.025	0.030	0.035
Smooth Rock	0.025	0.030	0.035
Lined Channels			
Smooth Finished Concrete	0.013	0.015	0.020
Riprap (Rubble)	0.30	0.40	0.50

- I. Water surface elevations and flow velocities in channels are impacted by the maintenance condition in the channel. Calculations shall be performed assuming maintained and unmaintained vegetative conditions. Lower (maintained) Manning's values shall be used to determine maximum velocities, while higher (unmaintained) Manning's values shall be used to determine water surface elevations per Figure 4.5.
- J. Any channel modification must meet the applicable requirements of all Local, State and Federal Regulatory Agencies.
- K. An Erosion Hazard Setback shall be included within the Floodplain Drainage Easement for the channel. The purpose of this setback is to reduce the potential for any damage to property or infrastructure caused by the erosion of the bank. The erosion hazard setback shall be determined as follows, and is provided in Figure 4.4:
 - 1. For stream banks composed of material other than rock, locate the toe of the natural stream bank. Project a 4:1 line sloping away from the bank until it intersects finished grade. From this intersection add 15-ft away from the bank. This shall be the limit of the erosion hazard setback. For stream banks composed of rock, the 4:1 line may start at the top of rock in the creek bank.
 - 2. Figure 4.4 is intended to illustrate various scenarios under which the erosion hazard setback can be applied. Scenario 1 shows a situation where the setback may be located outside the Floodplain boundaries. Scenarios 2 and 3 show locations where the erosion hazard setback will be located inside the Floodplain boundaries.
- L. Any modifications within the area designated as erosion hazard setback will require:
 - 1. A geotechnical and geomorphological stability analysis.
 - 2. Mitigation for flowline degradation, erosion at outside bends, or other areas of erosive risk. Mitigation could include but is not limited to:
 - a. Grade control
 - b. Bendways
 - c. Headcut armoring
 - d. Slope stabilization

Figure 4.4: Natural Open Channels



4.12 Hydraulic Design of Culverts

- A. All culverts, headwalls, wingwalls, and aprons shall be designed in conformance with the City Standard Details. The Engineer is responsible for selecting the applicable detail.
- B. Culvert calculations shall be provided to the City for review. Calculations may include, but are not limited to, headwall, tailwater, and flowline elevations, lowest adjacent grade and structure elevations, inlet and outlet control calculations and velocity calculations.
- C. There is a minimum 1-ft freeboard from top of grade at a culvert crossing to the 100-year fully-developed water surface elevation. An emergency overflow path shall be identified and provided on the construction plans. An emergency overflow path is the path the storm water will take when the drainage facilities becomes clogged or does not function in the manner as to which it was designed. The emergency overflow path shall be limited to public right-of-way or drainage easements.
- D. Culverts should always be aligned to follow the natural stream channel. The engineer shall provide sufficient information to analyze the upstream and downstream impacts of the culvert and illustrate the interaction of the channel and culvert alignment.
- E. Headwalls and Entrance Conditions:
 - 1. The Engineer shall be responsible for the headwall and wingwall designs. Headwalls refer to the entrances and exits of structures and are usually formed of cast-in-place concrete and located at either end of the drainage system. Wingwalls are vertical walls, which project out from the sides of a headwall.
 - 2. The culvert entrance losses are provided in Table 4.7. The values of the entrance coefficient K_e represent a combination of the effects of entrance and approach conditions. Losses shall be completed using the following formula:

$$H_e = K_e \left[\frac{V^2}{2g} \right]$$

- H_e = Entrance head loss (ft)
- K_e = Entrance loss coefficient
- v = Velocity (fps)
- g = Gravity constant (32.2 ft/s²)

- F. Concrete culvert headwalls and wingwalls shall use natural stone or brick veneer. The material palette shall be similar and complimentary to materials used throughout the development and are subject to approval by the Director of Development Services.

Table 4.7 Culvert Entrance Losses

Type of Structure	K _e
Pipe, Concrete	
-projecting from fill, socket and (groove end)	0.2
-projecting from fill, square cut end	0.5
-headwall or headwall and wingwalls: socket end of pipe (groove end)	0.2
-headwall or headwall and wingwalls: square edge	0.5
-headwall or headwall and wingwalls: rounded (radius = 0.0933D)	0.2
-mitered to conform to fill slope	0.7
-beveled edges, 33.7° or 45°	0.2
-side or sloped tapered inlet	0.2
Pipe, or Pipe-Arch	
-projecting from fill (no headwall)	0.9
-headwall or headwall and wingwalls: square edge	0.5
-mitered to conform to fill slope, paved / unpaved slope	0.7
-beveled edges, 33.7° or 45°	0.2
-side or sloped tapered inlet	0.2
Box, Reinforced Concrete	
-headwall parallel to embankment (no wingwalls): squared on three sides	0.5
-headwall parallel to embankment (no wingwalls): rounded on three sides to radius 1/12 barrel dimension on three sides	0.2
-wingwalls at 30° to 75° to barrel: square edged at crown	0.4
-wingwalls at 30° to 75° to barrel: crown edge rounded to radius of 2/12 barrel dimension or beveled top edge.	0.2

4.13 Bridge Design Hydraulics

- A. The City requires that head losses and depth of flow through bridges be determined with a HEC-RAS program or other approved program. The following guidelines pertain to the hydraulic design of bridges:
1. Fully developed 100-year water surface must not be increased upstream of the bridge.
 2. Excavation of the natural channel is not allowed as compensation for loss of conveyance.
 3. Channelization upstream or downstream of the proposed bridge will only be permitted when necessary to realign the flow to a more efficient angle of approach.
 4. Side swales may be used to provide additional conveyance downstream of and through bridges.
 5. Bridges are to be designed with the lowest point (low beam) low chord at least 2-ft above the fully-developed 100-year water surface elevation.
- B. A scour analysis shall be submitted with the construction plans. Go to section 9.04 Bridge Design item F. for analysis requirements.

4.14 Energy Dissipators

- A. The Engineer shall be responsible for all energy dissipation designs. This could include channel armoring, gabion structures, gabion mattresses, rip-rap, turf reinforcement mats, and others as proposed.
- B. All energy dissipation designs shall include supporting calculations showing the design is adequate. The City may require the Engineer to provide a hydraulic model as supporting documentation.
- C. All energy dissipators should be designed to facilitate future maintenance. The design of outlet structures in or near parks or residential areas shall give special consideration to appearance and shall be approved by the Director of Engineering Services.

4.15 Floodplain Alterations

- A. No construction is allowed within floodplain areas (FEMA Effective floodplain or City of Frisco Fully-Developed floodplain), but construction is allowed in those areas that have been reclaimed from the floodplain.
- B. Floodplain alteration shall be allowed only if all the following criteria are met:
 - 1. Flood studies shall include flows generated for existing conditions and fully-developed conditions for the 2, 5, 25, and 100-year storm events.
 - 2. Alterations shall not increase the 100-year fully developed water surface elevation on other properties.
 - 3. Alterations shall be in compliance with FEMA guidelines.
 - 4. Alterations of the floodplain shall meet the requirements of Section 4.03.
 - 5. Alterations shall result in no loss of valley storage for a Major Creek, as defined by the Subdivision Ordinance, and a 15% maximum loss of valley storage for any other tributary for any reach, except at bridge and culvert crossings where it can be proven that there are no detrimental effects downstream.
 - 6. Any alteration of floodplain areas shall not cause any additional expense in any current or projected public improvements, including maintenance.
 - 7. The floodplain shall be altered only to the extent permitted by equal conveyance on both sides of the natural channel, as defined by the United States Army Corps of Engineers in a HEC-RAS analysis. The right of equal conveyance applies to all owners and uses, including greenbelt, park areas, and recreational areas. Owners may relinquish their right to equal conveyance by providing a written agreement to the Director of Engineering Services.
 - 8. A grading permit and/or construction plan approval shall be required to perform any grading activities on site.
 - 9. The toe of any fill shall parallel the natural direction of the flow.

10. Floodplain alterations shall incorporate and consider other City planning documents and ordinances such as the Tree Preservation Ordinance, the Subdivision Ordinance, and the Floodplain Ordinance, and the 2004 Final Riparian and Wetland Assessment.
 11. Unless a pre-existing model is in place, United States Army Corps of Engineers (USACE) HEC-HMS and HEC-RAS shall be used. A request to use another type of hydrologic or hydraulic model must be submitted to Engineering Services for approval. Modified Puls method shall be used for flood routing information to ensure that the cumulative effects of the reduction in floodplain storage of floodwater will not cause downstream or upstream increases in water surface elevations and erosive velocities. If Modified Puls method is not feasible, a request to use another type of flood routing method must be submitted to Engineering Services for approval.
- C. The Engineer is responsible for providing documentation of the relevant USACE approved permits prior to beginning modification to the floodplain or impacts to Waters of the US (WoUS) or for providing a signed and sealed statement detailing why such permits are unnecessary.
- D. Verification of Floodplain Alterations:
1. The owner/developer shall furnish, at their expense, to the Director of Engineering Services sufficient engineering information to confirm that the minimum finished floor elevations proposed are as required by this ordinance.
 2. Construction plans will not be released for construction within areas subject to a Conditional Letter of Map Revision (CLOMR) or amendment until accepted by the Director of Engineering Services and FEMA.
 3. Letters of Map Revision (LOMR) application shall be submitted to the Director of Engineering Services prior to submittal to FEMA no later than 60-days from the City's final acceptance of the construction.
 4. All submittals to FEMA shall be submitted to the Director of Engineering Services prior to submittal to FEMA. A copy of all responses to FEMA comments shall be submitted to the City.

4.16 Erosion and Sedimentation Control

- A. See Section 8 for requirements for Stormwater Best Management Practices and Stormwater Management Plan.

4.17 Drainage Easements

- A. The following minimum width exclusive drainage easements are required when facilities are not located within public rights-of-way or easements:
 - 1. Storm sewers are to be located within the center of a 15-ft drainage easement or 1.5 times the depth plus the width of the structure rounded up to the nearest 5-ft, whichever is greater.
 - 2. Overflow paths are to be located within a minimum 10-ft drainage easement.
 - 3. A Floodplain Drainage easement is required to be dedicated over open channels or creeks. See figure 4.4.
 - 4. A Drainage and Detention Easement is required to be dedicated over detention facilities.
- B. Storm drain lines are considered public if they cross property lines and collect runoff from adjacent properties. Drainage easements shall be dedicated to the City when a drainage system crosses a property line. For single-family residential developments, storm drain lines shall not cross residential lots unless approved by the Director of Engineering Services.
- C. Floodplain Drainage Easements shall be dedicated for all floodplains and shall include an erosion hazard setback to reduce the potential for damage due to erosion of the bank.
- D. Drainage and Detention Easements shall be dedicated for all detention/retention facilities.

4.18 Stormwater Quality Treatment

Refer to Landscape Ordinance Subsection 4.02 (Landscape Requirements) of Section 4 (Site Development Requirements) of the Zoning Ordinance to determine if Stormwater Quality Treatment is required. Stormwater Quality Treatment shall be designed based upon the following minimum criteria:

- A. Quantitative Measures
 - 1. Stormwater quality volume is based on the first 1" of rainfall.
 - 2. All impervious areas to be treated unless otherwise approved by the Director of Engineering Services.
 - 3. Extended detention, biofiltration, or mechanical separators shall be used to remove 80% of total suspended solids.

B. Water Quality Volume (WQ_v)

The water quality volume is calculated by using the 1" rainfall event, the volumetric runoff coefficient and the site area. When a development contains multiple outfalls, Water Quality Volume should be calculated and addressed separately for each outfall.

For each outfall:

$$R_v = 0.05 + 0.009I$$

I = Percent of impervious cover (expressed as percent value not fraction)

R_v = Volumetric runoff coefficient

WQ_v is calculated using the following formula:

$$WQ_v = \frac{1.0R_vA}{12}$$

WQ_v = Water quality volume (acre-feet)

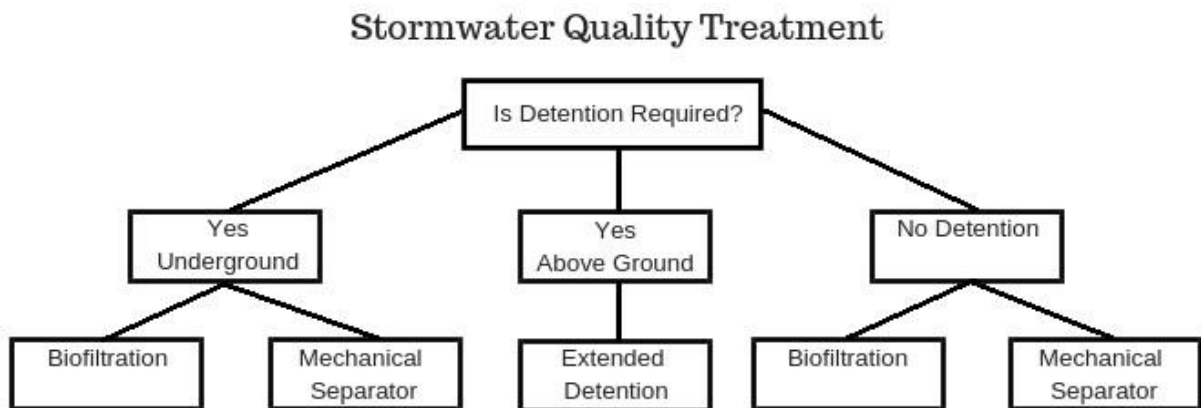
R_v = Volumetric runoff coefficient

A = Total drainage area (acres)

C. Best Management Practices (BMPs) -

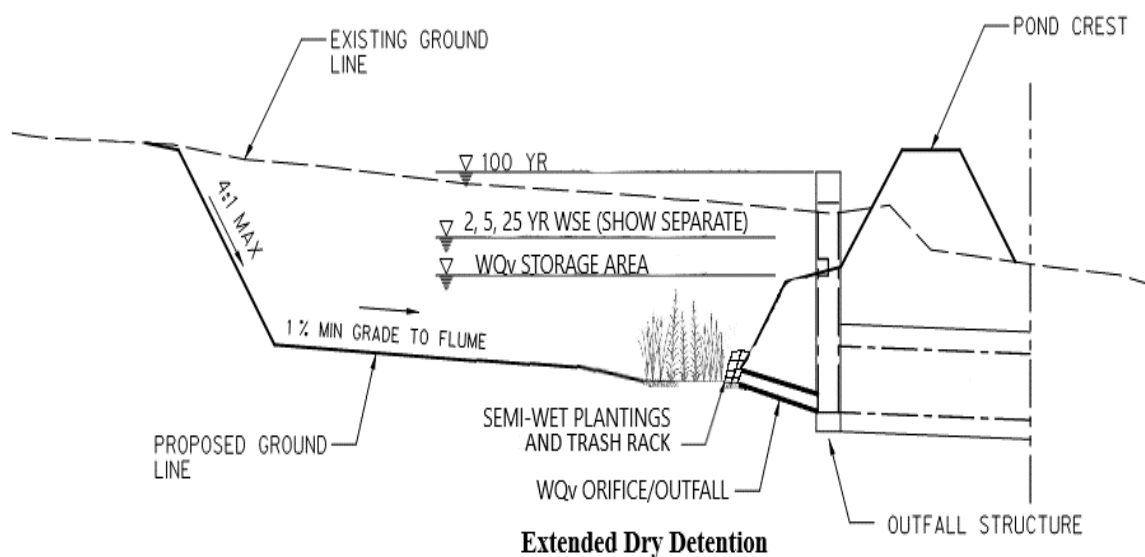
Stormwater Quality Treatment shall be achieved through one or more of the following BMPs: extended detention, biofiltration, or mechanical separators. Figure 4.7 summarizes the process for selecting a BMP.

Figure 4.7: Stormwater Quality Treatment Flowchart



1. Extended Detention – Dry or Wet Pond
 - a. Detention ponds must meet design requirements of Section 4.09 for detention.
 - b. Water quality orifice shall be no less than 3” in diameter.
 - c. May be included within open space if open space ordinance Subsection 4.13.03 (Nonresidential Open Space Requirements) of Section 4 (Site Development Requirements) of the Zoning Ordinance is met.
 - d. Inflow must travel through the extended detention and not be directly connected to the outfall.
 - e. Outfall shall include a pond drain with headwall and gate valve allowing for fully drained pond within a 24-hour period to allow for maintenance and operation of the system.
 - f. Dry pond requirements to achieve 80% TSS:
 - Size orifice and WQv storage area to meet required WQv. WQv storage area should be located adjacent to the outfall.
 - Add trash rack to water quality outfall. Trash rack shall not limit water quality outfall flows. Trash rack open area to be a minimum of 20 times the open area of the water quality orifice.
 - Provide semi-wet plantings to increase vegetative filtration and uptake of stormwater pollutants around outfall structure. Reference Approved Plant Materials on the City Website for semi-wet planting guidance.

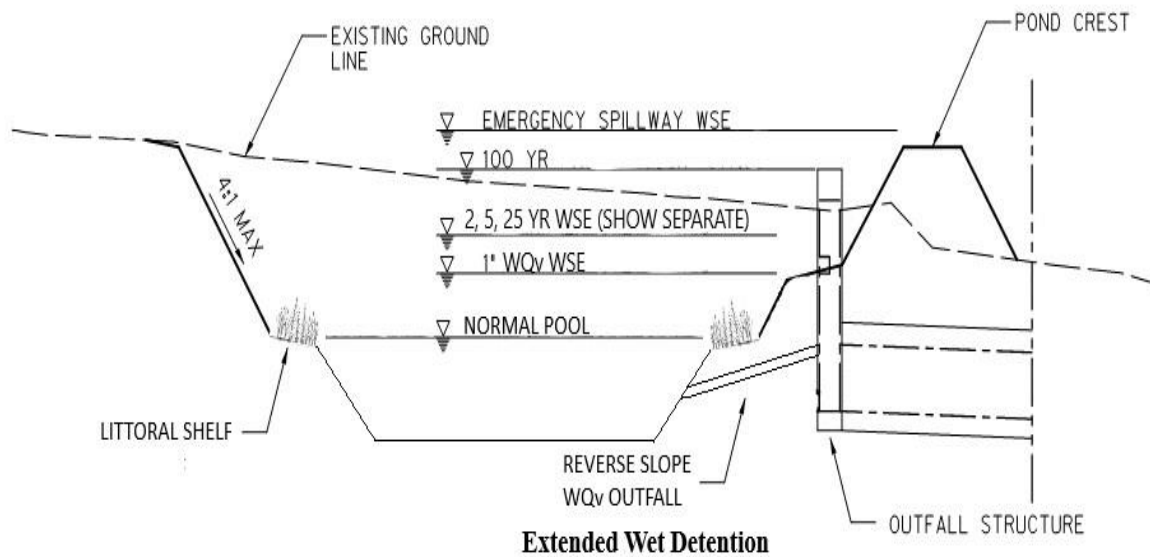
Figure 4.8: Extended Dry Detention



g. Wet pond requirements to achieve 80% TSS:

- Size orifice and WQv storage area to meet required WQv.
- The flowline of the water quality outfall should be set at the normal pool elevation. Wet pond should have submerged water quality outfall with reverse slope.
- Provide minimum 5' wide littoral shelf at 1' below normal pool perimeter. Reference the Approved Plant Materials on the City Website for littoral shelves planting guidance to increase vegetative filtration and uptake of stormwater pollutants.

Figure 4.9: Extended Wet Detention



h. Sizing for water quality outfall:

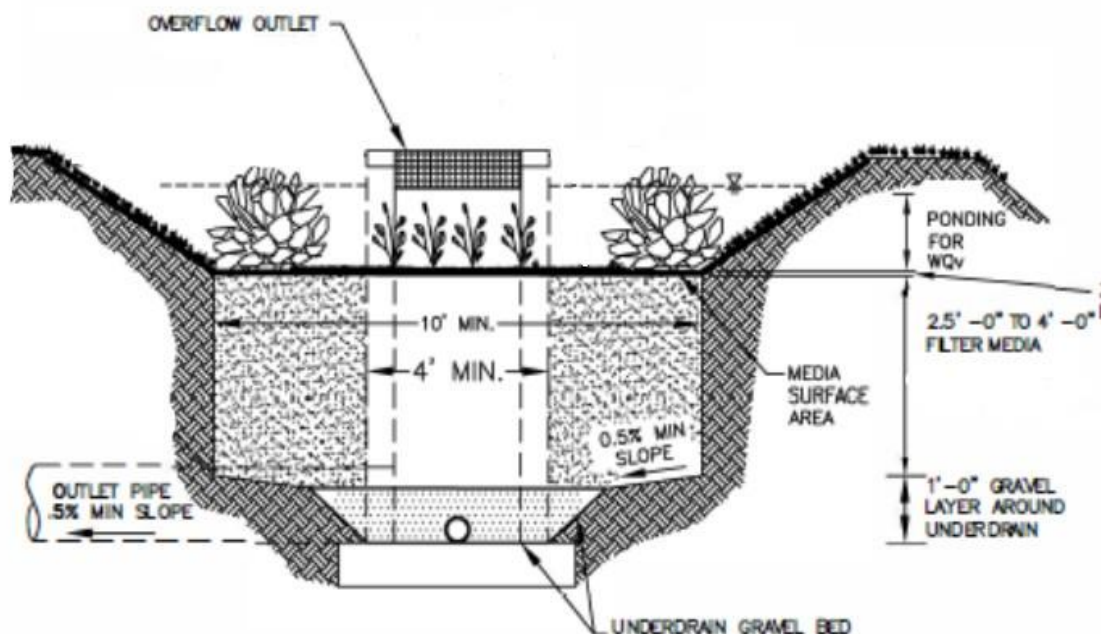
$$A = \frac{Q}{C\sqrt{2gh}} \quad Q = \frac{WQ_v}{t}$$

A	=	Water quality orifice open area (ft ²) Min. of 3" diameter
Q	=	Flowrate (cfs)
C	=	Orifice coefficient – (0.6)
g	=	Gravity (32.2ft/s)
h	=	Half maximum hydraulic head (ft)
WQv	=	Water quality volume (ft ³)
t	=	Drain time (seconds) Orifice sized for 24-48 hours of detention

2. Biofiltration

- a. May be included within open space if open space ordinance Subsection 4.13.03 (Nonresidential Open Space Requirements) of Section 4 (Site Development Requirements) of the Zoning Ordinance is met.
- b. Reference landscape ordinance Subsection 4.02 (Landscape Requirements) of Section 4 (Site Development Requirements) of the Zoning Ordinance and the Approved Plant Materials on the City Website for plantings to increase vegetative filtration and uptake of stormwater pollutants.
- c. Maximum drainage area is 5 acres per biofiltration system. Multiple biofiltration systems may be required.
- d. Biofiltration system shall provide storage capacity for the WQv. The maximum ponding depth is 12" above finished grade and contained within the biofiltration system.
- e. Drain time shall not exceed 48 hours.
- f. Engineered media or manufacturer's product can be used to adjust coefficient of permeability. Design the coefficient of permeability to include a safety factor of 2. Minimum design permeability must be demonstrated after installation.
- g. Include an underdrain system and overflow outlet.
- h. Size overflow outlet for the 100-year storm event. Set outlet opening a minimum three inches above finished grade.
- i. Inflow must travel through biofiltration system and not be directly connected to the outfall.

Figure 4.10: Biofiltration



j. Sizing:

$$A_f = \frac{WQ_v * d_f}{k(h_f + d_f)t_f}$$

A_f	=	Surface area of ponding area (ft ²)
WQ_v	=	Water quality volume (ft ³)
d_f	=	Filter bed depth (ft) 2.5 feet minimum
k	=	Coefficient of permeability (ft/day) use 0.03 ft/day for clay
h_f	=	Half maximum hydraulic head (ft)
t_f	=	Design filter bed drain time (days) 2 days maximum

k. Mechanical Separators

- Sized based on quantitative measures in 4.18.A, 4.18.B, and manufacturer's recommendations. Calculations and specifications to be provided in construction plans. Provide laboratory analysis justifying manufacturer's recommendation.
- Head loss from mechanical separators must be included in the storm drain calculations.
- Mechanical separators must remove and retain trash from runoff and meet normal maintenance schedule.

D. Maintenance

1. Engineer shall provide an Operations and Maintenance (O&M) Plan that will detail BMP specifics. Plan shall be recorded with the county.
2. A copy of the recorded O&M Plan needs to be provided to the City and a note added to the construction plans referencing the existence of the O&M Plan with the county recording information.

4.19 Sustainable Development

The City encourages developments to implement sustainable designs, concepts, and practices on site. The Engineer shall notify the City of the design intent and provide the necessary information, data, and calculations on the construction plans.

The Engineer shall refer to published technical resources on the design of these sustainable designs, concepts, and practices. Such technical resources may be found on the North Central Texas Council of Governments' (NCTCOG) storm water website or the [Environmental Protection Agency's \(EPA\) website for Low Impact Development](#).

Detention/Retention Pond Example**EXAMPLE**

GIVEN: A 10-acre site is currently undeveloped and will be developed as a non-residential use. The entire site is the drainage area for the proposed detention basin.

DETERMINE: Maximum release rate and required detention storage.

SOLUTION:

1.) Determine 100-year peak runoff rate for single family runoff ($Q=C*I*A$). This is the maximum release rate from the site after development. (Any area within the drainage area not being conveyed to the detention basin shall be accounted for in the calculation for the maximum release rate.)

Existing Conditions:	C	=	0.3
	T_c	=	20 minutes
	I_{100}	=	6.88" / hour
	A	=	10 acres
	Q_{100}	=	$(0.3)(6.88)10=20.64$ cfs

2.) Determine inflow Hydrograph for storms of various durations in order to determine maximum volume required with maximum release rate calculated in step 1. (Incrementally increase durations by 10 minutes until the duration of peak inflow is less than the maximum release rate or where the required storage is less than the storage for the prior duration. The prior duration storage shall be used for the required detention storage.)

Proposed Conditions:	C	=	0.90
	T_c	=	10 minutes
	I_{100}	=	8.74" / hour
	A	=	10 acres
	Q_{100}	=	$(0.90)(8.74)10 = 78.66$ cfs

Check various duration storms:

10 minutes	$I=8.74$;	$Q=0.9(8.74)10 =$	78.66	cfs
20 minutes	$I=6.88$;	$Q=0.9(6.88)10 =$	61.96	cfs
30 minutes	$I=5.74$;	$Q=0.9(5.74)10 =$	51.65	cfs
40 minutes	$I=4.95$;	$Q=0.9(4.95)10 =$	45.59	cfs
50 minutes	$I=4.38$;	$Q=0.9(4.38)10 =$	39.41	cfs
60 minutes	$I=3.94$;	$Q=0.9(3.94)10 =$	35.43	cfs
70 minutes	$I=3.59$;	$Q=0.9(3.59)10 =$	32.27	cfs
80 minutes	$I=3.30$;	$Q=0.9(3.30)10 =$	29.68	cfs
90 minutes	$I=3.06$;	$Q=0.9(3.06)10 =$	27.53	cfs

Maximum Detention Storage Volume is determined by deducting the volume of runoff released during the time of inflow from the total inflow for each storm duration:

10-minute storm			
INFLOW	=	$10(78.66)60 \text{ sec/min}$	= 47,196 cf

OUTFLOW	=	(0.5)20(20.64)60 sec/min	=	<u>12,392</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	34,804 cf
20-minute storm				
INFLOW	=	20(61.96)60 sec/min	=	74,354 cf
OUTFLOW	=	(0.5)30(20.64)60 sec/min	=	<u>18,588</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	55,765 cf
30-minute storm				
INFLOW	=	30(51.65)60 sec/min	=	92,975 cf
OUTFLOW	=	(0.5)40(20.64)60 sec/min	=	<u>24,785</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	68,190 cf
40-minute storm				
INFLOW	=	40(44.59)60 sec/min	=	107,006 cf
OUTFLOW	=	(0.5)50(20.64)60 sec/min	=	<u>30,981</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	76,026 cf
50-minute storm				
INFLOW	=	50(39.41)60 sec/min	=	118,219 cf
OUTFLOW	=	(0.5)60(20.64)60 sec/min	=	<u>37,177</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	81,042 cf
60-minute storm				
INFLOW	=	60(35.43)60 sec/min	=	127,541 cf
OUTFLOW	=	(0.5)70(20.64)60 sec/min	=	<u>43,373</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	84,168 cf
70-minute storm				
INFLOW	=	70(32.27)60 sec/min	=	135,516 cf
OUTFLOW	=	(0.5)80(20.64)60 sec/min	=	<u>49,569</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	85,947 cf
80-minute storm				
INFLOW	=	80(29.68)60 sec/min	=	142,485 cf
OUTFLOW	=	(0.5)90(20.64)60 sec/min	=	<u>55,765</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	86,720 cf
90-minute storm				
INFLOW	=	90(27.53)60 sec/min	=	148,679 cf
OUTFLOW	=	(0.5)100 (20.64)60 sec/min	=	<u>61,961</u> cf
STORAGE	=	INFLOW - OUTFLOW	=	86,717 cf

Required detention storage is 86,720 cf at the 80-minute storm duration.

SECTION 5 – WATER & WASTEWATER DESIGN REQUIREMENTS

Section 5 – Water & Wastewater Design Requirements

5.01 Water System – General

- A. The intent of the water system design requirements is to list minimum requirements for public water distribution and transmission system facilities and appurtenances. Private fire service mains shall also be designed according to these water system design requirements and the City's Fire Code and the National Fire Protection Association (NFPA) 24, Standard for the Installation of Private Fire Service Mains and Appurtenances, latest revision.
- B. Design criteria for all water systems shall comply with Texas Commission on Environmental Quality (TCEQ) Chapter 290, Subchapter D (Rules and Regulations for Public Water Systems), latest revision. Chapter 290 is included in Part I of Title 30 of the Texas Administrative Code.
- C. Water Main sizes shall comply with the Water, Wastewater and Reuse Master Plan unless approved in writing by the Director of Engineering Services.
- D. Developments shall be required to connect to two independent sources of water.
- E. Water mains shall be sized and extended through the limits of a development to serve adjacent properties.
- F. Dead end water mains are not allowed unless approved in writing by the Director of Engineering Services; however, if approved, an automatic flushing device shall be provided (See 5.1.12). Automatic flushing devices shall drain via a pipe system to the storm sewer system.

5.01.1 Water Main Location

- A. Water mains 12" and smaller shall be installed 2' from the back of the curb, as measured to the centerline of pipe.
- B. Water mains larger than 12" shall be installed at least 3' from the back of curb as measured to the centerline of pipe.
- C. Water mains shall not be located in alleys.
- D. Water mains shall not be located inside a storm sewer.
- E. Water mains shall not be located in the center of a roundabout
- F. Water mains shall be designed to minimize bends and fittings and follow right-of-way or centerline alignment curves at a uniform distance from the right-of-way or centerline.
- G. Dead end water mains shall extend a minimum of 5' beyond the edge of the pavement. If adjacent to a fitting, extend a minimum of 20' or one pipe joint beyond fitting.

5.01.2 Horizontal and Vertical Alignment

- A. Water mains shall be designed as straight as possible following the existing or proposed grade at the minimum depth of cover. Bends shall be provided where vertical slope changes exceed 80% of the manufacturer's recommended joint deflection.
- B. Line size 4" to 12" shall have a minimum cover of 4'.

- C. Line size 14" to 18" shall have a minimum cover of 5'.
- D. Lines larger than 20" shall have a minimum cover of 6'.
- E. A minimum clearance of 18" shall be required when crossing storm drain systems.
- F. Excessive high points that trap air and restrict water flow should be avoided.

5.01.3 Separation Distance between Water and Wastewater Mains

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

A. Preferred Design Layout

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

B. Water/Wastewater Pipe Trench Design

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

C. Cross Connection Prohibition

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

D. Preferred Design Layout Variances

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

1. New Waterline Installation – Parallel Lines:

a. Parallel to Existing Non-Leaking Wastewater Main:

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

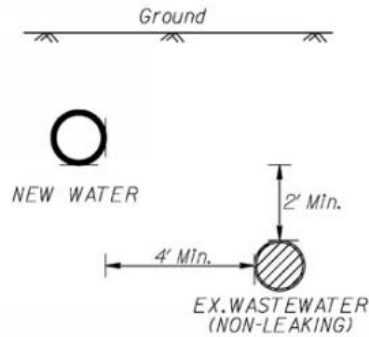


Figure 5.01.3.D.1.a:
New Water Main Parallel to Existing Non-Leaking Wastewater Main

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

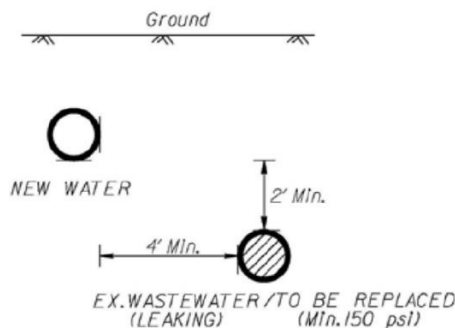


Figure 5.01.3.D.1.b:
New Water Main Parallel to Existing Leaking Wastewater Main

- c. **Pressure Rating of Wastewater Main:**
 Where a new potable waterline parallels a new wastewater main, the wastewater main or lateral shall be constructed of at least 150 psi pressure rated pipe. The new potable waterline shall be located at least two feet above the wastewater main or lateral, measured vertically, and at least four feet away, measured horizontally, from the wastewater main or lateral.

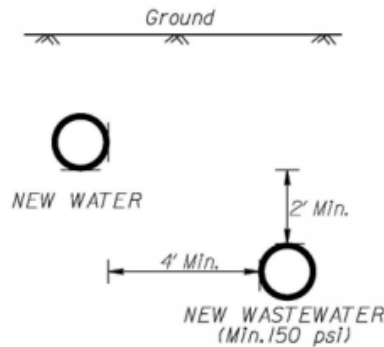


Figure 5.01.3.D.1.c
New Water Main Parallel to New Wastewater Main

2. New Waterline Installation – Crossing Lines:

a. Crossing Existing Non-Pressure Rated Wastewater Main:

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

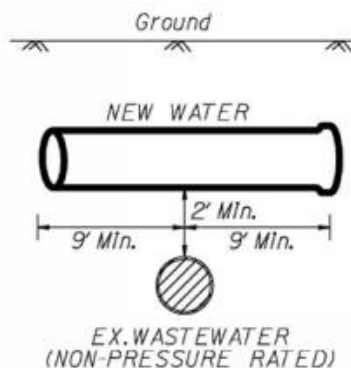


Figure 5.01.3.D.2.a
New Water Main Crossing Existing Non-Pressure Rated Wastewater Main

b. Crossing Existing Pressure-Rated Wastewater Main:

Where a new potable waterline crosses an existing, pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. If the

existing wastewater main or lateral shows signs of leaking, it shall be replaced for at least nine feet in both directions (18 feet total) with a least 150 psi pressure rated pipe.

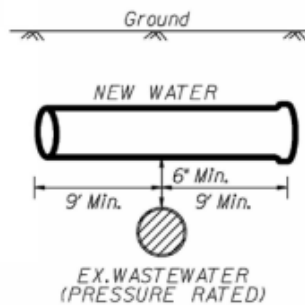


Figure 5.01.3.D.2.b
New Water Main Crossing Existing Pressure Rated Wastewater Main

- c. Crossing New Wastewater Minimum Pipe Segment:
Where a new potable waterline crosses a new, non-pressure rated wastewater main or lateral and the standard pipe segment length of the wastewater main or lateral is at least 18 feet, one segment of the waterline pipe shall be centered over the wastewater main or lateral such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the centerline of the wastewater main or lateral. The potable waterline shall be at least two feet above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The wastewater pipe shall be embedded in cement stabilized sand (see clause 5.01.3.D.2.d of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.

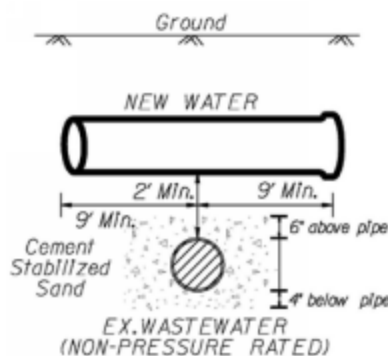


Figure 5.01.3.D.2.c
Crossing New Wastewater Main Minimum Pipe Segment

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

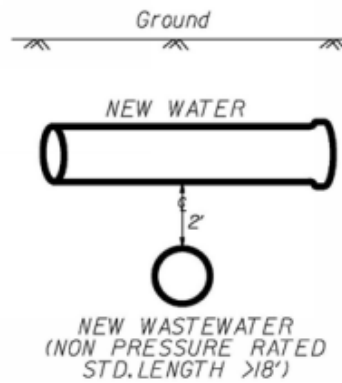


Figure 5.01.3.D.2.d

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

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

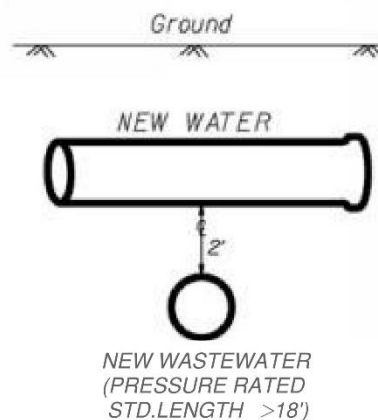


Figure 5.01.3.D.2.d.i

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

- ii. All sections of wastewater main or lateral within nine feet horizontally of the waterline shall be encased in an 18-foot (or longer) section of pipe. Flexible encasing pipe shall have a minimum pipe stiffness of 115 psi at 5.0% deflection. The encasing pipe shall be centered on the waterline and shall be at least two nominal pipe diameters larger than the wastewater main or lateral. The space

around the carrier pipe shall be supported at five-foot (or less) intervals with spacers or be filled to the springline with washed sand. Each end of the casing shall be sealed with watertight non-shrink cement grout or a manufactured watertight seal. An absolute minimum separation distance of six inches between the encasement pipe and the waterline shall be provided. The wastewater line shall be located below the waterline.

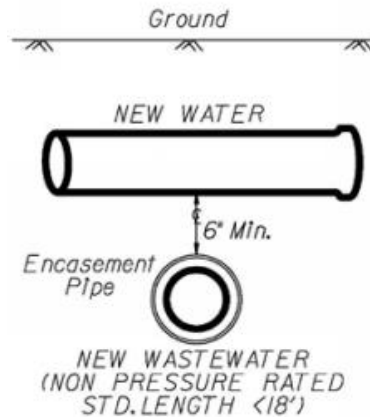


Figure 5.01.3.D.2.d.ii

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

- iii. When a new waterline crosses under a wastewater main or lateral, the waterline shall be encased as described for wastewater mains or laterals in subclause §5.01.3.D.2.d.ii of this clause or constructed of ductile iron or steel pipe with mechanical or welded joints as appropriate. An absolute minimum separation distance of one foot between the waterline and the wastewater main or lateral shall be provided. Both the waterline and wastewater main or lateral must pass a pressure and leakage test as specified in AWWA C600 standards.

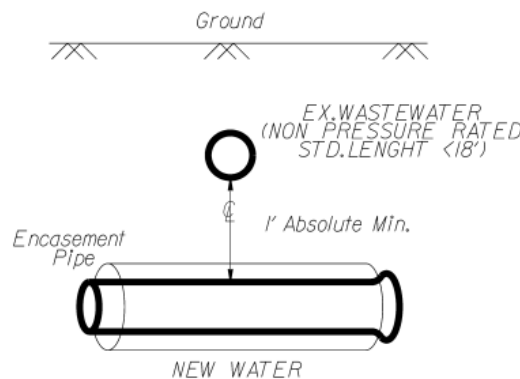


Figure 5.01.3.D.2.d.iii

Variance for Crossing New Wastewater Main With 1' Minimum Separation

e. Crossing New Pressure-Rated Wastewater Main:

Where a new potable waterline crosses a new, pressure rated wastewater main or lateral, one segment of the waterline pipe shall be centered over the wastewater line such that the joints of the waterline pipe are equidistant and at least nine feet horizontally from the center line of the wastewater main or lateral. The potable waterline shall be at least six inches above the wastewater main or lateral. Whenever possible, the crossing shall be centered between the joints of the wastewater main or lateral. The wastewater pipe shall have a minimum pressure rating of at least 150 psi. The wastewater main or laterals shall be embedded in cement stabilized sand (see clause under §5.01.3.D.2.f of this subparagraph) for the total length of one pipe segment plus 12 inches beyond the joint on each end.

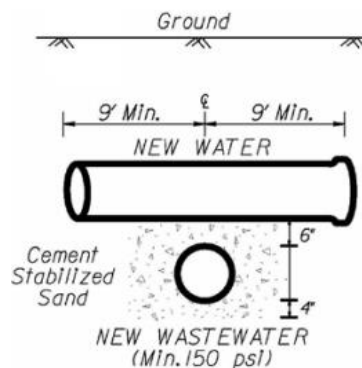


Figure 5.01.3.D.2.e
New Water Main Crossing New Pressure Rated Wastewater Main

f. Special Bedding Materials:

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

E. Proximity of Wastewater Main, Lateral, Manhole or Cleanout

The separation distance from a potable waterline to a wastewater main or lateral manhole or cleanout shall be a minimum of nine feet. Where the nine-foot separation distance cannot be achieved, the potable waterline shall be encased in a joint of at least 150 psi pressure class pipe at least 18 feet long and two nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five-foot intervals with spacers or be filled to the springline with

washed sand or grout as necessary. The encasement pipe shall be centered on the crossing and both ends sealed with cement grout or manufactured sealant.

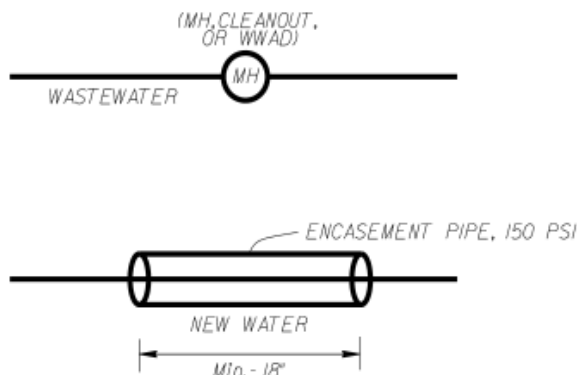


Figure 5.01.3.E

Separation between Waterline and Wastewater Mains/Lateral/Manhole/Cleanout

F. Location of Fire Hydrants

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

G. Proximity of Septic Tank Drainfields

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

H. Proximity of Reclaimed Water Mains

Water mains located adjacent to reclaimed water main shall comply with the separation criteria established in Frisco Water and Wastewater Design Requirements Section 5.03.3 regarding separation distance between reclaimed water and water/wastewater mains.

5.01.4 Average Daily Water Demands

The following values shall be used when calculating the average daily water demands, unless project specific water demand and/or actual flow measurements are provided:

TABLE 5.1: Average Daily Water Demands

Land Use	Design	Calculation
Apartment	<ul style="list-style-type: none"> 3.0 persons/unit 200 gallons per person per day 	600 gpd/unit
Residential/ Town Home/ Patio Home	<ul style="list-style-type: none"> 3.5 persons/unit 200 gallons per person per day 	700 gpd/unit
Hospital (Beds)	<ul style="list-style-type: none"> 720 gallons per day per bed 	720 gpd/bed
Nursing Home or Other Institution (Beds)	<ul style="list-style-type: none"> 240 gallons per day per bed 	240 gpd/bed
Commercial/ Industrial/Office	<ul style="list-style-type: none"> 1 person per parking space, or 1 person per 400 SF of building 	50 gpd/person
School	<ul style="list-style-type: none"> 30 gallons per student/day 	30 gpd/student

5.01.5 Water Main Sizing

- A. Water mains shall be sized in accordance with the current Water, Wastewater and Reuse Master Plan unless approved in writing by the Director of Engineering Services.
- B. The following criteria shall be used to size water mains.
 - 1. Average daily water demands less than 80,000 gallons per day:
 - a. Single Family Residential
 - i. Water mains shall be a minimum of 8" diameter and shall be extended to provide service to adjacent properties.
 - ii. 12" water mains shall be located along collector streets.
 - b. Multi-Family Residential
 - i. Water mains shall be a minimum of 8" and shall be extended to provide service to adjacent properties.
 - ii. Water mains greater than 600' in length or supplying more than one fire hydrant/fire service line shall be 12".
 - c. Commercial, Schools and Manufacturing
 - d. Looped 8" water mains may be used for fire hydrants located in parking lots and not adjacent to buildings.
 - e. Water mains greater than 1,000' in length or supplying more than two fire hydrants/fire service lines shall be a minimum of 12".
 - 2. Average daily water demands greater than 80,000 gallons per day shall submit the following information:
 - a. Zoning
 - b. Area in acres
 - c. Type of Development
 - d. Number of units and/or building square footage
 - e. Exhibit with connection locations and proposed water main schematic
 - f. Projected Average Daily Water Demands

5.01.6 Water Main Materials

- A. Polyvinyl Chloride (PVC) Pipe
 - 1. PVC water mains from 4" to 8" in diameter shall be AWWA C900 DR14.
 - 2. PVC water mains 12" in diameter shall be AWWA C900 DR18.

3. PVC water mains 16" in diameter and greater shall be AWWA C900-16 DR18 or latest edition.

B. Ductile Iron Pipe

Ductile iron water mains 16" in diameter and larger shall be in accordance with ANSI/AWWA C151/A21.50 with a minimum pressure class of 150 psi. It shall be the Engineer's responsibility to determine whether a higher pressure class is required.

C. Fittings

All fittings shall be ductile iron and have mechanical restraints and thrust blocking.

5.01.7 Water Services

Minimum requirements for water services are as follows:

- A. Minimum 1" meter and 1" services are required for all residential and commercial services. The size necessary shall be selected based on design calculations of actual demands.
- B. Twin meters in parallel are not permitted as meter size shall correlate to the line size. Bullhead connections are not permitted.
- C. Meters 3" and larger are required to be in a concrete vault.
- D. Domestic or irrigation service connections shall not be allowed on a fire hydrant lead or fire service line.
- E. A domestic or irrigation service connection shall not exceed 50' in length or contain fittings.
- F. All non-single family developments shall have a separate irrigation meter.
- G. A fire service line shall be a minimum of 8" unless otherwise approved by Fire Department.
- H. The water meter size shall be the same size as the service line.
- I. For a water service requiring a vault, a minimum 6" water line shall be required off the water main with a minimum 6" gate valve prior to reducing in size. Line size reducer shall be on the stub out piping from the vault.
- J. Meter boxes shall be placed within the right-of-way or in a dedicated water easement.
- K. Meter boxes and vaults shall be placed in landscaped areas or shall be protected from vehicular traffic with bollards. If not protected by bollards, either a traffic-rated vault or curb is required.
- L. Meters shall be placed generally in the center of residential lots according to the Standard Details. If lot width is 55 feet or less, water services shall be placed 2 feet off the side lot line.
- M. Refer to Approved Material List for acceptable products

- N. Water services should be placed in a 4" PVC casing pipe when crossing pavement, located in knuckles or as requested.

5.01.8 Valves

A. Isolation Valves

1. Isolation valves shall match the tee size, but shall not be smaller than 6".
2. Isolation valves shall be placed on or near street property lines.
3. Isolation valves shall not be over 600' apart in residential and multi-family areas.
4. Isolation valves shall not be over 500' apart in all other non-residential areas or on lines 12" and smaller. For lines 16" and larger, valves shall not be over 1000' apart.
5. Two isolation valves shall be placed such that each fire hydrant/firefighting apparatus or one fire sprinkler service system can be shut down separately. No more than three isolation valves shall be used to shut down a fire hydrant/firefighting apparatus or fire sprinkler system private service main.
6. Water mains supplying an automatic fire sprinkler system shall include isolation valves on the private fire service main.
7. Isolation valves shall not be located in parking spaces.
8. In undeveloped areas, main line isolation valves shall be spaced every 1,200' and adjacent to fire hydrants.
9. Isolation valves shall be anchored to the tees.
10. Isolation valves shall not be located within brick pavers.
11. Isolation valves shall not be located within the truncated domes of a barrier free ramp.
12. Isolation valves, 16" and larger, shall be butterfly valves.

B. Air Release Valves

1. The Engineer shall be responsible for locating and sizing air release valves in accordance with AWWA Manual M51: Air-Release, Air/Vacuum & Combination Air Valve.
2. Air release valves shall be installed on water mains larger than 12". Vent pipes shall discharge air above grade and above 100-year floodplain elevation, if applicable.
3. Air release valves are not required on water distribution mains smaller than 12" where fire hydrants and service connections provide a means for venting trapped air.
4. Air release valve manholes shall not be located in parking spaces.

C. Blowoff Valves

1. Blowoff valves shall be provided on water mains 16" and larger at low points and at isolation valves where the water main slopes toward the valve.
2. Blowoff valves shall discharge to a drainage channel, creek, storm sewer or culvert.

5.01.9 Fire Hydrants

Fire hydrants shall be provided as recommended by the "GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOW" published by the Insurance Service Office. The following minimum guidelines shall be met:

- A. Fire hydrants shall be installed at a minimum of 10' from the curb return on Thoroughfare Types A, B, and C.
- B. Fire hydrants shall be installed at a minimum of 2' and a maximum of 6' from the edge of pavement on Thoroughfare Types D, E, and F and fire lanes.
- C. Fire hydrants shall be located at all main entrances and intersecting streets and fire lanes.
- D. Fire hydrants shall be spaced every 1200' along undeveloped roadways.
- E. Fire hydrant leads exceeding 100' shall be looped with a minimum 8" line.
- F. Fire hydrants shall be provided every 500' within residential developments, as measured along the route that a fire hose is laid by a fire apparatus.
- G. Fire hydrants shall not be located in the sidewalk.
- H. Fire hydrant valves shall be positioned to one side of the fire hydrant pumper nozzle.
- I. Fire hydrants required to supplement water supply for automatic fire protection systems shall be located within 100' of the Fire Department connection for such system.
- J. Additional requirements for fire hydrant installation adjacent to, and along fire lanes is as follows:
 1. Occupancies other than 1 and 2 family dwellings
 - a. Fire hydrants shall be located every 300' as measured along the route that a fire hose is laid by a fire apparatus.
 - b. Fire hydrants shall be located outside the radius of the fire lane and at least 35' from all buildings.
 - c. A minimum of two fire hydrants shall be located within 500' of the front of any building as measured along the route that a fire hose is laid by a fire apparatus.
 2. Fire hydrants adjacent to or directly behind a parking space, or within a turn radii should be at least 3' from the curb.

3. Splash pads should be provided when fire hydrants are located in open spaces or non-sodded landscaped areas. Splash pads should be Class A concrete, 2' wide x 4" thick and extend from the front of the fire hydrant to the curb. Fire hydrants should not be set in concrete in these areas.
- K. 6" water mains shall be installed such that not more than one hydrant will be between intersecting lines.
- L. 8" water mains shall be installed such that not more than two fire hydrants will be between intersecting lines.
- M. Fire hydrants on private property shall be located within easements and protected by curb stops and bollards, the maintenance of which shall be the responsibility of the property owner. The property owner is responsible for keeping the curb stops or bollards in place.
- N. Fire hydrants on private property shall be accessible to the Fire Department at all times.
- O. The location of all fire hydrants is subject to approval of the Fire Department.
- P. Removal and re-installation of fire hydrants 8 years and older is not allowed and will have to be replaced with a new fire hydrant.

5.01.10 Connections to Existing Water Mains

- A. Connections to 12" water mains and larger shall be made with a pipe a minimum of one size smaller than the line being tapped.
- B. The smallest pipe connection to water mains 20" and larger is 6".
- C. Utilize existing stub-outs when available. Connections to same water line, 20" and larger, shall be limited to one per overall development unless otherwise approved by the Director of Engineering Services.
- D. Connection to water line will be made by use of tee and valve on branch of tee. Direct tapping will be allowed only when a water line cannot be shut down to install tee and valve.

5.01.11 Backflow Prevention

Backflow prevention devices shall be required at the following locations in order to protect the public water system from cross contamination:

- A. Commercial property water service lines
- B. Dedicated irrigation lines
- C. Private fire service main supplying fire sprinkler systems
- D. Multi-family residential water service lines

5.01.12 Automatic Flushing Valve

- A. Automatic Flush Valves shall be placed on dead-end water mains. Water mains anticipated to be extended in the future may be required to install an automatic flush valve, depending on the timing of future work and the specific location.
- B. Automatic Flush Valves shall drain via pipe to the storm drain system.
- C. Refer to Standard Detail for typical installation and Approved Material List for acceptable products.

5.01.13 Water Line Abandonment

- A. Existing unused water services and stub-outs shall be abandoned at the water main.
- B. Water services should be removed and plugged at the saddle.
- C. Dead end water lines should be removed and capped at the connection to the water main.
- D. The following applies to water lines to be abandoned in place
 - 1. The abandoned portion is to be cut, the first full length of pipe removed, then capped.
 - 2. All valves, stubs and services should be removed and capped or plugged at the connection to the abandoned water line.
 - 3. Return all abandoned meters and fire hydrants to Public Works Department.
- E. Easements shall be abandoned in accordance with Section 1.11 of the Engineering Standards.

5.02 Wastewater System – General

- A. Design criteria for all wastewater systems shall comply with TCEQ Chapter 217 (Design Criteria for Domestic Wastewater Systems), latest revision. Chapter 217 is included in Part 1 of Title 30 of the Texas Administrative Code.
- B. Wastewater mains shall be sized and extended through the limits of a development to serve adjacent properties.

5.02.1 Wastewater Main Location

- A. Wastewater mains serving residential and commercial developments shall be located under street paving along the center of the street.
- B. Wastewater mains shall not be located in alleys.
- C. Wastewater mains located near open waterways shall follow the alignment of the waterway along the high bank and be located a minimum of 15' beyond the top of bank.
- D. Wastewater manholes shall not be located in the flow line of an existing waterway and shall be located a minimum of 15 feet beyond the top of bank.
- E. Wastewater mains shall not be located inside the storm sewer system.
- F. Wastewater mains shall not be located within the center of a roundabout.

5.02.2 Horizontal and Vertical Alignment

- A. Wastewater mains shall be designed as straight as possible between manholes.
- B. Wastewater mains running parallel with public right-of-ways shall match change in street direction. When streets have horizontal curvature, curved sewers are acceptable to maintain parallel alignment.
- C. Minimum cover for wastewater main shall be 4'.
- D. In general, the minimum depth for a wastewater main to serve a given residential property with a 4" lateral shall be 3' plus 2% times the length of the house lateral (the distance from the wastewater main to the center of the house). Thus, for a house 135' from the wastewater main, the depth would be 3' plus $2\% \times 135' = 3.0 + 2.7 = 5.7'$. The depth of the flow line of the wastewater main should then be at least 5.7' below the elevation of the ground at the point where the service enters the house. Profiles of the ground line 20' past the building line will be required to verify that this criteria is met.
- E. No vertical bends or vertical curves shall be allowed between manholes.
- F. A parallel wastewater main shall be required for wastewater lateral connections on wastewater mains deeper than 12'.
- G. Wastewater mains shall be placed on such a grade that the velocity is not less than 2 fps or more than 10 fps at design peak flow. The following table of values may be used:

TABLE 5.3: Minimum and Maximum Grades for Wastewater Mains*

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

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

**For lines larger than 39" in diameter, the slope shall be determined using the following equation.

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

where:

- V = velocity of flow in wastewater main (fps)
n = roughness coefficient of the wastewater main
R = hydraulic radius of the wastewater main (ft), which is equal to the area of the flow divided by the wetted perimeter (R=A/P)
S = Slope of the hydraulic gradient (ft/ft)

5.02.3 Separation Distance between Wastewater and Water Mains

Refer to Section 5.01.3 for separation of wastewater and water mains.

5.02.4 Wastewater Flows

If project specific wastewater flow projections or actual flow measurements are not available, the criteria in Table 5.4 shall be used to calculate average daily and peak wastewater flows. This criteria meets or exceeds the minimum requirements as set by TCEQ in Title 30 of the Texas Administrative Code, Part 1, Chapter 217, Subchapter C, Rule 217.32(a)(3).

TABLE 5.4: Wastewater Flow Projections

Land Use	Design Factors	Average Daily Wastewater Flows	Peak Wastewater Flows*
Apartment	<ul style="list-style-type: none"> 3.0 persons/unit 102 gallons per person per day 	306 gpd/unit	1,224 gpd/unit
Residential/ Town Home/ Patio Home	<ul style="list-style-type: none"> 3.5 persons/unit 102 gallons per person per day 	357 gpd/unit	1,428 gpd/unit
Hospital (Beds)	<ul style="list-style-type: none"> 200 gallons per bed per day 	200 gpd/bed	800 gpd/bed
Nursing Home or Other Institution (Beds)	<ul style="list-style-type: none"> 100 gallons per day per bed 	100 gpd/bed	400 gpd/bed
Commercial/ Industrial/Office	<ul style="list-style-type: none"> 1 person per parking space, or 1 person per 400 sf of building 20 gallons per day/person 	20 gpd/person	80 gpd/person
School	<ul style="list-style-type: none"> 20 gallons per student/day 	20 gpd/student	80 gpd/student

* Peak flow is based on a peaking factor of 4.0.

5.02.5 Wastewater Main Sizing

- A. The Water, Wastewater and Reuse Master Plan should be used as a guide for sizing wastewater mains; however, actual size shall be determined by an engineering analysis of initial and future flow of the total drainage area to be served.
- B. Wastewater mains less than 21" diameter shall be sized to carry the ultimate peak flow at 100% of the full flow capacity of the pipe. Wastewater mains larger than 21" diameter shall be sized to carry the ultimate peak flow at 85% of full pipe capacity.
- C. A peaking factor of 4.0 shall be used in design of wastewater mains.
- D. Pipe capacity shall be calculated using Manning's equation. A roughness coefficient of 0.013 shall be used.
- E. City-maintained, gravity wastewater mains shall be a minimum of 8".

5.02.6 Wastewater Main Materials

- A. Polyvinyl Chloride (PVC) Wastewater Pipe
 1. Non-pressure rated, gravity wastewater mains between 6" to 15" diameter shall be SDR 35 if top of pipe is less than 10' below ground surface or SDR 26 if top of pipe is deeper than 10' below ground surface (ASTM D3034). When SDR 26 is required, the pipe shall be SDR 26 from manhole to manhole.
 2. Non-pressure rated gravity wastewater mains 18" diameter and greater shall have a minimum pipe stiffness of 46 psi or 115 psi and shall be manufactured in accordance with ASTM F679 (solid wall).
 3. Pressure rated gravity wastewater mains and force mains from 6" to 12" diameter shall be SDR 26 (ASTM D2241) with a minimum pressure rating of 160 psi.

4. Pressure rated gravity wastewater mains and force mains greater than 12" diameter shall be AWWA C905 DR25 with a minimum pressure rating of 165 psi.
 5. PVC profile wall pipe is not allowed.
- B. Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
1. Non-pressure rated gravity wastewater mains 18" diameter and greater shall be in accordance with ASTM D3262 with a minimum pipe stiffness of 46 psi and Class "B-2" embedment in accordance with NCTCOG Item 504.5 and Standard Drawing 3020.
 2. Pressure rated gravity wastewater mains and force mains 18" diameter and greater shall be in accordance with ASTM D3754 with a minimum pressure rating of 150 psi and Class "B+" embedment in accordance with NCTCOG Item 504.5 and Standard Drawing 3020.
- C. Vitrified clay pipe is not allowed.

5.02.7 Wastewater Service Laterals

The sizes and locations of laterals shall be designated as follows:

- A. Wastewater service laterals for single-family residential shall be a minimum of 4" diameter. Laterals shall be installed 10' downstream from the center of the lot and have a minimum separation distance of 10' separation from the water service.
- B. Wastewater service laterals for multiple units, apartments, local retail and commercial developments shall be a minimum of 6" diameter.
- C. Wastewater service laterals for manufacturing and industrial shall be a minimum of 8".
- D. Manholes are required on 6" and larger wastewater service laterals where they connect to the main line.
- E. Wastewater service laterals shall not be attached to wastewater mains that are deeper than 12'. Deep cut or drop connections are not be permitted.
- F. Each building shall have only one wastewater service lateral, except duplexes which shall have two wastewater service laterals independently attached to the wastewater main.
- G. All mains installed for future developable areas shall include wastewater service laterals; the use of boots will not be permitted.
- H. All wastewater service laterals crossing water mains shall conform to the requirements of the TCEQ Chapter 217, Subchapter C, Rule 217.53(d), latest revision, or Section 5.02.3 of this standard.
- I. Unused wastewater service laterals and main stubouts shall be abandoned and plugged at the manhole.

5.02.8 Manholes and Cleanouts

- A. Manholes shall be installed at all changes in grade and direction, and have a maximum spacing of 500'.

- B. Spacing between a manhole and an upstream cleanout shall be a maximum of 250'. A cleanout or manhole shall be located at the end of a wastewater main.
- C. Manholes on curved wastewater mains shall be located at the P.C. or P.T. of the curve and have a maximum spacing of 300' along the curve.
- D. Manholes shall be constructed of monolithic, cast-in-place concrete, precast concrete, polymer concrete, or fiberglass.
- E. Manholes shall be concentric type unless otherwise approved by the Director of Engineering Services.
- F. Drop manholes are required when the inlet pipe flow line elevation is more than 24" above the outlet pipe flow line elevation. Drops shall be outside the manhole unless otherwise approved by the Director of Engineering Services.
- G. Manholes shall be sized as follows:
 - 1. 4' diameter for 8", 10", and 12" pipe.
 - 2. 5' diameter for 15", 18", 21", 24" and 27" pipe.
 - 3. 6' diameter for 30" and 36" pipe.
 - 4. A minimum of 5' diameter for manholes deeper than 15'.
- H. Where more than three manholes in sequence are to be bolted and sealed, every third manhole shall be vented 2' above the 100-year floodplain elevation or 10' above the adjacent ground line, whichever is higher. The Engineer shall provide the elevation of the 100-year floodplain on the profile.
- I. Manholes are required within 25' to 30' of each end of aerial crossings or wastewater mains installed by other than open cut.
- J. Manholes shall not be located in parking spaces or residential lots.
- K. Manholes with pipes of different sizes must have the tops of the pipes at the same elevation and flow channels in the invert sloped on an even slope from pipe to pipe.
- L. Wastewater mains shall not be connected to a manhole at an angle of less than 90 degrees to direction of flow unless the flow line of the wastewater main is at least 6" above the outlet flow line elevation.
- M. If an existing manhole with an opening smaller than 30" diameter is modified, the cone section, ring, and cover shall be replaced with a minimum of 30" diameter cone section, ring, and cover.

5.02.9 Inverted Siphons

The use of an inverted siphon to avoid obstructions along the alignment of the wastewater main requires approval by the Director of Engineering Services. Should an inverted siphon be necessary the design shall include:

- A. Two or more barrels (pipes).

- B. A minimum pipe diameter of 6”.
- C. The necessary appurtenances for convenient flushing and maintenance.
- D. A manhole both upstream and downstream of the siphon for cleaning equipment, inspection and flushing. Manholes shall be monolithic, cast-in-place concrete or precast concrete.
- E. The siphon must be sized with sufficient head to achieve velocity of at least 3 fps at initial and design flows.
- F. The inlet and outlet shall divert the normal flow to one barrel.
- G. The system shall be designed to allow any barrel to be taken out of service.
- H. The system shall be designed with odor control.

5.02.10 Wastewater Lift Stations

Any proposed use of a wastewater lift station must be approved by the Director of Engineering Services.

- A. Lift stations shall be designed in accordance with TCEQ Chapter 217, Subchapter C.
- B. The Engineer shall prepare an engineering design report for the lift station.
- C. Lift station perimeter fence shall be a minimum of 150 feet from residential lot lines.
- D. The lift station shall be connected to the City Supervisory Control and Data Acquisition (SCADA) system. The Owner shall pay all costs associated with the SCADA including all labor, equipment, materials, and programming of the City’s computer and testing. The SCADA equipment installed shall conform to the City’s standard specifications for Computerized Monitoring and Control Specifications for Wastewater Lift Stations.
- E. Control panels shall have heaters and exhaust fans, CT for reading amperage, HOA switch, and an amp overload reset button on the outside of the panel.
- F. A 2” blow off with an isolation valve and RPZ shall be installed next to the vault opposite the control panel.
- G. Lift stations shall include an approved odor control system.
- H. The odor control tank shall have a concrete foundation.
- I. If carbon filters are required, the housing shall be painted per the approval of the Director of Engineering Services.
- J. Lift stations with two or more wet wells shall include a sluice gate between each wet well.
- K. Each pump shall have two guide rails.
- L. Pumps shall be controlled by floats.
- M. Pumps shall include hydraulic mixed flush valves.

- N. For triplex pump stations, all three pumps are required to have swinging check valves, breakers, starters and floats for emergency situations.
- O. Lift stations shall include a landscaping and irrigation plan approved by the City.
- P. The perimeter of lift station sites shall have an 8' tall welded tubular steel fence with a 16' slide gate.

5.02.11 Force Mains

- A. Use white-colored pipe material whenever available.
- B. 12" diameter and smaller pipe shall be PVC ASTM D2241 SDR 26, or as determined by the Engineer and approved by the Director of Engineering Services.
- C. Pipes larger than 12" diameter shall be PVC AWWA C900 DR 18, or as determined by the Engineer and approved by the Director of Engineering Services.
- D. Minimum size for force mains is 6" diameter.
- E. Plug valves shall be installed every 2,000'.
- F. All visible access points (valves, manholes, etc.) shall have cover/lids labeled "wastewater".

5.02.12 Dumpster Enclosure Drains

- A. Dumpster enclosures serving commercial sites requiring the enclosure to be washed out may provide a connection to the sanitary sewer system.
- B. The connection shall provide a water-tight sealed cover that can be removed to drain enclosure during periodic cleaning.
- C. The dumpster enclosure shall be constructed to prevent parking lot stormwater runoff from entering enclosure area.

5.02.13 Wastewater Abandonment

- A. Main Line Abandonment
 - 1. Remove abandoned main. OR
 - 2. Abandon in place by plugging the last 5' of each end of the main.
- B. Manhole Abandonment per City Standard Detail.

5.03 Reclaimed Water System – General

- A. Design criteria for all reclaimed water systems shall comply with TCEQ Chapter 210 (Use of Reclaimed Water), latest revision. Chapter 210 is included in Part I of Title 30 of the Texas Administrative Code.
- B. Reclaimed main sizes shall comply with the Water, Wastewater and Reuse Master Plan unless approved in writing by the Director of Engineering Services.

- C. Reclaimed water mains shall be sized and extended through the limits of a development to serve adjacent properties.
- D. A reclaimed water storage facility is only allowed with written permission of the Director of Public Works.
 - 1. The Owner shall pay all costs associated with the storage facility, including but not limited to connection to the public system, storage facility, meter, and backflow prevention.
 - 2. Backflow prevention shall be an air gap in accordance with TCEQ requirements unless otherwise approved by the Director of Public Works.
 - 3. The storage facility shall be connected to the City Supervisory Control and Data Acquisition (SCADA) system. The Owner shall pay all costs associated with the SCADA including all labor, equipment, materials, and programming of the City's computer and testing. The SCADA equipment installed shall conform to the City's standard specifications for Computerized Monitoring and Control Specifications.

5.03.1 Reclaimed Water Main Location

- A. Reclaimed water mains shall be located behind the curb outside of street paving.
- B. Reclaimed water mains crossing under storm sewers shall follow the same criteria in Section 5.01.2.E.

5.03.2 Horizontal and Vertical Alignment

- A. The horizontal and vertical alignment for the reclaimed water system shall follow the same criteria as the water system in Section 5.01.2.

5.03.3 Separation Distance between Reclaimed Water and Other Systems

- A. The separation distance for reclaimed water and potable water main shall follow the criteria outlined in Section 5.01.3.
- B. The minimum horizontal separation distance between reclaimed water and wastewater mains shall be 3' outside to outside, with the reclaimed water main located at or above the wastewater main.
- C. Reclaimed water mains that parallel wastewater mains may be placed in the same benched trench.
- D. The separation distance for reclaimed water mains crossing wastewater mains shall follow the criteria outlined in Section 5.01.3.D.2

5.03.4 Reclaimed Water System Materials

- A. Reclaimed water mains shall utilize the same pipe materials as water mains per Section 5.01.6.
- B. All reclaimed water main pipe shall be manufactured in purple or encased in purple polyethylene tubing.

5.04 Easements

- A. In single-family residential developments, water, wastewater, and reclaimed water mains shall not cross residential lots unless specifically approved by the Director of Engineering Services, in which case the easement shall be located within a single lot and be a minimum of 15' in width.
- B. Water mains 24" and larger shall be located in an easement parallel and adjacent to the right-of-way.
- C. All easements required by the City shall be dedicated by plat if within the platted boundary. If outside the platted boundary, easements shall be dedicated by separate instrument
- D. The following shall apply to utility easements, exclusive and general, unless otherwise approved by the Director of Engineering Services.
 - 1. Site paving, such as parking, fire lanes and access drives are allowed over utility easements.
 - 2. Repair or replacement of Enhanced pavement (stamped, stained, pavers, etc.) shall not be the responsibility of the City when working on City utilities.
 - 3. Masonry and retaining walls, crossing utility easements, should provide encasement of water and sewer mains under the wall. Encasement, concrete or steel, should extend at least 5' on either side of the wall.
- E. The following minimum width exclusive utility easements are required, and may be increased, when facilities are not located within public rights-of-way. The easements are subject to the approval of the Director of Engineering Services.
 - 1. Water/Reclaimed Water mains 12" diameter and smaller are to be located within the center of a minimum 15' utility easement.
 - 2. Water/Reclaimed Water mains 16" diameter and larger shall be a minimum of 20'.
 - 3. Wastewater mains with a depth up to 10' shall be located in the center of a 15' utility easement.
 - 4. Wastewater mains with depths between 10' and 20' shall be located in the center of a 20' utility easement.
 - 5. Wastewater mains with a depth greater than 20' shall be located in the center of a 30' utility easement.
- F. Fire hydrants and automatic flushing valves located outside of public rights-of-way shall be located within a 10' x 10' utility easement.
- G. 2" and smaller meters serving multi-family residential and non-residential developments shall be located within the right-of-way or in a minimum 5' x 5' utility easement.
- H. 3" and larger meters shall be located within a minimum 10' x 10' utility easement outside the right-of-way.
- I. All water main appurtenances such as air release valves with vents must be contained within utility easements with a minimum 3' clearance from the edge of the easement.

5.05 Thrust Restraint

- A. All pressurized water and wastewater mains shall be restrained against thrust forces due to change in pipeline diameter or alignment in order to prevent joint separation or movement.
- B. Thrust restraint shall be accomplished by concrete thrust blocks and restrained joints.
- C. All valves, fittings and changes in elevation shall have concrete thrust blocks and restrained joints installed.
- D. Thrust blocking shall be Class “PA” concrete per NCTCOG Item 702.2.4.3 and be able to withstand a minimum 200 psi test pressure with a minimum safety factor of 1.5 without exceeding the soil bearing capacity.
- E. Restrained joints lengths shall be calculated to withstand a minimum 200 psi test pressure with a minimum factor of safety of 2.0.
- F. The following technical references are available for calculating thrust restraint systems:
 - 1. AWWA Manual M9: Concrete Pressure Pipe by AWWA, Latest Edition.
 - 2. AWWA Manual M11: Steel Pipe – A Guide for Design and Installation by AWWA, Latest Edition.
 - 3. AWWA Manual M23: PVC Pipe – Design and Installation by AWWA, Latest Edition.
 - 4. Thrust Restraint for Ductile Iron Pipe by Ductile Iron Pipe Research Association (DIPRA), 2006, or Latest Edition.
 - 5. Thrust Blocking, National Fire Protection Association Standard 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2007 Edition

5.06 Pavement Cut and Repair

- A. Water and wastewater and reclaimed water main improvements shall be designed to minimize the impact to existing pavement, where feasible.
- B. No pavement shall be cut unless approved in writing by the Director of Engineering Services. Existing pavement cut, excavation and repair shall be in accordance with NCTCOG Item 402 and NCTCOG Standard Drawings 3070A through 3070D.
- C. If pavement cut and repair is permitted, full panel concrete pavement replacement will be required.

5.07 Trenchless Construction

- A. Launching and receiving pits for trenchless construction shall be a minimum of 5' from the edge of pavement.
- B. The location, size and depth of the launching and receiving pits for trenchless construction shall be evaluated during construction plan review.
- C. Approved Methods

1. Horizontal Boring - Horizontal boring shall require a steel casing pipe with a minimum yield strength of 35,000 psi and minimum wall thickness of (1/4"). Actual wall thickness shall be designed based on a highway loading of HL-20, a maximum deflection of 5% and a minimum factor of safety of 2.0.
2. Pipe Jacking - Pipe shall be designed to withstand all jacking forces with a factor of safety of 2.0 during construction.
3. Tunneling

5.08 Crossings

A. Highway Crossings

1. The design of water and wastewater mains within a state highway must be in compliance with all applicable requirements of the Texas Department of Transportation (TXDOT), unless a variance is approved by TXDOT. The following reference applies: Title 43 of the Texas Administrative Code, Part 1, Chapter 21, Subchapter C – Utilities Accommodation
2. Water and wastewater mains shall be located so as to avoid or minimize the impact to future highway projects and improvements, to allow other utilities in the right-of-way, and to permit access to water and wastewater mains and other utility facilities for their maintenance with minimum interference to highway traffic
3. New water and wastewater mains crossing a highway shall be installed at approximately 90° to the centerline of the highway,
4. New water and wastewater mains located longitudinally along a highway shall be designed parallel to and outside the ultimate the right-of-way.
5. All water and wastewater main crossings shall be encased with steel casing pipe in accordance with Section 5.07.C.1 Horizontal Boring, or approved equal. Casing pipe shall be extended to the right-of-way line
6. Water valves, manholes and other appurtenances shall not be placed in the pavement or shoulder of highway.
7. Water main crossings shall include a valve on each side of the highway crossing.
8. Individual service meters shall be placed outside the limits of the right-of-way.

B. Railroad Crossings

1. The design of water and wastewater mains within railroad right-of-way must be in compliance with the requirements of the appropriate railroad authority. The designer should determine which railroad company right-of-way is being crossed and obtain their utility accommodation policies prior to beginning the design. The following references may be applicable:
 - a. Utility Accommodation Policy by Burlington Northern Santa Fe (BNSF), Latest Edition.
 - b. American Railway Engineering & Maintenance Association (AREMA), Latest Edition.

2. New water and wastewater mains crossing a railroad shall be installed at approximately 90° to the centerline of the railroad.
3. New water and wastewater mains located longitudinally along a railroad shall be designed parallel to the right-of-way. No main shall be located closer than 25' from the centerline of the track or within the railroad right-of-way.
4. All water and wastewater crossings shall be encased with steel casing pipe in accordance with Section 5.07.C.1 Horizontal Boring or approved equal. Casing pipe crossing railroad tracks shall be designed to withstand E80 railroad loadings and shall extend to the right-of-way lines.
5. Water valves, manholes, meters and other appurtenances shall be placed outside the limits of the right-of-way.
6. Water main crossings shall include a valve on each side of the railroad crossing.

C. Creek Crossings

1. All water and wastewater mains crossing under a flowing stream or semi-permanent body of water such as a marsh or pond shall be encased with concrete or steel casing pipe in accordance with Section 5.07.C.1 Horizontal Boring or approved equal.
2. Wastewater main crossings shall include a manhole 15' beyond the top of creek bank on each side of the creek crossing.
3. Water main crossings shall include a valve 15' beyond the top of creek bank on each side of the creek crossing.
4. Water mains installed under and across creeks or ditches shall be designed according to the following:
 - a. Water mains with less than 4' of cover shall be protected by Class PC concrete encasement a minimum of 10' past the top of the embankment on each side.
 - b. Trench backfill under creeks and ditches shall consist of flowable backfill in accordance with NCTCOG Item 504.2.3.4.
 - c. Rock bottom creeks and ditches shall include a 6" concrete cap at the surface in accordance with NCTCOG Item 504.5.2.14 and Standard Drawing 3060.
 - d. Bank stabilization shall be required at all crossings and shall consist of a pervious armored surface to resist scour and shear forces on all disturbed areas.

D. Stormwater Crossings

1. Steel, or concrete, encasement of water and wastewater mains is required when crossing reinforced concrete box storm sewers for a distance of 5' each side. The encasement shall have a minimum vertical clearance of 2' from the bottom of the culvert.
2. Encasement of water and wastewater mains crossing storm sewer pipe may be required.

E. Aerial Crossings

1. Aerial crossings for water and wastewater mains are only permitted with written approval of the Director of Engineering Services.
2. The permit will define conditions for the design and construction to include but are not limited to hydrology and hydraulic studies to determine water surface rise, force of water for design storms on the crossing, geomorphology, erosion impacts and mitigation, other conveyance alternatives.
3. The Franchise, or dry, utility should be 18" below the water or wastewater main, lateral, service or lead that are less than 8' deep.

F. Franchise/Dry Utility Crossings

1. Franchise, or dry, utility crossings should be done at 90 degree angles to the City utility.
2. The Franchise, or dry, utility should be 18" below the water or wastewater main, lateral, service or lead that are less than 8' deep.

5.09 Corrosion Protection

- A. Corrosion protection should be considered on all metal water and wastewater mains 16" diameter or greater.
- B. Corrosion investigation of metal pipeline sites shall include:

TABLE 5.5: Conditions Requiring Corrosion Protection System

Soil Characteristics	Conditions Requiring Corrosion Protection System
Chloride	>500 ppm
Sulfate	>2,000 ppm
Soil pH	≤ 5.5 or >8.5
Soil/Water Resistivity	<2,000 ohm-cm

- C. External and internal protective coating shall be required.
- D. To prevent galvanic corrosion for all metal pipes, provide isolating joints by using insulating kits or other means in the following locations:
 1. Changes in pipeline materials
 2. Connections to existing piping, i.e. old and new piping, including taps
 3. Laterals from transmission mains
 4. Valve to metal pipe
 5. Metallic casing spacer to RCCP, PCCP, DI or Steel pipe

- E. All metal pipes that are 16" and larger shall be designed to be electrically continuous through joint bonding wires, or welded joints and shall install corrosion test stations at a maximum spacing of 1,000'.
- F. All water and wastewater mains requiring a corrosion protection system shall be designed by a NACE certified professional engineer.

SECTION 6 – LANDSCAPING DESIGN REQUIREMENTS

Section 6 – Landscaping Design Requirements

6.01 General

- A. The purpose of this section is to provide additional requirements and standards to address landscaping requirements only **within the medians of major and minor thoroughfares**. Refer to the following ordinances and documents:
1. [Zoning Ordinance, Section 2.05](#) – Special Zoning Districts
 2. [Zoning Ordinance, Section 4.01](#) – Tree Preservation Requirements
 3. [Zoning Ordinance, Section 4.02](#) – Landscape Requirements
- B. Landscape construction plans shall be prepared and sealed by a Landscape Architect licensed to practice Landscape Architecture within the State of Texas.
- C. Requirements for landscaping within the parkways are contained in the Zoning Ordinance, Section 4.02.

6.02 Landscape Requirements within the Median

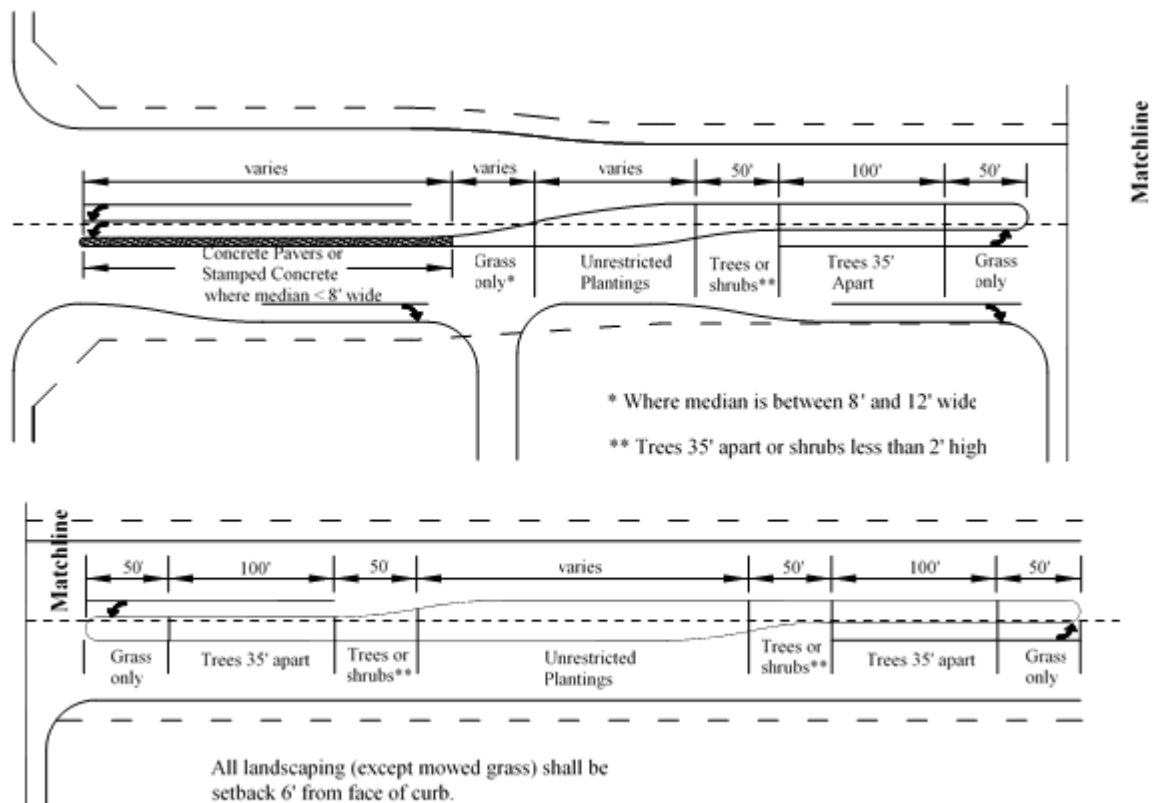


FIGURE 6.1: Typical Median Landscaping

- A. Landscaping that is located within the median of a thoroughfare shall meet the requirements shown in Figure 6.1.
- B. Refer to Section 2.07 (Thoroughfare Design Requirements) for corner visibility and sight line triangles with regards to landscaping and other obstructions.
- C. A minimum of 4" (or 6" in rock) suitable loam topsoil shall be furnished and installed in the areas behind the curbs.
- D. Only mowed grasses are permitted within 6' of the existing or future face of curb unless approved by the Director of Engineering Services and Director of Parks and Recreation.
- E. Irrigation shall be provided in accordance with the Irrigation Design Standards (Section 7 of the Engineering Standards) and Section 4.02.02 of the Zoning Ordinance.
- F. Median tree spacing shall be 35' (typical) apart center-to-center of tree trunk generally located in the center of the ultimate median.
- G. Trees shall not be planted within 25' of an existing street light.
- H. Trees shall be planted at least 4' from the outside edge of any pipelines.
- I. The City has final approval for all tree placements.
- J. Trees overhanging walks and parking shall have a minimum clear trunk height of 7'. Trees overhanging public street pavement drive aisles and fire lanes shall have a minimum clear trunk height of 14'.
- K. Trees and planting areas shall not be installed on slopes steeper than 3:1.
- L. Landscaping shall be located so that pedestrians can walk along the parkway whether a paved sidewalk is provided or not.
- M. Sod shall be placed to cover median areas and a minimum of 2' behind the curb along all public roadways in accordance with the City Technical Specifications.
 - 1. Buffalo Grass (median only) planting time is March to September.
 - 2. Planting outside of this time frame is only allowed with written permission of the Director of Engineering Services.
- N. Areas not required to be sodded must be approved by the Parks and Recreation Department and shall be seeded after properly preparing the ground as designated on the plans and in accordance with City Technical Specifications.
- O. Conduit for street lighting and irrigation shall be generally located as shown in Figure 6.2 to accommodate trees, street lights and irrigation within the roadway median.

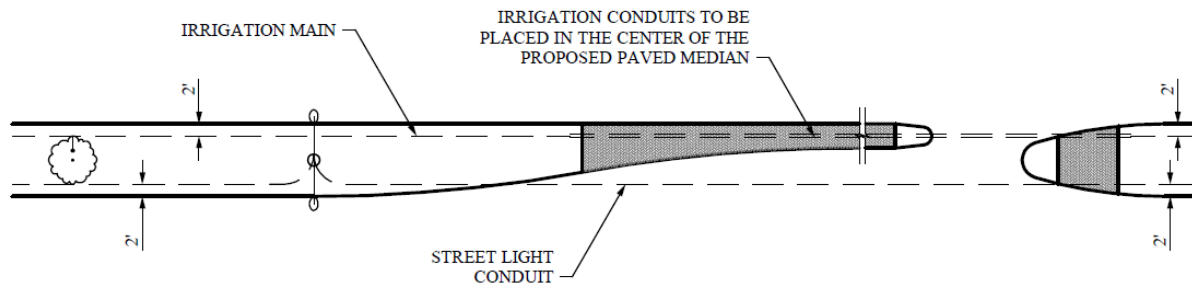


FIGURE 6.2: Conduit for Street Lighting and Irrigation

- P. Trees within 200' from the nose of a median shall have foliage trimmed to at least 10' above the ground.
- Q. Beyond a point 200' from the nose of the median, tree foliage should be trimmed to at least 7' from ground.
- R. Landscaping within a Roundabout:
 1. Landscaping is an important component of the design and operation of a roundabout. Landscaping within the central island is encouraged in order to prevent the driver from looking beyond the roundabout and instead draw attention to the shape and function of the roundabout.
 2. Landscaping within the splitter islands or central island of a roundabout shall be limited so that the minimum sight distances described in Section 2.02.F.12 are provided at the roundabout.
 3. Regardless of the landscaping to be installed, the central island of a multi-lane roundabout shall contain a mound of earth that is between three and a half feet (3.5') and six feet (6') high, measured at its center. The mound shall have a maximum slope of six to one (6:1), which shall flatten as it approaches the curb.
 4. The design for a roundabout shall include landscape design sheets identifying the dimensions of the central mound, plant locations, plant types, height of the mature plant measured from the roadway surface, the minimum pruning height for the lower branches of any trees to be planted, and the sight distance lines required in Section 2.02.F.12.
 5. Landscaping designs for a roundabout shall be approved by the Director of Engineering Services.

6.03 Approved Plant Materials

- A. Refer to the online Approved Material List for approved plant materials for median planting. Other species may be utilized with approval from the City's Parks and Recreation Department. Artificial plants are prohibited.
- B. Buffalo Grass shall be used in median plantings.
- C. Bermuda shall be used along parkways.

SECTION 7 – IRRIGATION DESIGN REQUIREMENTS

Section 7 – Irrigation Design Requirements

7.01 General

- A. The purpose of this section is to provide additional requirements and standards to address irrigation requirements **within the medians of major and minor thoroughfares**. Refer to the following ordinances and documents:
 - 1. [Irrigation Ordinance](#) (HB 1656)
 - 2. [Water Management Plan](#)
 - 3. [Zoning Ordinance, Section 4.02](#) – Landscape Requirements
- B. Irrigation construction plans shall be prepared and sealed by a State of Texas licensed Irrigator.
- C. Requirements for irrigation within the parkways are contained in the Zoning Ordinance, Section 4.02.02.

7.02 Roadway Irrigation Requirements

- A. Irrigation system shall be designed and installed to minimize runoff onto paved surfaces. Overspray on streets and walks are prohibited.
- B. All Irrigation plans shall be submitted to the Parks and Recreation Department for review.
- C. Private irrigation system mainlines, valves, or control wires located within the City's right-of-way shall be maintained by the adjacent property owner.
- D. The bore depth under streets, drive aisles, and fire lanes shall allow 2' minimum from the bottom of paving to the top of the sleeve, or greater if required to clear other utilities
- E. Only irrigation piping and boxes connected to the Reclaimed Water system shall be purple in color.
- F. A separate water meter is required for irrigation.
- G. Motorola controllers shall be installed on AC power and/or solar power as directed by the Parks and Recreation Department.
- H. A ball valve is required on the upstream side of control valves, attached to the control valve with a Schedule 80 nipple, and then leaving the control valve with a Schedule 80 nipple to downstream side. The ball valve shall be located in a standard irrigation valve box.
- I. Backflow prevention devices are required for all irrigation systems. They shall have a gate valve and WYE strainer upstream, in that order, and followed with an ARAD flow meter/master valve on the downstream side of the backflow device. All parts of this assembly shall be connected with Schedule 80 nipples with gate valve and WYE strainer located in a single standard irrigation valve box, backflow device in a jumbo irrigation valve box and ARAD flow meter/meter valve in a standard valve box.
- J. Provide a section valve to regulate pressure in the irrigation system.

- K. Check valves are required where elevation differences will cause low-head drainage.
- L. PVC water lines shall be Pressure Rated Class 200, DR 21.
- M. Minimum main line pipe size shall be 1-1/4".
- N. Minimum lateral line pipe size shall be 3/4".
- O. System shall deliver a minimum residual pressure of 30 pswi at the spray head and 50 pswi for rotors.
- P. Each valve shall irrigate a landscape zone containing plant materials with similar water requirements and similar site, slope and soil conditions.
- Q. Where drip systems are to be used, they shall be designed to provide water uniformly from sub-grade PVC piping.
- R. Trees shall be irrigated with one, one gpm bubbler each with a separate valve
- S. Irrigation heads shall comply with the following:
 - 1. Multi-stream multi-trajectory rotor heads.
 - 2. Low precipitation with 0.7DU or greater.
 - 3. Selected and spaced for 100% coverage.
 - 4. Matched precipitation rates on each zone.
 - 5. Have spring retracted pop-up operation.
 - 6. Installed on green 6" cut off riser.
 - 7. Adjust heads to ensure uniform coverage and to prevent overspray.
 - 8. Shall be installed a minimum of 6" from back of curb and in accordance with current TCEQ regulations.
 - 9. Connect all MSMTR or equivalent heads with bull head connection.
- T. Feeder laterals and mainlines shall be located as close to the center of median as feasible.
- U. Refer to the Approved Materials List for Median Right-of-Way Irrigation Equipment.

7.03 Additional Irrigation Design Requirements within Roadway

- A. Two 4" PVC conduits shall run from 2' behind the back of curb from median nose to median nose, extending beyond the limits of hardscape (concrete median nose, pavers, etc.). Two 4" PVC conduits shall also run from median to parkway as needed to provide water and power to the median. The end of the conduits shall be clearly marked with a sawcut.

- B. No swing pipe or flex pipe will be allowed on rotors or pop-up spray heads. Swing pipe or flex pipe may be used on tree bubblers as long as they are no longer than 3' from PVC fitting to tree well.
- C. Wiring shall include six 14 gauge (minimum) wires including two blue, two yellow and two other colors (not red or white) from the ARAD master valve back to Motorola controller.
- D. Refer to Section 6.02, Landscape Requirements within the Median for additional information on location of conduits for street lighting and irrigation in relation to tree planting.

SECTION 8 – ENVIRONMENTAL REQUIREMENTS

Section 8 – Environmental Requirements

8.01 General

The Owner must provide proof of compliance with applicable local, state, and federal environmental regulations upon request by the City.

8.02 Storm Water Management Plan (SWMP) – Permanent Controls

A. General Requirements

A Storm Water Management Plan (SWMP) shall be prepared for all developments in accordance with the Subdivision Ordinance for the preliminary and final submittals. The SWMP shall be developed and coordinated with the site drainage plan and may be shown on the same sheet. The SWMP shall identify permanent site features and controls that will be constructed with the project to minimize and mitigate the project's long-term effects on storm water quality and quantity.

The SWMP should also be coordinated with the landscaping plan to prevent conflicts and ensure compatible land use. The SWMP should be separate and not confused with the SWP3 discussed in Section 8.03.

B. Site Development Controls (Permanent) Reference Section 4.18

It is the responsibility of the engineer to design permanent controls that address site specific conditions for the intended land use using appropriate design criteria for the North Central Texas region. Refer to NCTCOG [iSWM Technical Manual](#) for current recommended practices. Some of the factors to be considered when evaluating and selecting controls for a development are as follows:

- Effect of the development on runoff volumes and rates
- Potential pollutants from the development
- On-site natural resources
- Configuration of site (existing waterways, topography, etc.)

The following are some examples of permanent controls:

- Preservation of natural creeks and riparian areas
- Site specific stormwater controls
- Vegetated swales
- Preservation of the 100-year floodplain
- Detention ponds
- Retention ponds
- Biofiltration areas and water quality structures
- Swales
- Rain water harvesting
- Stormwater quality treatment BMPs
- Other green infrastructure

- C. Permanent Controls During Construction: If the controls are manufactured, the manufacturer shall certify that the controls are installed correctly. Prior to the final inspection this certification shall be provided along with the operations and maintenance manual.

8.03 Temporary Controls during Construction.

All construction activities, regardless of size, shall be in compliance with Article IX the [City Stormwater Discharge Ordinance](#) and [the Construction General Permit](#) (CGP) (TXR150000).

When required notifications to the MS4 shall be done by email to MS4@friscotexas.gov.

8.04 Storm Water Pollution Prevention Plan (SWP3)

One of the requirements of the [Construction General Permit](#) (CGP) is to develop an SWP3. This shall be developed in accordance with CGP and the [SWP3 Guidance Policy for the City of Frisco](#). The purpose of the SWP3 is to provide guidelines for minimizing sediment and other pollutants that may originate on the site from flowing into municipal storm systems or jurisdictional waters during construction. The SWP3 must also address the principal activities known to disturb significant amounts of ground surface during construction.

The storm water management controls included in the SWP3 should focus on providing control of pollutant discharges with practical approaches that use readily available techniques, expertise, materials, and equipment. A copy of the SWP3 and NOI must be provided to the City prior to the scheduling of the preconstruction meeting. The SWP3 must be implemented prior to the start of construction activity.

A. Construction Controls

Structural and non-structural controls may be used for controlling pollutants for storm water discharges from small and large sites. Structural controls shall comply with details and specifications in the latest edition of the NCTCOG [iSWM Technical Manual](#) and these standards. When the NCTCOG Manual and these standards are in conflict, these standards shall govern.

The following are acceptable temporary controls for use during construction:

Non-Structural

- Minimizing the area of disturbance
- Preserving existing vegetation

Structural

- Silt fence
- Inlet protection
- Rock check dams
- Stabilized construction entrances
- Sediment traps
- Vegetated buffer strips
- Temporary detention structure
- Rock check dams
- Hydromulch
- Sedimentation basins
- Concrete washouts

Suggested construction controls can be found on the [NCTCOG iSWM](#) website.

It is the responsibility of the design engineer to select and design appropriate construction controls for each site. If the most appropriate control is not shown in the iSWM Technical Manual, the design engineer shall submit calculations and references for design of the control to the Department of Engineering Services for review and approval.

A sedimentation basin is required, where feasible, for a common drainage location that serves an area with ten (10) or more acres disturbed at one time. A sedimentation basin may be temporary or permanent, and must provide sufficient storage to contain a calculated volume of runoff from a 2-year, 24-hour storm from each disturbed acre drained. When calculating the volume of runoff from a 2-year, 24-hour storm event, it is not required to include the flows from offsite areas and flow from onsite areas that are either undisturbed or have already undergone permanent stabilization, if these flows are diverted around both the disturbed areas of the site and the sediment basin. Capacity calculations shall be included in the SWP3.

B. Waste and Hazardous Material Controls

Covered containers shall be provided for waste construction materials and daily trash. Hazardous materials shall be stored in a manner that prevents contact with rainfall and runoff. Onsite fuel tanks and other containers of motor vehicle fluids shall be placed in a bermed area with a liquid-tight liner or be provided with other secondary containment and spill prevention controls.

The SWP3 shall require federal, state and local reporting of any spills and releases of hazardous materials greater than the regulated Reportable Quantity (RQ) and reporting to Engineering Services of all spills and releases to the storm drainage system.

C. Temporary Stabilization

Portions of a site that have been disturbed, but where no work will occur for more than 21 days shall be temporarily stabilized as soon as practicable, and no later than 14 days, except when precluded by seasonal arid conditions, or prolonged drought.

Temporary stabilization shall consist of providing a protective cover, designed to reduce erosion on disturbed areas. Temporary stabilization may be achieved using temporary seeding, soil retention blankets, hydro-mulches and other techniques that cover 100 percent of the disturbed areas until either final stabilization can be achieved or until further construction activities take place.

Perimeter controls such as silt fence, vegetated buffer strips or other similar perimeter controls are intended to act as controls when stabilization has not occurred. Perimeter controls may remain in place during temporary stabilization.

D. Final Stabilization

Final stabilization consists of soil cover such as vegetation, geo-textiles, mulch, rock, or placement of pavement. For stabilizing vegetated drainage ways, sod or seeded soil retention blankets shall be used. Hydromulch will not be allowed in vegetated swales, channels or other drainage ways.

The plan for final stabilization shall be coordinated with permanent controls in the SWMP and with the landscaping plan, if applicable.

E. Notice of Intent (NOI)

If applicable, copies of the NOI shall be sent to the Engineering Services Department at least 2 days prior to construction. The NOI may be emailed to MS4@friscotexas.gov.

F. TCEQ Site Notice

A signed copy of the Construction Site Notice shall be posted at the construction site in a location where it is readily viewed by the general public during all construction activity.

G. Notice of Termination (NOT)

All parties that submitted a NOI shall submit a NOT within 30 days after final stabilization is established. When the owner of a residential subdivision transfers ownership of individual lots to builders before final stabilization is achieved, the SWP3 shall include controls for each individual lot in lieu of final stabilization. These controls shall consist of stabilization of the right-of-way and placement of structural controls at the low point of each individual lot or equivalent measures to retain soil on each lot during construction. All temporary controls must be removed prior to submitting the NOT. Additionally, the builder must submit a valid NOI before an NOT can be submitted by the owner.

H. Inspection and Maintenance during Construction

The owner shall construct all controls required by the SWP3. The owner shall have qualified personnel inspect the controls every 7 days with additional inspections after rain events. An alternative method may be used as long as it is in accordance with the CGP.

Certified inspection reports shall be retained as part of the SWP3. Within seven days of the inspection, controls identified as damaged or deteriorated shall be repaired or replaced, as appropriate. Controls shall also be routinely cleaned to maintain adequate capacity.

Changes or additions shall be made to the controls within 7 days to prevent discharges from the site. The owner shall implement procedures to remove discharged soil from all portions of the storm drainage system including streets, gutters, inlets, storm drain, channels, creeks, ponds, etc.

Notes requiring the inspection and maintenance shall be placed on SWP3 drawings. The SWP3 shall identify the responsible party for inspecting and maintaining each control. If no party is identified, each owner and operator that submitted a NOI for the site shall be fully responsible for implementing all requirements of the SWP3.

I. Construction and Maintenance

The owner shall submit an erosion control plan and site layout for each major phase of the project. These phases, at a minimum, shall include:

- Initial grading and utility construction
- Street and other pavement construction
- Post pavement construction
- Final acceptance to stabilization

The owner shall construct all permanent controls and is responsible for maintenance of the controls. When the control falls within a drainage easement, the plat or separate instrument dedicating the easement shall include a statement of the owner's responsibility for maintenance.

SECTION 9 – STRUCTURAL DESIGN REQUIREMENTS

Section 9 – Structural Design Requirements

9.01 General

- A. The Design Engineer of record shall bear the sole responsibility for meeting the engineering standard of care for all aspects of the design and providing a design that's required by the site-specific conditions and intended use of the facilities.
- B. For the purposes of this section of the Engineering Standards, the following items shall be considered structures: bridges, foundations, retaining walls (structural and gravity), headwalls and wingwalls, culverts, slopes and embankments, screening walls, and inlets.
- C. The City's review of any structural design is limited to determining whether the construction plans are in general compliance with the City's Master Plans and Engineering Standards. The City's review and release of the construction plans does not represent that the City has re-engineered or verified the engineering of the proposed improvements.
- D. The structural design must be signed and sealed by a structural engineer or civil engineer competent in structural engineering licensed in the State of Texas. The Design Engineer is responsible for all engineering and recognizes that specific site circumstances or conditions may require improvements constructed to exceed minimum standards contained in the City's Engineering Standards. The Design Engineer is responsible for the applicability and accuracy of the construction plans and specifications. The Design Engineer is responsible for acquiring from TXDOT the bridge registration number for applicable bridges and culverts.
- E. Retaining and Screening Walls shall be permitted and constructed in accordance with all requirements of these Engineering Standards. Third-party inspections shall be performed during construction, and reports provided to the City. A third-party shall certify wall was constructed in general compliance with the City-approved plans and specifications, and a certification shall be provided to the City. The Engineer of Record is permitted to act as the third-party inspector to perform inspections and certify construction.

9.02 Code Requirements

- A. All structural design shall comply with the City's currently adopted version of the *International Building Code*.
- B. The design and construction of structural concrete for buildings and where applicable in non-building structures shall be provided in accordance with the requirements of the current version of "Building Code Requirements for Structural Concrete (ACI 318)" as published by the American Concrete Institute.
- C. Placing reinforcing steel in reinforced concrete structures shall be provided in accordance with the requirements of the current version of the "ACI Detailing Manual (ACI 315)" as published by the American Concrete Institute.
- D. The design and construction of concrete tanks, reservoirs, and other structures commonly used in water and wastewater treatment works where dense, impermeable concrete with high resistance to chemical attack is required shall be provided in accordance with the requirements of the current version of "Environmental Engineering Concrete Structures (ACI 350)" as published by the American Concrete Institute. This code places special emphasis on structural design that minimizes the possibility of cracking and accommodates vibrating equipment and other special

loads. ACI 350's minimum requirements for proportioning of concrete, placement, curing, and protection against chemicals shall be met or exceeded. The design and spacing of joints shall also meet or exceed the minimum requirements of ACI 350.

- E. The design and construction of roadway bridges shall be provided in accordance with the requirements of the current version of the "Standard Specifications for Highway Bridges" as published by the American Association of State and Highway Transportation Officials (AASHTO).
- F. Concrete exposed to sulfate-containing solutions or soils shall be made with sulfate resistant concrete per Section 321313 unless Class F flyash is not available. When Class F flyash is not available or when specified in the drawings will alternate methods as described in section 9.02 G be allowed.
- G. Concrete exposed to sulfate-containing solutions or soils shall be made with sulfate-resisting cement. The concrete shall be provided in accordance with the requirements of ACI 318 Section 4.3. Table 4.3.1 lists the appropriate types of cement, the maximum water-cementitious material ratios, and the minimum specified compressive strengths for various exposure conditions.

TABLE 4.3.1: ACI 318 Section 4.3

Sulfate exposure	Water soluble sulfate (SO ₄) in soil, percent by weight	Sulfate (SO ₄) in water, ppm	Cement Type	Maximum water-cementitious materials ratio, by weight, normalweight aggregate concrete*	Minimum f_c' , normalweight and lightweight aggregate concrete, psi*
Negligible	$0.00 \leq \text{SO}_4 < 0.10$	$0 \leq \text{SO}_4 < 150$	—	—	—
Moderate [†]	$0.10 \leq \text{SO}_4 < 0.20$	$150 \leq \text{SO}_4 < 1500$	II, IP(MS), P(MS), I(PM)(MS), I(SM)(MS)	0.50	4000
Severe	$0.20 \leq \text{SO}_4 \leq 2.00$	$1500 \leq \text{SO}_4 \leq 10,000$	V	0.45	4500
Very severe	$\text{SO}_4 > 2.00$	$\text{SO}_4 > 10,000$	V plus pozzolan [‡]	0.45	4500

*When both Table 4.3.1 and Table 4.3.2 are considered, the lowest applicable maximum w/cm and highest applicable minimum f_c' shall be used.

[†]Seawater

[‡]Pozzolan that has been determined by test or service record to improve sulfate resistance when used in concrete Type V cement.

- H. ASTM test method C 1012 can be used to evaluate the sulfate resistance of mixtures using combinations of cementitious materials.
 - 1. In addition to the proper selection of cement, other requirements for durable concrete exposed to concentrations of sulfate are essential, such as, low water-cementitious material ratio, strength, adequate air entrainment, low slump, adequate consolidation, uniformity, adequate cover of reinforcement, and sufficient moist curing to develop the potential properties of the concrete.
- I. More stringent requirements may be required for unusual designs or specific site conditions. The codes cannot replace sound engineering knowledge, experience, and judgment.
- J. For any structure, the City or the structural engineer may require the quality of materials and construction to be higher than the minimum requirements as stated in the codes.

9.03 Geotechnical Performance Specifications

- A. Field investigation, geotechnical testing, and geotechnical engineering shall be performed in accordance with the standard of care taking into account local experience and conditions. The geotechnical recommendations shall establish the minimum design criteria based on the Design Engineer's experience and engineering judgment. The Design Engineer may use more conservative geotechnical design criteria for the structural design. In no case shall the Design Engineer use geotechnical design criteria less conservative than the geotechnical engineer's recommendations.
- B. A ROW Permit must be obtained prior to performing any boring within the City's right-of-way.
- C. The complexity of geological conditions and the type, length, and width of structure will determine the number and locations of test holes required. The following should be considered by the Design Engineer in coordination with the geotechnical engineer: Depth of test hole, location of proposed grade relative to existing grade, channel relocations and/or channel widening, scour, foundation loads, foundation types.
- D. Locate the test holes in an accessible area, avoiding overhead power lines and underground utilities where possible, and avoiding steep slopes and standing or flowing water. Identify test hole locations on the plans.
- E. Provide a complete soil and bedrock classification and log record for each test hole, including all pertinent information to complete the standard log. Location and surface elevation shall be shown on the boring logs.
- F. Perform the appropriate field and laboratory tests necessary to determine the soil shear strength for proper soil evaluation and geotechnical design criteria. The geotechnical engineer shall consider the short-term and long-term conditions. In addition, special attention is required when testing highly plastic clays. Tests of these soil types shall be performed at a slow enough rate such that any excess pore water pressure is dissipated, or in a manner that measures pore water pressure.
- G. Ground water elevations shall be included as part of the data acquisition. Site conditions may require the installation of piezometers to establish a true groundwater surface elevation and method of monitoring water surface fluctuations
- H. Minimum boring requirements are as follows:
 - 1. **Slopes and Embankments including Bridge Approaches.** Obtain soil borings for cuts greater than 10' or embankments taller than 10'. The exploration shall include the following:
 - a. The soil under future embankments. Advance borings to a depth at least equal to the embankment height or 20', whichever is greater, unless a greater depth is recommended by the geotechnical engineer.
 - b. Soil in proposed cuts. Advance borings to a depth of at least 15' below the bottom of the proposed cut, unless a greater depth is recommended by the geotechnical engineer.

2. Bridges

- a. In general, drill test holes 10' to 15' deeper than the probable top elevation of the bridge foundation.
- b. Test holes near each abutment of the proposed structure plus a sufficient number of intermediate holes to determine depth and location of all significant soil and rock strata.
- c. Major stream crossings (over channels more than 200' wide) require borings in the channel. A site inspection by the driller or logger is necessary to evaluate site accessibility and special equipment needs.
- d. Minor stream crossings over channels less than 200' wide shall provide a boring on each bank as close to the water's edge as possible. If boring information varies significantly from one side of the channel to the other, a boring in the channel may be required by the Director of Engineering Services.
- e. Grade Separations. If the borings indicate soft surface soils (fewer than 10 blows per foot), additional borings and testing shall be required for the design of the bridge approach embankments.

3. Retaining Walls Obtain soil borings for walls taller than 3-ft.

- a. Obtain soil borings at 200' spacing unless site conditions or the design engineer requires closer spacing. A greater spacing may be allowed by the Director of Engineering Services only if recommended in writing by the geotechnical engineer of record.
- b. Fill Walls. For spread footing walls and MSE walls, the depth of the boring shall be a minimum of as deep as the wall height depending on the wall type and existing and proposed ground lines. The minimum boring depth is 10' below the bottom of the proposed wall unless rock is encountered (see Section 9.03.H.4). Extend borings at least 5' into rock for fill walls unless additional depth is recommended by the geotechnical engineer.
- c. Cut Walls. For drilled shaft walls, tied-back walls, and soil and rock nail walls, the depth of the boring is based on the proposed ground line. Cantilever drilled shaft walls require the depth of boring to extend the anticipated depth of the shaft below the cut, which is typically between one and two times the wall height unless additional depth is recommended by the geotechnical engineer of record. Borings for soil nail and rock nailed walls need to be advanced through the material that is to be nailed. The minimum boring depth is 15' below the bottom of the proposed wall. Borings for proposed cut walls may need to penetrate rock significant distances depending on the depth of the cut and wall height.
- d. Provide additional testing for taller walls, walls on slopes, or walls on soft founding strata as necessary, or recommended by the geotechnical engineer of record, to completely evaluate wall stability.

4. Borings Encountering Rock

- a. Based on the geotechnical engineer's experience and engineering judgment, if rock is encountered the minimum boring depths specified above may be reduced but only at the direction of the geotechnical engineer.

9.04 Bridge Design

- A. The structural engineer shall be responsible for selecting the appropriate bridge foundation. The engineer shall consider the following factors in that selection:
 1. Design load.
 2. Geotechnical engineering recommendations. The strength and depth of subsurface formations determine the type of foundation chosen. In general, drilled shafts are well suited to areas with competent soil and rock, and is the preferred foundation type subject to concurrence of the geotechnical and structural engineers' concurrence. Alternative foundation types require approval in writing by the Director of Engineering Services.
 3. Corrosive conditions. Salts, chlorides, and sulfates are detrimental to foundations. Where these conditions exist, the Design Engineer shall take preventative measures. Use sulfate-resistant concrete as defined in these Engineering Standards as required.
- B. The structural engineer shall use the geotechnical investigation recommendations as minimum design criteria. If in the structural engineer's judgment, the structural design needs to be based upon more conservative geotechnical design criteria, the structural engineer shall provide the more conservative design.
- C. Disregard surface soil in the design of drilled shaft foundations. The disregarded depth is the amount of surface soil that is not included in the design of the foundation due to potential erosion from scour, future excavation, seasonal moisture variation (shrinkage and swelling), lateral migration of waterways, and recommendations of the geotechnical investigation.
- D. Drilled shaft capacity relies upon penetrating a specific stratum a specified depth. The plans shall provide a note instructing the contractor and field personnel of the penetration requirement. The plans shall identify the specific type of material to be penetrated and the minimum penetration depth. The plan may allow for the drilled shaft to be shortened if the founding stratum is encountered at a shallower depth, and it requires the shaft to be lengthened if the founding stratum is not encountered at the expected elevation.
- E. When the founding stratum is present at or near the surface, the structural engineer shall consider the load-carrying capacity along with the stability of the superstructure on the foundation. For these conditions, a minimum drilled shaft length shall be specified on the plans and the drilled shaft shall not be allowed to be shortened from plan length, but it may be lengthened if the founding stratum is not encountered at the expected elevation.
- F. Bridge foundations for bridges over waterways require a scour analysis. A scour analysis shall be conducted in accordance with the following:
 1. TxDOT guidelines in "Evaluating Scour at Bridges" (HEC-18).

2. Abutment scour does not need to be calculated. However, abutments shall be protected against potential scour through use of flexible revetment, where possible or hard armoring.
3. Design bridge foundations to withstand the scour depths for either the 100-year flood or smaller flood if it will cause scour depths deeper than the 100-year flood.
4. Check the bridge foundations against the scour depth associated with the 500-year flood. This flood event is considered an extreme event and the factor of safety on the bridge foundations shall be greater than or equal to 1.

9.05 Retaining Wall Design

- A. The Design Engineer is responsible for ensuring that the retaining wall selected for a given location is appropriate. The retaining wall selection process shall consider the following:
 1. Height. Any retaining wall which retains in excess of 3-ft. shall be engineered. The structural design shall be provided in accordance with the geotechnical recommendations and minimum design criteria provided in Section 9.03.
 2. Geometry. Determine applicability of wall type – cut, cut/fill, or fill – based on geometry, site constraints, existing and proposed topography, and wall alignment and location. Identify available ROW and any necessary ROW or easements to accommodate the proposed improvements and the access necessary to accommodate access for maintenance. Identify location and type of existing and proposed utilities and drainage structures.
 3. Economics. Evaluate the total installed cost of the wall and consider long-term maintenance requirements. Identify necessary excavation requirements (including shoring), required utility adjustments and costs, project schedule, construction phasing requirements, and these effects on the wall design and construction.
 4. Stability. The Design Engineer is responsible for the global stability of the wall. Evaluate all walls to ensure that the minimum applicable factors of safety are at least met (see Section 9.05.C), if not exceeded depending on the Design Engineer's judgment. When possible, avoid placing walls on slopes. A slope in front of the wall dramatically reduces the passive earth pressure (resistance), increasing the chance for wall failure. Additionally, a slope in front of the wall will have a significant effect on global stability of the wall and embankment in which it resides. For situations where the walls above a slope cannot be avoided, a rigorous slope stability analysis shall be required in accordance with these Engineering Standards.
 5. Constructability. Determine whether walls are near water or subject to inundation or groundwater. Identify access limitations for equipment both during and after construction. Ensure adequate horizontal and vertical clearances are provided.
 6. Drainage. Design the wall to prevent the build-up of hydrostatic pressure behind the wall. If conditions warrant, the City may require the wall design to withstand full hydrostatic pressure load. The wall design shall consider potential deleterious short and long term effects of water inundation including scour and rapid draw down.
 7. Aesthetics. Ensure that aesthetic treatments of walls complement the retaining wall and does not interfere with the functionality of the wall. Detailed consideration shall be given to aesthetic treatments of retaining walls that involve landscaping. Additionally, the wall's

- drainage system design shall avoid potential compromise of the wall aesthetics because of water related damages.
8. Loading. Design loads shall be in accordance with these Engineering Standards (for building code references, see Section 9.02), including construction loads and surcharge loads from slopes, structures, and vehicles.
- B. Analyze and design walls following accepted geotechnical engineering industry standards for the City of Frisco area and in accordance with these Engineering Standards. In analysis, use earth pressures that follow the requirements of the project's geotechnical investigation specifically addressing the retaining wall design requirements for the project's specific location.
- C. The Design Engineer must ensure that the retaining wall system is appropriate for its location and application. The Design Engineer shall design for all potential modes of wall system failure; including, sliding, overturning, bearing pressure, global stability, and structural capacity of the wall itself. The design of the retaining wall shall meet the following minimum factors of safety:
- | | |
|----------------------|-----|
| a. Sliding: | 1.5 |
| b. Overturning: | 2.0 |
| c. Bearing Pressure: | 3.0 |
| d. Global Stability: | 1.5 |
- D. Avoid perching wall on slopes steeper than 8H:1V. When walls must be placed on slopes steeper than 5H:1V, or the retaining wall height or the combined wall and slope heights exceed 8-ft., the geotechnical engineer shall conduct a short-term and long-term global stability analysis using applicable soil strength characteristics, geometry, and loading conditions (including load surcharge, hydrostatic, etc.). The Design Engineer is responsible for the design of the wall system, including its global stability.
- E. A series of two or more walls built in tiers shall be considered a single wall in height for the purposes of conforming to these Engineering Standards when the base of the upper tier is set back from the base of the lower tier less than two times the height of the lower tier wall.
- F. If TxDOT standard sheets pertaining to cast-in-place spread footing structural retaining walls are utilized, the Design Engineer shall ensure that the actual wall geometry and loading conditions are applicable to the standard wall design selected. The Design Engineer shall ensure that interruptions to the wall stem or footing reinforcement by openings, utilities, geometric changes or curved sections of the wall do not compromise the design and performance of the wall. No TxDOT standard wall design shall be modified unless the Design Engineer designs, draws, and seals the modified standard.
- G. TxDOT standard sheets pertaining to cast-in-place spread footing walls provide a choice between high pressure (HP) and low pressure (LP) footings. Selection by the Design Engineer is a function of the loading, geometry, and allowable soil pressures. **TxDOT standard sheets pertaining to cast-in-place spread footing walls are developed based on the wall being drained, and the design parameters for foundation and retained soils of a cohesion factor of zero, a friction factor of 30 degrees, and a unit weight of 120 pounds/cubic foot.** Give special consideration to the site-specific geotechnical requirements and whether a TxDOT standard wall design is applicable. Also give special consideration to walls subject to potential inundation.

- H. Retaining walls that are privately owned and maintained shall not be located within any right-of-way nor shall it support right-of-way.

9.06 Slope Stability Design Criteria

- A. All slopes exceeding 8-ft. in height with a steepness of 4H:1V or greater, regardless of soil type, cut, or fill, shall be evaluated for global stability for both the short-term and the long-term conditions. Additionally, any known areas of existing fill, deleterious material, or soft soils which have a height over 4 feet or slope angle greater than 6H:1V shall be evaluated for global stability for both the short-term and the long-term conditions. Specific site conditions may require evaluation for additional types of slope failure, such as bearing capacity, settlement, shear, and undercutting. Calculations pertinent to the analysis shall be submitted with the construction drawings when required by the City.
- B. Use the following data to analyze global stability of a slope:
 - 1. Geometry (cross section and loading conditions);
 - 2. Location of the water table;
 - 3. Soil/rock stratigraphy; and
 - 4. Soil/rock properties (unit weight, Atterberg Limits, undrained and drained shear strength).
- C. For global stability of a slope, the minimum factor of safety of 1.5 is required unless the geotechnical engineer recommends a higher value.

9.07 Screening Wall Design Criteria

- A. Screening Walls shall meet the minimum requirements included in the [Subdivision Ordinance](#), Section 8 and the [Zoning Ordinance, Section 4.03](#) – Screening Standards.
- B. An opening designed to allow for storm water drainage shall be provided unless it has been determined by the Director of Engineering Services that no drainage problems are anticipated. The opening shall be a uniform 2” high the full length between columns.
- C. All screening walls shall be designed by a Professional Engineer licensed in the State of Texas. Signed, sealed and dated plans shall be submitted to the City for review and permitting.

9.08 Excavation Support

- A. Trench excavation protection shall be used for the installation of linear drainage or utility facilities that result in trenches deeper than 5’. Such trench protection includes vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with Occupational Safety Health Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, “Excavations.”
- B. Temporary special shoring is used for installations of walls, footings, and other structures that require excavations deeper than 5’. Temporary special shoring is designed and constructed to hold the surrounding earth, water, or both out of the work area. It provides vertical or sloped cuts, benches, shields support systems, or other systems to provide the necessary protection in accordance with the approved design. Unless a complete design for temporary special shoring

systems are included in the plans, the contractor is responsible for the design of the temporary special shoring system. The Contractor must submit to the City, for informational purposes only, the design calculations and details sealed by a Professional Engineer licensed in the State of Texas before constructing the shoring. The design of the shoring must provide protection in accordance with Occupational Safety Health Administration (OSHA) Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations."

9.09 Construction Plans

- A. Construction drawings and technical specifications for **all structural** construction shall include the following:
1. Design engineer's seal, date, signature, and Texas Board of Professional Engineers (TBPE) firm registration number;
 2. Name and date of issue of the codes and supplements to which the design conforms;
 3. Name and date of the project-specific geotechnical engineering report upon which the Design Engineer relied;
 4. Live load and other loads used in the design, including surcharge loads and potential exposure to storm water inundation. Specifically identify the applicable loads and their load factors;
 5. Identification of geotechnical investigation and report to which the design conforms (including report name and number (if applicable), date of issuance, engineering firm name and address, firm TBPE firm registration number, and name of geotechnical engineer of record).
 6. Where plans indicate compacted soil, provide compaction specification.
 7. Specified compressive strength of concrete at stated ages or stages of construction for which each part of the structure is designed.
 8. The design shall specifically address construction loading and sequencing. Service loads shall not be applied until the concrete has reached its minimum specified compressive strength or the structure is adequately shored to withstand the service loads;
 9. Drainage system (if applicable), including material specification, diameter, daylight point, and outfall connection detail (if applicable), granular material (if applicable) specification, filter fabric material specification and installation requirements, and weepholes (if applicable), including material type, diameter, and spacing;
 10. Size and location of all structural elements, reinforcement, and anchors;
 11. Identification of shop drawing requirements for fabrication, bending, and placement of concrete reinforcement. Provide bar schedules, stirrup and tie spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Provide additional details for reinforcement of openings in concrete walls and slabs. Shop drawings shall be provided in accordance with the requirements of the technical specifications and submitted to the City for review and approval.

12. Provisions for dimensional changes resulting from creep, shrinkage, and temperature;
13. Details of all contraction, isolation joints, or expansion joints and the appropriate spacing specified;
14. Anchorage length of reinforcement and location and length of lap splices (if applicable);
15. Type and location of mechanical splices of reinforcement (if applicable). Welding of reinforcement shall not be permitted unless approved by the Design Engineer and the Director of Engineering Services;
16. The technical specifications for concrete mixtures shall be provided in accordance with the following:
 - a. Concrete for roadway pavement and related facilities (i.e. driveways, sidewalks, ramps, etc.) shall be in accordance with the City's technical specification 321313-Concrete Pavement;
 - b. Cast-in-place concrete applicable to TxDOT standard designs for storm drainage culverts and related structures, retaining walls, manholes, vaults, as well as bridges, shall be in accordance with the City's technical specification 033105-Concrete Structures-Cast-in-Place (TxDOT). Otherwise, concrete for cast-in-place structures shall be in accordance with the City's technical specification 033100-Concrete Structures Cast-in-Place (City); and
 - c. Precast concrete applicable to precast pipes, TxDOT standard designs for storm drainage culverts and related structures, manholes, vaults, as well as bridges, shall be in accordance with the City's technical specification 034105-Concrete Structures-Precast (TxDOT). Otherwise, concrete for precast structures shall be in accordance with the City's technical specification 034100-Concrete Structures-Precast (City);
17. Responsibility for maintenance of the structure shall be clearly noted on the plans. The plans shall clearly reference a structure maintenance plan and schedule. The maintenance plan shall clearly identify any drainage system required to relieve hydrostatic pressure on the structural system and ensure that it remains fully functional throughout the life of the structure; and
18. Sight visibility triangles (where applicable).

B. **Retaining wall** plans shall also include the following information:

1. Plan view. The plan view shall include location of soil borings, surface and subsurface drainage structures and utilities that could be affected by wall construction.
2. Elevation view. The elevation view shall include a profile of the existing ground line along the wall alignment, proposed finished grade at face of wall, limits of wall payment (if applicable), top of wall profile, soil boring log shown at the correct elevation and scale, wall rail if applicable, drainage structures and utilities as noted above. Unless noted otherwise and approved by the Director of Engineering Services, wall quantities shall be based upon the surface area of the wall from the top of wall to the bottom of wall. The bottom of wall is defined as the proposed finished grade at the face of the wall. The bottom of wall shall not be measured from the top of footing unless the top of footing is the proposed finished grade at the face of the wall.

3. Estimated quantity table. Include the estimated quantity table for each retaining wall type. The table should contain the area of wall (for payment) and linear footage of railing (if applicable).
4. Typical section. The typical section shall include a cross section with wall dimensions and showing the relationship of the wall to the roadway, property line, or controlling adjacency, control point(s) for horizontal and vertical alignment (typically the top outermost corner of the wall), indication of maximum slope on top of and in front of the wall, location of proposed finished grade, railing type, flume, and mow strip, etc. if applicable.
5. General notes. The general notes shall include a note stating the required minimum embedment depth of the footing (minimum typically 1'), a note stating that the wall quantity shall be measured for payment between the top of wall and "x" ft. below finished grade, railing shop drawing requirements (if applicable), references to all standard sheets (if applicable) for pertinent information, and any other pertinent information regarding wall design and construction.

C. **Spread Footing Retaining Wall** plans shall also include the following:

1. If TxDOT retaining wall standards are used, provide the panel design designation (for example, LC-10-32) for each wall panel corresponding to the appropriate cast-in-place spread footing wall standard sheet. The designation includes a reference to the controlling standard drawing, design height, and panel width.
2. Location of expansion and allowable construction joints (assuming 32' panels, every third joint is typically designated as an expansion joint).
3. Set bottom of wall (top of footing) horizontal and stepped to meet minimum embedment depth criteria. Distance from one step to the next is typically greater than 12". Provide bottom of wall elevations for all panels.
4. Include the appropriate TxDOT standard sheets pertaining to cast-in-place spread footing walls if applicable. Otherwise provide typical section details including a cross section with dimensions and reinforcement layout and callouts.
5. If TxDOT standard sheets pertaining to cast-in-place spread footing walls are not applicable to the design, a custom structural wall design shall be provided. The general notes shall specifically identify the applicable concrete specification, the requirement that no service loads shall be imposed until after the concrete has reached its specified minimum compressive strength, and that shop drawing submittals shall be required for fabrication, bending, and placement of concrete reinforcement.

D. **Screening Wall** plans shall include the following information (in addition to the information included under Section 9.09.A):

1. The title shall include the legal name of the property on which the wall is being constructed;
2. A plan view of the wall showing its location, limits, and stationing;
3. Wall material specification;
4. Mortar specification (if applicable).

5. A profile of the wall including grades for the top of the concrete mow strip, adjacent top of curb, sidewalk and finished floor of proposed and/or existing adjacent slabs;
 6. Elevation view of a typical column;
 7. Elevation view of the wall;
 8. Mow-strip detail;
 9. Drainage clearance under wall (uniform 2");
 10. Steel tensile strength;
 11. Concrete compressive strength; and
 12. Wind load calculations
- E. **Gravity Retaining Walls** plans shall also include the following:
1. Wall height, including batter requirements;
 2. Wall material specification;
 3. Base embedment depth and width requirements, including key depth if applicable;
 4. Wall thickness at bottom and top of wall;
 5. Mortared zone requirements (if applicable), including zone thickness and the specification to mortar on all sides and no voids;
 6. Non-mortared zone requirements (if applicable), including zone thickness and the specification that stones must fit tightly; and
 7. Clay cap, including material specification and dimension requirements.
- F. **Calculations** pertinent to the design of any and all walls shall be submitted with the construction drawings when required by the City.
- G. All wall construction plans and specifications submitted to the City for review must include a permit application submittal.

9.10 Construction Inspection and Certification

- A. A permit is required for the construction of any wall as defined in these Engineering Standards.
- B. A third-party, or the Engineer of Record, shall certify wall construction inspections were performed at periodic stages sufficient to determine conformance with the design.
- C. The final certificate of compliance shall be submitted to the City and include a certification letter, signed and sealed by a licensed professional engineer in the State of Texas, that includes a statement that the wall system was constructed in general compliance with the geotechnical design criteria identified in the plans and specifications and the City-approved construction plans and specifications. The letter shall reference the following:

- a. Specific reference to the City-approved plans and specifications for the wall;
- b. Specific reference to the address and/or legal description for the wall construction location;
- c. Specific reference to the name and date of the project-specific geotechnical engineering report.

SECTION 10 – SURVEY REQUIREMENTS

Section 10 – Survey Requirements

10.01 General

- A. In the interpretation and application of the provisions in these survey requirements, it is the intention of the City that the principals, standards and requirements provided herein shall be minimum standards for the projects involving survey, and where other Ordinances of the City are more restrictive, such Ordinances shall control, as they exist or may be amended. Refer to the [Frisco Survey Monument Metadata](#)
- B. [Frisco Survey Monument Map](#)
- C. [Frisco Survey Monument Sketches](#)

10.02 Survey Markers and Monumentation

A. Markers

Markers consisting of minimum 3/8" diameter steel rods at least 24" long with caps identifying responsible surveying firm or RPLS number shall be placed at all:

1. Lot and block corners (wherever a lot line bearing changes);
2. Intersection points of alley and block lines;
3. Curve and tangent points along block, lot and right-of-way lines within the subdivision; and
4. Right-of-way dedications.

B. Monuments

1. Three dimensional coordinates, reported as State Plane Coordinates, shall be established using the City's Monumentation System and using the City's Combined Scale Factor. The coordinates shall be noted on the Plat
2. Monuments shall be Markers and installed at locations shown on the Plat.

C. Subdivision Monumentation

At least two Markers shall be placed at property corners in addition to at least two Monuments at opposing ends of the property.

D. Capital Improvements Project Monuments

Found existing right-of-way monuments, survey markers, or property corners, and proposed monuments shall be shown on the construction drawings and located by station and offset, right or left from the control line, base line or center line, or by northing and easting.

- E. If new construction will damage, destroy, or alter existing survey markers, monuments, or property corners, they must be re-set prior to final acceptance.

F. Electronic Submittal Requirements for Record Drawings

To complete the electronic file submission requirement, a minimum of 3 CADD files will be provided. These 3 files will be a Final Plat, Water/Sewer Plan and Drainage (Storm Sewer) Plan. Drawings shall include all elements of the project inclusive of any offsite information and existing features that may aid in providing a geographic reference for the project. See item 5 for plat and plan line work details.

Note: All information shall be provided in basic 2D line work and text form. No program specific or 3-dimensional objects should be included.

1. Files shall be submitted in DWG/DXF format, saved as version 2013.
 2. Files shall be georeferenced in the State Plane, Texas North Central FIPS 4202 (feet) coordinate system, using a datum of NAD 83.
 3. If a surface adjustment factor is applied to the data, any surface adjustment factors used should be clearly documented on the drawing.
 4. If submissions for the Project relate to a plat, the file submitted must match exactly the plat that is submitted for recording.
 5. The file shall contain required features for the project type as detailed below:
 - a. Pre-Construction/As-Built Plans and/or Record Documents:
 - i. Layers from Final Plat Requirements as Applicable to Project Type.
 - Site geometry line work will include lot lines, pavement, rights-of-way, setbacks easements, property lines, centerlines, floodplain limits, county lines, and/or USACE deed restricted areas.
 - Lot and Block numbers
 - Street names and labels
 - Legal description
 - Line and Curve information
 - ii. Water/Sanitary Sewer Utility Features*
 - iii. Storm Sewer Features*
- *Water, Sanitary Sewer and Storm shall include Pipes, structures and centerlines (Base file), Plan view labels and Site geometry (Base file).
6. Each required feature group should be provided as a separate layer within the file.
 7. Layer names should be representative of the information contained in the layer.
 8. Line work should be continuous (e.g. no dashed lines in required layers) and complete (connecting lines should meet at corners) within the subdivision/project. Layers outside of project/subdivision boundary may be dashed in CAD data as required for Final Plats by Frisco Subdivision Ordinance Section 5.02.

10.03 Platting Requirements

- A. Plats (including, but not limited to, final plats, conveyance plats, replats and amending plats) shall, at a minimum, adhere to the following requirements:
1. The Surveyor will provide two Monuments (with three-dimensional coordinates) acceptable to the City and establish grid coordinates for the monuments in reference to the City of Frisco GPS Monuments. Monuments shall be iron rods or better. A “Cut X” in concrete is not considered an adequate monument.
 2. Elevations will be established on the two monuments on the vertical datum in reference to the City of Frisco GPS Monuments.
 3. The three-dimensional coordinates in grid coordinates established for these monuments will be clearly shown on the face of the plat. A note shall be added to the plat specifying the grid coordinates are not for design purposes.
 4. The plat shall hold grid bearings and shall not be from an assumed north.
 5. All distances shown on the plat will be surface distances.
 6. Refer to Development Application Handbook for required language on plats.
 7. Show the current and correct property lines, exclusive of any right-of-way that has been dedicated previously.
 8. Show all existing lot lines and easements on the property with the corresponding recording information. This includes all lot lines and/or easements dedicated by previous plats as well as by separate instruments.
 - a. All existing offsite easements that are adjacent to the boundary of the plat shall be shown to the extent that is necessary to ascertain and/or coordinate the connection of utilities, drainage, pavement, access rights, etc. If the entirety of any adjacent lot is shown on the plat, all existing offsite easements on that lot shall be shown.
 9. Show the full and correct spelling of the platted street name of any existing right-of-way or public way easement, along with its recording information.
 10. Show the full and correct spelling of the street name for any new right-of-way or public way easement being dedicated by the plat. All new street names must be approved by the Development Services Department before a plat can be approved.
 11. Show all new easements and lot lines being dedicated by the plat. These shall match the most recent preliminary plat, preliminary site plan and/or site plan unless a change during construction was approved by the Director of Engineering Services.
 - a. When dedicating new easements, the label shall include the type of easement and the width of easements that maintain consistent widths along their length (or the dimensions of rectangular shaped easements). The term “by this plat” shall not be used for the dedication of new easements.

12. The full extent of all existing and new easements shall be clearly delineated with the use of leader lines and dimensions. Overlapping easements shall be clearly labeled as many times as necessary to properly distinguish the extent of each easement. Inset details shall be used as necessary to show the details of crowded and/or complicated easement areas.
13. Fire lane and access easements shall encompass the full extent of the pavement constructed for that purpose. This includes all curvature of the fire lane where it intersects streets or other fire lanes.
14. Access easements shall encompass the full extent of any drive aisle or parking space pavement that will be constructed by the owner of Lot X on some adjacent Lot Y.
15. Fire lane, access & utility easements shall be dedicated on any plat that creates multiple lots wherever the fire lanes will straddle common lot lines or where necessary so that each lot could develop independently with at least two points of access and no dead-end fire lanes.
16. Where street easements are required under Section 2.03.D.1.c, a larger street easement can be dedicated in lieu of a necessary sidewalk easement. Such a street easement should extend to a point two feet (2') beyond the edge of the sidewalk.
17. No right-of-way can be abandoned on a plat without approval from the Director of Engineering Services and without following the procedure described in Section 1.11.D.
18. No easements or rights-of-way can be dedicated or abandoned on adjacent property outside the boundary of the plat.
19. Offsite easements shall not be shown on a plat that will be filed with the County unless they have already been dedicated by another plat or by separate instrument. If so, the recording information for the easement shall be shown. (As an exception, future offsite easements should be shown on a Preliminary Plat.)
20. No physical features shall be shown on a plat that will be filed with the County. Physical features include, but are not limited to, pavement, buildings, structures, fences, poles, utilities, trees, streams, bodies of water, topography, etc. (Preliminary plats are not filed at the County and are exempt from this requirement.)
21. A plat describes the easements that exist or are being dedicated at the moment the plat is filed at the County. No future actions shall be described on a plat that will be filed with the County. To eliminate unintentional references to future actions, easements being dedicated or abandoned by the plat shall not be labeled as "To Be Dedicated" or "To Be Abandoned." Intentional future actions, such as the future dedication of an easement on a future plat or the future recordation of a separate instrument, shall not be shown or described on the plat. (Preliminary plats are not filed at the County and are exempt from this requirement.)
22. When existing easements or rights-of-way are being abandoned on a plat, the extent of the easement being abandoned shall be clearly identified, the original recording information shall be listed, and it shall be labeled as "Abandoned by this Plat." If an easement or right-of-way was abandoned on a previous plat, neither the original easement nor the abandonment of the easement shall be shown on the new plat.
23. All information shown on a plat shall be correct, up-to-date, legible, easily understood, consistent, and shown to the proper scale.

- B. Preliminary plats are not filed at the County and instead serve the purpose of showing the proposed dedication of lots, streets and easements as well as summarizing what infrastructure will be constructed. Preliminary plats shall show the proposed pavement within the rights-of-way, the turn lanes and sidewalks to be constructed along major and minor thoroughfares, and the sidewalks and trails to be constructed along open space lots, as well as show cross-sections of each type of proposed street. The dedication of new rights-of-ways and easements shall, at a minimum, follow these requirements:
- C. Final Plat
1. In order to ensure that all necessary easements are reflected on the Final Plat, all public improvements shall be completed before the Final Plat is submitted for filing.
 2. Prior to Final Plat Approval, all required Monuments must be found and re-set, if damaged during construction.
 3. Additional filing and approval requirements can be found in Section 4.03 of the Subdivision Ordinance.

SECTION 11 – WATER WELL DESIGN REQUIREMENTS

Section 11 – Water Well Design Requirements

11.01 General

- A. The purpose of this section is to provide the minimum requirements and standards for water wells, including consideration of the influences of geologic and hydrologic conditions and water quality and well construction for City of Frisco maintained water wells.
- B. The Engineer and Contractor should be familiar with the specifications. The construction of water wells is governed by the following Specifications:
 - 1. 26 20 00B: Low-Voltage AC Induction Motors
 - 2. 33 21 13.01B: Water Well Mobilization-Demobilization
 - 3. 33 21 13.02B: Water Well Conductor Casing and Sanitary Seal
 - 4. 33 21 13.03B: Water Well Drilling
 - 5. 33 21 13.04B: Water Well Geophysical Logging
 - 6. 33 21 13.06B: Water Well Casing
 - 7. 33 21 13.07B: Water Well Screen and Gravel
 - 8. 33 21 13.08B: Water Well Grouting
 - 9. 33 21 13.10B: Well Pumping Test
 - 10. 33 21 13.12B: Water Well Video Inspection
 - 11. 33 21 13.13B: Water Well Disinfection
 - 12. 44 42 56.03B: Vertical Turbine Pumps

11.02 References

The following is a list of standards which may be referenced in this section or in the specifications:

- A. American Water Works Association (AWWA)
 - 1. A100-15, Water Wells.
 - 2. C654, Disinfection of Wells.
- B. American Petroleum Institute (API):
 - 1. 5L, Specification for Line Pipe.
 - 2. 5CT, Specification for Casing and Tubing.
 - 3. RP 5C1, Recommended Practice for Care and Use of Casing and Tubing.

4. Specification 10A, Specification for Cements and Materials for Well Cementing, December 2010
- C. American Society of Mechanical Engineers (ASME):
1. B31.3, Process Piping.
 2. B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids.
 3. B31.8, Gas Transmission and Distribution Piping Systems.
- D. American Welding Society (AWS): AWS B2.1, Specification for Welding Procedures and Performance Qualification.
- E. ASTM International (ASTM):
1. A36/A36M, Standard Specification for Carbon Structural Steel.
 2. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. A139/A139M, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
 4. A242/A242M, Standard Specification for High-Strength Low-Alloy Structural Steel.
 5. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 6. A536, Standard Specification for Ductile Iron Castings.
 7. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 8. C150, Standard Specification for Portland Cement.
 9. C494/C494M, Standard Specifications for Chemical Admixtures for Concrete.
- F. International Association of Drilling Contractors (IADC), API-Approved Official Daily Drilling Report Form.
- G. National Pollutant Discharge Elimination System (NPDES).
- H. Hydraulic Institute Standards (HIS):
1. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 2. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
- I. NSF International (NSF):
1. NSF/ANSI 61, Drinking Water System Components – Health Effects.
 2. NSF/ANSI 372, Drinking Water System Components - Lead Content.

- J. American Bearing Manufacturers Association (ABMA):
 - 1. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11, Load Ratings and Fatigue Life for Roller Bearings.
- K. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - 2. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
- L. National Electrical Manufacturers Association (NEMA):
 - 1. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - 2. MG 1, Motors and Generators.
- M. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- N. Underwriters Laboratories (UL):
 - 1. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
 - 2. Standard for Safety for Overheating Protection for Motors

11.03 Well Design Requirements

- A. Design calculations, signed and sealed by a professional engineer registered in Texas, for selection of screened intervals, gravel pack, and screen slot size shall be submitted. Include drill cuttings sieve analyses and other relevant data.
- B. Design shall conform to the Typical Well Design shown in Figure 11.1.

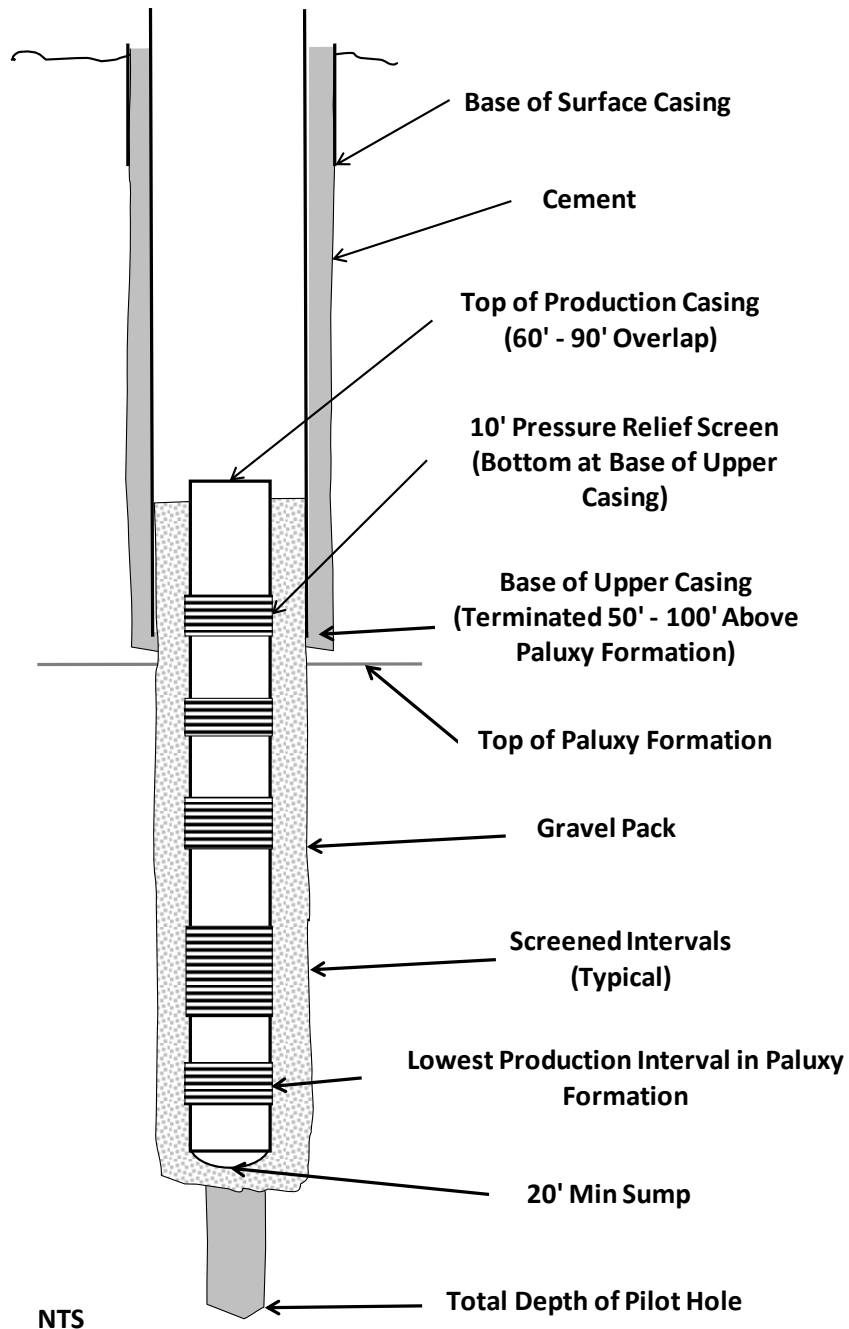


FIGURE 11.1: Typical Well Design

11.04 Casings

- A. Final casing lengths to be selected by a professional engineer registered in Texas. The design to consider the drill cuttings, geophysical logs, and sieve analyses of samples from the pilot hole.
 1. Install well casing/well screen assembly at a sufficient height above the bottom of boring to ensure weight of casing will not be resting on the bottom.

2. Top of casing shall extend about 18 inches above land surface.
3. Length of conductor casing shall be a minimum of 40 feet.

B. Conductor (Surface) Casing Hole Diameter

1. Well Capacity up to 75 gpm;
Borehole shall be a minimum of 3 inches larger than the OD of the conductor casing.
2. Well Capacity Greater than 75 gpm and less than 200 gpm;
Borehole shall be a minimum of 4 inches larger than the OD of the conductor casing.

C. Upper Casing Reamed Hole Diameter and Interval:

1. Well Capacity up to 75 gpm; minimum hole diameter: 10 5/8-inch.
2. Well Capacity Greater than 75 gpm and less than 200 gpm;
minimum hole diameter: 12 1/4-inch.
3. Interval extends from land surface to within 50 feet to 100 feet of the top of the Paluxy Formation.

D. Production Casing Reamed Hole Diameter and Interval:

1. Well Capacity up to 75 gpm; minimum hole diameter: 7 7/8-inch.
2. Well Capacity Greater than 75 gpm and less than 200 gpm;
minimum hole diameter: 8 1/2-inch.
3. Interval extends from the base of the upper casing to the lowest production interval in the Paluxy Formation.

E. Well Casings shall comply with the following requirements:

1. Well Capacity up to 75 gpm;

Interval	Min. Outside Diameter (inches)	Min. Wall Thickness (inches)
Conductor Casing	11 3/4	0.333
Upper Casing	8 5/8	0.264
Production Casing	2 7/8	0.217

2. Well Capacity Greater than 75 gpm and less than 200 gpm;

Interval	Min. Outside Diameter (inches)	Min. Wall Thickness (inches)
Conductor Casing	13 3/8	0.330
Upper Casing	9 5/8	0.312
Production Casing	4	0.226

- F. Well Casing Guides shall be fitted on all casing using Halliburton Company, or equal, centralizers with “bow-spring” straps.
- G. Well Casing Centralizers:
1. Centralizers shall be designed to provide adequate centering of well casing of the diameter and depths required.
 2. Place at 60 foot intervals starting 5 feet from the bottom of the string and extending to ground surface.
 3. Place at least four, equally-spaced, around the casing in such a manner that interference with grout placement is minimized.
- H. Conductor Casing Centralizers:
1. Weld three to conductor casing at 120 degree intervals around casing and at intervals of not more than 20 feet vertically to centralize and hold casing in the proper position until concrete sanitary seal is in place.
 2. Place first set of guides 5 feet from bottom of conductor casing.
 3. Install a minimum of two sets of guides.
 4. Guides shall be 2 feet long, minimum, and extend at least 1 inch from casing wall.

11.05 Well Screens

- A. Screens shall be designed and manufactured to withstand tensile and collapse pressures for installation to a depth up to 2,000 feet below land surface.
- B. Screens shall be Rod-based or Pipe-based, Continuous Slot, Wire-Wound Screen and designed with V-shaped wire to provide maximum inlet area consistent with strength requirements.
- C. Material Requirements:

1. Mild Steel Perforated Pipe: ASTM A53/A53M Grade B.
2. Stainless Steel Rod and Wire: ASTM A312/A312M, Type 304L or Type 316L.

D. Well Screen Dimensions:

1. Outside diameter shall match section of production casing to which it is joined.
2. Inside diameter shall match section of production casing to which it is joined.
3. Section end wall thickness shall match section of production casing to which it is joined.
4. Fabricated section lengths shall not be less than 10 feet.
5. Slot Size and Screen Length:
 - a. Screen slot size shall be determined in conjunction with gravel pack size.
 - b. Determination of size shall depend on results of sieve analyses.
 - c. No more than one slot aperture size may be specified over a screened interval.

E. Centralizers:

1. Centralizers shall be a minimum 2 inches wide and at least 2 feet long.
2. Centralizers shall be placed at 40-foot intervals starting 5 feet from the bottom of the string and extend to the top of the screened interval.
3. Place at least four, equally spaced centralizers around the screen, at each interval and in such a manner that interference with gravel pack placement is minimized.
4. Centralizers shall extend out at least 2 inches from well screen wall.
5. Centralizers shall be fabricated of same chemical composition and physical properties as the material to which they are attached.

F. Isolation Connection Coupling:

1. Dimensions:
 - a. Nominal Size shall match section of well casing to which it is joined.
 - b. Maximum outside diameter of coupling shall match section of well casing to which it is joined.
 - c. Minimum inside diameter shall be equal to inside diameter of well casing
 - d. Wall Thickness shall match mating pipe.
2. Dielectric Isolation Material shall be NSF 61 approved thermosetting fiberglass epoxy material.

11.06 Gravel Pack

- A. Gravel pack shall be in accordance with AWWA A100, Section 4.6
- B. The size and gradation of gravel pack shall be selected by the engineer based on sieve analyses from cuttings collected while drilling.
- C. Gravel pack material shall be hard, water-worn, at least 90 percent silica, and washed clean of silt, sand, dirt, and foreign matter.

11.07 Sanitary Seal / Grout

- A. Fill annular space between conductor casing and borehole with grout from bottom of boring to land surface.
- B. Calculated volume of annular space between well casing and final borehole shall be submitted by the Engineer.

11.08 Vertical Turbine Pumps

- A. The following information shall be submitted:
 - 1. Make, model, weight, and horsepower of each equipment assembly.
 - 2. Complete catalog information, descriptive literature, specifications, and identification of materials.
 - 3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
 - 4. Power and control wiring diagrams, including terminals and numbers.
 - 5. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
 - 6. Special shipping, storage and protection, and handling instructions.
 - 7. Manufacturer's printed installation instructions.
 - 8. Factory Performance Test Reports, as required. Factory Test Report shall include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.
 - 9. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - 10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
 - 11. Operation and maintenance data.

12. Manufacturer's Certificate of Proper Installation

11.09 Low-Voltage AC Induction Motors

- A. For multiple units of the same type of equipment, identical motors and accessories of a single manufacturer are required. A single supplier shall provide drive motor, its driven equipment, and specified motor accessories.
- B. Motors shall meet the requirements of NEMA MG 1.
- C. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- D. Operating Conditions:
 - 1. Minimum ambient temperature at least 32 degrees C required for submersible motors.
 - 2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding rated temperature rise.
 - 3. Overspeed in either direction in accordance with NEMA MG 1.
 - 4. Minimum Service Factor of 1.1 at rated ambient temperature.
- E. Voltage and Frequency Ratings:
 - 1. System Frequency: 60 Hz.
 - 2. Voltage Rating: 460 volts.
 - 3. Suitable for full voltage starting.
 - 4. Motors 100 hp and larger also must be suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.
 - 5. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.
- F. Requirements for Submersible Pump Motors:
 - 1. At 100 Percent Load:

Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

- 2. Insulation System shall be manufacturer's standard Class F.

3. Enclosure shall be hermetically sealed, watertight, for continuous submergence up to 400-foot depth or wet type with breather diaphragm for pressure compensation and mechanical seals.
4. Water-lubricated.
5. Connecting Cables:
 - a. One cable containing power, control, and grounding conductors.
 - b. The power cable assembly shall be furnished in the proper length to extend from the motor terminals to the junction box mounted at the surface plate. No splice will be permitted between the motor terminals and the junction box.
 - c. The power cable assembly design shall include a sealing terminal plug arrangement with metal guards for protection against rubbing the casing I.D. during installation.
 - d. The power cable assembly shall include a factory hot-injection molded plug at the motor terminal end. The plug design shall incorporate a sealing plug-in design, which can be removed without disassembling any part of the motor. The cable plug design shall be capable of withstanding full submergence pressure without failure.
 - e. The power cable assembly, complete, including the flat cable splice and plug shall be Hi-Pot tested to twice rated voltage plus 1,000 volts. The power cable will be supported on the column pipe by stainless steel bands at intervals not exceeding 15 feet when installed.

11.10 Well Verification

- A. Well Efficiency analysis calculations shall be signed and sealed by a professional engineer registered in Texas.
- B. The efficiency for well completion shall be a minimum of 70 percent. The determination of final well efficiency will be made based on the completion of the 24-hour constant-discharge pumping test using calculated transmissivity and regional storativity values. The straight-line method presented by Cooper and Jacob (1946) will be used with data from the pumping well to compute the theoretical well drawdown. The ratio of the theoretical drawdown at the limits of the reamed hole to the measured drawdown in the pumped well (at 60 minutes) will determine well efficiency.

GN

GENERAL NOTES

GN – General Notes

Overview

The following General Notes shall apply to all construction projects, public or private. The Owner's Engineer may supplement the General Notes with project-specific notes with City approval.

General Notes for All Construction Activities

1. All construction, testing, and materials shall be in accordance with the City's current standards, details, and specifications.
2. Testing and inspection of materials shall be performed by a commercial testing laboratory approved by the City. Contractor shall furnish materials or specimens for testing, and shall furnish suitable evidence that the materials proposed to be incorporated into the work are in accordance with the specifications.
3. Contractor shall notify the City at least 48 hours prior to beginning construction.
4. Contractor is responsible for obtaining all necessary permits and approvals prior to beginning any construction. Contact ROW Inspection division of Public Works at 972-292-5820 for a permit to work within City ROW.
5. Contractors are allowed to make connections to the City water system by opening an account and renting a fire hydrant meter from the Department of Public Works. The company or individual is solely responsible for the cost of the rental equipment and its proper use within the City of Frisco water system. The company or individual is also responsible for the cost of the water used. Refer to the City of Frisco Fire Hydrant Meter Policy (<http://friscotexas.gov/DocumentCenter/View/11332>) for fees and requirements.
6. Contractor must keep available onsite, at all times, approved construction plans and copies of any required permits along with the appropriate versions of the following references: City of Frisco Engineering Standards, NCTCOG specifications, TxDOT specifications, TxDOT standard drawings.
7. All shop drawings, working drawings or other documents which require review by the City, shall be submitted by the Contractor sufficiently in advance of scheduled construction to allow no less than 14 calendar days for review and response by the City.
8. Contractor shall be responsible for all required construction surveying and staking and shall notify the City of any discrepancies prior to proceeding with any work.
9. Contractor shall be responsible for protecting all survey markers including iron rods, property corners, or survey monuments within the limits of construction and outside ROW during construction. Any survey markers disturbed during construction shall be replaced by the Contractor at no cost to the City.
10. Contractor shall provide a construction schedule and weekly progress reports.

11. Contractor is responsible for keeping streets and driveways adjacent to the project free of mud and debris at all times. Contractor shall clean up and remove all loose material resulting from construction operations. The Contractor shall take all available precautions to control dust.
12. The existence and locations of the public and franchise utilities shown on the drawings were obtained from available records and are approximate. The Contractor shall determine the depth and location of existing underground utilities prior to excavating, trenching, or drilling and shall be required to take any precautionary measures to protect all lines shown and / or any other underground utilities not of record or not shown on the plans. The Contractor shall be responsible for contacting all public agencies and franchise utilities 48 hours prior to construction. (Texas811 1-800-344-8377) The Contractor may be required expose these facilities at no cost to the City. The Contractor will be responsible for damages to utilities if the damage is caused by negligence or failure to have locates performed.
13. Contractor shall be responsible for any damage to existing facilities or adjacent properties during construction. Any removal or damage to existing facilities shall be replaced or repaired to equal or better condition by the Contractor.
14. Contractor shall not store materials, equipment or other construction items on adjacent properties or right-of-way without the prior written consent of the property owner and the City.
15. Temporary fencing shall be installed prior to the removal of existing fencing. Temporary fencing shall be removed after proposed fencing is approved by the City. All temporary and proposed fencing locations shall be subject to field revisions as directed by the City.
16. Unusable excavated material, or construction debris shall be removed and disposed of offsite at an approved disposal facility by the Contractor at his expense.
17. It is the Contractor's responsibility to maintain a neat and accurate record of construction for the City's records.

General Notes for Traffic Control

1. Contractor shall be responsible for furnishing and installing all temporary and permanent traffic control in accordance with the minimum requirements of the latest revision of the Texas Manual on Uniform Traffic Control Devices (TMUTCD) and TxDOT Barricade and Construction Standards.
2. Contractor shall not impede traffic on existing streets, driveways, alleys, or fire lanes open to the public. In the event the construction work requires the closure of an existing street, alley, or fire lane, the Contractor shall request the road closure through the City Traffic Division 972-292-5400 a minimum of 48 hours in advance of the requested closure. Closures will not be allowed prior to 9:00 a.m. or after 3:30 p.m., Monday through Friday unless otherwise approved by the City.

General Notes for Paving

1. All paving construction, testing, and materials, including concrete, reinforcement, jointing, and subgrade preparation and treatment shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. No earthwork, lime application, or other preparation of the subgrade for paving of streets, alleys, or fire lanes shall be initiated without authorization from the City. The City will authorize the subgrade

work in preparation for paving after utility trench backfill testing has been completed and verified to meet the City requirements.

3. Placing of Concrete Pavement:

- A. Machine Finished: A Slip-form paving machine shall be used for all public streets and alleys unless otherwise approved by the Director of Engineering Services.
- B. Hand Finished: Hand finished pavement is permitted for turn lanes, deceleration lanes, driveway approaches, or panel replacement of public streets or alleys.

4. Contractor is responsible for ensuring all pedestrian work meets or exceeds the current American with Disabilities Act Accessibility Guidelines (ADAAG) and the Texas Accessibility Standards (TAS). The Contractor shall remove and replace any constructed or installed items not meeting the current ADAAG and TAS requirements at no additional cost to the City.

General Notes for Traffic Signals and Street Lighting

1. All traffic signal and street lighting construction, testing, and materials shall be in accordance with the City's current standards, details, and specifications unless otherwise noted. All electrical work shall be in accordance with the most current National Electrical Code, City and TxDOT specifications and standards.
2. Contractor shall notify the Traffic Department (Tracy Nichols) at least 7 business days prior to any work, provide a construction schedule and weekly progress reports to the Traffic Department, and notify the Traffic Department at least 48 hours prior to signal turn-on.
3. Contractor shall coordinate electrical services with the City and either ONCOR or COSERV representatives (according to their respective area).
4. Contractor shall coordinate with the electric company to de-energize any overhead or underground power lines. Any cost associated with de-energizing the power line and/or any other protective measures required shall be at no cost to City.
5. The Contractor shall coordinate with the appropriate utility company and TxDOT/NTTA (if within TxDOT/NTTA ROW) prior to beginning erection of poles, luminaries and structures located near any overhead or underground utilities.
6. Proposed concrete foundation and conduit alignment shall be staked by the Contractor and approved by the City prior to installation.
7. Contractor shall contact the City Traffic Department (between 8 am – 5pm) for inspection prior to pouring any concrete foundation and digging for conduit runs at least 48 hours in advance.
8. Contractor shall have a qualified IMSA Level II or a TRF453 certified technician on the project site to place the traffic signals in operation.
9. Electrical work shall be performed by certified persons in accordance with the requirements of the contract and may be rejected as unsuitable for use due to poor workmanship. The required electrical certification course is available and is scheduled periodically by TEEX. Alternatively, the Contractor may purchase an entire course for their personnel to be held at a time and location of their choice as

negotiated through TEEX. For more information, contact: TEXAS ENGINEERING EXTENSION SERVICE (TEEX), TxDOT ELECTRICAL SYSTEM COURSE, (979) 845-6563.

10. The Contractor shall not place pedestrian crosswalk and stop bar pavement markings until signal is operational.
11. All lighting poles, fixtures, and arms which are removed shall be delivered to the City Public Works facility (11300 Research Road, Frisco, Texas 75034) by the Contractor and will remain the property of the City. Contact the Traffic Department at least 24 hours in advance of delivery.
12. During the 30-day traffic signal test period, Contractor shall respond to and diagnose all trouble calls with qualified personnel within a reasonable travel time from a Dallas address, but not more than two (2) hours maximum. Contractor shall repair any malfunctions of signal equipment supplied by Contractor on the project. A local telephone number (not subject to frequent changes) where trouble calls are to be received on a 24-hour basis shall be provided to the City by the Contractor. Appropriate repairs shall be made within 24 hours. The Contractor shall keep a record of each trouble call reported in the logbook provided by the City and shall notify the City of each trouble call. The error log in the malfunction management unit (MMU) shall not be cleared during the 30-day test period without the approval of the City.
13. Texas State Law, Article 1436C, makes it unlawful to operate equipment or machines within 10-feet of any overhead electrical lines unless danger against contact with high voltage overhead lines has been effectively guarded against pursuant to the provisions of this Article. When construction operations require working near an overhead electrical line, the Contractor shall contact the owner/operator of the overhead electrical line to make adequate arrangements and to take necessary safety precautions to ensure that all laws, electrical line owner/operator requirements and standard safety practices are met.

General Notes for Storm Drain

1. All storm drain construction, testing, and materials shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. Contractor shall submit a Trench Safety Plan prior to the Pre-Construction Meeting.
3. Two weeks prior to connecting to existing storm drain lines, the contractor should inspect the existing line and contact the stormwater inspector should the line need to be cleaned.
4. Contractor should inspect all storm drain outfalls no earlier than two weeks prior to final inspection and remove all silt and debris.

General Notes for Water and Wastewater

1. All water and wastewater construction, testing, and materials shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. Contractor shall submit a Trench Safety Plan prior to the Pre-Construction Meeting.
3. Contractor shall not operate existing valves. Contact the City's Public Works Department to request valve changes.

4. Any existing fire hydrant that is modified and has a date that exceeds 8 years in age shall be replaced and the old fire hydrant returned to the Public Works Department by the Contractor at his expense.
5. Any existing manhole with an opening smaller than 30" diameter that is modified shall have the cone section, ring, and cover replaced with a minimum of 30" diameter cone section, ring, and cover by the Contractor at his expense.

General Notes for Landscaping

1. All landscaping construction, installation, testing, and materials shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. Contractor shall avoid damage to existing trees. When necessary, trees and shrub trimming for construction shall be performed by certified tree worker or under the direction of a registered landscape architect or certified arborist.
3. Contractor shall locate and protect all existing landscape irrigation systems. Damage to existing irrigation systems and landscape materials shall be restored to equal or better condition at no cost to City.
4. Prior to obtaining a grading permit or scheduling a pre-construction meeting:
 - A. Where transplanting or tree removal is required, Contractor must apply for a Tree Permit. Contact Development Services Landscape Architect for Tree Permit.
 - B. All tree markings and protective fencing must be installed by the Contractor and be inspected by the City's Landscape Architect.
 - C. Coordinate with Parks Department on any trees that require being transplanted or removed from medians.
5. All trees which are to remain on site shall be protected with a 4' tall brightly colored plastic fence placed at the drip line of the trees.
6. Trees to be removed may be chipped and used for mulch on site or hauled off-site. Burning of removed trees, stumps, or foliage requires written approval by the Fire Department.
7. Plant materials shall not impede or obstruct vision or route of travel for vehicular, pedestrian, or bicycle traffic along City right-of-way, visibility easements, sidewalks or other easements.
8. No signs, wires, or other attachments other than those of a protective nature shall be attached to any tree to remain on site.
9. If topsoil is to be added to a rough grade, till 3 to 4 inches deep, then add topsoil for better binding and eliminate laying.
10. Spray existing weeds with non-selective herbicide prior to sod installation.
11. Apply pre-emerge (Ronstar) prior to sod installation.
12. The Owner's representative reserves the right to inspect sod farm to select sod to be harvested.

13. Inspection of turfgrass sod by the Owner's representative may be made at the growing site, but such inspection will not preclude rejections after delivery to the job site.
14. No more turfgrass sod shall be delivered to the job site on any day than can be placed and watered on that day.
15. The general contractor shall be responsible for having adequate water available at the site prior to and during installation of the turfgrass sod.
16. Any turfgrass sod so rejected shall be removed from the site immediately and replaced with accepted turfgrass sod.
17. Contractor shall provide optimum installation time period for sod. No installation on frozen soil. No harvest of frozen sod.
18. Planting time for medians is March to September.
 - A. Outside of this time frame the median shall be stabilized.
 - B. Escrow for the removal of temporary stabilization and installation of buffalo grass sod per spec.

General Notes for Irrigation

1. All irrigation construction, installation, testing, and materials shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. A permit from the Building Inspection Division is required for each irrigation system.
3. Contractor shall notify the Parks Department prior to any modifications to the existing irrigation system.
4. Contractor shall contact the Parks Department to coordinate work prior to commencing work on any existing irrigation and prior to any installation of new irrigation.
5. Contractor shall locate and protect all existing landscape irrigation systems. Damage to existing irrigation systems and landscape materials shall be restored to equal or better condition at no cost to City.
6. Contractor shall program each controller zone based on sprinkler type, plant variety, soil characteristic, slope and solar orientation as designated on the plans. The Contractor shall coordinate with the City Parks Department for approval of the controller settings.
7. Contractor shall be responsible for coordinating with franchise utility provider to provide power to each irrigation controller. Contractor shall have underground power lines installed from power source up to the controller. Contractor shall meet controller specifications for power requirements.
8. Contractor shall set a temporary controller to establish landscape. Once landscape is established, Contractor shall contact the City's Parks and Recreation Department for assistance on installation of a Motorola controller.

General Notes for Erosion Control & Stormwater

1. Erosion control devices shall be installed on all projects prior to beginning construction and shall be maintained throughout the project in a condition acceptable to the City.
2. Steel posts shall not be used to install erosion control measures within City ROW.
3. Wire reinforcement shall be used on all silt fence used for erosion control.
4. Asphalt bags shall be placed at construction entrances to prevent curb damage.
5. Geotextile fabric shall be placed on subgrade prior to stone placement for construction entrances.
6. No equipment shall be cleaned on-site, or other liquids deposited and allowed to flow overland or subterranean within the limits of the critical root zone of trees that remain on site. This includes paint, oil, solvents, asphalt, concrete, concrete equipment wash water, mortar of similar materials.

General Notes for Water Wells

1. All water well materials, construction, and testing, shall be in accordance with the City's current standards, details, and specifications unless otherwise noted.
2. Components and Materials in Contact with Water for Human Consumption shall comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
3. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.
4. Contractor shall submit copies of all permits and associated permitting information required to complete the Work. Where applicable, Contractor will obtain drilling permits from the appropriate regulatory districts and authorities.
5. Contractor shall be licensed in the State of Texas 16 Texas Administrative Code, Chapter 76, Water Well Drillers and Water Well Pump Installers. Contractor shall submit a copy of the Texas Water Well Driller's License for the Field Superintendent and copies of licenses for all other personnel working on the Project that possess a designation as a Texas Water Well Driller or Driller's Apprentice
6. Contractor shall submit a diagram showing the diameter and depth of all holes.
7. Contractor shall site the well in accordance with Title 16, Texas Administrative Code, Chapter 76.100, Technical Requirements--Locations and Standards of Completion for Wells.
8. Downhole tools and equipment that may be positioned directly above borehole or completed well shall arrive onsite free of surface deposits of friable solids; for example, mud, sand, grout, caked on cuttings and cleaned of grease, oils, and other petroleum products. Exception is provided for normal amounts of thread joint compound on drill pipe and tool joints, and normal amounts of lubricating grease on mechanical equipment is allowed.
9. Contractor shall comply with applicable permits, laws, and regulations in disposing of drilling fluids, drill cuttings, and water generated during grouting. The permits, laws and regulations shall include, but not be limited to, the following:

- A. The water quality effluent limitations specified in the project's NPDES Permit.
 - B. Federal, state, and local laws, regulations, and ordinances related to disposing of materials generated in constructing wells.
10. Do not empty, spill, splash, or slosh containerized drilling mud and fluids onto ground surface while moving containers, pipes and equipment.
 11. Volatile wastes and other potential sources of pollution shall be properly stored in covered metal containers at least 150 feet from the well.
 12. Wastes shall not be buried or burned on the Site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the Site and disposed of in a manner complying with local ordinances and antipollution laws. Waste from spilled oils and material from maintenance activities are specifically prohibited from being disposed of onsite.
 13. Factory Tests are required for motors greater than 75 horsepower in accordance with IEEE 112 for polyphase motors.
 14. Contractor shall submit copies of all required data and as-built construction records required to be submitted to regulatory districts and authorities for well registration.

TS

TECHNICAL SPECIFICATIONS

TS – Technical Specifications – Table of Contents

Spec No.	Description	Date
<u>DIVISION 01 – General Requirements</u>		
013233	Video and Photographic Documentation	August 2020
015813	Project Sign	August 2020
017113	Mobilization	August 2020
017416	Dust Control	August 2020
<u>DIVISION 02 – Existing Conditions</u>		
024100	General Site Preparation	August 2020
<u>DIVISION 03 – Concrete</u>		
032100	Reinforcing Steel	August 2020
032200	Welded Wire Fabric	August 2020
033100	Concrete Structures – Cast-in-Place (City)	August 2020
033101	Drilled Shaft Foundation	August 2020
033105	Concrete Structures – Cast-in-Place (TxDOT)	August 2020
033106	Concrete Retaining Walls (TxDOT)	August 2020
034100	Concrete Structures – Precast (City)	August 2020
034105	Concrete Structures – Precast (TxDOT)	August 2020
<u>DIVISION 07 – Thermal and Moisture Protection</u>		
071300	Moisture Barrier	August 2020
<u>DIVISION 26 – Electrical</u>		
260500	Electric Conductor	August 2020
260501	Electrical Service	August 2020
262000	Low-Voltage AC Induction Motors	August 2020
265619	Luminaire Pole	August 2020
265620	Luminaire Fixture	August 2020
<u>DIVISION 27 – Communications</u>		
270500	Conduit	August 2020
<u>DIVISION 31 – Earthwork</u>		
312316	Excavation (Roadway)	August 2020
312317	Unclassified Channel Excavation	August 2020
312323	Select Fill	August 2020
312413	Embankment	August 2020
312500	Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control	August 2020
313600	Gabions and Gabion Mattresses	August 2020
313700	Riprap	August 2020
<u>DIVISION 32 – Exterior Improvements</u>		
321112	Moisture Treated Subgrade	August 2020
321113	Lime Treatment	August 2020
321116	Flexible Base	August 2020

321123	Sand Bedding	August 2020
321126	Asphalt Base Course	August 2020
321133	Portland Cement Treatment	August 2020
321216	Hot Mix Asphalt Pavement	August 2020
321313	Concrete Pavement	August 2020
321314	Rolling	August 2020
321373	Joint Sealant	August 2020
321400	Concrete Pavers	August 2020
321613	Concrete Curb and Gutter	August 2020
321645	Driveway Approach	August 2020
321650	Reinforced Concrete Sidewalk	August 2020
321655	Barrier Free Ramp	August 2020
321660	Concrete Median Nose	August 2020
321665	Reinforced Concrete Header	August 2020
321723	Pavement Markers and Markings	August 2020
321725	Prefabricated Pavement Marking (with Warranty)	August 2020
328000	Irrigation System	August 2020
329113	Fertilizer	August 2020
329119	Topsoil	August 2020
329223	Turfgrass Planting	August 2020
329225	Buffalo Grass	August 2020
329300	Tree, Shrub, and Groundcover Planting	August 2020
329600	Removal, Protection and Replacement of Trees, Shrubbery, Plants, Sod and Other Vegetation	August 2020

DIVISION 33 – Utilities

330131	Wastewater and Manhole Testing	August 2020
330132	Television Inspection for Wastewater Mains	August 2020
330510	Trenching, Backfilling and Compaction	August 2020
330523	Trenchless Utility Installation	August 2020
331113	Ductile Iron Pipe and Fittings	August 2020
331114	PVC Pipe for Water Distribution	August 2020
331213	Water Service Connections	August 2020
331216	Air Release Valves for Potable Water Systems and Wastewater Force Mains	August 2020
331217	Resilient Seated Gate Valves	August 2020
331218	Butterfly Valves	August 2020
331219	Fire Hydrants	August 2020
331240	Polyethylene Encasement	August 2020
331245	Tapping Sleeves for PVC and Ductile Iron Pipe	August 2020
331260	Mechanical Restraint for PVC and Ductile Iron Pipe	August 2020
332113.01	Water Well Mobilization/Demobilization	August 2020
332113.02	Water Well Conductor Casing and Sanitary Seal	August 2020
332113.03	Water Well Drilling	August 2020
332113.04	Water Well Geophysical Logging	August 2020
332113.06	Water Well Casing	August 2020
332113.07	Water Well Screen and Gravel Pack	August 2020
332113.08	Water Well Grouting	August 2020
332113.10	Water Well Pumping Test	August 2020
332113.12	Water Well Video Inspection	August 2020
332113.13	Water Well Disinfection	August 2020

333109	Wastewater Lateral Connections	August 2020
333110	PVC Pipe for Gravity Wastewater Mains	August 2020
333115	Pressure Rated PVC Pipe for Gravity Wastewater Mains	August 2020
333130	Centrifugally Cast Fiberglass Reinforced Pipe for Gravity Wastewater Mains	August 2020
333913	Wastewater Manhole Frames and Covers	August 2020
333914	Cast-in-Place Concrete Manholes	August 2020
333915	Precast Concrete Manholes	August 2020
333916	Fiberglass Manholes	August 2020
334113	Reinforced Concrete Pipe	August 2020
334200	Reinforced Box Culvert	August 2020
334913	Storm Sewer Manhole	August 2020
334914	Headwalls and Wingwalls	August 2020
334915	Safety End Treatment	August 2020
334920	Standard and Recessed Curb Inlets and Other Inlets	August 2020
<u>DIVISION 34 – Transportation</u>		
344113	Installation of Highway Traffic Signal	August 2020
344125	Vehicle and Pedestrian Signal Heads	August 2020
344130	Traffic Signal Cable	August 2020
344135	Ground Box	August 2020
344140	Temporary Traffic Signal	August 2020
344150	Small Roadside Sign Supports and Assemblies	August 2020
347113	Barricades, Signs, and Traffic Handling	August 2020
<u>DIVISION 44 – Pollution Control Equipment</u>		
444256.03	Vertical Turbine Pumps	August 2020

SECTION 013233

VIDEO AND PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools, and superintendence necessary to take and provide video and photographic documentation of pre-construction, mid-construction, and post-construction conditions to the City.

1.02 SUBMITTALS

- A. Submit pre-construction, mid-construction, and post-construction digital videos and photographs as record data in accordance with General Condition 4.3
- B. Submit all pre-construction videos and photographs of the entire construction area as one submittal at the beginning of the project. Sections submitted separately will not be accepted.
- C. Submit all mid-construction videos and photographs as separate submittals at six-month intervals upon completion of the pre-construction videos and photographs.
- D. Submit all post-construction videos and photographs as one submittal at the end of the project.
- E. All videos and photographs are to become the property of the City. Videos and photographs may not be used for publication, or public or private display without the written consent of the City.

PART 2 - PRODUCTS

2.01 VIDEOS

- A. Videos shall be in a digital format with a minimum resolution of 1080p that can be viewed with Windows Media Player.
- B. The quality of the video must be sufficient to determine the existing conditions of the construction area.
- C. Camera panning must be performed while at rest. Do not pan the camera while walking or driving. Camera pans should be performed at intervals sufficient to clearly view the entire construction area.

2.02 PHOTOGRAPHS

- A. Photographs shall be in a digital format with a minimum resolution of 1280 x 960.

PART 3 - EXECUTION

3.01 WORK INCLUDED

A. Pre-Construction & Mid-Construction

1. Provide digital videos and photographs of the project site:
 - a. Prior to the beginning of construction when construction staking is complete, but prior to any clearing, and at six-month intervals thereafter.
 - b. Label videos and photographs by project name, date, stationing, offset, and left or right.
 - c. Pipeline projects should be recorded linearly from beginning to end.
 - d. Provide additional imaging as directed by the City if the videos or photographs provided are not considered suitable for documenting pre-existing conditions.
 - e. Record the condition of all existing facilities in or abutting the construction area, right-of-way, and easements. This should include, but not be limited to streets, curb and gutter, utilities, driveways, fencing, walls, landscaping, etc.

B. Post-Construction

1. Provide digital videos and photographs of the project site to clearly depict the completed Project.
 - a. Capture all significant areas of completed construction.
 - b. Completion videos and photographs are not to be taken until all construction trailers, excess materials, trash and debris have been removed.
 - c. Label videos and photographs by project name, date, stationing, offset, and left or right.
 - d. Provide additional imaging as directed by the City of the videos or photographs provided are not considered suitable for documenting post-construction conditions.
 - e. Record the final condition of all facilities in or abutting the construction area, right-of-way, and easements. This should include, but not be limited to streets, curb and gutter, utilities, driveways, fencing, walls, landscaping, etc.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance this Item will not be paid for directly but will be subsidiary to the pertinent Items.

END OF SECTION

SECTION 015813

PROJECT SIGN

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, and maintain Project Sign.

1.02 REFERENCES

- A. City of Frisco Standard Detail for Project Sign.

PART 2 - PRODUCTS

- A. Contractor may contact Southwest Signs & Graphics, Frisco, Texas at (972) 335-0234 or other City approved manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Contractor shall coordinate with the City regarding the location prior to installation. The City shall provide on-site inspection of the installation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a per Each (EA) basis.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item and measured as provided under MEASUREMENT will be paid for at the unit bid price for "Project Sign" in accordance with the City of Frisco's Standard Detail for Project Sign. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to furnish and install Project Sign.

END OF SECTION

SECTION 017113

MOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

The work under this section of the specification shall include the establishment of offices and other facilities on the project site and the movement of personnel, construction equipment, and supplies to the project site or to the vicinity of the project site to enable the Contractor to begin work on the other contract items that will be performed by the Contractor. This Item also includes all costs associated with bonding and insurance.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a Lump Sum (LS) basis as the work progresses.
- B. The maximum bid amount for this Item shall be 5% of the total amount bid for the project.

4.02 PAYMENT

Partial payments of the bid for Mobilization will be as follows. The adjusted contract amount for construction items as used below is defined as the total contract amount less the bid for Mobilization.

- A. When 1% of the adjusted contract amount for construction items is earned, 50% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- B. When 5% of the adjusted contract amount for construction items is earned, 75% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- C. When 10% of the adjusted contract amount for construction items is earned, 90% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.
- D. When 50% of the adjusted contract amount for construction items is earned, 100% of the mobilization lump sum bid will be paid. Previous payments under this Item will be deducted from this amount.

END OF SECTION

SECTION 017416

DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Dust Control in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.8.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 024100

GENERAL SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. All materials, labor, equipment, tools and superintendence necessary for the preparation of the project site not covered elsewhere in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.

B. This Section also includes:

Protecting existing vegetation to remain.

Removing existing vegetation.

Clearing and grubbing.

Demolition.

Removal of all items within the limits of construction not specifically noted to remain.

1.02 REFERENCES

A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 203.1, 203.2, and 203.3.

1.03 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from City and authorities having jurisdiction.

Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvaged materials: Carefully remove items indicated to be salvaged and store as directed by the City.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

2. Call Texas811 at 1-800-344-8377

3. Contact City's ROW Division of Public Works at 972-292-5820 for locates

D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.1, 203.2 and 203.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis, unless indicated otherwise and shall include the removal of all items within the limits of construction not specifically called out to remain.
- B. Removal of existing pavement will be measured separately and paid for by the square yard (SY), regardless of thickness and type. Concrete curb and gutter removal will not be measured separately and is considered subsidiary to this item.
- C. Removal of existing sidewalk and ramps will be measured separately and paid for by the square yard (SY), regardless of thickness and type.
- D. Removal of existing inlets, headwalls, manholes, etc. will be measured separately and paid for per each (EA) inlet removed, regardless of the size of the existing inlet. Removal of existing pipe will not be measured separately and is considered subsidiary to this item.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 032100

REINFORCING STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforcing Steel in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.

1.03 RELATED SECTIONS

- A. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.
- B. Specified reinforcing steel (#4 bars and larger) shall conform to the requirements of ASTM A615, Grade 60.
- C. Grade 40 reinforcing steel (#3 bars) will only be allowed in sidewalks or with approval of the Director of Engineering Services.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.9 and 303.2.11.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will not be measured separately.

4.02 PAYMENT

- A. This Item will not be paid separately, but considered subsidiary to pertinent Items.

END OF SECTION

SECTION 032200

WELDED WIRE FABRIC

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Welded Wire Fabric in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10 and 303.2.11.

1.03 RELATED SECTIONS

- A. Section 313700 – Riprap

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.10 and 303.2.11.
- B. Welded Wire Fabric is acceptable as reinforcement for concrete riprap of bridge abutments only.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will not be measured separately.

4.02 PAYMENT

- A. This Item will not be paid separately, but considered subsidiary to pertinent Items.

END OF SECTION

SECTION 033100

CONCRETE STRUCTURES – CAST-IN-PLACE (CITY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Cast-in-Place (City) in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 702.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2 and 303.3.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.
- C. All concrete shall be sulfate resistant mixes. Mix Design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete drivers.
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.2 is hereby modified to allow only Type I/II Portland Cement.
- E. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.4 is hereby modified to allow only Class F flyash.
- F. Provide Class F or Class M concrete.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 033101

DRILLED SHAFT FOUNDATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Drilled Shaft Foundations (including Traffic Signal Poles or Street Light Poles).

1.02 REFERENCES

- A. TxDOT Items 416, 420, 421, 440, and 448
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal.
- B. Section 265619 – Luminaire Pole

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 416.
- B. Type A concrete shall be used for non-reinforced foundations. Type C concrete shall be used for reinforced foundations.
- C. All concrete shall be sulfate resistant mixes. Mix design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete deliveries.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 416.
- B. A 3/4 inch chamfer (beveled) shall be formed on the top edge of each pole foundation.
- C. The Contractor shall probe before drilling foundations to determine the location of utilities and structures. Foundations shall be paid for once regardless of extra work caused by obstructions. Foundations shall not be placed within 3-feet of a water line or fire hydrant and must be a minimum of 25-feet from all tree trunks unless otherwise directed by the City. If any City or any other water utility is near a proposed pole foundation (within 3 feet), then the Contractor will hand dig to uncover the water line and verify that the proposed pole foundation location is satisfactory. The Contractor shall be liable for all damages done, and restoration to utilities as a result of their operations.

- D. Contractor shall contact the City for inspection prior to pouring any concrete foundation and digging for conduit runs at least 48 hours in advance (between 8 am – 5pm).
- E. No poles shall be placed on foundations prior to 7 days following pouring of concrete.
- F. Contractor shall clean up and remove all loose material resulting from construction operations.
- G. Top of foundation shall be 3 inches above the finished grade unless otherwise shown on the plans and shall be formed or provided a smooth finish satisfactory to the City. Foundation piers shall be drilled plum, the top of foundation poured level, and the top 3 inches of the exposed foundation above finished grade shall have the sonotube removed.
- H. Anchor bolts shall extend above the top of the foundation concrete as shown on anchor bolt detail. Refer to manufacturer's specifications for bolt circle dimensions and anchor bolt specifications.
- I. Anchor bolts, ground rod, all reinforcing and conduit shall be in place before pouring concrete pier foundations. Foundations shall have one continuous concrete pour.
- J. Contractor shall keep a record set of plans and mark any differences between the locations shown in the plans and the as-built locations. This record set shall be provided to the City time of acceptance of the work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 416.

4.02 PAYMENT

- A. Refer to TxDOT Item 416.
- B. Foundations shall be paid for once regardless of extra work caused by obstructions.

END OF SECTION

SECTION 033105

CONCRETE STRUCTURES – CAST-IN-PLACE (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures - Cast-In-Place (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 420.

1.02 REFERENCES

- A. TxDOT Item 420
- B. TxDOT and City Standard details, included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 420.2.
- B. All concrete shall be sulfate resistant mixes. Mix design must be submitted and approved by the City at least 7 days prior to scheduled pour. The Contractor will be required to provide tickets for all concrete deliveries.
- C. TxDOT, Item 416, 420, and 421 are hereby modified to allow only 20% to 25% Class F flyash per weight basis for sulfate resistant mix design. Class C Flyash is not allowed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 420.3 and 420.4.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 420.5 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT 420.6 or as indicated in the Contract Documents.

END OF SECTION

SECTION 033106

CONCRETE RETAINING WALLS (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Retaining Walls (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 423.

1.02 REFERENCES

- A. TxDOT Item 423
- B. TxDOT Standard Details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 423.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 423.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 423 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT 423 or as indicated in the Contract Documents.

END OF SECTION

SECTION 034100

CONCRETE STRUCTURES – PRECAST (CITY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Precast (City) in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 702.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.
- B. All concrete shall be sulfate resistant.
- C. Provide Class F or Class M concrete.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 701.2 and 702.

PART 4 –MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 034105

CONCRETE STRUCTURES – PRECAST (TxDOT)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Structures – Precast (TxDOT) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 424.

1.02 REFERENCES

- A. TxDOT Item 424
- B. TxDOT Item 425
- C. TxDOT Standard Details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 424.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 424.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 424 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Refer to TxDOT Item 424 or as indicated in the Contract Documents.

END OF SECTION

SECTION 071300

MOISTURE BARRIER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Moisture Barrier.

1.02 REFERENCES

- A. Project's Geotechnical Report

1.03 RELATED SECTIONS

- A. Section 321112 - Moisture Treated Subgrade

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The moisture barrier shall consist of a minimum 10 mil polyethylene sheeting. Covered with a minimum 8 inches of lightly compacted soil.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The moisture barrier shall be placed horizontally on the treated subgrade from the edge of pavement and extending at minimum 6 feet on either side of the pavement in a neat line after final compaction unless indicated otherwise on the plans.
- B. The moisture barrier shall be covered with at least 8 inches of lightly compacted soil. Care should be taken not to rip or tear the polyethylene sheeting during placement of the cover fill.
- C. The moisture barrier shall be placed after any improvements that may impact the barrier (i.e. landscaping, irrigation, conduit, etc.).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Square Yard (SY) basis.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Moisture Barrier." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

- B. Payment for the 8 inches of lightly compacted soil shall be considered subsidiary to the “Moisture Barrier” Item.

END OF SECTION

SECTION 260500

ELECTRIC CONDUCTOR

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Electric Conductors for Traffic Signals and/or Street Lighting.

1.02 REFERENCES

- A. TxDOT Item 620
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal
- B. Section 270500 – Conduit

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 620.
- B. All electrical connectors for breakaway poles shall be breakaway (BUSSMAN HEBW, LITTLEFUSE LEB, FERRAZ-SHAWMUT FEB, HMC FLOOD-SEAL SLK-MD or approved equal) in accordance with the latest TxDOT RID standards. All electrical connections for neutrals shall be breakaway and shall have a white colored marking and a permanently installed solid neutral (BUSSMAN HET, LITTLEFUSE LET, FERRAZ-SHAWMUT FEBN, HMC FLOOD-SEAL SDK-MD or approved equal).
- C. A continuous bare or green insulated copper wire No.6 or larger shall be installed in every conduit throughout the electrical and the traffic signals system in accordance with TxDOT Item 680, the electrical details, and the current edition of the National Electrical Code. This bare or green insulated copper wire shall be stranded for this project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 620.
- B. Where two or more conductors are present in one conduit or enclosure, the conductors shall be identified as shown in the electrical details. If the identification tag with two plastic straps is too large for the referenced conductors, a tag with a single plastic strap may be used if approved by the city. In any case, each tag shall indicate circuit number, letter, or other identification as shown in the plans.

- C. Grounding conductors that share the same conduit, junction box, ground box or structure shall be bonded together at every accessible point in accordance with the current edition of the National Electric Code.
- D. Electrical work performed by non-certified persons is not in accordance with the requirements of the contract and may be rejected as unsuitable for use due to poor workmanship. The required electrical certification course is available and is scheduled periodically by TEEX. Alternatively, the Contractor may purchase an entire course for their personnel to be held at a time and location of their choice as negotiated through TEEX. For more information, contact: TEXAS ENGINEERING EXTENSION SERVICE (TEEX), TxDOT ELECTRICAL SYSTEM COURSE, (979) 845-6563

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis for each single conductor, complete in place. The length is the straight line distance between the ground boxes, foundations, or pads.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Electric Conductor." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the Bid Form.

END OF SECTION

SECTION 260501

ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All electrical service conductors, labor, equipment, tools and superintendence necessary to furnish and install Electric Service.

1.02 REFERENCES

- A. TxDOT Items 620 and 628
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.
- D. Irrigation Plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 620 and 628.
- B. The electrical service enclosure shall have a powder-coated paint finish of RAL9017 (TRAFFIC BLACK) or City approved equal to match the color of the traffic signal pole assemblies.
- C. Electrical Service for Traffic Signals will be provided by the City. Contractor shall provide and install electrical services for Street Lighting and Irrigation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All enclosure-mounted components shall be installed in the main service enclosure including all lighting components and the main disconnect as required by the plans. The main disconnect shall not be accessible from outside the main service enclosure.
- B. All neutral wire shall be white insulated wire only.
- C. The address for electrical service shall be obtained from the City of Frisco. The electrical service for this project shall be billed in the name of City of Frisco.
- D. If the Contractor is required to provide the service, the Contractor shall submit for approval four (4) copies of catalog cut sheets for each of the following items: Electrical Service Enclosure, Breakers, Lighting Contractor, Fuses, Terminal Blocks, Photocell and Socket, and Lighting Arrestor.
- E. The service enclosure shall be manufactured in a UL listed shop. It shall have a continuous piano hinge with stainless steel pin along the side. An enclosure with the hinge along the top

of the box will not be acceptable. Service enclosures shall have no more than two (2) pieces of dead front trim. All conduits entering the service enclosure shall be through the bottom of the services enclosure.

F. For traffic signal installations with luminaries and illuminated street name signs (ILSN), separate photocell and lighting contactor will be required for luminaries and ILSN (Total two photocells and two lighting contactor).

G. Install in line fuses at all service connections.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. This Item shall be measured on a per Each (EA) electrical service installed or removed.

4.02 PAYMENT

A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for as provided under measurement for "Electrical Service" in accordance with TxDOT Item 628. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 262000

LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 - GENERAL

1.01 RELATED SECTIONS

- A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section
 - 1. American Bearing Manufacturers Association (ABMA):
 - a. 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. 11, Load Ratings and Fatigue Life for Roller Bearings.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. MG 1, Motors and Generators.
 - 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 5. Underwriters Laboratories (UL):
 - a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
 - b. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

- A. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.
- B. Motor Nameplate Horsepower: Rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

1.04 SUBMITTALS

- A. Required Submittals:
 - 1. Nameplate data in accordance with NEMA MG 1.
 - 2. Enclosure type and mounting (such as, horizontal, vertical).
 - 3. Description, ratings, and wiring diagram of motor thermal protection.
 - 4. Maximum brake horsepower required by the equipment driven by the motor.
 - 5. Factory test reports
 - 6. Operation and maintenance data.
 - 7. Manufacturer's certificate of proper installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Byron Jackson.
2. Pleuger.
3. Franklin Electric.

2.02 GENERAL

- A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.
- C. Meet requirements of NEMA MG 1.
- D. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
- E. Lifting lugs are required on motors weighing 100 pounds or more.
- F. Operating Conditions:
 - 1. Minimum ambient temperature at least 32 degrees C for submersible motors.
 - 2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding rated temperature rise.
 - 3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

- A. As designated in motor-driven equipment specification.
- B. Constant Speed Applications: Brake horsepower of driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

- A. 1.1 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

- A. System Frequency: 60 Hz.
- B. Voltage Rating: 460 volts.
- C. Suitable for full voltage starting.
- D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.

- E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 BALANCE AND VIBRATION CONTROL

- A. In accordance with NEMA MG 1, Part 7.

2.07 EQUIPMENT FINISH

- A. External Finish: Prime and finish coat manufacturer's standard.
- B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.08 SPECIAL FEATURES AND ACCESSORIES

- A. Nameplates:
 - 1. Raised or stamped letters on stainless steel or aluminum.
 - 2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
 - 3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

2.09 SPECIAL MOTORS

- A. Submersible Pump Motor:
 - 1. At 100 Percent Load:

Submersible Pump Motors		
Horsepower	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

- 2. Insulation System: Manufacturer's standard Class F.
- 3. Enclosure:
 - a. Hermetically sealed, watertight, for continuous submergence up to 400-foot depth or wet type with breather diaphragm for pressure compensation.
 - b. Seals: Mechanical.
- 4. Bearing and Lubrication:
 - a. Water-lubricated.
- 5. Connecting Cables:
 - a. One cable containing power, control, and grounding conductors.
 - b. The power cable assembly shall be furnished in the proper length to extend from the motor terminals to the junction box mounted at the surface plate. No splice will be permitted between the motor terminals and the junction box.
 - c. The power cable assembly design shall include a sealing terminal plug arrangement with metal guards for protection against rubbing the casing I.D. during installation.

- d. The power cable assembly shall include a factory hot-injection molded plug at the motor terminal end. The plug design shall incorporate a sealing plug-in design, which can be removed without disassembling any part of the motor. The cable plug design shall be capable of withstanding full submergence pressure without failure.
- e. The power cable assembly, complete, including the flat cable splice and plug shall be Hi-Pot tested to twice rated voltage plus 1,000 volts. The power cable will be supported on the column pipe by stainless steel bands at intervals not exceeding 15 feet when installed.

2.10 FACTORY TESTING

- A. Tests are required for motors greater than 75 horsepower in accordance with IEEE 112 for polyphase motors.

END OF SECTION

SECTION 265619

LUMINAIRE POLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Luminaire Poles for City of Frisco standard street lighting.

1.02 REFERENCES

- A. Manufacturer's Standard Details and Specifications for Luminaire Pole.

1.03 RELATED SECTIONS

- A. Section 033101 – Drilled Shaft Foundation
- B. Section 265620 – Luminaire Fixture
- C. Section 260500 – Electric Conductor
- D. Section 260501 – Electrical Service
- E. Section 344135 – Ground Box
- F. Section 347113– Barricades, Signs, and Traffic Handling

1.04 SUBMITTALS

- A. Manufacturer's Standard Details and Specifications.
- B. The Contractor shall furnish four (4) sets of submittals of the carbon steel pole to the City. These submittals shall be approved by the City before the Contractor begins work.
- C. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials furnished by the Contractor shall be new, UL-listed, meet NEMA, NEC, AASHTO, and the Electrical Detail standard sheet requirements.
- B. The lighting assembly pole shall be 29.5 feet in height. The pole shall be a round tapered 11 gauge steel shaft with hand hole. Poles shall include breakaway coupling system that includes four couplings with associated hardware and a two piece aluminum skirt with attachment hardware. The aluminum skirt finish match color and type of finish specified for the light pole. The breakaway coupling system shall conform to current AASHTO standards and shall be approved by FHWA for breakaway characteristics at impact speeds for 20 to 60 mph.

- C. The assembly will contain either one or two bracket arms. The bracket arm shall be 4 foot in length, have a 2 3/8 inch OD and have a 21 inch upsweep. Finish color and finish type shall match that specified for the light pole.
- D. Luminaire Poles shall be either one of the following types:
 - 1. Valmont Industries, Inc. Twin Arm Catalog No. DS30-750A290-4D-FP with 30"x96" concrete pier.
 - 2. KW RTSU30-7.5-11-BLK-24S- BSC-1.0-SKT-NC
- E. All Luminaire Poles shall have a powder-coated paint finish of RAL9017 (TRAFFIC BLACK) unless otherwise directed by the City. All assemblies shall be hot dipped galvanized to ASTM 123 and 153 specifications. Once galvanizing is completed, all exposed surfaces shall be mechanically etched by blast cleaning to remove mill scale, impurities and non-metallic foreign materials. All surfaces visually exposed are to be coated with a Urethane or Triglycidyl (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. The coating shall be electrostatically applied and cured in a gas fired convention oven by heating the steel substrate between 350 and 400 degrees Fahrenheit.

PART 3 - EXECUTION

3.01 PREPARATION

- A. The Contractor shall notify the Traffic Department at least 7 business days prior to any work on this project and provide a construction schedule with weekly progress reports.
- B. The Contractor shall clean up and remove all loose material resulting from construction operations.
- C. All electrical work shall be in accordance with the most current National Electrical Code, City and TxDOT specifications and standards.
- D. The Contractor shall coordinate electrical services with the City of Frisco and either ONCOR or COSERV representatives (according to their respective area).
- E. Proposed street light pole foundations shall be staked by the Contractor and approved by the City prior to installation.
- F. Erection of poles, luminaries and structures located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company and TxDOT prior to beginning such work.
- G. All shop drawings, working drawings or other documents which require review by the City and shall be submitted by the Contractor sufficiently in advance of scheduled construction to allow no less than 14 calendar days for review and response by the City.
- H. If any overhead or underground power lines need to be de-energized, the Contractor shall call the electric company to do this work. Any cost associated with de-energizing the power line and/or any other protective measures required shall be at the Contractor's expense.

- I. All lighting poles, fixtures, and arms which are removed with this project shall be delivered to the City of Frisco Public Works facility (11300 Research Road, Frisco, Texas 75034) by the Contractor and will remain the property of the City of Frisco.
- J. Texas State Law, Article 1436C, makes unlawful the operation of equipment or machines within 10-feet of any overhead electrical lines under danger against contact with high voltage overhead lines has been effectively guarded against pursuant to the provisions of the article. When construction operations require working near an overhead electrical line, the Contractor shall contact the owner/operator of the overhead electrical line to make adequate arrangements and to take necessary safety precautions to ensure that all laws, electrical line owner/operator requirements and standard industry safety practices are met.
- K. All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following items:
 - a. TxDOT Item 616 "Performance Testing of Lighting Systems"
 - b. TxDOT Item 620 "Electrical Conductors"

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Luminaire Pole." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Foundations shall be paid for once regardless of extra work caused by obstructions.

END OF SECTION

SECTION 265620

LUMINAIRE FIXTURE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install or install City-supplied Luminaire Fixtures for City of Frisco standard street lighting.

1.02 REFERENCES

- A. Manufacturer's Standard Details and Specifications for Luminaire Fixture.

1.03 RELATED SECTIONS

- A. Section 265619 – Luminaire Pole
- B. Section 033101 – Drilled Shaft Foundation
- C. Section 347113 – Barricades, Signs, and Traffic Handling
- D. Section 260500 – Electric Conductor
- E. Section 344135 – Ground Box
- F. Section 260501 – Electrical Service

1.04 SUBMITTALS

- A. Manufacturer's Standard Details and Specifications.
- B. If the Luminaire Fixtures are to be supplied by the Contractor, the Contractor shall furnish four (4) sets of submittals of the fixture to the City. These submittals shall be approved by the City before the Contractor begins work. Prior to beginning fabrication, two (2) copies of the completed material identification form shall be furnished to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials furnished by the Contractor shall be new, UL-listed, meet NEMA, NEC, AASHTO, and the Electrical Detail standard sheet requirements.
- B. If specified, the Contractor shall provide the Luminaire Fixtures. The Luminaire Fixture shall be Phillips Lumec Road Focus Medium LED Cobra Head Luminaires, LED Module Type 3 Short, 347-480VAC, standard dimmable driver 0-10V with standard twist lock receptacle 5 pin, black. Finish shall be electrostatically applied thermoset polyester powder coat color Traffic Black (RAL9017).

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to City of Frisco's General Notes for Traffic Signals and Street Lighting.
- B. All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this Item and the pertinent requirements of the following items:
 - a. TxDOT Item 616 "Performance Testing of Lighting Systems"
 - b. TxDOT Item 620 "Electrical Conductors"

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Luminaire Fixture (install City-supplied)" or "Luminaire Fixture (furnish and install)." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 270500

CONDUIT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Conduit for Traffic Signals, Street Lighting, or Irrigation.

1.02 REFERENCES

- A. TxDOT Item 618
- B. TxDOT Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.
- D. Irrigation Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signals
- B. Section 260500 – Electric Conductor

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 618.
- B. All conduit underground for signals and street lighting shall be Schedule 40 white PVC unless indicated otherwise. Conduit size shall be as shown in the plans.
- C. Conduit above ground shall be 2 inch rigid metal, unless otherwise directed by the City. Conduit size shall be as shown in the plans.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor shall secure permission from the proper authority and the approval of the City prior to cutting into or removing any sidewalks or curbs, which may be required for installation.
- B. The locations of conduit and ground boxes are diagrammatic only and may be shifted with City approval to accommodate field conditions.
- C. A colored cleaner primer shall be used on all PVC to PVC joints before application of PVC cement.

- D. Conduit shall be placed under existing pavement by an approved boring method unless otherwise directed by the City. Pits for boring shall not be closer than 2 feet from the edge of the pavement unless otherwise directed by the City.
- E. Water jetting will not be permitted.
- F. When boring is used under pavement conduit installations, the maximum allowable over-cut shall be 1 inch in diameter.
- G. When conduits are bored, the vertical and horizontal tolerances shall not exceed 18" as measured from the intended target point.
- H. All conduit shall be installed at a minimum depth of 36" below grade measured from the bottom of the concrete slab.
- I. The use of pneumatically driven device for punching holes beneath the pavement (commonly known as a "missile") will not be permitted.
- J. The Contractor shall install a non-metallic pull rope in conduit runs in excess of 50 feet.
- K. When rigid metal conduit is exposed at any point and where rigid metal conduit extends into ground boxes, the metal conduit shall be bonded to the grounding conductor with grounding type bushings or by other UL listed grounding connectors approved by the City.
- L. PVC conduit systems that snap or lock together without glue that are designed and UL listed to be used for bored PVC electrical conduit applications will be allowed for bored PVC schedule 40. No additional compensation will be paid to the Contractor when these specific purpose conduit systems are substituted for this purpose.
- M. Liquid-tight flexible metal (LTFM) conduit shall be used where the plans refer to flexible metal conduit. Flexible metal shall not be permitted.
- N. Contractor shall place duct seal at the ends of all conduits where conductors and/or cables are present with a permanently soft, non-toxic duct seal that does not adversely affect other plastic materials or corrode metals.
- O. The conduit shall be installed in a trench free of rocks that would damage the conduit and first 2 inches of backfill shall be free of rock.
- P. All conduit shall start and end in a ground box, foundation, or at a transformer pad along with a 1/4 inch polyline (pullstring) with a break strength of 500 pounds or greater.
- Q. Each change of direction in the conduit run requires a ground box (pull box) unless it is less than 20 feet to the end of the run or unless otherwise directed by the City.
- R. Conduit shall be placed within an easement or street ROW. When placed in easements, the location of the conduit shall be 30 inches off the lot lines to avoid being damaged by fence post placement.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis for each Conduit type and size, complete in place. The length is the straight line distance between the ground boxes, foundations, or pads.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Conduit," of the size and type specified. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Flexible conduit will not be paid for directly but will be subsidiary to pertinent Items.
- C. Rigid metallic conduit elbows 1" and larger that are required to be installed on conduit systems will not be paid for directly but will be subsidiary to pertinent Items.
- D. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the Bid Form.

END OF SECTION

SECTION 312316

EXCAVATION (ROADWAY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Excavation (Roadway) in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 110.

1.02 REFERENCES

- A. TxDOT Item 110.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 110.2.
- B. All excavation shall be unclassified, and shall include the removal of all materials encountered, regardless of their nature or the manner in which they are removed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 110.2
- B. Frequency of compaction testing shall not exceed one test for every three hundred linear feet 300' spacing or less, alternating from left quarter point to center line to right quarter point of the cross section width. Every street, including stub outs to future phases shall have a minimum of one test.
- C. For density and moisture requirements of moisture treated excavation areas see Section 32112 Moisture Treated Subgrade.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 110.3 or as indicated in the Contract Documents.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity for which payment will be made.

4.02 PAYMENT

A. Refer to TxDOT Item 110.4 or as indicated in the Contract Documents.

END OF SECTION

SECTION 312317

UNCLASSIFIED CHANNEL EXCAVATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Unclassified Channel Excavation in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.
- B. All excavation shall be unclassified, and shall include the removal of all materials encountered, regardless of their nature or the manner in which they are removed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 203.5.

4.02 PAYMENT

- A. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity for which payment will be made.

END OF SECTION

SECTION 312323

SELECT FILL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to install Select Fill in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 132.

1.02 REFERENCES

- A. TxDOT Item 132.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 132.2 Type A.
- B. Eagle Ford may not be imported to other areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 132.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item unless noted otherwise.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items unless noted otherwise.

END OF SECTION

SECTION 312413

EMBANKMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Embankment in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 132.

1.02 REFERENCES

- A. TxDOT Item 132.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 132.2 and as specified in the Contract Documents.
- B. Eagle Ford may not be imported to other areas.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 132.3.
- B. Frequency of compaction testing shall not exceed one test for every three hundred linear feet 300' spacing or less, alternating from left quarter point to center line to right quarter point for every layer of embankment.
- C. For density and moisture requirements of moisture treated embankments see Section 32112 Moisture Treated Subgrade.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Embankment will be measured by the cubic yard. The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. Shrinkage or swell factors will not be considered in determining the calculated quantities.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying

the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will be measured as provided for at the unit price bid for "EMBANKMENT" of the compaction method and type specified. The price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.
- B. No separate pay for sprinkling, rolling (including proof rolling).
- C. Correction of soft spots in the subgrade will be at the Contractor's expense.

END OF SECTION

SECTION 312500

TEMPORARY EROSION, SEDIMENTATION, AND WATER POLLUTION PREVENTION AND CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, maintain and remove Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201

1.03 SUBMITTALS

- A. The Contractor must provide a separate Storm Water Pollution Prevention Plan (SW3P) before the Notice to Proceed will be issued. The Erosion Control Plans included in the plans will not be considered a SW3P. The SW3P shall comply with the regulations established by the Texas Commission on Environmental Quality (TCEQ).
- B. The Contractor is required to submit all appropriate forms and pay all fees, including the NOI and NOT, as well as producing and submitting all inspection reports through the duration, as required, to the TCEQ and the City. The Contractor will be responsible for submitting all required forms and fees on behalf of the City, and shall submit two (2) copies of all NOIs and proof of payment to the City prior to Notice to Proceed is issued.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.
- B. Where existing grasses are disturbed, restoration shall consist of equal or better permanent vegetation. Provide a minimum of eight feet (8') of the appropriate seasonal seeded Curlex adjacent to all street and fire lane curbs and four feet (4') adjacent to alleys. The use of innovative products is encouraged, such as those made with composting materials, as long as they are approved by the Director of Engineering Services and permanent vegetative stabilization is established.
- C. Twenty four (24") to thirty six (36") inches in width of rock riprap shall be placed along the top and sides of the ground interface with all headwalls and end sections and street, alley, and fire lane stub outs.

2.02 EQUIPMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 201.
- B. Payment for the preparation of a Storm Water Pollution Prevention Plan shall be paid under the line item – “Storm Water Pollution Prevention Plan.”

END OF SECTION

SECTION 313600

GABIONS AND GABION MATTRESSES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Gabions and Gabion Mattresses in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 459.

1.02 REFERENCES

- A. TxDOT Item 459

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 459.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 459.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 459.4.

4.02 PAYMENT

- A. Refer to TxDOT 459.5.

END OF SECTION

SECTION 313700

RIPRAP

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install RipRap in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 432.

1.02 REFERENCES

- A. TxDOT Items 247, 420, 421, 431, 432, and 440.
- B. City of Frisco's Standard Details for Storm Sewer Curbed Flume.
- C. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 334915 – Safety End Treatments
- B. Section 312316 – Unclassified Street Excavation

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 432.2. Riprap type (dry, grout, mortar) shall be specified in the plans.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 432.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 432.4. Replace the first sentence of TxDOT 432.4 with the following: "This Item shall be measured by the square yard (SY) of material complete in place."

4.02 PAYMENT

- A. Refer to TxDOT 432.5.

END OF SECTION

SECTION 321112

MOISTURE TREATED SUBGRADE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for the moisture treatment of the subgrade in all areas to be paved.

1.02 REFERENCES

- A. Project's Geotechnical Report

1.03 RELATED SECTIONS

- A. Section 071300 - Moisture Barrier
- B. Section 312413 – Embankment
- C. Section 312316 – Excavation (Roadway)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Not used.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Weathered Eagle Ford shale material (classified as shale or shaley clay and not roc) encountered within 8 feet below finished subgrade shall be excavated to a depth of required moisture treatment and replaced with on-site light brown or dark brown clays or other approved material.
- B. Moisture treatment shall extend at least 4 feet beyond the edge of pavement and to the depth as shown on the plans. The subgrade shall be moisture treated to a minimum of 3 percentage points above optimum moisture content at a minimum of 95 percent standard Proctor (ASTM D 698).
- C. Moisture treated lifts shall not exceed eighteen inches (18") of thickness.
- D. Any embankment requiring moisture conditioning below pavement including four feet (4') beyond the edge of pavement shall be treated for the entire height of the embankment.
- E. Moisture treatment by injection is not an acceptable method to treat roadway subgrades.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured per Square Yard (SY) basis at the depth(s) specified in the Contract Documents.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Moisture Treated Subgrade.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321113

LIME TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Item shall govern stabilization of the new or existing subgrade and shall consist of all labor, equipment and material necessary to pulverize the subgrade clays or existing pavements, add the specified percentage of hydrated lime, mix, mellow, remix and compact the mixture as specified in this Item. The Contractor shall be responsible for making allowances for subgrade bulking during stabilization to achieve design finished subgrade elevation and meeting specified thickness. The finished Item shall be a compacted and finished subgrade meeting the grades, thicknesses, lines and typical cross sections shown on the plans and specifications.

1.02 REFERENCES

- A. Project's Geotechnical Report

1.03 RELATED SECTIONS

- A. Section 071300 – Moisture Barrier
- B. Section 312316 – Unclassified Street Excavation
- C. Section 321112 – Moisture Treated Subgrade

1.04 SUBMITTALS

- A. At least 30 days prior to beginning lime stabilization work, the Contractor shall furnish the City the following:
 - 1. The proposed source and supplier of lime.
 - 2. Description of the proposed construction equipment, construction methods, expected production rates and planned sequence of lime stabilization of subgrade.
 - 3. A lime/on-site soil mix design in accordance with Eades-Grim Method. Design shall comply with the following requirements:
 - a. pH = 12.4 (or maximum pH) after mellowing (ASTM D 2976)
 - b. Swell Potential: < 1.0 percent under 200 psf stress test (ASTM D 4546)
- B. The approval of the lime-soil mix design shall be at the discretion of the City. Once the design is approved in writing, the mix design shall be incorporated into these specifications by reference.
- C. During lime stabilization work, the Contractor shall furnish the following information to the City at the end of each day:

1. Certified truck weight tickets of lime, delivered to or used at the site.
2. A summary of the amount of lime used each day, areas stabilized with lime and first mixed, areas second mixed, completed, and areas with curing completed

PART 2 - PRODUCTS

2.01 MATERIALS

All materials used in the construction shall meet the following requirements. In the event the Contractor wishes to use materials not listed in this section, the Contractor shall submit to the City a mix design data and proof of performance data as required by the City who shall review the submittal and determine whether the materials will meet the design intent. No other materials shall be used without the written permission of the City.

- A. Lime - The lime shall meet the requirements of ASTM C977 / AASHTO M 216; contain at least 92 percent calcium and magnesium oxide, and the rate of slaking test for moderate reactivity per ASTM C110 / AASHTO T 232. All lime shall come from a single source, shall be the same source as used in the design, and shall be subject to periodic testing to confirm properties. Each shipment of lime shall be accompanied by a Certificate of Compliance stating the conformance of the product to these specifications. Certificates shall be provided to the City. In the event the Contractor changes lime sources, no work shall be done until the City accepts, in writing, a new lime-soil mix design using the new lime source.
- B. Water - Water used for slaking, mixing or curing shall be free of oil, salts, acid, alkali, sugar, vegetable, or other deleterious substances which may cause damage to the finished product. All water shall meet the material requirements AASHTO T 26. Known potable water may be used without testing.
- C. Soil - Subgrade soils used in the stabilization shall be of the same AASHTO or ASTM classification and Plasticity Index range as used in the approved mix design. All organics, roots and deleterious materials shall be removed from the area to be stabilized and shall be wasted. The condition of the subgrade soils must be approved by the City prior to beginning work.
- D. Asphalt - Asphalt used to seal the surface of the lime stabilized subgrade shall be CSS1h or other approved asphalt as approved by the City and shall conform to the requirements of TxDOT Item 300, "Asphalts, Oils and Emulsions". Each shipment shall be accompanied by a Certificate of Compliance stating the conformance of the product to these specifications which shall be provided to the City.

PART 3 - EXECUTION

3.01 EQUIPMENT

The machinery, tools and equipment necessary for proper prosecution of the work on this Item shall be on the project and approved by the City prior to beginning this Item. All machinery, tools and equipment used shall be maintained in a satisfactory working condition.

- A. Lime Storage - Lime shall be suitably stored in closed, weatherproof containers until immediately before use. Storage bins, when used, shall be completely enclosed.
- B. Lime Weight Verification - When lime is furnished in trucks, the weight of lime shall be determined on certified scales or the Contractor shall provide a set of standard platform truck scales at a location approved by the City. Scales shall conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment".
- C. Slurry Equipment - Quick lime used to manufacture slurry on the project, or other location approved by the City shall be slurried in agitated slurry tanks. The slurrying of Quick lime must be handled in such a way as to not generate any dust hazardous to job personnel or to the public or be potentially damaging to any adjacent property.
- D. Distributor Trucks - The distributor truck used for slurry placing shall be equipped with an agitator and a calibrated measuring device or as approved by the City and shall be in good working order. The Contractor shall provide to the City the spread rate calibration (or other acceptable means to calculate the spread rate) prior to use of the equipment.
- E. Mixers - Mixers shall be of appropriate size and capacity so as not to delay the project and shall be capable of pulverization to these specifications and mixing of the product.
- F. Compaction Equipment - Finishing equipment shall consist of smooth steel wheel vibratory compactors or pneumatic tired roller compactors having a minimum tire pressure of 90 psi. Other types of compaction equipment may be approved at the sole discretion of the City.

3.02 CONSTRUCTION

The completed course shall be uniformly stabilized, free from cracks, loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

- A. Preparation of Subgrade - Prior to stabilization the subgrade shall be compacted and shaped to conform to the typical sections, as shown on the plans with allowances made for bulking of the subgrade. The subgrade shall be moisture treated to the lines and grades shown on the plans and as provided for in the pavement design report. The minimum moisture content shall be 3 percentage points above standard Proctor optimum (ASTM D698) with compaction to at least 95%. If the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

- B. In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans and as established by the City.
- C. Pulverization - The existing pavement or base material shall be pulverized or scarified so that 100 percent shall pass the one (1) inch sieve.
- D. Application - The design percentage by weight or pounds per square yard of lime to be added will be as shown on the plans and may be varied by the City if conditions warrant. Only two application methods are acceptable; dry application of pebble quick lime or slurried hydrate or quick lime. The rate of application shall be verified using the methods provided in ASTM D 3155.
- E. Dry quick lime shall be spread only on that area where the mixing operations can be completed during the same working day. Slurried quick lime shall be spread and mixed within 1 hour. Slurry exposed to the air for over 1 hour shall not be accepted.
- F. Unless otherwise approved by the City, the lime operation shall not be started when the air temperature is below 40° F and falling, but may be started when the air temperature is above 35° F and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed during periods of rain or when weather conditions in the opinion of the City are not suitable. **CAUTION:** Use of quick lime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quick lime.
- G. Double Application Method - When required, lime shall be applied using the double application method. All other requirements and methods shall remain in force except as follows. One-half the specified quantity of lime shall be applied, mixed and mellowed for at least 3 days or longer as required by the approved mix design. The remaining lime shall be applied, mixed, and mellowed for at least 3 days or longer as required by the approved mix design.
- H. Dry Placement - Pebble quick lime shall be distributed by a spreader approved by the City. The lime shall be distributed at a uniform rate to achieve the mix design lime content and in such a manner as to reduce the scattering of lime by wind. Lime shall not be applied when wind conditions, in the opinion of the City, are such that blowing lime becomes objectionable to adjacent property owners or dangerous to traffic. The material shall be sprinkled as approved by the City.
- I. Slurry Placement - Lime Slurry shall be delivered to the project in slurry form at or above the minimum lime concentration as listed in the approved mix design. The residue or "stones" remaining in the tank from the slurry procedure shall be spread uniformly over the length of the roadway currently being processed, or wasted, unless otherwise approved by the City. Slurry shall be of such consistency that it can be applied uniformly without difficulty.
- J. Initial Mixing - The mixing procedure shall be the same for "Dry Placement" or "Slurry Placement" as herein described. The soil and lime shall be thoroughly mixed by equipment approved by the City. A minimum of 4 passes of the mixer is required. The soil and lime mixture shall be brought to a moisture content at least four (4) percentage points above the design optimum moisture content and shall be left to mellow for three (3) days or longer as required by the approved mix design. The mixing shall continue until a homogeneous friable mixture of material and lime is obtained. The mixture shall have a minimum pH 12.4 (additional lime shall be required to meet this specification).

Minimum passing 3/4" sieve:	100 percent
Minimum passing No. 4 sieve:	60 percent

The mixture shall be sprinkled and mixed during the mellowing process as required to assist in the chemical reaction. Moisture contents shall remain above optimum for the entire mellowing period.

Where measured sulfate level in ANY Eagle Ford formation exceeds 0.6 percent (6000 ppm) a double lime application is required. The mellowing period shall be extended for at least 5 days or as indicated in the mix design, whichever is longer.

- K. Final Lime Mixing - After the required mellowing period the second lime application, if required, shall be made. Upon approval by City, the material shall be uniformly mixed by the approved methods. If the mixture contains clods, they shall be reduced in size by approved pulverizing methods so that the remainder of the clods shall meet the following requirements (visual observation, not testing, required):

Minimum passing 1" sieve:	100 percent
Minimum passing No. 4 sieve:	60 percent

At final mixing, the lime, water content and pH for each course of subgrade stabilization shall conform to the following:

Lime:	+1 percent above design percentage based on dry unit weight of soil
Water:	+2 percentage points above optimum moisture content
pH:	12.4

Samples shall be taken at random locations by a qualified geotechnical testing laboratory selected by the Contractor and approved by the City per the City-required testing schedule.

- L. Compaction Methods - Compaction of the mixture shall begin immediately after the requirements listed above are met. NOTE: Where double mixing is required by the mix design, the required additional lime shall be added and the mixture shall be moisture conditioned and pulverized.

Compaction shall continue until the entire depth of the mixture is uniformly compacted to a minimum of 95 percent of standard Proctor density (ASTM D698) at a minimum of 2 percentage points above optimum moisture content.

All irregularities, depressions, or weak spots which develop as determined by the City shall be corrected immediately by scarifying the areas affected, adding or removing materials as required, and reshaping and recompacting by moisture conditioning and rolling. The surface of the course shall be maintained in a moist, smooth condition, free from undulations, ruts and cracking, until other work is placed thereon or the work is accepted.

In addition to the requirements specified for density, the full depth of the material shown on the drawings shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the geotechnical testing laboratory and submitted to the City. If the material fails to meet the density requirements, it shall be reworked to meet the requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the drawings and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course or pavement is placed, it shall be recompact and refinished at the entire expense of the Contractor. When shown on the plans or approved by the City, multiple lifts will be permitted.

- M. Finishing and Curing - After the final layer or course of lime-stabilized subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling with a pneumatic or other suitable roller sufficiently light to prevent hair line cracking. The finished surface shall not deviate by more than 0.04 feet (0.5 inch) from the actual finish grade. Any variations in excess of this tolerance shall be corrected by the Contractor, at the Contractor's entire expense immediately prior to placement of the next paving course, in a manner satisfactory to the City.

The completed section shall be moist-cured until a non-yielding surface is obtained to support construction traffic and the next layer of the pavement is constructed, as approved by the City.

In the event the surface cannot be covered by the next layer of pavement or be kept moist, an asphalt membrane shall be applied at the rate of 0.25 gallons per square yard. The Contractor shall protect the membrane from traffic and contamination until the next layer of the pavement system is placed. Additional testing may be required to verify moisture content as determined by the City.

- N. Reworking a Section - When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified percentage of lime.
- O. Stormwater Control- Lime (concentrated or diluted) shall not be allowed to enter a storm drain system or natural waterway. The lime shall be applied in a manner that prevents puddling or runoff. Runoff will be considered a spill. Spills shall be immediately reported to The City of Frisco Stormwater Inspector during City working hours or to the Fire Department dispatcher during evenings and weekends. The spill site shall be neutralized, cleaned up, and removed from the site. Washing down the spill is not allowed. This is subsidiary to the Lime Treatment item, and no additional payment shall be made.

3.03 TOLERANCES

The following requirements shall apply to the finished lime stabilized subgrade:

- A. Tolerance in Thickness - One measurement shall be taken at random locations by the geotechnical testing laboratory on center of roadway at 300 feet spacing along each roadway direction. When the measurement is not deficient by more than 0.5 inch from the plan thickness, full payment will be made. When such measurement is deficient more than 0.5 inch and not more than 1.0 inch from the plan thickness, two additional measurements shall be taken at random (typically, 25 feet either side of the deficient measurement) and used in

determining the average thickness. When the average of the 3 measurements is not deficient by more than 0.5 inch from the plan thickness, full payment will be made. When the average thickness is deficient by more than 0.5 inch, the entire area shall be reprocessed at the Contractor's entire expense.

3.04 QUALITY CONTROL

- A. The City may periodically require tests by the geotechnical testing laboratory to assist him or her in evaluating the quality of work and Contractor performance. The Contractor shall assist the City by excavating and backfilling shallow areas as necessary to take density tests.
- B. Any constructed course which does not meet specification requirements shall be reworked, at the Contractor's entire expense, to bring that work within specification requirements. The City's test shall be used in evaluating whether project meets specification requirements. The following table provides minimum testing requirements:

TEST TYPE	TEST STANDARD	MINIMUM FREQUENCY OF TESTS
In-Place Soil Density and Moisture Content	ASTM D 698 ASTM D 1556 ASTM D 2167 ASTM D 2922 ASTM D 2216 ASTM D 3017	One test for every 300 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
pH	Eades and Grim procedures ASTM D 2976	One test per 600 feet spacing or less along each roadway direction, but no less than test per day for each roadway subgrade
Thickness		One test for 300 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
Compressive Strength	ASTM D 558 ASTM D 1633 ASTM D 2166	(a) One test for 900 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade, sealed and cured at 100 degrees F for 5 days (b) Strength not corrected for length/diameter.
Pulverization Testing	Tex-101-E, Part III	One test for every 600 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade
Swell Potential	ASTM D 4546	One test for every 900 feet spacing or less along each roadway direction, but no less than one test per day for each roadway subgrade

Note: The City may test any other property of the materials or lime-soil mixture in this Item at intervals or occasions of his/her choosing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. The Lime Stabilized Subgrade shall be measured by the Square Yard (SY) complete in place and accepted for the thickness shown in the Contract Documents.
- B. The Lime shall be measured by the Ton (TN) complete in place at rate shown in the Contract Documents.

4.02 PAYMENT

- A. The Lime Stabilized Subgrade shall be paid for at the unit contract price and shall be total compensation for preparing the roadbed, for loosening, pulverizing, application of lime, water content in the slurry mixture and mixing water; mixing, shaping, sprinkling, compacting, finishing, curing and maintaining; for manipulations required; and for all labor, equipment, fuels, tool, and incidentals necessary to complete the work, all in accordance with the plans and specifications.
- B. The Lime material shall be paid for at the unit contract price bid for Lime which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing and handling; and for all labor, equipment, fuels, tools, and incidentals necessary to complete the work.

END OF SECTION

SECTION 321116

FLEXIBLE BASE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Flexible Base in accordance with Texas Department of Transportation (TxDOT) *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 247.

1.02 REFERENCES

- A. TxDOT Item 247
- B. Frisco Approved Materials List
- C. Project's Geotechnical Report

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 247.2
- B. All flexible base shall be Type D, Grade 1 or 2.
- C. Geogrid Base Reinforcement shall be placed under flexible base (see Frisco Approved Materials List).

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 247.3 and 247.4
- B. All flexible base shall be compacted per recommendations in Geotechnical Report.
- C. Geogrid shall be installed per manufacturers specifications and requirements, and requirements below.
 - a. Prepare the subgrade as indicated on the plans or as directed. Set string lines for alignment if directed. Install geogrid in accordance with the lines and grades as shown on the plans. Place base material in lift thicknesses and compact as shown on the plans or as directed. Do not operate tracked construction equipment on the geogrid until a minimum fill cover of 6 in. is achieved. Rubber tire construction equipment may operate directly on the geogrid at speeds of less than 5 mph if the underlying material will support the loads. Where excessive substructure deformation is apparent, correct grid placement operations as recommended by the manufacturer of as directed.
 - b. Geogrid Placement. Orient the geogrid length as unrolled parallel to the direction of roadway. Overlap geogrid sections as shown on the plans as directed. Use plastic ties

at overlap joints or as directed. Placement of geogrid around corners may require cutting and diagonal lapping. Pin geogrid at the beginning of the backfill section as directed. Keep geogrid taut at the beginning of the backfilling section but not restrained from stretching or flattening.

- c. Longitudinal Joints. Overlap longitudinal joints by a minimum of 1 ft. Space longitudinal ties 10 ft. to 20 ft. or as directed.
- d. Traverse Joints. Overlap transverse joints by a minimum of 1 ft. Space transverse ties 4 ft to 5 ft. or as directed.
- e. Damage Repair. As directed, remove and replace contractor damaged or excessively deformed areas without additional compensation. Lap repair areas a minimum of 3 ft in all directions. Tie each side of repair grid in at least 3 locations but do not exceed normal construction spacing; tie spacing for odd shapes will be as directed. Repair excessively deformed materials underlying the grid as directed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Flexible base will be measured Complete in Place by either the Square Yard or Ton in accordance with TxDOT Item 247.5 or as indicated in the Contract Documents.

4.02 PAYMENT

- A. Flexible base will be paid Complete in Place in accordance with TxDOT Item 247.6 or as indicated in the Contract Documents.
- B. Geogrid Base Reinforcement will be subsidiary to the Flexible Base pay item.

END OF SECTION

SECTION 321123

SAND BEDDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to install Sand Bedding in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item unless otherwise noted.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321126

ASPHALT BASE COURSE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Asphalt Base Course in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 302.3, 302.7, 302.8, 302.9, and 302.10

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.8.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

END OF SECTION

SECTION 321133

PORTLAND CEMENT TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Portland Cement Treatment in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1 and 301.3.

END OF SECTION

SECTION 321216

HOT MIX ASPHALT PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Hot Mix Asphalt Pavement in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 302.2, 302.3, 302.7, and 302.10

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.9.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 302.10.

END OF SECTION

SECTION 321313

CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Pavement in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303
- B. City of Frisco Standard Details for Concrete Pavement

1.03 SUBMITTALS

- A. Submit mix design for each class of concrete.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2 and 303.3.
- B. All concrete shall be sulfate resistant mix design.
- C. Specified reinforcing steel (#4 bars and larger) shall be of domestic manufacture and shall conform to the requirements of ASTM A615, Grade 60.
- D. Grade 40 reinforcing steel (#3 bars) will only be allowed in sidewalks or with approval of the Director of Engineering Services.
- E. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.2 is hereby modified to allow only Type I/II Portland Cement.
- F. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.2.4 is hereby modified to allow only 20% to 25% Class F flyash per weight basis for sulfate resistant mix design.
- G. Expansion joints in paving shall be redwood boards only.
- H. As approved by the Director of Engineering sulfate resistant concrete mix designs per TxDOT Item 421.4.A.1 can be used as dictated by material availability of Class F flyash.

2.02 EQUIPMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.4.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303.5. and 303.8. Samples of all materials for testing shall be solely the responsibility and expense of the Contractor. Item 303.8 is hereby modified to state:
 - a. 56-day breaks shall not be considered
 - b. If minimum strength is not attained cores shall be done within two days of a failed 28-day break.
- B. Conform to City of Frisco's Standard Details for Concrete Pavement.
- C. Slip form pavement method shall be used for all public streets and alleys unless otherwise approved by the Director of Engineering Services. Hand formed pavement method may be used for turn lanes, deceleration lanes, driveway approach, or replacing a panel of public street or alley pavement.
- D. Curb shall be cast integral with paving unless otherwise approved by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.9.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.9.
- B. Monolithic curb shall be considered incidental to the work performed and materials furnished in accordance with this Item, and will not be paid for directly but will be subsidiary to Concrete Pavement unless otherwise specified in the plans and in the bid proposal.

END OF SECTION

SECTION 321314

ROLLING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Rolling in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 301.1.2

PART 2 - PRODUCTS

2.01 MATERIALS

A. TAMPING ROLLER

1. Tamping rollers shall consist of two (2) metal rollers, drums or shells of not less than forty inches (40") in diameter, each not less than forty-two inches (42") in length and unit mounted in a rigid frame in such a manner that each roller may oscillate independently of another. Each roller, drum or shell shall be surmounted by metal studs with tamping feet projecting not less than seven inches (7") from the surface and spaced not less than six inches (6") nor more than 10 inches (10") measured diagonally center to center; and the cross-sectional area of each tamping foot measured perpendicular to the axis of the stud, shall be not less than five square inches (5") nor more than eight square inches (8"). The roller shall be of the type that by ballast loading, the load on each tamping foot may be varied uniformly from 125 p.s.i. of cross-sectional area. The load per tamping foot will be determined by dividing the total weight of the roller by the number of tamping feet in one row parallel to or approximately parallel to the axis of the roller.
2. The tamping roller shall be drawn by approved equipment of adequate tractive effort. Power equipment used in embankment construction shall be the crawler type tractor. Two (2) tamping rollers conforming to the above requirements, drawn by approved equipment, shall be considered a roller unit.

B. TIRE ROLLER

1. Tire rollers shall consist of not less than nine (9) pneumatic-tired wheels, running on axles in such a manner that the rear group of tires will not follow in the tracks of the forward group of wheels, and mounted in a rigid frame, and shall be of a type suitable for ballast loading. The distance between the front and rear axles shall be not less than five feet (5') no more than 10 feet (10').
2. The front axle shall be attached to the frame in such a manner that the roller may be turned in a minimum circle. The pneumatic tire roller shall have an effective rolling width of approximately sixty inches (60"), and shall be ballast loaded so that the load may be varied uniformly from not less than 100 p.s.i. of width of tire tread to 325 pounds per inch of tire tread. The roller, under working conditions, shall provide a uniform compression under all wheels. The total combined width of effective tire tread shall be not less than eighty-five percent (85%) of the effective rolling width. The pneumatic tire roller shall be drawn by either an approved crawler type, a pneumatic tread tractor, or a truck of adequate tractive effort; and the roller when drawn by either type of equipment

shall be considered a pneumatic tire roller unit. Power equipment for rolling on asphalt shall be equipped with pneumatic tires.

PART 3 - EXECUTION

3.01 PREPARATION

- A. The embankment or base course shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips at least one-half (1/2) of the width of the pneumatic tire roller unit. Alternate trips of the roller unit shall begin at the low sides and progress toward the high sides.
- B. The speed of the power roller and the tamping roller unit, unless otherwise directed by the City, shall be between two (2) and three (3) miles per hour. The speed of the pneumatic tire unit, unless otherwise directed by the City, shall be between four (4) and twelve (12) miles per hour for asphalt surfacing work and between two (2) and six (6) miles per hour for all other compaction work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321373

JOINT SEALANT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Joint Sealant in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.5.4.7.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2 and 303.5

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Crafcro RoadSaver 221 or approved Class 3 material.
- B. Refer to Frisco Approved Materials list
- C. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.2.14.1.1. Hot Poured Polymer
- D. ALT 671 Flex Crete shall be used for sidewalks and flumes.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.5.2 and manufacturers' recommendations.
- B. Joint sealant shall apply to roadways, sidewalks, and Public Work concrete paving projects.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 321400

CONCRETE PAVERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for Concrete Pavers in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.
- B. Colors for use in Frisco include Pavestone Frisco Maroon and Frisco Charcoal or approved equivalent.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.
- B. Medians, median noses, roundabout truck apron, splitter island shall have a soldier course on all outside edges and a herringbone pattern on the inside.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Item shall be measured complete in place per square-foot (SF) and in accordance with the Contract Documents.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 304.

END OF SECTION

SECTION 321613

CONCRETE CURB AND GUTTER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Curb and Gutter in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 203.4, 303 and 305.1
- B. City of Frisco's Standard Detail for Concrete Curb and Gutter.

1.03 RELATED SECTIONS

- A. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 203.4 and 305.1.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Concrete Curb and Gutter will not be measured separately unless indicated otherwise.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Concrete Curb and Gutter". This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321645

DRIVEWAY APPROACH

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Driveway Approach in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items, 303, 305.1 and 305.2
- B. City of Frisco's Standard Details for Driveway Approaches

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.1.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items and 305.2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Square Yard (SY) basis, specified by type (Commercial, Residential), complete in place. Measurement shall start at the back of the laydown curb and shall include the area of the curb radii as indicated in the Standard Details. Curbs on driveways shall not be measured separately but shall be included as a part of the driveway concrete.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Driveway Approach." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321650

REINFORCED CONCRETE SIDEWALK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Sidewalk in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303, 305.1 and 305.2
- B. TxDOT current Standard Details for Pedestrian Facilities
- C. Current Texas Department of Licensing and Regulation (TDLR) and Americans with Disabilities Act (ADA) requirements.

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 – Concrete Pavement
- C. Section 321655 – Barrier Free Ramp
- D. Section 321373 – Joint Sealant

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.1.
- B. Welded Wire Fabric is not acceptable as reinforcement.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items and 305.2.
- B. All Reinforced Concrete Sidewalk must be approved by TDLR prior to acceptance.
- C. Control Joint shall be created by sawing, tooled joints are not allowed.
- D. Expansion Joints shall be sealed per Standard Construction Detail.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Square Yard (SY) basis complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Reinforced Concrete Sidewalk.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.
- B. Barrier Free Ramps shall be measured and paid for separately in accordance with Section 321655 – Barrier Free Ramp.

END OF SECTION

SECTION 321655

BARRIER FREE RAMP

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Barrier Free Ramps in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303, 305.1 and 305.2.
- B. TxDOT and City Standard Details for Pedestrian Facilities.
- C. Current Texas Department of Licensing and Regulation (TDLR) and Americans with Disabilities Act (ADA) requirements.

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 311313 – Portland Cement Concrete
- C. Section 321650 – Reinforced Concrete Sidewalk

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.1.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.2.
- B. All Barrier Free Ramps must be approved by TDLR prior to acceptance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis, specified by type, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Barrier Free Ramp.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321660

CONCRETE MEDIAN NOSE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Concrete Median Noses in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 305.1, and 305.3.
- B. City of Frisco's Standard Detail for Monolithic Median Nose

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 311313 – Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.
- B. All median noses shall be monolithic in accordance with the City of Frisco's Standard Detail for Concrete Median Nose.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis, specified by Type, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Concrete Median Nose.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Concrete Pavers within the medians shall be paid for separately.

END OF SECTION

SECTION 321665

REINFORCED CONCRETE HEADER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Header in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 305.4.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 303 and 305.4.
- B. City of Frisco Standard Detail for Concrete Header

1.03 RELATED SECTIONS

- A. Section 032100 – Reinforcing Steel
- B. Section 321313 –Concrete Pavement

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 303.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Linear Foot (LF) basis complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Reinforced Concrete Header.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work.

END OF SECTION

SECTION 321723

PAVEMENT MARKERS AND MARKINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Pavement Markers and Markings.

1.02 REFERENCES

- A. TxDOT Items 666, 672, 677, and 678
- B. City of Frisco's Standard Details for Pavement Markers and Markings.
- C. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 347113 – Barricades, Signs, and Traffic Handling

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 666, 672, 677, and 678.
- B. Refer to the City of Frisco's Standard Details for Pavement Markers and Markings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 666, 672, 677, and 678.
- B. Each class of raised pavement marker shall be from the same manufacturer.
- C. Contact City for approval of pavement marking layouts prior to installation.
- D. Surface to which markers are to be attached by an adhesive shall be prepared by any method approved by the City to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond.
- E. All pavement markings shall be thermoplastic (Type I) markings with a Type II marking as the sealer unless otherwise noted in the plans.
- F. Guides to mark the lateral location of pavement markings shall be established as shown on the plans. The Contractor shall establish the pavement marking guides and the City will verify the location of the guides.

- G. The pavement markers shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet of roadway. The maximum deviation shall not exceed two (2) inches nor shall any deviation be abrupt.
- H. Markers placed that are not in alignment of sequence, as shown on the plans or as stated in this specification, shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with TxDOT Item 677 "Eliminating Existing Pavement Markings and Marker", except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.
- I. Unless otherwise shown on the plans, the Contractor shall use the following adhesive materials for placement of markers:
 - 1. Epoxy adhesive for Class E markers.
 - 2. Bituminous adhesive for Classes A, B, C, and D markers on bituminous pavements.
 - 3. Epoxy adhesive for Class A, B, C, and D markers on Portland cement concrete pavements.
- J. Adhesive shall be applied in sufficient quantity to ensure that 100 percent of the bonding area of the raised pavement markers shall be in contact with the adhesive.
- K. Raised pavement markers, except Class E, shall be in contact with the pavement surface but shall be seated on a continuous layer of adhesive.
- L. Unless otherwise noted, adhesives shall be applied in accordance with the manufacturer's recommendations.
- M. When bituminous adhesive is used, pavement and raised pavement marker temperature shall be at least 40 degree F. The bituminous adhesive shall not be heated above 400 degree F. The bituminous adhesive shall be agitated intermittently to ensure even heat distribution.
- N. Epoxy adhesive shall be machine mixed.
- O. Raised pavement markers shall be free of rust, scale, dirt, oil, grease, moisture, or contaminants which may adversely affect the adhesive bond.
- P. Raised pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.
- Q. The roadway to be marked will remain open to traffic and the Contractor shall provide all necessary warning and barricading to insure the safety of the workmen and traffic, and the Contractor must insure proper maintenance of all warning and barricading devices at all times. Construction, signing, channelizing devices, and markings shall conform to the current *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) at all times.
- R. A minimum of one lane in each direction shall remain open to through traffic at all times.
- S. The Contractor shall conduct the installation so as to minimize the duration of restricted traffic movements.
- T. The Contractor shall apply pavement markers and markings during off-peak traffic hours (9:00 am – 3:30 pm) or as directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis complete in place or by Each (EA) and Linear Foot (LF) as indicated in the plans.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "Pavement Markers and Markings." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Surface Preparation and Type II marking sealer will not be paid for directly, but considered subsidiary to this Item.

END OF SECTION

SECTION 321725

PREFABRICATED PAVEMENT MARKINGS (WITH WARRANTY)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Prefabricated Pavement Markings as indicated in the plans with a manufacturer's warranty bond for a 6 year period. The City will allow a Contractor provided warranty bond in lieu of the manufacturer's bond if all conditions of the manufacturer's warranty including the requirements of this Item are met. In such case, the Contractor is responsible for meeting the warranty requirements. Use the form provided by the City. The City will allow substitution of a contractor's bond with a manufacturer's bond after execution of the Contract prior to final acceptance.

1.02 REFERENCES

- A. City of Frisco's Standard Details for Pavement Markers and Markings.

1.03 RELATED SECTIONS

- A. Section 347113 – Barricades, Signs, and Traffic Handling.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Contractor shall use 3M 270 Tape (or approved equal) for all directional arrows and messages, and 3M 380 Tape for all longitudinal pavement markings and 12" channelization lines as indicated in the plan. Approved equal pavement markings must meet the TxDOT requirements of Type B markings in DMS-8240.

2.02 EQUIPMENT

- A. Provide equipment as required or directed according to the following (The provider of the warranty bond is responsible for providing equipment during the warranty period unless otherwise shown on the plans.):
 - 1. Preparation and Application. Use equipment designed for the pavement preparation and application of the type of pavement marking material selected.
 - 2. Colorimeter. Provide a colorimeter using 45°/0° geometry CIE, D65 Illuminant, 2° standard observation angle meeting the requirements of ASTM E 1347, E 1348, or E 1349.
 - 3. Retroreflectometer. Unless otherwise shown on the plans, provide a portable or mobile retroreflectometer meeting the following requirements.
 - a. Portable Retroreflectometer. Provide a portable retroreflectometer that meets the requirements of ASTM E 1710
 - b. Mobile Retroreflectometer. Provide a mobile retroreflectometer that:

- (1) is approved by the City and certified by the Texas Transportation Institute Mobile Retroreflectometer Certification Program for project evaluation of retroreflectivity
- (2) is calibrated daily, before measuring retroreflectivity on any pavement stripe, with a portable retroreflectometer meeting the following requirements: ASTM E 1710, entrance angle of 88.76°, observation angle of 1.05°, and an accuracy of $\pm 15\%$;
- (3) requires no traffic control when retroreflectivity measurements are taken and is capable of taking continuous readings at or near posted speed.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Contractor to ensure a manufacturer's representative is present during installation of all pavement markings.
- B. Prepare the pavement surface using controlled techniques that minimize pavement damage and hazards to the traveling public. Apply the materials, according to the manufacturer's recommendations, using widths, colors, shapes, and at locations as shown on the plans.
- C. Obtain approval for the sequence of work and estimated daily production. Use traffic control as shown on the plans or as approved. Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed, and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway. Apply markings in alignment with the guides and without deviating for the alignment more than 1 in. per 200 ft. of roadway or more than 2 in. maximum.
- D. Remove all applied markings that are not in alignment or sequence as stated in the plans or as stated in the specifications at the Contractor's expense and in accordance with TxDOT Item 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment.
- E. The City will conduct visual performance evaluations of the markings. For markings that do not meet the City's visual performance evaluation, the Contractor may present test results for color (using a colorimeter), retroreflectivity (using a retroreflectometer), and durability (in accordance with ASTM D 913) for the City's use in making acceptance or rejection decisions. For pavement markings not meeting performance requirements, repair or replace until reevaluation shows the Pavement Markers and Markings meet the performance requirements as approved by the City.
- F. Written Acceptance. The City will provide written acceptance after the Contractor meets the initial performance requirements. This written acceptance (see attached sample form) will include the date, location, length, and type of pavement markings.

3.02 PERFORMANCE REQUIREMENTS

- A. Color. Provide pavement markings consisting of pigments blended to provide color conforming to highway colors as shown in Table 1.

Table 1
Color Requirements

Federal 595 Color		Chromaticity Coordinates								Brightness s (Y)
		1		2		3		4		
		x	y	x	y	X	y	x	y	
White	17855	.290	.315	.310	.295	.350	.340	.330	.360	60 min
Yellow	33538	.470	.455	.510	.489	.490	.432	.537	.462	30 min
Black										5 max

- B. Retroreflectivity. Provide pavement markings for longitudinal markings meeting the minimum retroreflectivity values listed in Table 2.

Table 2
Minimum Retroreflectivity Requirements

Color	Retroreflectivity, mcd/m ² /lx, Min
White	120
Yellow	120

- C. Durability. Provide pavement markings that do not lose more than 5% of the striping material in a 1,000- ft. section of continuous stripe or broken stripe (25 broken stripes). Pavement markings must remain in the proper alignment and location.
- D. Performance Evaluation Procedures. Provide traffic control and conduct evaluations of color, retroreflectivity, and durability as required or directed by the City.

1. Color. Measure color using 45°/0° geometry CIE, D65 Illuminant, 2° standard observation angle in accordance with ASTM E 1347, E 1348, or E 1349.
2. Retroreflectivity. Unless otherwise shown on the plans, conduct retroreflectivity evaluations of pavement markings with either a portable or mobile retroreflectometer. Make all measurements in the direction of traffic flow, except for broken centerline on 2-way roadways, where measurements will be made in both directions.

If using a portable retroreflectometer, take a minimum of 1 measurement every mile on each series of markings (i.e., edgeline, center skipline, each line of a double line, etc.), at locations approved by the City. If more than 1 measurement is taken, average the measurements. For all markings measured in both directions, take a minimum of 1 measurement in each direction. If the measurement taken on a specific series of markings within each mile segment falls below the minimum retroreflectivity values, take a minimum of 5 more measurements at locations determined by the City within that mile segment for that series of marking. If the average of these 5 measurements falls below the minimum retroreflectivity requirements, that mile segment of the applied markings does not meet the performance requirement.

If using a mobile retroreflectometer, review the results to determine deficient sections and deficient areas of interest. These areas do not meet the performance requirements.

3. Durability. Measure durability in accordance with ASTM D 913 for marking material loss and visual inspection for alignment and location. Conduct evaluations at locations approved by the City.

3.03 WARRANTY REQUIREMENTS

- A. Each warranty period is for 6 yr. and starts the day after written acceptance.
- B. The marking warrantor is responsible for meeting the Performance Requirements for the duration of the warranty period.
- C. During the warranty period, the City will conduct periodic visual performance evaluations of the pavement markings. For retroreflectivity the City will use Tex-828-B, "Determining Functional Characteristics of Pavement Markings." The warrantor may be present during these evaluations. For areas, which, in the opinion of the City have a questionable visual evaluation, the warrantor may replace the pavement markings or may conduct a performance evaluation for the performance requirement in question, conduct retroreflectivity evaluations using either portable or mobile retroreflectometer unless otherwise indicated in the Contract Documents. The warrantor is responsible for traffic control when conducting performance evaluations.
- D. The warrantor will replace pavement markings that fail to meet the color, retroreflectivity, or durability performance requirements during the warranty period, and must replace the pavement markings that fail to meet the performance requirements within 30 days of notification.
- E. All replacement pavement markings must meet the materials and performance requirements of this specification.
- F. The end of the warranty period does not relieve the warrantor from the performance deficiencies requiring corrective action identified during the warranty period.
- G. The City may exclude pavement markings from the replacement provisions of the warranty period, provided the City determines that the failure is a result of outside causes rather than defective material. Examples of outside causes are extreme wear at intersections, damage by snow or ice removal, and premature pavement failure.
- H. Provide a contact person, address and telephone number for notification of needed pavement markings replacement.
- I. Each class of raised pavement marker shall be from the same manufacturer.
- J. The pavement markers shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet of roadway. The maximum deviation shall not exceed two (2) inches nor shall any deviation be abrupt.
- K. Unless otherwise noted, adhesives shall be applied in accordance with the manufacturer's recommendations.
- L. The roadway to be marked will remain open to traffic and the Contractor shall provide all necessary warning and barricading to insure the safety of the workmen and traffic, and the Contractor must insure proper maintenance of all warning and barricading devices at all times. Construction, signing, channelizing devices, and markings shall conform to the current Texas Manual on Uniform Traffic Control Devices (TMUTCD) at all times.
- M. A minimum of one lane in each direction shall remain open to through traffic at all times.

- N. The Contractor shall conduct the installation so as to minimize the duration of restricted traffic movements.
- O. The Contractor shall apply pavement markers and markings during off-peak traffic hours (9:00 am – 3:30 pm) or as directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis complete in place or by Each (EA) and Linear Foot (LF) as indicated in the plans.
- B. The plan quantity will be determined through calculations and will be used for determining final quantity amounts for payment purposes. Contract adjustments may be made if the actual measured quantity varies by more or less than 5% of the total estimated plan quantity amount. Either the City or the Contractor may initiate this adjustment. If the adjustment is requested by the Contractor, the Contractor must obtain field measurements and calculations justifying the revised quantity. If the adjustment is made by the City, the revised quantity will constitute the final quantity which payment will be made.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Prefabricated Pavement Marking” of the color, shape, and width. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work. Surface Preparation will not be paid for directly, but considered subsidiary to this Item.

END OF SECTION

SECTION 328000

IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete Irrigation System as shown on plans as described herein.

1.02 REFERENCES

- A. Refer to City of Frisco's Approved Material List.

1.03 RELATED SECTIONS

- A. Section 329223 - Turfgrass Planting
- B. Section 329300 - Tree, Shrub, and Groundcover Planting

1.04 QUALITY ASSURANCE

A. Substitutions:

1. Time: Submit substitution request in writing seven (7) days prior to bid opening.
2. Required Submittal Material:
 - a. Sample proposed substitute sprinkler.
 - b. Manufacturer's data of sprinkler, discharge rates (GPM), minimum allowable operating pressure, maximum allowable spacing and distance of throw.
 - c. Detailed pressure loss computations if proposed differ from those specified.
 - d. If proposed substitute require a change in head and piping layout as designed, submit detailed drawings showing design changes and proposed layout.
3. Approval: Approval of proposed substitute will not relieve responsibility for providing a system that will operate according to intent of originally designed system.

B. Installer:

1. Irrigator licensed in State with 5 years minimum continuous experience installing systems of this size and complexity must supervise installation.
2. Complete mainline installation with personnel that have successfully installed equipment and materials as specified on at least three other projects equal in scope.

- C. Testing: Perform required testing under observations of Owner. Give 48 hours notice that such tests are to be conducted.

D. Assembly Procedures:

1. Do not alter design hydraulics by installing additional tees or elbows unless approved by Owner.
2. Prior to start of construction; confirm the static water pressure in writing to Owner. If static pressure differs from pressure shown on drawings, do not start work until notified to do so, in writing, by the Owner.

1.05 REFERENCES: The following ASTM designations apply:

A536	Ductile Iron Fittings
D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
D2672	Bell-End Poly (Vinyl Chloride) (PVC) Pipe
D2464	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Threaded, Schedule 80
D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Socket Type, Schedule 40
D2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Socket Type, Schedule 80
D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
D2287	Flexible Poly Vinyl Chloride (PVC) Plastic Pipe
F656	Poly Vinyl Chloride (PVC) Solvent Weld Primer
C213	AWWA Dual Compression Gasket Seal Fittings
D2855	Making Solvent - Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
F477	Ductile Iron Fitting Gaskets

1.06 SUBMITTALS

- A. Product Data: Submit seven (7) copies of manufacturer's specifications and literature for all specified materials.
- B. Project Record Documents:
 - 1. Comply with Contract Documents and requirements.
 - 2. Locate by written dimension, routing of mainline piping, remote control valves and quick coupling valves. Locate mainlines by single dimensions from permanent site features provided they run parallel to these elements. Locate valves, intermediate electrical connections, and quick couplers by two dimensions at approximately 70 degrees to each other provided they are within 50 feet of a permanent site feature. Valves, electrical connections and quick couplers beyond 50 feet must be located by triangulation using three dimensions from building corners, walk intersections or similar junctures.
 - 3. When dimensioning is complete, transpose work to mylar reproducible tracings. Owner will provide tracings.
 - 4. Submit completed tracings prior to final acceptance. Mark tracings "Record Prints Showing Significant Changes". Date and sign plans.
 - 5. Provide three complete operation manuals and equipment brochures neatly bound in a hard back three-ring binder. Include any warranties and guarantees extended to the Contractor by the manufacturer of all equipment. Include seven (7) executed copies of "Guarantee for Landscape Irrigation System".

GUARANTEE FOR LANDSCAPE IRRIGATION SYSTEM

We hereby guarantee that the landscape irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the plans and specifications, ordinary wear and tear and unusual abuse or neglect expected. We agree to repair or replace any defects in material or workmanship, which may develop, and to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense. We will pay the costs and charges therefore upon demand. This guarantee shall remain in effect for a period of two (2) years from the date of Final Completion, as determined by the Owner or the Owner's Representative.

PROJECT: _____

LOCATION: _____

SIGNED: _____

COMPANY: _____

ADDRESS: _____

PHONE: (____) ____ - _____

DATE OF ACCEPTANCE: ____ / ____ / _____

1.07 COORDINATION

- A. Complete sleeve installation (not otherwise provided) in coordination with paving and other concrete pours.
- B. Coordinate to ensure that electrical power source is in place.
- C. Coordinate system installation with work specified in other Sections and coordinate with landscape installer to ensure plant material is uniformly watered in accordance with intent shown on Plans.

1.08 WARRANTY AND MAINTENANCE

- A. Extend to Owner any warranties and guarantees provided by manufacturer of equipment used.
- B. Warranty materials and workmanship for a minimum of two years after final acceptance.
- C. Include repair of backfill settlement, packing the earth firmly around the heads, quick couplers, and valve boxes.
- D. Limit warranty to repair and replacement of defective materials or workmanship, including repair of backfill settlement.

1.09 CONNECTION TO DOMESTIC WATER SUPPLY

- A. Complete connection to water supply in accordance with governing codes and regulations.
- B. Provide and pay for any required permits.

PART 2 - PRODUCTS

2.01 DEFINITIONS

- A. Sprinkler Mains: Piping from water source to operating valves. Hydrant lines and quick coupling valves (QCV) are considered sprinkler mains.
- B. Lateral Piping: Piping from operating valves to sprinkler heads.

2.02 POLYVINYL CHLORIDE PIPE

- A. Polyvinyl Chloride Pipe (hereinafter referred to as PVC pipe) shall be manufactured in accordance with the product standards as follows:
 - 1. Mainline Piping-PVC, Schedule 40 - solvent weld joints
 - 2. Lateral Piping-PS-22-70, SDR-21, Class 200 - solvent-weld joints
 - 3. Marking and Identification: Permanently marked with the following information: manufacturer's name, pipe size, type of pipe and material, SDR Number, Commercial Standard Number, and NSF (National Sanitation Foundation) Seal.
 - 4. Purple pipe required for all irrigation maintained by the City (medians, etc).

2.03 PIPE FITTINGS:

- A. PVC Sch. 40, as manufactured by the Lasco Company, or approved equal.
 - B. All PVC fittings shall be of the same material as the PVC pipe specified and be compatible with the PVC pipe furnished.
 - C. Use only solvent recommended by the manufacturer of the PVC pipe and the manufacturer of the PVC fittings.
- 2.04 COPPER PIPE AND FITTINGS:
- A. Pipe: Type "M", hard, straight lengths, of standard size and dimensions.
 - B. Fittings: Cast brass or wrought copper sweat-solder type.
- 2.05 VALVE WIRING:
- A. Single conductor copper type UF wire with 4/64 in. vinyl insulation U.L. approved for direct underground burial in 30 volt AC or less service.
 - B. Valve wiring to controllers: Fourteen- (14) minimum (heavier if required based on length of run).
 - C. Ground wiring from electric valves to controllers: Fourteen- (14) gauge minimum (heavier if required based on length of run)
- 2.06 FLEXIBLE PVC NIPPLES: Lawn heads: Nominal ½" x 12" long flexible PVC.
- 2.07 SWING JOINT ASSEMBLY: Swing joints are not allowed.
- 2.08 PVC NIPPLES:
- A. High-Pop Shrub Head: ½" dia. Unitized O-Ring Assembly. Lasco #T5-32-212
 - B. Rotary Spray Head: ¾" dia. Unitized O-Ring Assembly. Lasco #T7-32-212
- 2.09 MATERIALS LIST: Refer to plans.
- 2.10 MAINLINE SHUT-OFF VALVES:
- A. Four inch (4") and larger: Cast iron bodied, bronze fitted gate valves with gasket type pipe connections and a 200 W.O.G. rating. Valve stems shall be fit with square operating nuts of standard size. Manufacturer - Kennedy #597X or approved equal.
 - B. Three inch (3") and smaller: Plastic bodied, ball valves with threaded connections and an ASTM standard F-1970 pressure rating. Manufacturer – Colonial TUBV or approved equal.
- 2.11 DRAIN VALVES:
- A. Bronze bodied globe valves with rubber seats and threaded IPS pipe connections with a 125 W.O.G. rating. Valve stems shall be equipped with a round wheel handle.
 - B. Manufacturer: Nibco or approved equal.
- 2.12 QUICK COUPLER VALVES AND KEYS:

- A. Valves: One-inch (1") bronze bodied valves with a rubber seat and locking vinyl cover.
 - B. Keys: Bronze construction with 1" MIP x 3/4" FIP threads.
 - C. Manufacturer: RAINBIRD 44LRC or approved equal.
- 2.13 REINFORCEMENT STAKES: Galvanized steel pipe 1-inch diameter, Sch. 40. Secure to QCV with stainless steel worm gear clamps.
- 2.14 ROTARY HEADS: At the discretion of the City of Frisco, multi-stream multi-trajectory rotary nozzles, oscillating stream nozzles, bubbler systems, drip systems and rotor heads shall be installed on all irrigation systems. The city reserves the right to require efficient irrigation products where suitable.
- A. High impact plastic gear driven rotary heads with a 3/4" IPS connection. Head shall have interchangeable nozzles. Nozzle as specified on plans.
 - B. Manufacturer: Hunter PGP or approved equal.
- 2.15 SPRAY HEADS:
- A. Pop-up spray heads, 4" or 12" pop-up assembly as shown with a poly carbonate body. Nozzles shall be efficient technology nozzles such as multi-stream multi-trajectory rotary nozzles, oscillating stream nozzles or other nozzles with a minimum precipitation rate of 1 inch per hour and .7 minimum distribution uniformity Refer to plans for size.
 - B. Manufacturer: Hunter MP Rotator, Toro Precision Series, and RAINBIRD Rotary nozzles. Series or approved equal.
- 2.16 ELECTRIC VALVES:
- A. Normally closed glass filled nylon body valve with a Buna N reinforced diaphragm fitted with a 24 volt, 1/4 amp solenoid in a waterproof housing and pressure regulating module.
 - B. Manufacturer: RAINBIRD PEB-PRS-B. Refer to plan for size or approved equal.
- 2.17 VALVE BOXES:
- A. Electric Valves:
 - 1. 12 in. x 17 in. x 12 in. deep plastic valve box with locking lid and extensions as required.
 - 2. Manufacturer: Ametek or approved equal.
 - B. Quick Coupling Valves:
 - 1. 10 in dia. x 12 in. deep plastic valve box with extensions as required.
 - 2. Manufacturer: Ametek or approved equal.
 - C. Backflow Preventer:
 - 1. Jumbo plastic valve box with locking lid and extensions as required.
 - 2. Manufacturer: Ametek or approved equal.

D. Meter Boxes for Reclaimed Water:

1. Regular Box: 17" x 30" x 18" Purple Box w/ Purple Locking AMR Lid
 - a. Top: D1730-18-PBody, Series D1730, 17" x 30"
 - b. Base: D1730-18-PKSPSM, Series D1730, 17" x 30"
 - c. Lid: D1730-KSPSM-LID, Series D1730, 17" x 29 ½"
2. Jumbo Box: 26" x 15" x 14" Purple Locking AMR Lid
 - a. Top: DFW65C-14 PBody, Series 65C, 26" x 15" x 14"
 - b. Base: DFW65C-14-PKSPSM, Series 65C, 26" x 15" x 14"
 - c. Lid: DFW65C-PKSPSM-Lid, Series 65C, 26 7/8" x 15 ¼"
3. Manufacturer: DFW Plastics or approved equal.
4. Purple Plastic Locking Lid:
 - a. Plastic lid shall be purple solid through and have a key locking mechanism.
 - b. Lid shall be spring loaded with brass locking mechanism with standard brass key. Manufactured by Midland Mfg. Co. or Approved Equal.
 - c. Lid shall have "RECLAIM WATER" and manufacturer's name and logo molded into the lid. Font: Standard Fadal CNC Font with 1" characters x .150" deep.
 - d. Lid shall seat securely and evenly inside the box and shall not overlap the top edge of the box. Tread Dimensions: .188" x .938" x .150".
 - e. Lid shall be molded with grid pattern in an effort to provide skid resistance.
 - f. Lid shall have an AMR Slide Mount molded into the lid. Mount to be molded on underside of lid and off center for placements of an AMR transponder.
5. Purple Plastic Body
 - a. Body of box shall be purple and have crush resistant ribbing along outside of box.
 - b. Body shall have a flange around the lid opening to prevent settling and aide in adjustment to grade.
 - c. Body shall have one pipe slot on each end of the body measuring 4"x9".

2.18 WIRE SPLICES:

- A. Valve Wiring: Waterproof type connectors with plastic housing and non-settling sealant.
- B. DBY by 3M Company, King One Step wire connector, or approved equal.

2.19 RAIN/FREEZE SENSOR:

- A. Wireless Rain/Freeze Sensor with transmitter and receiver.
- B. Attach to top of 2" galvanized pipe 10 foot above grade and 2 feet below grade set in concrete.
- C. Paint pipe semi gloss black.
- D. Manufacturer: RAINBIRD or approved equal.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which irrigation sprinkler system is to be installed.
- B. Verify that interfacing work specified elsewhere is complete.
- C. Notify Owner in writing of conditions detrimental to proper and timely completion of Work.
- D. Do not proceed until conditions are satisfactory.

3.02 INSTALLATION:

A. General:

- 1. Compliance: Complete installation in strict accordance with manufacturer's recommendation, which shall be considered a part of these specifications.
 - 2. Stake location of each sprinkler for approval of Owner before proceeding. Do not exceed manufacturer's maximum spacing limits.
 - 3. Piping Layout: Piping layout is diagrammatic. Route piping around trees and shrubs to avoid damage to plantings. Do not dig within balls of newly planted trees and shrubs.
 - 4. Discrepancies:
 - a. Point out any discrepancy between the plans and the field conditions that may affect uniform coverage. Do not proceed until any design change made necessary by such discrepancy is approved by Owner.
 - b. Should such changes create extra cost, approval for extra compensation shall be obtained in writing by Owner before commencing work.
 - c. Should such changes create savings in cost, a written reduction in the contract price shall be approved in writing by Owner before commencing work.
- B. Excavations: Excavations are unclassified and include earth, loose rock, or combinations, in wet or dry state. Backfill trenches with material removed except if rock is encountered haul this material off site, and backfill to ensure a minimum of 3 inches of rock free soil surrounding pipe.
- C. Water Meter and Backflow Prevention: Refer to plans.

3.03 PIPE INSTALLATION:

- A. General: Width of trenches to be approximately twice as large as the pipe diameter.
- B. Mainline and Lateral Piping: Install with 12 inches of soil cover over laterals and 24" coverage over 8" mainline and 18" coverage over 6" and small mainline.
- C. Trenching: Provide firm, uniform bearing for entire length of pipe to prevent uneven settlement. Wedging or blocking of pipe is not permitted. Remove foreign matter from inside of pipes before assembly. Keep inside of piping clean during and after layout of pipes.
- D. Backfill: Water jet and compact to 90% to prevent after-settling. Hand rake trenches and adjoining areas to leave grade in condition equal to before installation.

3.04 PVC PIPE AND FITTINGS ASSEMBLY:

- A. Solvent: Use solvent and procedures recommended by manufacturer to make solvent-welded joints. Thoroughly clean pipe and fittings before applying solvent.
- B. PVC to Metal Connections: Use Teflon tape.
- C. Threaded PVC Connections: Use threaded PVC adapters into which pipe may be welded. Use Teflon tape on threads.

3.05 ELECTRICAL VALVES:

- A. Provide valves in accordance with materials list and size according to plans.
- B. Install valves in a level position in accordance with manufacturer's specifications.
- C. Provide plastic valve box, centered over valve, flush with finish grade. Provide valve box extensions as required.
- D. Install 0.5 cubic feet washed pea gravel in bottom of valve box.

3.06 SPRINKLERS:

- A. General: Provide in accordance with materials list with nozzle in accordance with plans. Change nozzle degree and trajectory if wind conditions affect coverage. Receive approval from the Owner prior to any change. Install heads adjacent to walks and curbs 2 inches clear of paving.
- B. High-Pop Shrub Heads: Provide nozzles as indicated in 2.15 twelve (12") inch pop-up body. Attach to lateral piping with 1/2". Firmly tamp soil around base plate and leave head plumb. Underside of flange shall be set flush to 1" above finish grade.
- C. Lawn Heads: Attach sprinklers to lateral piping with flex PVC pipe. Firmly tamp soil around base plate and leave head plumb. Underside of flange shall be set flush to 1/4" above finish grade in hydro seeded areas and 1" above finish grade in solid sodded areas.
- D. Rotary Heads: Install as detailed on the plans on swing joints. Follow manufacturer's assembly and installation procedure. Set heads flush with finish grade or sod.

3.07 QUICK COUPLING VALVES (QCV): Provide in accordance with materials list and as detailed on plans. Stake with a 1" galvanized pipe.

3.08 WIRING:

A. Sprinkler Controls to Valves:

1. Conduit is not required for U.F. wire unless otherwise noted on plans. Tuck wire under piping.
2. Make wire connections with waterproof connectors according to manufacturer's recommendations.
3. Provide a separate wire from controller to each electric valve. Provide a common neutral wire from controller to valves served by a particular controller.
4. Provide a 24 inch long wire coils at valves.

5. An expansion coil shall be provided every 200 feet, which consists of 10 wraps around a 1" PVC pipe or some other method approved by the Owner.
6. All valve wires from the same controller shall be bundled together every 10 feet with plastic electrical tape.

B. Wire Testing:

1. Before any backfills are placed over the communication cable, test the wires with a megger for wire installation resistance. Minimum insulation resistance to ground shall be 100K OHMS to ground. Any conductor not meeting this requirement shall be replaced and retested.
2. After backfill is completed, retest the wires with a megger. The minimum acceptable insulation resistance to ground on this test shall be 100K OHMS to ground. Replace and retest any conductor not meeting this requirement.

3.09 TESTING:

- A. Notify Owner to review work 48 hours prior to testing pipe and fittings for leaks.
- B. Test mains for a period of four hours under static pressure. If leaks (or pressure drops) occur, correct defect and repeat test.

3.10 FINAL ADJUSTMENT:

- A. Make final adjustments of sprinkler system prior to Owner's final inspection.
- B. Flush system by removing nozzles from heads on ends of lines and operating system.
- C. Adjust sprinklers for proper operation and proper alignment for direction of throw.
- D. Adjust each section for operating pressure and balance to other sections by use of flow adjustment on top of each valve. Correct operating pressure at last head of each section - 50 psi for rotary heads and 20 to 25 psi for spray heads.
- E. Adjust nuzzling for proper coverage. Prevailing wind conditions or slopes may indicate that arc of angle or trajectory of spray should be other than as shown on plans. Change nozzles to provide correct coverage.

3.11 CLEANUP: Keep premises clean and neat.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 329113

FERTILIZER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Fertilizer in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.4.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 329119

TOPSOIL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Topsoil in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.
- B. Soil analysis shall be submitted for approval prior to placement of topsoil material and shall be within the limits of 2% to 20% organics and a pH range of 5.5 to 7.6.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2.3 is hereby modified to allow a minimum of 4 inches of topsoil.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2 unless otherwise specified in the Contract Documents.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.2 unless otherwise specified in the Contract Documents.

END OF SECTION

SECTION 329223

TURFGRASS PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work includes all labor, materials, and equipment for soil preparation, fertilization, planting, and other requirements regarding Turfgrass Planting areas shown on the plans.

1.02 RELATED SECTIONS

- A. Section 024100 - General Site Preparation
- B. Section 328000 - Irrigation System
- C. Section 329113 – Fertilizer
- D. Section 329119 - Topsoil

1.03 SUBMITTALS

- A. Delivery Receipts and Invoices: All delivery receipts and copies of invoices for materials used for this work shall be subject to checking by the Owner and shall be subsequently delivered to the office of the Owner.
- B. Samples and Producers' Specifications: Various samples, certificates, and specifications of seed, fertilizer, sand, compost, other soil amendments, and other materials shall be submitted for approval as required by subsequent sections of this specification.

PART 2 - PRODUCTS

2.01 TURFGRASS

- A. Bermudagrass Seed (not in median, unless approved by the Director of Public Works and Engineering Services): Turfgrass seed shall be “Cynodon dactylon” (Common Bermudagrass). The seed shall be harvested within one (1) year prior to planting, free of Johnsongrass, field bind weed, dodder seed, and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall not be a mixture. The seed shall be hulled, extra fancy grade, treated with fungicide, and have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85% using the formula: purity % times (germination % times plus hard or sound seed %). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.
 - 1. Certificate Submittal: Prior to planting, provide the Owner or his representative with the State Certificate stating analysis of purity and germination of seed.
- B. Sod: Turfgrass sod shall be “Cynodon dactylon” (Common Bermudagrass shall not be installed in median unless approved by the Director.). Sod shall consist of stolons, leaf blades, rhizomes, and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than three-quarters (3/4”) inch. Sod shall be alive, healthy, vigorous,

free of insects, disease, stones, and undesirable foreign materials and grasses. The grass shall have been mowed prior to sod cutting so that the height of the grass shall not exceed two (2") inches. Sod shall have been produced on growing beds of clay or clay-loam topsoil. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival will be affected. All sod is to be harvested, delivered, and planted within a twenty-four (24) hour period of time. Sod shall be protected from exposure to wind, sun, and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots-to-roots and grass-to-grass.

1. Dimensions: All sod shall have been machine cut to uniform soil thickness of one (1") inch plus or minus one-quarter (1/4") inch. All sod shall be of the same thickness. Rectangular sections of sod may vary in length, but all shall be of equal width and of a size that permits the sod to be lifted, handled, and rolled without breaking. Broken pads and torn, uneven ends will be unacceptable.

2.02 FERTILIZER

- A. General: Fertilizer shall be a commercial product, uniform in composition, free flowing, and suitable for application with approved equipment, Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer which has been exposed to high humidity and moisture has become caked or otherwise damaged making it unsuitable for use will not be acceptable.
- B. Initial Planting Application: Fertilizer for the initial planting application shall be of an organic base containing by weight the following (or other approved) percentages of nutrients: 15-15-15 (N-P-K), also containing 10-15% sulphate and traces of iron and zinc as required and approved by the Owner. At least 50% of the nitrogen component must be of a slow-release formulation such as area-based and plastic resin-coated fertilizers.
 1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.
- C. Post Planting Application: Fertilizer for the post planting application will be a chemical base fertilizer containing by weight the following percentages of nutrients: 21-0-0 (N-P-K) ammonium sulphate or the nitrogen equivalent of 33-0-0 ammonium nitrate.
 1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.

2.03 HYDRAULIC-MULCH MATERIALS

- A. Refer to the Public Works Construction Standards, NCTCOG 4th Edition, Item 202.6.4.4.
- B. Public Works Construction Standards, NCTCOG 4th Editions, Item 202.6.4.4 is hereby modified by excluding the compliance with NCTCOG Item 202.4 Fertilizer.
- C. Fertilizer for hydraulic mulching will comply with requirements of this specification.

2.04 SOIL AMENDMENTS (Not required.)

PART 3 - EXECUTION

3.01 GENERAL

- A. All turfing operations are to be executed across the slope, parallel to finished grade contours.

3.02 SOIL PREPARATION

- A. Contractor shall kill all vegetation prior to soil preparation.
- B. Tillage: Tillage shall be accomplished to loosen the soil, destroy existing vegetation, and prepare an acceptable seed/sprig/sod bed. All areas shall be tilled with a heavy duty disc or a chisel-type breaking plow, chisels set not more than ten (10") inches apart. Initial tillage shall be done in a crossing pattern for double coverage, followed by a disc harrow. Depth of tillage shall be five (5") inches. A heavy duty rototiller may be used for areas to be planted with sod.
- C. Cleaning: Soil shall be further prepared by the removal of debris, building materials, rubbish, weeds, and stones larger than three-quarters inch (3/4") diameter.
- D. Fine Grading: After tillage and cleaning, all areas to be planted shall be leveled, fine graded, and drag with a weighted spike harrow or float drag. The required result shall be the elimination of ruts, depressions, humps, and objectionable soil clods. This shall be the final soil preparation step to be completed before the commencement of fertilizing and planting.
- E. Rock Removal: During the soil preparation process, a "Rock Pick" or other approved piece of machinery shall be used to gather surface stones as small as three-quarter (3/4") inch in diameter. The Contractor shall be responsible for the disposal of collected materials as waste per "Clean Up" Paragraph 3.10.

3.03 FERTILIZING

- A. Initial Planting Application: The specified fertilizer shall be applied at the rate of (18) pounds per one thousand (1,000) square feet (800 pounds per acre).
 - 1. Timing: The initial planting application of fertilizer for seeded/sprigged areas shall be applied after the soil preparation, but not more than two (2) days prior to turfgrass planting. (Fertilizer shall be applied over sodded areas after planting, but not more than two (2) days later.)
- B. Post Planting Application: Thirty (30) days after planting, turfgrass areas shall receive an application of 21-0-0 or 33-0-0 fertilizer at the rate of nine (9) pounds per one thousand (1,000) square feet (400 pounds per acre).
 - 1. Timing: The Owner or his representative will determine if it is too late in the growing season for the post planting application. In the event that it is, the application shall be made in the spring of the next year, or the cost of the application may become a credit due to the Owner.
 - 2. Post Planting Maintenance: See Paragraph 3.07. Areas without a uniform stand (complete coverage) that must be maintained later than thirty (30) days after the initial planting shall receive subsequent applications of fertilizer, as described above, every thirty (30) days until a uniform stand is achieved.

3.04 PLANTING:

- A. Seeding: Following soil preparation and initial fertilizing, apply Bermudagrass seed at the rate of two (2) / three (3) pounds per one thousand (1,000) square feet (90/130 pounds per acre) or ryegrass seed at the rate of eight (8) pounds per one thousand (1,000) square feet (350 pounds per acre). Seed shall be uniformly placed with a Brillion seeder-cultipacker, or the seed shall be broadcast uniformly, followed by rolling with a weighted lawn roller.
1. Timing: Bermudagrass shall not be seeded in planting periods other than the following unless special permission is granted by the Owner: April 15 to June 15, and August 15 to September 15.
 2. Hydraulic Mulch (where required): Refer to Public Works Construction Standards, NCTCOG 4th Edition, Item 202.6.4.4.
- B. Solid Sodding: Prior to laying the sod, the planting bed shall be raked smooth to true grade and moistened to a depth of four (4") inches, but not to the extent causing puddling. The sod shall be laid smoothly, tightly butted edge to edge, and with staggered joints. The sod shall be pressed firmly into contact with the sod bed by rolling or by hand tamping with an approved tamper so as to eliminate all air pockets, provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Following compaction, fine screened soil of good quality shall be used to fill all cracks between sods. Excess soil shall be worked into the grass with suitable equipment and shall be well watered. The quantity of fill soil shall be such that it will cause no smothering of the grass.

- 3.05 PROTECTION: No heavy equipment shall be moved over the planted lawn area unless the soil is again prepared, graded, leveled, and replanted. It will be the responsibility of this Contractor to protect all paving surfaces, curbs, utilities, plant materials, and any other existing improvements from damage. Any damages shall be repaired or replaced at no cost to the Owner. This Contractor will also locate and stake all irrigation heads, valve risers, etc., prior to beginning any soil preparation work.
- 3.06 ESTABLISHMENT AND ACCEPTANCE: Regardless of unseasonable climatic conditions or other adverse conditions affecting planting operations and the growth of the turfgrass, it shall be the sole responsibility of the Contractor to establish a uniform stand of turfgrass as herein specified. When adverse conditions such as drought, cold weather, high winds, excessive precipitation, or other factors prevail to such an extent that satisfactory results are unlikely, the Owner may, at his own discretion, stop any phase of the work until conditions change to favor the establishment of turfgrass.
- 3.07 POST-PLANTING MAINTENANCE: Contractor shall begin maintenance immediately after each portion of grass area is planted. All planted areas will be protected and maintained by watering, weed control, and replanting as necessary for at least thirty (30) days after initial planting and for as much longer as necessary to establish a UNIFORM STAND WITH COMPLETE COVERAGE OF THE SPECIFIED GRASS. It is anticipated that a minimum of one (1) mowing will occur before the grass areas are acceptable to the Owner. Only those areas which are not completely covered with the specified grass at the end of thirty (30) days will continue to be replanted and maintained by the Contractor until complete coverage and acceptable results are achieved. Any water equipment deemed necessary by the Contractor will be provided by the Contractor at his expense.

- A. Watering: Use the automatic irrigation system to apply at least one-half (1/2") inch of water over the entire planted area every three (3) days. Contractor shall water thoroughly and infrequently once grass is established to encourage deep root growth.
 - B. Mowing: Once grass is established the planted area shall be mowed at least once a week during the growing season. Grass shall be mowed to a height of one (1") inch and shall not exceed four inches (4") in height. Mowing during dormant season will be done as necessary.
 - C. Weed Control: No sooner than 45 days after grass has germinated any weed growth shall be arrested by applying MSMA broadcasted over the entire planted area. Additional applications of MSMA will be required to eliminate weed growth that continues to grow after the initial application. MSMA will only be used during the growing season. All weed growth during the dormant season will be controlled with spot applications of "Round-Up." "Round- Up" will not be used until the grass is totally dormant.
- 3.08 GRADING: All grading and placing of topsoil on any given area will be done prior to the beginning of this work. It will be the Contractor's responsibility to maintain the existing grades and leave them in a true and even condition after planting turfgrass. Finish condition of turfgrass will be such that sod sits flush with paving (topsoil 1" below paving) and such that drainage grades and swales function and to not trap drainage on the paving.
- 3.09 EROSION CONTROL: Throughout the project and the maintenance period for turfgrass, it is the Contractor's responsibility to maintain the topsoil in place at specified grades. Topsoil and turfgrass losses due to erosion will be replaced by the Contractor until establishment and acceptance is achieved.
- 3.10 CLEAN UP: This Contractor shall remove any excess material or debris brought onto the site or unearthed as a result of his turfgrass operations.
- 3.11 GUARANTEE: This Contractor shall guarantee all materials used for this work to be the type, quality, and quantity specified.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 329225

BUFFALO GRASS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work includes all labor, materials, and equipment for soil preparation, fertilization, planting, and other requirements regarding Turfgrass Planting areas shown on the plans.

1.02 RELATED SECTIONS

- A. Section 024100 - General Site Preparation
- B. Section 328000 - Irrigation System
- C. Section 329113 – Fertilizer
- D. Section 329119 – Topsoil

1.03 SUBMITTALS

- A. Delivery Receipts and Invoices: All delivery receipts and copies of invoices for materials used for this work shall be subject to checking by the Owner and shall be subsequently delivered to the office of the Owner.
- B. Samples and Producers' Specifications: Various samples, certificates, and specifications of seed, fertilizer, sand, compost, other soil amendments, and other materials shall be submitted for approval as required by subsequent sections of this specification.

PART 2 - EXECUTION

2.01 GENERAL

- A. All operations are to be executed across the slope, parallel to finished grade contours.

2.02 SOIL PREPARATION

- A. Grade sod planting area to accommodate 4" of incorporated Soil (mature compaction 1" above grade)
- B. Install irrigation
- C. Incorporate 2" of approved local soil free of rock, limbs, lumps, clods of hard earth, plants or their roots weeds, foreign grasses, and other extraneous matter. Under no circumstances shall topsoil be accepted unless it is free of the aforementioned contaminants. Topsoil containing Dallas grass or Nutgrass shall be rejected.
- D. Add 2" of amended soil (dyno dirt or equivalent)
- E. Till amended soil 2" into local soil

2.03 ESTABLISHMENT

- A. Plant 609 or Prairie Varieties
- B. Preferred planting time is March to September
- C. Keep sod moist, but not saturated until rooted into subsoil
- D. Decrease watering as soon as agronomically possible
- E. Manage sod moisture to insure establishment
- F. Do not mow until height reaches 8 to 10 inches
- G. Hand-remove weed encroachment weekly for first full season
- H. Apply 1.5 pounds of balanced slow-release fertilizer (3 to 4 month residual) once sod is rooted into subsoil
- I. Apply Top Choice insecticide at recommended rate at the same time as fertilizer

2.04 MAINTENANCE

- A. Maintain height at 8 to 10 inches
- B. Mow once or twice per year to 6 inches
- C. Mow with “ clean mowers “ not contaminated with alternate grass communities
- D. Insure mower blades are sharp
- E. Monitor moisture content to retain assertive growth and color presentation
- F. Apply adequate moisture during peak heat season to retain assertive health
- G. Apply Ronstar Granular Premergent Herbicide in February at recommend rates following the first full season of growth
- H. Apply 1.5 pounds of balanced slow-release fertilizer (3 to 4 month residual) in March
- I. Apply Top Choice Insecticide at recommended rate in February
- J. Manually remove invasive weeds as needed throughout the year
- K. Maintain street curbed areas as needed

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 427.3 and 427.4
- B. All flexible base shall be compacted per recommendations in Geotechnical Report.

- C. Geogrid shall be installed per manufacturers specifications and requirements, Specification 5001, latest addition.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 329300

TREE, SHRUB, AND GROUNDCOVER PLANTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work includes all final fine grading and minor leveling of planting areas, soil preparation, and planting. Furnish all labor, materials, equipment and services required as herein specified and indicated on the drawings. Refer to planting details on plans. NOTE: Plant beds to be left 1" below adjacent paving and slabs after settling.

1.02 RELATED SECTIONS

- A. Section 024100 - General Site Preparation
- B. Section 328000 - Irrigation System
- C. Section 329113 - Fertilizer

PART 2 - PRODUCTS

2.01 TOPSOIL

- A. All planting bed topsoil shall be soil/compost mix as produced by Living Earth Technology Co., Dallas, Texas, or approved equal.
- B. Submittal: Submit 1 gallon samples to Owner for Approval.
- C. Existing topsoil may be used or amended if it meets the requirements for imported soil and is approved by the landscape architect. Provide a minimum of one soil sample with accompanying soil test report for each topsoil type found on the site.

2.02 COMMERCIAL FERTILIZER

- A. Shall be organic base fertilizer containing the following minimum percentages of available plant nourishment, by weight 5-10-5 (N-P-K), mixed nitrogen, not less than fifty (50%) percent from an organic source and trace elements, Wacco brand or approved equal. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be accepted.
- B. Commercial fertilizer shall be a complete organic fertilizer, part of the element of which is derived from organic sources. It shall be the type percentages and applied at the rate specified in the soil analysis. Fertilizer shall be delivered mixed as specified in standard size bags, showing weight, analysis, and name of manufacturer, and shall be stored in a weatherproof storage place, and in such a manner that it will be kept dry and its effectiveness will not be impaired.
- C. Submittal: Submit labels to Owner for Approval.

2.03 SOIL AMENDMENTS (None required.)

2.04 MULCH

- A. Shall be shredded cypress bark mulch.
 - B. Submittal: Submit a one (1) quart sample of proposed mulch for Owner approval.
- 2.05 ROOT ACTIVATOR (Not required.)
- 2.06 WATER: Water shall be available at the site via irrigation system. Water required in connection with planting will be furnished and paid for by the Owner provided it is not used in a wasteful manner. Any hose or other watering equipment shall be provided by the Landscape Contractor to water planting areas until the job is accepted by the Owner.
- 2.07 PLANT MATERIALS
- A. Plant Name and Location: The names and locations of all plants are noted on the drawings. The nomenclature of all plant materials is per Standardized Plant Names, 1942 edition and Manual of Cultivated Plants by L. H. Bailey. Plant materials not conforming to these two references will be rejected by the Owner.
 - B. Quality and Size: All plant materials shall be first class representatives of their normal species or variety unless otherwise specified. They shall have a habit of growth that is normal for the species and shall be healthy, shapely, well-rooted, and vigorous. All plant materials shall be free from insect pests, plant diseases, and injuries. The containers and balls of all plants delivered to the site shall be free from any weeds or grasses which could be considered noxious or objectionable; i.e., nutgrass or Johnsongrass. ALL PLANT MATERIALS SHALL BE EQUAL TO OR EXCEED THE MEASUREMENTS SPECIFIED ON THE PLANTING PLAN WHICH ARE THE MINIMUM ACCEPTABLE SIZES. They shall be measured after pruning with the branches in normal position. The requirements for measurement, branching, grading, quality, balling and burlapping of plants specified generally follow the code of the standards currently recommended by the American Nursery and Landscape Association, in the American Standards for Nursery Stock.
 - a. Trees shall not be headed back in the nursery or on site. Trees with multiple leaders, unless specified, will be rejected. Trees with damaged or crooked leader, bark abrasions, sunscald, disfiguring knots, insect damage, or cuts of limbs over 20 mm (3/4 in.) in diameter that are not completely closed will be rejected. The root flare shall be visible. Trees with girdling roots will be rejected.
 - C. Packaging:
 - 1. Container Grown Plants: Plants designated as “container grown” on the plans shall be full or heavy grade and shall have been growing in the specified size container for one full season prior to delivery to the site.
 - 2. Balled and Burlapped Plants (B&B): Plants designated “B&B” on the plans shall be balled and burlapped. They shall be dug with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Balls shall be firmly wrapped with burlap or similar materials and bound with twine, cord, or wire mesh. Where necessary, to prevent breaking or cracking of the ball during the process of planting, the ball may be secured to a platform.
 - 3. Alternate to B&B: Plants grown in containers may be accepted as B&B provided that the plant has been growing in the container for one full growing season prior to delivery. Alternate must be approved by Owner.

- D. Substitutions: Substitutions will be permitted only upon submission of proof that any plant is not obtainable and authorization by the Owner or his representative by a Change Order providing for the use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of contract price.
- E. Biostimulants: shall contain soil conditioners, VAM, and endomycorrhizal and etomycorrhizal fungi spores and soil bacteria appropriate for existing soil conditions. Submit manufacturer literature for approval.

2.08 SOIL STERILANT: (Not required.)

2.09 WEED CONTROLLER: Shall be "Round-Up" as manufactured by Monsanto, Inc or approved equal.

PART 3 - EXECUTION

3.01 LAYOUT

Location and spacing for plants and outline of areas to be planted shall be as denoted by stem location or by notations on the plan. All tree and shrub planting locations shall be staked by the Landscape Contractor and shall be approved by the Owner prior to digging the planting pits.

3.02 SCARIFICATION

- A. All bed areas to receive planting shall be scarified to a depth of twelve (12") inches and all debris, stone, rubbish, and weeds shall be removed from the site.
- B. Weed Control: Prior to scarification the Contractor shall apply "Round-Up" herbicide to all bed areas. Follow manufacturer's directions as to timing requirements for effective weed control.

3.03 BED PREPARATION

- A. Planting areas shall be dug and soil fully prepared, graded, and made ready to receive the plants before delivery of plant materials. After planting, all beds shall be one (1") inch above finished grade to allow for settling.
- B. Groundcover and Vine Planting Areas:
 - 1. Commercial Soil Mix: All planting beds shall be excavated to twelve (12") inches below finished grade by Landscape/General Contractor, and all debris, stone, rubbish, weeds, and topsoil shall be removed from the site. The subgrade shall then be tilled to a depth of six (6") inches and the planting bed shall be backfilled with soil compost mix as available from Living Earth Technology Co., Inc., Dallas, Texas, or approved equal. Upon replacement of topsoil with mix and after watering in, the bed should be at the specified level.
- C. Tree and Shrub Planting Pits:
 - 1. Planting Pits: After scarifying, the planting pits shall be excavated. All shrub pits shall be a minimum of six (6") inches larger in diameter and three (3") inches deeper than the shrub ball or root spread. All tree pits shall be a minimum of twelve (12") inches larger in diameter and 2-3 inches less deep than the rootball. All tree pits shall be tested for

percolation. If water does not drain within 24 hours, drainage or a more suitable species or location shall be provided. sp.

2. Soil Mix: Soil mix for backfilling the tree and shrub planting pits shall be soil/compost mix as specified for Groundcover and Vine Planting Areas.

D. Raised Planters:

1. Backfilling: Planters shall be backfilled with specified commercial soil mix.

3.04 DELIVERY OF PLANT MATERIALS

Plants shall be packed and protected during delivery and after arrival at the site, against climatic, seasonal, wind damage, or other injuries, and at no time shall be allowed to dry out.

3.05 PROTECTION OF PLANT MATERIALS

All plants shall be handled so that roots are adequately protected at all times from drying out and from other injury. The balls of balled plants which cannot be planted immediately on delivery shall be "heeled in" for protection with soil mulch, straw, or other acceptable material.

3.06 SETTING THE PLANTS

All plants shall be planted in pits, centered, and set to touch such depth that the finished grade level at the plant after settlement will be the same as that at which the plant was grown. Each plant shall be planted upright and faced to give the best appearance or relationship to adjacent plants or structures. No burlap shall be pulled out from under balls or balls broken when taken from containers. All broken or frayed roots shall be cut off cleanly. Prepared soil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. When the hole is nearly filled, add water and root activator, mixed per manufacturer's recommendations, and allow it to soak away. Fill the hole to finished grade and form a shallow saucer around each tree or shrub by placing a ridge of topsoil around the edge of each pit after planting.

3.07 MULCHING

All plants will be mulched after planting with a three inch (3") deep layer of mulch material entirely covering the area around each plant except as noted. The root flare of trees shall not be covered with mulch. In the groundcover and massed shrub areas, the entire area between the plants is to be so treated, regardless of plant spacing.

3.08 GRADING

The surface of all planting areas shall slope as shown on the plans. Unless otherwise shown, slope one-quarter (1/4") inch per foot (two (2%) percent gradient) away from foundations and walk.

3.09 CLEANUP

All excess soil, soil preparation materials, fertilizer, or plant containers shall be removed from the site upon completion of the work.

3.10 PRUNING AND SPRAYING

Each tree will be pruned to preserve the natural shape and character of the plant. All pruning will be done after delivery to the site, under supervision of the Owner. All soft wood or sucker growth

and all broken or badly bruised branches shall be removed. All pruning diameter will be painted with tree surgery paint, applied on all cambium and other living tissues immediately after cuts are made. Immediately after planting and staking, all plant material except coniferous evergreens must be sprayed with an antidesiccant, if required, using an approved power sprayer for applying an adequate film over trunks, branches, and foliage. Antidesiccants and surgery paint shall be delivered in manufacturer's sealed containers and used in accordance with their recommendations.

3.11 MAINTENANCE

The Landscape Contractor is responsible for watering, cultivating, and other necessary maintenance (including regular mowing) until the completion and acceptance of the project.

3.12 INSPECTION FOR ACCEPTANCE

- A. Inspections: Inspection of work and planting to determine completion of the work, exclusive of possible warranty plant replacement, will be made by the Owner upon notice by the Landscape Contractor. The Owner needs not less than two (2) days notice prior to the anticipated date, enabling him to schedule the inspection.
- B. Acceptance: Acceptance of all work and planting, exclusive of possible plant replacements subject to guarantee, will be granted to the Landscape Contractor, provided there are no deficiencies at inspection time. After inspection, the Landscape Contractor will be notified by a letter of acceptance of work by the Owner. All plants must be healthy (not dry or wilted) to be accepted.

3.13 GUARANTEE

- A. Terms: All shrubs and groundcover shall be guaranteed for a minimum of one (1) year and all trees for one (1) year or in accordance with the Contract Documents, whichever is greater. Guarantee begins upon Final Acceptance of project by City.
- B. Plant Replacement: At the end of each guarantee period, inspection will be made by the Owner and the Landscape Contractor. Any plant material required under this contract that is dead or not in satisfactory growth condition shall be removed and replaced with the same size and kind of plant specified, at no cost to the Owner.

3.14 MAINTENANCE GUIDE

The Landscape Contractor, upon delivery of the plant materials, shall deliver to the Owner a brief, written maintenance guide. This guide should describe recommended planting maintenance procedures, methods, products, quantities, timing, etc.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. Measurement and Payment shall be specified in the Contract Documents.

END OF SECTION

SECTION 329600

REMOVAL, PROTECTION AND REPLACEMENT OF TREES, SHRUBBERY, PLANTS, SOD, AND OTHER VEGETATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary for removal, protection and replacement of trees, shrubbery, plants, sod and other vegetation in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1
- B. ANSI A300, Pruning Standards
- C. City of Frisco Tree Preservation Ordinance
- D. City of Frisco Tree Protection Standard Details

1.03 RELATED SECTIONS

- A. Section 024100 - General Site Preparation

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1.
- B. Unless otherwise specified on the plans, trees and shrubs with calipers greater than three (3") inches shall not be cleared (removed) provided that both of the following conditions are met:
 - 1. The vegetation exists in an area that is not proposed for pavement, a structure, or the playing bounds of an athletic field.
 - 2. The vegetation is in an area where the cut or fill does not exceed six inches (6").
- C. The Owner will assist the Contractor in identifying trees that are to be saved from clearing if not specified in the plans. The Contractor will protect such trees from construction damage

such as trunk impacts and scrapes, limb breakage, compaction of soil within the drip line, and other injurious construction activities. If necessary, the Owner may direct the Contractor, at the Contractor's expense, to erect protective stockades along the drip lines of trees that the Owner considers vulnerable to damage. Such stockades shall be of eight foot (8') long x six inch (6") diameter posts vertically buried three feet (3') deep at six foot (6') intervals along the drip line.

- D. Where grading or clearing and grubbing operations are to occur between trees that are to be preserved and protected, the Contractor will prune the lower branches of these trees as necessary to prevent their breakage and to permit access by construction machinery. Branches will be cut off to the trunk or major limb pursuant to ANSI A300. The Owner may direct that the Contractor remove additional branches in such a manner that the tree presents a balanced appearance. Scars will be treated with a heavy coat of an approved tree sealant.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1 unless otherwise specified in the Contract Documents.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 202.1 unless otherwise specified in the Contract Documents.

END OF SECTION

SECTION 330131

WASTEWATER AND MANHOLE TESTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to test wastewater mains and manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.1.5 and 507.5.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.1.5 and 507.5.

1.03 SUBMITTALS

- A. Copies of all test reports.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 WASTEWATER MAIN TESTING

The Contractor shall complete each of the following tests on all wastewater mains.

- A. Low pressure air testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.1.3.
- B. Deflection testing of flexible wastewater mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.1.4. Deflection testing shall not begin until 30 days after trench is backfilled.

3.02 WASTEWATER MANHOLE TESTING

The Contractor shall complete one of the following tests on all wastewater manholes.

- A. Exfiltration testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.5.1.
- B. Vacuum testing in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.5.2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Wastewater and manhole testing shall be subsidiary to the wastewater main and manhole bid items. No separate pay item for wastewater and manhole testing.

END OF SECTION

SECTION 330132

TELEVISION INSPECTION FOR WASTEWATER MAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to perform television inspection of wastewater mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2

1.03 SUBMITTALS

- A. CD or DVD with wastewater main television inspection videos and data log summary sheets.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.5.2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Television inspection of wastewater mains shall be subsidiary to the wastewater main bid items. No separate pay item for television inspection of wastewater mains.

END OF SECTION

SECTION 330510

TRENCHING, BACKFILLING AND COMPACTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to perform Trenching, Backfilling and Compaction operations for utility construction in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504

1.03 SUBMITTALS

- A. Trench safety plan in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.3.

PART 2 - PRODUCTS

Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.2.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 107.19.3, 203 and 504.
- B. Trenches shall be excavated by a trenching machine, backhoe or dragline, except in locations where hand trenching is required. The banks of trenches shall be vertical, to a point one foot (1') above the top of pipe.
- C. The excavation shall not advance more than three hundred feet (300') ahead of the completed and backfilled line. Pipe shall be laid in all trenches that have been opened before the end of each day's work, unless the Contractor secures written permission to do otherwise from the Inspector.
- D. The final backfill shall be moisture treated at a minimum of 95 percent standard Proctor (ASTM D 698) to:
 - 1. A minimum of 3% above optimum moisture content for Eagle Ford Shale formation; or
 - 2. 0% to 4% of optimum moisture content in Austin Chalk limestone formation.
- E. If a project site has both Eagle Ford and Austin Chalk characteristics, Eagle Ford specifications shall apply for the entire project.

3.02 TESTING

- A. Moisture/density tests are the responsibility of the Contractor and shall be performed by a private Geotechnical Consultant. Contractor to notify City Inspector 24 hours prior to any testing.
 - 1. The method of testing of the compacted material and the validity of the results shall be the responsibility of the Geotechnical Consultant certifying the testing.
 - 2. Signed test results or signed field work sheets shall be submitted to the City by the Contractor or the Geotechnical Consultant within 24 hours of the test(s).
 - 3. Testing frequency for density tests on backfill for water pipe; wastewater pipe; storm sewer pipe; or utility conduits shall be:
 - a. One set of density tests per two feet of backfill starting at two feet above the pipe or conduit for every 300 feet of trench;
 - b. One test every other main stubout crossing right-of-way or firelane;
 - c. One test on every sixth long service.
 - 4. Manhole or other utility structures shall be tested spirally in each sequential quadrant for every two feet of backfill. Moisture/density tests in vicinity of manholes or other utility structures (for example cleanouts, hydrants, junction boxes or vaults) shall be performed a maximum of one foot from manhole or other utility structure.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.7 for measurement of backfill.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.6 for measurement of trench safety.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 504.7 for payment of backfill.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 107.19.3.6 for payment of trench safety.
- C. All excavation for utility installation shall be considered subsidiary to the utility bid item. No separate pay item for excavation, backfill and/or trenching, unless otherwise noted.

END OF SECTION

SECTION 330523

TRENCHLESS UTILITY INSTALLATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install utility lines using trenchless installation methods in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503
- B. City of Frisco's Standard Details included in the plans.

1.03 QUALITY ASSURANCE

A. DESIGN CRITERIA

The pipe casing (or carrier pipe on uncased bores) shall be designed by a Licensed Professional Engineer for the following loading conditions and applicable combinations thereof:

1. Cooper's E-80 Railway loading or AASHTO HL93 loading as applicable
2. Earth loading with the height of fill above the casing as shown on the plans
3. Loads applied during jacking, including axial load from jacking
4. All other applicable loading conditions, including loads applied during transportation and handling.

B. INSTALLER'S QUALIFICATIONS

Installation shall be by a competent, experienced contractor or sub-contractor. The installation contractor shall have a satisfactory experience record of at least three (3) years engaged in similar work of equal scope.

All welding shall be performed by a certified welder in the state of Texas.

C. PERFORMANCE REQUIREMENTS

Lateral or vertical variation in the final position of the pipe casing (or carrier pipe on uncased bores) from the line and grade established by the ENGINEER shall be permitted only to the extent of 1" in 10' feet, provided that such variation shall be regular and only in the direction that will not detrimentally affect the function of the carrier pipe.

1.04 SUBMITTALS

Submittals shall include:

- A. Shop drawings of the casing pipe (or carrier pipe for uncased bores) from the manufacturer. Shop drawings shall include calculations for the design of the casing pipe (or carrier pipe for uncased bores) by a Licensed Professional Engineer.

- B. Provide Certificate of Adequacy of Design of casing and/or carrier pipe.
- C. Provide record data of casing insulators including sketches of insulators with material components and dimensions and proposed locations of insulators.
- D. Provide Pressure Grout material and method.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.2.
- B. High Density Polyethylene casing spacers are required unless otherwise specified. Refer to the City of Frisco Approved Materials List.
- C. Steel casing pipe shall be new (or used if approved by the OWNER) and suitable for the purpose intended and shall have a minimum yield strength of 35,000 psi. Casing shall meet ASTM A-36, ASTM A-570, ASTM A-135, ASTM A-139, or approved equal.
- D. Casing pipe shall be coated and lined with coal tar epoxy (15 mils min.) in accordance with AWWA C-210. Pipe joints shall be welded in accordance with AWWA C-206. After pipe is welded, coating shall be repaired.

PART 3 - EXECUTION

3.01 GENERAL

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.3.
- B. All casing pipe joints shall be watertight with no water entering the casing from any sources prior to carrier pipe installation.
- C. The carrier pipe shall be installed within the casing between the limits indicated on the Plans to the specified lines and grades, and utilizing methods which include due regard for safety of workers, adjacent structures and improvements, utilities, and the public.
- D. Furnish all necessary equipment, power, water, and utilities for carrier pipe installation, insulator runner lubricant, grouting, and other associated Work required for the Contractor's methods of construction.
- E. Conduct all operations such that trucks and other vehicles do not interfere with traffic or create a dust or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of spoils and slurry spillage and any slurry discharges.
- F. All Work shall be done so as not to disturb roadways, adjacent structures, landscaped areas, or existing utilities. Any damage shall be immediately repaired to original or better condition and to the satisfaction of Engineer.

3.02 INSTALLATION OF CARRIER PIPE

- A. Pipe Installation: Carrier pipe shall meet the requirements of the applicable Specification section. Remove all loose soil from casing. Grind smooth all rough welds at casing joints. Provide casing spacers, or insulators, or other approved devices, as required, to prevent

flotation, movement, or damage to the pipe during installation and annular space grout placement. Every individual pipe section should be supported by spacers as shown in the City's Standard Details. Carrier pipe shall be installed without sliding or dragging it on the ground or in the casing in a manner that could damage the pipe. Coat the casing spacer runners with a non-corrosive/environmentally safe lubricant to minimize friction when installing the carrier pipe.

- B. Testing of Carrier Pipe: Testing of the carrier pipe joints shall be completed prior to the filling of the annular space between the casing and carrier pipe with grout. Pressure testing shall be performed in accordance with the specification for the selected pipe material. Any leakage found during this inspection shall be corrected.
- C. Backfill Annular Space with Grout: After the installation of the carrier pipe, the annular space (all voids) between the casing and the carrier shall be filled with grout so all remaining surfaces of the exterior carrier pipe wall and casing interior are in contact with the grout. Furnish the necessary grout, equipment, hoses, valves, and fittings for the backfilling operation. Grout shall be pumped through a pipe or hose. Use grout pipes, or other appropriate materials to avoid damage to carrier pipe during grouting. The grout shall be proportioned to flow and to completely fill all voids between the carrier pipe and the casing. The Contractor shall provide end seals, as approved by the Engineer at each end of the casing to contain the grout backfill. The end seals shall be designed to withstand the anticipated grouting pressure and be watertight to prevent groundwater from entering the casing. Block the carrier pipe during grouting to prevent flotation during grout installation. The Contractor shall also protect and preserve the interior surfaces of the casing from damage. It is the responsibility of the Contractor to submit to the Engineer sufficient information indicating all proposed equipment, materials, and the method for filling this void.

3.03 SAFETY

- A. The Contractor is responsible for safety on the job site. Perform all Work in accordance with the current applicable regulations of the Federal, State, and local agencies. In the event of conflict, comply with the more restrictive applicable requirement.
- B. No gasoline powered equipment shall be permitted in jacking shafts and receiving shafts/pits. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations.
- C. Methods of construction shall be such as to ensure the safety of the Work, Contractor's and other employees on site, and the public.
- D. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are underground. Perform all required air and gas monitoring. Ventilation system shall provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in all underground work areas.
- E. Perform all Work in accordance with all current applicable regulations and safety requirements of the Federal, State, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA. In the event of conflict, comply with the more stringent requirements.
- F. The Contractor shall develop an emergency response plan for rescuing personnel trapped underground in a shaft excavation or pipe. Keep on-site all equipment required for emergency response in accordance with the agency having jurisdiction.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.4.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 503.4.

END OF SECTION

SECTION 331113

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Ductile Iron Pipe and Fittings in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7. and Item 506.

1.02 REFERENCES

- A. ANSI/AWWA C104/A21.4 - American National Standard for Cement - Mortar Lining for Ductile-Iron Pipe and Fittings for Water, Latest Revision.
- B. ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement, Latest Revision.
- C. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- D. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- E. ANSI/AWWA C115/A21.15, AWWA Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges, Latest Revision.
- F. ANSI/AWWA C150/A21.50,⁸ American National Standard for the Thickness Design of Ductile-Iron Pipe, Latest Revision.
- G. ANSI/AWWA C151/A21.51, AWWA Standard for Ductile Iron Pipe, Centrifugally Cast, Latest Revision.
- H. ANSI/AWWA C153/A21.53, AWWA Standard for Ductile-Iron Compact Fittings for Water Service, Latest Revision.
- I. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances, Latest Revision.
- J. AWWA C651, AWWA Standard for Disinfecting Water Mains, Latest Revision.
- K. AWWA Manual of Practice M41 Ductile-Iron Pipe and Fittings, Latest Revision.
- L. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.7 and 506.

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 331240 – Polyethylene Encasement

C. Section 331245 – Tapping Sleeves for PVC and Ductile Iron Pipe

D. Section 331260 – Mechanical Restraint for Ductile Iron Pipe

1.04 SUBMITTALS:

Submittals shall be in accordance with the General Conditions and shall include the following:

A. Submittals required prior to fabrication

1. Pipe design calculations sealed by a Licensed Engineer in the State of Texas.
2. Pipe layout drawings including horizontal stations and locations and vertical elevations sealed by a Licensed Engineer in the State of Texas.
3. Thrust restraint calculations sealed by a Licensed Engineer in the State of Texas.
4. Certification with full compliance with the specifications
5. Complete materials specification for each part to be furnished.
6. Technical Bulletins and Brochures
7. Statement of Warranty.
8. An estimated delivery date for the equipment (which shall be stated in calendar days after the releases date to the manufacturer).
9. Name, address, phone number, and fax number of manufacturer's representative.
10. Test to be run during manufacturing process

B. Submittals required prior to Shipping

1. Certified copies of all test.
2. Lifting instructions

1.05 QUALITY ASSURANCE

- A. Manufacturer: Finished pipe shall be the product of one (1) manufacturer. Pipe manufacturing operations (pipe, fittings, lining, coating) shall be performed at one (1) location.

1.06 DELIVERY AND STORAGE

- A. Delivery and Storage shall be in accordance with AWWA C600 and AWWA Manual of Practice M41.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. Buried ductile iron pipe may be mechanical joint, push-on joint, or restrained push-on joint.
- D. All ductile iron pipe shall be cement mortar lined in accordance with AWWA C104.
- E. All buried pipe shall be polyethylene encased in accordance with AWWA C105.

- F. The pressure rating, thickness class, net weight of pipe without lining, length of pipe and name of manufacturer shall be clearly marked on each pipe.

2.02 DUCTILE IRON FITTINGS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.7.
- B. Mechanical joints shall be furnished complete with accessories. Bolts and nuts shall be Cor-Ten or stainless steel.
- C. Fittings shall be provided with bituminous exterior coating and cement-mortar lining inside with seal coat in accordance with AWWA C104.
- D. All buried fittings shall be polyethylene encased in accordance with AWWA C105.
- E. Unless otherwise specified, all fittings shall be of the mechanical joint type with a minimum pressure rating of 250 psi.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 505.1. and 502.4.

3.02 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.
- B. Jointing Push-On Pipe
 1. Remove any foreign matter in the gasket seat of the socket, wipe gasket clean, flex gasket and place in socket with the large round end or bulb end entering first.
 2. Seat gasket evenly around the inside of the socket with the groove fitted over the bead. Remove any bulges.
 3. Apply a thin film of lubricant furnished by the pipe manufacturer to the inside surface of the gasket. No lubricant other than that furnished with the pipe by the pipe manufacturer will be allowed to be used.
 4. Wipe plain end of pipe, to be entered; clean and place in approximate alignment with the bell of the pipe to which it is to be jointed.
 5. Apply a thin film of the lubricant to the outside of the plain end about 1" back from the end.
 6. Align the pipe and carefully enter the plain end into the socket until it just makes contact with the gasket.
 7. Complete joint assembly by forcing the plain end of the entering pipe past the gasket until it makes contact with the bottom of the socket.
 8. The maximum deflection at each joint shall not exceed 80% of manufacturer's recommendation.
- C. Jointing Mechanical Joint Pipe
 1. After carefully cleaning both spigot and bell and after slipping the following ring and the gasket over the spigot end, the spigot shall be slipped into the bell.
 2. A lubricant shall be applied to the spigot end to assist in the assembly as directed by the Inspector.

3. The gasket shall be carefully seated by hand so as to be even in the bell at all points.
 4. After drawing up the follower ring to uniform bearing against the gasket the bolts shall be inserted and tightened by hand in pairs using bolts opposite each other.
 5. The nuts are to be tightened to hold the required pressure. Extension wrenches or pipes over wrench handles will not be permitted. Ten-inch (10") ratchet wrenches with a tension setting control shall be used to tighten the nuts unless other types of wrenches are approved by the Inspector.
 6. The finished joint shall be neat and uniform and shall be watertight.
- D. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
 - E. Water mains twelve inches (12") and smaller in the right-of-way near storm inlets shall be constructed behind the inlet by pulling the pipe using longitudinal bending in accordance with the manufacturer's requirements.
 - F. The maximum deflection angle of pipe joints shall be restricted to 80% of the manufacturers' recommendation. Otherwise, horizontal bends will be required.
 - G. Potable water mains and wastewater mains must be installed in separate trenches.
 - H. New tracer wire shall be installed in the trench with all water mains with a terminal box located in each water main valve pad.

3.03 HYDROSTATIC TEST

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.5 alternative 2-hour testing in accordance with AWWA C600.
- B. The pump, pipe connection, and all necessary apparatus including gauges and meters shall be furnished by the Contractor. The City will furnish water for filling lines and making tests through existing mains.
- C. The test pressure shall be measured at the point of lowest elevation.
- D. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged.
- E. At intervals during the test the entire route of the pipe line shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided, and the test shall be repeated until satisfactory results are obtained.

3.04 PURGING AND DISINFECTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.7.
- B. The contractor is solely responsible for injecting the chlorine disinfectant into the conduit, monitoring the solution, collecting samples, and performing the water analysis by an approved laboratory.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.1.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.2.

END OF SECTION

SECTION 331114

PVC PIPE FOR WATER DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Polyvinyl Chloride (PVC) Water Pipe For Water Distribution in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.14.

1.02 REFERENCES

- A. AWWA C900, AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100 mm through 1,500 mm) for Water Distribution or latest edition.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.14, 502.4.2, and 502.5

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 331245 – Tapping Sleeves for PVC and Ductile Iron Pipe
- C. Section 331260 – Mechanical Restraint for PVC and Ductile Iron Pipe

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.14.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. Pipe shall be manufactured in the United States of America and shall be blue in color.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 505.1. and 502.4.

3.02 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 502.4 and 506.
- B. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
- C. Water mains twelve inches (12”) and smaller in the right-of-way near storm inlets shall be constructed behind the inlet by pulling the pipe using longitudinal bending in accordance with the manufacturer’s requirements.

- D. The maximum deflection angle of pipe joints shall be restricted to 80% of the manufacturers' recommendation. Otherwise, horizontal bends will be required.
- E. Potable water mains and wastewater mains must be installed in separate trenches.

3.03 HYDROSTATIC TEST

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.5 alternative 3-hour testing in accordance with AWWA C605. Testing pressure is 200 psi.
- B. After the pipe has been laid and backfilled, but prior to replacement of pavement, each valved section of newly laid pipe shall be subjected to a hydrostatic pressure test.
- C. Each valved section of pipe shall be slowly filled with water by means of a pump connected to the pipe in a satisfactory manner.
- D. The pump, pipe connection, and all necessary apparatus including gauges and meters shall be furnished by the Contractor. The City will furnish water for filling lines and making tests through existing mains.
- E. The test pressure shall be measured at the point of lowest elevation.
- F. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at the points of highest elevation and afterwards tightly plugged.
- G. At intervals during the test the entire route of the pipe line shall be inspected to locate any leaks or breaks. Any defective joints, cracked or defective pipe, fittings or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided, and the test shall be repeated until satisfactory results are obtained.

3.04 PURGING AND DISINFECTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.7.
- B. The contractor is solely responsible for injecting the chlorine disinfectant into the conduit, monitoring the solution, collecting samples, and performing the water analysis by an approved laboratory.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.2.

END OF SECTION

SECTION 331213

WATER SERVICE CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Water Service Connections in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.

1.02 REFERENCES

- A. AWWA C800, AWWA Standard for Underground Service Line Valves and Fittings
- B. AWWA C901, Polyethylene Pressure Pipe and Tubing, 1 in. Through 3 in. for Water Service, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10
- D. City of Frisco Standard Detail for Typical Service Connection.

PART 2 - PRODUCTS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.10 and 501.21.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. Water service pipe shall be polyethylene tubing with detectable tracing wire.
- D. Tracing wire shall be 10 AWG Standard with HDPE coating.
- E. Tape for the tracing wire shall be polypropylene.
- F. Service couplings, meter valves and corporation stops shall be “no-lead brass” fittings.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.3.
- B. Tracer wire shall be attached to the polyethylene tubing with two independent, continuous, spiral-wound polypropylene tape layers.
- C. Bullhead services that branch at the end of a service line to serve two or more customers will not be allowed.

3.02 CONSTRUCTION

- A. Service taps shall be made after the mains have been laid.

- B. A tapping saddle shall be used to connect service lines to pipe mains.
- C. The service pipe shall be placed at a minimum depth of twenty-four inches (24") under the finished grade except where the service pipe shall pass under the curb. At this point the service pipe shall be a minimum of twenty-four inches (24") under the top of curb or a minimum of six inches (6") under the bottom of the curb and gutter section, or lime stabilized subgrade whichever is greater.
- D. Excessive bending of the service pipe, which will injure or reduce the cross sectional area of the pipe, will not be permitted.
- E. The length of the service pipe shall extend from the main to a point two feet (2') back of the street curb or to the property line if no curb exists, unless shown otherwise on the plans.
- F. The service pipe shall be continuous with no fittings under paving.
- G. If there is a curb, the curb shall be sawcut with "I" and marked with good quality blue paint at the point where the service pipe passes the curb.
- H. Sand embedment shall be required two feet (2') on either side of the service saddle all the way around the water main.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.3.2.2.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.3.2.2.

END OF SECTION

SECTION 331216

AIR RELEASE VALVES FOR POTABLE WATER SYSTEMS AND WASTEWATER FORCE MAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Air Release Valves For Potable Water Systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3.

1.02 REFERENCES

- A. AWWA C512, AWWA Standard for Air Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service, Latest Revision.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3
- C. City of Frisco's Standard Details for Combination Air Vacuum Valves.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.3.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331217

RESILIENT SEATED GATE VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Resilient Seated Gate Valves for potable water systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2.

1.02 REFERENCES

- A. AWWA C509, AWWA Standard for Resilient Seated Gate Valves for Water Supply Service, Latest Revision.
- B. AWWA C515, AWWA Standard for Reduced Wall, Resilient Seated Gate Valves for Water Supply Service, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2
- D. City of Frisco's Standard Detail for Gate Valves.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.2.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. Valve boxes shall be three (3) piece screw type cast iron of the extension type. The three (3) pieces shall consist of the top section, bottom section and cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.1.
- B. All valve locations shall be marked with a "V" sawcut on the curb or pavement. The "V" shall point to the location of the valve as follows:

Valve in pavement	Upright "V"
Valve outside pavement	Upside Down "V"

- C. Valve boxes over four feet (4') deep shall require extensions. Valve box extensions shall be cast iron. PVC pipe is not allowed.

3.02 HYDROSTATIC TEST

- A. Gate valves shall be tested at a hydrostatic test pressure of 400 psi and shall be guaranteed for 200 psi working pressure.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331218

BUTTERFLY VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Butterfly Valves For Potable Water Systems in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5.

1.02 REFERENCES

- A. AWWA C504, AWWA Standard for Rubber-Seated Butterfly Valves, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5
- C. City of Frisco's Standard Detail for Butterfly Valves.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.5.
- B. Refer to City of Frisco's Approved Material List, Latest Edition.
- C. Butterfly valves shall be Mueller Model Series 3211 or M&H Model Series 4500/1450 or approved equal. Valves shall be Class 250.
- D. Valve boxes shall be three (3) piece screw type cast iron of the extension type. The three (3) pieces shall consist of the top section, bottom section and cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.6.
- B. All valve locations shall be marked with a "V" sawcut on the curb or pavement. The "V" shall point to the location of the valve as follows:

Valve in pavement	Upright "V"
Valve outside pavement	Upside Down "V"

- C. The butterfly valve operator shall face away from the curb line on all installations.
- D. Valve boxes over four feet (4') deep shall require extensions. Valve box extensions shall be cast iron. PVC pipe is not allowed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.6.8.

END OF SECTION

SECTION 331219

FIRE HYDRANTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Fire Hydrants in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.

1.02 REFERENCES

- A. AWWA C502, AWWA Standard for Dry-Barrel Fire Hydrants, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3
- C. City of Frisco's Standard Details for Fire Hydrants.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.
- B. Refer to City of Frisco's Approved Material List.
- C. Hydrant barrel inside diameter shall not be less than 7 1/4".
- D. All hydrants shall be equipped with two (2) hose nozzles and one (1) steamer nozzle. The hose nozzles shall be two and one-half inches (2 1/2") nominal I.D. National Standard Thread. Pumper nozzle shall be four inches (4") nominal I.D. National Standard Thread. All nozzles shall be mechanically attached.
- E. All fire hydrants shall open by turning to the left (counter-clockwise).
- F. All hydrants shall be of the breakable type.
- G. All hydrants shall have a 4 mil epoxy coating on the interior of the shoe.
- H. All hydrant extensions and parts are to be manufacture brand name only. Aftermarket products are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.2.
- B. All hydrants shall be painted with two coats of Tnemec Series 530 Omnithane Aluminum, Silver paint.

- C. The top bonnet, including the lip, and the nozzle caps of all hydrants shall be painted according to the following table:

Size of Main Connected to Fire Hydrant Lead	Color
6"	Aluminum / Silver
8"	True Blue / Safety
12" or larger	Yellow / Safety

- D. Fire hydrants shall be installed so the breakaway point will be no less than four inches (4") and no greater than eight inches (8") above the final grade elevation. If grade adjustments are made during residential or commercial construction, the fire hydrant shall be adjusted by builder to meet breakaway requirements listed previously before obtaining certificate of occupancy.
- E. Fire hydrants shall be located a minimum of two feet (2') and a maximum of six feet (6') from the fire lane or public roadway, based on the location of the sidewalk. The fire hydrant shall not be located in the sidewalk.
- F. All fire hydrants shall be installed so that the steamer connection will face the fire lane or public roadway.
- G. Fire hydrants shall be located no closer than ten feet (10') from the curb return at street or fire lane intersections.
- H. A blue reflector shall be placed just off center of the street or fire lane opposite fire hydrants. At intersections, reflectors shall be placed on both roadways opposite fire hydrant.
- I. Removal and re-installation of 8 year old fire hydrants is not allowed and will have to be replaced with a new fire hydrant.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.3.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.3.3.

END OF SECTION

SECTION 331240

POLYETHYLENE ENCASEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install polyethylene encasement around metal pipe and fittings in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.

1.02 REFERENCES

- A. AWWA C105, AWWA Standard for Polyethylene Encasement for Ductile Iron Pipe Systems.
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.1.
- B. Refer to City of Frisco Approved Materials List, latest Edition.
- C. The polyethylene encasement may be in tube or sheet form and shall have a minimum thickness of 8 mils.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.2.
- B. The polyethylene seams and overlaps shall be wrapped and held in place by 2" wide plastic backed adhesive tape with 2 foot wide overlaps.
- C. The wrap on the barrel of the pipe shall be loose enough to allow the polyethylene encasement to shift with the soil.
- D. The polyethylene encasement shall be installed without breaks, tears or holes.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.4.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.8.4.

SECTION 331245

TAPPING SLEEVES FOR PVC AND DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install tapping sleeves for polyvinyl chloride (PVC) and ductile iron water pipe in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.6.

1.02 REFERENCES

- A. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- B. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.6

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.2.3.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Tapping shall only be allowed if cutting in a tee to the main line is not an option.
- B. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.6.
- C. Size on size taps for twelve inches and smaller will be allowed and shall be installed per all the manufactures recommendations.
- D. Taps must be at least one nominal size smaller than the water main being tapped for connections to water mains larger than twelve inches (12") in diameter.
- E. The minimum size tap allowed on water mains twenty inches (20") and larger shall be six inch (6").
- F. No tapping sleeves allowed on asbestos cement water mains.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.1.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 506.9.2.

END OF SECTION

SECTION 331260

MECHANICAL RESTRAINT FOR PVC AND DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install thrust restraint for polyvinyl chloride (PVC) and ductile iron water pipe in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.2.

1.02 REFERENCES

- A. ANSI/AWWA C110/A21.10, AWWA Standard for Ductile-Iron and Gray-Iron Fittings, Latest Revision.
- B. ANSI/AWWA C111/A21.11, AWWA Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings, Latest Revision.
- C. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.2

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.
- B. Concrete thrust blocks and mechanically restrained joints shall be required to resist thrust forces at all horizontal and vertical bends, tees and other fittings.
- C. Concrete thrust blocking shall be poured against undisturbed earth and will not bear against the backfill or bedding of another utility.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.4.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.4.4.

END OF SECTION

SECTION 332113.01

WATER WELL MOBILIZATION/DEMOBILIZATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work under this section of the specification shall include the establishment of offices and other facilities on the project site and the movement of personnel, construction equipment, and supplies to the project site or to the vicinity of the project site to enable the Contractor to begin work on the other contract items that will be performed by the Contractor. This Item also includes all costs associated with bonding and insurance.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall site the well in accordance with Title 16, Texas Administrative Code, Chapter 76.100, Technical Requirements--Locations and Standards of Completion for Wells.
- B. Contractor shall obtain all permits.
- C. Contractor is responsible for temporary water service during construction.
- D. Equipment:
 - 1. The minimum equipment required consists of:
 - a. Drilling rig, drilling equipment, and associated self-contained fluid circulation equipment.
 - b. Temporary test pump, pump service rig, and equipment capable of setting and operating pumps as specified in these Specifications.
 - c. Tanks and storage bins to contain drilling fluid, drill cuttings, and high solids displacement water sufficient to complete the Work.
 - d. Sedimentation and disposal system including tanks, temporary pipelines, pumps, and associated equipment to treat and dispose of development water and aquifer test discharge water.
 - e. High pressure washer and miscellaneous associated equipment for removing mud and trackable debris from drilling equipment.

3.02 SITE MAINTENANCE AND CLEANUP

- A. Volatile wastes and other potential sources of pollution shall be properly stored in covered metal containers at least 150 feet from the well.

- B. Wastes shall not be buried or burned on the Site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the Site and disposed of in a manner complying with local ordinances and antipollution laws. Waste from spilled oils and material from maintenance activities are specifically prohibited from being disposed of onsite.

3.03 NOISE CONTROL

- A. If the well is within 500 feet of property that is zoned and used as residential, Temporary Sound Walls may be required. If required, they shall meet the following:
 - 1. Sound wall will be required to be in place prior to casing or screen installation or gravel pack or cement grout placement.
 - 2. Wall must be placed within 100 feet of the well and completely shield residential property.
 - 3. Wall to extend vertically a minimum of 16 feet above existing grade and be constructed of 3/4-in thick plywood panels attached to a support frame. The plywood panels will be continuous with no gaps.
 - 4. The side of the panels facing the work will be completely covered with sound attenuation blankets. The blankets will have minimum performance of:
 - a. STC = 30.
 - b. NRC = 0.80.

3.04 EQUIPMENT CLEANING

- A. Downhole tools and equipment that may be positioned directly above borehole or completed well shall arrive onsite free of surface deposits of friable solids; for example, mud, sand, grout, caked on cuttings and cleaned of grease, oils, and other petroleum products. Exception is provided for normal amounts of thread joint compound on drill pipe and tool joints, and normal amounts of lubricating grease on mechanical equipment is allowed.
- B. Clean downhole equipment, tools, and other equipment that may become soiled with petroleum products before resuming work on well.
- C. Remove trackable mud, cuttings, sand, grout and other materials from undercarriage, tires and other surfaces of equipment prior to moving equipment on or across public roads and pathways.
- D. Do not empty, spill, splash, or slosh containerized drilling mud and fluids onto ground surface while moving containers, pipes and equipment.
- E. Cleanup drilling mud, settled solids, and other semi-liquids and solids that spill from, or are emptied from, equipment as it is being moved.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall not be measured as a separate contract Item.

4.02 PAYMENT

- A. The work performed and materials furnished in accordance with this Item will not be paid for directly but will be subsidiary to pertinent Items.

END OF SECTION

SECTION 332113.02

WATER WELL CONDUCTOR CASING AND SANITARY SEAL

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Petroleum Institute (API):
 - a. 5L, Specification for Line Pipe.
 - b. 5CT, Specification for Casing and Tubing.
2. American Water Works Association (AWWA): C206, Standard for Field Welding of Steel Water Pipe.
3. American Welding Society (AWS): AWS B2.1, Specification for Welding Procedure and Performance Qualification.
4. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. A139/A139M, Standard Specification for Electric-Fusion (Arc) Welded Steel Pipe (NPS 4 and Over).

1.02 SUBMITTALS

A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.

B. Required Submittals:

1. Mill-test reports showing chemical composition of steel conductor casing.
2. Cementing Log: The Contractor shall submit two cementing reports provided by the cementing service contractor. The reports must include both graphical and tabular data detailing the cementing process, including cement density, pumping rate, pumping pressure, displacement volumes, and other relevant administrative information.
3. As-built drawings showing details of construction materials, including dimensions and quantities of materials used.

PART 2 - PRODUCTS

2.01 CONDUCTOR CASING

A. Well Capacity up to 75 gpm:

1. The conductor casing shall be minimum 11.75-inch outside diameter (OD) with a minimum wall thickness of 0.333 inch.
 2. The borehole for the conductor casing shall be a minimum of 3 inches larger than the OD of the conductor casing.
- B. Well Capacity Greater than 75 gpm and less than 200 gpm:
1. The conductor casing shall be minimum 13.375-inch outside diameter (OD) with a minimum wall thickness of 0.330 inch.
 2. The borehole for the conductor casing shall be a minimum of 4 inches larger than the OD of the conductor casing.
- C. The conductor casing shall be mild steel meeting the requirements of ASTM A53, Grade B and be factory assembled in not less than 20-ft lengths.
- D. Threaded and Coupled Connection shall be API short round thread casing (STC).
- E. Plain End Casing: The ends of each joint shall be machine beveled perpendicular to the casing axis to ensure the straightness of each assembled section.
- F. All conductor casing material shall be new and unused.
- G. The annular space shall be filled with neat grout cement.

2.02 GROUT

- A. As specified in Section 33 21 13.08, Water Well Grouting.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify City of Frisco Utility Operations Superintendent at least 48 hours prior to installation of conductor casing and sanitary seal and of any anticipated delays as they become apparent.

3.02 WELDING

- A. Weld field joints by qualified welders in accordance with the requirements of AWWA C206 and applicable sections of AWS code.
- B. For non-threaded and coupled casing, field joints shall be properly butt welded during installation.
1. Bevel ends of each casing section to accommodate the welds so outside diameter of weld is equal to or less than outside diameter of casing.
 2. Special care shall be exercised to ensure conductor casing is straight and plumb.

3.03 CONDUCTOR CASING INSTALLATION

- A. When borehole has been completed, install conductor casing. Length of conductor casing shall be a minimum of 40 feet.

B. Centralizer Installation:

1. Steel Guides:

- a. Weld three to conductor casing at 120 degree intervals around casing and at intervals of not more than 20 feet vertically to centralize and hold casing in the proper position until concrete sanitary seal is in place.
- b. Place first set of guides 5 feet from bottom of conductor casing.
- c. Install a minimum of two sets of guides.
- d. Guides shall be 2 feet long, minimum, and extend at least 1 inch from casing wall.

3.04 SANITARY SEAL INSTALLATION

A. Place after conductor casing borehole is advanced and conductor casing is placed in hole.

1. Fill annular space between conductor casing and borehole with grout from bottom of boring to land surface.
2. Place grout in accordance with Section 33 21 13.08, Water Well Grouting.

END OF SECTION

SECTION 332113.03

WATER WELL DRILLING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D422, Standard Test Method for Particle-Size Analysis of Soils.
2. American Petroleum Institute (API):
 - a. 13A, Specification for Drilling-Fluid Materials.
 - b. 13B 1, Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids.
3. International Association of Drilling Contractors (IADC): API Approved Official Daily Drilling Report Form.
4. National Pollutant Discharge Elimination System (NPDES).
5. NSF International (NSF): 60, Drinking Water Treatment Chemicals - Health Effects.

1.02 SUBMITTALS

- A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.
- B. Contractor shall submit copies of all permits and associated permitting information required to complete the Work. Where applicable, Contractor will obtain drilling permits from the appropriate regulatory districts and authorities.
- C. Contractor shall submit a copy of the Texas Water Well Driller's License for the Field Superintendent.
- D. Contractor shall submit copies of licenses for all other personnel working on the Project that possess a designation as a Texas Water Well Driller or Driller's Apprentice.
- E. Contractor shall submit design calculations, signed and sealed by a professional engineer registered in Texas, for selection of screened intervals, gravel pack, and screen slot size. Include drill cuttings sieve analyses and other relevant data.
- F. Contractor shall submit a diagram showing the diameter and depth of all holes.
- G. Contractor shall submit cutting logs with geologic descriptions of all cutting samples from the pilot hole.
- H. Contractor shall submit copies of all required data and as-built construction records required to be submitted to regulatory districts and authorities for well registration.

I. Required Submittals:

1. Daily Drilling Log.
2. Eastman Drift Indicator Log.
3. Calibration test of mechanical drift indicator tool.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable permits, laws, and regulations in disposing of drilling fluids, drill cuttings, and water generated during drilling and well construction. Permits, laws and regulations shall include, but not be limited to, the following:
 - a. The water quality effluent limitations specified in the TPDES Construction General Permit for discharges from construction activities.
 - b. Federal, state, and local laws, regulations, and ordinances related to disposing of materials generated in constructing wells.

PART 2 - PRODUCTS

2.01 DRILLING FLUID

- A. Use new materials in the formation of drilling fluid at each well site. Used drilling fluid materials shall not be reused at subsequent well sites.
- B. Drilling fluid shall be comprised of either a polymer-based “mud” or a bentonite “gel”-based mud. In the case of a “gel”-based mud, the material must be a high-yield, 200-mesh sodium bentonite (Baroid Quik-Gel® or CETCO Super Gel-X®, or equal). A bentonite viscosifier only meeting the requirements of API Standard 13A is considered insufficient for the applications in this Project.
- C. The drilling fluid shall possess such characteristics as are required to adequately condition the walls of the hole to prevent caving of the walls as drilling progresses, and to permit recovery of representative samples of cuttings.
- D. All drilling fluid components and additives shall be NSF 60 approved.
- E. The use of salt or brine as a method of increasing the mud weight during drilling will not be permitted under any circumstances during construction of the well.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify Utility Operations Superintendent at least 5 working days before drilling begins and of anticipated delays when they become apparent.

3.02 DRILLING EQUIPMENT

- A. Provide direct or reverse circulation rotary drilling equipment and accessories required to complete well as specified.

3.03 DRILLING BITS

- A. Drill bits will be of a tri-cone roller-bit type and will not utilize carbide nozzles. The removal of the nozzles is necessary to prevent high velocity fluid from “washing out” the diameter of the pilot hole and degrading the quality of the borehole geophysical logs.

3.04 DRILLING FLUIDS

A. Properties:

1. Contractor shall be responsible for maintaining the quality of the drilling fluid to assure protection of the water bearing formations exposed in the borehole for the purpose of adequately maintaining the walls of the hole in order to prevent caving of the walls as drilling progresses, and to permit recovery of representative samples of cuttings. Mud properties shall be maintained as follows, unless otherwise approved:
 - a. Sand Content: Less than 5 percent.
 - b. Density: Less than 9.0 lb/gal.
 - c. Filtrate: Less than 15 cc.
 - d. Wall Cake: Less than 2/32 inch.

B. Water:

1. Use potable water, with a minimum chlorine residual of 0.5 mg/L, in formulating drilling fluids whether employed alone or in combination with drilling additives.
2. Soda ash is permitted for use to increase pH of the water used to mix drilling fluids.

3.05 CIRCULATION SYSTEM

A. General:

1. System shall minimize recirculation of drill cuttings.
2. Design to facilitate retrieval of representative samples from the discharge with a minimum of recirculation of material.

- B. Include settling tanks of adequate size, a sampling trough, a shaker table, and a desanding/desilting system.

C. Settling Tanks:

1. Vessels used for mixing drilling fluids shall be clean and free of contaminants and extraneous materials prior to their use in drilling operations.
2. Use above ground tanks for mixing, circulation and inclusion of approved additives.

3. Use proper controls to prevent spillage of mud or additives onto ground.

3.06 TEST EQUIPMENT

- A. Drilling fluid test equipment and test procedures shall conform to API 13B 1.
- B. Equipment for measuring fluid properties shall be made immediately available at drill site.
- C. Mechanical Drift Indicator: Furnish and employ self-checking type to measure borehole deflection.
 1. Manufacturer: Eastman Oil Well Survey Company.

3.07 BOREHOLE DRILLING

- A. Before drilling, install temporary or permanent conductor casing needed to stabilize surface material.
- B. Drill wells by direct or reverse circulation rotary method.
- C. Drill boreholes sufficiently straight and plumb to permit installation of casing and screen in the center of the hole.
- D. Borehole Deflection:
 1. Use mechanical drift indicator to measure borehole deflection.
 - a. Calibration test shall be performed by tool manufacturer prior to use of tool on Project.
 2. Conduct mechanical drift indicators at no more than 60 foot intervals.
 3. Deflection:
 - a. The drift from vertical shall be not more than 0.5 degree between any two consecutive surveys, and not more than one degree over the entire length of the well.
 - b. If the test does not meet the above criteria, the Project Developer, at his expense, shall correct the plumbness.
 4. Periodically conduct analysis of drift indicator record and make part of drilling log record.
- E. Prior to conducting geophysical logging, condition borehole to allow free passage of logging tools to bottom and remove excessive filter cake from the borehole wall.
- F. Use of additional bentonite, clay, mud, or other foreign matter that has a tendency to build a mud cake on the walls of the hole and clog or seal up water-bearing stratum will not be permitted.

3.08 PILOT HOLE DRILLING AND SAMPLING

- A. Drill a 5 7/8-inch to 6 7/8 inch diameter test hole to fully penetrate the Paluxy Formation.

- B. Contractor will have representative onsite during drilling to determine exact depth of test hole based on cuttings.
- C. As test holes are advanced, collect representative formation samples at 10 foot intervals.
- D. Collect samples from circulation fluid.
- E. To ensure the most representative formation samples during drilling, the pilot borehole penetration rate shall not exceed the ability of the mud system to condition the mud.

3.09 BOREHOLE REAMING

A. Upper Casing Reamed Hole Diameter and Interval:

- 1. Well Capacity up to 75 gpm; minimum hole diameter: 10 5/8-inch.
- 2. Well Capacity Greater than 75 gpm and less than 200 gpm; minimum hole diameter: 12 1/4-inch.
- 3. Interval extends from land surface to within 50 feet to 100 feet of the top of the Paluxy Formation, as shown in Figure 1.

B. Production Casing Reamed Hole Diameter and Interval:

- 1. Well Capacity up to 75 gpm; minimum hole diameter: 7 7/8-inch.
- 2. Well Capacity Greater than 75 gpm and less than 200 gpm; minimum hole diameter: 8 1/2-inch.
- 3. Interval extends from the base of the upper casing to the lowest production interval in the Paluxy Formation.

C. The borehole diameter for the conductor casing is indicated in Section 33 21 13.02, Casing and Sanitary Seal.

3.10 DRILLER DAILY LOG

A. General:

- 1. Keep driller's log of borehole which carefully and accurately describes the materials penetrated.
- 2. Drilling log shall be available for inspection at Site at all times.

B. Data:

- 1. Include the following:
 - a. Formations encountered from surface to total depth, indicating the depth of each change in formation and including difficulties and unusual conditions met during drilling.
 - b. Drilling rate.

- c. Depth at which water is first encountered.
- d. Other pertinent phenomena observed.
- e. Record of variations in the addition and amount of approved clays or chemical products or water required.
- f. Properties of drilling fluids as described in Article Drilling Fluids and depth at which changes were required.

3.11 SAMPLE COLLECTION

- A. Every 10 feet and at each change in the strata, collect a large, representative sample of the interval or new strata.
- B. Cuttings shall be circulated to surface and discharged into a container of adequate volume to ensure collection of fine formation sediments.
- C. Storage:
 - 1. Store each sample in a cloth sample bag.
 - 2. Label shall include well number, date, time, and depth interval.
 - 3. Sample containers shall be stored in a manner to prevent breakage or loss.

3.12 SIEVE ANALYSIS

- A. The grain size distribution for at least one (1) cuttings sample per screen interval shall be determined by sieve analysis.
- B. Perform sieve analysis in accordance with ASTM C136 and include a table and plot of the cumulative percent of particles retained by each sieve versus particle size.

END OF SECTION

SECTION 332113.04

WATER WELL GEOPHYSICAL LOGGING

PART 1 - GENERAL

1.01 SUBMITTALS

- A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.
- B. Required Submittals:
 - 1. Geophysical logging data for each well.
 - a. Provide two final copies of each log.
 - b. In addition to the paper copies, submit Digital ASCII and .LAS files of geophysical data on a CD-ROM. Should the geophysical logging subcontractor supply electronic log copies using that subcontractor's proprietary log viewer, that software shall also be available on CD-ROM.

1.02 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Geophysical logs shall be performed by a qualified service company experienced in water well logging.
 - 2. Operator shall be knowledgeable in the interpretation of logs, to the degree that they can make decisions regarding the accuracy and validity of the logs and the sensitivity of the instruments, while using a geophysical logging system capable of producing logs in digital format.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 EQUIPMENT

- A. Caliper Logging Features:
 - 1. Minimum of three arms.
 - 2. Capable of indicating borehole diameter up to 24 inches.

3.02 GEOPHYSICAL LOGS

- A. Borehole geophysical logging suite shall include:
 - 1. Spontaneous potential.

2. 16 inch normal and 64-inch normal resistivity (or array induction).
3. Natural gamma ray.
4. Caliper.

B. Presentation:

1. Provide logs at a vertical scale of 50 feet to 1 inch. Horizontal scale shall be appropriate for the range of measured data.
2. Provide logs at two vertical scales: 50 feet to 1 inch and 20 feet to 1 inch. Horizontal scale shall be appropriate for the range of measured data.
3. A guide for log presentations is as follows:
 - a. Logs shall have zero depth at ground level.
 - b. Location with latitude, longitude shall be on log header.
 - c. Run gamma ray back to land surface if mechanically possible.

3.03 GEOPHYSICAL LOGGING

A. General:

1. Notify City of Frisco Utility Operations Superintendent 24 hours prior to time when geophysical survey will be run and of anticipated delays whenever they become apparent.
 2. Perform geophysical logging suite immediately after completion of borehole.
 3. Post processing of logging data shall be performed by geophysical logging subcontractor or specialist.
 4. Instrumentation:
 - a. Resolution and precision of each instrument shall be adequate for the interpretation of the formation properties being studied.
 - b. Calibration standards independent of the logging equipment shall be used.
 - c. Present calibration and quality control information on logs.
 - d. Record each log using an accurate depth measurement.
- B. Immediately upon completion of pilot borehole and before running geophysical logs, cease drilling and circulate fluid for not less than one hour. The borehole shall be conditioned to total depth prior to logging company performing geophysical logs. Drilling mud circulation in borehole shall not stop until logging company is at drilling site.
- C. Record survey response curves to show adequate deflections for evaluation of the penetrated formations.

- D. Each log shall be recorded using a depth measurement that is accurate to within 0.1 foot.
Each log shall include a repeat section at a depth.

END OF SECTION

SECTION 332113.06

WATER WELL CASING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Petroleum Institute (API):
 - a. 5L, Specification for Line Pipe.
 - b. 5CT, Specification for Casing and Tubing.
 - c. RP 5C1, Recommended Practice for Care and Use of Casing and Tubing.
2. American Society of Mechanical Engineers (ASME):
 - a. B31.3, Process Piping.
3. American Welding Society (AWS): AWS B2.1, Specification for Welding Procedure and Performance Qualification.
4. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. A139/A139M, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
 - c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
5. NSF International (NSF): 61, Drinking Water System Components – Health Effects.

1.02 RELATED SECTIONS

A. Section 33 21 13.07, Water Well Screen and Gravel Pack.

1.03 SUBMITTALS

- A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.
- B. Design calculations, signed and sealed by a professional engineer registered in Texas, for selection of casing and screened intervals, gravel pack, and screen slot size. Include drill cuttings sieve analyses and other relevant data. Design shall conform to the requirements in the supplements following “End of Section,” of this Specification, Typical Well Design.
- C. Required Submittals:

1. Mill test reports, showing chemical composition of well casing, if applicable.
2. Welding certifications of welders.
3. Copy of Texas Water Well Drillers and Water Well Pump Installers license.
4. State of Texas Well Report.
5. As-built drawing showing details of construction materials, including dimensions and quantities of materials used.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Welders: Certified in accordance with AWS B2.1 for Level AR 1 or AR 3 and in the 2G and 5G positions or the 6G position.
2. Well Driller Qualifications: Entity constructing well shall be licensed in the State of Texas under 16 Texas Administrative Code, Chapter 76, Water Well Drillers and Water Well Pump Installers.
3. Guarantee well against defective materials and workmanship, and against pumping water in excess of 5 ppm sand for a period of 1 year from date of completion of Project. In the event of defective materials, or workmanship, or of sand pumping, Project Developer to remedy defects at their sole cost and expense.

PART 2 - PRODUCTS

2.01 WELL CASING

- A. All final casing material shall be new and unused.
- B. Threaded and Coupled Connection: Shall be API short round thread.
- C. Plain End Casing: The ends of each joint shall be machine beveled perpendicular to the casing axis to ensure the straightness of each assembled section.
- D. For wells with capacities up to 75 gpm, the well casing shall comply with the requirements in the schedule below:

Interval	Min. Outside Diameter (inches)	Min. Wall Thickness (inches)
Upper Casing	8 5/8	0.264
Production Casing	2 7/8	0.217

- E. For wells with capacities greater than 75 gpm and less than 200 gpm, the well casing shall comply with the requirements in the schedule below:

Interval	Min. Outside Diameter (inches)	Min. Wall Thickness (inches)
Upper Casing	9 5/8	0.312
Production Casing	4	0.226

F. Mild steel casing shall meet the requirements of ASTM A53, Grade B, or API 5L, Grade B. The casing shall be factory assembled in not less than 20-foot lengths. Smaller lengths of 5 and 10 feet shall also be furnished to accommodate the final well design.

G. Well Casing Guides:

1. Materials shall be physically and chemically compatible with the well casing and screens.
2. Casing guides shall be fitted on all casing using Halliburton Company, or equal, centralizers with “bow-spring” straps.
3. Casing centralizers shall meet the requirements of API Specification 10D.
4. Centralizers shall be designed to provide adequate centering of well casing of the diameter and to the depths required for this Project.

PART 3 - EXECUTION

3.01 WELL CONSTRUCTION

- A. Final casing lengths to be selected by a professional engineer registered in Texas. The design to consider the drill cuttings, geophysical logs, and sieve analyses of samples from the pilot hole. Design shall conform to the requirements in the supplements following “End of Section,” of this Specification, Typical Well Design.
- B. The Contractor shall lay casing in order of installation, with heat numbers clearly visible for inspection.
- C. Threaded Connections shall be made in accordance with API RP 5C1.
- D. Welding:
 1. In accordance with the AWS B2.1.
 2. Weld reinforcement shall be as specified by AWS.
 3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
 4. Repair welds to produce a workmanlike appearance, with uniform weld contours and dimensions.
 5. Welding rod or wire shall match the material being welded and be approved by Engineer.

E. Welding Collars:

1. Lap-weld in accordance with AWS welding code to provide a watertight joint.
2. Outside diameter of welds within bevel shall be equal to or less than the outside diameter of collar.

F. Casing:

1. Install well casing/well screen assembly at a sufficient height above the bottom of boring to ensure weight of casing will not be resting on the bottom.
2. Top of casing shall extend about 18 inches above land surface.

G. Centralizers:

1. Extend out a minimum of 1 inch from casing.
2. Place at 60-foot intervals starting 5 feet from the bottom of the string and extending to ground surface.
3. Place at least four equally, spaced around the casing, at each interval in such a manner that interference with grout placement is minimized.

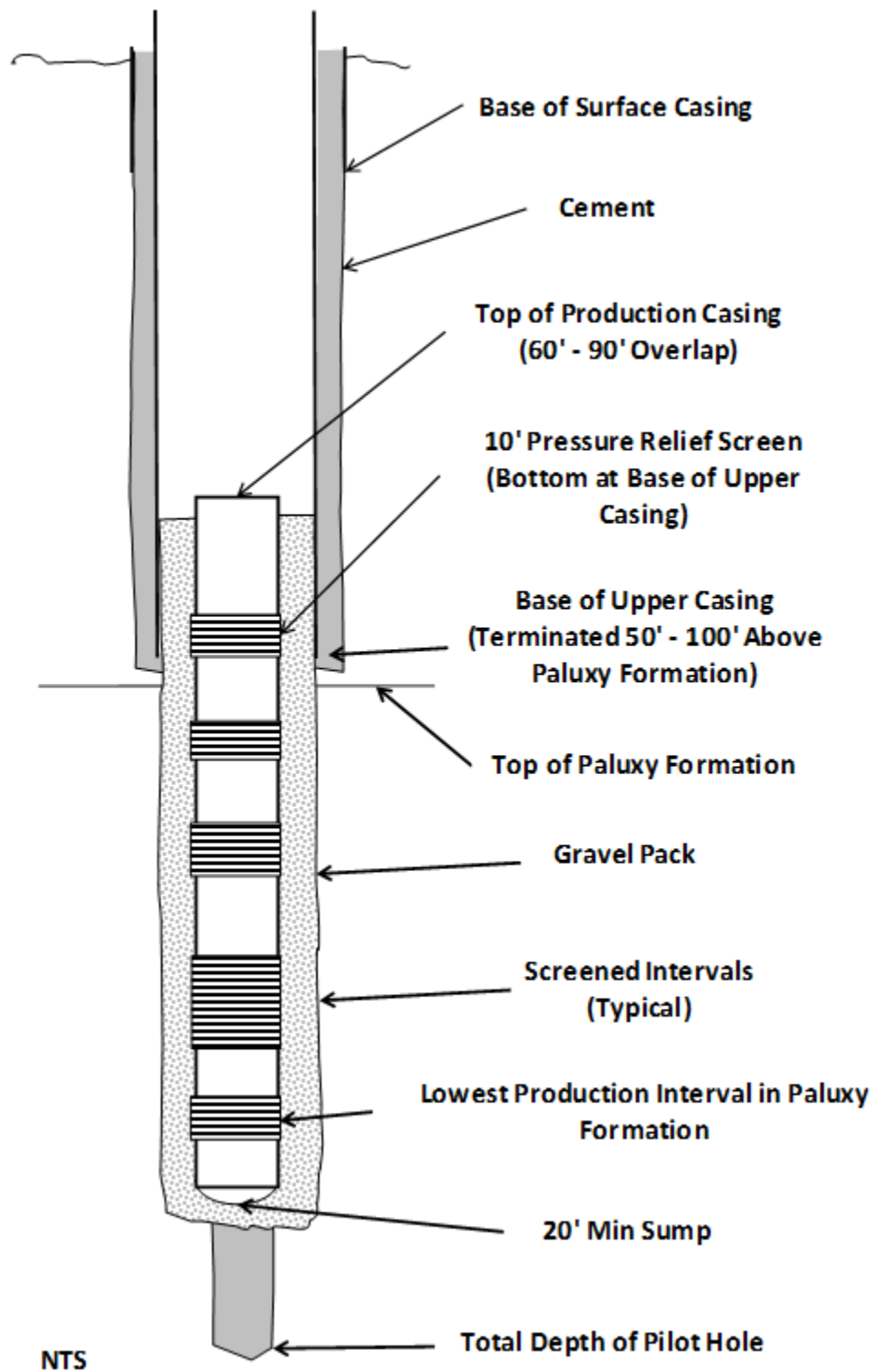
3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification.

1. Typical Well Design.

END OF SECTION

TYPICAL WELL DESIGN



SECTION 332113.07

WATER WELL SCREEN AND GRAVEL PACK

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Petroleum Institute (API):
 - a. 5L, Specification for Line Pipe.
 - b. 5CT, Specification for Casing and Tubing.

B. The following is a list of standards which may be referenced in this section:

1. American Petroleum Institute (API):
 - a. 5L, Specification for Line Pipe.
 - b. 5CT, Specification for Casing and Tubing.
 - c. RP 5C1, Recommended Practice for Care and Use of Casing and Tubing.
2. American Society of Mechanical Engineers (ASME):
 - a. B31.3, Process Piping.
 - b. B31.4, Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids.
 - c. B31.8, Gas Transmission and Distribution Piping Systems.
3. American Water Works Association (AWWA):
 - a. A100-15, Water Wells.
 - b. C654, Disinfection of Wells.
4. American Welding Society (AWS): AWS B2.1, Specification for Welding Procedures and Performance Qualification.
5. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. A139/A139M, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
 - c. A242/A242M, Standard Specification for High-Strength Low-Alloy Structural Steel.

- d. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- 6. International Association of Drilling Contractors (IADC), API-Approved Official Daily Drilling Report Form.
- 7. NSF International (NSF): 61, Drinking Water System Components – Health Effects.

1.02 RELATED SECTIONS

- A. Section 33 21 13.06, Water Well Casing.

1.03 SUBMITTALS

- A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.
- B. Design calculations, signed and sealed by a professional engineer registered in Texas, for selection of casing and screened intervals, gravel pack, and screen slot size. Include drill cuttings sieve analyses and other relevant data. Design shall conform to the requirements in the supplement in Section 33 21 13.06, Water Well Casing, Typical Well Design.
- C. Required Submittals:
 - 1. Welding certifications of welders.
 - 2. Copy of Texas Water Well Drillers and Water Well Pump Installers license.
 - 3. Mill test reports, showing chemical composition of well screen.
 - 4. State of Texas Well Report.
 - 5. As-built drawing showing details of construction materials, including dimensions and quantities of materials used.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Welders shall be certified in accordance with AWS B2.1 for level AR-1 or AR-2, and in the 2G and 5G positions or the 6G position.
 - 2. Entity constructing well shall be licensed in the State of Texas 16 Texas Administrative Code, Chapter 76, Water Well Drillers and Water Well Pump Installers.
 - 3. Guarantee well against defective materials and workmanship, and against pumping water in excess of 5 ppm sand for a period of 1 year from date of completion of Project. In the event of defective materials, or workmanship, or of sand pumping, Contractor is responsible to remedy defects at their sole cost and expense.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Continuous Slot, Wire-Wound Screen:
 - a. Johnson Screens.
 - b. Weatherford—Houston Well Screen.
 - c. Alloy Screen Works.
2. Isolation Connection Coupling:
 - a. Pipeline Seal & Insulator, Houston, TX; PSI ElectroStop.
3. Gravel Pack Material:
 - a. Colorado Silica Sand, Inc. (a subsidiary of Oglebay Norton, Inc.).
 - b. Heart of Texas Sand Inc.

2.02 WELL SCREEN

A. General:

1. Screen will be designed and manufactured to withstand tensile and collapse pressures for installation to a depth up to 2,000 feet below land surface.
2. Equip each section of screen with a welding ring of material to match well screen; plain ends beveled for welding.
3. If stainless steel weld rings are used, connect ends of screen assembly to carbon steel blank casing using a dielectric isolation coupling.

B. Type:

1. Rod-based or Pipe-based, Continuous Slot, Wire-Wound Screen: Design with V-shaped wire to provide maximum inlet area consistent with strength requirements.

C. Material:

1. Mild Steel Perforated Pipe:
 - a. Composition matching ASTM A53/A53M Grade B.
 - b. Material shall be new and unused.
2. Stainless Steel Rod and Wire:
 - a. ASTM A312/A312M, Type 304L or Type 316L.
 - b. Material shall be new and unused.

D. Dimensions:

1. Outside Diameter shall match section of production casing to which it is joined.
 2. Inside Diameter shall match section of production casing to which it is joined.
 3. Section End Wall Thickness shall match section of production casing to which it is joined.
 4. Fabricated Section Lengths shall not be less than 10 feet.
 5. Slot Size and Screen Length:
 - a. Selected by engineer.
 - b. Screen slot size shall be determined in conjunction with gravel pack size. Determination of size shall depend on results of sieve analyses.
 - c. No more than one slot aperture size may be specified over a screened interval.
- E. Threaded and Coupled Connection shall be API short round thread.
- F. Plain Ends:
1. Machined flat perpendicular to axis of casing, with a maximum variance of 0.010 inch at any point from a true plane at right angles to axis of casing.
 2. Plain ends beveled for welding meeting requirements of API 5L, electric resistance welded or seamless pipe.
- G. Welding Collar:
1. Fabrication:
 - a. Thickness to match pipe wall being welded, and 5-inch minimum width.
 - b. Same physical and chemical properties as the corresponding casing section.
 - c. Roll collar to fit outside casing diameter; weld to casing section prior to application of internal coating.
 - d. Grind or scrape the inside edge of collar to remove sharp edges or burrs.
 - e. Bevel end of each collar to accommodate weld such that outside diameter of weld is equal to or less than outside diameter of collar.

2.03 ISOLATION CONNECTION COUPLING

- A. Properties:
1. ASME B31.3, ASME B31.4, ASME B31.8, DIN EN ISO 2505, and DIN 2413.
 2. Tensile Strength: Suitable for the production string.
 3. Boltless type, completely factory assembled, welded or threaded into casing section, with a regular shaped low profile to enhance ease of installation and gravel pack placement.

4. Materials shall match adjoining pipe material.

B. Dimensions:

1. Nominal Size: Match section of well casing to which it is joined.
2. Maximum O. D. of Coupling: Match section of well casing to which it is joined.
3. Wall Thickness shall match mating pipe.
4. Minimum Inside Diameter shall be equal to inside diameter of well casing.

- C. Dielectric Isolation Material: Thermosetting fiberglass epoxy material; NSF 61 approved. Sealing shall be by static, pressure energized “O” ring seals housed in accurately machined grooves, fully protected from cavitation.

- D. Provide each coupling to attach to casing and screen by either welding or threaded ends.

1. If welded ends are used, provide carbon steel end with weld rings identical to and compatible with those specified for well casing joints. Weld rings shall prevent burning of interior coating on coupling and casing during welding.
2. Threads shall be tapered, 8 threads per inch, API or equivalent, and match adjacent coupling.

2.04 CENTRALIZERS

- A. Dimensions: Minimum 2 inches wide and at least 2 feet long.
- B. Extend out at least 2 inches from well screen wall.
- C. Fabricated of same chemical composition and physical properties as material to which they are attached.
- D. Weld-on type to be attached at coupling or blank pipe; welding to screen wire is not permitted.
- E. Manufacturer: Halliburton Company.

2.05 GRAVEL PACK MATERIAL

A. Gravel Pack:

1. Size and gradation of gravel pack to be selected by Project Developer’s engineer based on sieve analyses from cuttings collected while drilling.
2. In accordance with AWWA A100, Section 4.6.
3. Hard, water-worn, at least 90 percent silica, and washed clean of silt, sand, dirt, and foreign matter.

4. Crushed gravel will not be accepted.

PART 3 - EXECUTION

3.01 GENERAL

- A. Final screen length, slot size, and gravel pack gradation to be selected by a professional engineer registered in Texas. The design to consider the drill cuttings, geophysical logs, and sieve analyses of samples from the pilot hole. Design shall conform to the requirements in the supplement in Section 33 21 13.06, Water Well Casing, Typical Well Design.
- B. Notify City of Frisco Utility Operations Superintendent of proposed well completion activities at least 24 hours before activities begin and of anticipated delays when they become apparent.

3.02 WELL SCREEN INSTALLATION

- A. Place bottom of well casing/well screen assembly at a distance above the bottom of the hole to ensure that none of the weight of casing will be supported from the bottom of the hole.
- B. Threaded connections shall be made in accordance with API RP 5C1.
- C. Welding:
 1. In accordance with AWS applicable codes and result in a continuous, strong, and watertight joint.
 2. Gap joints slightly prior to each weld to help facilitate full penetration welds.
 3. Weld Reinforcement: In accordance with AWS code.
 4. Join well screen by a continuous full fillet weld of thickness equal to thickness of coupling. Alignment holes shall be completely filled by welding.
 5. Upon completion of welding, remove weld splatter, flux, slag, and burrs.
 6. Allow welded joints to cure for not less than 20 minutes before weld is placed in contact with water.
 7. Repair welds to produce a workmanlike appearance, with uniform weld contours and dimensions.
- D. Centralizers:
 1. Place at 40-foot intervals starting 5 feet from the bottom of the string and extend to the top of the screened interval.
 2. Place at least four, equally spaced around the screen, at each interval in such a manner that interference with gravel pack placement is minimized.
- E. The weight of the casing shall be supported by the drilling rig until gravel packing of the screen is complete.

- F. If the screen cannot be landed in the correct position, the Contractor shall construct another well immediately adjacent to the original location and complete this well in accordance with these specifications and the final design. The abandoned hole shall be sealed in accordance with all applicable regulations.

3.03 GRAVEL PACK INSTALLATION

A. General:

1. Place gravel pack by tremie method using a tremie pipe set to the depth required for the pack.
2. Support and anchor well casing and screen in such a way as to hold them in place during placement of gravel pack.

B. Disinfect gravel pack according to AWWA C654, Section 4.3.

- C. Control: The top of the gravel pack shall be tagged using the tremie pipe every 20 feet to confirm complete fill of the annular space and avoid bridging.

D. Water:

1. Before gravel pack placement, make adequate preparations for continuous circulation of potable water.
2. Circulate potable water while installing pack.
3. Circulation shall be continuous until pack is fully in place.
4. Project Developer is responsible for temporary water service during construction.

3.04 FIELD QUALITY CONTROL

- A. Well screen that fails, collapses, or separates, shall be repaired or replaced, or a new well drilled.
- B. If the borehole does not take the calculated volume of gravel pack with allowances for normal losses and settling, City will have cause to reject the well.

END OF SECTION

SECTION 332113.08

WATER WELL GROUTING

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. API: Specification 10A, Specification for Cements and Materials for Well Cementing, December 2010.
2. ASTM International (ASTM):
 - a. C150, Standard Specification for Portland Cement.
 - b. C494/C494M, Standard Specifications for Chemical Admixtures for Concrete.
3. AWWA: A100-15, Standard for Water Wells.
4. International Association of Drilling Contractors (IADC): API-Approved Official Daily Drilling Report Form.
5. National Pollutant Discharge Elimination System (NPDES).
6. NSF International (NSF): 61, Drinking Water System Components – Health Effects.

1.02 SUBMITTALS

- A. All submittals shall be delivered to the City of Frisco Utility Operations Superintendent.
- B. Contractor shall submit two cementing reports provided by the cementing service contractor. The reports must include both graphical and tabular data detailing the cementing process, including cement density, pumping rate, pumping pressure, displacement volumes, and other relevant administrative information.
- C. Grout composition for each grout batch for each well.
- D. Calculated volume of the annular space between well casing and reamed borehole.
- E. As-built drawing showing details of construction materials, including dimensions and quantities of grout seal materials used.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable permits, laws, and regulations in disposing of drilling fluids, drill cuttings, and water generated during grouting. The permits, laws and regulations shall include, but not be limited to, the following:

- a. The water quality effluent limitations specified in the project's NPDES Permit.
- b. Federal, state, and local laws, regulations, and ordinances related to disposing of materials generated in constructing wells.

PART 2 - PRODUCTS

2.01 GROUT

- A. Material used in sealing of the surface casing and borehole annular space shall consist of API Class A cement.
- B. Additives may be mixed with the cement to speed setting time or to expand the material. They shall not exceed the following:
 1. Not more than 2 percent, by weight, calcium chloride.
 2. Not more than 6 percent, by weight, bentonite.
- C. The water added per 94 pound sack of cement shall not be more than:
 1. 5.2 gal/sack for zero percent bentonite.
 2. 6.5 gal/sack for 2 percent bentonite.
 3. 7.8 gal/sack for 4 percent bentonite.
 4. 9.1 gal/sack for 6 percent bentonite.

2.02 WATER

- A. Use potable water. Acquisition of suitable water supply is the responsibility of the Contractor.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify City of Frisco Utility Operations Superintendent a minimum of 48 hours prior to placement of grout seal and of anticipated delays when they become apparent.
- B. Calculate volume of annular space between well casing and final borehole prior to placement. Calculated volume shall be reviewed by an Engineer.
- C. In all cementing operations the Contractor must be assisted by a subcontractor familiar with cementing the type of formations expected to be encountered and experienced in using the type of cements and methods typically utilized for the work as specified in these Contract Documents and Technical Specifications. The Contractor will utilize the services of a company such as Halliburton Services, or equivalent, as approved by the Director of Public Works.

3.02 INSTALLATION

A. Grout Placement:

1. Cementing will be done using the Positive Displacement-Internal Method (AWWA 100-15). This method requires cement to be pumped through grout pipe run inside of the casing to the base of casing. The top of the casing is sealed so that cement is forced into the annulus and to land surface.
 2. Following the initial grouting, cement should be brought to land surface using the tremie method.
 3. Cementing by the tremie method shall be continuous for each lift after cementing begins.
- B. No work on the well shall be conducted during the 24-hour period immediately following placement of the grout.
- C. Contain displaced fluids as required by applicable regulatory requirements.

END OF SECTION

SECTION 332113.10

WATER WELL PUMPING TEST

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. AWWA A100-15, Standard for Water Wells.

1.02 SUBMITTALS

A. All submittals shall be delivered to the City of Frisco Utility Operations Superintendent.

B. Required Submittals:

1. Well Efficiency analysis calculations shall be signed and sealed by a professional engineer registered in Texas and will include a summary of all relevant data.
2. Well test water level data. Data should be provided as an electronic data deliverable (EDD) in the form of a Microsoft Excel™ spreadsheet.
3. Water quality analysis test results and Chain of custody documentation.
4. Flow Meter Calibration Sheet: Serial number, model number, gears, test apparatus size, meter reading and flow rate for at least three steps, percent error for each step, tester's name and title.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. The Contractor shall provide an operable pump capable of producing at least 1.25 times the design rate for the well.
- B. An operable pressure transducer/datalogger shall be provided for collection of water-level data during all pumping tests. Transducers shall have adequate length of cable to remain submerged for the duration of the tests. These transducers/dataloggers shall be accurate to 1.0 foot.
- C. The Contractor will provide discharge measurement equipment that is capable of accurately measuring well discharges to at least 1.25 times the design rate for the well. The equipment will include, at a minimum, an in-line flow measurement device (propeller meter or ultrasonic meter) with an in-line meter with 6-digit, straight reading totalizer, registering in units of 100 gallons, together with a rate of flow indicator dial, which reads in units of gallons per minute and is suitable for the expected flow range.
- D. Provide Rossum Sand Tester during development to measure amount of sand produced from well.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify City of Frisco Utility Operations Superintendent at least 48 hours prior to beginning the constant-rate test.
- B. Testing shall not begin prior to 24 hours after completion of well development activities.
- C. Measure static water level prior to start of testing.
- D. Recovery will be considered complete after well has been allowed to rest for a period at least equal to elapsed pumping time of test.
- E. Contractor shall conform to all discharge requirements imposed by the appropriate regulatory agencies.
- F. Required water quality samples shall be collected from the pump discharge after at least 20 hours of pumping during the constant-rate test.

3.02 CONSTANT-RATE TESTING

- A. A constant-rate pump test will be run for the purpose of determining performance characteristics of the production wells. Following a minimum period of 24 hours for well recovery after well development, each production well shall be pumped continuously for 24 hours at a constant discharge rate of at least 1.25 times the design capacity of the well. The selected discharge rate shall be maintained throughout the test plus or minus 5 percent. If the discharge rate is not maintained within 5 percent of the initial rate, the test will be repeated.
 - 1. The constant-discharge test shall include water-level measurements from the pumping well. All water-level measurements shall be recorded using pressure transducer/datalogger devices and manually.
 - 2. During the constant-discharge test, the pumping water level shall be measured based on the schedule presented below. Should the measurements during any portion of the aquifer testing not be made at the times specified, the actual time of each measurement shall be recorded. Upon completion of pumping, recovery measurements shall also be made according to the schedule below.
 - 3. Maximum Recommended Time Intervals for Aquifer Test Water Level Measurements:

Pumping Test Lapsed Time	Data Collection Interval
0 to 2 minutes	Log Scale Readings
2 to 15 minutes	Every minute
15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
120 minutes to 24 hours	Every 30 minutes

- B. The pump will remain in the well for a minimum period of 12 hours after pumping has been terminated to permit accurate measurement of recovery data.

- C. The level of gravel pack in the lap between the upper and production casings will be filled to within 5 feet of the top of the production casing following the final constant-rate test.

3.03 WATER QUALITY SAMPLING

- A. Samples shall be collected, stored, and shipped in accordance with the laboratory's instructions.
- B. Chain of Custody forms shall be completed for all water samples. All persons handling the samples shall be required to sign the Chain of Custody form. Copies forms shall be submitted to City of Frisco Utility Operations Superintendent within ten days of final delivery of the samples to the laboratory.
- C. Analyses:
1. All samples, with the exception of the fecal coliform samples will be collected prior to disinfection.
 2. Where possible, the testing laboratory shall choose an appropriate method to provide a reporting limit at or below the maximum contaminant level.
 3. A list of water quality analytes is listed in the following table:

Analyte	MCL (mg/L)	Preferred Analysis Method
Metals		
Arsenic	0.01	EPA 200.8
Lead	0.015	EPA 200.8
Aluminum	0.2	EPA 200.8
Copper	1	EPA 200.8
Iron	0.3	EPA 200.8
Manganese	0.05	EPA 200.8
Sodium	None	EPA 200.8
Zinc	5	EPA 200.8
Calcium as CaCO ₃	None	EPA 200.8
General Water Chemistry		
Fluoride	4	EPA 300.0
Nitrate	10	EPA 300.0
Nitrite	1	EPA 300.0
Chloride	300	EPA 300.0
pH	≥7.0	SM4500-H+ B
Sulfate	300	EPA 300.0
Total Dissolved Solids	1,000	SM2540C
Alkalinity as CaCO ₃	None	SM2320B

3.04 MINIMUM WELL EFFICIENCY

- A. The efficiency for well completion shall be a minimum of 70 percent. The determination of final well efficiency will be made based on the completion of the 24-hour constant-discharge pumping test using calculated transmissivity and regional storativity values. The straight-line method presented by Cooper and Jacob (1946) will be used with data from the pumping well to compute the theoretical well drawdown. The ratio of the theoretical drawdown at the limits of the reamed hole to the measured drawdown in the pumped well (at 60 minutes) will determine well efficiency.

3.05 FINAL SAND CONTENT

- A. Sand production during well development and testing shall be measured by the Contractor and recorded on test records. Sand production shall be quantified as measured by a Rossum Sand Sampler. Sand production shall not exceed 5 parts per million at the end of the constant-discharge pumping test as per AWWA Standard A100-15.

3.06 TEST FAILURE

- A. In the event that test fails to meet specified duration requirement, or if test is initiated too soon after an aborted test, test will be invalid, and shall require a retest.
- B. Failure of pump operation during test shall require test be aborted and further testing suspended until well recovery is achieved.
- C. Wells tested below 70 percent will be developed and re-tested until the minimum efficiency is achieved.

3.07 WELL TEST DATA

- A. Maintain well test data for each test.
- B. Records shall include pumping rate, water level, drawdown, specific capacity, elevation of gravel pack, sand content, color of discharge water, and all other pertinent information regarding well testing. Each page of the test record shall be signed and dated by a licensed Texas Water Well Driller and Water Well Pump Installer.

3.08 CLEANUP

- A. Remove sand and debris that accumulated in the bottom of well after completion of water level monitoring, and after pump has been removed.
- B. Remove lubricating oil from well.

END OF SECTION

SECTION 332113.12

WATER WELL VIDEO INSPECTION

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Contractor shall submit two DVD copies of the well video log after completion of the log to the City of Frisco Utility Operations Superintendent.

1.02 QUALITY ASSURANCE

- A. Survey Specialist shall have been in the business of conducting well video surveys for a minimum of 5 years.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 GENERAL

- A. Perform color video survey to serve as a final inspection document for the well.
- B. Notify City of Frisco Utility Operations Superintendent a minimum 48 hours prior to performing the video survey and of anticipated delays when they become apparent.
- C. Conduct Video Survey:
 - 1. Following completion of the final well discharge test.
 - 2. After gravel pack level has been verified.
 - 3. After sediment accumulated in well from test pumping has been removed.
 - 4. After fresh water has been introduced from surface to clarify water standing in well.
 - 5. After final disinfection of the well.

3.02 EQUIPMENT

- A. Thoroughly clean and disinfect all equipment and cable that will be placed into the well casing prior to arrival at the location.
- B. Camera Features:
 - 1. Color vertical down-hole and horizontal side-hole viewing capability with centralizers.
 - 2. Horizontal side-hole viewing shall be controllable to allow viewing at angles within a 360-degree rotation.
 - 3. Produce a video with an automatic on-screen depth indication to nearest 0.1 foot.

3.03 VIDEO SURVEY

A. Procedures:

1. Prior to conducting survey, remove test pump and bail well clean of lubricating oil, sediment, and debris; allow to remain idle for at least 24 hours.
2. Prior to and during survey, introduce sufficient quantity of clear water into well to produce clear viewing conditions during survey.
3. Run a dynamic vertical down-hole view video from top of well to the bottom of well at a speed not exceeding 30 feet per minute.

- B. City of Frisco Utility Operations Superintendent, or his designated representative, may, if present, interrupt video camera during the dynamic vertical down-hole view run for periodic static horizontal side-hole viewing.

3.04 FIELD QUALITY CONTROL

- A. If survey fails to produce a clear picture of internal casing condition, introduce clear, potable water and rerun the survey until a clear video is obtained.

B. Defects:

1. Defects noted in the video survey may be cause for rejection of the well. Defects may include:
 - a. Inadequate gravel pack fill.
 - b. Excessive sediment in the bottom of the well.
 - c. Partial collapse of the casing, holes in the casing, or separation of the casing at a joint.
 - d. Incomplete gravel pack envelope in screened intervals.
 - e. Damage to screen wire.

3.05 VIDEO SURVEY DATA

A. Features:

1. Original and copies of survey shall be in DVD format.
2. Beginning and end of video shall contain date and well name.
3. Clearly label exterior of DVD with Project name, date, and well name.

END OF SECTION

SECTION 332113.13

WATER WELL DISINFECTION

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
 - a. 10084, Standard Methods for the Examination of Water and Wastewater.
 - b. A100-15, Water Wells.
 - c. C654, Disinfection of Wells.

1.02 SUBMITTALS

A. Test results for presence of coliform bacteria shall be delivered to the City of Frisco Utility Operations Superintendent.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 GENERAL

- A. Notify City of Frisco Utility Operations Superintendent at least 5 working days before disinfection activities begin and of anticipated delays when they become apparent.
- B. Disinfection will take place immediately after completing the constant-rate discharge test but before removing the test pump.
- C. Sodium Hypochlorite Solution shall be used in accordance with AWWA C654.

3.02 DISINFECTION PROCEDURE

- A. The method of chlorination to be used shall consist of treating the water in each well casing to provide a chlorine residual of approximately 50 mg/L; circulating the chlorinated water within each well casing and pump column; and pumping each well to waste to remove chlorinated water. The quantity of chlorine compounds required to produce a chlorine residual of 50 mg/L may be calculated by multiplying the appropriate quantity shown in ANSI/AWWA C654, Appendix A, Table A.1 by the appropriate factor.

3.03 WELL CAPPING

- A. Upon completion of construction, development, testing, disinfection and bacteriological evaluation, and well video survey, cap well by installation of a minimum 0.375-inch thick plate continuously welded to top of casing at a minimum of 2-feet above grade.

3.04 EVALUATION

- A. The disinfected wells shall be tested for the presence of coliform in accordance with ANSI/AWWA C654 and 30 TAC 290.41 (c) (3) (F).
- B. If bacterial evaluation fails, disinfection and testing shall be repeated until the results indicate a pass. Three passing samples collected on consecutive days are required to pass this evaluation.

END OF SECTION

SECTION 333109

WASTEWATER LATERAL CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Wastewater Lateral Connections in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.

1.02 REFERENCES

- A. ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4
- C. City of Frisco Standard Details for Wastewater Laterals.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.18.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. Wastewater laterals shall be PVC SDR 35 in accordance with ASTM D3034 or PVC SDR 26 in accordance with ASTM D2241.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.
- B. The wastewater lateral shall extend from the wastewater main to the customer's property line. The elevation of the wastewater lateral at the property line shall be at such a depth that will provide for a lateral from the proposed building site with a minimum grade of one percent (1%) and a maximum grade of one and one-half percent (1.5%) from the building site to the property line. A depth in excess of six feet (6') at the property line is not approved.
- C. If there is a curb, the curb shall be sawcut with "II" and marked with good quality green paint at the point where the wastewater lateral passes under the curb.
- D. A standard wastewater lateral connection shall consist of the service wye or tee and necessary fittings.
- E. All residential wastewater laterals shall be extended to a point ten feet (10') from the back of the property line at a maximum depth of four feet (4'). The lateral shall then be extended at a forty-five degree angle to four feet (4') above the finished grade and capped.

- F. Fittings are not permitted on wastewater service laterals between the wye and the property line.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.3.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.10.4.3.

END OF SECTION

SECTION 333110

PVC PIPE FOR GRAVITY WASTEWATER MAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Polyvinyl Chloride (PVC) Pipe For Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17, 505 and 507.

1.02 REFERENCES

- A. ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Latest Revision
- B. ASTM F679 Standard Specification for Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings, Latest Revision
- C. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17, 505 and 507

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 330131 – Wastewater and Manhole Testing
- C. Section 330132 – Television Inspection for Wastewater Mains

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.17.
- B. Refer to City of Frisco's Approved Material List, Latest Edition.
- C. All gravity PVC wastewater pipe shall be green in color.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.
- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit

postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.

- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

SECTION 333115

PRESSURE RATED PVC PIPE FOR GRAVITY WASTEWATER MAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Pressure Rated Polyvinyl Chloride (PVC) Pipe For Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15, 505 and 507.

1.02 REFERENCES

- A. ASTM D2241 Standard Specification for Polyvinyl Chloride (PVC) Pressure Rated Pipe (SDR Series), Latest Revision
- B. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals, Latest Revision
- C. ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15

1.03 RELATED SECTIONS

- A. Section 330510 – Trenching, Backfilling and Compaction
- B. Section 330131 – Wastewater and Manhole Testing
- C. Section 330132 – Television Inspection for Wastewater Mains

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.15.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.

- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.
- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

SECTION 333130

CENTRIFUGALLY CAST FIBERGLASS REINFORCED PIPE FOR GRAVITY WASTEWATER MAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Centrifugally Cast Fiberglass Reinforced Pipe For Gravity Wastewater Mains in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.24, 505 and 507.

1.02 REFERENCES

- A. ASTM D3262 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Sewer Pipe, Latest Revision
- B. ASTM D4161 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals, Latest Revision
- C. ASTM D3840 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
- D. *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 501.24, 505 and 507

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 501.24.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Items 505 and 507.
- B. The construction of all wastewater mains shall begin at the outlet or lower end, unless otherwise directed by the Inspector.
- C. Appurtenances shall be constructed as soon as the wastewater main of which they are a part is constructed to their locations. Upon request by the Contractor, the Inspector may permit postponement of the construction of manholes on wastewater mains, and the Contractor shall, without additional cost to the Owner, lay the pipe continuously through the manhole location.
- D. The construction of appurtenances in advance of construction of the wastewater line will not be permitted.
- E. No connecting wastewater main shall project beyond the inside surface of the wastewater mains or appurtenances.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.1.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 507.6.2.

END OF SECTION

SECTION 333913

WASTEWATER MANHOLE FRAMES AND COVERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Wastewater Manhole Frames and Covers in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3.

1.02 REFERENCES

- A. ASTM A48 Standard Specification for Gray Iron Castings, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3
- C. City of Frisco Standard Details for Manhole Lid and Frame

1.03 RELATED SECTIONS

- A. Section 333914 – Cast-in-Place Concrete Manholes
- B. Section 333915 – Precast Concrete Manholes

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.3.
- B. Refer to City of Frisco's Approved Material List, Latest Edition.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. For sanitary sewers with diameter less than 27 inches, all wastewater manhole frame and covers shall be installed with inflow protection inserts.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 333914

CAST-IN-PLACE CONCRETE MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Cast-In-Place Concrete Manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1

1.03 RELATED SECTIONS

- A. Section 333913 – Wastewater Manhole Frames and Covers
- B. Section 330131 – Wastewater and Manhole Testing

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.1.1.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. A manhole-pipe connection must use water tight, size on size resilient connectors that allow for differential settlement and must conform to ASTM C923.
- D. A manhole located in a roadway or other paved area subject to vehicular traffic must meet or exceed the American Association of State Highways and Transportation Officials standard M-306 for load bearing.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. For fifteen inch (15”) to twenty-seven inch (27”) wastewater mains, the manhole shall have a minimum diameter of five feet (5’).
- C. For wastewater mains larger than twenty-seven inches (27”), the manhole shall have a minimum diameter of six feet (6’).
- D. Manholes deeper than fifteen feet (15’) shall have a minimum diameter of five feet (5’).

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 333915

PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Precast Concrete Manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.

1.02 REFERENCES

- A. ASTM C478 Standard Specification for Precast Reinforced Concrete Manhole Sections, Latest Revision
- B. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1

1.03 RELATED SECTIONS

- A. Section 333913 – Wastewater Manhole Frames and Covers
- B. Section 330131 – Wastewater and Manhole Testing

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.1.1.
- B. Refer to City of Frisco Approved Materials List, Latest Edition.
- C. A manhole-pipe connection must use water tight, size on size resilient connectors that allow for differential settlement and must conform to ASTM C923.
- D. A manhole located in a roadway or other paved area subject to vehicular traffic must meet or exceed the American Association of State Highways and Transportation Officials standard M-306 for load bearing.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. For fifteen inch (15”) to twenty-seven inch (27”) wastewater mains, the manhole shall have a minimum diameter of five feet (5’).
- C. For wastewater mains larger than twenty-seven inches (27”), the manhole shall have a minimum diameter of six feet (6’).
- D. Manholes deeper than fifteen feet (15’) shall have a minimum diameter of five feet (5’).
- E. The exterior of all concrete manholes shall be coated with bituminous waterproofing material.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 333916

FIBERGLASS MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Fiberglass Manholes in accordance with *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.

1.02 REFERENCES

- A. *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1
- B. City of Frisco's Standard Details for Fiberglass Manholes.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.1.2.
- B. Requirements to Item 502.1.1.2.1 are to manufacture the fiberglass manholes as a one piece unit that includes a fiberglass bottom.
- C. Requirements to Item 502.1.1.2.1 are to manufacture the fiberglass manholes with the stub-outs installed at the manufacturing plant.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.4.
- B. Meet all requirements of TCEQ §217.55 Manholes and Related Structures.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

4.02 PAYMENT

- A. Refer to *Public Works Construction Standards*, NCTCOG, 4th Edition, Item 502.1.6.

END OF SECTION

SECTION 334113

REINFORCED CONCRETE PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Concrete Pipe in accordance Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 464.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 403, 420, 464, 467, and 473
- B. Section 330510 Trenching, Backfilling and Compaction
- C. City of Frisco's Standard Detail for Storm Drain Embedment and Backfill.
- D. TxDOT standard details included in the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 464.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT Item 464.3. The *Excavation, Shaping, Bedding, and Backfill* section references TxDOT Item 400. The City of Frisco's Standard Detail for Standard Storm Drain Embedment and Backfill detail shall replace Figure 1 in TxDOT Item 400.
- B. After compaction and subgrade preparation but prior to paving, television inspections tests are required on all storm sewer mains laterals and culverts as identified on the construction plans. The minimum information to be provided to the Owner and City's inspectors, in both text and video form, are line designation, length, slope, and joints. Acceptable video formats are CD and DVD. Any line or lines found to be defective will be corrected and another television inspection shall be performed at the contractor's expense

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 464.4.

4.02 PAYMENT

- A. Refer to TxDOT 464.5.

END OF SECTION

SECTION 334200

REINFORCED BOX CULVERT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Reinforced Box Culverts in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 462.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 403, 420, 421, 440, 462, 464, 466, 467 and 473
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 462.2

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 462.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 462.4.

4.02 PAYMENT

- A. Refer to TxDOT 462.5.

END OF SECTION

SECTION 334913

STORM SEWER MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Storm Sewer Manholes in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-Item 465.

1.02 REFERENCES

- A. TxDOT Items 421, 440, 465, and 471
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)
- B. Section 034105 – Concrete Structures – Precast (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 465.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 465.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 465.4.

4.02 PAYMENT

- A. Refer to TxDOT 465.5.

END OF SECTION

SECTION 334914

HEADWALLS AND WINGWALLS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Headwalls and Wingwalls in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*-TxDOT Item 466.

1.02 REFERENCES

- A. TxDOT Items 420, 421, 430, 432, 440, 464, and 466
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 466.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 466.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 466.4.

4.02 PAYMENT

- A. Refer to TxDOT 466.5.

END OF SECTION

SECTION 334915

SAFETY END TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Safety End Treatment in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* -Item 467.

1.02 REFERENCES

- A. TxDOT 400, 420, 421, 432, 440, 442, 445, 460, 464, and 467
- B. TxDOT Standard Details included in the plans.

1.03 RELATED SECTIONS

- A. Section 033105 – Concrete Structures – Cast-in-Place (TxDOT)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT 467.2.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 467.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 467.4.

4.02 PAYMENT

- A. Refer to TxDOT 467.5.

END OF SECTION

SECTION 334920

STANDARD AND RECESSED CURB INLETS AND OTHER INLETS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Standard and Recessed Curb Inlets and Other Inlets in accordance with Texas Department of Transportation *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges* Item 465.

1.02 REFERENCES

- A. TxDOT Items 400, 402, 420, 424, 464, 467, and 467
- B. City of Frisco's Standard Detail for Standard Storm Drain Embedment and Backfill.
- C. TxDOT standard details included in the plans.

1.03 RELATED SECTIONS

- A. Section 034105 – Concrete Structures – Precast (TxDOT facilities only)
- B. Section 033100 – Concrete Structures – Cast-In-Place (City)

PART 2 - PRODUCTS

2.01 MATERIALS

- A. TxDOT 465.2. is hereby modified from “Precast manholes, inlets, risers, and appurtenances are acceptable unless otherwise shown on plans” to “Precast manholes, inlets, risers, and appurtenances are not acceptable unless otherwise shown on plans.”

PART 3 - EXECUTION

3.01 PREPARATION

- A. Refer to TxDOT 465.3.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT 465.4.

4.02 PAYMENT

- A. Refer to TxDOT 465.5.

END OF SECTION

SECTION 344113

INSTALLATION OF HIGHWAY TRAFFIC SIGNAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install a Traffic Signal in accordance with TxDOT Item 680.

1.02 REFERENCES

- A. TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 260500 – Electric Conductor
- B. Section 260501 – Electric Service
- C. Section 270500 – Conduit
- D. Section 033101 – Drilled Shaft Foundation
- E. Section 344125 – Vehicle and Pedestrian Signal Heads
- F. Section 344130 – Traffic Signal Cable
- G. Section 344135 – Ground Box
- H. Section 347113 – Barricade, Signs, and Traffic Handling

1.04 SUBMITTALS

- A. Shop Drawings for all traffic signal equipment as required by the City (5 copies).
- B. Shop Drawings for street signs (except illuminated signage) (5 copies).

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266.
- B. The Contractor shall furnish and install the pedestal pole and push button station pole assemblies.
- C. The contractor shall furnish and install the APS push button assemblies and signs.

D. All traffic signal mast arm poles, pedestal poles, push button station poles, and APS push button assemblies shall be powder coated. The powder coat paint shall be RAL9017 (TRAFFIC BLACK) or City approved equal.

1. All assemblies that are to be powder coated shall be hot dipped galvanized to ASTM 123 and 153 specifications. Once galvanizing is completed, all exposed surfaces shall be mechanically etched by blast cleaning to remove mill scale, impurities and non-metallic foreign materials. All surfaces visually exposed are to be coated with a urethane or Triglycidyl (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils. The coating shall be electrostatically applied and cured in a gas fired convention oven by heating the steel substrate to between 350 and 400 degrees Fahrenheit.

E. Roadway Illumination Assemblies (TxDOT Item 610):

1. Luminaire ballasts shall be rated for operation at 240 volts.
2. Luminaire lamps for this project shall be LED. The luminaire housings shall be powder coated using RAL 9017 (traffic black) paint or City approved equal. The covers for the luminaries shall be a clear flat-glass insert.
3. When luminaires are to be installed on steel mast arm poles, a separate terminal strip in the signal pole access compartment shall be provided. The terminal strip shall be 4 circuit Buchanan Type 104SN or Kulka Type 985-GP-4 CU or equivalent.
4. Sections of TxDOT standards RID (LUM1) and RID (LUM2) that pertain to High-Pressure Sodium (HPS) specifications are not applicable to this project.
5. The conductors from the service pole to the terminal strip shall be No. 8 XHHW wires. The conductors from the terminal strip to the luminaire shall be No. 12 XHHW wires.

F. City Furnished Material

1. Install NEMA Controller Cabinet Assembly
2. Install Illuminated Street Name Signs
3. Install all Detection and Video Monitoring Equipment
4. Install Opticom Cable
5. Install Opticom Detector
6. Install Opticom Discriminator Module
7. Install count-down ped displays
8. Install signal heads and LEDs
9. Install electrical service pedestal panel
10. Install traffic signal poles
11. Install Ethernet cable for communications equipment
12. Install Ethernet cable for PTZ camera
13. Install LED luminaires

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Items 502, 610, 636, 656, 680, 684, 686, 687, 688, 6006, and 6266.
- B. This project shall consist of furnishing and installing all materials and equipment necessary for a complete signal system at the proposed location. In addition to these Items, the contractor shall be responsible for the following:

1. Furnishing and installing all signs for mounting on signal mast arms, pedestal poles, push button station poles, and existing sign posts. These signs shall be furnished in accordance with TxDOT Item 636 (subsidiary). Signs shall be mounted with ASTRO-SIGN BRAC or SIGNFIX Aluminum Channel or City approved equal. The standard street name signs shall have 12" upper case and 12" lower case lettering with clearview hwy 3w font (unless otherwise shown on the plans). Illuminated street name signs (ILSN) and mounting hardware will be provided by the City. The Contractor shall be responsible for installation of ILSN.
2. During the 30-day test period, the Contractor shall utilize qualified personnel to respond to and diagnose all trouble calls. The Contractor shall repair any malfunctions to signal equipment supplied on the project. A local telephone number (not subject to frequent changes) where trouble calls are to be received on a 24-hour basis shall be provided to the City by the Contractor. The Contractor's response time to reported calls shall be within a reasonable travel time from a Dallas address, but not more than two (2) hours maximum. Appropriate repairs shall be made within 24 hours. The contractor shall keep a record of each trouble call reported in the log book provided by the City. The Contractor shall notify the City of each trouble call. The error log in the malfunction management unit (MMU) shall not be cleared during the 30-day test period without the approval of the City.
3. The existing "stop" signs, shall be removed after the traffic signals are in operation and returned to the City of Frisco as noted.
4. All Opticom Cable, opticom detectors with mounting brackets, and opticom discriminator module will be provided by the City of Frisco. The contractor shall be responsible for installing and making the opticom system operational.
5. The City will furnish the traffic signal controller and cabinet. The contractor shall connect all field wiring to the controller assembly. The City will assist in determining how the detector loop lead-in cables are to be connected (i.e., series or parallel). The City will program the controller for operation, hook up the conflict monitor, detector units, and other equipment in the controller cabinet and turn on the controller. The contractor shall obtain the signal cabinet from the City of Frisco signal shop. When using City supplied controllers, the contractor shall have a qualified technician on the project site to place the traffic signals in operation.
6. All detection equipment including cameras, processor system, set-up system, and detection cable will be provided by the City. The contractor shall be responsible for installing and making the detection operational. The City will set-up detection zones with Contractor's assistance in aiming cameras and radar units.
7. The Contractor shall provide at least 48 hours of notice to the City for pick-up of the City supplied equipment.
8. All nuts installed on the anchor bolts for traffic signal pole assemblies need to be installed using an air impact wrench followed by two impacts from a striker wrench.
9. The Contractor shall install the traffic signal pole and mast arm assemblies furnished by the City.
10. Erection of poles, luminaries and structures located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company and the City prior to beginning such work.
11. No extra compensation will be allowed for fulfilling the requirements stated above.
12. After the traffic signal pole assembly is plumb and all nuts are tight, tack weld each anchor bolt nut in 2 places to its washer. Tack weld each washer to the base plate in 2 places. Never weld components to the bolt. Tack weld in accordance with Item 441, "Steel Structure". After tack welding, repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.5 "Repairs".

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item will be measured on a Lump Sum (LS) basis.
- B. Contractor shall submit a Schedule of Values prior to beginning any work on this project.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit price for "Installation of Highway Traffic Signal." This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete this work.

END OF SECTION

SECTION 344125

VEHICLE AND PEDESTRIAN SIGNAL HEADS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All labor, equipment, tools and superintendence necessary to furnish and install Vehicle and Pedestrian Signal Heads.

1.02 REFERENCES

- A. TxDOT Item 682
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signals

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 682.
- B. City furnished vehicle and pedestrian signal heads, LEDs and backplates. Contractor shall supply the mounting hardware.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 682.
- B. The Contractor shall install all vehicle and pedestrian signal heads, LEDs, and backplates furnished by the City of Frisco.
- C. No exposed cable or wiring will be permitted.
- D. Signal heads mounted on poles and mast arms shall be level and plumb and aimed as directed by the City.
- E. The signal head to mast arm connection must allow for adjustment about the horizontal and vertical axis
- F. All mast arm mounted signal heads shall be turned down and all other signal heads shall be covered with burlap or other material approved by the City until placed into operation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 682.

4.02 PAYMENT

- A. All work performed in accordance with this Item will be paid for at the unit bid price for “Vehicle And Pedestrian Signal Heads,” at the size and type specified. This price is full compensation for all labor, equipment, tools, and superintendence necessary to complete the work.

END OF SECTION

SECTION 344130

TRAFFIC SIGNAL CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install a Traffic Signal Cable.

1.02 REFERENCES

- A. TxDOT Item 684
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 684.
- B. Individual conductors shall be No. 14 AWG.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 684.
- B. The conductors in the Traffic Signal Cable shall be stranded.
- C. Each cable shall be identified as shown on the plans (CABLE 1, etc.) With permanent marking labels (PANDUIT TYPE PLM STANDARD SINGLE MARKER TIE, THOMAS & BETTS TYPE 5512M or equivalent) at each ground box and controller

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 684.

4.02 PAYMENT

- A. Refer to TxDOT Item 684.

END OF SECTION

SECTION 344135

GROUND BOX

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Ground Boxes for Traffic Signals and/or Street Lighting.

1.02 REFERENCES

- A. TxDOT Items 421, 440 and 624
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans and/or Street Lighting Plans.

1.03 RELATED SECTIONS

- A. Section 344113 – Installation of Highway Traffic Signal

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 624.
- B. All ground boxes used for lighting shall have "LIGHTING" and "DANGER-HIGH VOLTAGE" imprinted on the cover.
- C. All ground boxes used for signals shall have "SIGNALS" and "DANGER-HIGH VOLTAGE" imprinted on the cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 624.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a per Each (EA) basis for each Ground Box, complete in place.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Ground Box,” of the size and type specified. This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete the work, including installing the ground box and concrete apron.

END OF SECTION

SECTION 344140

TEMPORARY TRAFFIC SIGNAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish, install, operate, maintain, reconfigure, and remove a Temporary Traffic Signal.

1.02 REFERENCES

- A. TxDOT Items 625, 627, and 681
- B. TxDOT's Standard Details included in the plans.
- C. Traffic Signal Plans

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Items 625, 627, and 681.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 625, 627, and 681.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 681.

4.02 PAYMENT

- A. Refer to TxDOT Item 681.

END OF SECTION

SECTION 344150

SMALL ROADSIDE SIGN SUPPORTS AND ASSEMBLIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Small Roadside Sign Supports and Assemblies.

1.02 REFERENCES

- A. TxDOT Items 421, 440, 441, 442, 445, 634, 636, 643, 644, and 656
- B. City of Frisco and TxDOT's Standard Details included in the plans.
- C. Signing Plans

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Refer to TxDOT Item 644.
- B. The Contractor shall provide field galvanizing and metalizing equipment, per TxDOT Item 445, at all times and shall make repairs to galvanized surfaces according to these specifications at intervals as directed by the City.
- C. Any signs required that are not detailed on the plan sheets shall be in conformance with the most recent Texas MUTCD and the "Standard Highway Sign Designs for Texas."
- D. All small sign assemblies shall be installed as shown in the City of Frisco Standard Detail: "Sign Posts, Stop Signs, and Street Name Signs"
- E. Individual units requiring cleaning shall be washed with an approved cleaning solution to remove all grease, oil, dirt, smears, streaks, debris, and other foreign particles.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to TxDOT Item 644.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Refer to TxDOT Item 644 and as indicated in the Contract Documents.

4.02 PAYMENT

A. Refer to TxDOT Item 644 and as indicated in the Contract Documents.

END OF SECTION

SECTION 347113

BARRICADES, SIGNS, AND TRAFFIC HANDLING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. All material, labor, equipment, tools and superintendence necessary to furnish and install Barricades, Signs, and Traffic Handling in accordance with the Contract Documents.

1.02 REFERENCES

- A. TxDOT Item 502
- B. TxDOT's Standard Details included in the plans.
- C. City of Frisco's General Notes

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All traffic control devices requiring reflective sheeting shall have Type C -high specific intensity sheeting for signs with white backgrounds and Type E -fluorescent prismatic sheeting for signs with orange backgrounds.

PART 3 - EXECUTION

3.01 IMPLEMENTATION

- A. Refer to TxDOT Item 502.
- B. The Traffic Control Plan (TCP) shall be in accordance with the standard plan sheets WZ(BTS-1) & WZ(BTS-2) for signals, and as provided for in the latest edition of *Texas Manual on Uniform Traffic Control Devices for Streets and Highways* (TMUTCD).
- C. Barricades and warning signs, as appropriate, shall be placed at stockpiles to adequately warn motorists. At all stockpile sites that are less than 30 feet from the edge of any traveled lane, a Type III barricade shall be erected immediately in front of or at each end if required by the City. When a stockpile site equals or exceeds 100 feet in length, one object marker (OM-2HP) per 100 feet shall be placed alongside the stockpile.
- D. All traffic control signs shall be clean and legible, and maintained clean and legible throughout the construction phases.
- E. The Contractor shall plan his or her work sequence in a manner that will cause the minimum interference with traffic during construction operations. Before beginning work, the Contractor shall submit, for approval by the City, a plan of construction operations outlining in detail a sequence of work to be followed, setting out the method of handling traffic along, across, and adjacent to work.

- F. If, at any time during construction, the Contractor's proposed plan of operation for handling traffic does not provide for safe, comfortable movement, the Contractor shall immediately change its operations to correct the unsatisfactory condition.
- G. Subject to the approval of the City and in accordance with the plans, portions of this project, which are not affected by or in conflict with the proposed method of handling traffic or utility adjustments, can be constructed during any phase.
- H. During construction, the Contractor shall furnish, place, and maintain vertical panels or drums as indicated in the plans along the edge of pavements and fills in accordance with the latest edition of TMUTCD. The vertical panels shall be supplemented with lights as directed by City.
- I. Barricades and signs shall be placed in such a manner as to not interfere with the sight distance of drivers entering the highway from driveways or side streets. To facilitate shifting, barricades and signs used in lane closures or traffic staging may be erected and mounted on portable supports. The designs of these supports shall be in compliance with current TxDOT and Texas MUTCD standards and are subject to the approval of the City.
- J. The Contractor shall provide and maintain flaggers at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and contractor's personnel, and as shown on the plans or as directed by the city. These flaggers shall be located at each end of the lane closure and shall be properly attired. The two flaggers shall be in two-way radio contact with each other at all times.
- K. The Contractor will not be permitted to commence work on the road before sunrise and shall arrange his work so that no machinery or equipment shall be closer than 30 feet to the traveled roadway after sunset except as authorized by the City. The Contractor must comply with the City's Noise Ordinance at all times.
- L. The Contractor shall keep traveled surfaces used in his hauling operation clear and free of dirt or other material.
- M. The use of rubber-tired equipment, licensed for operation on public highways, will be required for moving dirt and other materials along or across paved surfaces.
- N. Where the Contractor desires to move any equipment not licensed for operation on public highways on or across any pavement, the Contractor shall protect the pavement from all damage as directed by the City.
- O. No lane closures will be allowed prior to 9:00 a.m. or after 3:30 p.m., Monday through Friday unless otherwise directed by the City.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. This Item shall be measured on a Lump Sum (LS) basis or on a Monthly (MO) basis as indicated in the Contract Documents.

4.02 PAYMENT

- A. All work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for “Barricades, Signs, and Traffic Handling.” This price is full compensation for all material, labor, equipment, tools and superintendence necessary to complete all work including, but not limited to, signage, barricades, flagmen, temporary pavement markers and markings, detours, and temporary pavement.

END OF SECTION

SECTION 444256.03

VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A536, Standard Specification for Ductile Iron Castings.
 - c. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
2. Hydraulic Institute Standards (HIS):
 - a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
 - b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
4. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. All required submittals shall be directed to the City of Frisco Utility Operations Superintendent.

B. Required Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
4. Power and control wiring diagrams, including terminals and numbers.
5. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
6. Special shipping, storage and protection, and handling instructions.
7. Manufacturer's printed installation instructions.
8. Factory Performance Test Reports, as required.

9. Suggested spare parts list to maintain equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and maintenance data.
12. Manufacturer's Certificate of Proper Installation.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption shall comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 ACCESSORIES

- A. Equipment Identification Plate shall be 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs are required for equipment weighing over 100 pounds.

2.03 FACTORY FINISHING

- A. Prepare and prime and finish coat in accordance with Manufacturer's standard baked enamel finish.

2.04 SOURCE QUALITY CONTROL

- A. Factory Test Report shall include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.
- B. Performance Test:
 1. Required for pumps with motor greater than 75 horsepower.
 2. Conduct on each pump at rated speed.
 3. Perform under simulated operating conditions.
 4. Test for a continuous 3-hour period without malfunction.
 5. Test Log: Record the following:
 - a. Total head.
 - b. Capacity.
 - c. Horsepower requirements.
 - d. Flow measured by factory instrumentation and storage volumes.

- e. Average distance from suction well water surface to pump discharge centerline for duration of test.
 - f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
 - g. Calculated velocity head at the discharge flange.
 - h. Bowl head.
 - i. Driving motor voltage and amperage measured for each phase.
 - 6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards, if necessary.
- C. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
- D. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

3.02 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Testing and completion of Manufacturer's Certificate of Proper Installation.

3.03 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
 - 1. Pump Data Sheet.

END OF SECTION

VERTICAL TURBINE PUMP DATA SHEET

Manufacturers and Product: (1) Flowserve Worthington
(2) ITT Goulds Pumps
(2) National Pump Company
(3) Sulzer Johnston

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Raw groundwater
Pumping Temperature (Fahrenheit): Max 92
pH: 8.0 – 9.0
Abrasive (Y/N) Y Caused by: Sand
Total suspended solids (mg/L) < 5
Location: Indoor (Y/N): N Outdoor (Y/N): Y

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: As specified by Project Developer
Total Dynamic Head (Ft): Rated: As specified by Project Developer
BHP at Rated Point: As specified by Project Developer
Min. Pump Hydraulic Efficiency at Rated Capacity (%): 68
Max. Pump Speed at Rated Capacity (rpm): 3,500
Constant (Y/N): Y
Adjustable (Y/N): N

DESIGN AND MATERIALS

Pump Type: Open Line Shaft (Y/N) Y
Bowl: 316 St. Steel CF-8M Bowl Wear Rings: 316 St. Steel
Bowl Bearings: Carbon (Babbit Filled)
Column: ASTM A53, Grade B, coated steel, threaded and coupled pipe, sized for less than 6 ft/sec flow velocity at design rate
Impeller:
Type: Enclosed
Material: 316 St. Steel CF-8M
Impeller Wear Rings: 316 St. Steel

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: as specified by Project Developer Voltage: 460 Phase: 3
Synchronous Speed (rpm): 3,500
Service Factor: 1.1

NOTES:

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.
Pump head shall be continuously rising with decreasing flow on pump curve.



AM
APPROVED MATERIALS LIST

City of Frisco
Approved Materials List for Roadway
Contact: David Chacon (972) 292-5875

BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES
Detectable Warning Device	ADA Ramp	Pavestone	ADA Compliant Truncated Dome Pavers		
Detectable Warning Device	ADA Ramp	Tekway,	High Performance ADA Domes Modified Running Bond Pattern		Brick Pattern
Geogrid Materials for use with Flex Base	Type II	Various	http://ftp.dot.state.tx.us/pub/txdot-info/cmd/mpl/gridber.pdf	Section 321116	
Joint Sealers	Class 3	Various	http://ftp.dot.state.tx.us/pub/txdot-info/cmd/mpl/jtsealrs.pdf	Section 321373	

City of Frisco
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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Air Valves		Manufacturer				
Combination Air Valves	Distribution/ Transmission	Vent-O-Mat	RBX Series	NCTCOG 502.6.3		NSF
Combination Air Valves	Distribution/ Transmission	International Valve Marketing		NCTCOG 502.6.3		
Combination Air Valves	Force Mains	Vent-O-Mat	RGX Series	NCTCOG 502.6.3		
Combination Air Valves	Force Mains	International Valve Marketing		NCTCOG 502.6.3		
Angle Meter Valve		Manufacturer				
Angle Meter Valve	1"	Ford	BA43-444W-G-NL		Comp x Meter Tail or FL	
Angle Meter Valve	2"	Ford	FV43-777W-G-NL		Comp x Meter Tail or FL	
Angle Meter Valve	1"	Cambridge	210NL-GJ4T4		Comp x Meter Tail or FL	
Angle Meter Valve	2"	Cambridge	210NL-GJ7MF7		Comp x FL	
Angle Meter Valve	1" to 2"	A.Y. McDonald	74602BG		Comp x Meter Tail or FL	
Automatic Flush Device		Manufacturer				
Eclipse		Kupferle Foundry	9800WC - Eclipse Warm Climate			

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Casing Spacers		Manufacturer				
Raci Spacers		Raci North America a JR Group Company	Various		Center/ Restrained	
PSI Model S		Pipeline Seal and Insulator, Inc.	S8G2, S8GN2, S12G2, S12GN2		Center/ Restrained	
Cleanouts		Manufacturer				
Cleanout Castings		Bass & Hays	Pattern No. 339			
Cleanout Castings		Dallas Foundry	No. 349			
Cleanout Castings		Trinity Valley Iron & Steel	No. 1684			
Corporation Stop		Manufacturer				
Plug Type	1"	Ford	F1000-4	AWWA C800	AWWA Taper x Grip Comp	
Plug Type	1"	Cambridge	302NL-A4GJ4	AWWA C800	AWWA Taper x Grip Comp	
Plug Type	1" or 2"	A.Y. McDonald	74701G	AWWA C800	AWWA Taper x Grip Comp	
Ball Type	1"	Ford	FB1000-4-G-NL	AWWA C800	AWWA Taper x Grip Comp	
Ball Type	2"	Ford	FB1000-7-G-NL	AWWA C800	AWWA Taper x Grip Comp	

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Ball Type	1"	Cambridge	301NL-A4GJ4	AWWA C800	AWWA Taper x Grip Comp	
Ball Type	2"	Cambridge	301NL-A7GJ7	AWWA C800	AWWA Taper x Grip Comp	
Ball Type	1" or 2"	A.Y. McDonald	74701BG	AWWA C800	AWWA Taper x Grip Comp	
Fire Hydrants		Manufacturer				
Fire Hydrant		American Flow Control	5 1/4" Waterous Pacer	AWWA C502	Rain cap Required	NSF
Fire Hydrant		American Flow Control	5 1/4" American Darling B-84-B-5	AWWA C502	Rain cap Required	NSF
Fire Hydrant Paint (Entire Hydrant)	All Main Sizes	Tnemec	Series V530 Omnithane		Aluminum	
Fire Hydrant Paint (Top bonnett, lip and nozzle caps)	6" Main Size	Tnemec	Series V530 Omnithane		Aluminum	
Fire Hydrant Paint (Top bonnett, lip and nozzle caps)	8" Main Size	Tnemec	Series 2H		True Blue / Safety	
Fire Hydrant Paint (Top bonnett, lip and nozzle caps)	12" and Larger Main Size	Tnemec	Series 2H		Yellow / Safety	
Fire Hydrant Extension		Manufacturer				
Fire Hydrant Extension		Match Hydrant Manufacturer			Breakaway coupler shall be located per manufacturer recommendation	

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Fire Hydrant Reflector		Manufacturer				
Fire Hydrant Reflector		Stimsonite	C88-AB		Blue	
Fittings		Manufacturer				
Ductile Iron Fittings		American, U.S. Pipe, Tyler Pipe, Star Pipe Products, SIP Industries	Full Body or Compact	AWWA C110/ AWWA C153	Distribution/ Transmission	NSF
Manhole Appurt.		Manufacturer				
Manhole Ring and Cover	30" Opening Wastewater	ej	00149595A01		With Logo	
Manhole Ring and Cover	30" Opening Wastewater	ej	00147925W01	ASTM 48	Watertight- Bass and Hays is master distributor in DFW area	
Manhole Ring and Cover	30" Opening Wastewater	Neenah Foundry	NF-1931T20	ASTM A-48	WH FRISCO LOGO CLASS 35B GRAY IRON	
Manhole Ring and Cover	30" Opening Wastewater	Neenah Foundry	NF-1931T19	ASTM A-48	WH FRISCO LOGO CLASS 35B GRAY IRON BOLTED LID	
Manhole Ring and Cover	30" Opening Wastewater	SIP Industries	2283	ASTM A-48	With Logo	
Manhole Ring and Cover	30" Opening Wastewater	SIP Industries	2283WT	ASTM A-48	With Logo	
Manhole Cover	30" Opening Wastewater	SIGMA CORP.	15001FN-35	ASTM A-48	With Logo	

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Manhole Ring and Cover	30" Opening Wastewater	SIGMA CORP.	1671FN-35	ASTM A-48	WH FRISCO LOGO CLASS 35B GRAY IRON BOLTED LID	
Manhole Ring	30" Opening Wastewater	SIGMA CORP.	16602-35	ASTM A-48	INCLUDE GROOVE	
Manhole Reversible Ring	30" Opening	SIP Industries	VM19 32		32 Inch Reversible Ring Only	
Manhole Cover	30" Opening (Storm water)	SIP Industries	2283STMC		32 Inch Cover only Bass Fish Logo (Storm Sewer MH)	
Manhole Ring and Cover	24" Opening (Storm water)	Bass and Hays	BH400-24		Bass Fish Logo (Storm Sewer MH)	
Manhole Ring and Cover	24" Opening (Storm water)	SIP Industries	2294		Bass Fish Logo (Storm Sewer MH)	
Manhole Ring and Cover	24" Opening (Storm water)	SIGMA CORP.	140TB-35		Bass Fish Logo (Storm Sewer MH)	
Manhole Ring and Cover	18" Opening (Storm water)	Bass and Hays	BH 184L		Bass Fish Logo (Storm Sewer Inlet)	
Manhole Ring and Cover	18" Opening (Storm water)	SIP Industries	19CFSTRC		Bass Fish Logo (Storm Sewer Inlet)	
Manhole Ring and Cover	18" Opening (Storm water)	SIGMA CORP.	171B-35		Bass Fish Logo (Storm Sewer Inlet)	
Manhole to Pipe Connectors	6" to 15"	Trelleborg	Kor-N-Seal I 106/406 Series	ASTM C923	Precast Manholes	

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Manhole to Pipe Connectors	18" to 48"	Trelleborg	Kor-N-Seal II 206 Series	ASTM C923	Precast Manholes	
Manhole to Pipe Connectors	8" to 48"	A-LOK Products	A-LOK Premium	ASTM C923	Precast Manholes	
Manhole to Pipe Connectors	8" to 48"	A-LOK Products	A-LOK Fiberglass Field Sleeve	ASTM C923	Cast-In-Place Manholes	
Manhole Waterproofing Material	16 mils	Carboline	Bitumastic 300M	AWWA C210	Precast / Cast-In-Place	
Odor Control Material		Manufacturer				
Odor Control Cannister	1850 Odor Control Sewer Valve	Wager Company	1800- Odor Control		for Goose Neck Vents	
Pipe Material		Manufacturer				
Ductile Iron Pipe	16" to 48"	American, U.S. Pipe, McWane	Pressure Class 150, 250, 300, 350	AWWA C151	Distribution/ Transmission	NSF
PVC Pipe	6" to 30"	Various Manufacturers	DR-14, DR-18	AWWA C900 AWWA C905	Distribution/ Transmission	NSF
PVC Pipe	6" to 15"	Various Manufacturers	SDR 26 (PS 115) SDR 35 (PS 46)	ASTM D3034	Non-pressure Wastewater	
PVC Pipe	18" to 48"	Various Manufacturers	PS 115	ASTM F679	Non-pressure Wastewater	
PVC Pipe	6" to 12"	Various Manufacturers	SDR 26 (Pressure rated 160 psi)	ASTM D2241	Pressure Wastewater; Green in Color	
PVC Pipe	16" to 42"	Various Manufacturers	DR-25	AWWA C905	Pressure Wastewater; Green in Color	

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Fiberglass Pipe	18" to 72"	Hobas, Flowtite, Future	PS 46	ASTM D3262	Non-pressure Wastewater	
Polywrap		Manufacturer				
Polyethylene Encasement	Ductile Iron Pipe and Fittings	Various Manufacturers	8 mils	AWWA C105		
Adhesive Tape	2" Wide	Polyken	Scotchrap No. 50			
Retainer Glands		Manufacturer				
Retainer Glands	For MJ DI Pipe Up to 36"	Uni-Flange	Series 1400-D	AWWA C600 NCTCOG 502.4		
Retainer Glands	For MJ DI Pipe Up to 36"	Star Pipe Products	Star Grip Series 3000	AWWA C600 NCTCOG 502.4		
Retainer Glands	For MJ DI Pipe Up to 48"	Ebba Iron	Megalug Series 1100, 1100SD	AWWA C600 NCTCOG 502.4		
Retainer Glands	For MJ DI Pipe Up to 48"	SIP Industries	EZ GRIP	AWWA C600 NCTCOG 502.4		
Retainer Glands	For MJ PVC Pipe Up to 24"	Uni-Flange	Series 1500, 1500-C	AWWA C600 NCTCOG 502.4		
Retainer Glands	For MJ PVC Pipe Up to 24"	Ebba Iron	Megalug Series 2000PV	NCTCOG 502.4		
Retainer Glands	For MJ PVC Pipe Up to 36"	Star Pipe Products	Star Grip Series 4000			
Retainer Glands	For MJ PVC Pipe Up to 36"	SIP Industries	EZ GRIP	NCTCOG 502.4		

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Retainer Glands	For MJ Valves and fittings	infactcorp	Foster Adaptor 3" to 36"			
Reclaimed Water Meter		Manufacturer				
	1"-6"	Neptune (sole source)			No Lead	
Reclaimed Water Meter Boxes		Manufacturer				
Water Meter Box	1"	DFW Plastics	DFW36C-12-5BA		purple	
Water Meter Box	1 1/2" or 2"	DFW Plastics	DFW1730F-18-5BA		purple	
Service Saddles		Manufacturer				
Service Saddle	3/4" to 2"	Ford	Style 202B		Brass with double bronze straps	
Service Saddle	3/4" to 2"	Cambridge	Series 810		Brass with double bronze straps	
Service Saddle	3/4" to 2"	A.Y. McDonald	Model #3825		Brass with double bronze straps	
Service Saddle	2"	Ford	Model S40-204		For use on Meter Vault Bypass only	
Tapping Sleeve		Manufacturer				
Tapping Sleeve	For DI, CI, PVC Up to 24"	Mueller	Model #H-615	AWWA C600	Gray or DI, Full Bodied	NSF
Tapping Sleeve	For DI Up to 36"	American	Series 2800	AWWA C600	DI Full Bodied	NSF

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Tapping Sleeve	For CI or DI 14" to 36"	American	Series 1004	AWWA C600	DI Full Bodied	NSF
Tapping Sleeve	For DI, CI, PVC Up to 36"	U.S. Pipe	T-9	AWWA C600	DI Full Bodied	NSF
Tapping Sleeve	20" and Larger	Smith-Blair	Style 623	AWWA C600	Stainless Steel	NSF
Valves		Manufacturer				
Gate Valve (Distribution)	6" to 12" 150 psi test	Mueller	2360 Series	AWWA C509	Reclaimed Water System Valve shall turn clockwise to open	NSF
Gate Valve (Distribution)	16" to 24" 150 psi test	M&H	Style 4067	AWWA C509	Reclaimed Water System Valve shall turn clockwise to open	NSF
Gate Valve (Distribution)	6" to 16" 150 psi test	M&H	Style 7571	AWWA C515	Reclaimed Water System Valve shall turn clockwise to open	NSF
Gate Valve (Distribution)	6" to 24" 150 psi test	American Flow Control	Series 2500	AWWA C509	Reclaimed Water System Valve shall turn clockwise to open	NSF
Butterfly Valve (Distribution/Transmisson)	16" to 48"	Mueller	3211 Series	AWWA C504	Reclaimed Water System Valve shall turn clockwise to open	NSF
Butterfly Valve (Distribution/Transmisson)	16"to 24"	M&H	Style 4500	AWWA C504	Reclaimed Water System Valve shall turn clockwise to open	NSF

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Butterfly Valve (Distribution/Transmission)	30" to 48"	M&H	Style 1450	AWWA C504	Reclaimed Water System Valve shall turn clockwise to open	NSF
Plug Valve (Eccentric)	4" to 24"	M&H	Style 1820	AWWA C504 AWWA C505		NSF
Valve Stack		Manufacturer				
Valve Stack	3 piece screw type	Tyler Union, PROSELECT, Star Pipe Products	Tyler Union 30U 6850, PROSELECT PSVBxxxSW, Star Pipe VB-0001		2 Piece Screw types with lid to make 3 Piece	
Valve Box Insert		Manufacturer				
Valve Box Insert		Parsons Environmental	Valve Box Insert	ASTM D1248	5 1/4" SRC	
Water Meter AMR Lids		Manufacturer				
	18" x 18"	DFW Plastics	DFW18 AMR -1SF 6540 FRICO LID	ASTM C857-95		
	28" x 18"	DFW Plastics	DFW20G-1BT-LID	ASTM C857-95		
Water Meter Vaults & Internals		Manufacturer				
Domestic Meter Vault	3" to 6" Meter	Park Environmental Equipment Co.	Precast Concrete		Galvanized Steel Hatchway (Bolt Down & Traffic Rated)	
Domestic Meter Vault	3" to 6" Meter	FORTERRA	Precast Concrete		Galvanized Steel Hatchway (Bolt Down & Traffic Rated)	

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Double Detector Check Fire Meter Vault	4" to 10" Meter	Park Environmental Equipment Co.	Precast Concrete		Aluminum Hatchway	
Double Detector Check Fire Meter Vault	4" to 10" Meter	FORTERRA	Precast Concrete		Aluminum Hatchway	
By Pass	2"		Brass		For Water Meter Vault	
By Pass	4"		Ductile Iron		For Water Meter Vault	
By Pass Flange	2"	Ford	RF-21-NL		Brass Flange for 2" By Pass	
Water Meter Strainer	3",4",6"	Neptune (sole source)			See Water Meter Couplings	
Service Saddle	1"	Ford	S70-204		For use on Brass Bypass only	
Service Saddle	1"	Ford	F202B-750-CC4		For use on Ductile Iron Bypass only	
Flanged Coupling Adapter	3" to 6" Meter	Smith-Blair	Model 912			
Flanged Coupling Adapter	3" to 6" Meter	PowerSeal	Model 3521			

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BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Water Meter Boxes		Manufacturer				
Water Meter Boxes	1"	DFW Plastics	DFW-1814F-1SF6450 FRISCO			
Water Meter Boxes	1-1/2" to 2"	DFW Plastics	DFW-2818-1BT			
Water Meter Boxes	1"	DFW Plastics	DFW-37C-KSBSM		Reclaimed only (Purple)	
Water Meter Boxes	1-1/2" to 2"	DFW Plastics	D1730 -18-KSBSM		Reclaimed only (Purple)	
Water Services		Manufacturer				
Pipe Inserts	1"	Ford (Sole Source)	Insert -52			
Pipe Inserts	2"	Ford (Sole Source)	Insert -55			
HDPE Water Service Pipe	3/4" to 2"	Endot Industries	EndoTrace	AWWA C901 ASTM D2239	Blue with Tracer wire	NSF

City of Frisco
Approved Materials List for Grass in Detention Ponds, Swales, Bioretention Areas
Darell Bagley (972) 292-5352

Grass/Turf			
Common Name	Scientific Name	Acceptable Form	Remarks
Prairie Cordgrass	<i>Spartina pectinata</i>	Container/ seed	Bottom
Bushy bluestem	<i>Andropogon glomeratus</i>	Container/ seed	Bottom
Crowfoot Caric Sedge	<i>Carex crus-corvi</i>	Container/ seed	Bottom
Eastern Gramagrass	<i>Tripsacum dactyloides</i>	Container/ seed	Bottom
Lowland Switchgrass	<i>Panicum virgatum L.</i>	Container/ seed	Bottom
Alamo Switchgrass	<i>Panicum virgatum 'Alamo'</i>	Container/ seed	Bottom
Lometa Indiangrass	<i>Sorghastrum nutans 'Lometa'</i>	Container/ seed	Slope
Earl Big Bluestem	<i>Andropogon gerardii 'Earl'</i>	Container/ seed	Slope
Little Bluestem	<i>Schizachyrium scoparium</i>	Container/ seed	Slope
Canada Wildrye	<i>Elymus canadensis</i>	Container/ seed	Slope
Spring Obedient Plant	<i>Physostegia intermedia</i>	Container/ seed	Slope
Maximilian Sunflower	<i>Helianthus maximiliana</i>	Container/ seed	Slope
Halberd-leaf Hibiscus	<i>Hibiscus laevis</i>	Container/ seed	Slope
Haskell Sideoats Grama	<i>Bouteloua curtipendula</i>	Container/ seed	Slope

City of Frisco
Approved Materials List for Grass in Medians and Parkways
Ricardo Sanchez (972) 292-6526

Grass/Turf			
Common Name	Scientific Name	Acceptable Form	Remarks
Buffalograss	<i>Bouteloua dactyloides</i>	Sod	Native (Median Only)
Bermudagrass	<i>Cynodon dactylon</i>	Sod or hydromulch	Adapted (Parkway Only)

City of Frisco
Approved Materials List for Trees in Medians and Parkways
Ricardo Sanchez (972) 292-6526

TREES (LARGE SHADE)

Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
Oak, Chinquapin	<i>Quercus muehlenbergii</i>	See Plans	80' h 80' w	Native

TREES (MEDIUM SHADE)

Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
Bald Cypress	<i>Taxodium distichum</i>	See Plans	80' h 50' w	Native
Elm, Cedar	<i>Ulmus crassifolia</i>	See Plans	90' h 80' w	Native

TREES (SMALL ORNAMENTAL)

Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
Desert Willow	<i>Chilopsis linearis</i>	See Plans	20-30'h 15-25'w	Native
Texas Redbud (or approved variety)	<i>Cercis canadensis var. texensis</i>	See Plans	15-30'h 15-25'w	Native

Texas Mountain Laurel	<i>Dermatophyllum secundiflorum</i>	See Plans	15-35'h 10'w	Native
Mexican Plum	<i>Prunus mexicana</i>	See Plans	25-30'h 20-25'w	Native
Yaupon Holly	<i>Ilex vomitoria</i>	See Plans	15-25'h 15-20'w	Native
Possumhaw Holly	<i>Ilex decidua</i>	See Plans	10-15'h 10-15'w	Native
Mexican Buckeye	<i>Ungnadia speciosa</i>	See Plans	20-30'h 15-20'w	Native
TREES (LIVING SCREEN)				
Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
Holly, Foster	<i>Ilex x attenuata 'Fosteri'</i>	See Plans	20' h 10' w	Adapted
Holly, Nellie R.Stevens	<i>Ilex x 'Nellie Stevens'</i>	See Plans	25' h 15' w	Adapted

City of Frisco
Approved Materials List for Shrubs in Medians and Parkways
Ricardo Sanchez (972) 292-6526

SHRUBS				
Common Name	Scientific Name	Container Size to be Planted	Maximum Mature Size	Remarks
Dwarf Crape Myrtle	<i>Lagerstroemia indica</i>	See Plans	3' h 3' w	Dwarf
Dwarf Nandina	<i>Nandina domestica</i>	See Plans	3' h 3' w	Dwarf
Dwarf Yaupon Holly	<i>Ilex vomitoria 'Nana'</i>	See Plans	3' h 3' w	Dwarf
Hawthorn, Indian	<i>Raphiolepis indica</i>	See Plans	3' h 4' w	Adapted
Red Yucca	<i>Hesperaloe parviflora</i>	See Plans	3' h 3' w	Native
Texas Sage, Silverado	<i>Leucophyllum frutescens 'Silverado'</i>	See Plans	4' h 4' w	Native

City of Frisco
Approved Materials List for Irrigation
Steve Sutton (972) 292-6534

BASIC PRODUCT CATEGORY	PRODUCT SUB-CATEGORY	MANUFACTURER	MODEL, TYPE, OR STYLE APPROVED	GOVERNING SPECIFICATION	NOTES	NSF 61 CERTIFIED
Rotors		Hunter, Rainbird, Toro	High Efficiency			
Spray Nozzels (Turf Areas)		Hunter, Rainbird, Toro	High Efficiency			
Shrub Nozzle Adapter (Plant Bed Areas)		Rainbird				
Shrub Nozzles (Plant Bed Areas)		Riggs	SN8-24			
Brass Gate Valve, Domestic Manufacturer		Nibco	T-113			
Drip Irrigation		Netafim	Unitechline or Techline			
Solenoid Valve w/ DC Latching Solenoid		Rain Bird	PEB-PRS-B Series			
Quick Coupling Valves		Rain Bird	Model 44RC			
PVC Ball Valves		Spears or Approved Equal	Compact Unit			
Backflow Preventer		Febco	Double Check Valve			
Double Check Box			Plastic "Jumbo" DCA			
Valve Box		DFW Plastics	DFW65C-14-PKSPSM (Reclaim Water)			
D1730-18-PKSPSM (Reclaim Water)						
Quick Coupler Valve Box		Ametek	Purple 10" Circular Box w/ Purple Lid			
PVC Solvent and Purple Tinted Primer		IPS	P-70/PVC Purple Tinted			



SD

STANDARD CONSTRUCTION DETAILS

SD – Standard Construction Details – Table of Contents

Detail No.	Description	Date
<u>GENERAL</u>		
G01	Project Sign	August 2020
<u>PAVING</u>		
P01	Thoroughfare Classes “A” Through “G” – Typical Section (with Moisture Conditioning)	August 2020
P02	Thoroughfare Classes “C” Through “G” – Typical Section (without Moisture Conditioning)	August 2020
P03	Typical Pavement Reinforcement and Concrete Curb	August 2020
P04	Mountable Curbs	August 2020
P05	Existing Concrete Pavement Widening	August 2020
P06	Concrete Pavement – Jointing Layout	August 2020
P07	Concrete Pavement – Single Lane Roundabout Jointing Layout	August 2020
P08	Concrete Pavement – Multi-Lane Roundabout Jointing Layout	August 2020
P09	Concrete Pavement – Roundabout Steel Reinforcement Layout	August 2020
P10	Concrete Pavement – Construction Joint	August 2020
P11	Concrete Pavement – Expansion Joint	August 2020
P12	Concrete Street Headers	August 2020
P13	Monolithic Median Nose – Type 1	August 2020
P14	Monolithic Median Nose – Type 2	August 2020
P15	Median Nose – Type 3	August 2020
P16	Median Pavers	August 2020
P17	Commercial Driveway Approach	August 2020
P18	Residential Driveway Approach with Vertical Sawcut	August 2020
P19	Residential Driveway Approach with Horizontal Sawcut	August 2020
P20	Typical Alley Section	August 2020
P21	Typical Mews Section	August 2020
P22	Speed Table	August 2020
P23	Reinforced Concrete Sidewalk	August 2020
P24	Alternate Barrier Free Ramps at Residential Intersections	August 2020
P25	Barrier Free Ramp at Residential Intersections	August 2020
P26	Sidewalk and Roadway Pavers	August 2020
<u>TRAFFIC</u>		
T01	Pavement Markings and Markers – Sheet 1 of 2	August 2020
T02	Pavement Markings and Markers – Sheet 2 of 2	August 2020
T03	Sign and Street Light Placement	August 2020
T04	Sign Post and Mounting Details	August 2020
T05	Sign Installation Details	August 2020
T06	Road Closed Barricade	August 2020
T07	Road Closed With Object Marker Signs	August 2020
T08	Stop Signs and Stop Bars	August 2020
T09	Street Name Blade	August 2020
T10	Parking Space Curbs and Wheel Stops	August 2020
T11	Future Street Extension Sign	August 2020

DRAINAGE

D01	Curbed Flume	August 2020
D02	Standard Curb Inlet – Sheet 1 of 2	August 2020
D03	Standard Curb Inlet – Sheet 2 of 2	August 2020
D04	Recessed Curb Inlet – Sheet 1 of 2	August 2020
D05	Recessed Curb Inlet – Sheet 2 of 2	August 2020
D06	Center Support Beam & Inlet Section for Recessed and Standard Inlets	August 2020
D07	Storm Sewer Inlets & Manhole General Notes	August 2020
D08	Storm Sewer Curb Inlet Lid Detail – Sheet 1 of 2	August 2020
D09	Storm Sewer Manhole Lid Detail – Sheet 2 of 2	August 2020
D10	2', 3' and 4' Wye Inlets	August 2020
D11	5' & 6' Wye Inlets	August 2020
D12	Concrete Collar for Pipe Connections	August 2020
D13	Junction Box – Type I	August 2020
D14	Junction Box – Type II	August 2020
D15	Combo Inlet for Alleys – Sheet 1 of 2	August 2020
D16	Combo Inlet for Alleys – Sheet 2 of 2	August 2020
D17	Rip Rap Around Headwalls	August 2020

UTILITY

U01	Embedment “B” (Storm)	August 2020
U02	Embedment “B+” (Water)	August 2020
U03	Embedment “C+”	August 2020
U04	Embedment “G”	August 2020
U05	Embedment “I” (Wastewater)	August 2020
U06	Embedment “H” (Wastewater)	August 2020
U07	Embedment (Multi-Ducts)	August 2020
U08	Embedment (Multi-Ducts) Under Pavement	August 2020
U09	Gabion Armoring for Sewer Crossing – Sheet 1 of 2	August 2020
U10	Gabion Armoring for Sewer Crossing - Sheet 2 of 2	August 2020
U11	Casing Spacers	August 2020
U12	Embedment Detail for Non-pressure Rated Wastewater Mains Below Water Mains	August 2020
U13	Embedment Detail for Non-pressure Rated Wastewater Mains Above Water Mains	August 2020
U14	Encasement Detail for Proposed Water Mains Below Wastewater Mains	August 2020
U15	Embedment Detail for New Pressure Rated Wastewater Mains Below New Water Mains	August 2020

WATER

W01	Horizontal Thrust Block at Pipe Bend – Sheet 1 of 3	August 2020
W02	Horizontal Thrust Block at Pipe Bend – Sheet 2 of 3	August 2020
W03	Horizontal Thrust Block at Pipe Bend – Sheet 3 of 3	August 2020
W04	Thrust Harness	August 2020
W05	Vertical Thrust Block at Pipe Bend	August 2020
W06	Thrust Block – General Notes	August 2020
W07	Gate Valve	August 2020
W08	Butterfly Valve	August 2020
W09	Combination Air Vacuum Valve Type “1” and Air Vent	August 2020

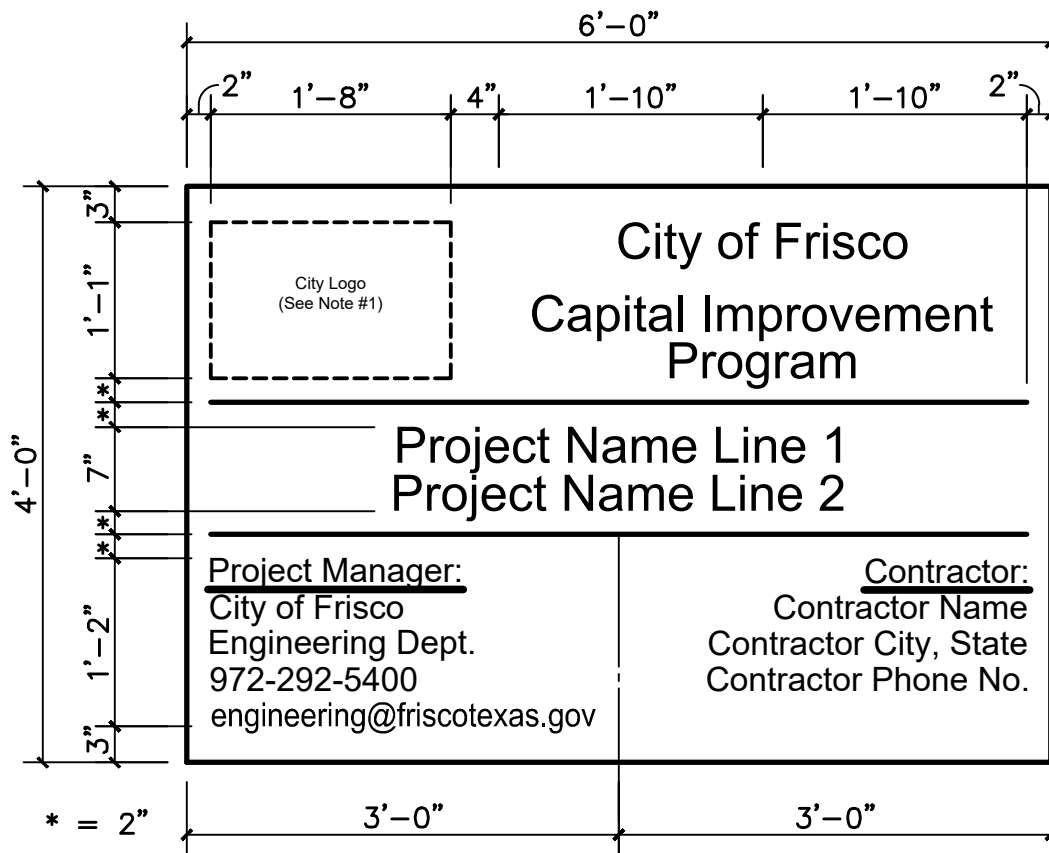
W10	Blow Off Valve	August 2020
W11	Automatic Flushing Device	August 2020
W12	Fire Hydrant	August 2020
W13	Fire Hydrant Installation	August 2020
W14	Pipe Bollard	August 2020
W15	Residential Service Locations	August 2020
W16	Typical Service Connection	August 2020
W17	Domestic 3" Water Meter Vault	August 2020
W18	Domestic 4" Water Meter Vault	August 2020
W19	Domestic 6" Water Meter Vault	August 2020
W20	Water Main Lowering Below Wastewater Main	August 2020
W21	Offsite Water Main Marker	August 2020
W22	Wellhead Installation	August 2020
W23	Manual Access Pipe / Pipe Floor Support	August 2020
W24	Double Detector Check Fire Vault	August 2020

WASTEWATER

S01	Standard Cast-In-Place Manhole	August 2020
S02	Precast Concrete Manhole	August 2020
S03	Manhole to Pipe Resilient Connector	August 2020
S04	Vented Type S Manhole	August 2020
S05	Vented Flat Top Manhole	August 2020
S06	Pressure Manhole Lid and Frame	August 2020
S07	Standard Manhole Lid and Frame	August 2020
S08	Manhole Drop Connection	August 2020
S09	Manhole Drop Connection for a Parallel Line	August 2020
S10	Wastewater Manhole Main Intersection	August 2020
S11	Wastewater Manhole False Bottom	August 2020
S12	Manhole Abandonment	August 2020
S13	Wastewater Main Cleanout	August 2020
S14	Wastewater Lateral	August 2020
S15	Offsite Wastewater Marker	August 2020

LANDSCAPING

L01	Tree Planting (Single Trunk)	August 2020
L02	Tree Planting (Multi-Trunk)	August 2020
L03	Shrub Planting	August 2020
L04	Groundcover Planting	August 2020
L05	Tree Protection	August 2020
L06	Concrete Mow Strip	August 2020
L07	Steel Edging	August 2020
L08	Median Grass Planting	August 2020



NOTES:

1. LOGO AVAILABLE FROM CITY OF FRISCO BY REQUEST. LOGO COLOR SHALL BE PMS 1795 (OC/94M/100Y/0K). TAG LINE COLOR SHALL BE BLACK.
2. SIGN SHALL HAVE A WHITE BACKGROUND WITH BLACK LETTERING. LETTERING (EXCEPT LOGO) SHALL BE ARIAL FONT.
3. SIGN LAYOUT SHALL BE APPROVED BY CITY PRIOR TO FABRICATION.
4. SIGN MAY BE SKID MOUNTED OR POST MOUNTED. CONTRACTOR IS RESPONSIBLE FOR REMOVING SIGN STRUCTURE AND RESTORING GROUND PRIOR TO FINAL ACCEPTANCE.
5. REFER TO TECHNICAL SPECIFICATION 015813.



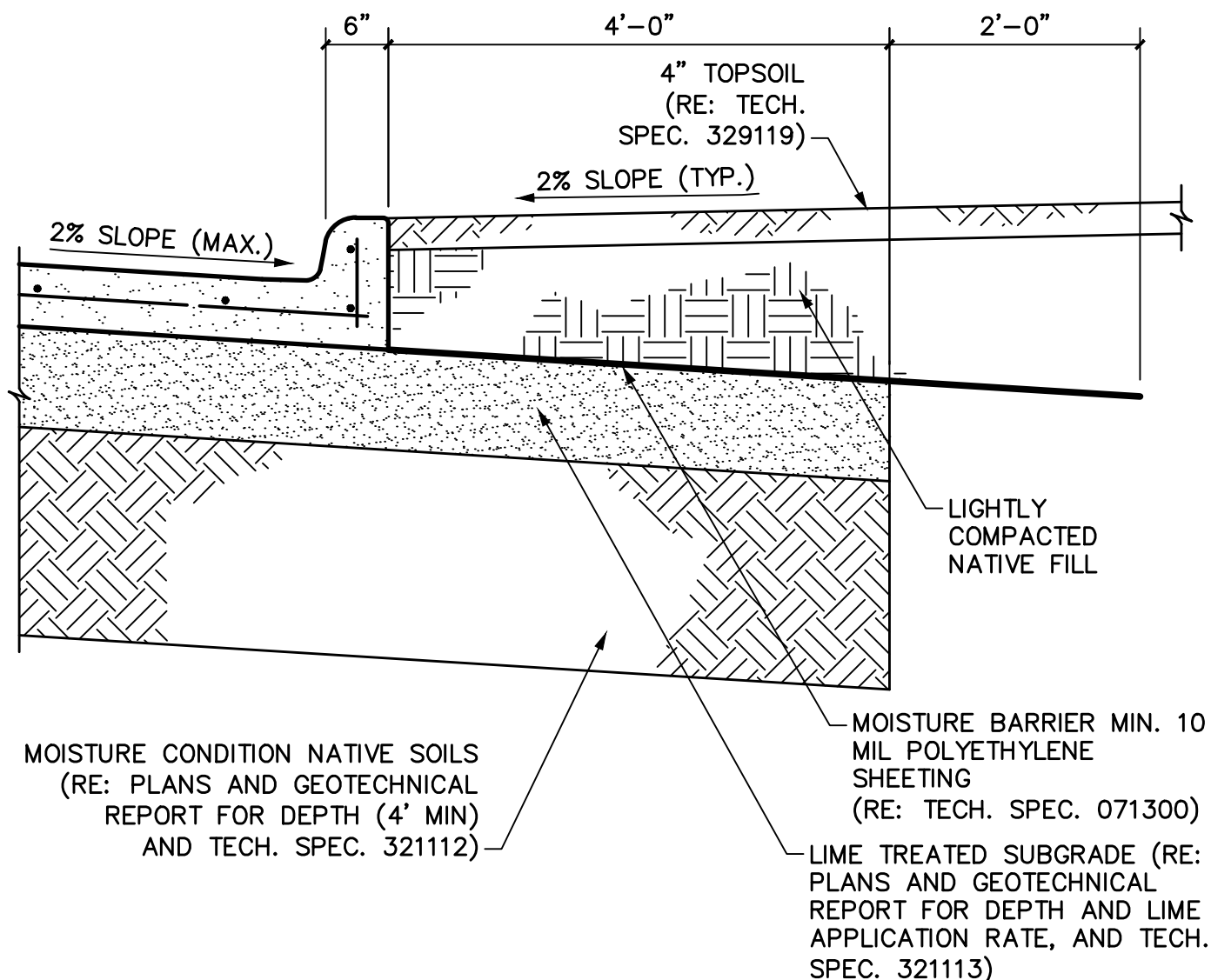
STANDARD CONSTRUCTION DETAIL

PROJECT SIGN

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

G01



	ROW WIDTH	PAVEMENT WIDTH (FACE TO FACE)
TYPE A	120'	DIVIDED-36' EACH WAY
TYPE B	90'	DIVIDED-24' EACH WAY
TYPE C	60'	36'
TYPE D	60'	36'
TYPE E	50'	26'
TYPE F	60'	30'
TYPE G	60'	26'

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. REFER TO DETAIL P03 FOR CONCRETE PAVEMENT REINFORCEMENT.
3. CARE SHALL BE TAKEN NOT TO RIP OR TEAR THE MOISTURE BARRIER DURING PLACEMENT OF THE COVER FILL.

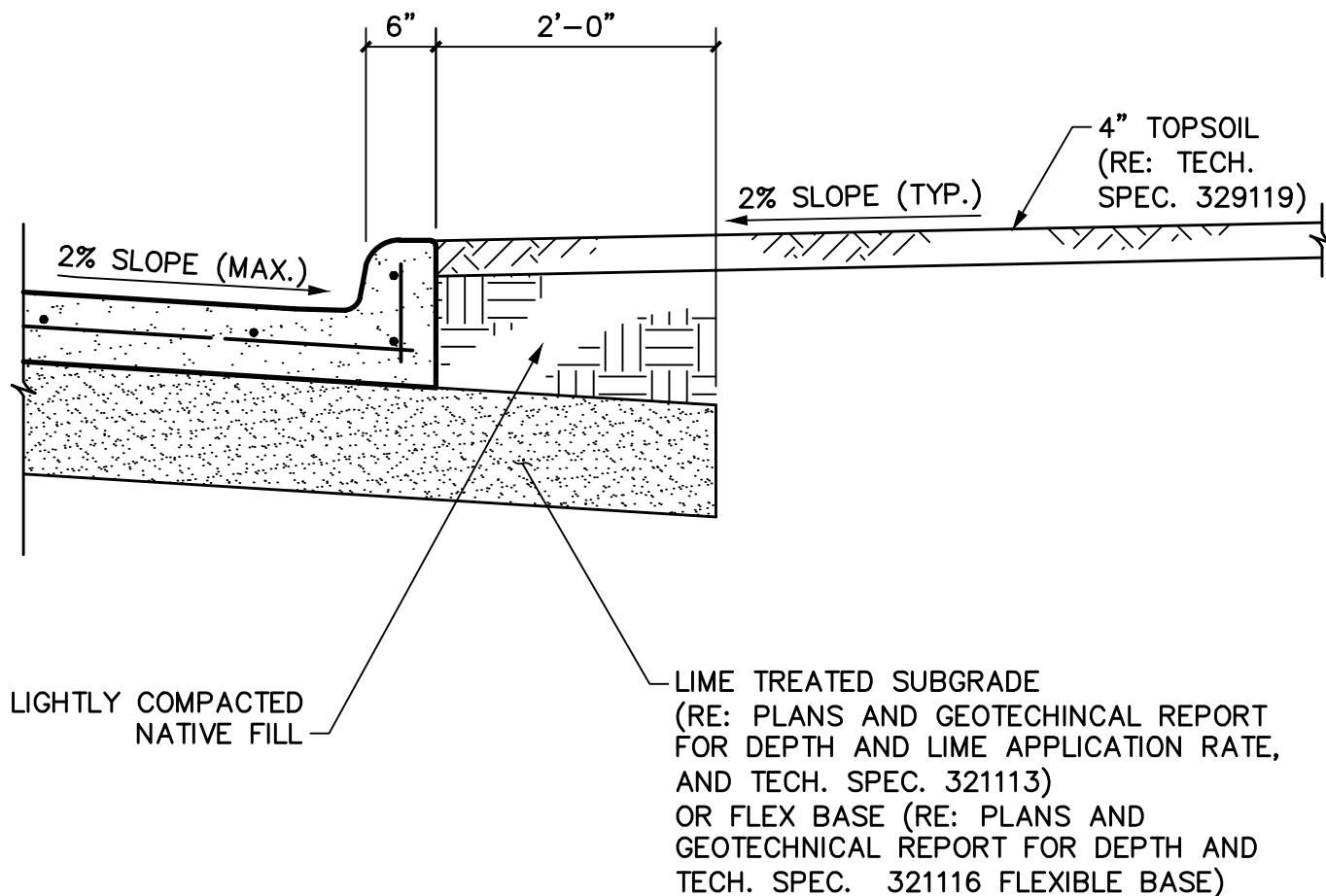


STANDARD CONSTRUCTION DETAIL THOROUGHFARE CLASSES "A" THROUGH "G" TYPICAL SECTION (WITH MOISTURE CONDITIONING)

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

P01



	ROW WIDTH	PAVEMENT WIDTH (FACE TO FACE)
TYPE A	120'	DIVIDED-36' EACH WAY
TYPE B	90'	DIVIDED-24' EACH WAY
TYPE C	60'	36'
TYPE D	60'	36'
TYPE E	50'	26'
TYPE F	60'	30'
TYPE G	60'	26'

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. REFER TO DETAIL P03 FOR CONCRETE PAVEMENT REINFORCEMENT.

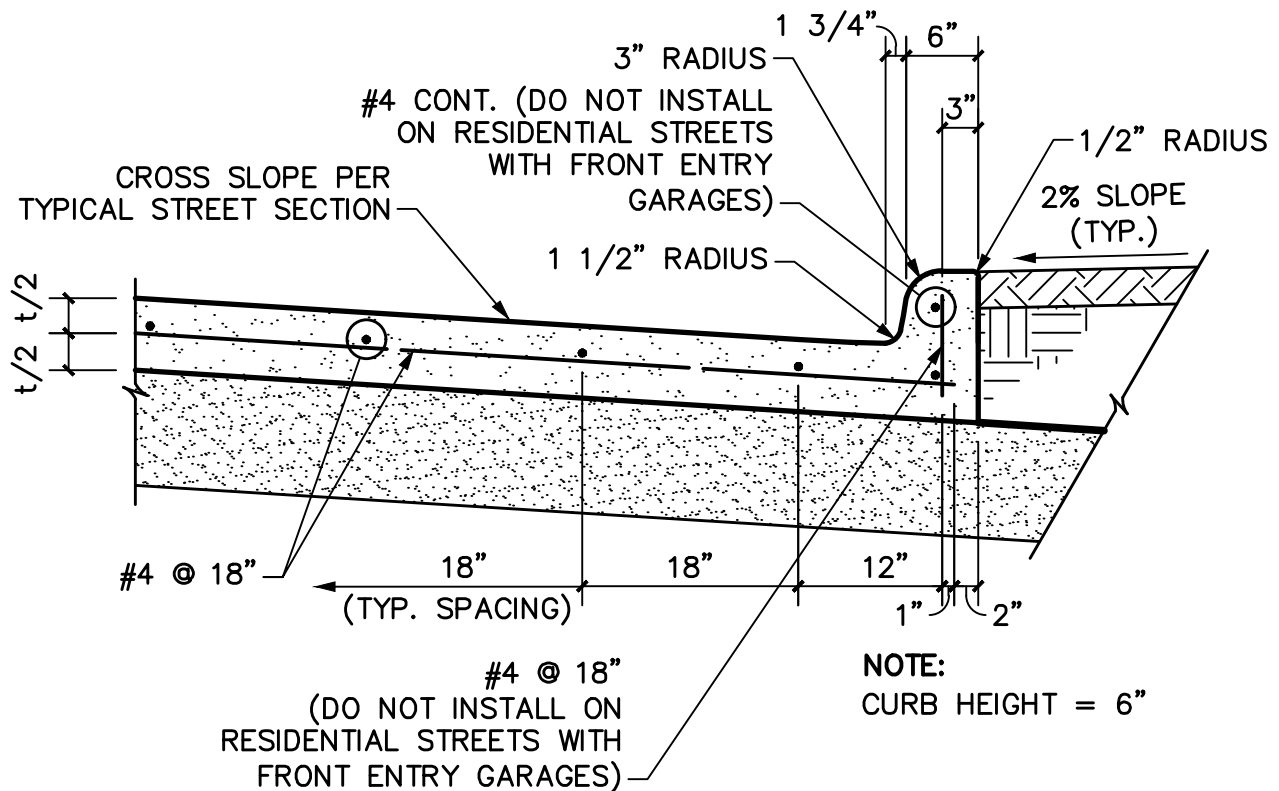


**STANDARD CONSTRUCTION DETAIL
THOROUGHFARE CLASSES "C" THROUGH "G"
TYPICAL SECTION (WITHOUT MOISTURE CONDITIONING)**

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

P02



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. ALL REINFORCING STEEL SHALL BE #4 DEFORMED STEEL BARS CONFORMING TO ASTM A615 (GRADE 60) IN ACCORDANCE WITH TECHNICAL SPECIFICATION 032100.
3. INITIAL TRANSVERSE REINFORCING STEEL SPACING SHALL BE 12".
4. INITIAL LONGITUDINAL REINFORCING STEEL SPACING SHALL BE 12" AS SHOWN ABOVE.

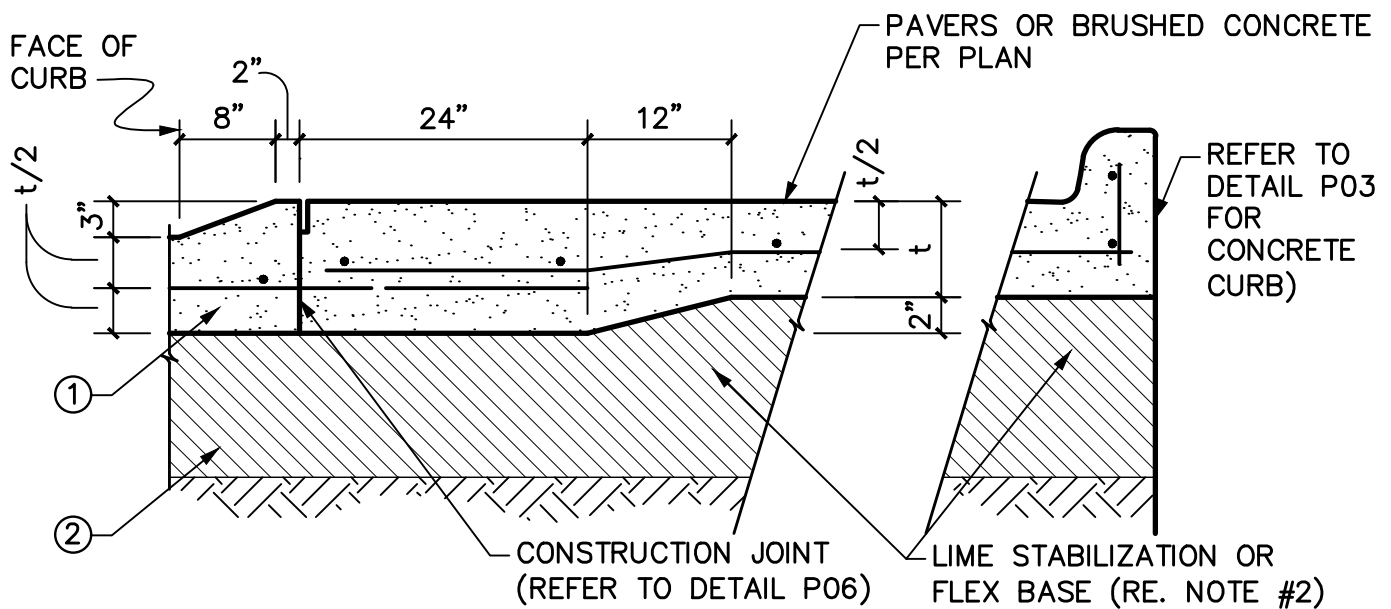


STANDARD CONSTRUCTION DETAIL TYPICAL PAVEMENT REINFORCEMENT AND CONCRETE CURB

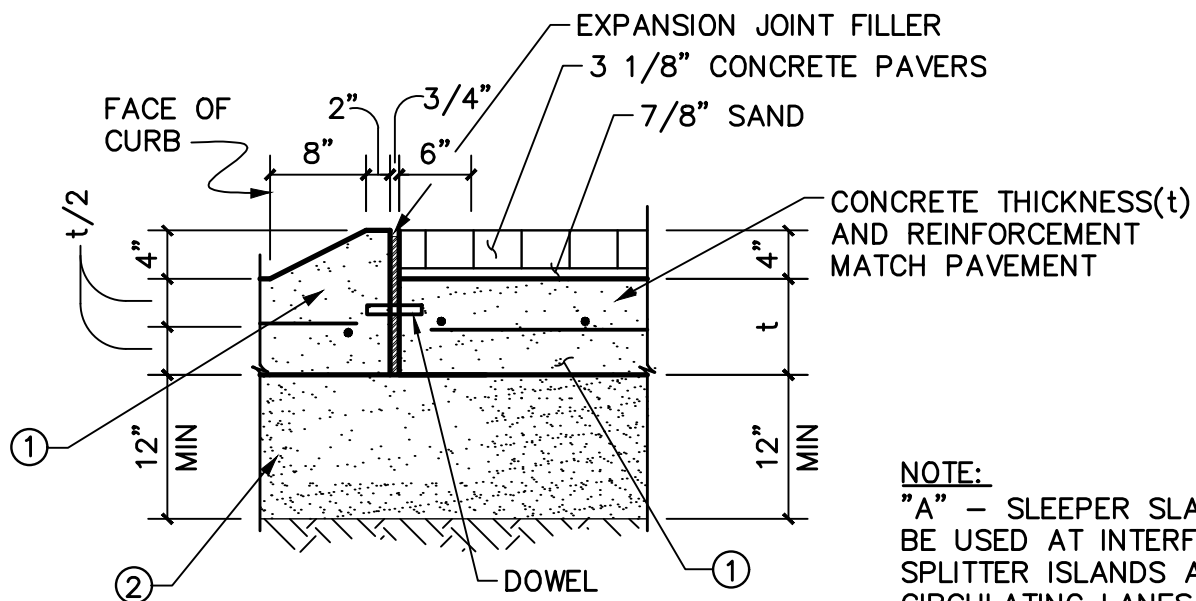
SCALE: 3/4"=1'-0"

REVISED: AUG 2020

P03



3" MOUNTABLE TRUCK APRON CURB



4" MOUNTABLE CURB (SPLITTER ISLANDS)

LEGEND:

- ① REINFORCED CONCRETE PAVEMENT MONOLITHIC CURB (CLASS P1 [MACHINE FINISHED] OR P2 [HAND FINISHED]) (REFER TO DETAIL P05C FOR REINFORCEMENT).
- ② REFER TO PLANS FOR SUBGRADE REQUIREMENTS (EITHER LIME OR FLEX BASE). SUBGRADE TREATMENT EXTENDS BEYOND CURB SEE P01 OR P02



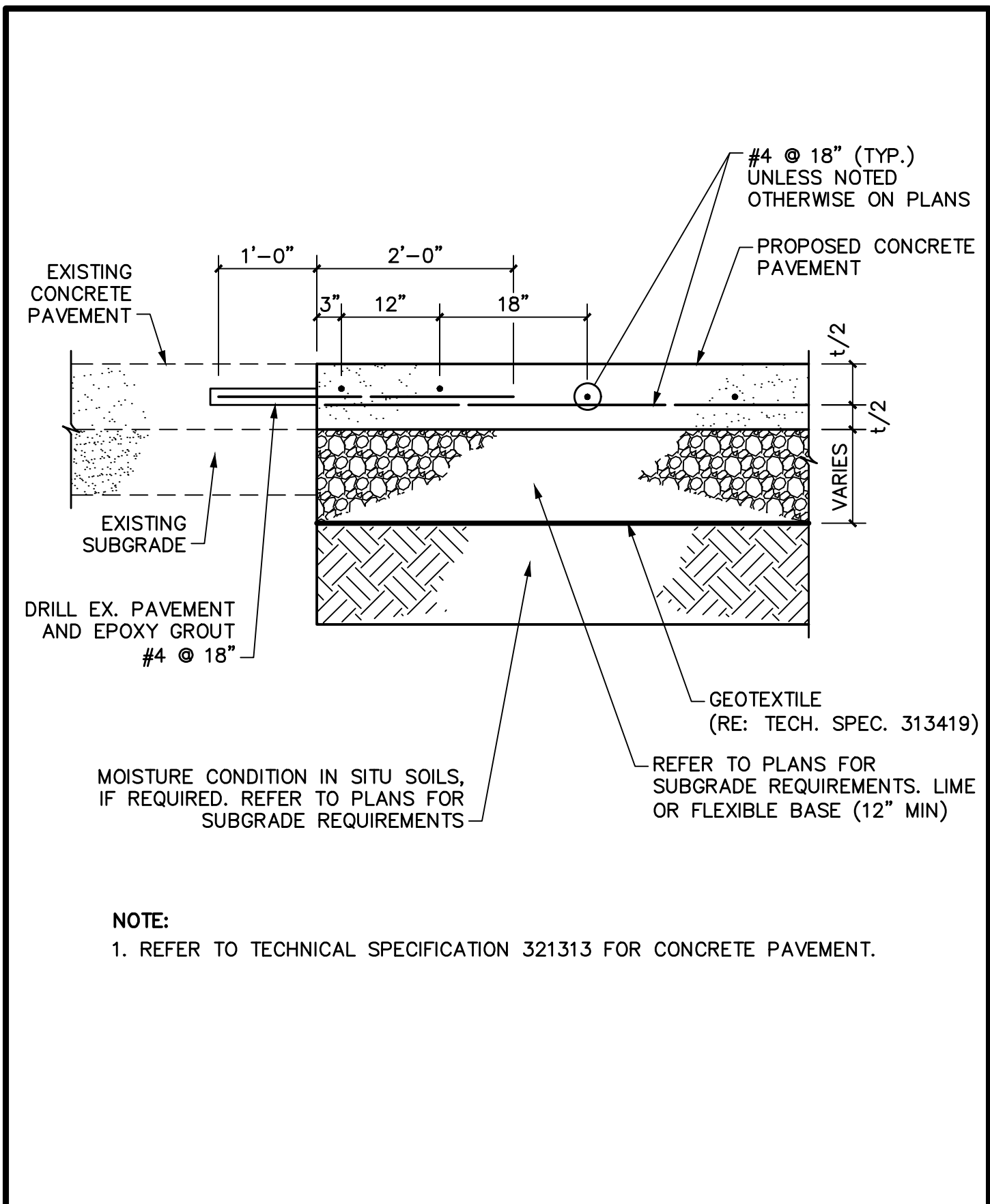
STANDARD CONSTRUCTION DETAIL

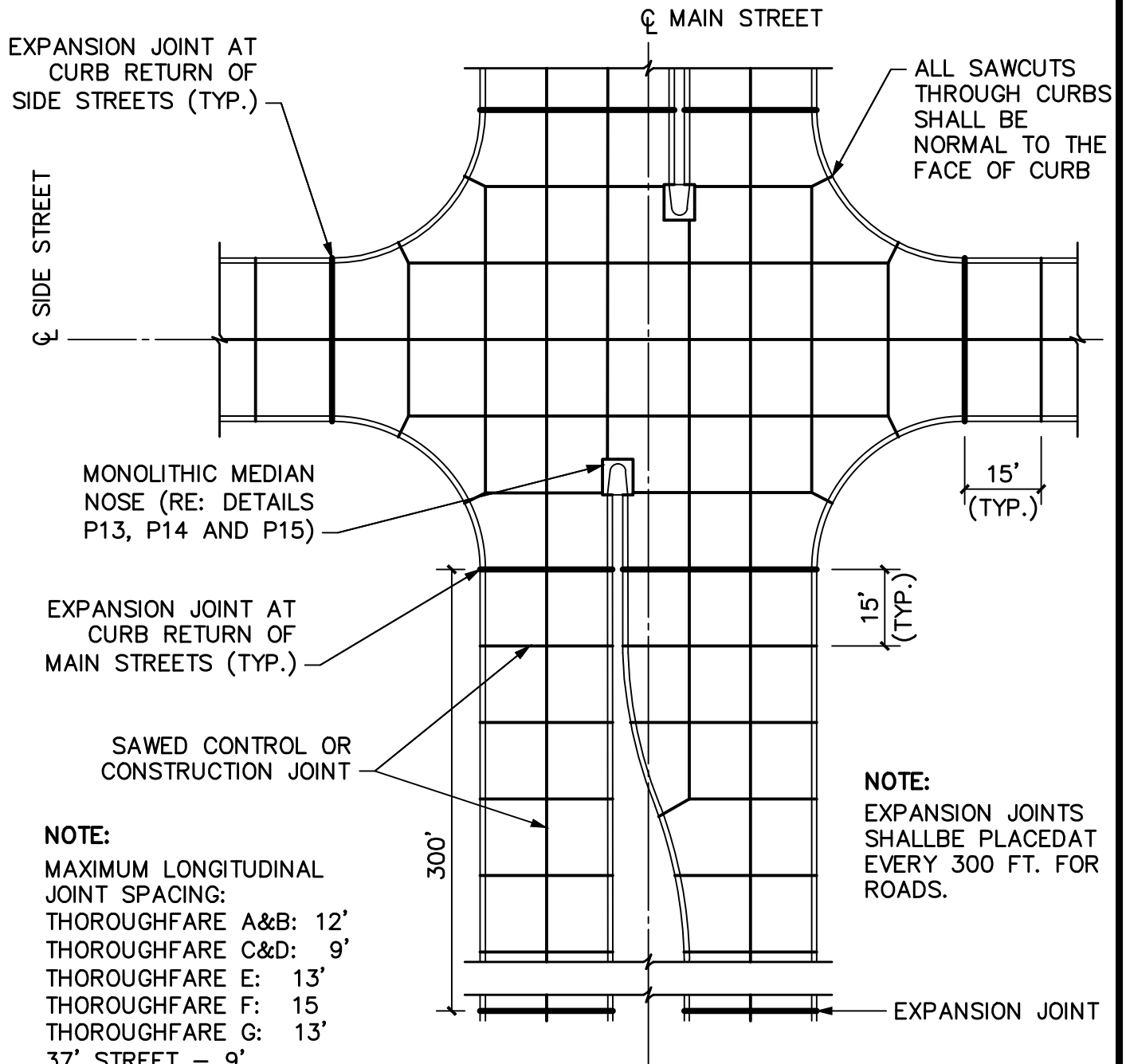
MOUNTABLE CURBS

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

P04





NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. PAVEMENT JOINTS ARE EITHER EXPANSION, SAWED CONTROL, OR CONSTRUCTION JOINTS UNLESS NOTED OTHERWISE.
3. MAXIMUM TRANSVERSE JOINT SPACING IS 15'.
4. LONGITUDINAL JOINT SPACING SHALL MATCH LANE LINES UNLESS NOTED OTHERWISE.
5. ALL SAWCUTS SHALL BE 1/8" TO 1/4" WIDE AND ONE-FOURTH THE DEPTH OF THE PAVEMENT THICKNESS.
6. ALL PAVEMENT JOINTS SHALL BE SEALED. JOINT SEALANT SHALL BE PROVIDED IN ACCORDANCE TECHNICAL SPECIFICATION 321373.
7. EXPANSION JOINTS SHALL BE PLACED AT EVERY 200 FT FOR ALLEYS.

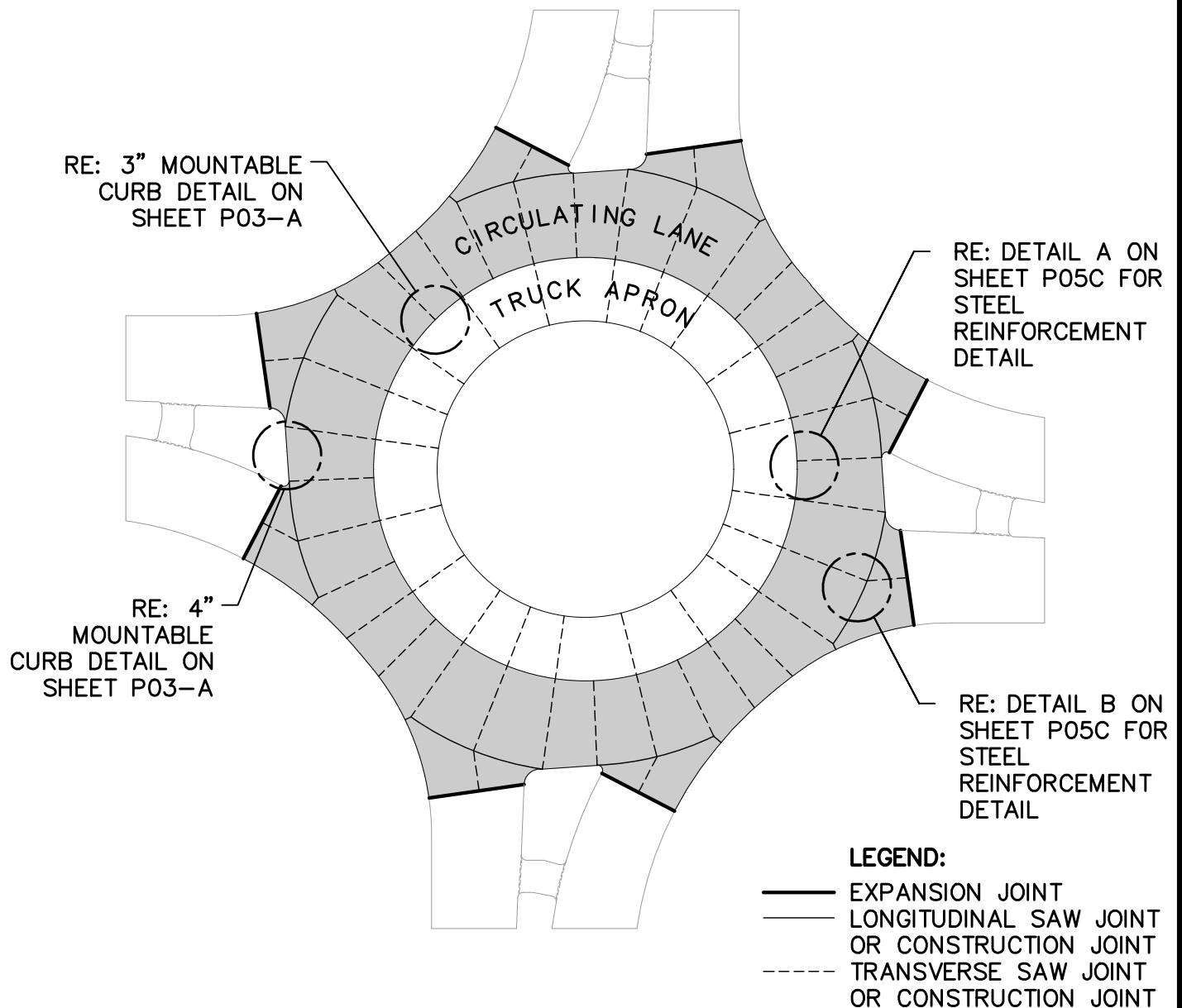


**STANDARD CONSTRUCTION DETAIL
 CONCRETE PAVEMENT
 JOINTING LAYOUT**

SCALE: 1"=30'

REVISED: AUG 2020

P06



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. PAVEMENT JOINTS ARE EITHER EXPANSION, SAWED CONTROL, OR CONSTRUCTION JOINTS UNLESS NOTED OTHERWISE.
3. TRANSVERSE JOINT SPACING: DESIRABLE: 15', MAXIMUM: 18', MINIMUM: 4'.
4. LONGITUDINAL JOINT SPACING SHALL MATCH LANE LINES UNLESS NOTED OTHERWISE.
5. ALL SAWCUTS SHALL BE 1/8" TO 1/4" WIDE AND ONE-FOURTH THE DEPTH OF THE PAVEMENT THICKNESS.
6. ALL PAVEMENT JOINTS SHALL BE SEALED. JOINT SEALANT SHALL BE PROVIDED IN ACCORDANCE TECHNICAL SPECIFICATION 321373.
7. ROUNDABOUT REINFORCING SHALL BE PLACED RADIALY IN ACCORDANCE WITH DETAIL P05C.
8. ROUNDABOUT JOINTING PLAN SHALL BE SUBMITTED TO THE CITY FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.

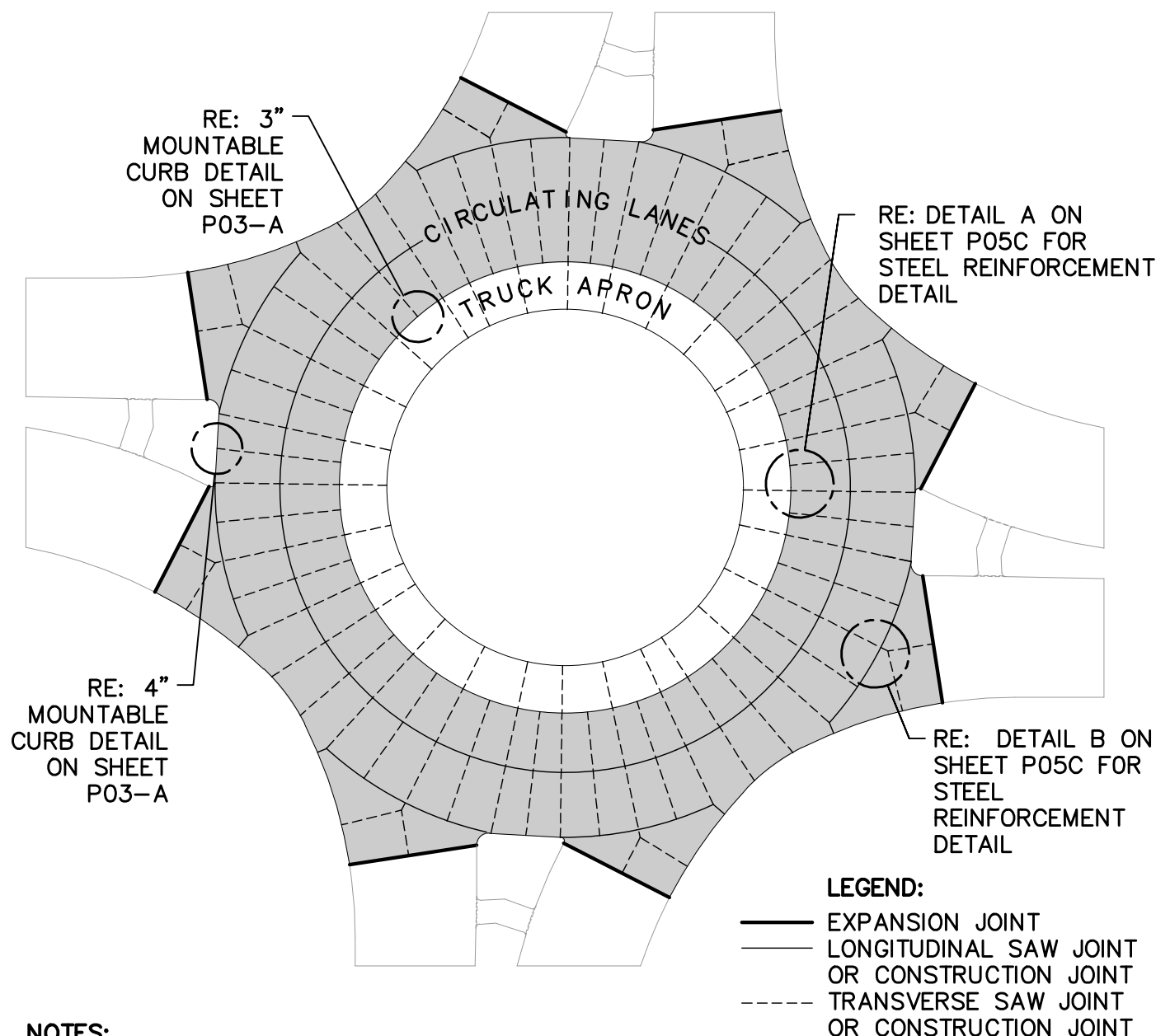


STANDARD CONSTRUCTION DETAIL
CONCRETE PAVEMENT
SINGLE LANE ROUNDABOUT JOINTING LAYOUT

SCALE: 1"=30'

REVISED: AUG 2020

P07



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. PAVEMENT JOINTS ARE EITHER EXPANSION, SAWED CONTROL, OR CONSTRUCTION JOINTS UNLESS NOTED OTHERWISE.
3. TRANSVERSE JOINT SPACING: DESIRABLE: 15', MAXIMUM: 18', MINIMUM: 4'.
4. LONGITUDINAL JOINT SPACING SHALL MATCH LANE LINES UNLESS NOTED OTHERWISE.
5. ALL SAWCUTS SHALL BE 1/8" TO 1/4" WIDE AND ONE-FOURTH THE DEPTH OF THE PAVEMENT THICKNESS.
6. ALL PAVEMENT JOINTS SHALL BE SEALED. JOINT SEALANT SHALL BE PROVIDED IN ACCORDANCE TECHNICAL SPECIFICATION 321373.
7. ROUNDABOUT REINFORCING SHALL BE PLACED RADIALLY IN ACCORDANCE WITH DETAIL P05C.
8. ROUNDABOUT JOINTING PLAN SHALL BE SUBMITTED TO THE CITY FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.



STANDARD CONSTRUCTION DETAIL CONCRETE PAVEMENT MULTI-LANE ROUNDABOUT JOINTING LAYOUT

SCALE: 1"=40'

REVISED: AUG 2020

P08

TRUCK APRON
REINFORCEMENT SHALL
BE PLACED RADIALLY,
SPACING OF TRANSVERSE
STEEL SHALL BE 18" MAX
AT EXTERIOR EDGE OF
TRUCK APRON

CONSTRUCTION
JOINT

CIRCULATING LANES

#4 AT EQUAL SPACING
(18" MAX)

EXTEND REINFORCING
24" INTO TRUCK APRON
(18" MAX SPACING
EVERY OTHER BAR)

STEEL REINFORCEMENT DETAIL A

NOTES:

1. PROVIDE
CONTINUOUS NO. 4
REBAR 2" OFF
FACE AT ALL
CONSTRUCTION
JOINTS, ON BOTH
SIDES OF JOINT.
2. ALL REBAR 18"
MAXIMUM SPACING

#4 AT EQUAL SPACING
(18" MAX)

CONSTRUCTION
JOINT

CIRCULATING LANES

CIRCULATING LANE
REINFORCEMENT SHALL
BE PLACED RADIALLY,
SPACING OF TRANSVERSE
STEEL SHALL BE 18" MAX
AT EXTERIOR EDGE OF
CIRCULATING LANES

#4 X 4'-0" AT
EQUAL SPACING
(18" MAX
DEFORMED BARS).

STEEL REINFORCEMENT DETAIL B

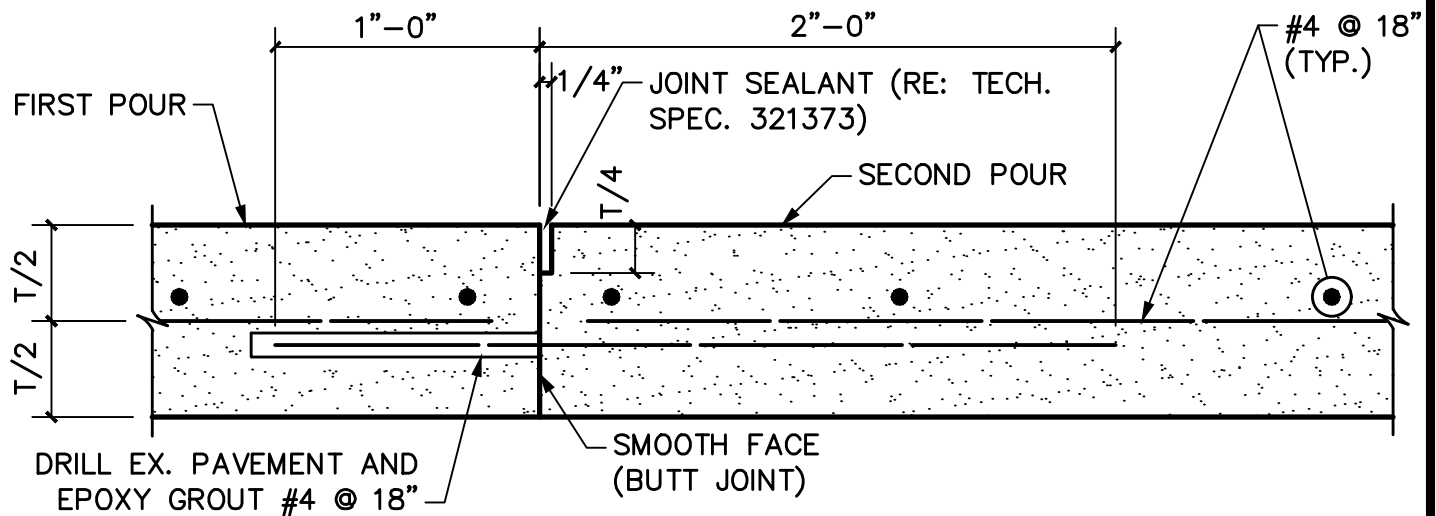


**STANDARD CONSTRUCTION DETAIL
CONCRETE PAVEMENT
ROUNABOUT STEEL REINFORCEMENT LAYOUT**

SCALE: 1"=5'

REVISED: AUG 2020

P09



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. DOWELS MUST BE INSTALLED IN THE PAVEMENT PARALLEL TO THE PAVEMENT SURFACE.
3. DOWELS IN TRANSVERSE JOINTS MUST BE INSTALLED IN THE PAVEMENT PARALLEL TO THE PAVEMENT CENTERLINE.
4. DOWELS IN LONGITUDINAL JOINTS MUST BE INSTALLED IN THE PAVEMENT NORMAL TO THE PAVEMENT CENTERLINE.

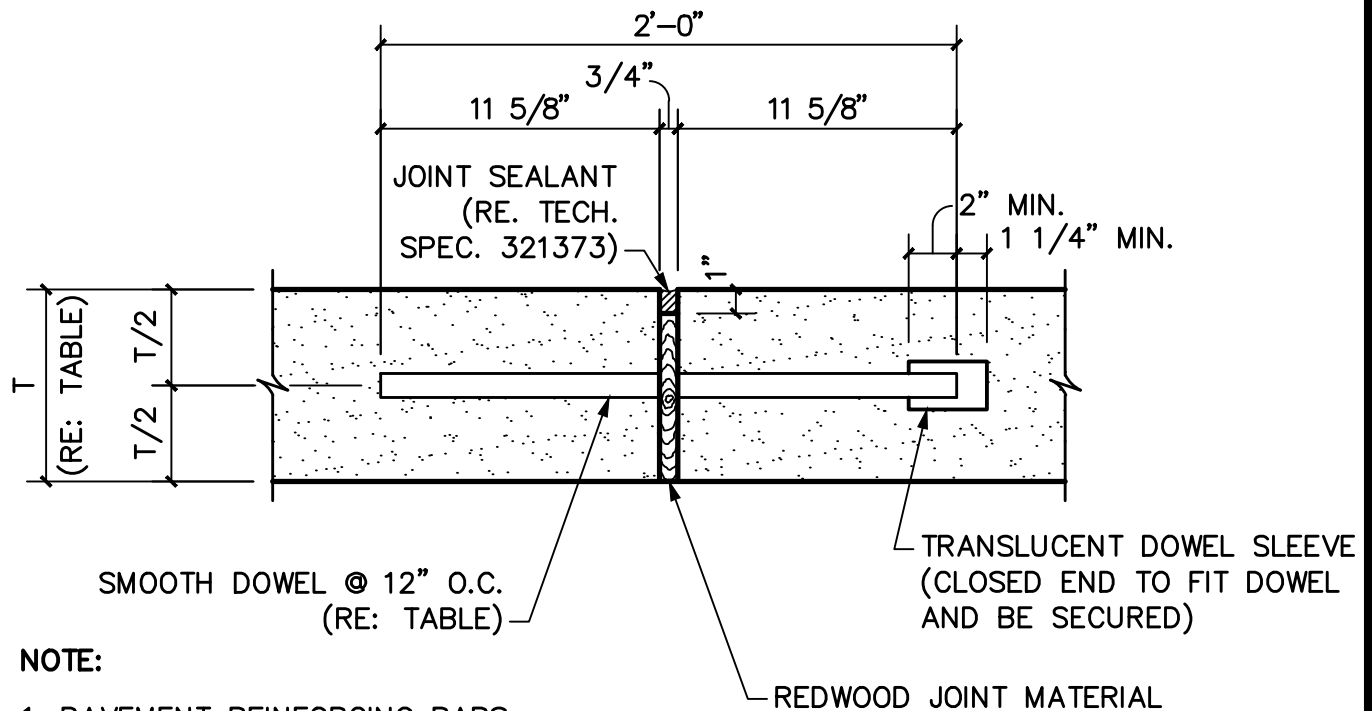


STANDARD CONSTRUCTION DETAIL CONCRETE PAVEMENT CONSTRUCTION JOINT

SCALE: 1 1/2"=1'-0"

REVISED: AUG 2020

P10



NOTE:

1. PAVEMENT REINFORCING BARS NOT SHOWN FOR CLARITY.

TABLE			
STREET CLASS	T (IN.)	DOWEL SIZE (IN.)	DOWEL LENGTH (L) (IN.)
A	9	1.0	24
B	8	1.0	24
C	7	0.75	24
D	6	0.75	24
E	6	0.75	24
F	6	0.75	24
G	6	0.75	24

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. DOWEL SUPPORT MATERIALS AND LAYOUT SHALL BE SUBMITTED TO THE CITY FOR REVIEW AND APPROVAL PRIOR TO ORDERING MATERIALS AND CONSTRUCTION.
3. CAPPED END OF THE DOWEL SHALL BE LUBRICATED FROM CAP TO REDWOOD.
4. DOWELS MUST BE INSTALLED IN THE PAVEMENT PARALLEL TO THE PAVEMENT SURFACE AND TO THE CENTERLINE.
5. EXPANSION JOINTS SHALL BE PLACED AT EVERY 300 FT FOR ROADS.

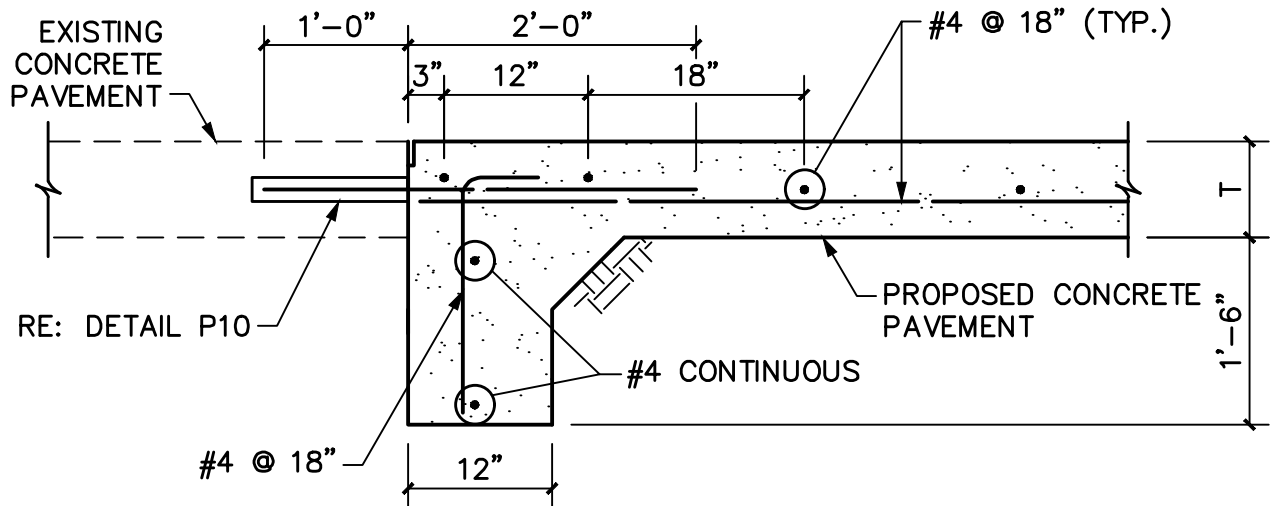


**STANDARD CONSTRUCTION DETAIL
CONCRETE PAVEMENT
EXPANSION JOINT**

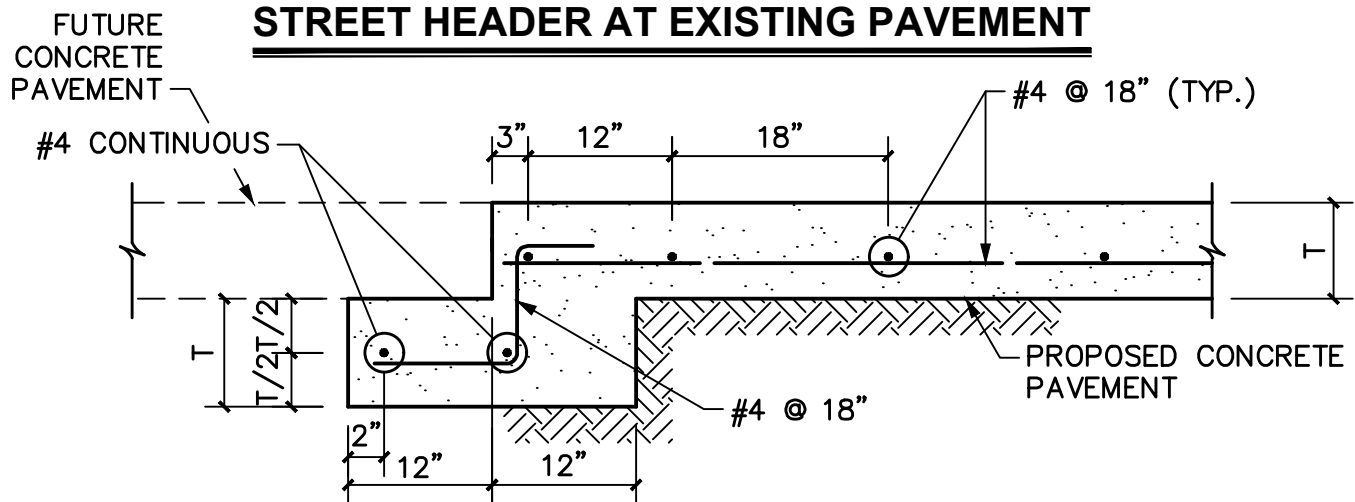
SCALE: 1 1/2"=1'-0"

REVISED: AUG 2020

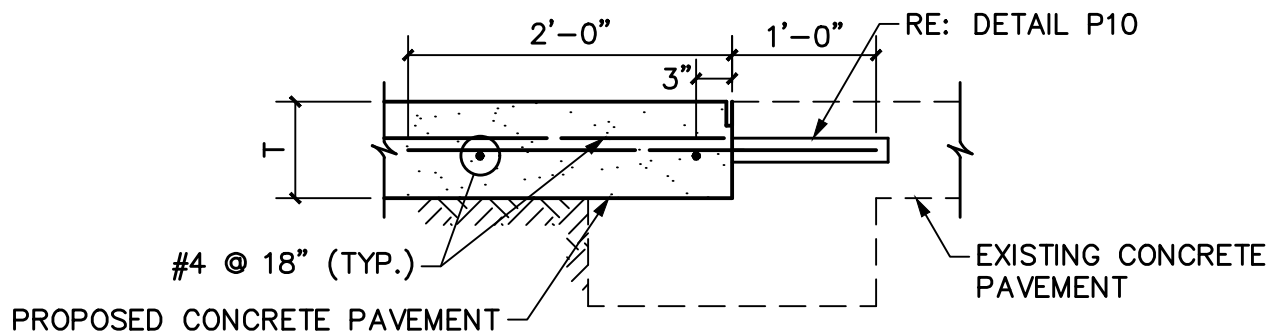
P11



STREET HEADER AT EXISTING PAVEMENT



STREET HEADER FOR FUTURE CONCRETE PAVEMENT



CONCRETE PAVEMENT AT STREET HEADER

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. REFERENCE TYPICAL SECTIONS FOR PROPOSED CONCRETE PAVEMENT THICKNESS AND SUBGRADE TREATMENT.



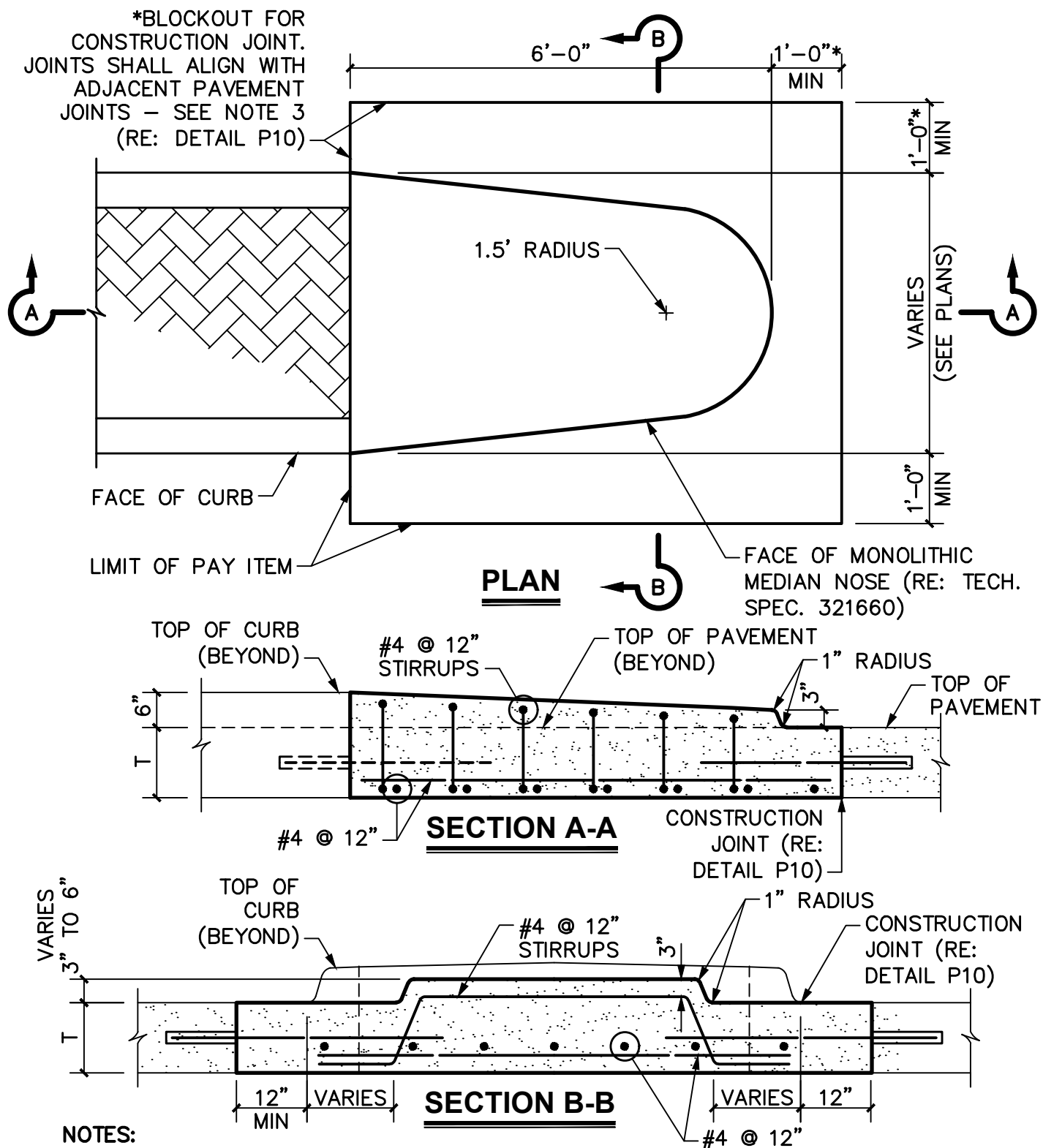
STANDARD CONSTRUCTION DETAIL

CONCRETE STREET HEADERS

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

P12



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. PROVIDE TYPE 1 MONOLITHIC MEDIAN NOSE AT ALL MEDIANS 8' WIDE OR LESS.
3. CONSTRUCTION JOINT MAY BE AN EXPANSION JOINT WHEN INSTALLING MONOLITHIC MEDIAN NOSE ADJACENT TO EXISTING PAVEMENT AT DISCRETION OF ENGINEER.

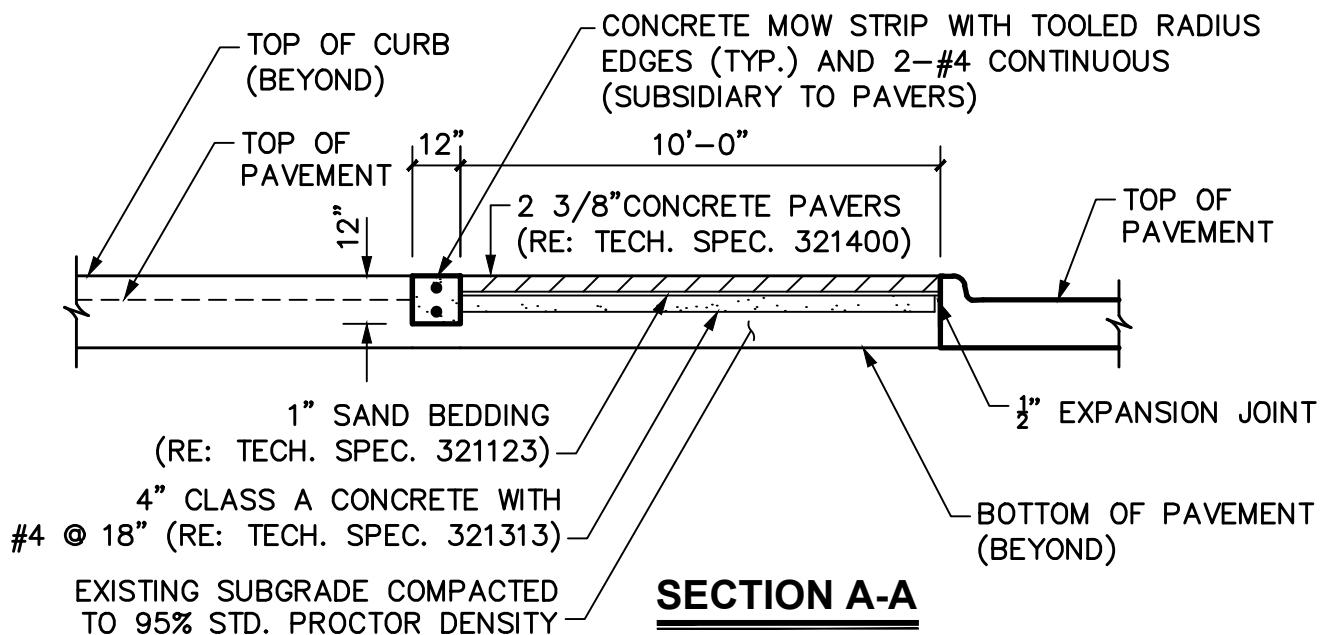
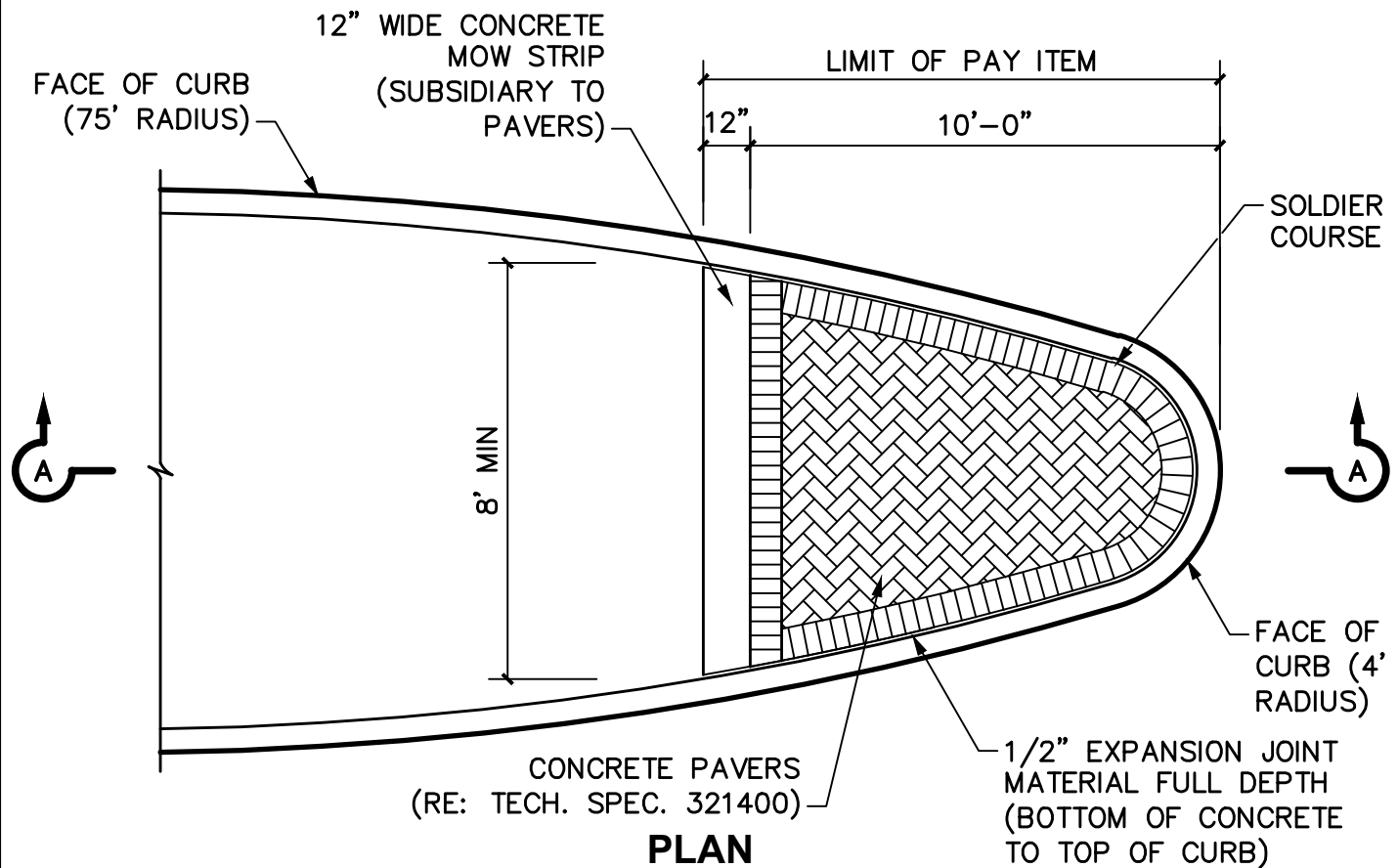


STANDARD CONSTRUCTION DETAIL
MONOLITHIC MEDIAN NOSE
TYPE 1

SCALE: 1/2"=1'-0"

REVISED: AUG 2020

P13



NOTE:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.



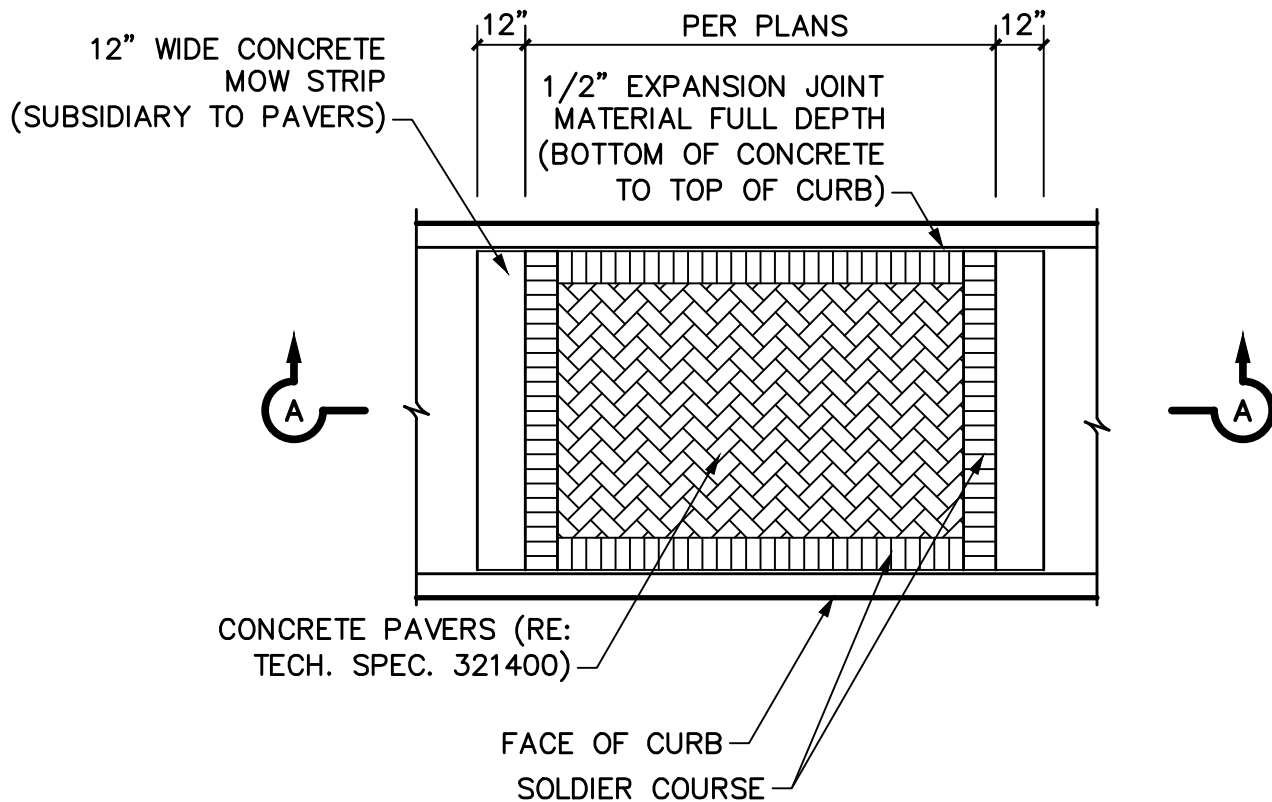
STANDARD CONSTRUCTION DETAIL

MEDIAN NOSE TYPE 3

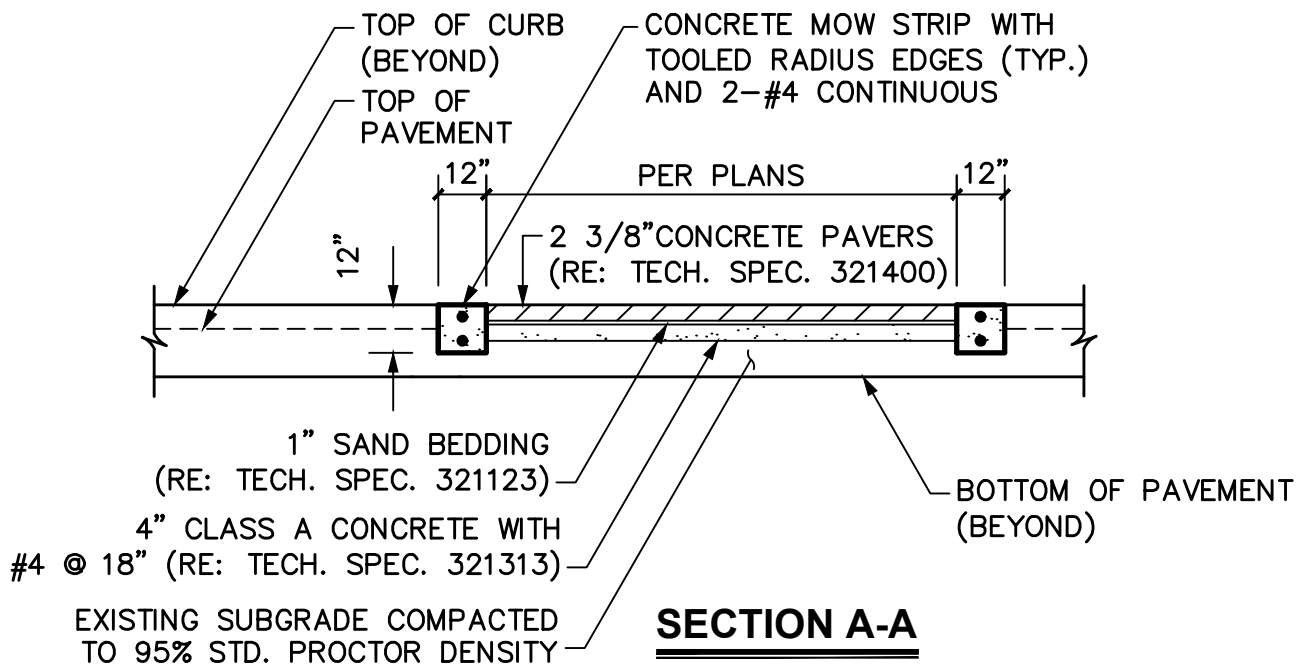
SCALE: 1/4"=1'-0"

REVISED: AUG 2020

P15



PLAN



SECTION A-A

NOTE:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.



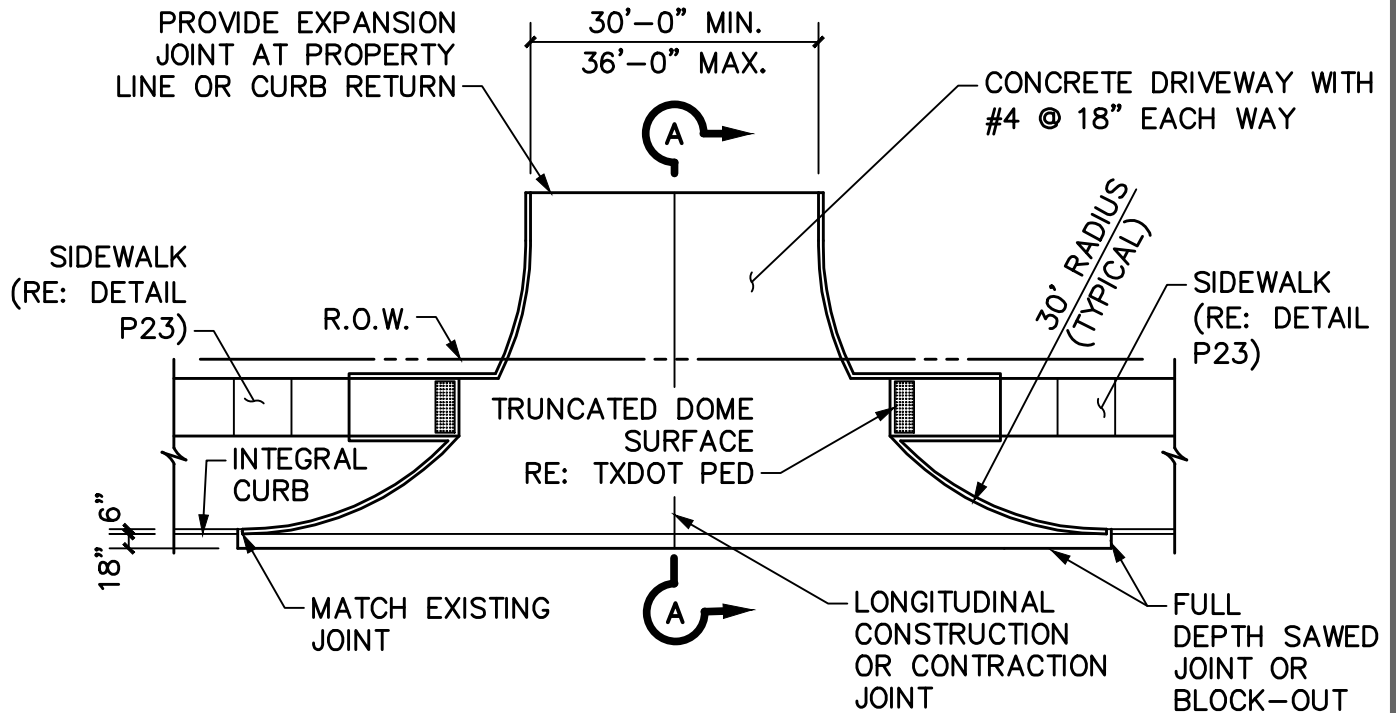
STANDARD CONSTRUCTION DETAIL

MEDIAN PAVERS

SCALE: 1/4"=1'-0"

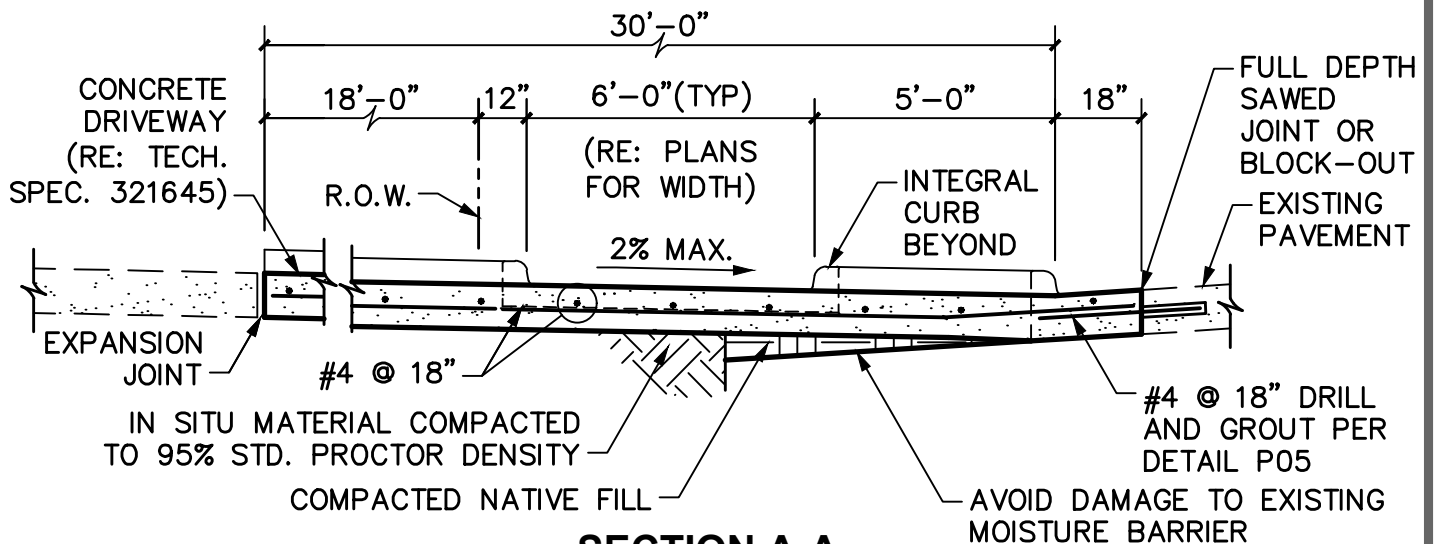
REVISED: AUG 2020

P16



PLAN

SCALE: 1"=20'



SECTION A-A

SCALE: 1/4"=1'-0"

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT
2. EXISTING CURB AND GUTTER SHALL BE VERTICALLY SAWCUT. HORIZONTAL SAWCUTTING OF CURB NOT ALLOWED.
3. SIDEWALK SECTION THROUGH DRIVEWAY SHALL BE POURED SAME THICKNESS AS DRIVEWAY APPROACH (EXISTING SIDEWALK, IF ANY, SHALL BE REMOVED).
4. DRIVEWAY THICKNESS TO MATCH STREET PAVEMENT THICKNESS (6" MINIMUM).

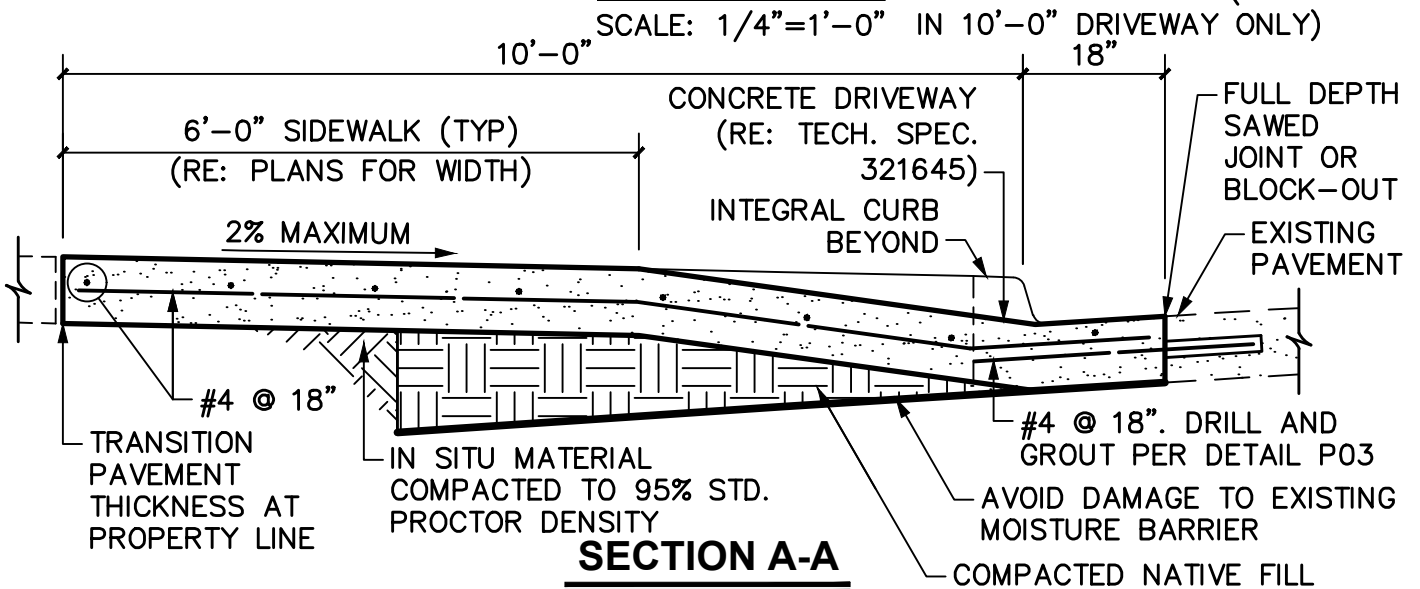
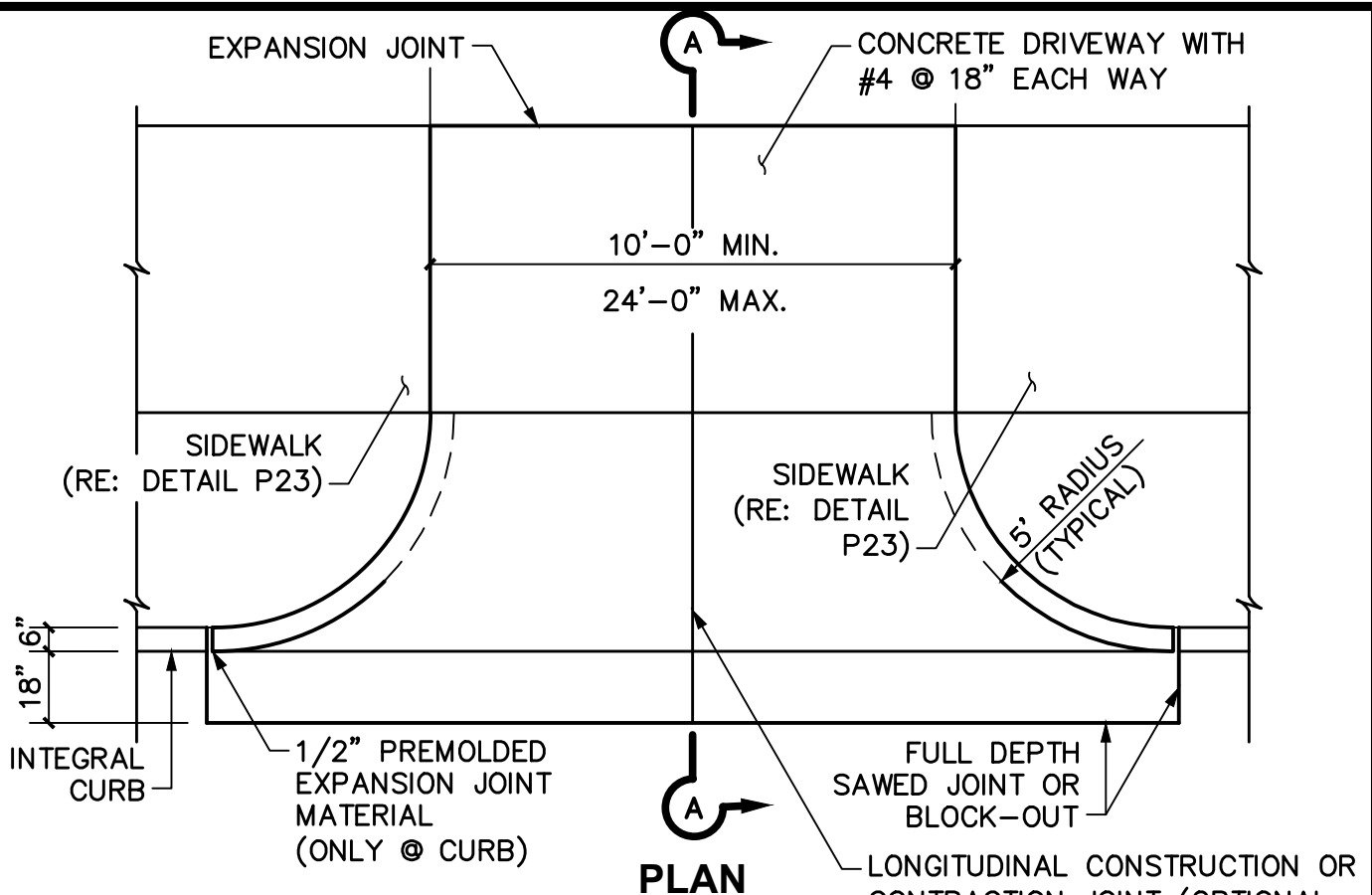


STANDARD CONSTRUCTION DETAIL COMMERCIAL DRIVEWAY APPROACH

SCALE: AS MARKED

REVISED: AUG 2020

P17



NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. SIDEWALK SECTION THROUGH DRIVEWAY SHALL BE POURED SAME THICKNESS AS DRIVEWAY APPROACH (EXISTING SIDEWALK, IF ANY, SHALL BE REMOVED).
3. DRIVEWAY THICKNESS TO MATCH STREET PAVEMENT THICKNESS (6" MINIMUM).
4. DRIVEWAYS CONSTRUCTED ON PRIVATE PROPERTY SHALL TAPER AT 1:1 RATIO TO INTERSECT AT PROPERTY LINE NO GREATER THAN 24' WIDTH.



**STANDARD CONSTRUCTION DETAIL
RESIDENTIAL DRIVEWAY APPROACH
WITH VERTICAL SAWCUT**

SCALE: AS MARKED

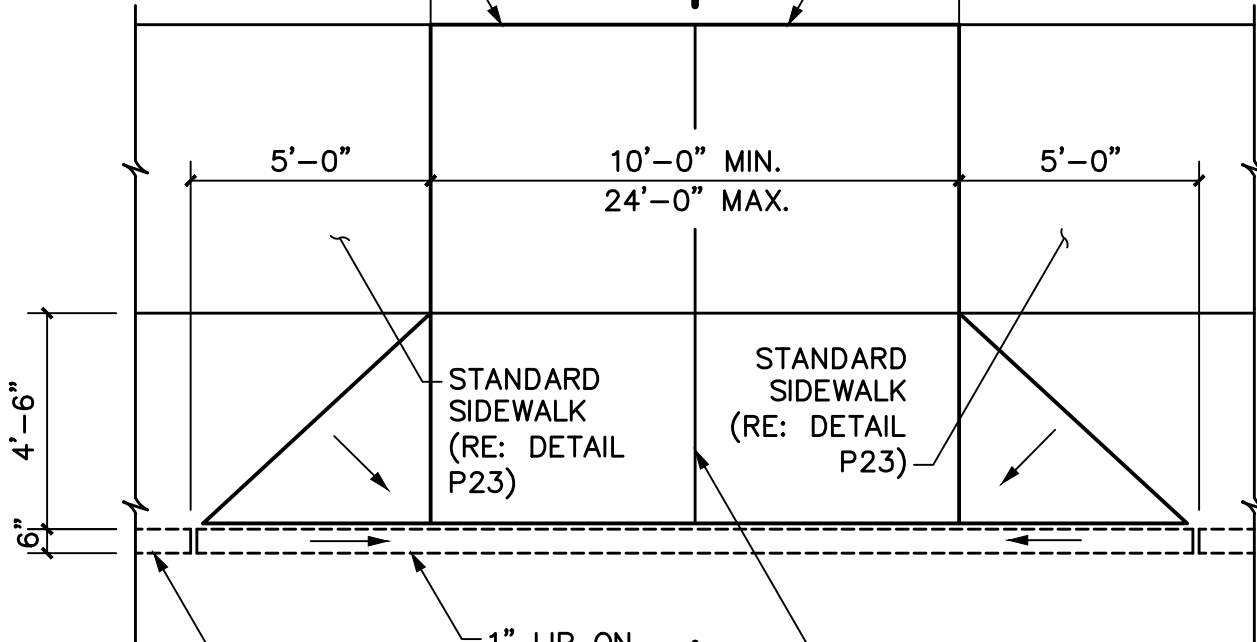
REVISED: AUG 2020

P18

PROVIDE EXPANSION JOINT
ONLY IF CONNECTING TO
EXISTING CONCRETE DRIVE

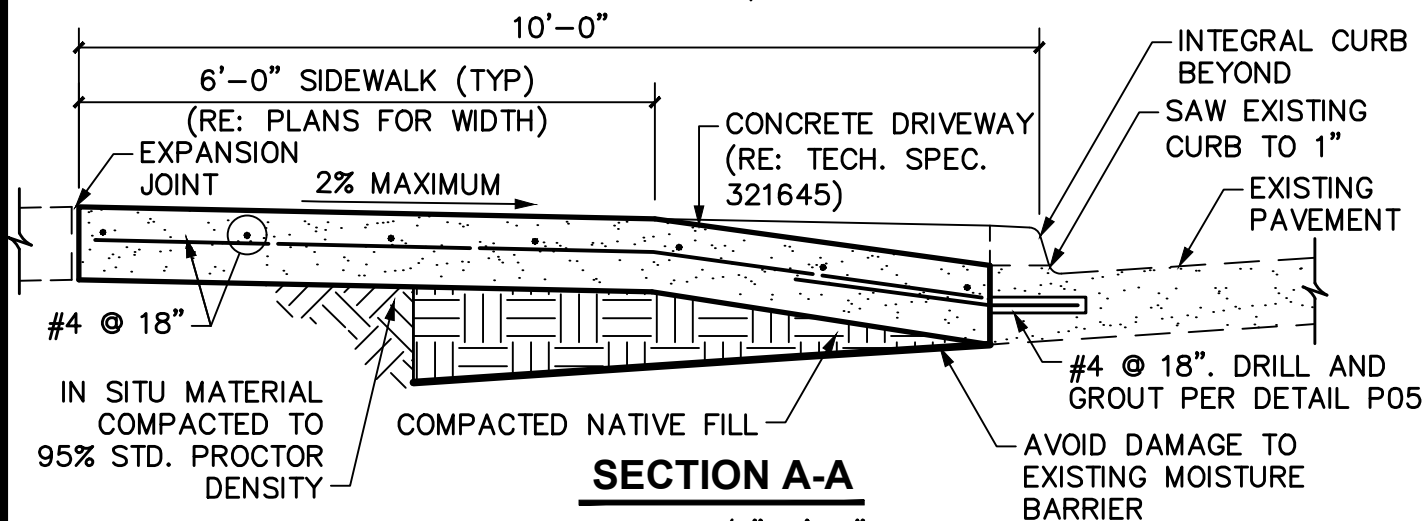


CONCRETE DRIVEWAY WITH #4
@ 18" EACH WAY



PLAN

SCALE: 1/4"=1'-0"



SECTION A-A

SCALE: 1/2"=1'-0"

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. SIDEWALK SECTION THROUGH DRIVEWAY SHALL BE POURED SAME THICKNESS AS DRIVEWAY APPROACH (EXISTING SIDEWALK, IF ANY, SHALL BE REMOVED).
3. DRIVEWAY THICKNESS TO MATCH STREET PAVEMENT THICKNESS (6" MINIMUM).
4. DRIVEWAYS CONSTRUCTED ON PRIVATE PROPERTY SHALL TAPER AT A 1:1 RATIO TO INTERSECT APPROACH AT SIDEWALK NO GREATER THAN 24' WIDTH.



STANDARD CONSTRUCTION DETAIL RESIDENTIAL DRIVEWAY APPROACH WITH HORIZONTAL SAWCUT

SCALE: AS MARKED

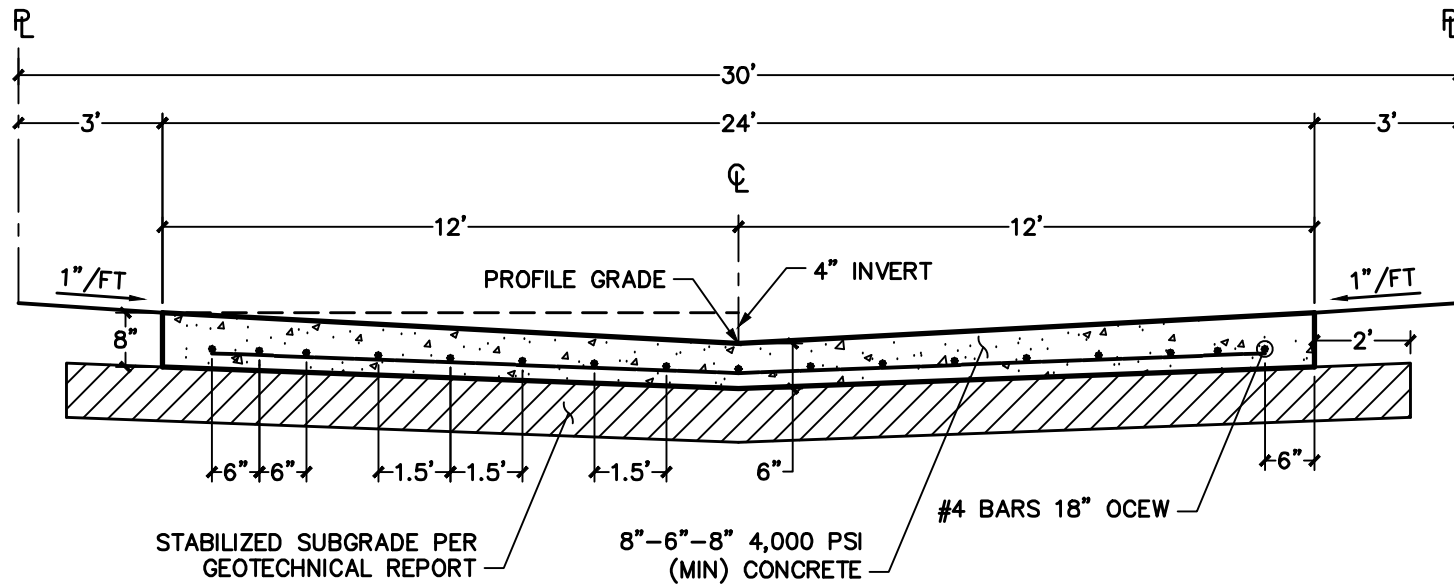
REVISED: AUG 2020

P19

Technical drawing of a concrete curb and gutter section. The drawing shows a cross-section of the curb and gutter assembly. The curb is 4" thick with #3 reinforcement at 18" OCEW. The gutter is 5" deep. The concrete is 8"-5"-8" (Class P1 or P2). The drawing includes dimensions for the curb height (4"), gutter depth (5"), and various horizontal distances (3'-0", 6'-0", 1'-6", 1'-6", 1'-6", 1'-0"). It also shows the profile grade and the expansion material (redwood) used for the curb. The drawing is labeled with 'P' and 'G' at the ends, indicating the profile and gutter lines.

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. ALL REINFORCING STEEL SHALL BE #4 BARS CONFORMING TO ASTM A615 (GRADE 60) IN ACCORDANCE WITH TECHNICAL SPECIFICATION 032100.
3. EXPANSION JOINTS SHALL BE PLACED AT EVERY 200 FT FOR ALLEYS.





NOTES:

1. REFER TO TECHNICAL SPECIFICATION 321313 FOR CONCRETE PAVEMENT.
2. ALL REINFORCING STEEL SHALL BE #4 BARS CONFORMING TO ASTM A615 (GRADE 60) IN ACCORDANCE WITH TECHNICAL SPECIFICATION 032100.
3. EXPANSION JOINTS SHALL BE PLACED AT EVERY 200 FT FOR MEWS.

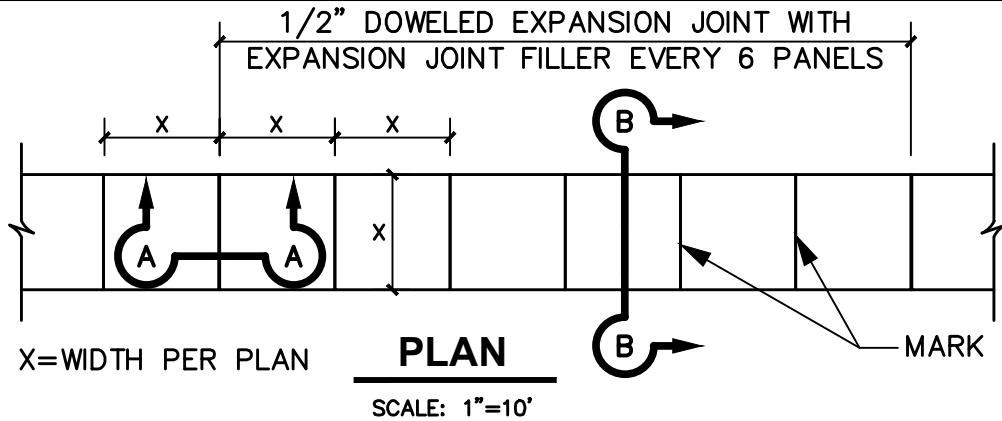


STANDARD CONSTRUCTION DETAIL
TYPICAL MEWS SECTION

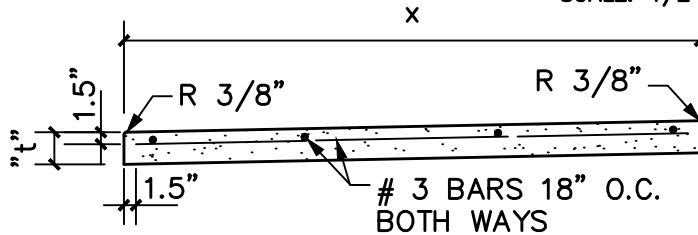
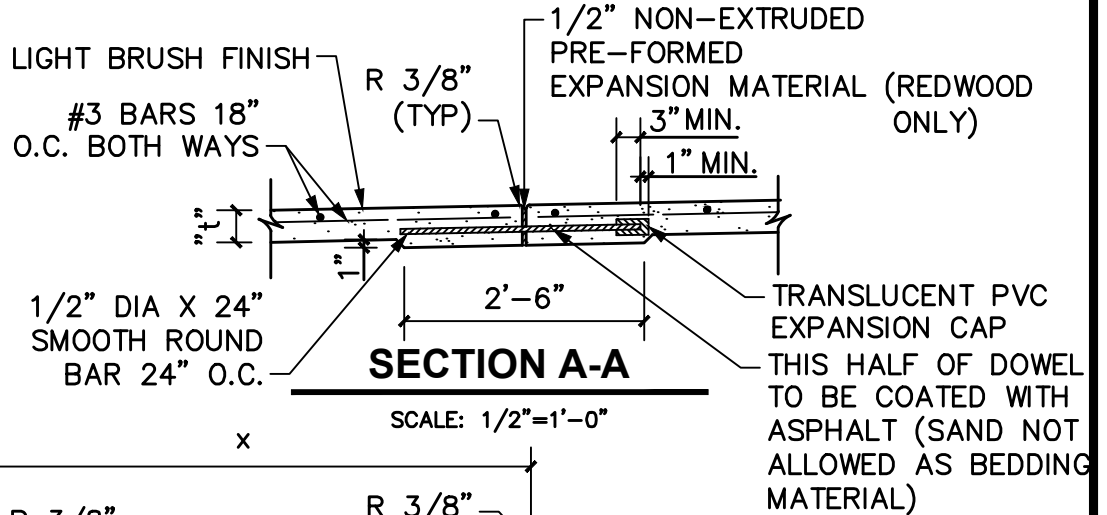
SCALE: 1/4"=1'-0"

REVISED: AUG 2020

P21



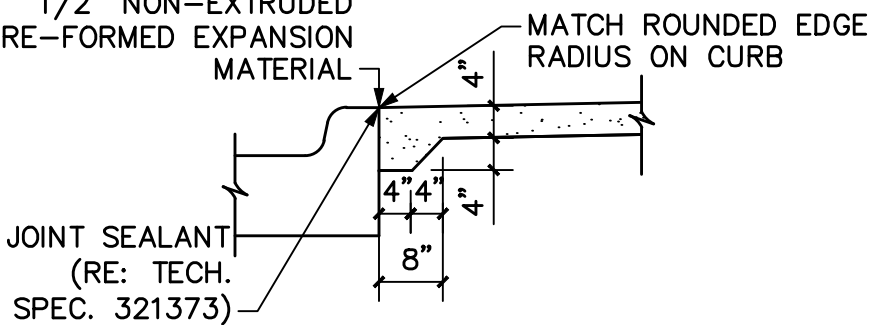
SIDEWALK	
WIDTH	"t"
UP TO 6'	4"
6'1" TO 7'11"	5"
8'+	6"



NOTES:

1. MAXIMUM LONGITUDINAL GRADE OF THE SIDEWALK SHALL BE FIVE PERCENT (5%) OR THE GRADE OF THE ADJACENT STREET.
2. CROSS SLOPE OF SIDEWALK SHALL BE TWO PERCENT (2%) MAX PER A.D.A.
3. OTHER THAN 6' SIDEWALK WIDTH, MAY BE SPECIFIED BY OWNER. 6' SIDEWALK WIDTH FOR A & B THOROUGHFARES.
4. ALL SIDEWALK SHALL BE CLASS A CONCRETE (RE: TECH SPEC 321650).
5. ALL HONEYCOMB IN BACK OF CURB TO BE TROWEL-PLASTERED BEFORE POURING SIDEWALK.
6. LUG MAY BE FORMED BY SHAPING SUBGRADE TO APPROXIMATE DIMENSIONS SHOWN.
7. SUBGRADE SHALL BE COMPACTED TO AT LEAST 95% OF MAXIMUM DENSITY (RE: TECH SPEC 321650).
8. EXPANSION JOINTS SHALL BE SEALED (RE: TECH SPEC 321373, ALT-671 FLEX CRETE).

USE EDGER-BOTH SIDES
1/2" NON-EXTRUDED
PRE-FORMED EXPANSION
MATERIAL



**JOINT LUG DETAIL FOR
SIDEWALK ADJACENT TO CURB**

SCALE: 1/2"=1'-0"



**STANDARD CONSTRUCTION DETAIL
REINFORCED CONCRETE SIDEWALK**

SCALE: AS MARKED

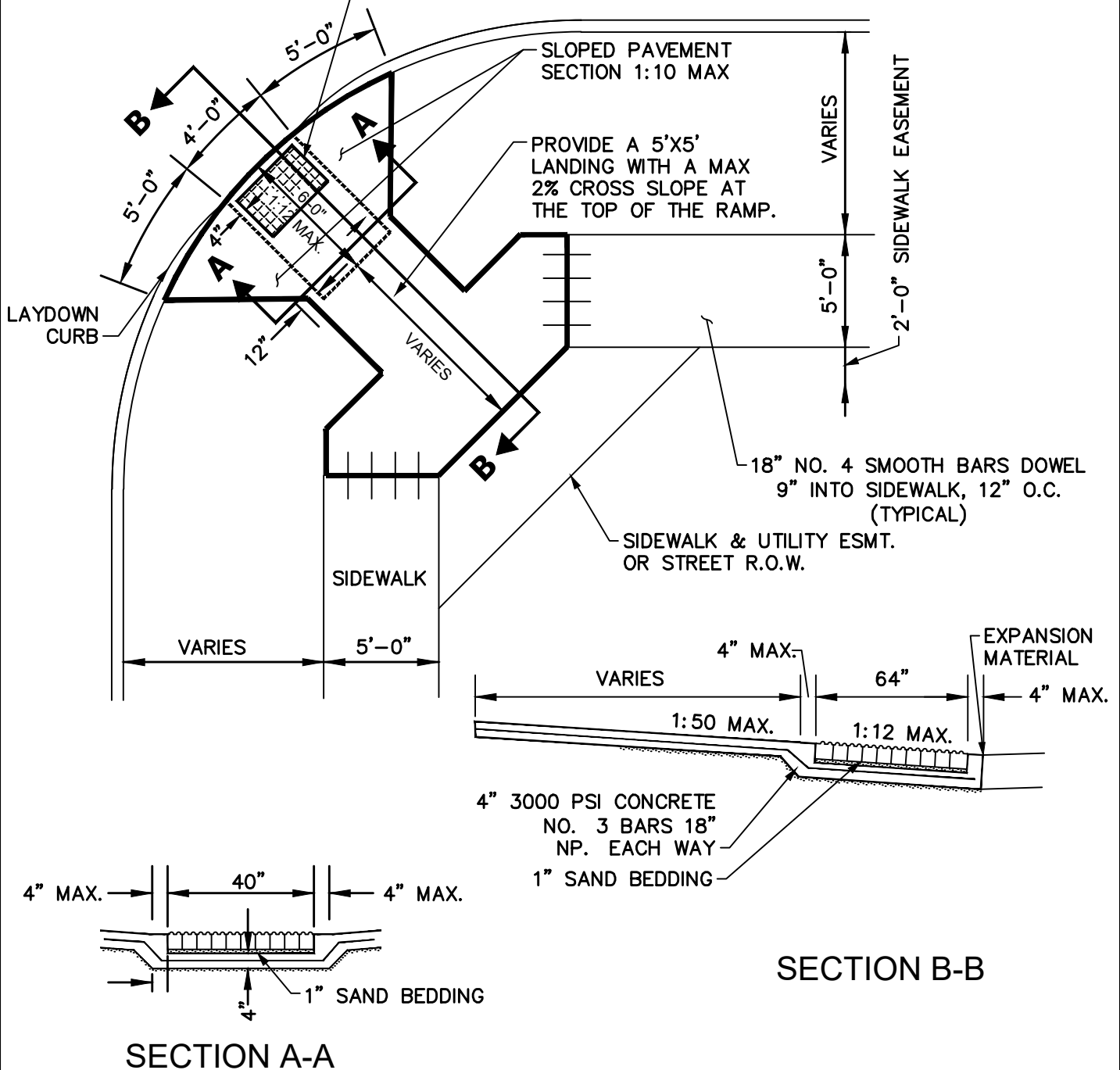
REVISED: AUG 2020

P23



P24

BRICK PAVERS SHALL BE 8"X 4"X 2-1/2" ANTIQUE RED PAVERS IN COLOR MEETING ADA SECTION 4.29.2. (WHITACRE GREER ANTIQUE RED SHADE NO. 32 OR APPROVED EQUAL). PAVERS SHALL HAVE DETECTABLE WARNING THAT CONSIST OF RAISED TRUNCATED DOMES WITH A DIA. OF 0.9 IN. (23MM), A HEIGHT OF NOMINAL 0.2 IN. (5MM) AND A CENTER TO CENTER SPACING OF NOMINAL 2.35 IN. (60MM).



STANDARD CONSTRUCTION DETAIL BARRIER FREE RAMP AT RESIDENTIAL INTERSECTIONS

SCALE: N.T.S

REVISED: AUG 2020

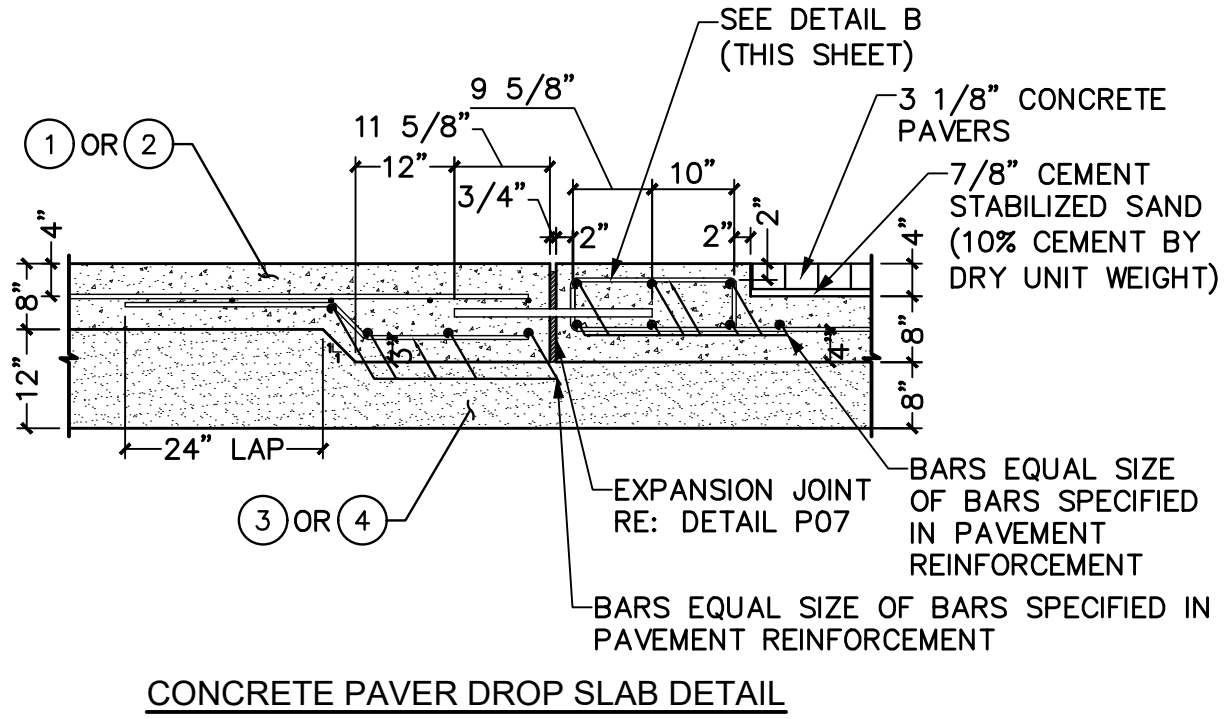
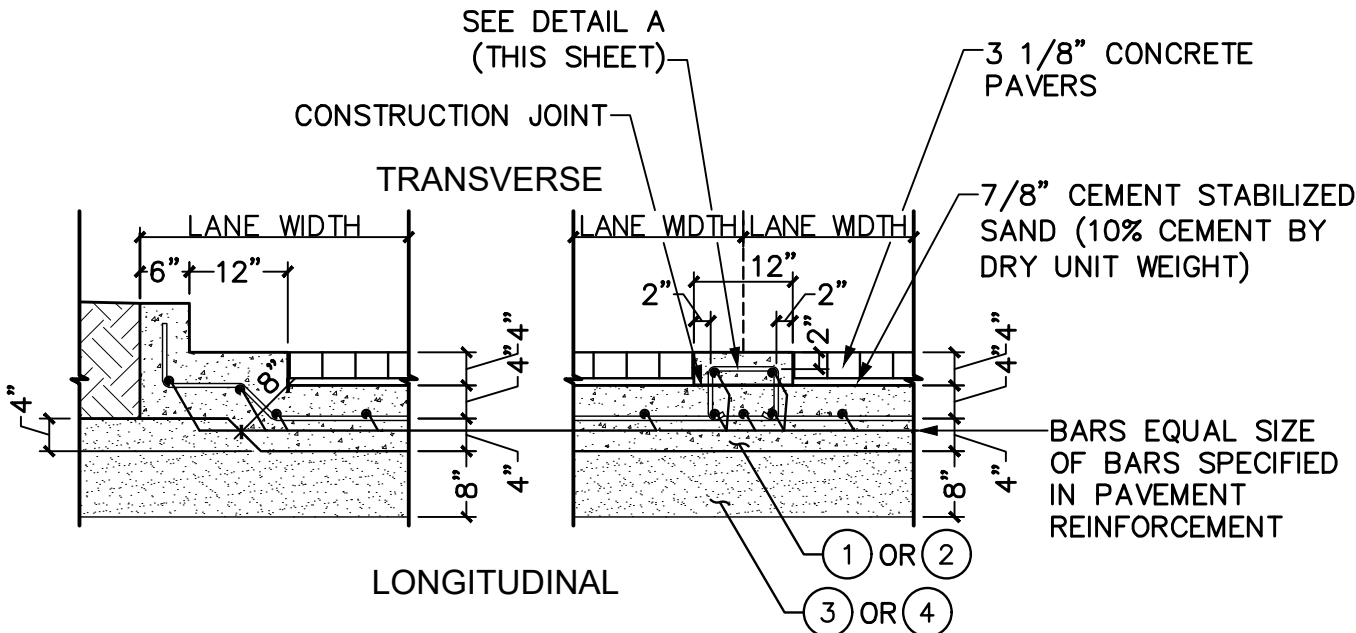
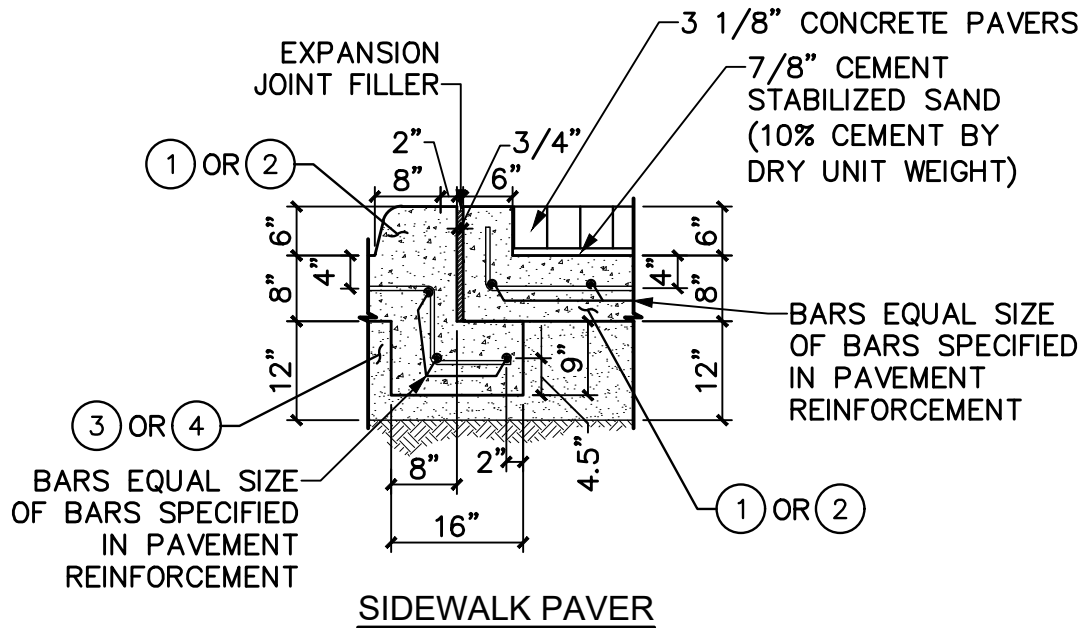
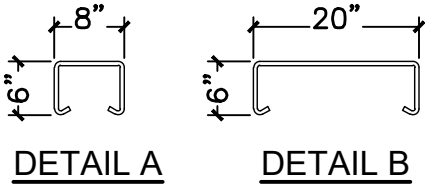
P25

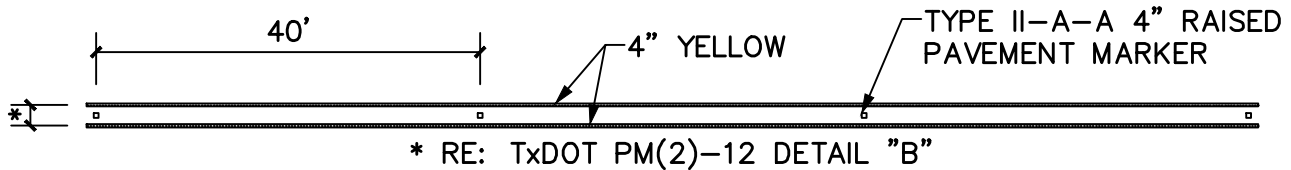
NOTES:

1. TYPICAL SECTIONS ARE APPROXIMATE. REFER TO PLAN SHEETS FOR STATIONING AND LIMITS.
2. REFER TO CITY STANDARD TECHNICAL SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

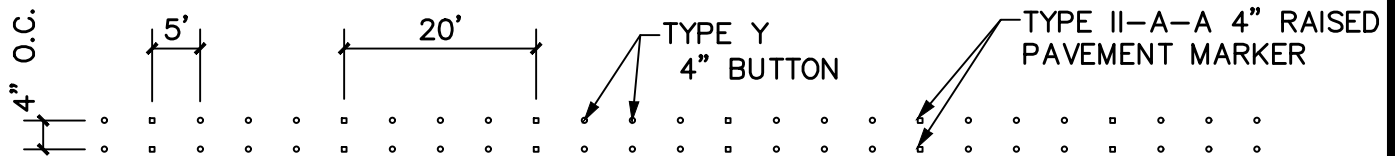
LEGEND:

- ① 8" REINFORCED CONCRETE PAVEMENT WITH 6" MONO CURB (CLASS P2 [HAND FINISHED]) (#4 BARS @ 18" O.C.E.W.)
- ② 7" REINFORCED CONCRETE PAVEMENT WITH 6" MONO CURB (CLASS P2 [HAND FINISHED]) (#4 BARS @ 18" O.C.E.W.)
- ③ 8" LIME STABILIZED SUBGRADE (9% APPROX. 92 LB/SY) COMPACTED PER GEOTECHNICAL RECOMMENDATIONS UNLESS STATED OTHERWISE IN PLAN SET.
- ④ 12" FLEX BASE TxDOT ITEM 247, TYPE A, GRADE 1, COMPACTED PER GEOTECH RECOMMENDATION, REFER TO CITY OF FRISCO APPROVED MATERIALS LIST. NO SUBSTITUTIONS UNLESS STATED OTHERWISE IN PLAN SET.

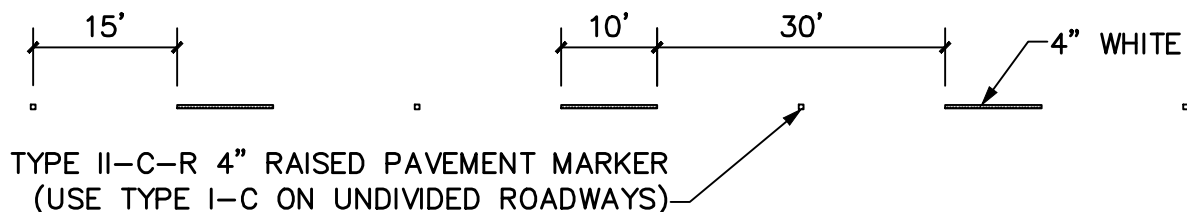




DOUBLE YELLOW LINE (PAVEMENT MARKINGS)



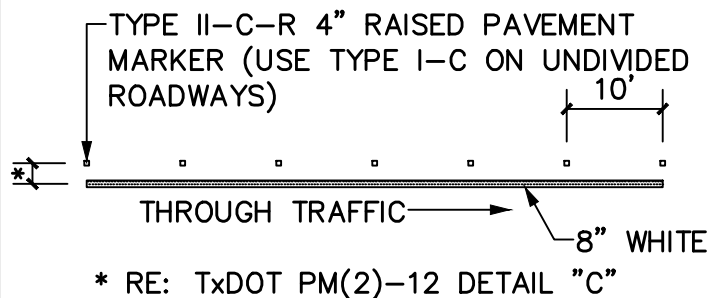
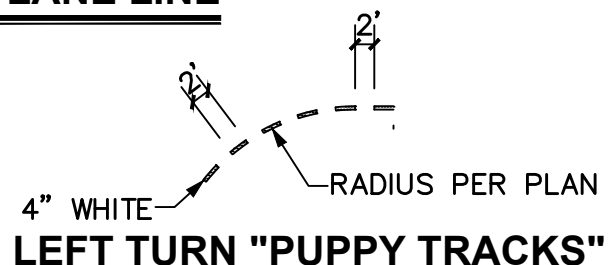
DOUBLE YELLOW LINE (BUTTONS, RAISED PAVEMENT MARKERS)



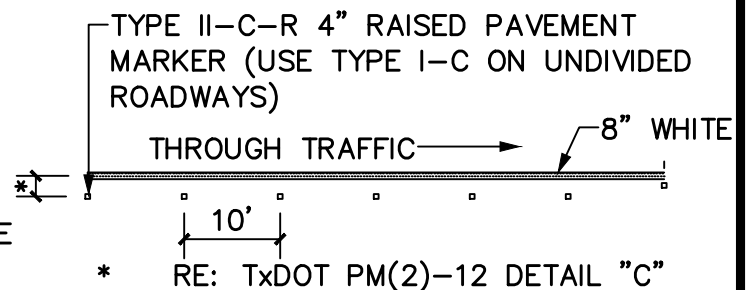
BROKEN WHITE LANE LINE



WHITE OR YELLOW EDGE LINE



LEFT TURN BAY LINE

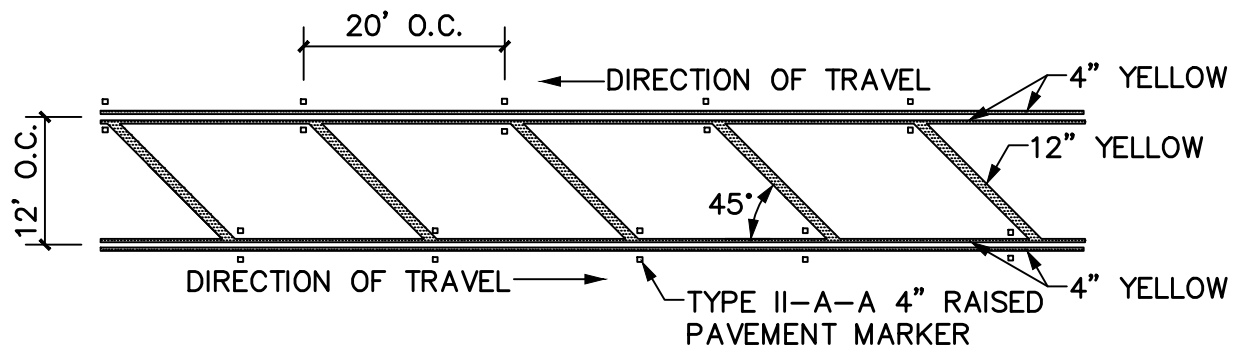


RIGHT TURN BAY LINE

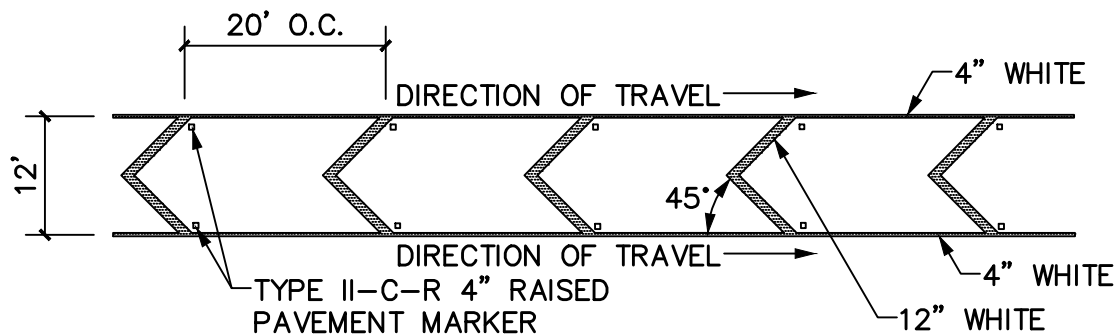
NOTES:

1. ALL STRIPING, ARROWS AND WORDS ON PAVEMENT SHALL BE THERMOPLASTIC UNLESS OTHERWISE NOTED IN PLANS.
2. REFER TO TECHNICAL SPECIFICATION 321723.

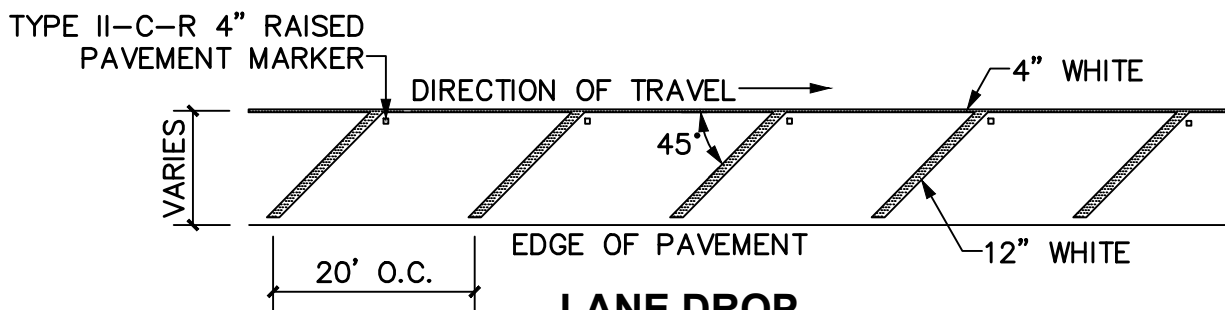




OPPOSING TRAFFIC GORE DETAIL



NEUTRAL AREA CHANNELIZATION

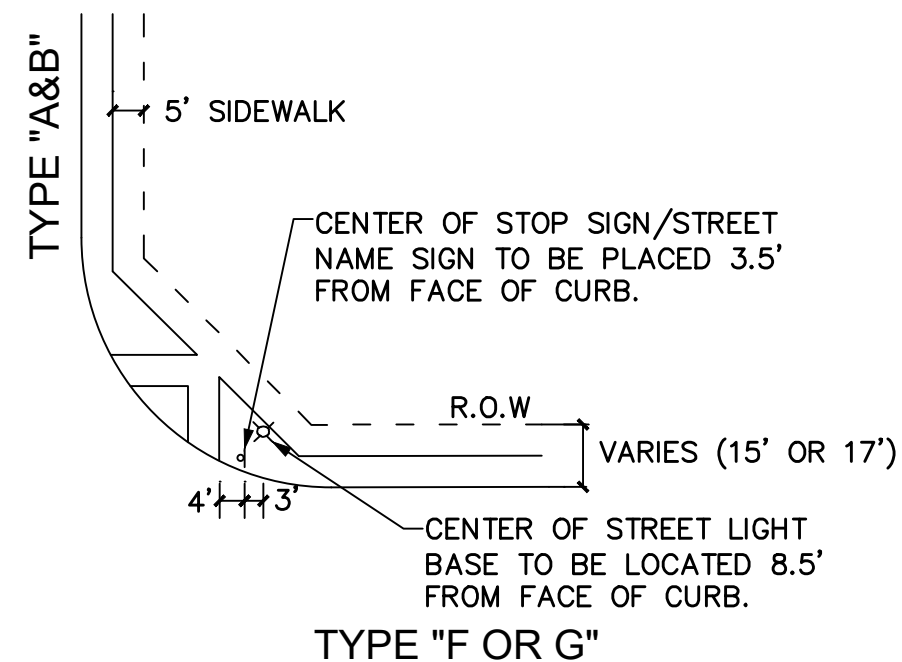
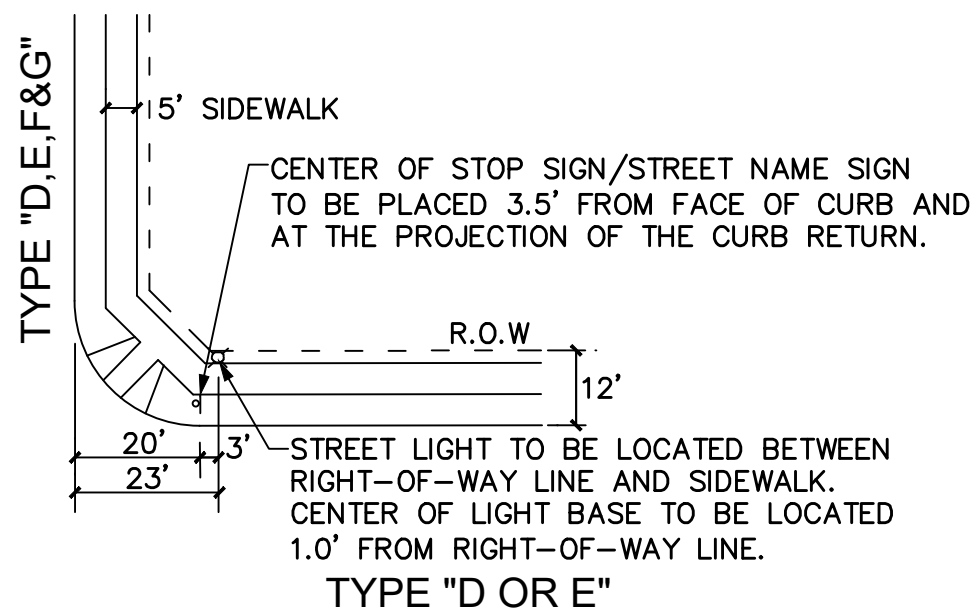
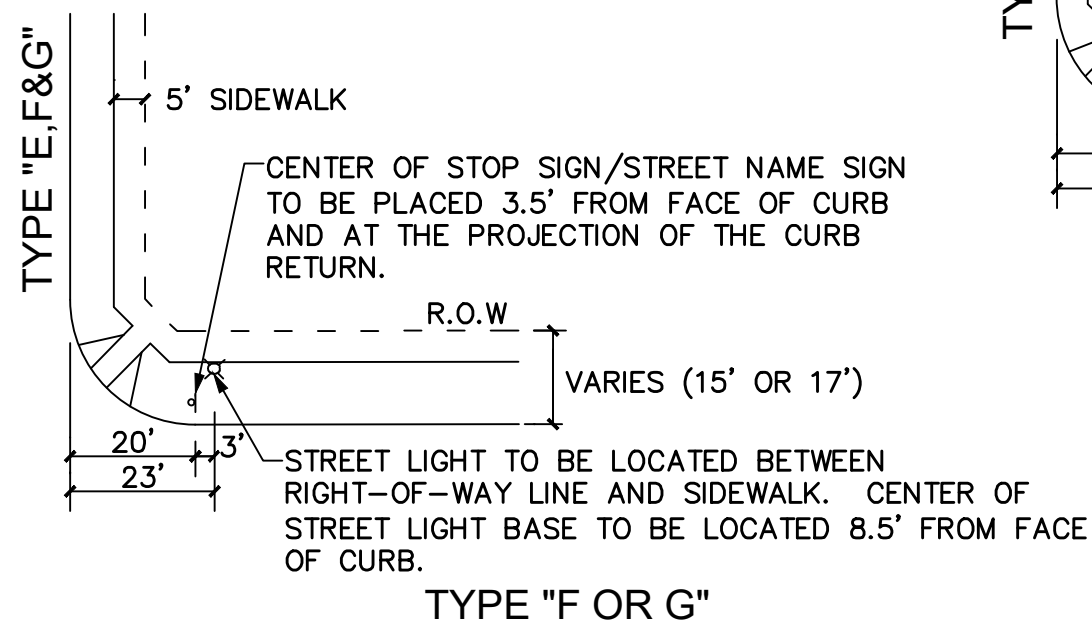
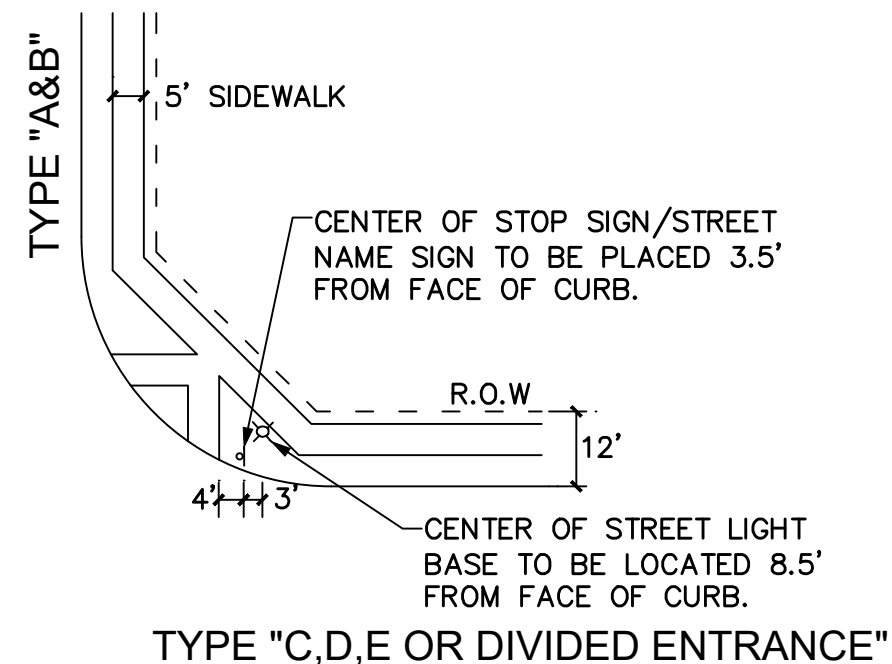
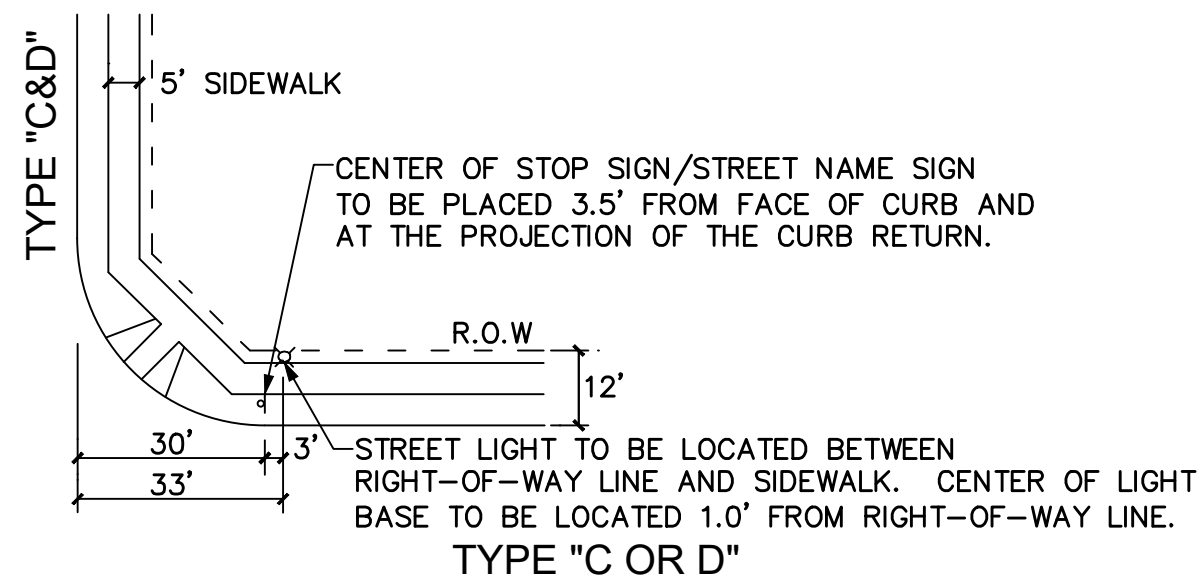


LANE DROP

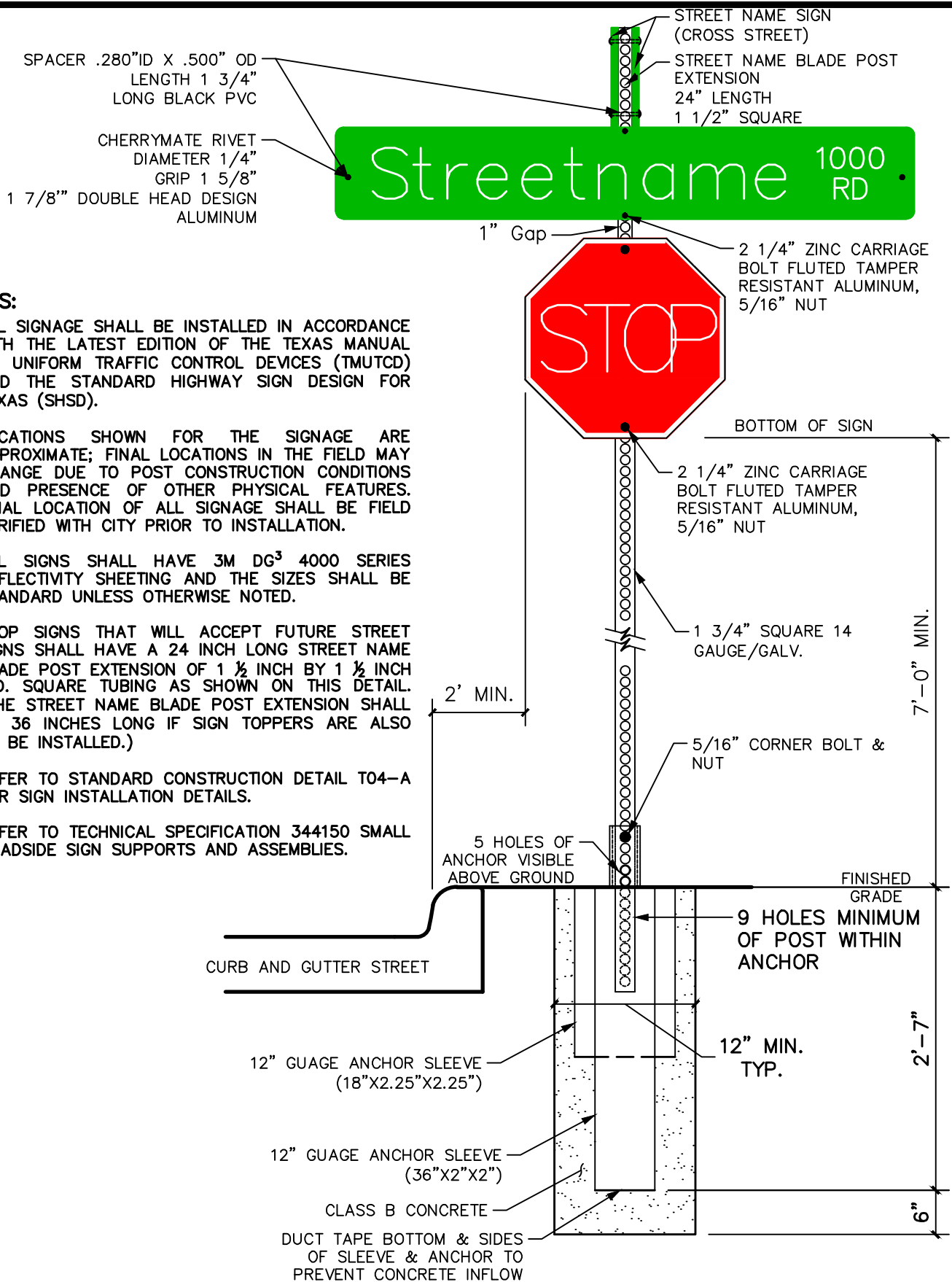
NOTES:

1. REFER TO TxDOT PM(2)-12 DETAIL "A" FOR DIMENSION BETWEEN PAVEMENT MARKINGS AND MARKERS.
2. REFER TO TECHNICAL SPECIFICATION 321723.





NOTE:
IN CASE OF VARIATIONS, STREET LIGHT AND STOP SIGN CENTERS SHALL BE OFFSET Laterally A MINIMUM OF 5.0 FEET.



NOTES:

1. ALL SIGNAGE SHALL BE INSTALLED IN ACCORDANCE WITH THE LATEST EDITION OF THE TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (TMUTCD) AND THE STANDARD HIGHWAY SIGN DESIGN FOR TEXAS (SHSD).
2. LOCATIONS SHOWN FOR THE SIGNAGE ARE APPROXIMATE; FINAL LOCATIONS IN THE FIELD MAY CHANGE DUE TO POST CONSTRUCTION CONDITIONS AND PRESENCE OF OTHER PHYSICAL FEATURES. FINAL LOCATION OF ALL SIGNAGE SHALL BE FIELD VERIFIED WITH CITY PRIOR TO INSTALLATION.
3. ALL SIGNS SHALL HAVE 3M DG³ 4000 SERIES REFLECTIVITY SHEETING AND THE SIZES SHALL BE STANDARD UNLESS OTHERWISE NOTED.
4. STOP SIGNS THAT WILL ACCEPT FUTURE STREET SIGNS SHALL HAVE A 24 INCH LONG STREET NAME BLADE POST EXTENSION OF 1 1/2 INCH BY 1 1/2 INCH O.D. SQUARE TUBING AS SHOWN ON THIS DETAIL. (THE STREET NAME BLADE POST EXTENSION SHALL BE 36 INCHES LONG IF SIGN TOPPERS ARE ALSO TO BE INSTALLED.)
5. REFER TO STANDARD CONSTRUCTION DETAIL T04-A FOR SIGN INSTALLATION DETAILS.
6. REFER TO TECHNICAL SPECIFICATION 344150 SMALL ROADSIDE SIGN SUPPORTS AND ASSEMBLIES.



STANDARD CONSTRUCTION DETAIL

SIGN POST AND MOUNTING DETAILS

SCALE: N.T.S.

REVISED: AUG 2020

T04

INSTALLATION NOTES:

1. REMOVE PROTECTIVE COATING FROM ALL THE SIGNS PRIOR TO INSTALLATION.
2. INSTALL ALL STREET NAME BLADES ON STREET NAME BLADE EXTENSION POST USING PRE DRILLED HOLES ON SIGNS AND BOLTS AS SHOWN ON DETAIL T04.
3. ATTACH END OF STREET NAME SIGNS TOGETHER AS SHOWN ON THE DETAIL T04.
4. IF TRAFFIC ENGINEERING APPROVES THE USE OF A SIGN TOPPER THAT IDENTIFIES THE NEIGHBORHOOD, ONE LEVEL OF SIGN TOPPER FLAT BLADES MAY BE ADDED ABOVE THE STREET NAME BLADES AND ATTACHED IN A SIMILAR MANNER USING A LONGER EXTENSION POST (AS SPECIFIED ON DETAIL T04). A SIGN TOPPER SHALL NOT EXCEED 24 INCHES IN LENGTH OR 9 INCHES IN HEIGHT.
5. INSERT EXTENSION POST ON TO THE SIGN POST AND ATTACH AS SHOWN ON DETAIL T04. INSTALL ADDITIONAL SIGN (GENERALLY STOP SIGN) AS SHOWN ON DETAIL T04.
6. ENSURE A MINIMUM OF 7 FEET CLEARANCE BETWEEN FINISHED GROUND AND THE BOTTOM ON THE LOWEST SIGN.
7. ENSURE A MINIMUM OF 2 FEET OF HORIZONTAL CLEARANCE IS MAINTAINED BETWEEN CURB FACE AND CLOSEST SIGN EDGE.
8. ALL SIGNS SHALL BE INSTALLED WITH A CONCRETE BASE AS SHOWN ON DETAIL T04.
9. INSERT SIGN POST AND SIGN ASSEMBLY ON TO THE ANCHOR SLEEVE AND BASE ASSEMBLY. CONNECT BOTH ASSEMBLIES USING A 5/16" CORNER BOLT & NUT AS SHOWN ON THE DETAIL T04.
10. INSTALL A STICKER AT THE BACK OF SIGN INDICATING MONTH AND THE YEAR OF THE INSTALLATION.
11. REFER TO DETAIL T03 FOR PLACEMENT OF STOP SIGNS AT INTERSECTIONS.



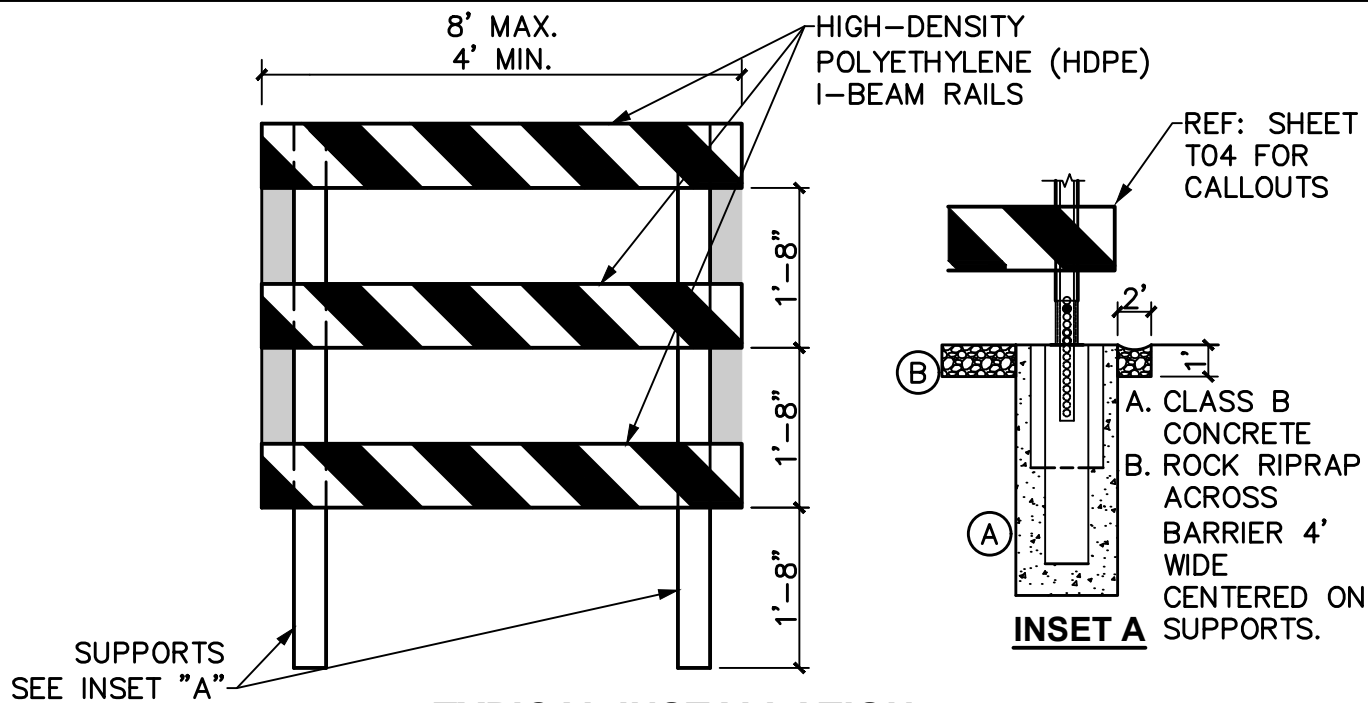
STANDARD CONSTRUCTION DETAIL

SIGN INSTALLATION DETAILS

SCALE: N.T.S.

REVISED: AUG 2020

T05



TYPICAL INSTALLATION

NOTES:

1. ALL BARRICADES SHALL BE IN ACCORDANCE WITH THE LATEST REVISION OF THE TEXAS MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (TMUTCD) AND THE STANDARD HIGHWAY SIGN DESIGNS FOR TEXAS (SHSD).
2. BARRICADE MUST COVER ENTIRE WIDTH OF PAVED ROADWAY OR FIRELANE SURFACE.
3. ALL RAILS TO BE HIGH-DENSITY POLYETHYLENE (HDPE), I-BEAM, 0.7 LB/FT MAXIMUM, 8-INCH SINGLE THICKNESS WEB, AND HOLLOW CORE FLANGES.
4. ALL SUPPORTS TO BE A 1-3/4" SQUARE 14 GAUGE/GALV POST. POST SUPPORT SHALL BE ANCHORED USING 2-1/4" ANCHOR SLEEVE COMBO. 36" ANCHORS SHALL BE INSTALLED WITH 5 HOLES ABOVE FINISHED GRADE. ROCK RIPRAP SHALL BE USED AT GROUND LEVEL.
5. BARRICADES SHALL BE DESIGNED AND CONSTRUCTED TO THE STANDARDS OF THE COMPLIANT WORK ZONE TRAFFIC CONTROL DEVICE LIST.
6. DIAGONAL STRIPING SHALL BE PLACED IN A MANNER THAT DIRECTS TRAFFIC IN THE APPROPRIATE DIRECTION OF TRAVEL.
7. PROPOSED BARRICADE STRIPING SHALL BE APPROVED BY THE CITY PRIOR TO PLACEMENT OF BARRICADE.



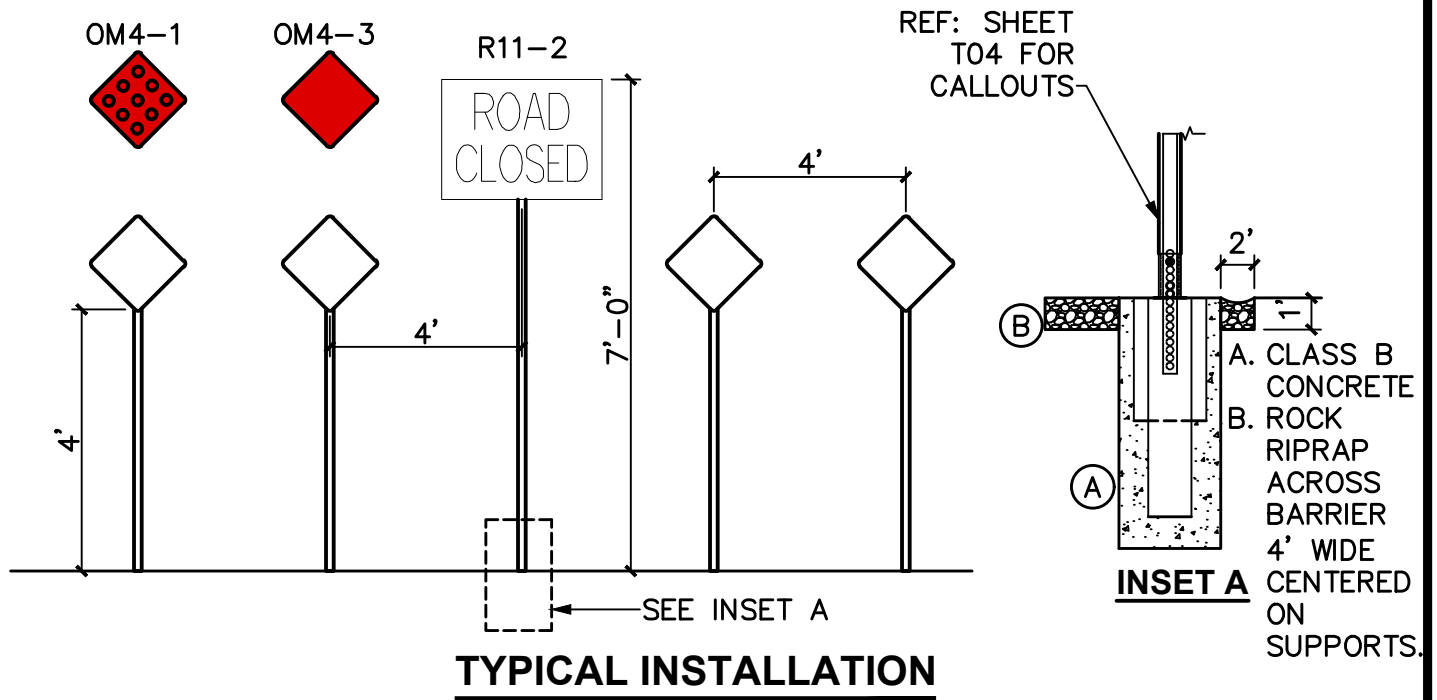
STANDARD CONSTRUCTION DETAIL

ROAD CLOSED BARRICADE

SCALE: 1/2"=1'

REVISED: AUG 2020

T06



NOTES:

1. OBJECT MARKER SIGNS MUST SPAN THE ENTIRE WIDTH OF THE PAVED ROADWAY OR FIRELANE SURFACE. A SIGN POST SHALL BE INSTALLED WITHIN 4' OF EACH EDGE OF THE PAVED ROADWAY OR FIRELANE.
2. ALL SUPPORTS TO BE A 1-3/4" SQUARE 14 GAUGE/GALV POST. POST SUPPORT SHALL BE ANCHORED USING 2-1/4" ANCHOR SLEEVE COMBO. 36" ANCHORS SHALL BE INSTALLED WITH 5 HOLES ABOVE FINISHED GRADE. ROCK RIPRAP SHALL BE USED AT GROUND LEVEL.
3. SIGNS SHALL BE DESIGNED AND CONSTRUCTED TO THE STANDARDS OF THE COMPLIANT WORK ZONE TRAFFIC CONTROL DEVICE LIST.



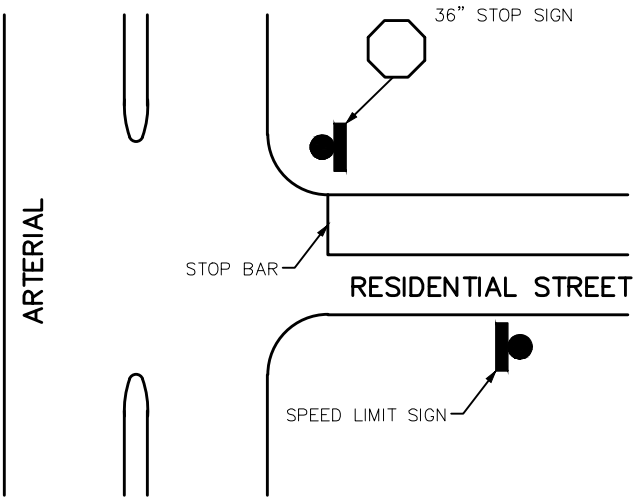
STANDARD CONSTRUCTION DETAIL

ROAD CLOSED WITH OBJECT MARKER SIGNS

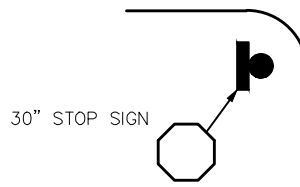
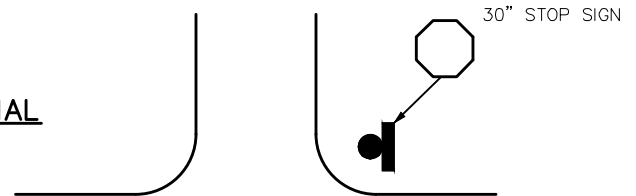
SCALE: N.T.S.

REVISED: AUG 2020

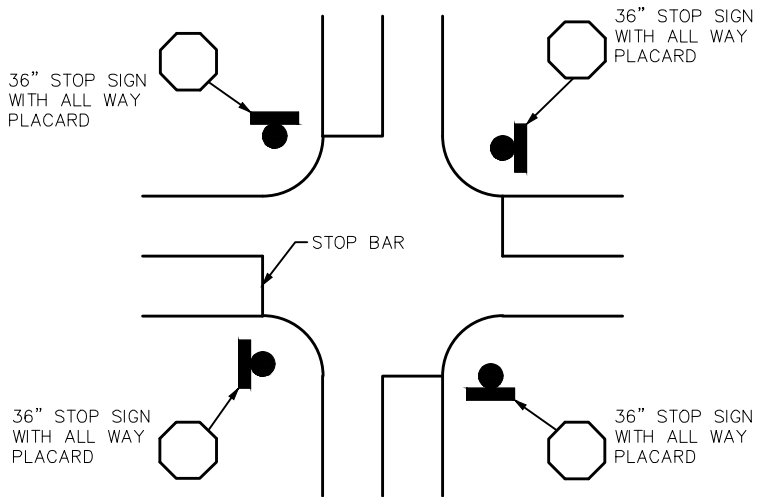
T07



RESIDENTIAL STREET INTERSECTING ARTERIAL



RESIDENTIAL 2-WAY STOP



RESIDENTIAL ALL WAY STOP

NOTE:

1. SEE DETAIL T03 FOR EXACT PLACEMENT OF STOP SIGNS. STOP BARS SHALL BE INSTALLED IN LINE WITH THE STOP SIGN.



STANDARD CONSTRUCTION DETAIL

STOP SIGNS AND STOP BARS

SCALE: N.T.S.

REVISED: AUG 2020

T08

52"



LOCATION:

- 9" FLAT BLADE SHALL BE USED AT ALL INTERSECTIONS.

BLADE REQUIREMENTS:

- 9" FLAT BLADE SHALL BE 0.08 INCH THICK ALUMINUM.
- MAX BLADE LENGTH SHALL BE 60".

LETTERING ALIGNMENT:

- STREET NAME SHALL BE LEFT JUSTIFIED.
- BLOCK NUMBERS SHALL BE LOCATED IN UPPER RIGHT HAND CORNER.
- ABBREVIATED STREET DESIGNATIONS SHALL BE LOCATED IN THE LOWER RIGHT HAND CORNER AND RIGHT JUSTIFIED.

LETTERING FOR 9" BLADES:

- FONT SHALL BE CLEAR VIEW 2W.
- LETTERS AND NUMBERS IN STREET NAME SHALL BE 6" TALL AND UPPER/LOWER CASE.
- LETTERS IN ABBREVIATED STREET DESIGNATIONS SHALL BE 3" TALL AND ALL UPPERCASE (I.E. LN, PKWY, DR, CT, ETC.)
- BLOCK NUMBERS SHALL BE 3" TALL.

SIGN SHEETING AND COLOR:

- BACKGROUND COLOR SHALL BE GREEN (3M, EC 1177) ON PUBLIC STREETS
- BACKGROUND COLOR SHALL BE BLUE (3M, EC 1175) ON PUBLIC WAYS AND FIRE LANES.
- LEGEND SHALL BE WHITE (3M, DG³ 4090).

NO OUTLET STREETS:

- A STREET WITH A CUL-DE-SAC END WILL REQUIRE A YELLOW (3M, DG³ 4081) "NO OUTLET" LOGO TO BE INSTALLED ON THE END OF THE BLADE CLOSEST TO THE CUL-DE-SAC.
- LOGO SHOULD BE MINIMUM SIZE OF 9"X9"

BLOCK NUMBER:

- BLOCK NUMBERS ARE REQUIRED ON ALL STREET NAME BLADES, EVEN IF NO HOUSE/BUILDINGS FRONT ONTO THE STREET. (EXCEPTION: NAMED FIRE LANES DO NOT HAVE BLOCK NUMBERS.)



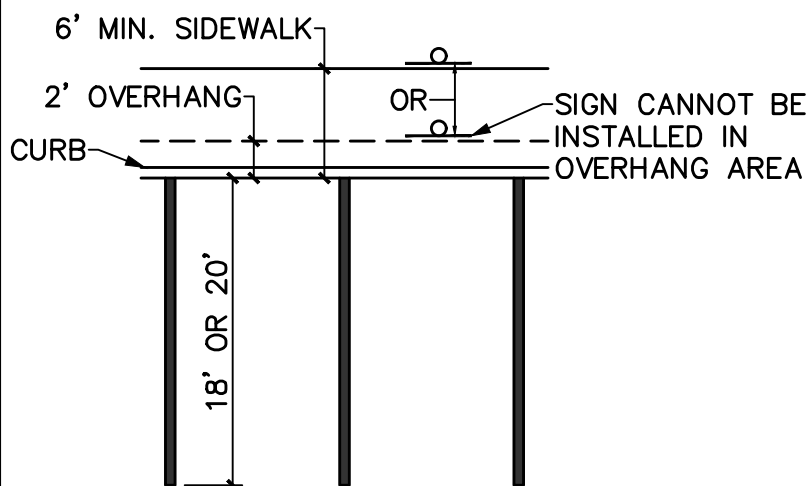
STANDARD CONSTRUCTION DETAIL

STREET NAME BLADE

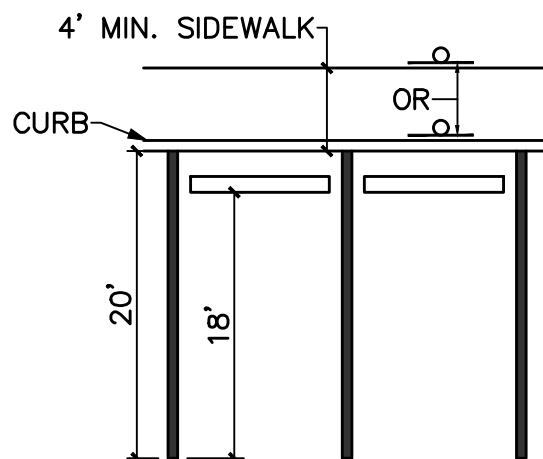
SCALE: N.T.S.

REVISED: AUG 2020

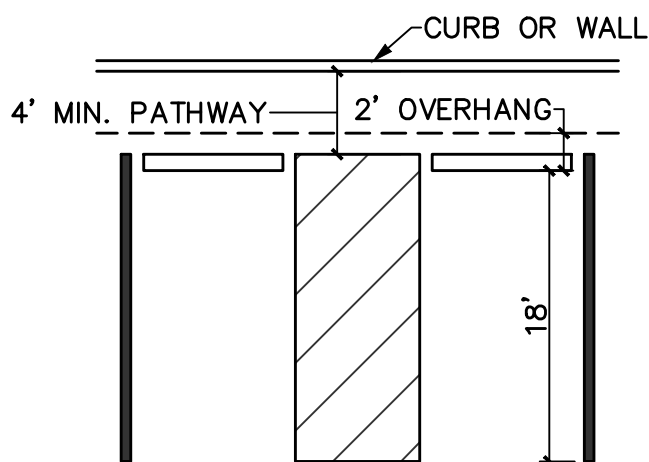
T09



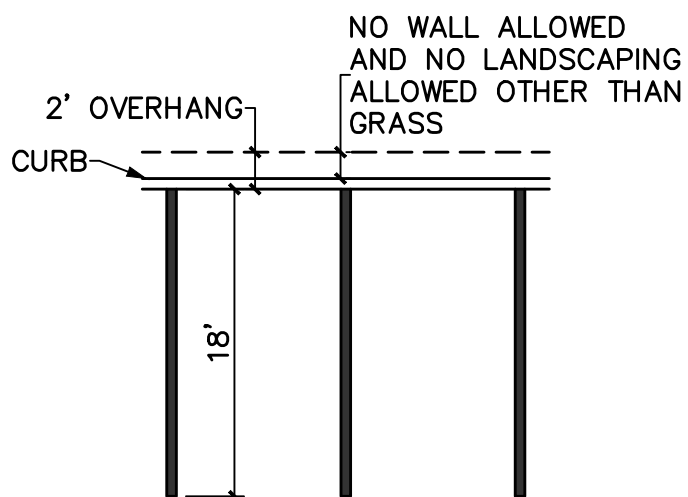
**SIDEWALK WITH
NO WHEEL STOPS**



**SIDEWALK WITH
WHEEL STOPS**



**NO CURB WITH
WHEEL STOPS**



NO SIDEWALK

NOTES:

1. WHEN USED, WHEEL STOPS SHALL BE INSTALLED SO THAT ALL PARKING SPACES ARE A MINIMUM OF 18 FEET DEEP MEASURED FROM THE FACE OF THE WHEEL STOP.
2. ANY VERTICAL OBSTRUCTION IN FRONT OF A SURFACE PARKING SPACE SHALL BE LOCATED 20 FEET FROM THE BACK OF THE PARKING SPACE.



1.5" RADIUS, 0.6" BORDER, 0.4" INDENT, BLACK ON WHITE.
ALL TEXT SHALL BE CLEARVIEWHWY-1 50% SPACING



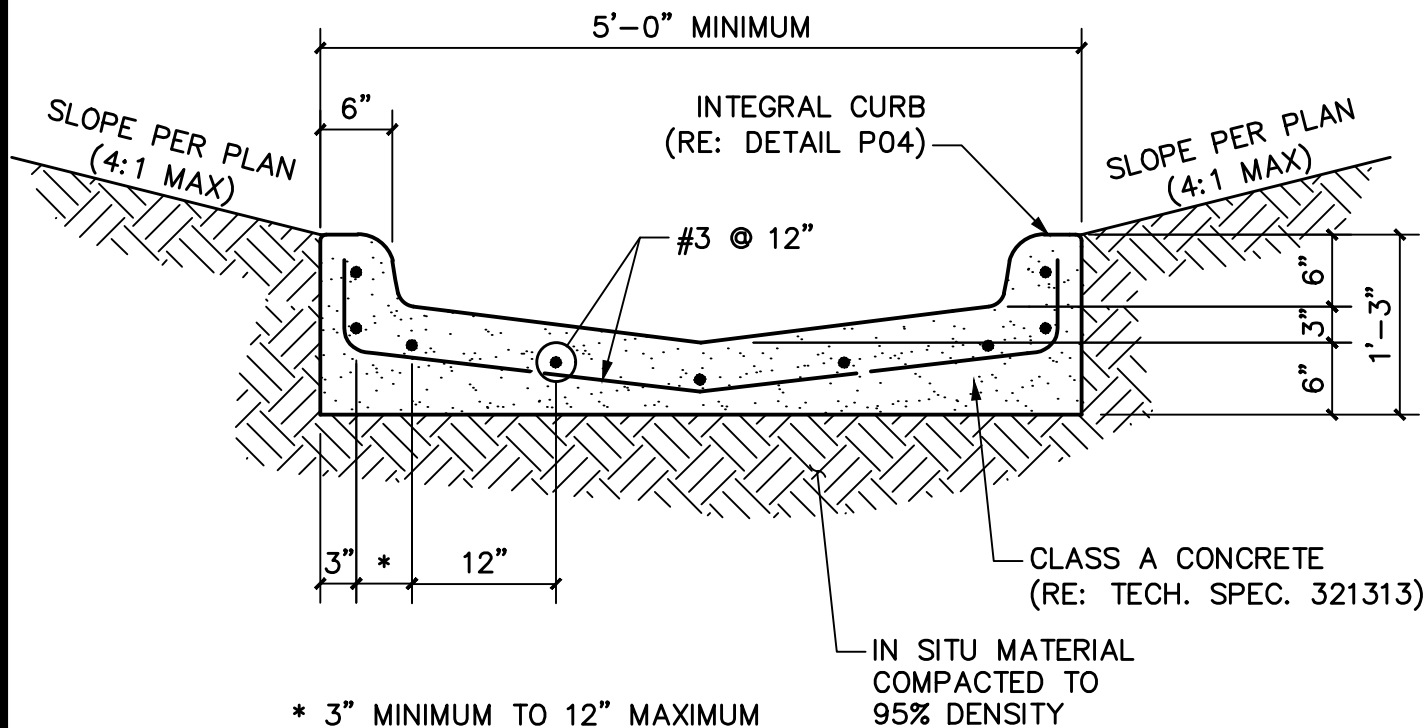
STANDARD CONSTRUCTION DETAIL

FUTURE STREET EXTENSION SIGN

SCALE: N.T.S.

REVISED: AUG 2020

T11



NOTES:

1. IF FLUME IS 7' OR WIDER, INSTALL 7' X 6" DIAMETER STEEL BOLLARDS (FILLED WITH CONCRETE) BURIED TO 4' DEPTH AT BOTH START AND END OF FLUME.
2. FIRST FIVE FEET OF SLOPE SHALL BE STABILIZED WITH PERMANENT TURF REINFORCEMENT MAT OR EQUIVALENT.
3. 1/2" DOWLED EXPANSION JOINT EVERY 30'
4. EXPANSION JOINTS SHALL BE SEALED (RE: TECH SPEC 321373)



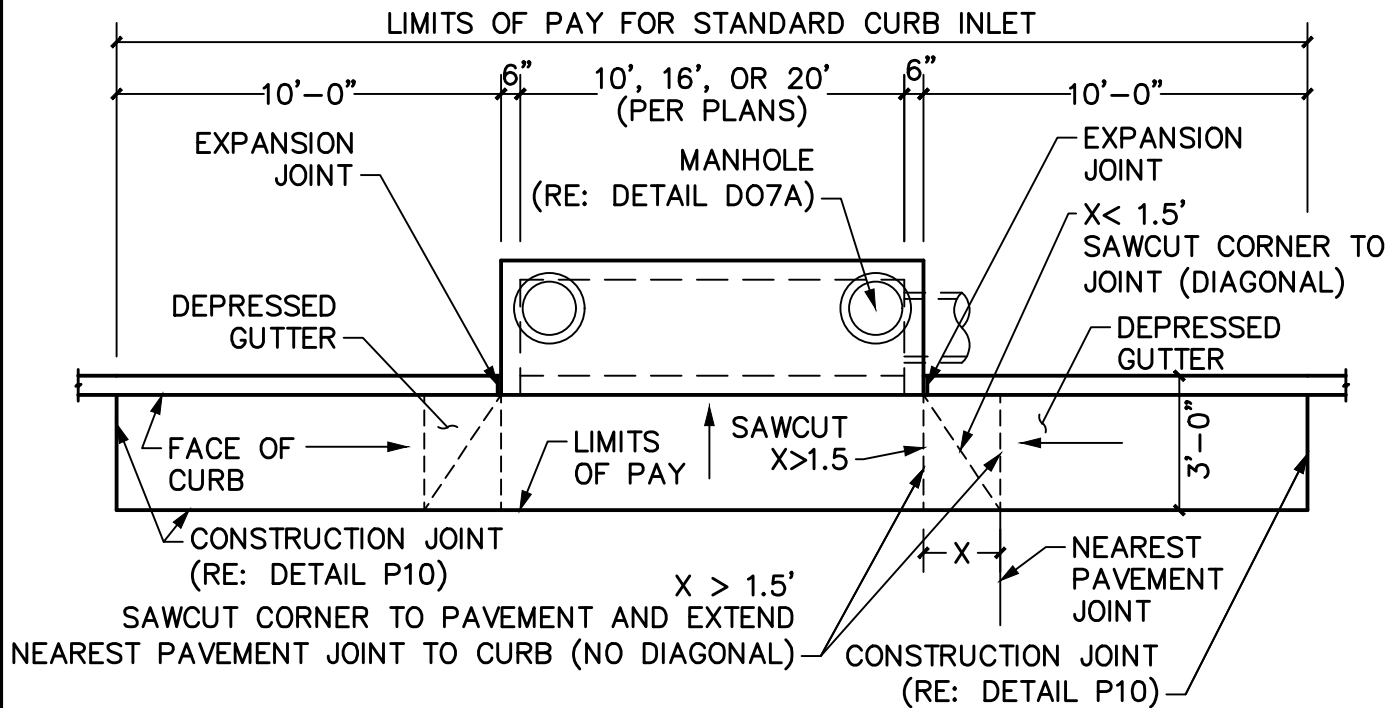
STANDARD CONSTRUCTION DETAIL

CURBED FLUME

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

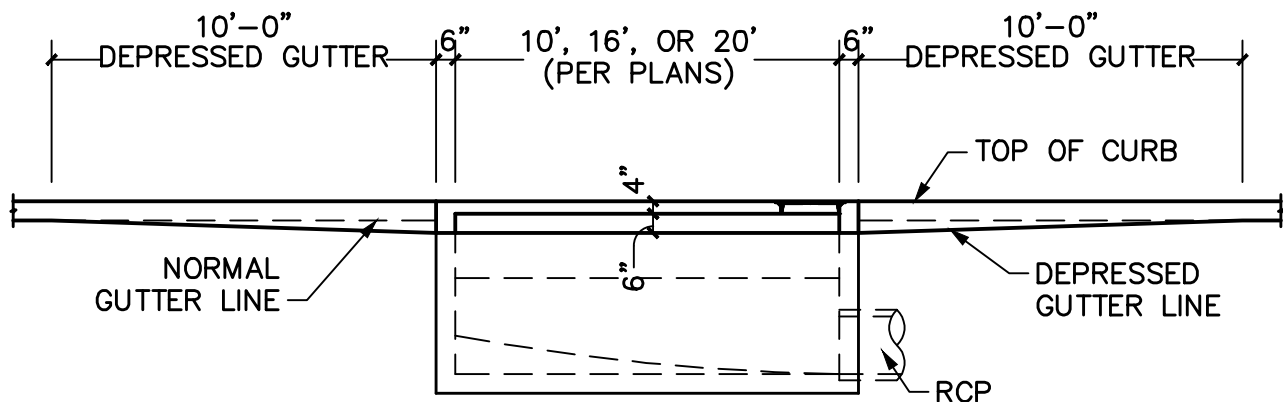
D01



PLAN

NOTES:

1. TOP OF INLET TO SLOPE 2% TOWARDS STREET OR PER PLAN.
2. CENTER SUPPORT BEAM REQUIRED FOR 16' AND 20' STANDARD CURB INLETS.
3. ADDITIONAL REINFORCING STEEL TO BE PLACED AROUND MANHOLE OPENING.



PROFILE

NOTES:

1. MANHOLE TO BE PLACED AT LOW END OF INLET. TWO MANHOLES ARE REQUIRED ON 16' AND 20' INLETS ONLY, ONE ON EACH END.
2. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

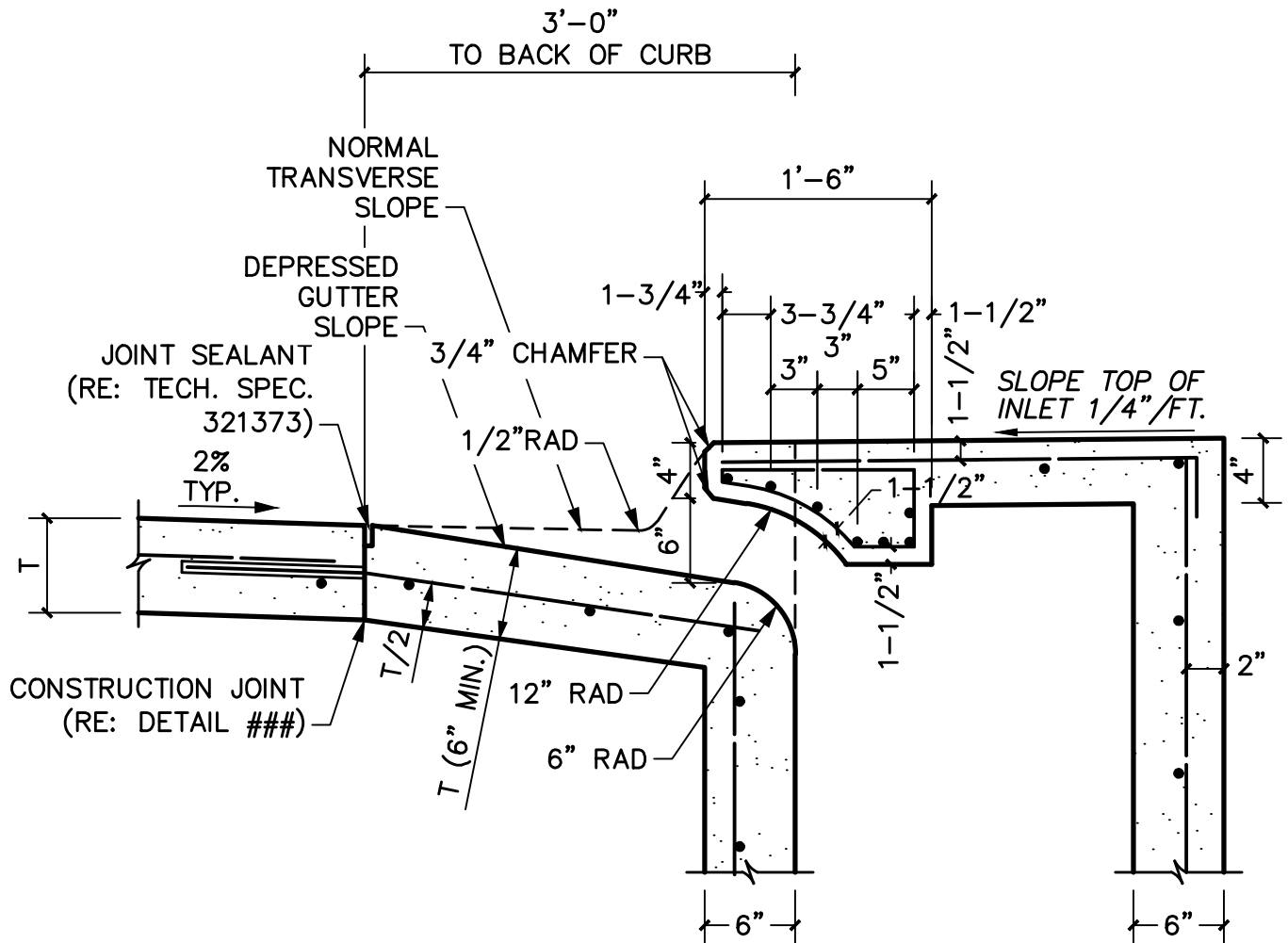


STANDARD CONSTRUCTION DETAIL STANDARD CURB INLET SHEET 1 OF 2

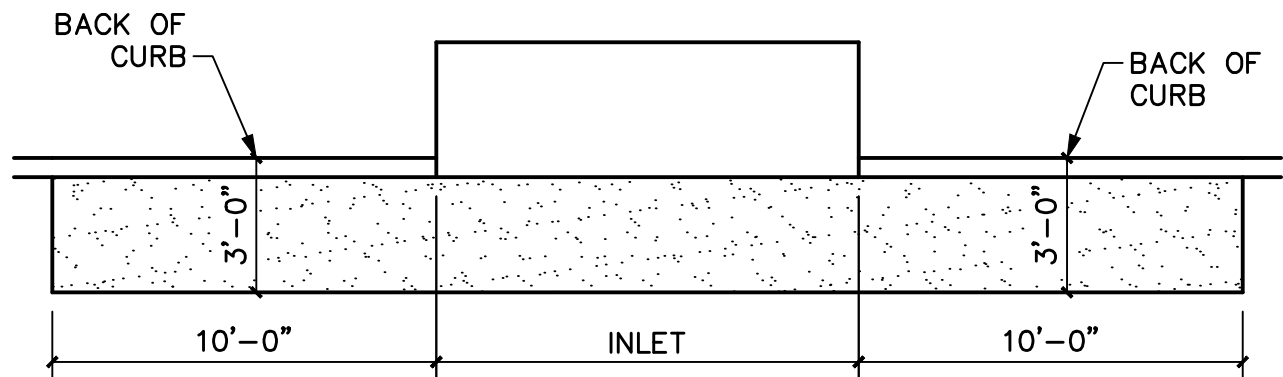
SCALE: 1"=5'

REVISED: AUG 2020

D02



THROAT SECTION



PAVEMENT BLOCKOUT

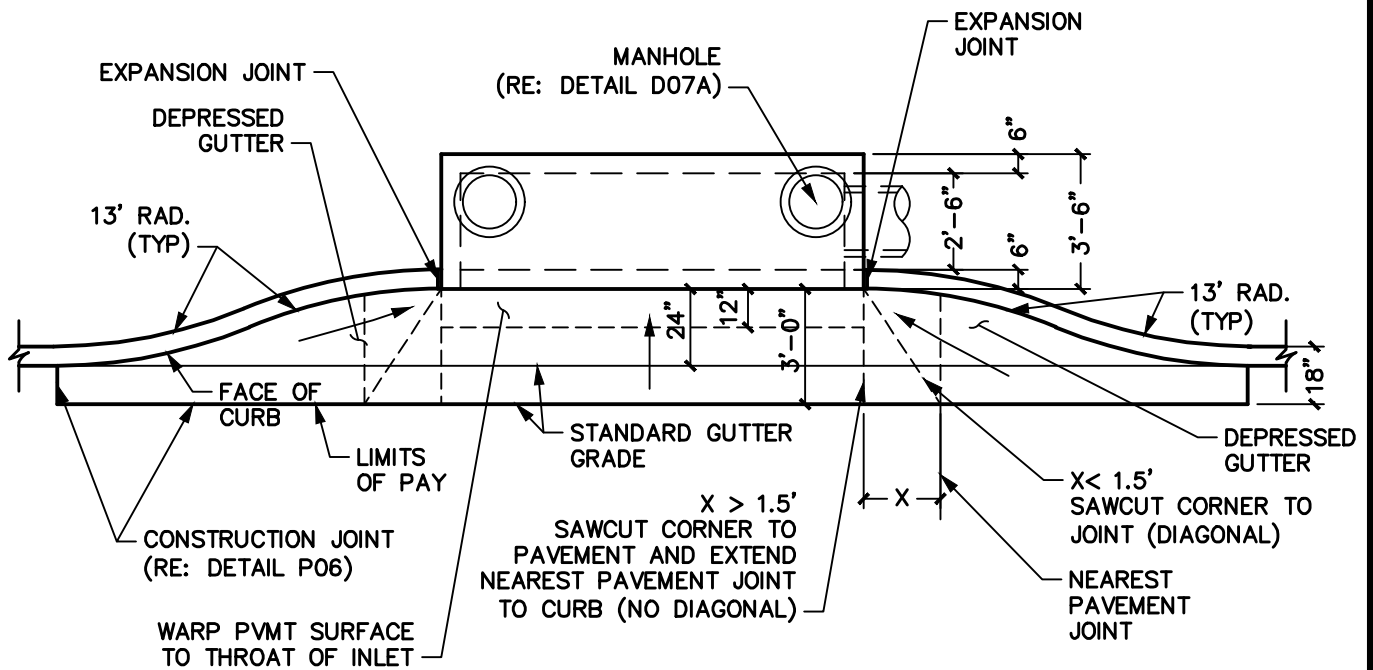


STANDARD CONSTRUCTION DETAIL
STANDARD CURB INLET
SHEET 2 OF 2

SCALE: 1"=1'-0"

REVISED: AUG 2020

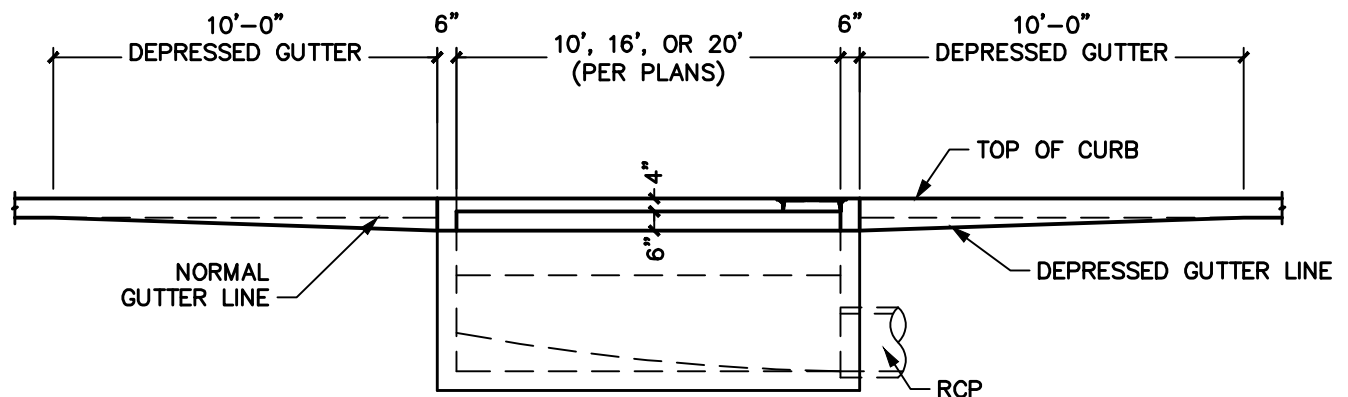
D03



NOTES:

PLAN VIEW

1. TOP OF INLET TO SLOPE 2% TOWARDS STREET OR PER PLAN.
2. CENTER SUPPORT BEAM REQUIRED FOR 16' AND 20' STANDARD CURB INLETS.
3. ADDITIONAL REINFORCING STEEL TO BE PLACED AROUND MANHOLE OPENING.



PROFILE

NOTES:

1. MANHOLE TO BE PLACED AT LOW END OF INLET. TWO MANHOLES ARE REQUIRED ON 16' AND 20' INLETS ONLY, ONE ON EACH END.
2. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.



STANDARD CONSTRUCTION DETAIL

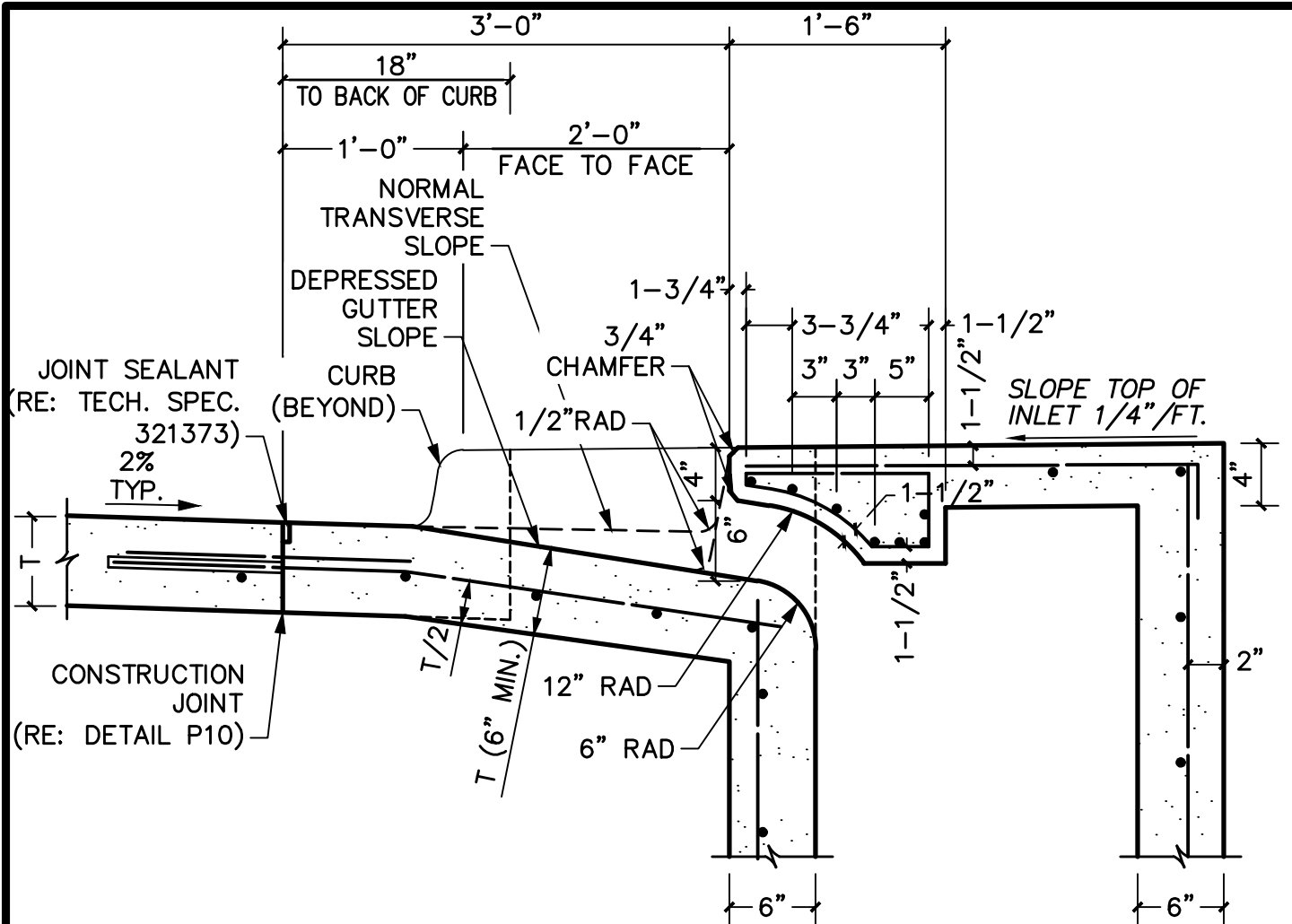
RECESSED CURB INLET

SHEET 1 OF 2

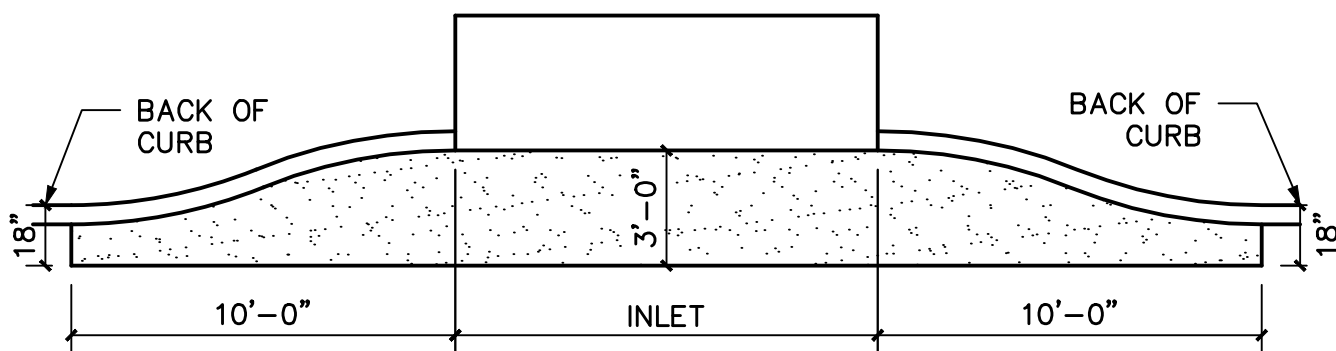
SCALE: 1"=5'

REVISED: AUG 2020

D04



THROAT SECTION



PAVEMENT BLOCKOUT

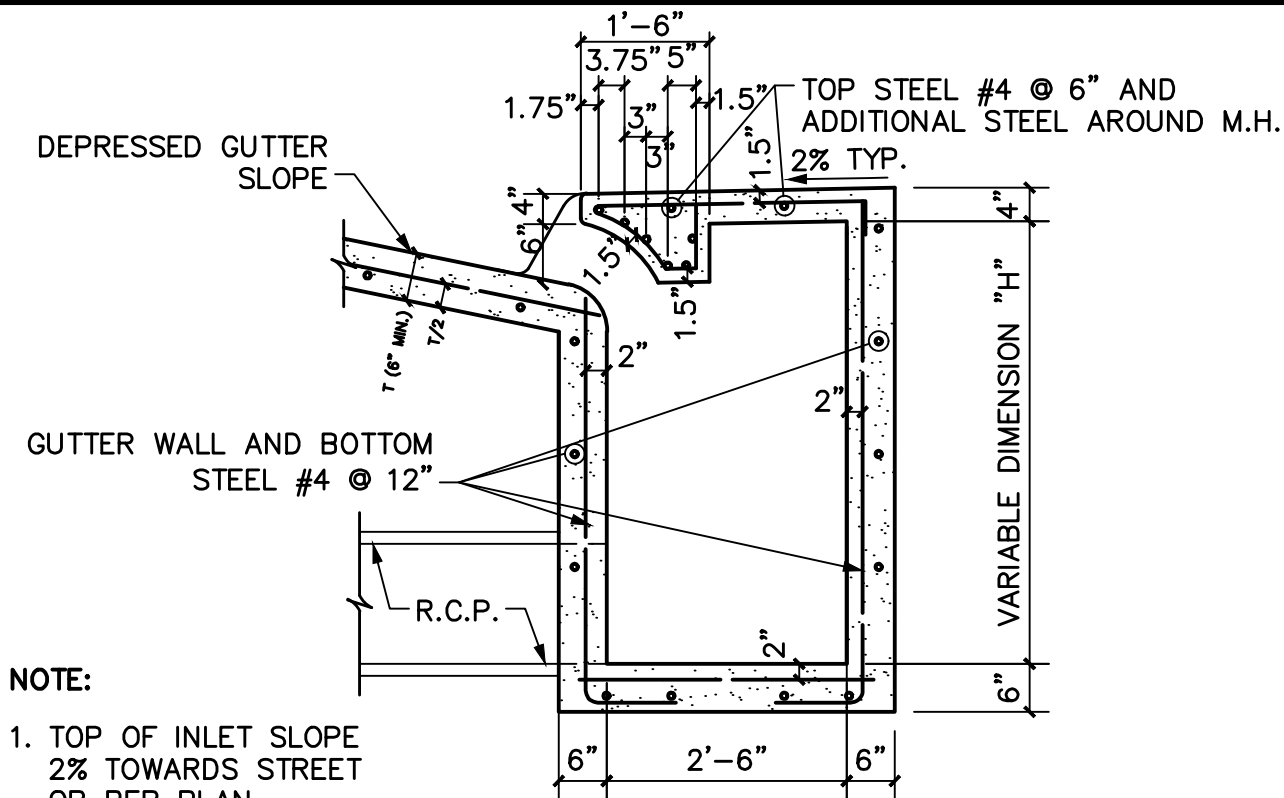


STANDARD CONSTRUCTION DETAIL
RECESSED CURB INLET
SHEET 2 OF 2

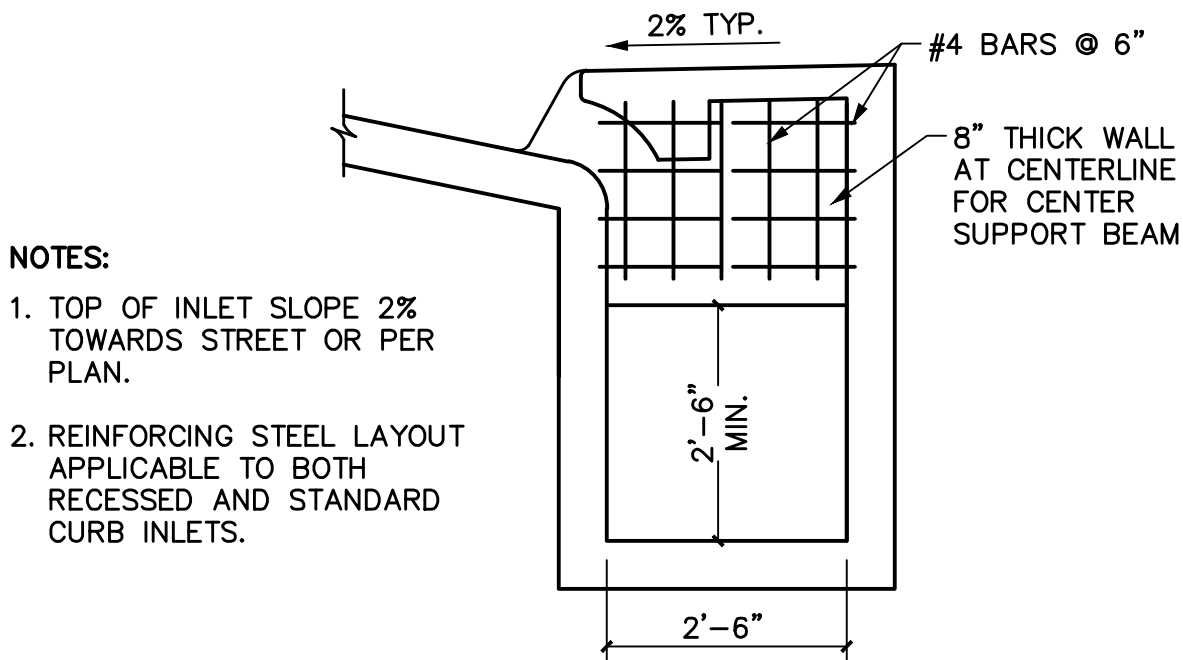
SCALE: 1"=1'-0"

REVISED: AUG 2020

D05



INLET SECTION FOR RECESSED AND STANDARD INLETS



CENTER SUPPORT BEAM FOR 15' & 20' RECESSED AND STANDARD INLETS



STANDARD CONSTRUCTION DETAIL CENTER SUPPORT BEAM & INLET SECTION FOR RECESSED AND STANDARD INLETS

SCALE: 1/2"=1'-0"

REVISED: AUG 2020

D06

GENERAL NOTES:

1. ALL CONCRETE SHALL BE 4,000 PSI AND SULFATE RESISTANT.
2. ALL REINFORCING STEEL SHALL BE NEW BILLET STEEL CONFORMING TO ASTM A-615.
3. CHAMFER ALL EXPOSED CORNERS 3/4" EXCEPT WHERE OTHERWISE NOTED.
4. DIMENSIONS RELATING TO REINFORCING STEEL ARE TO CENTERS OF BARS.
5. FIELD CUT AND BEND BARS AS NECESSARY TO ACCOMMODATE STORM SEWER PIPE.
6. ALL REINFORCING STEEL SHALL HAVE A MINIMUM COVER OF 2".
7. RECESSED CURB INLETS SHALL BE REQUIRED ON ALL A THROUGH D STREETS. STANDARD INLETS WILL BE PERMITTED ON E THROUGH G STREETS.
8. STANDARD CURB INLET SIZES ARE 10', 15', OR 20'. NO OTHER SIZES WILL BE ALLOWED WITHOUT APPROVAL FROM DIRECTOR OF ENGINEERING SERVICES.

PRIVATE DEVELOPMENT ALTERNATIVE NOTE:

1. THESE NOTES ARE SUPPLEMENTAL TO THE GENERAL NOTES AND APPLY ONLY WHEN PREFABRICATED BOXES ARE CALLED OUT ON THE PLANS AND ALLOWED BY ENGINEERING SERVICES.
2. ROCK FOUNDATION SHALL BE USED DURING PREFABRICATED INLET BOX INSTALLATION. 6" FOR BACKFILL WITH FLOWABLE FILL TO FILL VOIDS OR COMPACT WITH SELECT SURPLUS EXCAVATION COMPACTED IN 8" LIFTS TO 95% STANDARD PROCTOR DENSITY.

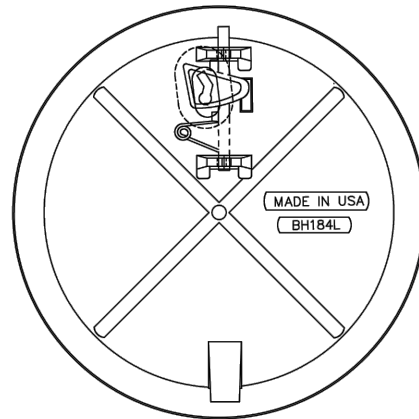


STANDARD CONSTRUCTION DETAIL STORM SEWER INLETS & MANHOLE GENERAL NOTES

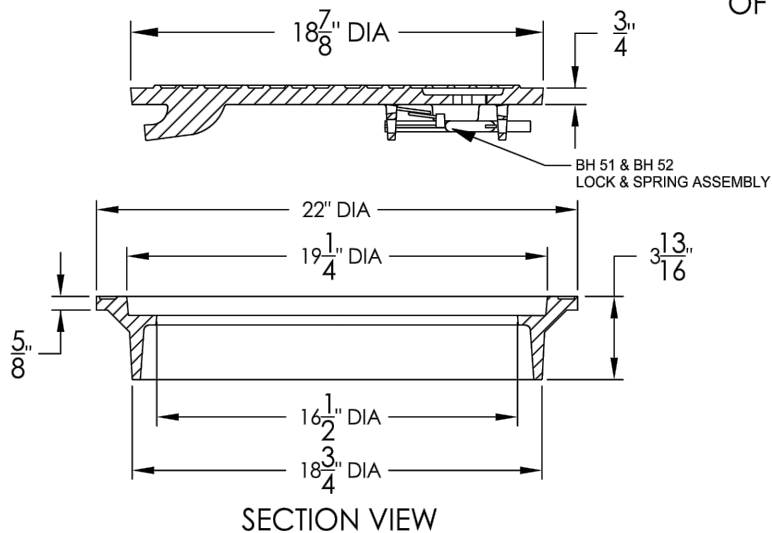
SCALE: N.T.S.

REVISED: AUG 2020

D07



BOTTOM VIEW
OF COVER



SECTION VIEW

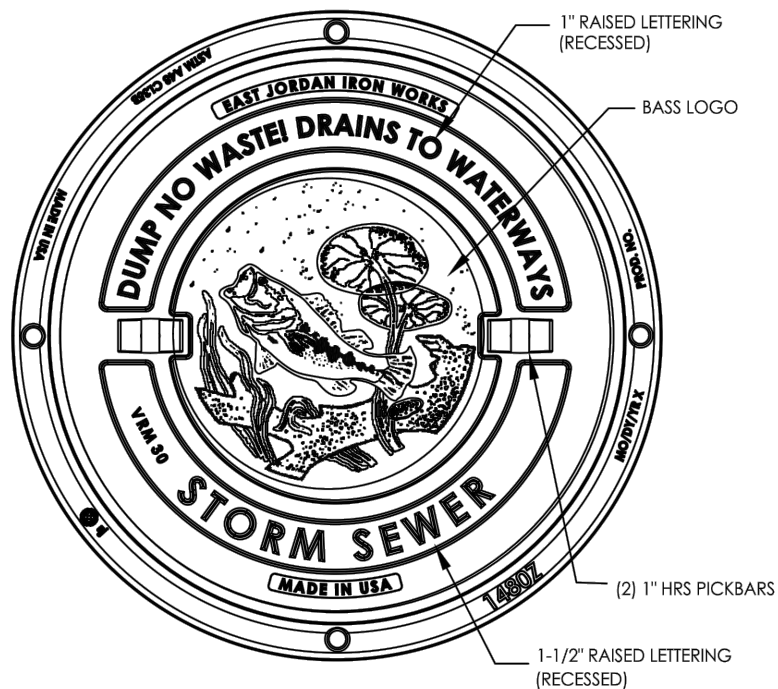
NOTE:

1. MANHOLE COVER AND FRAME SHALL BE SELECTED FROM THE APPROVED MATERIALS LIST.
2. STORMWATER QUALITY DEVICES SHALL HAVE MANUFACTURER'S MANHOLE LID.

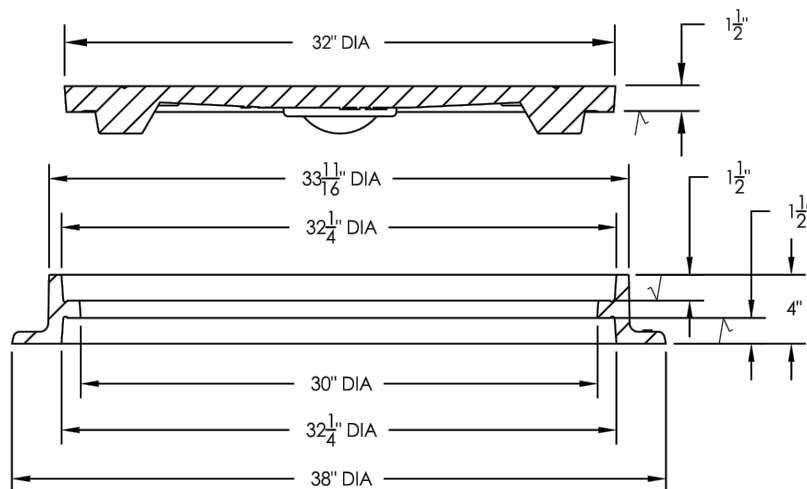


STANDARD CONSTRUCTION DETAIL
STORM SEWER CURB INLET LID DETAIL

SCALE: N.T.S.
REVISED: AUG 2020
D08



TOP VIEW



SECTION VIEW

NOTES:

1. MANHOLE COVER AND FRAME SHALL BE SELECTED FROM THE APPROVED MATERIALS LIST.
2. STORMWATER QUALITY DEVICES SHALL HAVE MANUFACTURER'S MANHOLE LID.

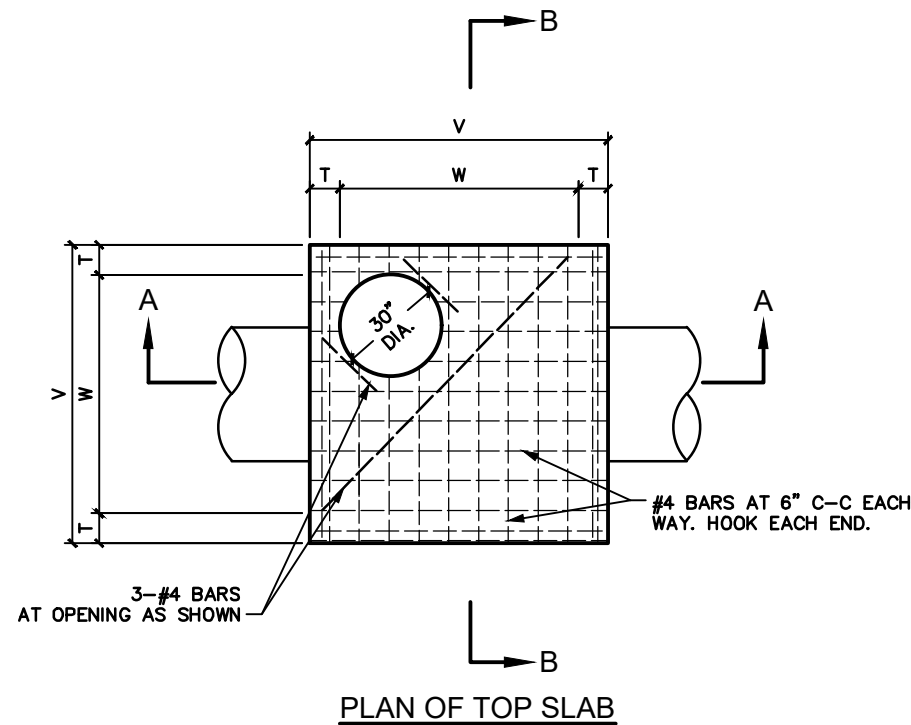


STANDARD CONSTRUCTION DETAIL
STORM SEWER MANHOLE LID DETAIL

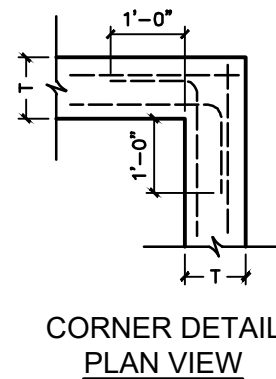
SCALE: N.T.S.

REVISED: AUG 2020

D09

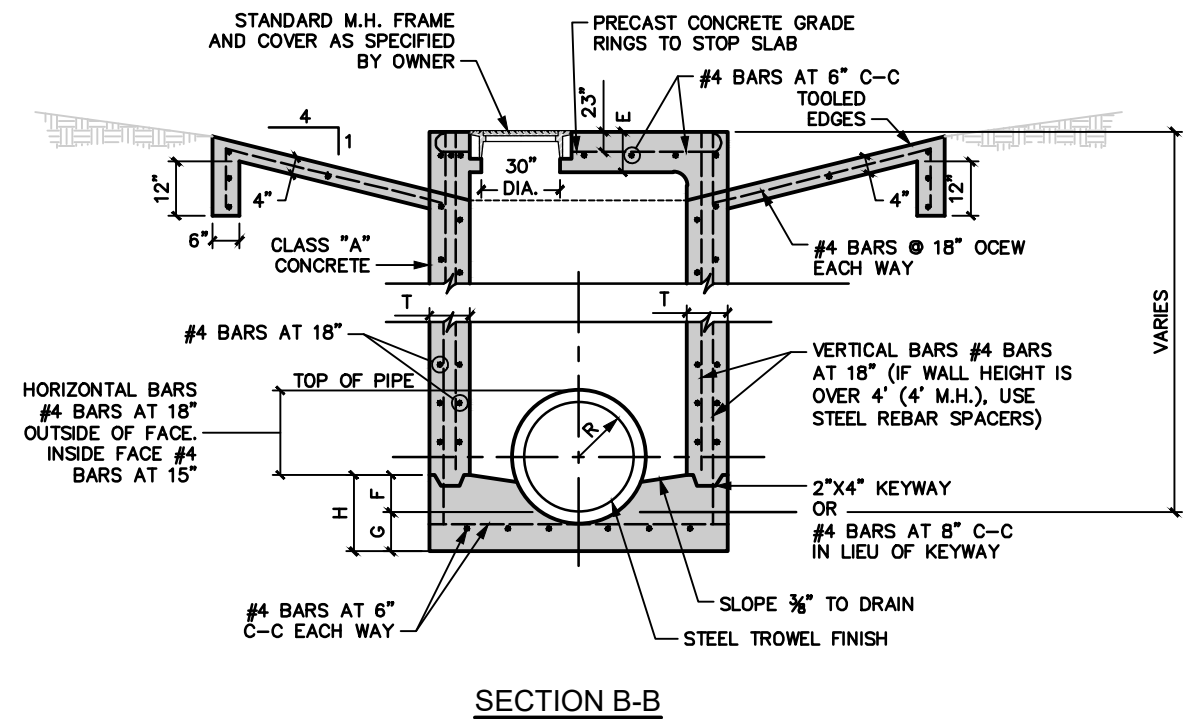
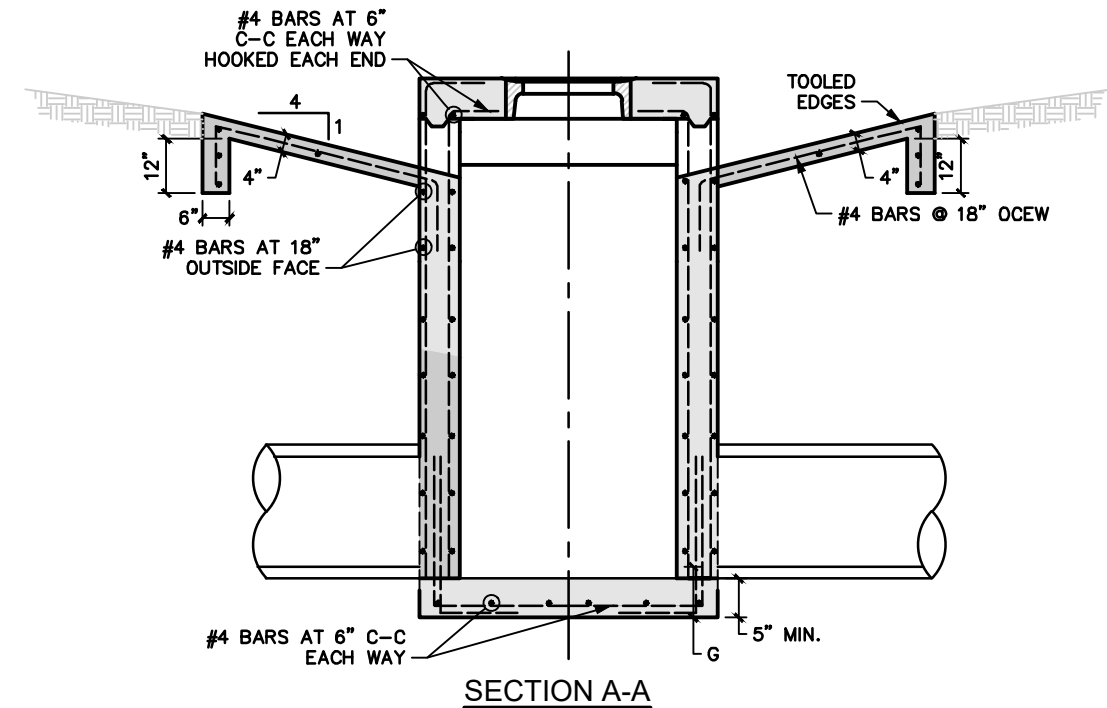


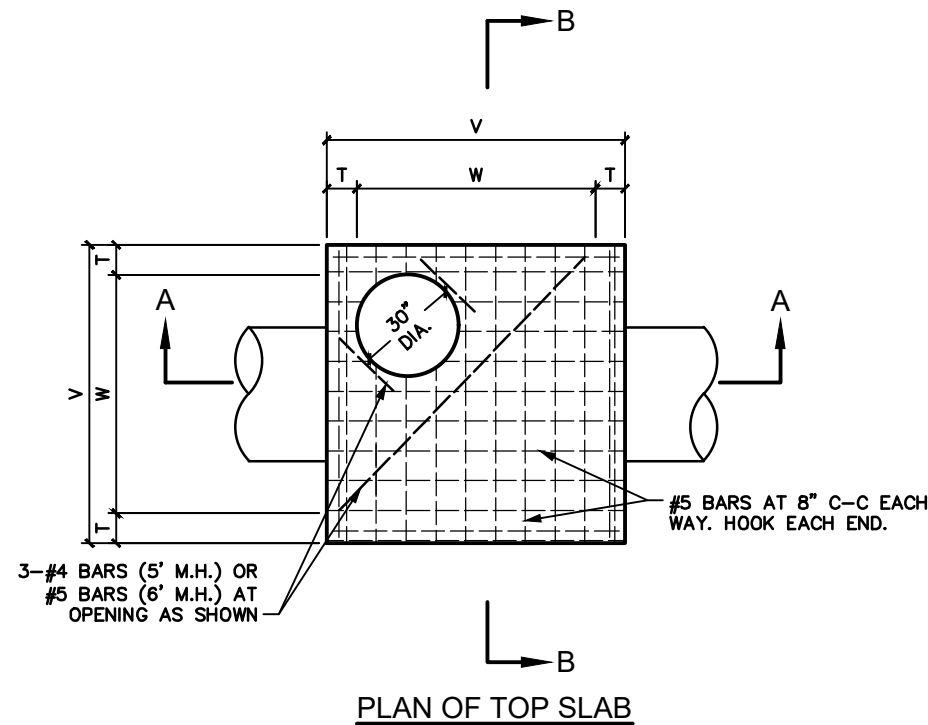
INLET SIZE	T	W	V	E	F	G	H
2' SQUARE	7"	2'-0"	3'-2"	6"	0"	6" MIN.	6"
3' SQUARE	7"	3'-0"	4'-0"	9"	0"	6" MIN.	9"
4' SQUARE	8"	4'-0"	4'-0"	6"	9"	6"	1'-3"



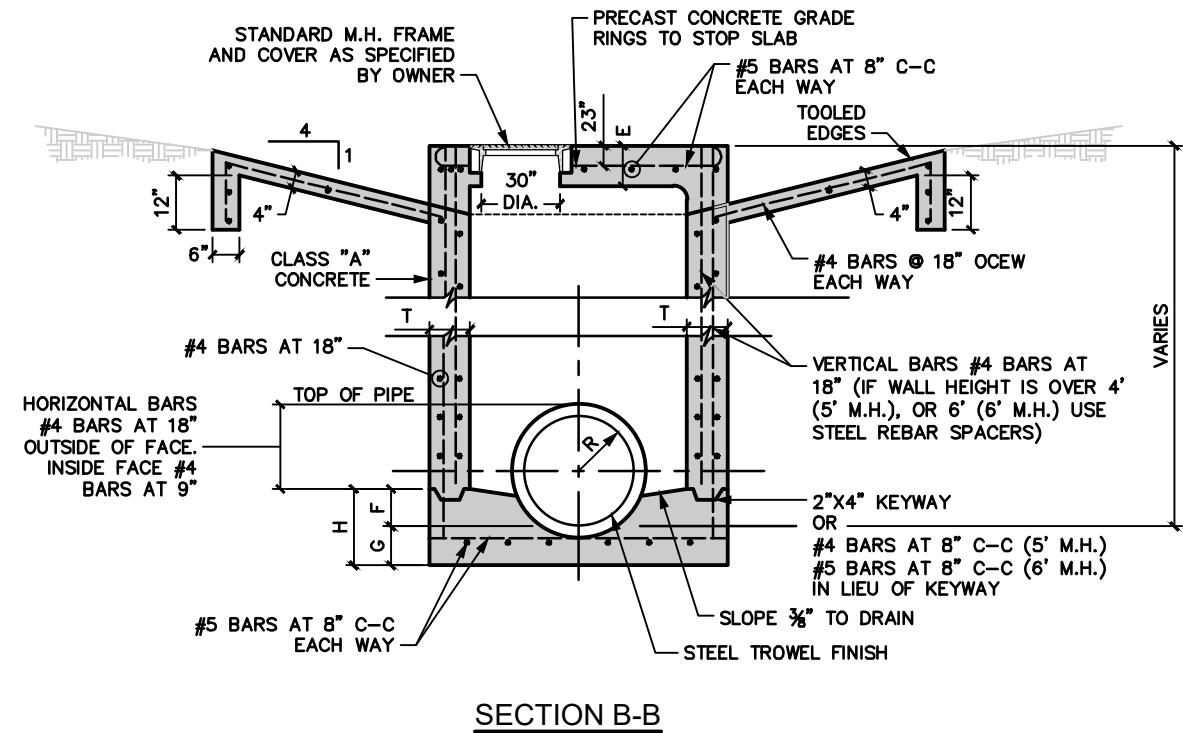
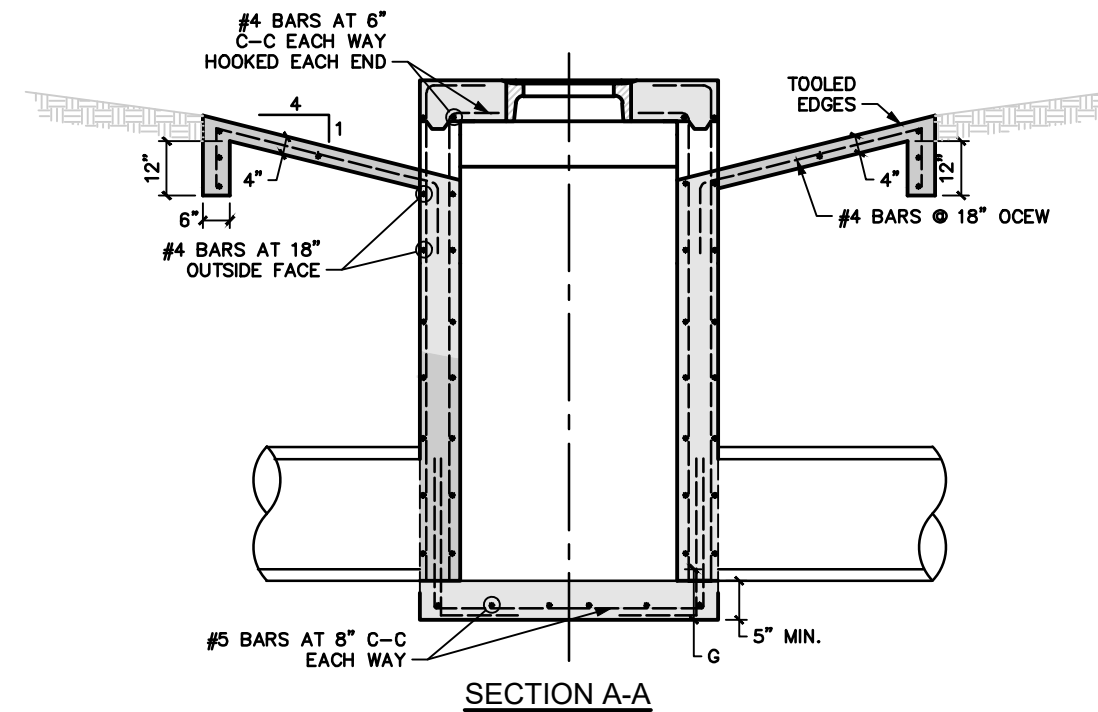
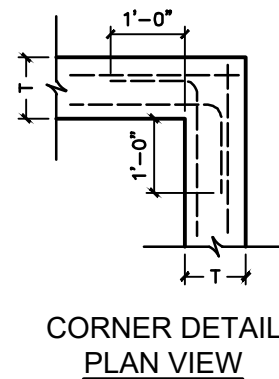
NOTES:

1. MATERIAL AND WORKMANSHIP SHALL CONFORM WITH THE REQUIREMENTS OF NCTCOG STANDARD SPECIFICATIONS FOR STANDARD CONCRETE MANHOLES. MINIMUM CLASS "A" CONCRETE, 4000 PSI, AND SULFATE RESISTANT.
2. LAYERS OF REINFORCING STEEL NEAREST THE INTERIOR AND EXTERIOR SURFACES SHALL HAVE A COVER OF 2" TO THE CENTER OF BARS, UNLESS OTHERWISE NOTED.
3. DEPTH OF DROP INLET FROM FINISHED GRADE TO FLOW LINE OF INLET IS VARIABLE. APPROXIMATE DEPTH WILL BE SHOWN ON PLANS AT LOCATION OF INLET.
4. ALL STANDARD WYE INLETS SHALL HAVE ONE OPENING ON EACH SIDE UNLESS OTHERWISE SHOWN ON PLANS.
5. APRON REQUIRED UNLESS USED IN STORMWATER QUALITY DEVICE.
6. USE CURB INLET LID FOR WYE INLETS 3' AND SMALLER AND MANHOLE LID FOR WYE INLETS 4' AND LARGER





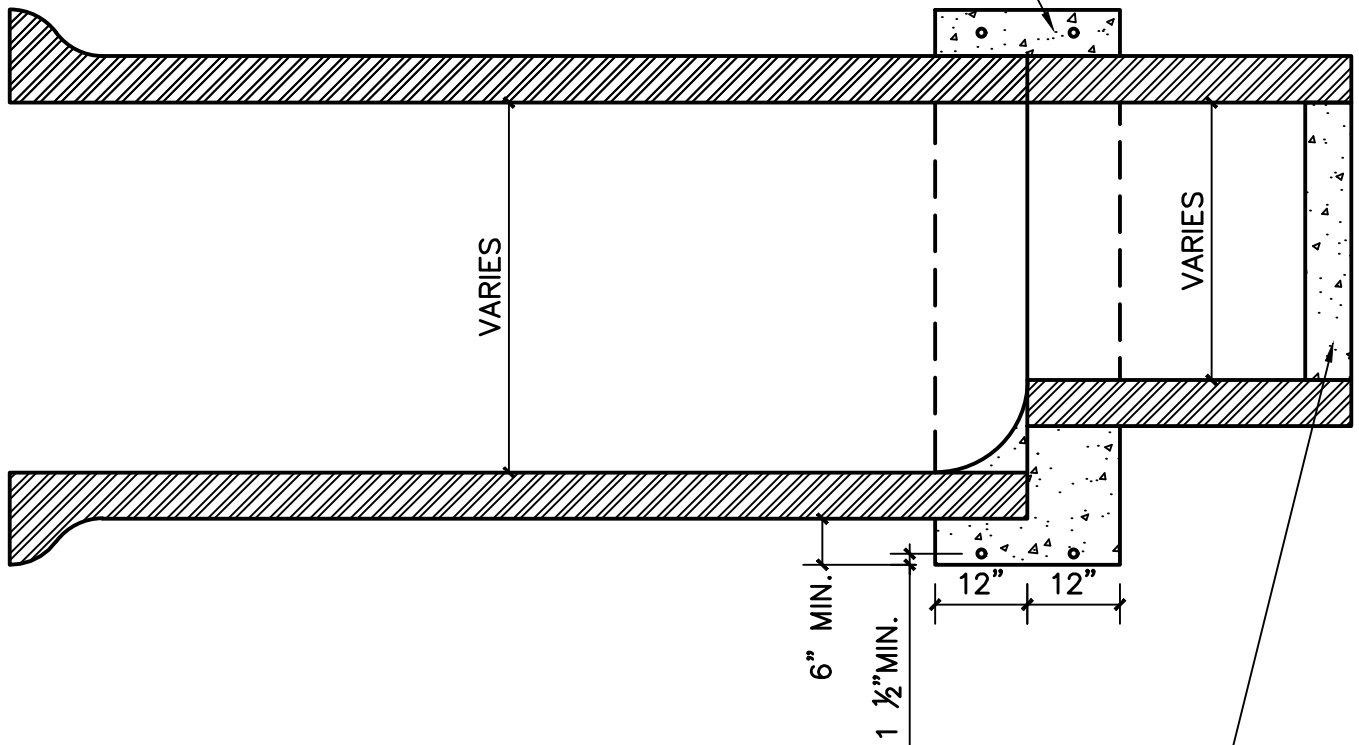
INLET SIZE	T	W	V	E	F	G	H
5' SQUARE	8"	5'-0"	5'-0"	6"	12"	8"	1'-8"
6' SQUARE	9"	6'-0"	6'-0"	9"	16"	10"	2'-2"



NOTES:

1. MATERIAL AND WORKMANSHIP SHALL CONFORM WITH THE REQUIREMENTS OF NCTCOG STANDARD SPECIFICATIONS FOR STANDARD CONCRETE MANHOLES. MINIMUM CLASS "A" CONCRETE, 4000 PSI, AND SULFATE RESISTANT
2. LAYERS OF REINFORCING STEEL NEAREST THE INTERIOR AND EXTERIOR SURFACES SHALL HAVE A COVER OF 2" TO THE CENTER OF BARS, UNLESS OTHERWISE NOTED.
3. DEPTH OF DROP INLET FROM FINISHED GRADE TO FLOW LINE OF INLET IS VARIABLE. APPROXIMATE DEPTH WILL BE SHOWN ON PLANS AT LOCATION OF INLET.
4. ALL STANDARD WYE INLETS SHALL HAVE ONE OPENING ON EACH SIDE UNLESS OTHERWISE SHOWN ON PLANS.
5. APRON REQUIRED UNLESS USED IN STORMWATER QUALITY DEVICE.
6. USE CURB INLET LID FOR WYE INLETS 3' AND SMALLER AND MANHOLE LID FOR WYE INLETS 4' AND LARGER

MECHANICALLY FORMED JOINT
FORMED WITH 2 #3 BARS



ALL STORM SEWER PIPE
PLUGS SHALL BE CONCRETE

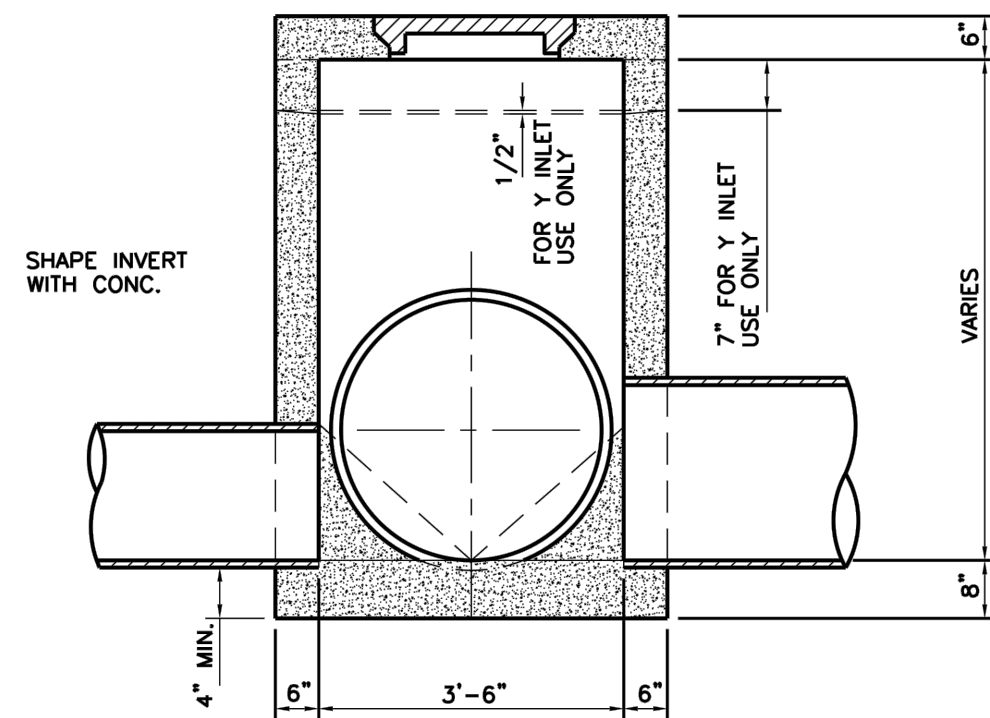
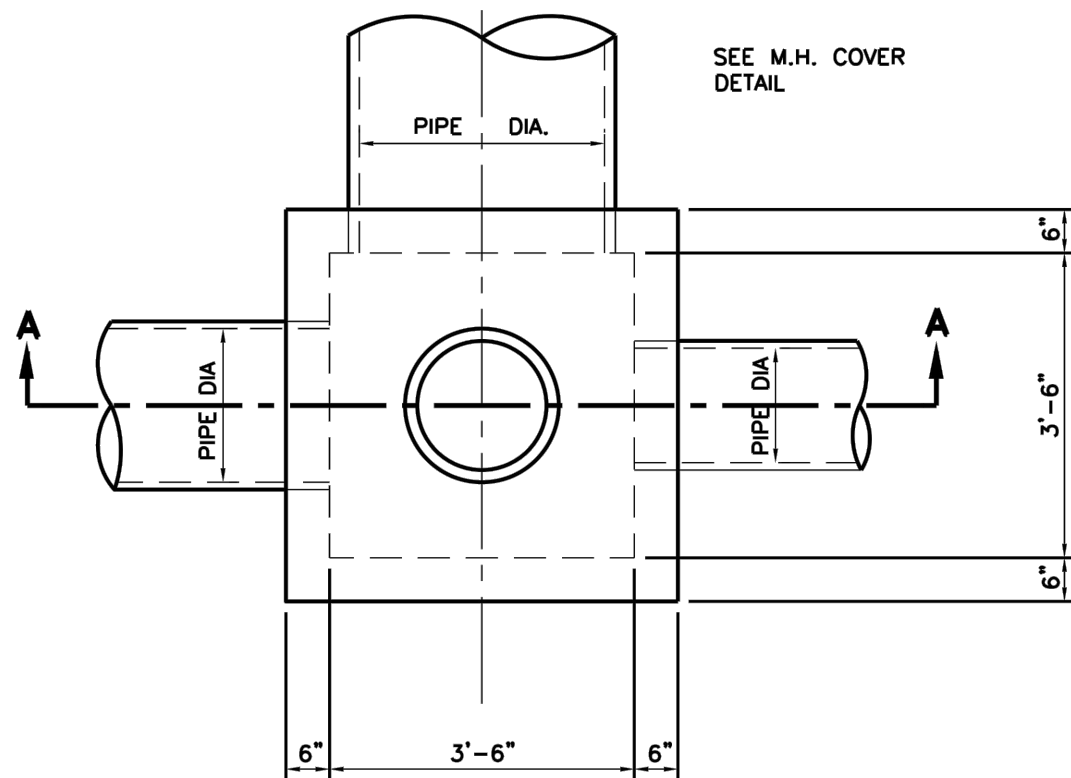


STANDARD CONSTRUCTION DETAIL
CONCRETE COLLAR FOR PIPE CONNECTIONS

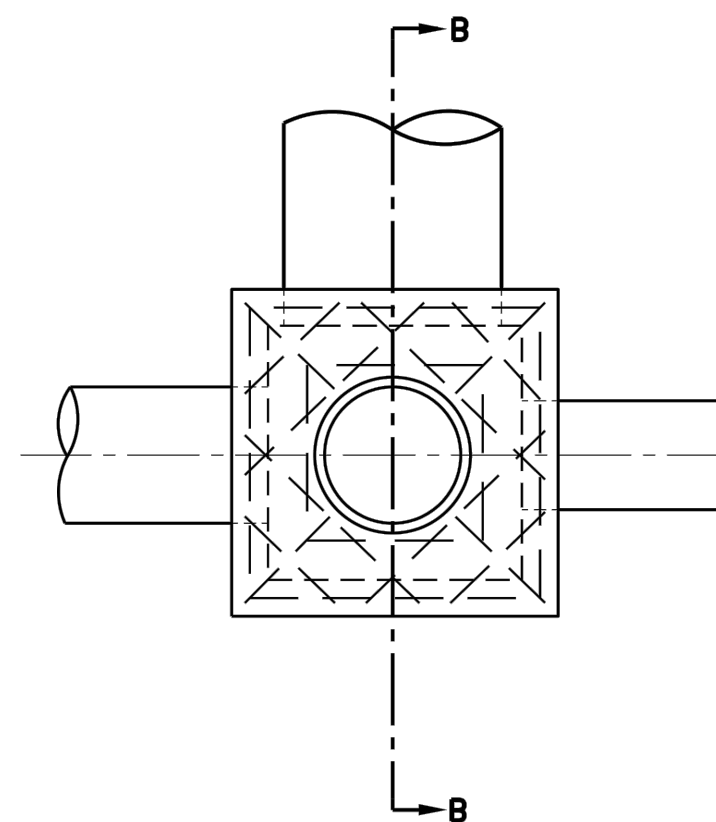
SCALE: N.T.S.

REVISED: AUG 2020

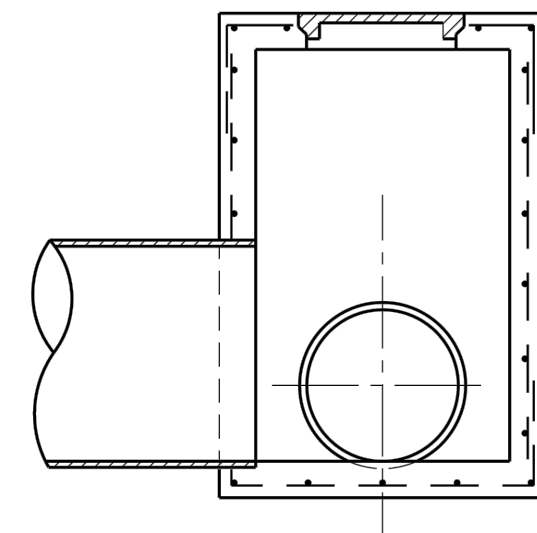
D12



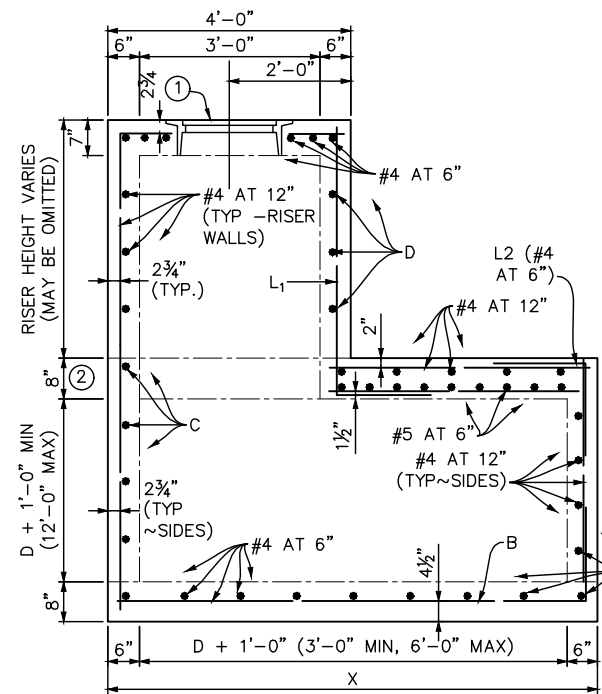
TYPE I REINF. TABLE				
ITEM	SIZE	QUANTITY	LENGTH	REMARKS
BARS A	NO. 5	4		24" 18"
BARS B	NO. 4	VARIES	4'-2"	
BARS C	NO. 3	4	2'-0"	
BARS D	NO. 3	4	3'-4"	
BARS E	NO. 3	4	2'-4"	
BARS F	NO. 3	16	VARIES	
BARS G	NO. 3	10		18" 3'-4" 18"



STRUCTURAL PLAN

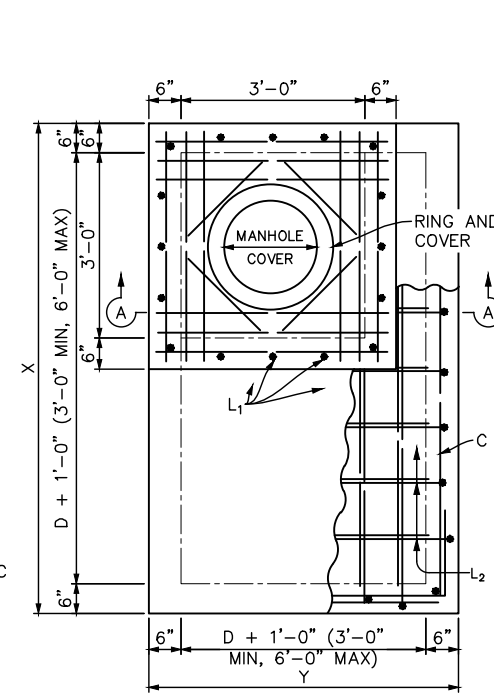


SECTION B-B



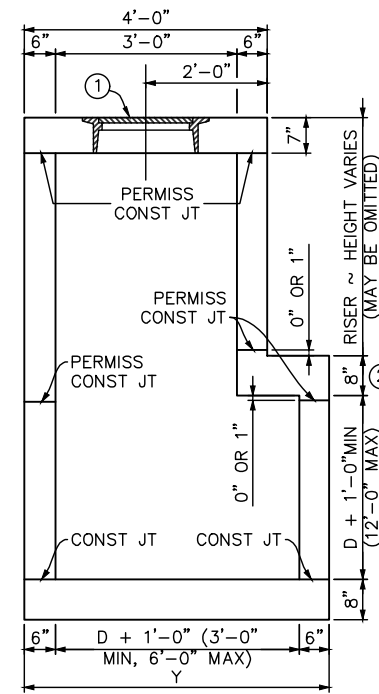
ELEVATION

D = MAXIMUM INSIDE DIAMETER OF ANY PIPE ENTERING THE SIDE SHOWN OR THE OPPOSITE SIDE

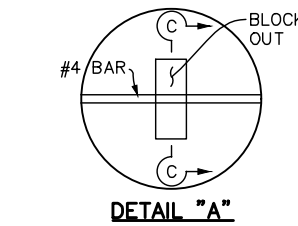


PLAN

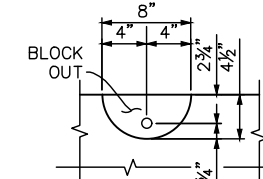
MANHOLE WITH CAST-IN-PLACE RISER



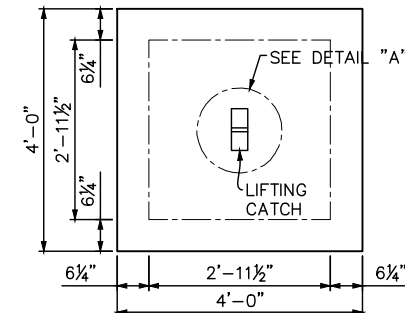
SECTION A-A



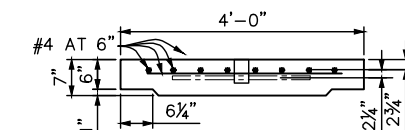
DETAIL "A"



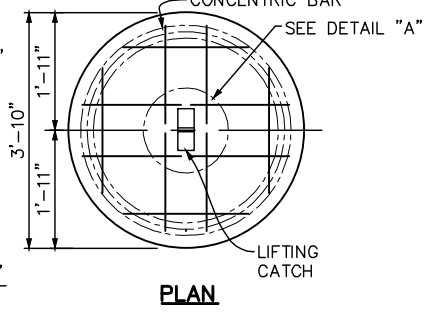
SECTION C-C
LIFTING CATCH



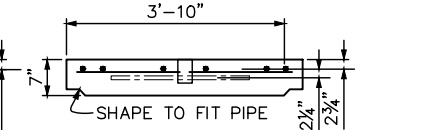
PLAN



ELEVATION



PLAN



ELEVATION

CAST-IN-PLACE RISER COVER CONCRETE PIPE RISER COVER
OPTIONAL PRECAST CONCRETE LIFT-OFF COVERS

GENERAL NOTES:

UNLESS OTHERWISE SHOWN IN THE PLANS, PAYMENT WILL BE MADE FOR EACH MANHOLE OF THE TYPE M.

ALTERNATE DESIGN DRAWINGS BEARING THE SEAL OF A REGISTERED PROFESSIONAL ENGINEER WILL BE ACCEPTABLE FOR PRECAST CONSTRUCTION OF THE MANHOLES.

SHOP DRAWINGS WILL NOT BE REQUIRED.

THE CONTRACTOR MAY WITH THE APPROVAL OF THE ENGINEER FURNISH MANHOLES OF EQUIVALENT STRUCTURAL DESIGN

IN AREAS OF CONFLICT BETWEEN REINFORCING STEEL, BLOCK-OUTS, PIPES, ANCHOR BOLTS OR OTHER REINFORCING STEEL, THE REINFORCEMENT SHALL BE BENT OR ADJUSTED TO CLEAR AS DIRECTED BY THE ENGINEER.

THE RISER MAY BE CONSTRUCTED OF REINFORCED CONCRETE AS SHOWN OR OF REINFORCED CONCRETE PIPE, CLASS III, IN ACCORDANCE WITH ASTM DESIGNATION C-76. IF PIPE IS USED, JOINTS SHALL CONFORM TO THE ITEM "REINFORCED CONCRETE PIPE CULVERTS". PRECAST CONCRETE LIFT-OFF COVER MAY BE SUBSTITUTED FOR RING AND COVER.

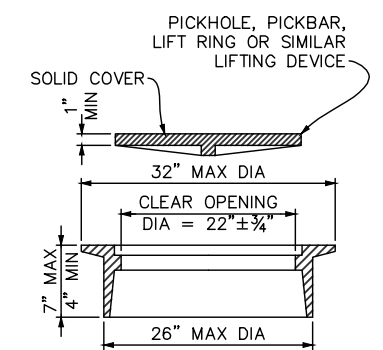
THE RISER, EITHER CAST-IN-PLACE OR CONCRETE PIPE, MAY BE LOCATED IN ANY CORNER.

ALL REINFORCING STEEL SHALL BE #4 UNLESS OTHERWISE NOTED.

PIPES MAY ENTER ANY OR ALL WALLS. THE MAXIMUM SIZE OF PIPE THAT CAN BE ACCOMMODATED IS 60". MORE THAN ONE PIPE MAY ENTER A SIDE, SUBJECT TO THE MAXIMUM BOX DIMENSIONS SHOWN. THE CLEAR DISTANCE BETWEEN ADJACENT PIPES SHOULD BE 9" MINIMUM.

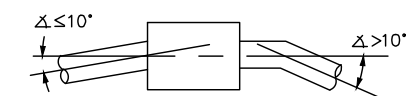
RING AND COVER SHALL CONFORM TO THE REQUIREMENTS OF AASHTO M306, "STANDARD SPECIFICATION FOR DRAINAGE STRUCTURE CASTINGS". MATERIALS SHALL CONFORM TO ASTM A48, CLASS 35B FOR GRAY IRON CASTINGS OR ASTM A536, GRADE 65-45-12 FOR DUCTILE IRON CASTINGS. ALUMINUM ALLOY CASTINGS SHALL NOT BE PERMITTED. CONCRETE FOR MANHOLE CONSTRUCTION SHALL BE 4,000 P.S.I. AND SULFATE RESISTANT.

BOXES LARGER THAN 6'X6' SHALL BE DESIGNED BY A STRUCTURAL ENGINEER.



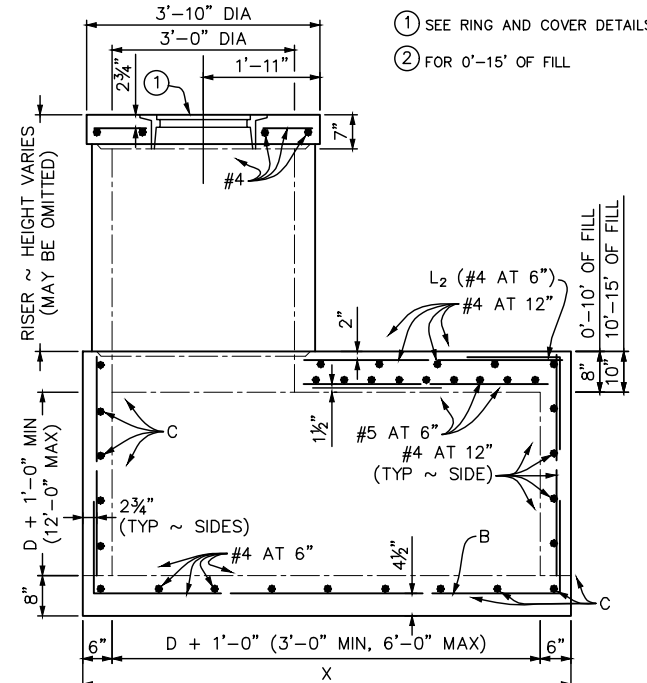
RING AND COVER DETAILS

APPROXIMATE WEIGHT = 245 LBS

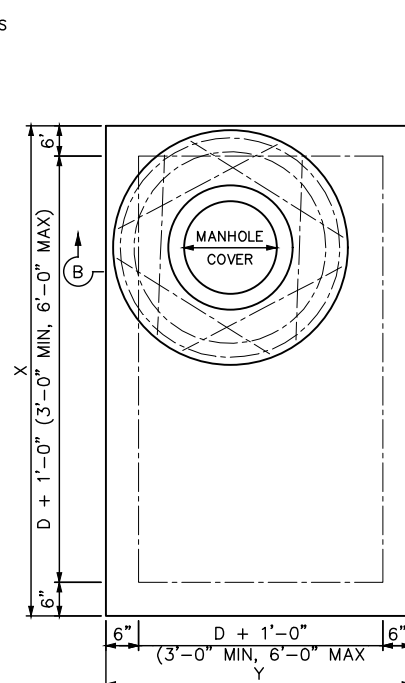


PIPE CONNECTION DETAIL

CONNECTING PIPES SHOULD ENTER WITHIN 10 DEG. OF NORMAL TO INLET WALL. IF NECESSARY, PIPE ELBOW OR CURVED APPROACH ALIGNMENT SHOULD BE USED TO STAY WITHIN THIS LIMIT.

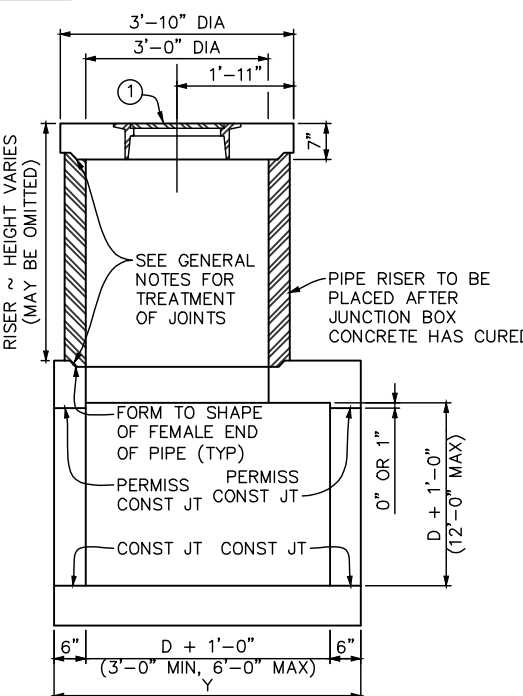


ELEVATION

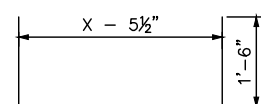


PLAN

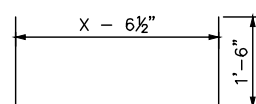
OPTIONAL MANHOLE WITH CONCRETE PIPE RISER



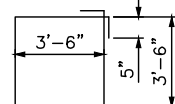
SECTION B-B



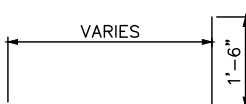
BARS B



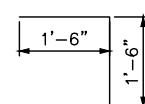
BARS C



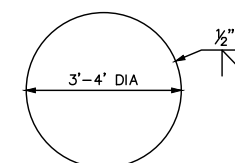
BARS D



BARS L1



BARS L2



CONCENTRIC BAR

STANDARD CONSTRUCTION DETAIL

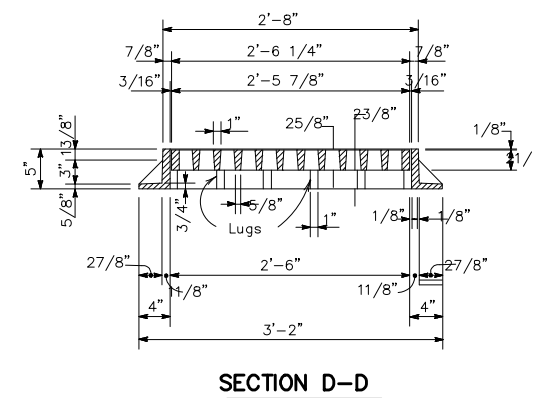
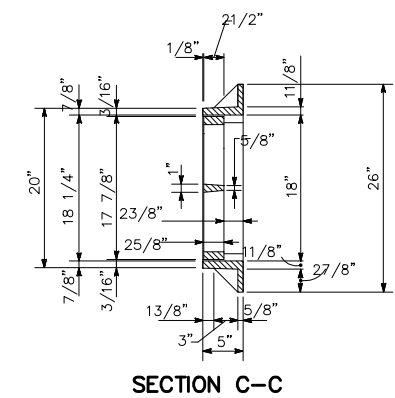
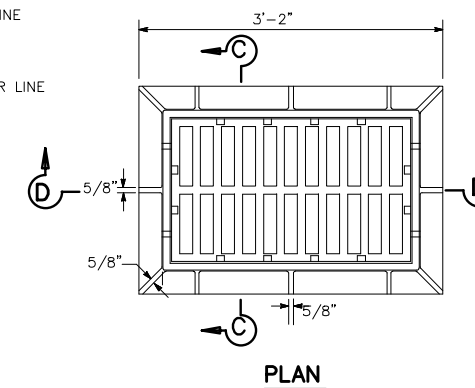
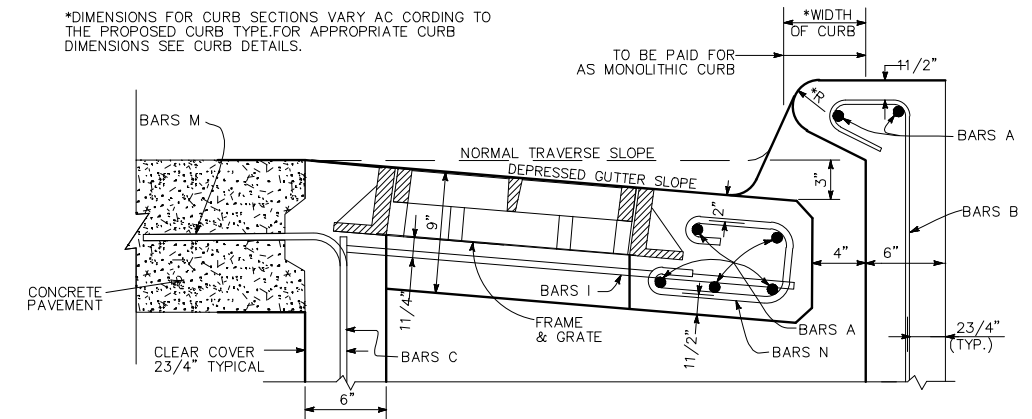
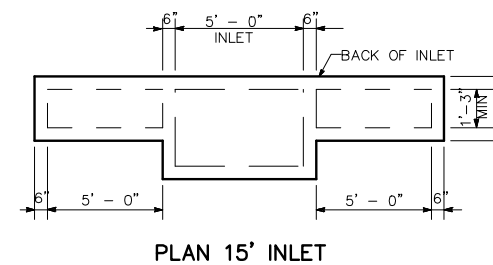
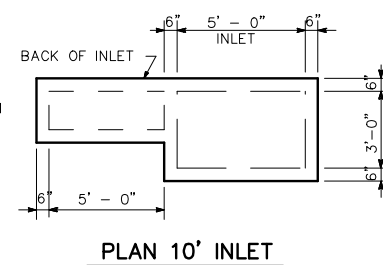
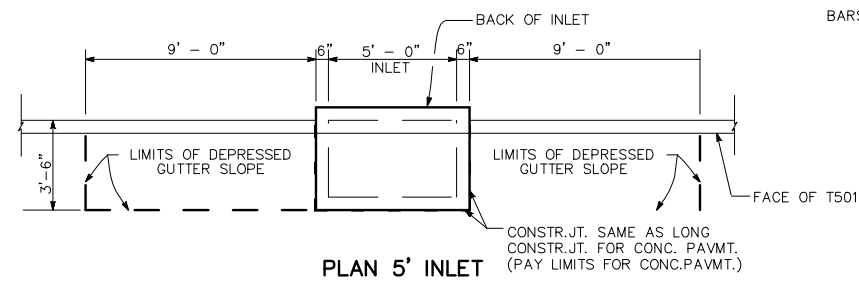
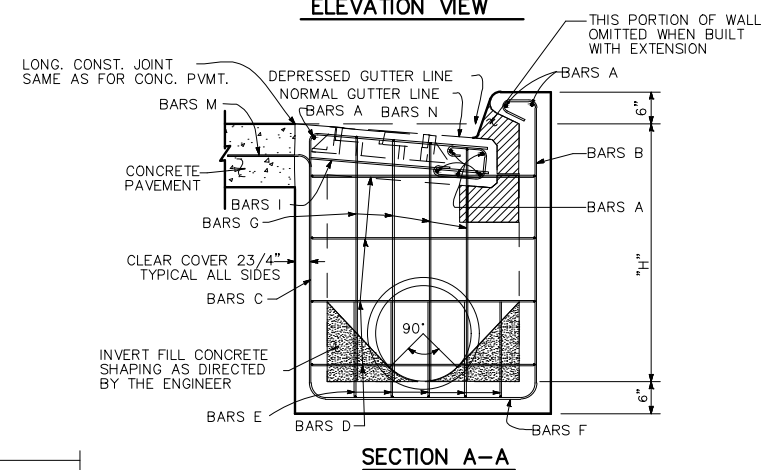
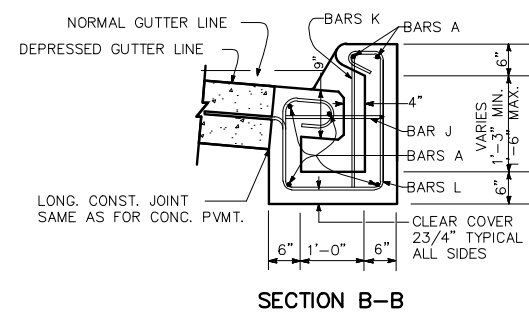
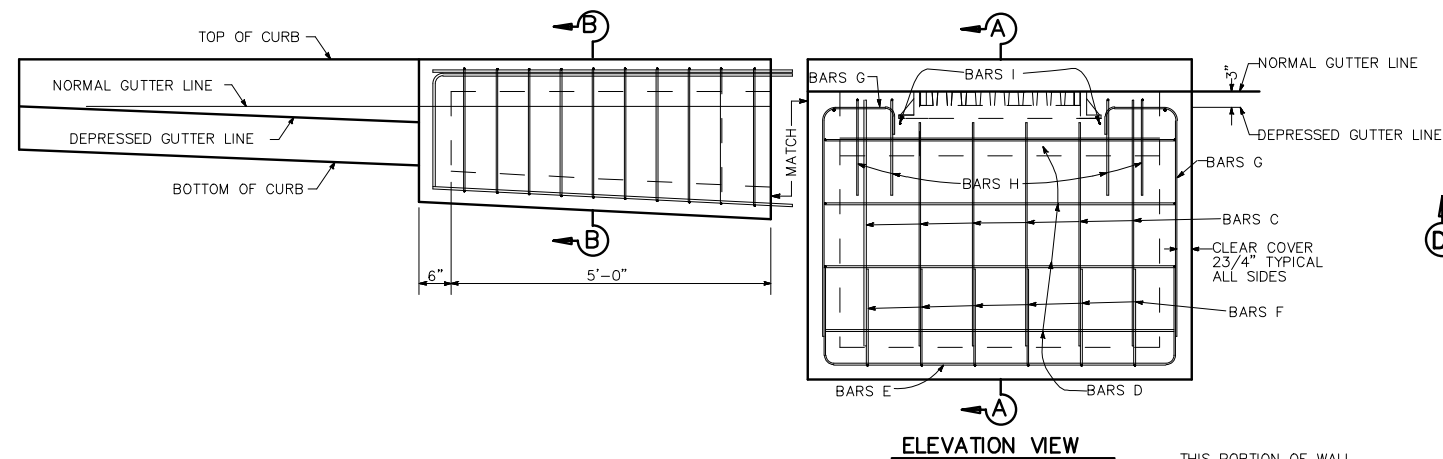
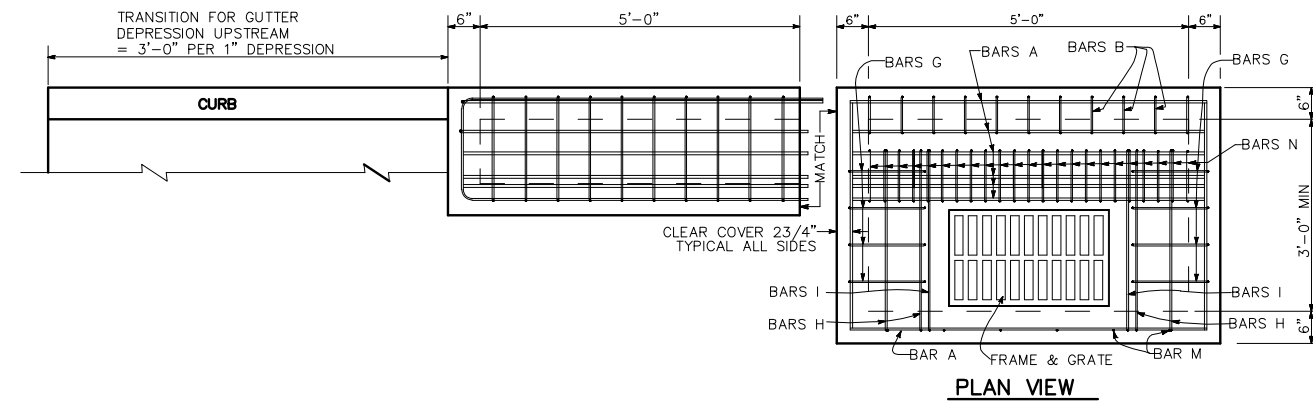
TYPE II JUNCTION BOX



SCALE: N.T.S.

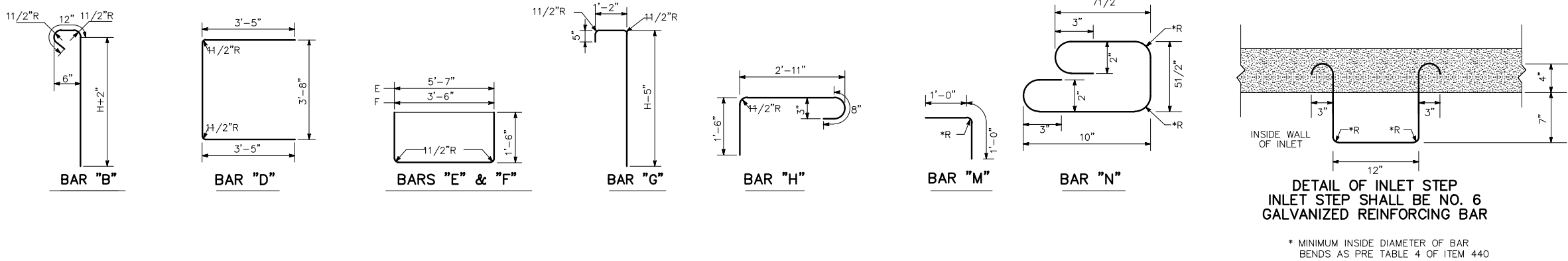
REVISED: AUG 2020

D14



FRAME & GRATE TYPE "A"

NOTE:
FRAME AND GRATE TO BE OF GRAY CAST IRON
CONFORMING TO A.S.T.M. SPEC. A-48 FOR
CLASS NO. 30 CAST IRON



INLET SIZE		INLET REINFORCING STEEL AND CONCRETE																																							
HEIGHT FT.	WIDTH FT.	BAR "A"					BAR "B"					BAR "C" *					BAR "D"					BAR "E"					BAR "F"					BAR "G"					BAR "H"				
		NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.
2.5	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	2'-4"	17	6	4	10"C.C.	2'-4"	9	4	12"C.C.	10'-6"	28	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	3'-8"	20	4	4	AS SHN	4'-11"	13	
3.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	2'-10"	21	6	4	10"C.C.	2'-10"	11	6	4	12"C.C.	10'-6"	42	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	4'-2"	22	4	4	AS SHN	4'-11"	13
3.5	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	3'-4"	24	6	4	10"C.C.	3'-4"	13	6	4	12"C.C.	10'-6"	42	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	4'-8"	25	4	4	AS SHN	4'-11"	13
4.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	3'-10"	28	6	4	10"C.C.	3'-10"	15	8	4	12"C.C.	10'-6"	56	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	5'-2"	28	4	4	AS SHN	4'-11"	13
4.5	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	4'-4"	32	6	4	10"C.C.	4'-4"	17	8	4	12"C.C.	10'-6"	56	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	5'-8"	30	4	4	AS SHN	4'-11"	13
5.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	4'-10"	36	6	4	10"C.C.	4'-10"	19	10	4	12"C.C.	10'-6"	70	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	6'-2"	33	4	4	AS SHN	4'-11"	13
5.5	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	5'-4"	39	6	4	10"C.C.	5'-4"	21	10	4	12"C.C.	10'-6"	70	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	6'-8"	36	4	4	AS SHN	4'-11"	13
6.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	5'-10"	43	6	4	10"C.C.	5'-10"	23	12	4	12"C.C.	10'-6"	84	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	7'-2"	38	4	4	AS SHN	4'-11"	13
7.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	6'-10"	50	6	4	10"C.C.	6'-10"	27	14	4	12"C.C.	10'-6"	98	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	8'-2"	44	4	4	AS SHN	4'-11"	13
8.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	6'-10"	58	6	4	10"C.C.	6'-10"	31	14	4	12"C.C.	10'-6"	98	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	8'-2"	49	4	4	AS SHN	4'-11"	13
9.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	6'-10"	65	6	4	10"C.C.	6'-10"	35	14	4	12"C.C.	10'-6"	98	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	8'-2"	54	4	4	AS SHN	4'-11"	13
10.0	3.0	8	6	AS SHN	5'-6"	66	11	4	6"C.C.	6'-10"	72	6	4	10"C.C.	6'-10"	39	14	4	12"C.C.	10'-6"	98	5	4	7"C.C.	8'-0"	27	6	4	10"C.C.	6'-0"	24	8	4	7"C.C.	8'-2"	60	4	4	AS SHN	4'-11"	13

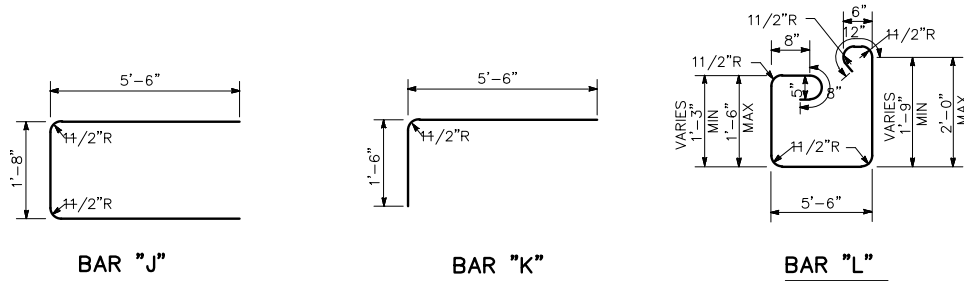
* REDUCE BAR LENGTH AS
NECESSARY TO PROVIDE
CLEARANCE UNDER GRATE

INLET SIZE		INLET REINFORCING STEEL AND CONCRETE (CONT.)												TOTALS				
HEIGHT FT.	WIDTH FT.	BAR "I"					BAR "M"					BAR "N"					STEEL LBS.	CONC. C.Y.
		NO.	SZ.	SPACING	LENGTH	WT.	NO.	SZ.	SPACIN	LENGTH	WT.	NO.	SZ.	SPACING	LENGTH	WT.		
2.5	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	236	1.63
3.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	258	1.80
3.5	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	266	1.96
4.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	289	2.13
4.5	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	297	2.29
5.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	320	2.46
5.5	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	328	2.62
6.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	350	2.79
7.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	381	3.12
8.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	398	3.45
9.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	414	3.78
10.0	3.0	2	4	AS SHN	2'-9"	4	7	4	24"C.C.	2'-0"	9	21	3	3"C.C.	2'-5"	19	431	4.11

CONCRETE TO BE DEDUCTED FOR ONE PIPE	
PIPE DIA.	CONC. C.Y.
15"	0.04
18"	0.05
21"	0.07
24"	0.09
27"	0.11
30"	0.14
36"	0.20

GENERAL NOTES:

- ALL CONCRETE SHALL BE CLASS "A".
- ALL EXPOSED CORNERS SHALL BE CHAMFERED 3/4".
- INLET STEPS SPACED 14" C.C. AND LOCATED AND DIRECTED BY THE ENGINEER, SHALL BE PROVIDED AND INSTALLED IN ALL INLETS WHERE THE DEPTH EXCEEDS 5'-0".
- DIMENSIONS RELATING TO REINFORCING STEEL ARE TO THE CENTER OF THE BARS.
- TOTAL QUANTITIES SHOWN FOR CONCRETE AND REINFORCING STEEL ARE APPROXIMATE AND ARE PLACED HEREON FOR INFORMATIONAL PURPOSES ONLY.



INLET REINFORCING STEEL AND CONCRETE FOR ONE 5' EXTENSION					
BAR	NO.	SIZE	SPACING	LENGTH	WT.
A	6	6	AS SHN	5'-6"	50
J	1	4	AS SHN	12'-8"	8
K	1	4	AS SHN	7'-4"	5
L	10	4	6"C.C.	6'-7" TO 7'-1"	46
M	4	4	24"C.C.	1'-11"	5
TOTAL REINFORCING STEEL (LBS.)					114
TOTAL CONCRETE (C.Y.)					0.64

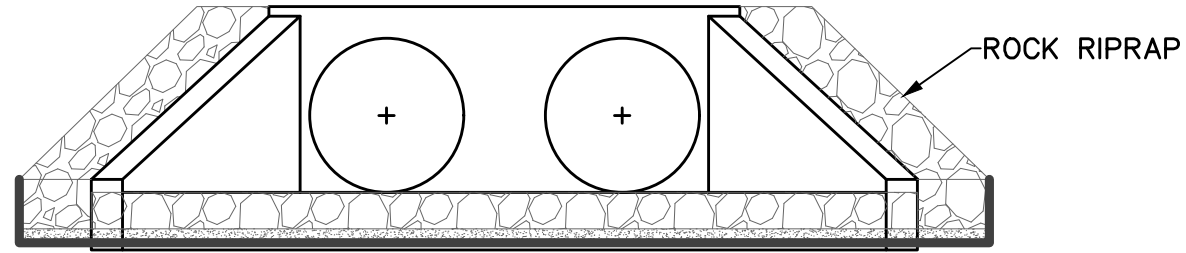


STANDARD CONSTRUCTION DETAIL
COMBO INLET FOR ALLEYS
SHEET 2 OF 2

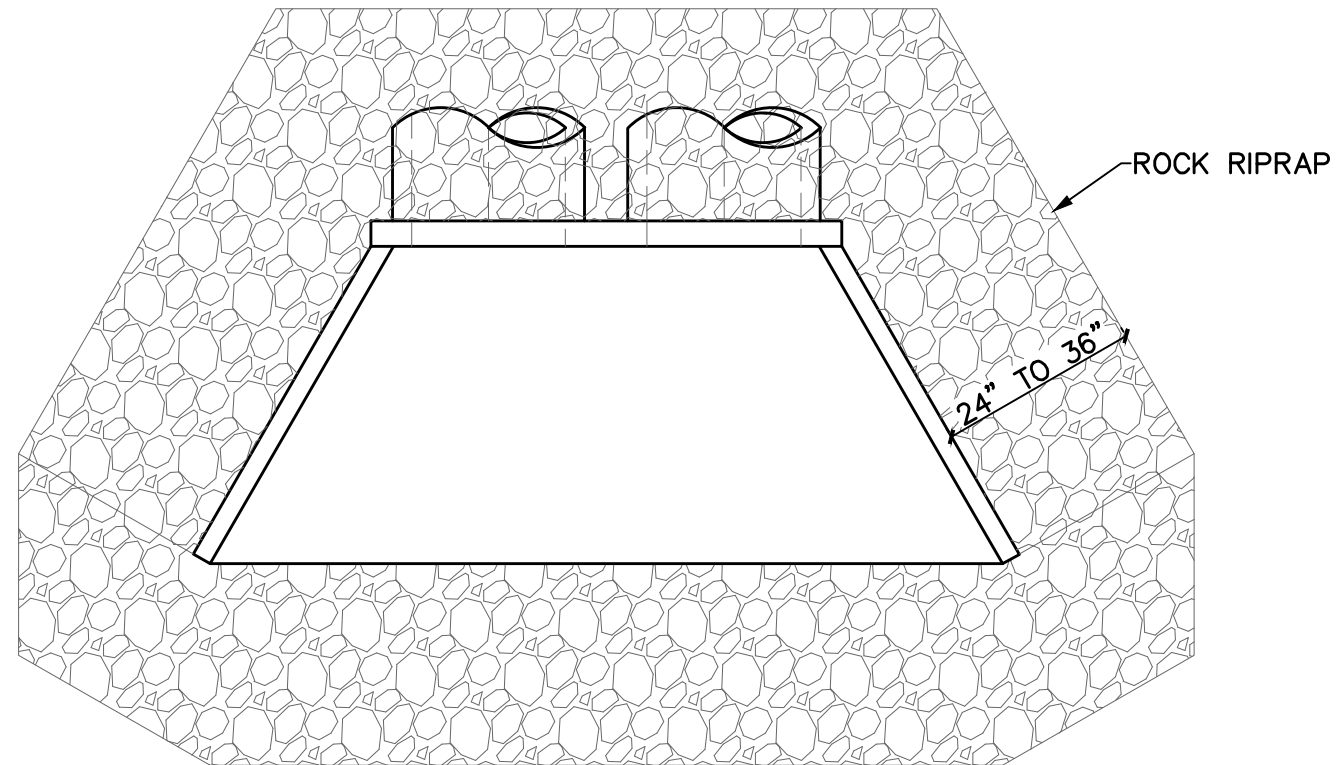
SCALE: N.T.S.

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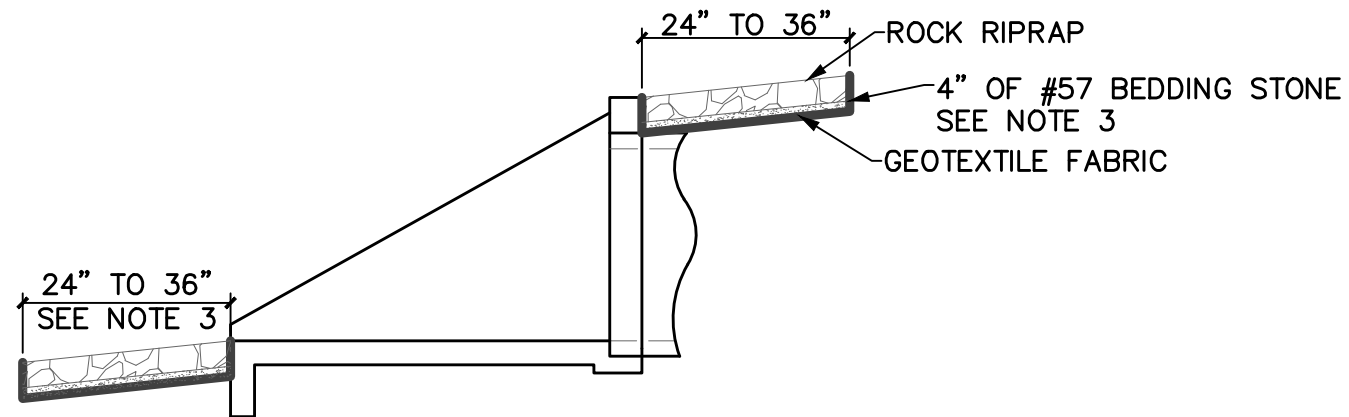
D16



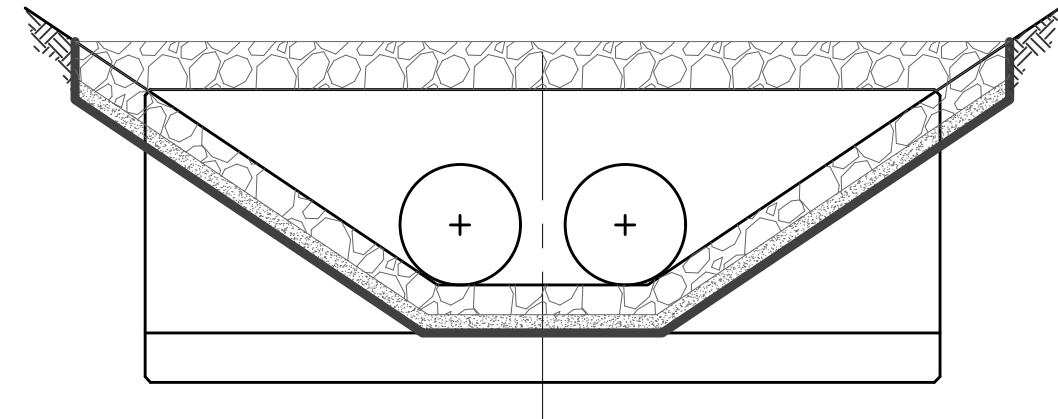
ELEVATION VIEW



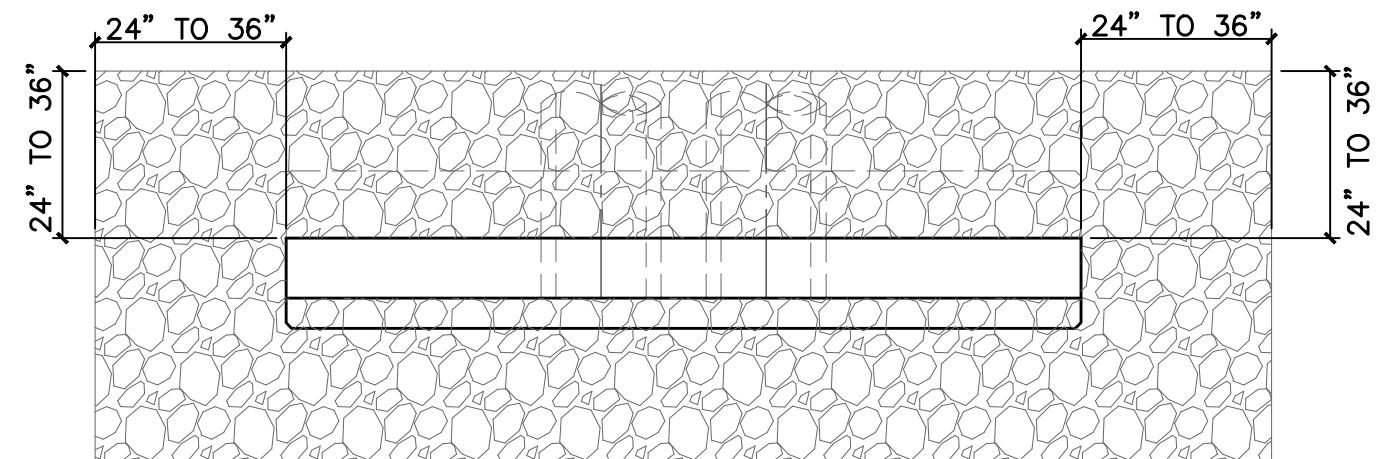
PLAN VIEW



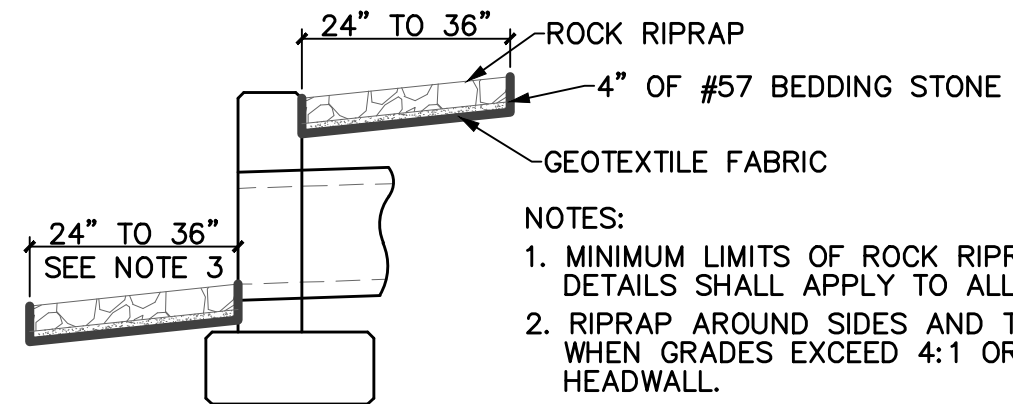
SECTION VIEW



ELEVATION VIEW



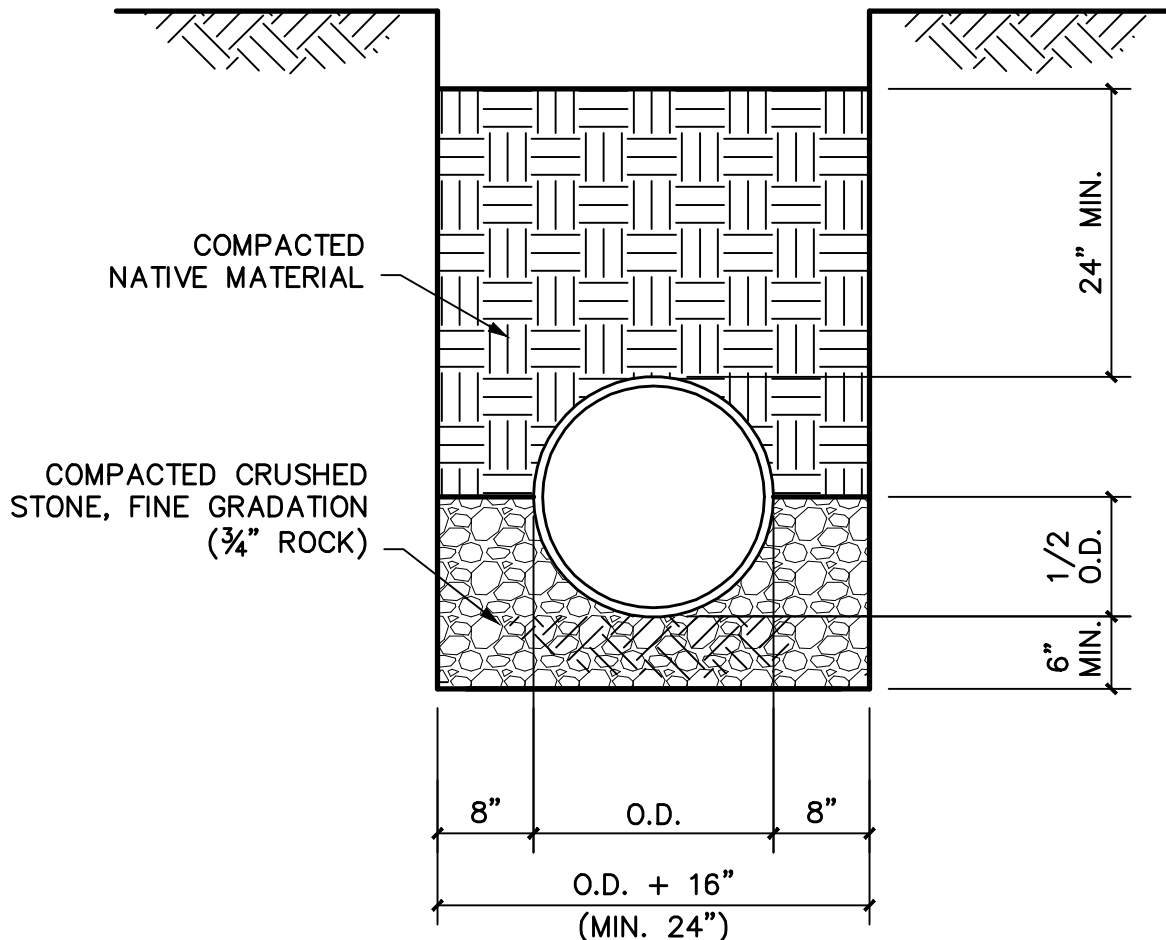
PLAN VIEW



SECTION VIEW

NOTES:

1. MINIMUM LIMITS OF ROCK RIPRAP SHOWN ON THESE DETAILS SHALL APPLY TO ALL STANDARD PIPE HEADWALLS.
2. RIPRAP AROUND SIDES AND TOP OF HEADWALL REQUIRED WHEN GRADES EXCEED 4:1 OR RUNOFF FLOWS OVER HEADWALL.
3. DESIGN LIMITS, SIZE, AND DEPTH OF RIPRAP AND BEDDING BASED ON THE ISWM TECHNICAL MANUAL FOR HYDRAULICS.
4. UNLESS SHOWN OTHERWISE IN THE PLANS.



CLASS "B"

NOTES:

1. UTILIZE CLASS "B" EMBEDMENT FOR RCP STORM DRAIN INSTALLATIONS.
2. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
3. BEDDING DEPTH MEASURED FROM OUTSIDE THE PIPE BELL.
4. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ FOR AUSTIN CHALK.



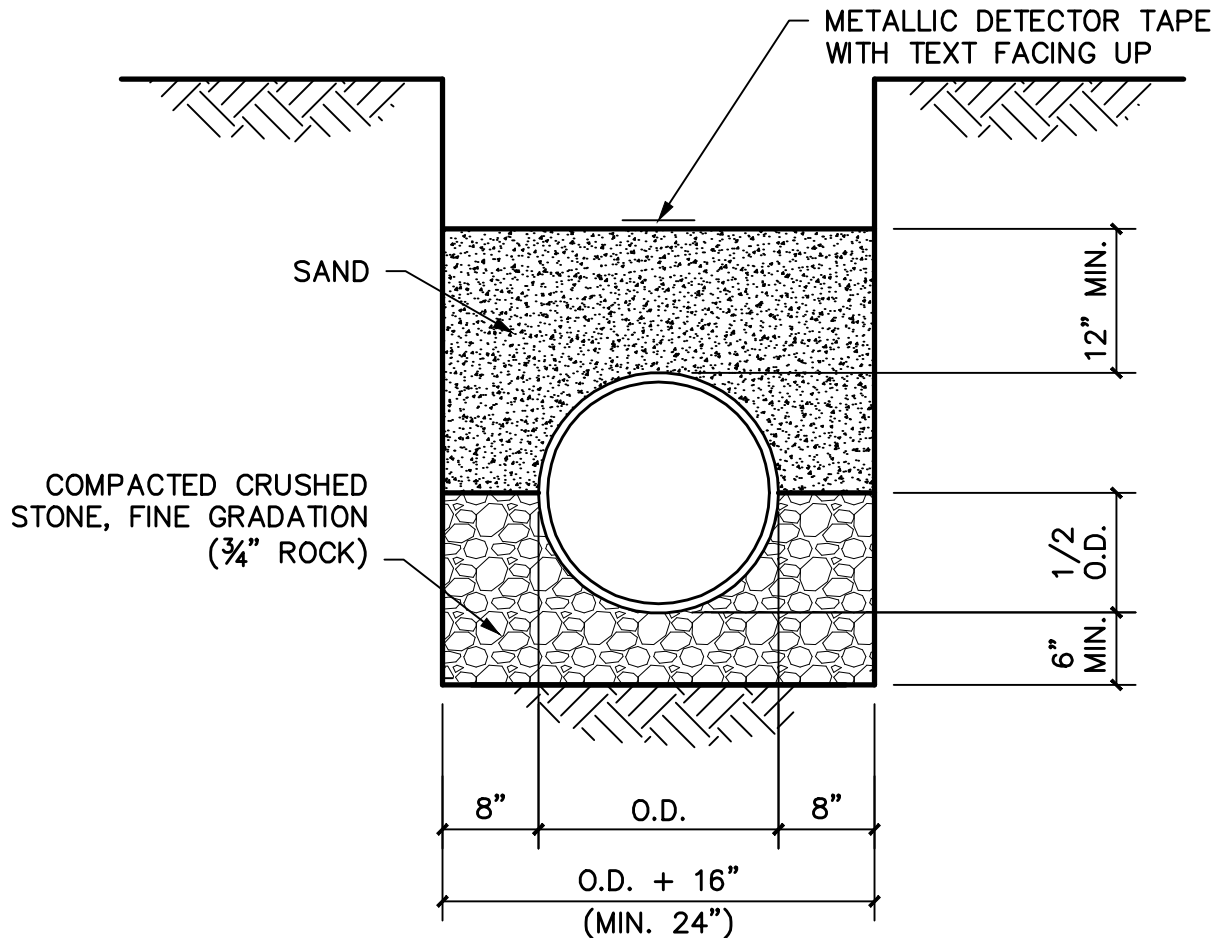
STANDARD CONSTRUCTION DETAIL

EMBEDMENT "B" (STORM)

SCALE: $\frac{3}{4}$ "=1'-0"

REVISED: AUG 2020

U01



CLASS "B+"

NOTES:

1. UTILIZE CLASS "B+" EMBEDMENT FOR PVC WATER LINES.
2. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
3. BEDDING DEPTH MEASURED FROM OUTSIDE THE PIPE BELL.
4. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ FOR AUSTIN CHALK.



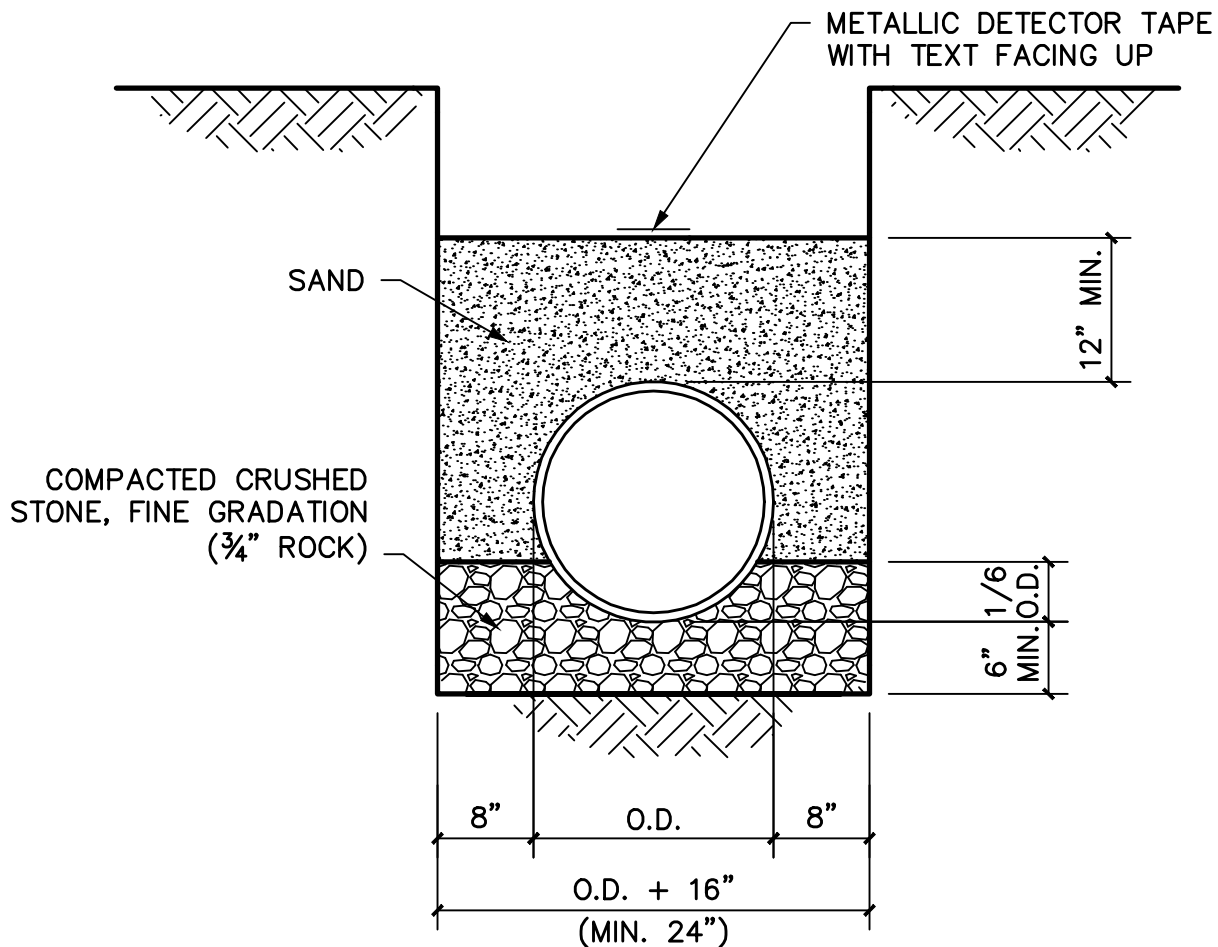
STANDARD CONSTRUCTION DETAIL

EMBEDMENT "B+" (WATER)

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

U02



CLASS "C+"

NOTES:

1. UTILIZE CLASS "C+" EMBEDMENT FOR DUCTILE IRON.
2. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
3. BEDDING DEPTH MEASURED FROM OUTSIDE THE PIPE BELL.
4. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ FOR AUSTIN CHALK.



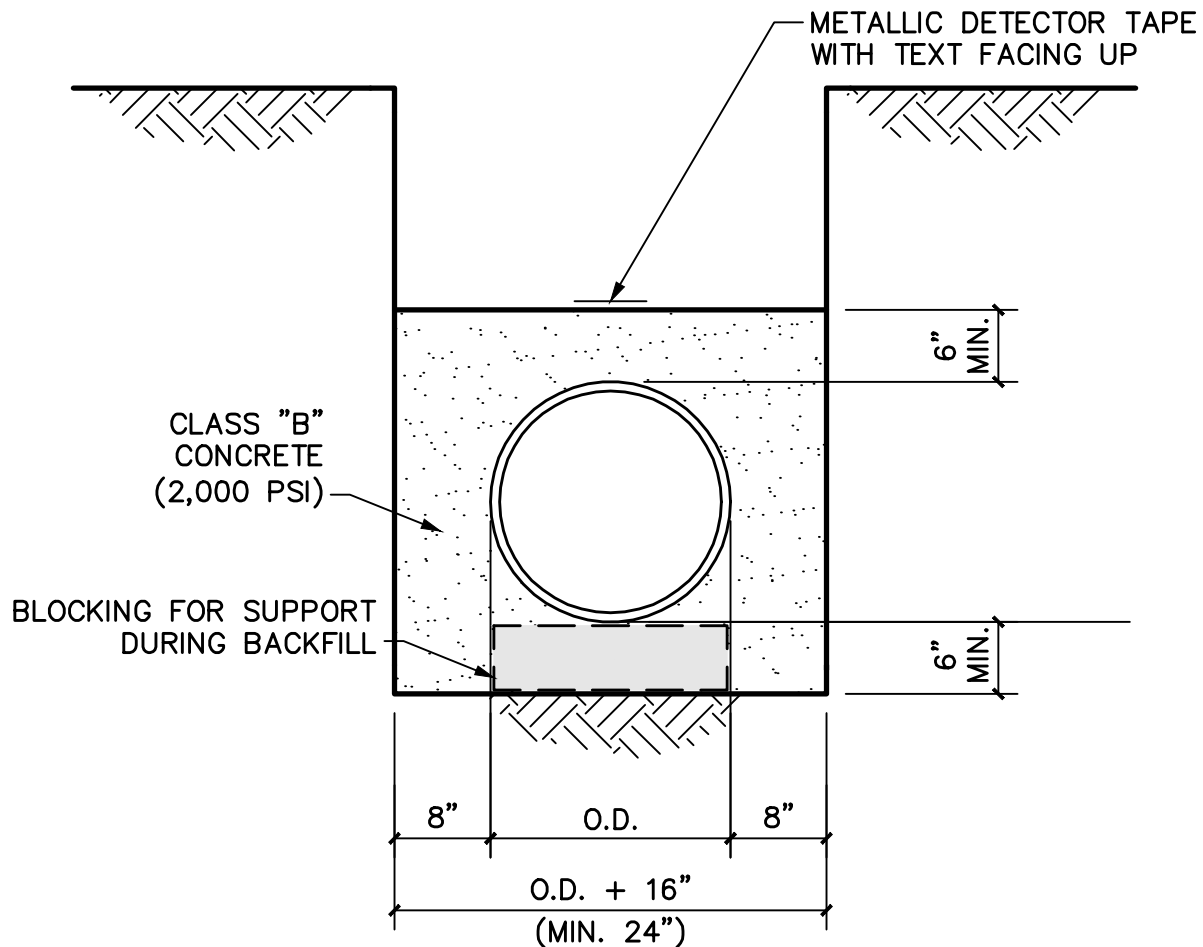
STANDARD CONSTRUCTION DETAIL

EMBEDMENT "C+"

SCALE: $3/4"=1'-0"$

REVISED: AUG 2020

U03



CLASS "G"

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
2. BEDDING DEPTH MEASURED FROM OUTSIDE OF PIPE BELL.
3. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND 0 ±4% AUSTIN CHALK.



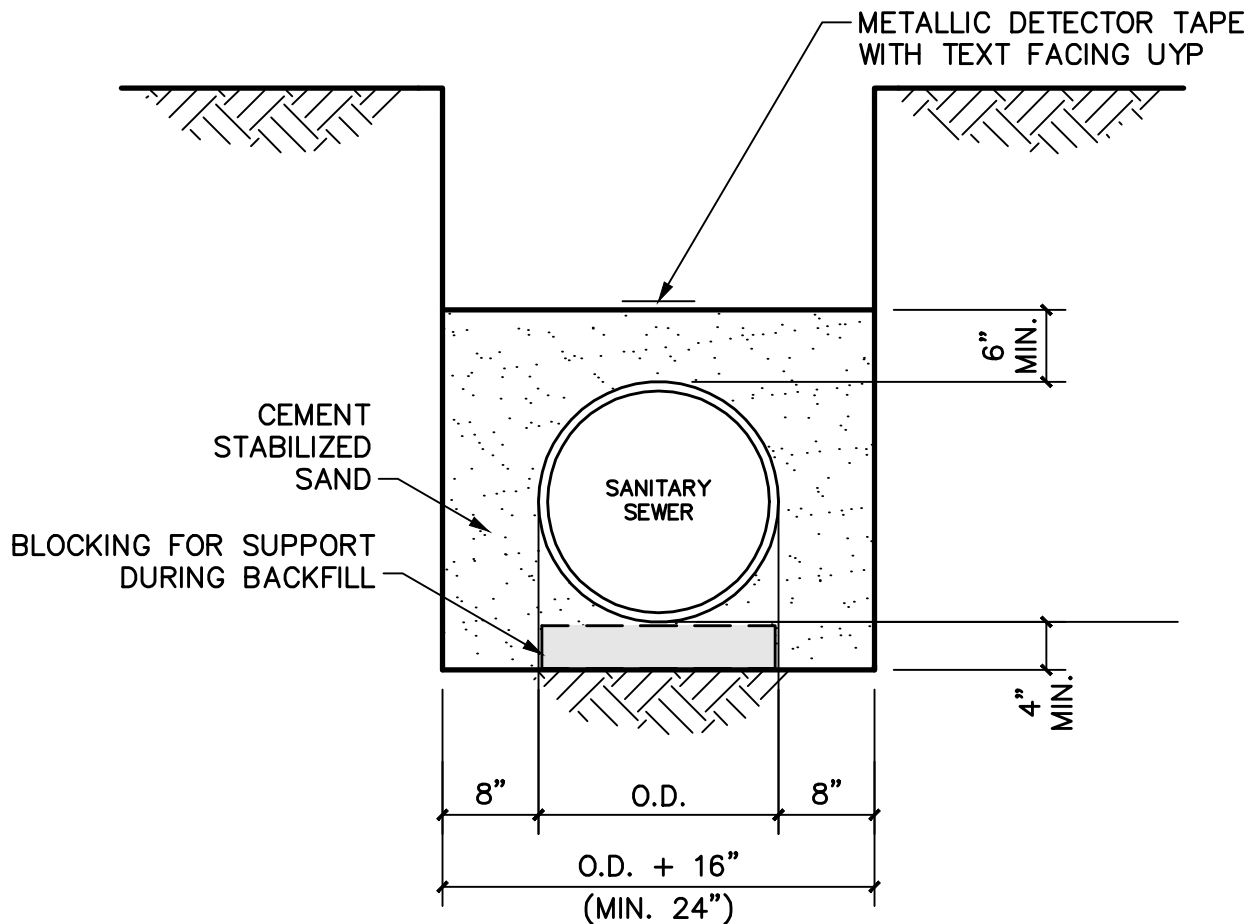
STANDARD CONSTRUCTION DETAIL

EMBEDMENT "G"

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

U04



CLASS "I"

NOTES:

1. CEMENT STABILIZED SAND SHALL HAVE A MINIMUM OF 10% CEMENT PER CUBIC YARD OF CEMENT STABILIZED SAND MIXTURE, BASED ON LOOSE DRY WEIGHT VOLUME (AT LEAST 2.5 BAGS OF CEMENT PER CUBIC YARD OF MIXTURE).
2. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
3. BEDDING DEPTH MEASURED FROM OUTSIDE OF PIPE BELL.
4. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ AUSTIN CHALK.



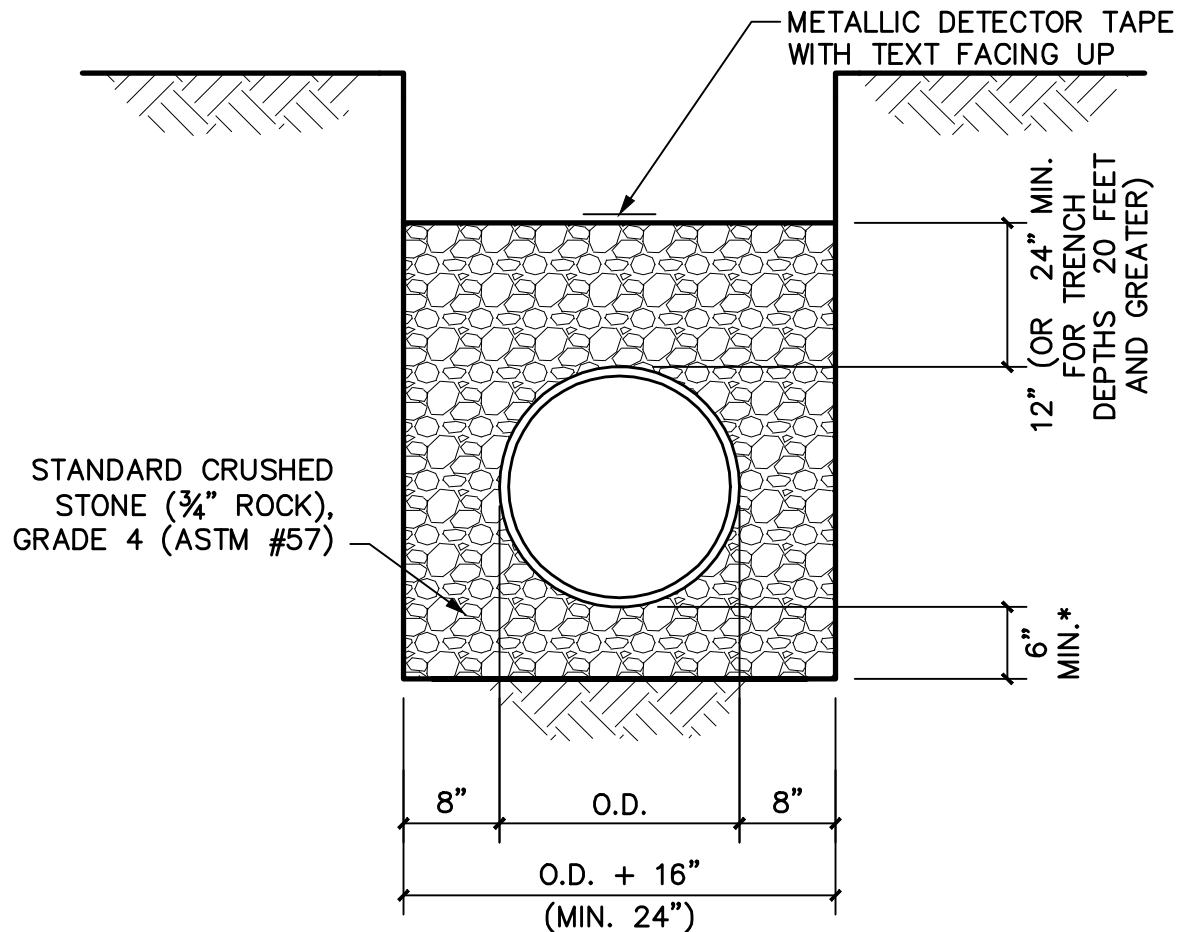
STANDARD CONSTRUCTION DETAIL

EMBEDMENT "I" (WASTEWATER)

SCALE: 3/4"=1'-0"

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U05



CLASS "H"

* BEDDING DEPTH MEASURED FROM OUTSIDE OF PIPE BELL.

NOTES:

1. UTILIZE CLASS "H" EMBEDMENT FOR WASTEWATER LINES.
2. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.

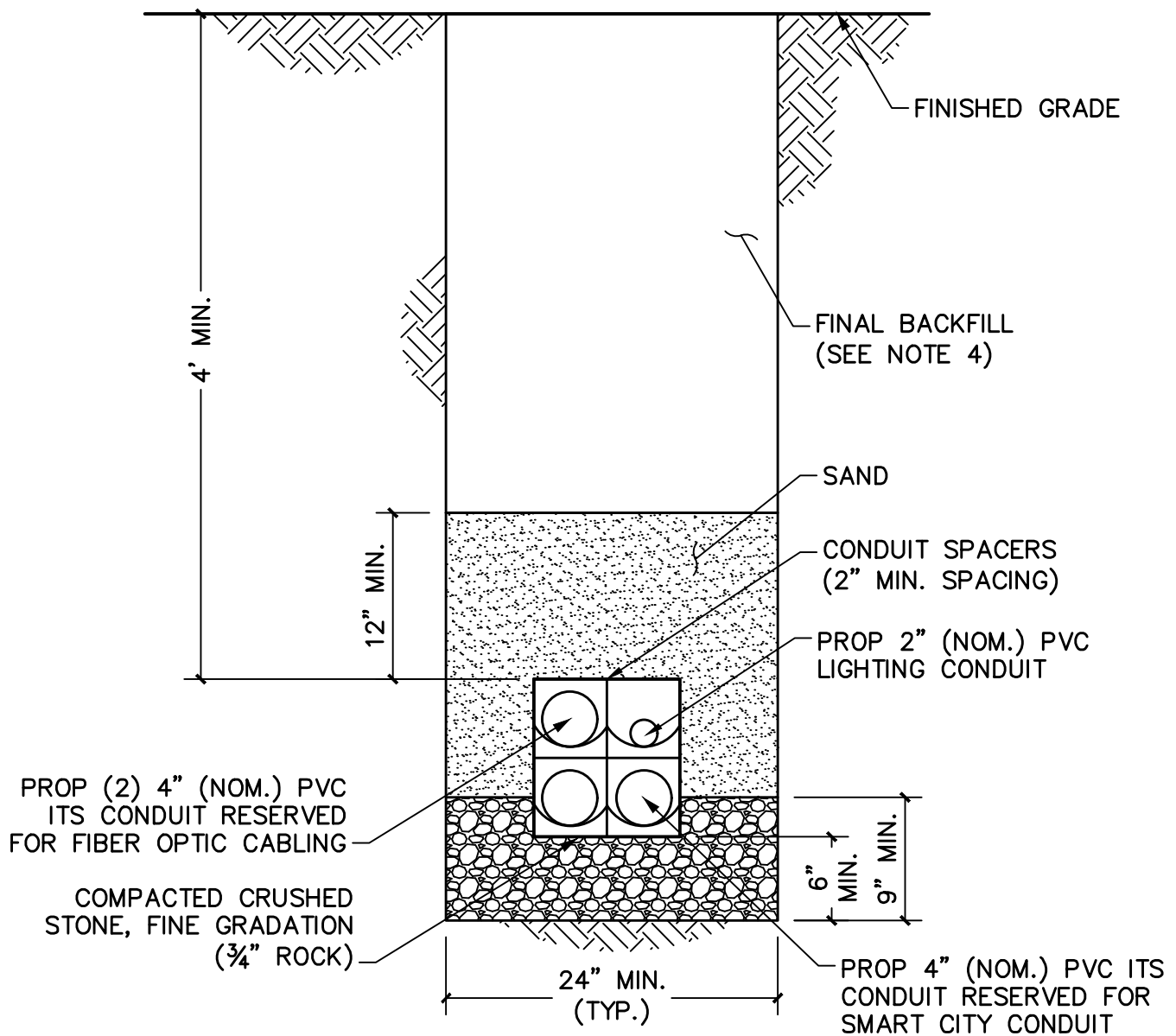


STANDARD CONSTRUCTION DETAIL EMBEDMENT "H" (WASTEWATER)

SCALE: $\frac{3}{4}$ "=1'-0"

REVISED: AUG 2020

U06



EMBEDMENT FOR MULTI-DUCTS

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
2. BEDDING DEPTH MEASURED FROM OUTSIDE THE MULTI-DUCTS.
3. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ FOR AUSTIN CHALK.



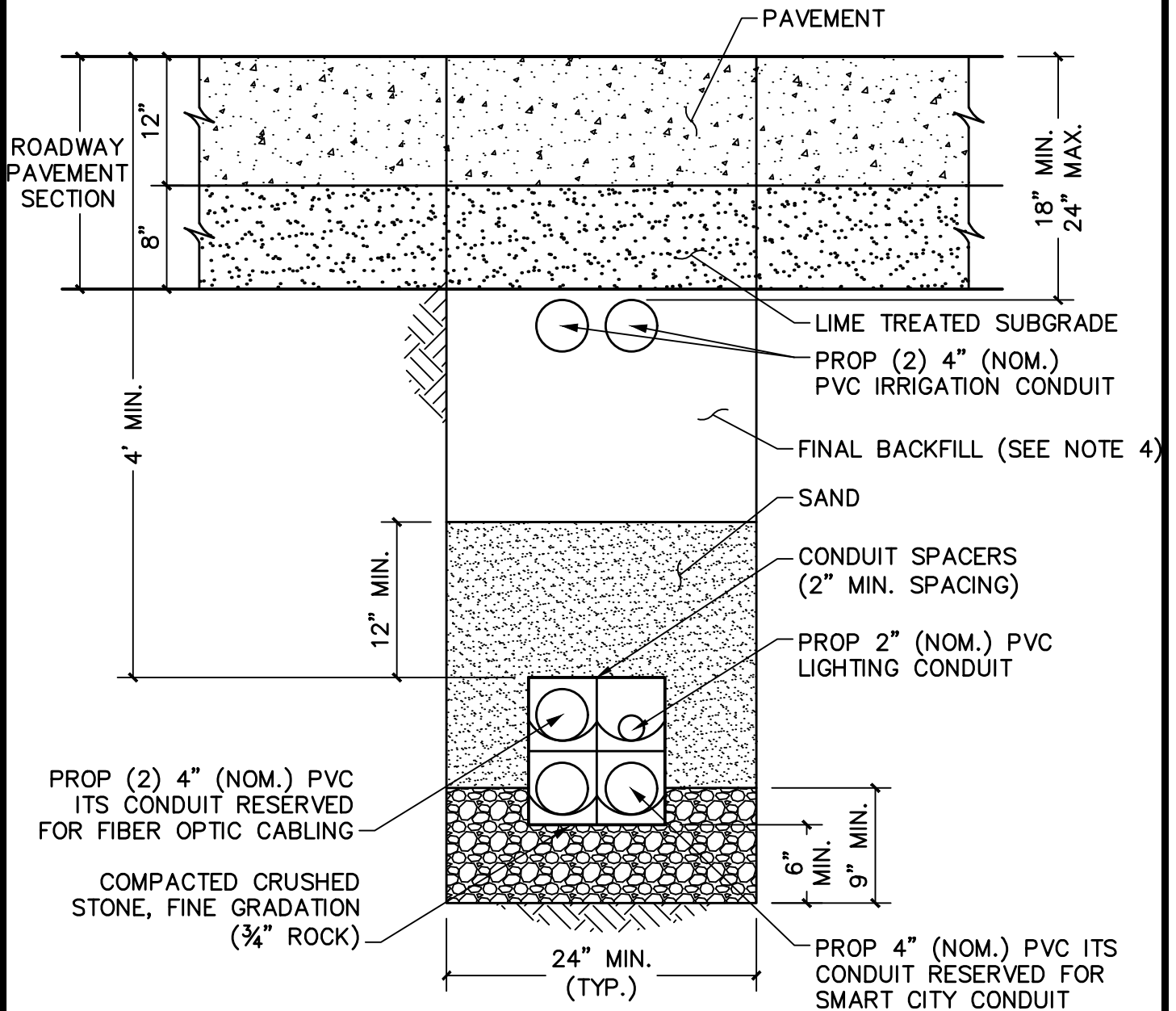
STANDARD CONSTRUCTION DETAIL

EMBEDMENT (MULTI-DUCTS)

SCALE: 1"=1'

REVISED: AUG 2020

U07



EMBEDMENT (MULTI-DUCTS) UNDER PAVEMENT

NOTES:

1. REFER TO TECHNICAL SPECIFICATION 330510 TRENCHING, BACKFILLING AND COMPACTION.
2. BEDDING DEPTH MEASURED FROM OUTSIDE THE MULTI-DUCTS.
3. FINAL BACKFILL MOISTURE TREATED TO 3% ABOVE OPTIMUM AT 95% STANDARD PROCTOR FOR EAGLE FORD AND $0 \pm 4\%$ FOR AUSTIN CHALK.

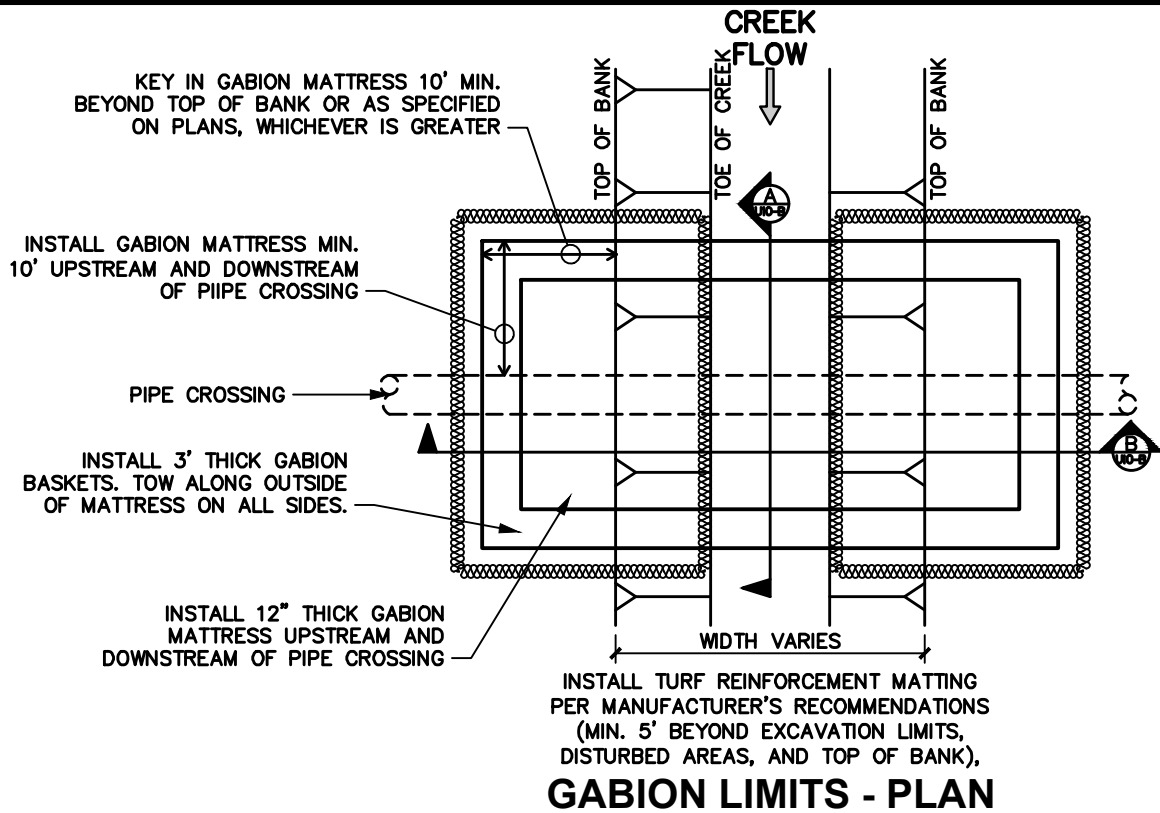


STANDARD CONSTRUCTION DETAIL
EMBEDMENT (MULTI-DUCTS)
UNDER PAVEMENT

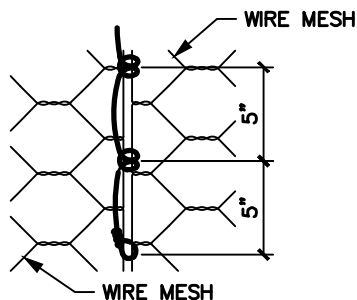
SCALE: 1"=1'

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U08



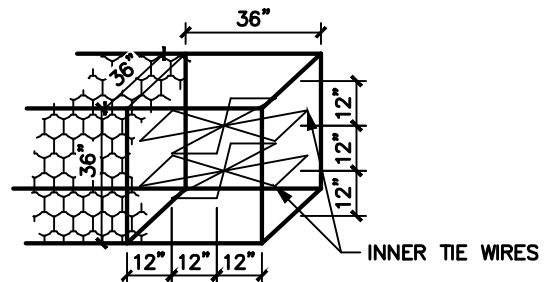
SCALE: N.T.S.



GABIONS MUST BE TIED IN THIS MANNER AT EACH STEP OF CONSTRUCTION:

1. INITIAL ASSEMBLY
2. TYING TO ADJACENT GABIONS ALONG ALL CONTACTING EDGES
3. TYING OF LID TO SIDES
4. TYING OF LID TO ALL DIAPHRAGMS
5. RE-TYING OF THE CUT GABION
6. TYING OF THE GABION MATTRESS TO THE GABION WALL ALONG ALL CONTACTING EDGES
7. REINFORCING TIE WIRE WITH HOG RINGS

GABION TYING METHOD



INNER TIE WIRES SHALL BE PLACED HORIZONTALLY IN EACH CELL EVERY 12" OF VERTICAL HEIGHT CONNECTING THE FRONT AND BACK FACES AND ANY UNSUPPORTED FACE LENGTHWISE.

GABION TIE WIRE INSTALLATION METHOD

TYPE A CREEK CROSSING GENERAL NOTES:

1. GABIONS SHALL BE INSTALLED TO MEET CITY OF FRISCO DESIGN SPECIFICATION NUMBER 313600:: GABIONS AND GABION MATTRESSES.
2. ALL PROPOSED GABION MATTRESSES SLOPES SHALL BE NO STEEPER THAN 2 HORIZONTAL TO 1 VERTICAL UNLESS OTHERWISE NOTED.
3. MINOR CHANGES IN DIMENSIONS OF GABIONS WILL BE ALLOWED IN ORDER TO PROVIDE FOR ECONOMICAL USE OF STANDARD GABION SIZES. CONTRACTOR SHALL SUBMIT DESIGN REVISIONS TO THE ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION.
4. BOTTOMS AND BACKS OF ALL GABION TOES AND MATTRESSES SHALL BE LINED WITH FILTER FABRIC UNLESS OTHERWISE SPECIFIED.
5. ALL GABION TOES AND MATTRESSES SHALL HAVE PVC COATED WIRE MESH.
6. FILTER FABRIC SHALL BE NONWOVEN GEOTEXTILE WITH U.S. SIEVE SIZE MIN. NO. 100 APPARENT OPENING SIZE (PER ASTM-D-4751). FILTER CLOTH SPLICES SHALL HAVE A MINIMUM OVERLAP OF 18.
7. GABION BASKETS FOR TOE WALLS ARE SHOWN AS 3'x3'x3' (LENGTH x WIDTH x HEIGHT); HOWEVER, CONTRACTOR MAY USE BASKET LENGTHS UP TO 12 FEET OR ANY ECONOMICAL COMBINATION OF STANDARD LENGTHS. MINOR CHANGES IN DIMENSIONS OF GABIONS WILL BE ALLOWED IN ORDER TO PROVIDE FOR ECONOMICAL USE OF STANDARD GABION SIZES. IF CHANGES TO GABION DESIGN ARE MADE, THE CONTRACTOR SHALL SUBMIT GABION DESIGN TO ENGINEER FOR REVIEW PRIOR TO CONSTRUCTION. GABION DESIGN CHANGES SHALL BE SIGNED AND SEALED BY A LICENSED ENGINEER BY THE STATE OF TEXAS.
8. TURF REINFORCEMENT MATTING SHALL BE CURLEX HIGH-VELOCITY, OR APPROVED EQUAL.

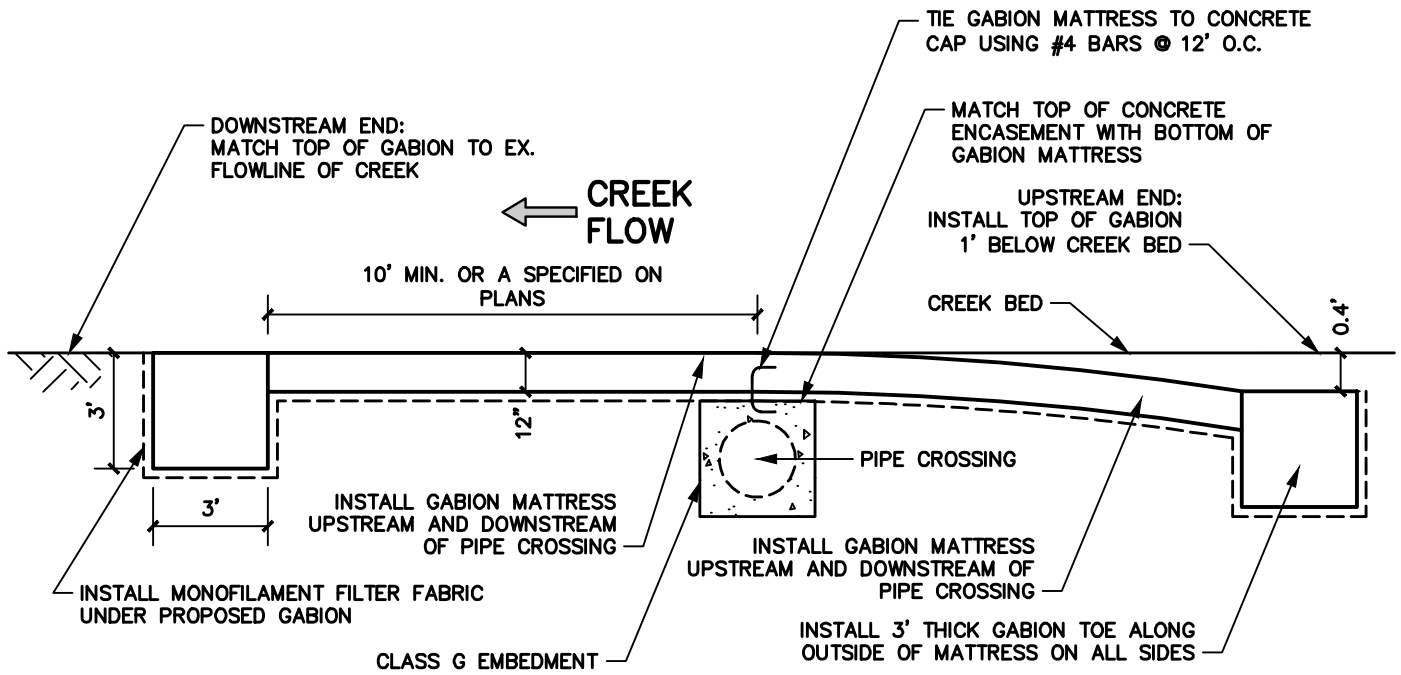


STANDARD CONSTRUCTION DETAIL GABION ARMORING FOR SEWER CROSSING SHEET 1 OF 2

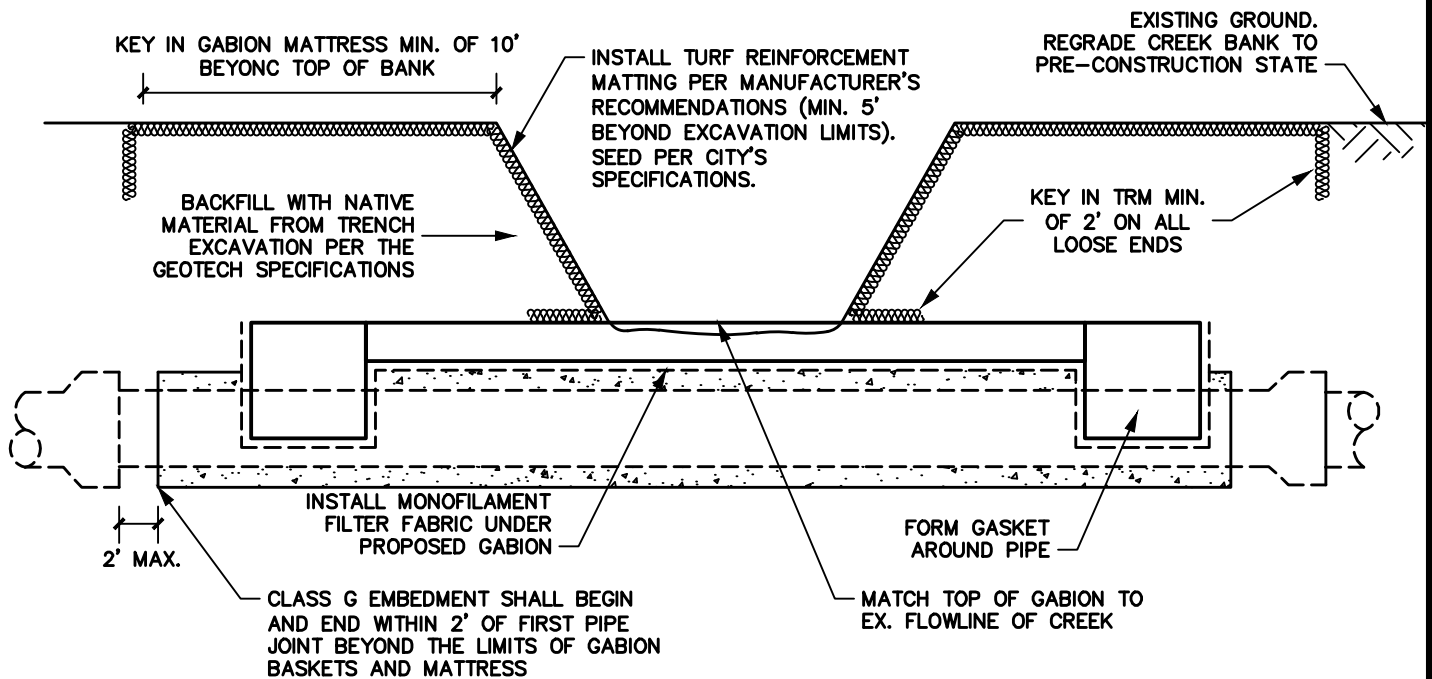
SCALE: N.T.S.

REVISED: AUG 2020

U09



A CROSS SECTION
U10-B N.T.S.



B PLAN SECTION
U10-B N.T.S.

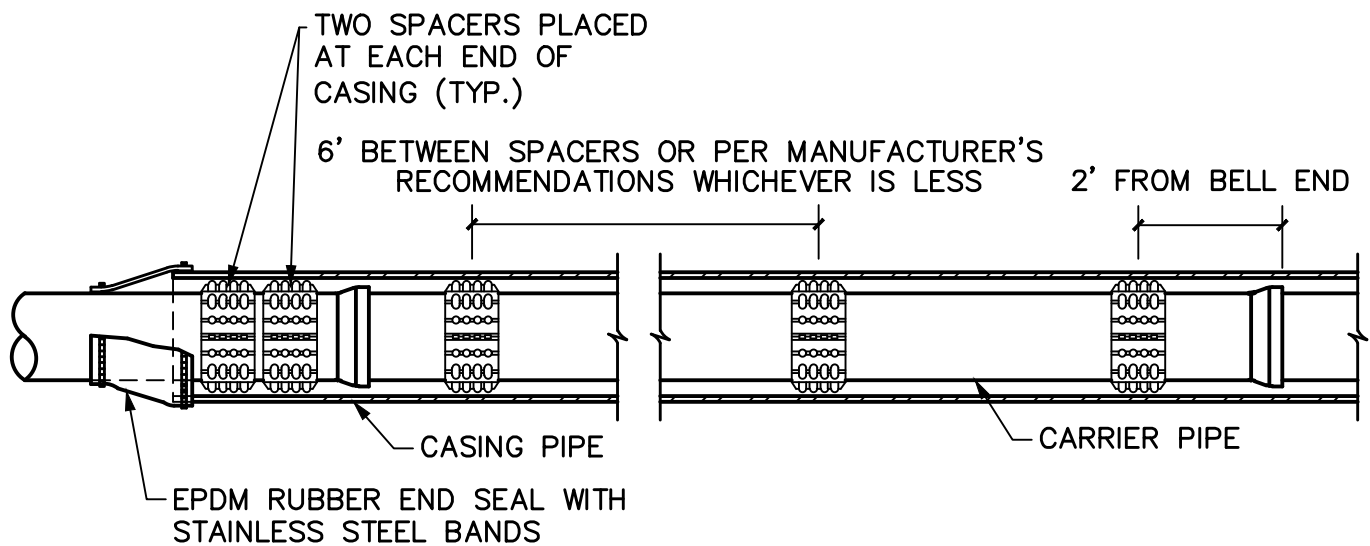


**STANDARD CONSTRUCTION DETAIL
GABION ARMORING FOR SEWER CROSSING
SHEET 2 OF 2**

SCALE: 1/12"=1'

REVISED: AUG 2020

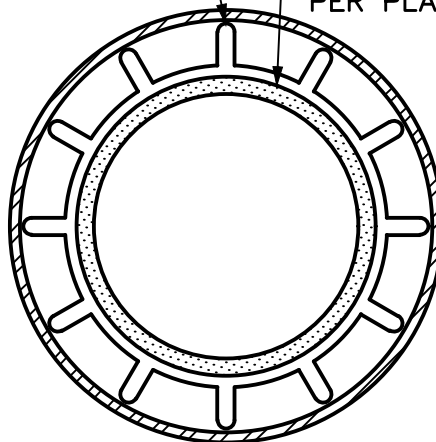
U10



CASING SPACER PROFILE

HIGH DENSITY POLYETHYLENE CASING SPACERS

CARRIER PIPE SIZE AND TYPE PER PLANS



CASING SPACER

NOTE:

1. REFER TO APPROVED MATERIALS LIST FOR CASING SPACERS.



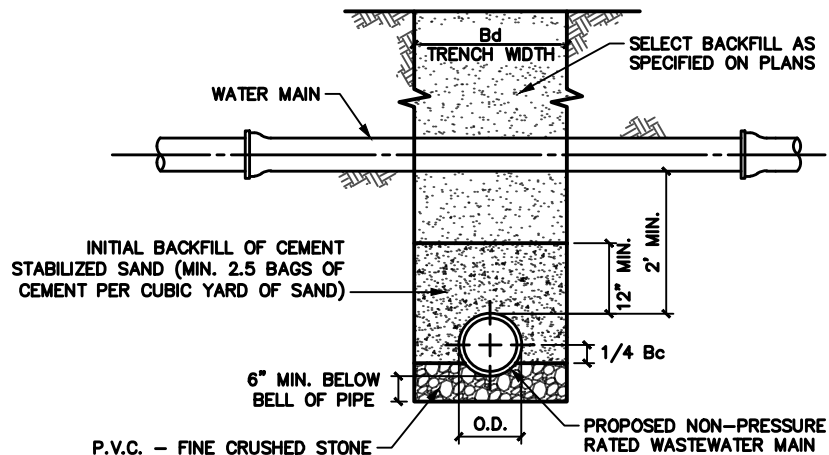
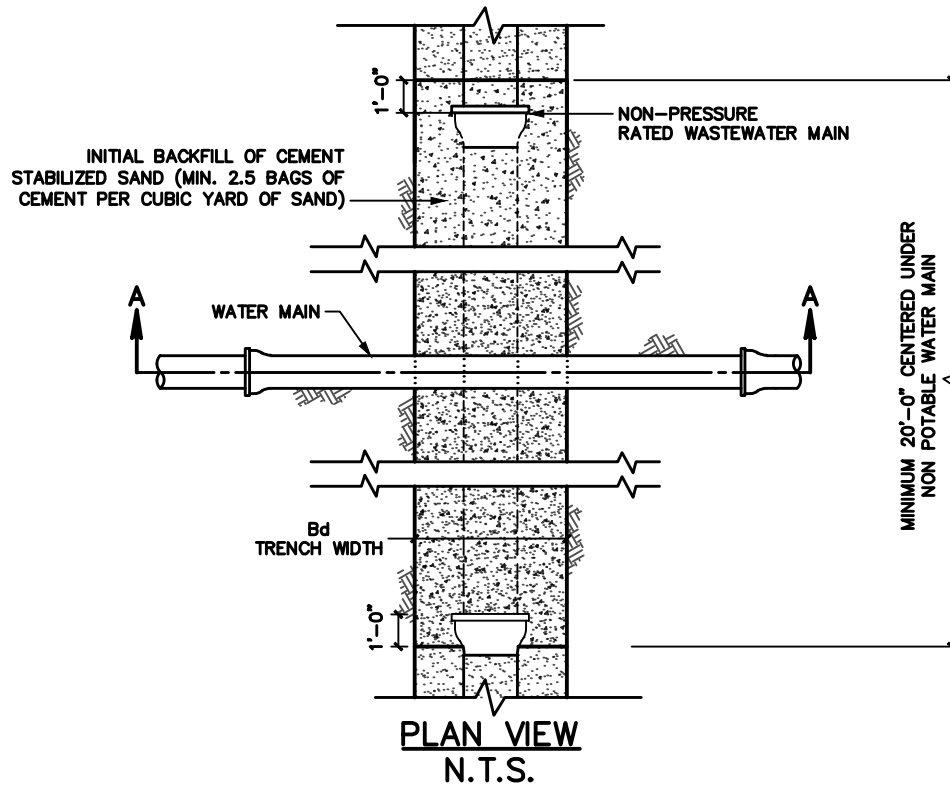
STANDARD CONSTRUCTION DETAIL

CASING SPACERS

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

U11



NOTES:

1. Bd = TRENCH WIDTH (SEE EMBEDMENT DETAILS)

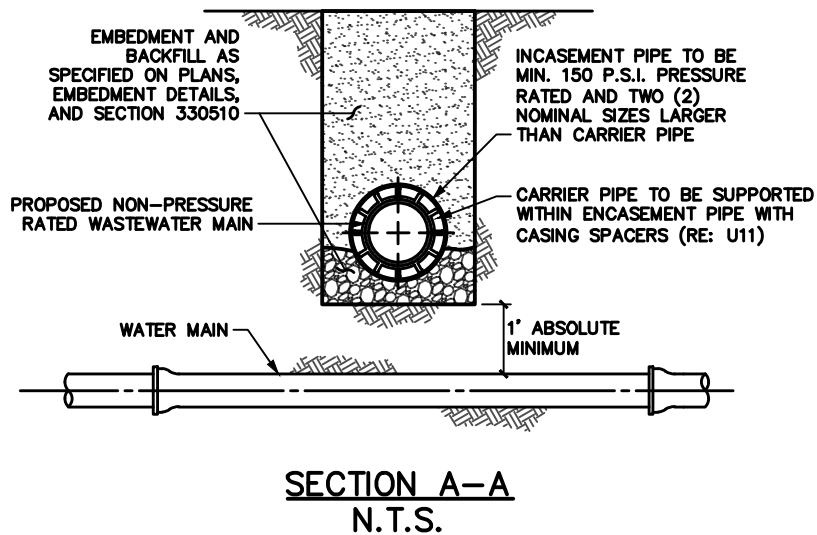
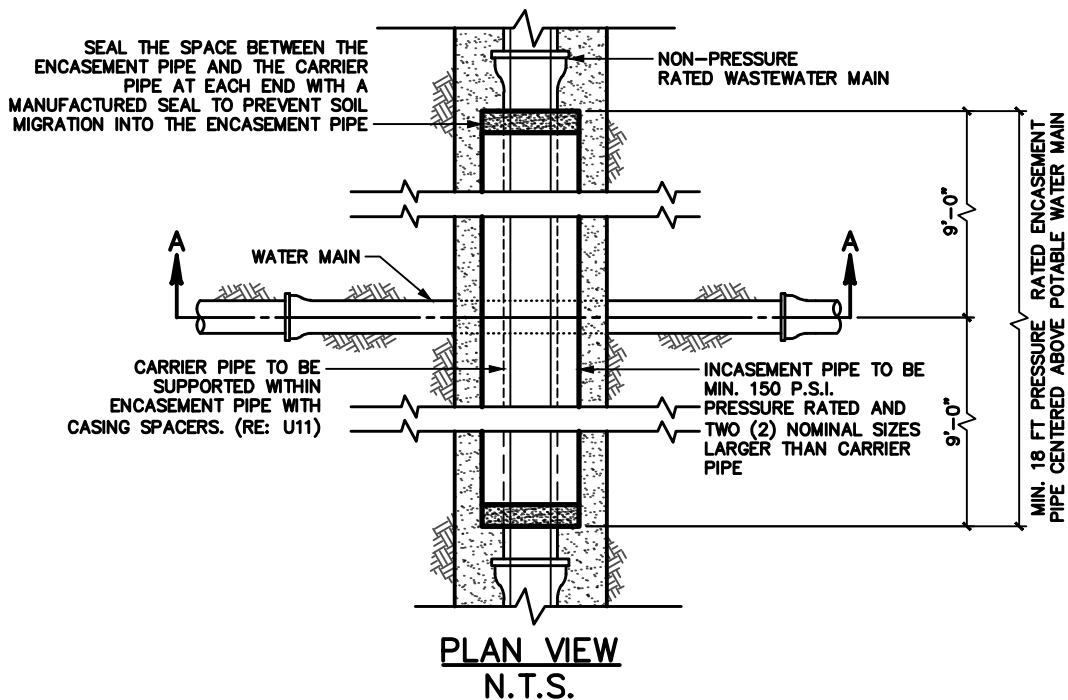


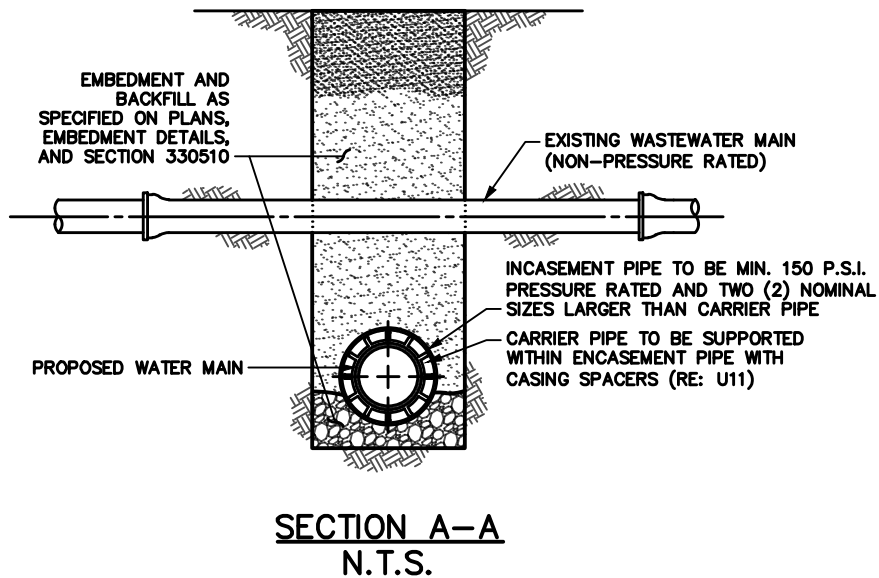
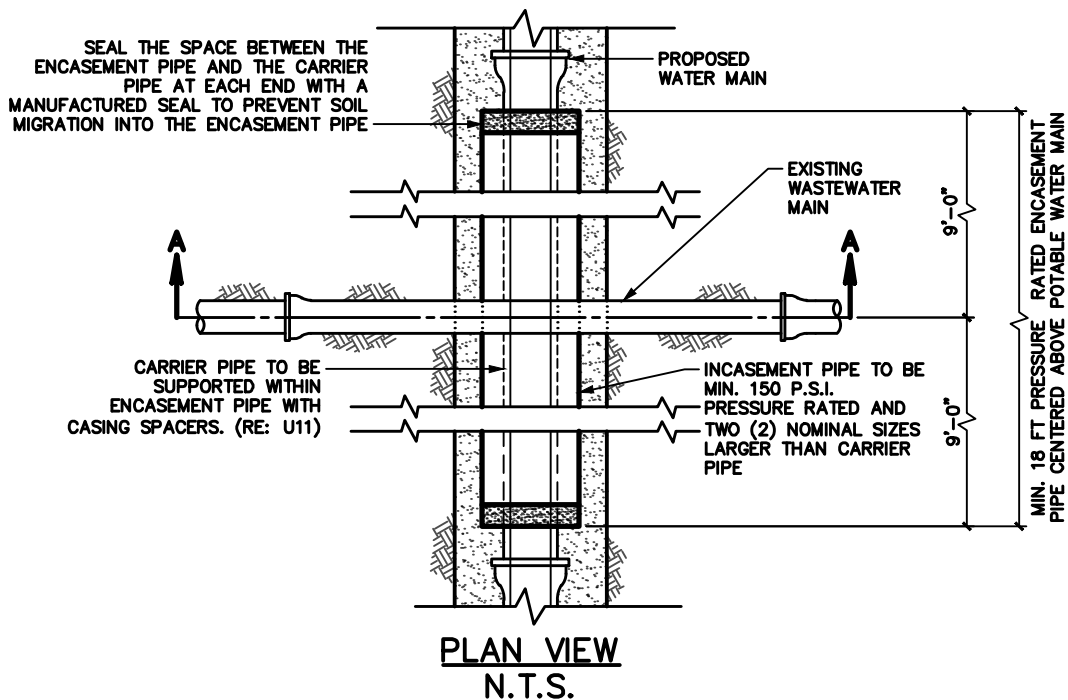
**STANDARD CONSTRUCTION DETAIL
EMBEDMENT DETAIL FOR NON-PRESSURE RATED
WASTEWATER MAINS BELOW WATER MAINS**

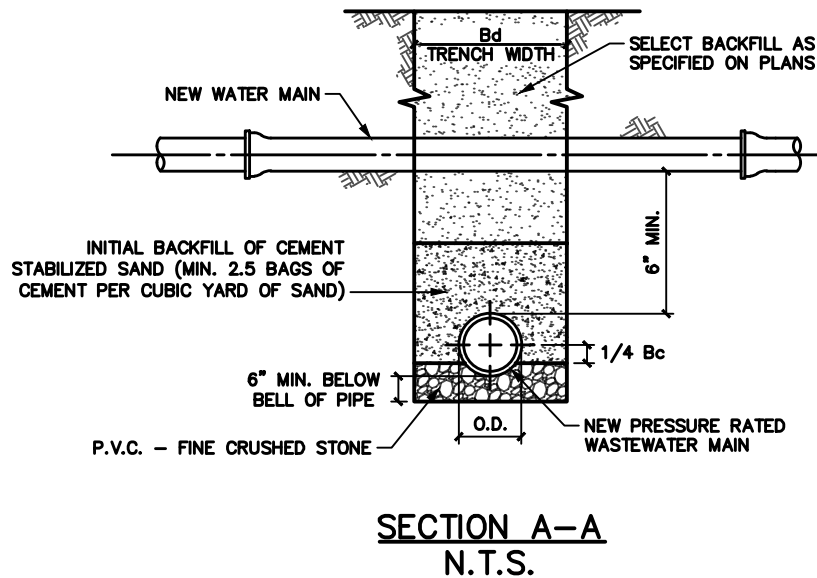
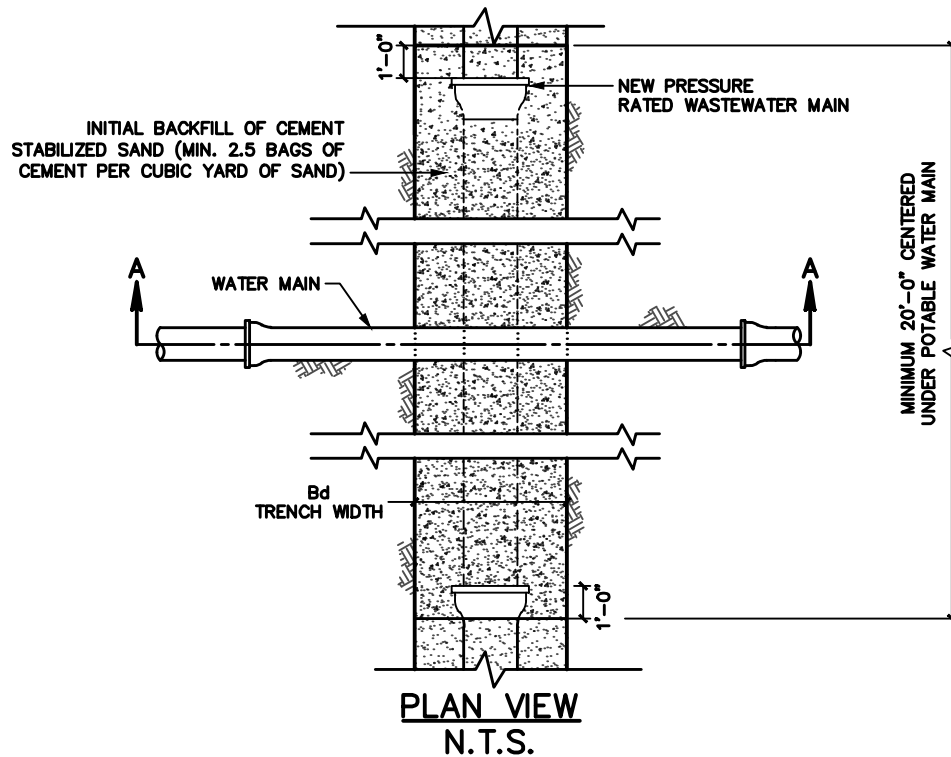
SCALE: N.T.S.

REVISED: AUG 2020

U12







NOTES:

1. Bd = TRENCH WIDTH (SEE EMBEDMENT DETAILS)

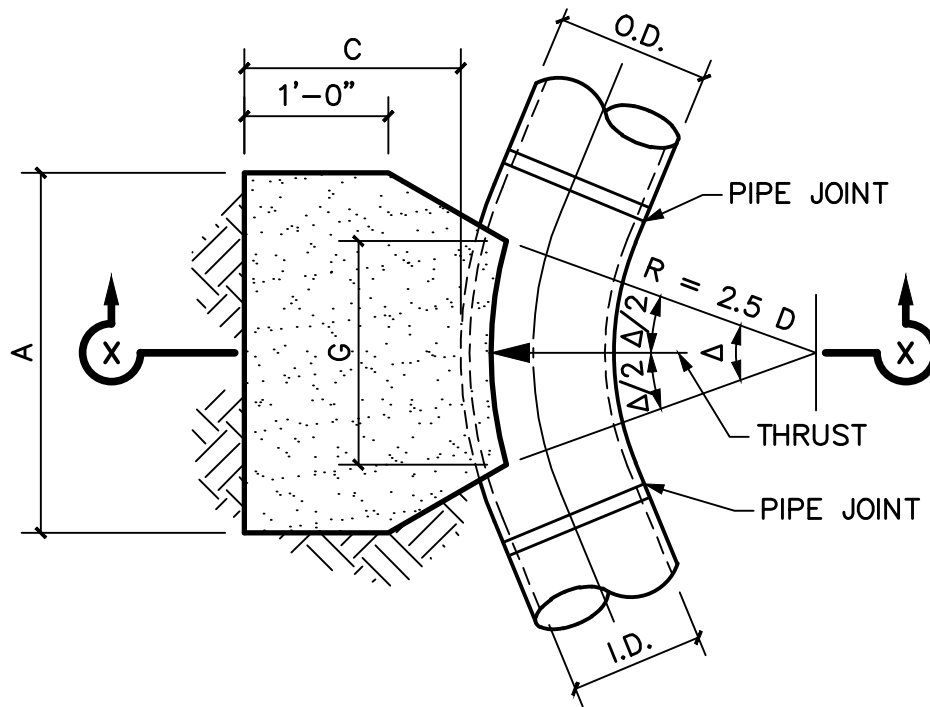


STANDARD CONSTRUCTION DETAIL
EMBEDMENT DETAIL FOR NEW PRESSURE RATED
WASTEWATER MAINS BELOW NEW WATER MAINS

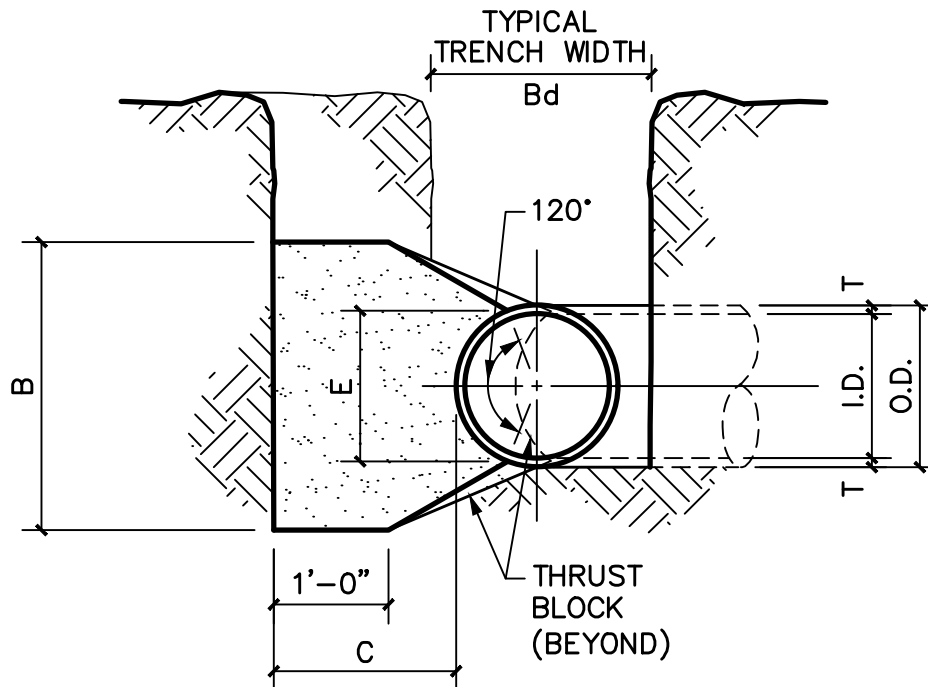
SCALE: N.T.S.

REVISED: AUG 2020

U15



PLAN



SECTION X-X

NOTES:

1. REFER TO STANDARD DETAIL W02 AND W03 FOR TABLES OF DIMENSIONS AND QUANTITIES.
2. REFER TO STANDARD DETAIL W06 FOR GENERAL NOTES.



**STANDARD CONSTRUCTION DETAIL
HORIZONTAL THRUST BLOCK AT PIPE BEND
SHEET 1 OF 3**

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

W01

I.D. (IN.)	T (IN.)	$\Delta = 11.25^\circ$ C (IN.)	$\Delta \geq 22.50^\circ$ C (IN.)	E (IN.)
4,6,8	0.4	1.5	1.5	0.9
10,12	0.5	1.5	1.5	1.2
16,18	0.6	1.5	1.5	1.6
20	0.7	1.5	1.5	1.8
24	0.9	1.5	1.5	2.1
30	2.9	1.5	1.9	2.6
36	4.5	1.5	2.3	3.3
42	5.0	1.8	2.6	3.8
48	5.5	2.0	3.0	4.3
54	6.0	2.3	3.4	4.8
60	6.5	2.5	3.8	5.3
66	6.8	2.8	4.1	5.7
72	7.5	3.0	4.5	6.3
78	7.5	3.3	4.9	6.7
84	8.0	3.5	5.3	7.2
90	8.5	3.8	5.6	7.7
96	9.0	4.0	6.0	8.2

I.D. (IN.)	$\Delta = 11.25^\circ$							
	G (FT.)	THRUST (TONS)	EARTH			ROCK		
			A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)
4,6,8	0.4	1.0	1.0	1.5	0.1	1.0	1.0	0.1
10,12	0.6	2.2	1.5	1.5	0.1	1.0	1.5	0.1
16,18	0.8	5.0	2.0	2.5	0.3	1.5	2.0	0.2
20	0.9	6.2	2.0	3.5	0.4	1.5	3.0	0.3
24	1.1	8.9	3.0	3.5	0.5	1.5	3.0	0.3
30	1.4	10.4	3.0	3.5	0.6	2.0	3.5	0.4
36	1.7	15.0	3.5	4.5	0.9	2.0	4.0	0.5
42	1.9	20.4	4.5	5.0	1.5	2.5	5.0	0.8
48	2.2	26.6	4.5	6.0	2.0	2.5	6.0	1.1
54	2.5	33.7	6.0	6.0	3.0	3.0	6.0	1.4
60	2.7	41.6	6.0	7.0	3.8	3.0	7.0	1.8
66	3.0	50.3	6.5	8.0	5.1	3.5	8.0	2.7
72	3.3	59.9	7.5	8.0	6.3	4.0	8.0	3.3
78	3.6	70.2	8.0	9.0	8.1	4.0	9.0	3.9
84	3.8	81.5	8.5	10.0	10.3	4.5	10.0	5.3
90	4.1	93.5	9.5	10.0	12.2	5.0	10.0	6.3
96	4.4	106.4	10.0	11.0	15.0	5.0	11.0	7.4

I.D. (IN.)	$\Delta = 22.50^\circ$							
	G (FT.)	THRUST (TONS)	EARTH			ROCK		
			A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)
4,6,8	0.8	2.0	1.5	1.5	0.1	1.0	1.0	0.1
10,12	1.1	4.4	2.0	2.5	0.3	1.5	1.5	0.1
16,18	1.6	9.9	3.0	3.5	0.6	2.0	2.5	0.3
20	1.8	12.3	3.5	3.5	0.7	2.0	3.0	0.4
24	2.2	17.7	4.0	4.5	1.0	3.0	3.5	0.5
30	2.7	20.7	5.0	4.5	1.5	3.0	4.0	0.8
36	3.3	29.8	5.5	5.5	2.3	4.0	4.0	1.3
42	3.8	40.5	7.0	6.0	3.9	4.5	5.0	2.1
48	4.4	52.9	8.0	7.0	5.7	4.5	6.0	2.8
54	4.9	67.0	9.0	8.0	8.0	6.0	6.0	4.1
60	5.5	82.7	9.5	9.0	10.6	6.0	7.0	5.3
66	6.0	100.1	10.5	10.0	14.1	6.5	8.0	7.2
72	6.6	119.1	11.0	11.0	17.6	7.5	8.0	9.1
78	7.1	139.8	12.0	12.0	22.5	8.0	9.0	11.7
84	7.6	162.1	13.0	12.5	27.2	8.5	10.0	14.8
90	8.2	186.1	14.0	13.5	33.7	9.5	10.0	17.7
96	8.7	211.7	15.0	14.5	41.2	10.0	11.0	21.8



STANDARD CONSTRUCTION DETAIL
HORIZONTAL THRUST BLOCK AT PIPE BEND
SHEET 2 OF 3

SCALE: N.T.S.
REVISED: AUG 2020
W02

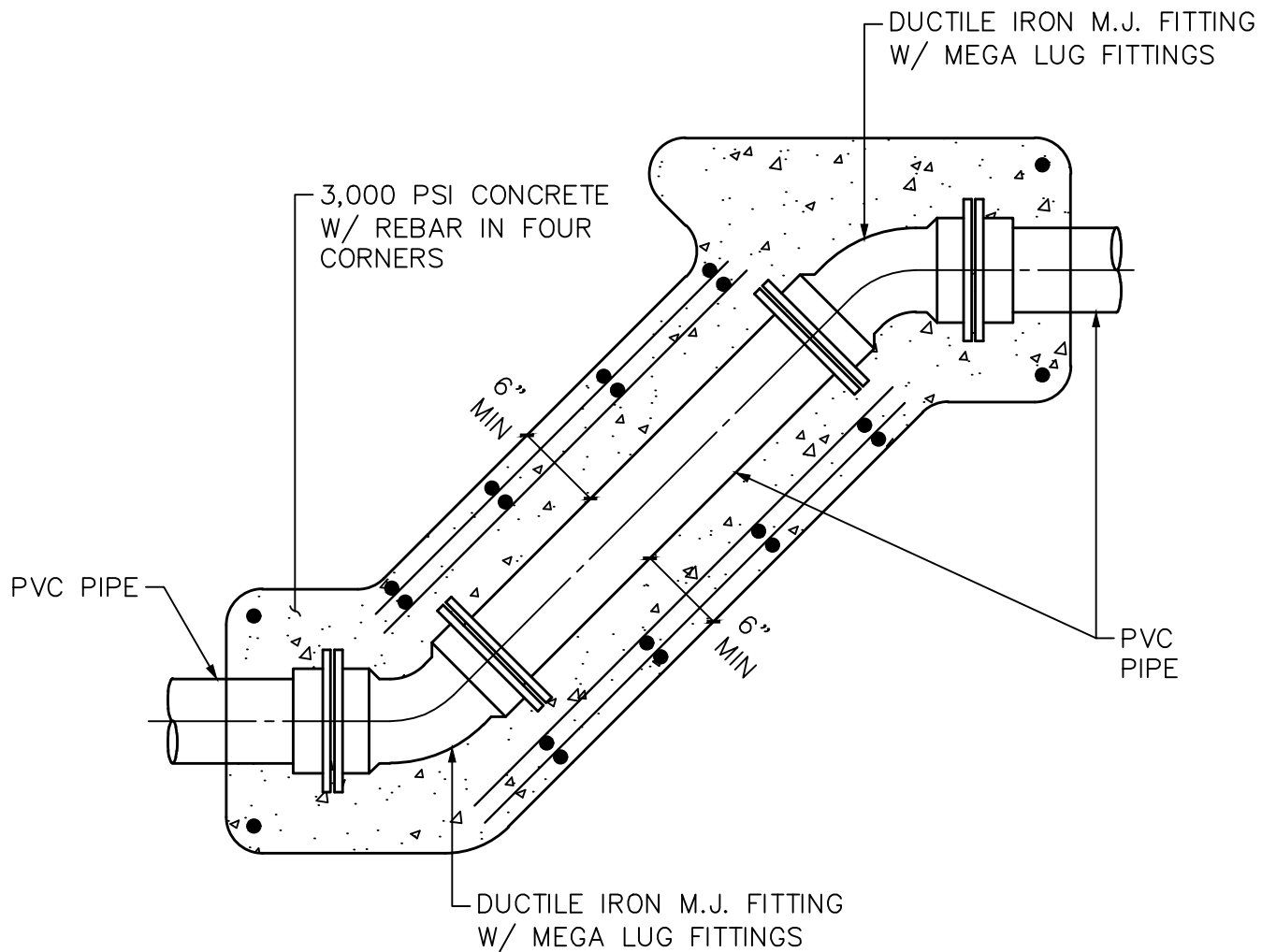
$\Delta = 30^\circ$									$\Delta = 45^\circ$								
I.D. (IN.)	G (FT.)	THRUST (TONS)	EARTH			ROCK			I.D. (IN.)	G (FT.)	THRUST (TONS)	EARTH			ROCK		
			A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)				A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)
4,6,8	1.0	2.6	2.0	1.5	0.2	1.0	1.5	0.1	4,6,8	1.5	3.9	2.0	2.0	0.2	1.5	1.5	0.1
10,12	1.5	5.9	2.5	2.5	0.3	2.0	1.5	0.2	10,12	2.2	8.7	3.5	2.5	0.5	2.0	2.5	0.3
16,18	2.2	13.2	3.5	4.0	0.8	2.5	3.0	0.4	16,18	3.2	19.5	4.5	4.5	1.2	3.0	3.5	0.6
20	2.4	16.3	4.5	4.0	1.0	3.0	3.0	0.5	20	3.6	24.1	5.5	4.5	1.5	3.5	3.5	0.7
24	2.9	23.4	6.0	4.0	1.4	3.5	3.5	0.7	24	4.3	34.6	8.0	4.5	2.3	4.5	4.0	1.1
30	3.6	27.5	6.5	5.0	1.9	3.5	4.0	0.9	30	5.4	40.6	8.5	5.0	3.2	5.5	4.0	1.6
36	4.4	39.5	7.0	6.0	3.4	4.5	4.5	1.6	36	6.5	58.5	10.0	6.0	5.3	6.5	4.5	2.6
42	5.1	53.8	8.0	7.0	5.1	5.5	5.0	2.5	42	7.5	79.6	11.5	7.0	8.1	8.0	5.0	4.2
48	5.8	70.3	9.0	8.0	7.4	6.0	6.0	3.7	48	8.6	104.0	13.0	8.0	11.9	9.0	6.0	6.3
54	6.5	89.0	10.0	9.0	10.3	7.0	6.5	5.3	54	9.7	131.5	15.0	9.0	17.1	10.5	6.5	8.9
60	7.3	110.0	11.0	10.0	13.9	7.5	7.5	7.3	60	10.7	162.4	16.5	10.0	23.1	11.0	7.5	12.0
66	8.0	132.9	12.5	11.0	18.9	8.5	8.0	9.6	66	11.8	196.5	18.0	11.0	30.1	12.0	8.5	16.2
72	8.7	158.6	13.5	12.0	24.0	9.0	9.0	12.3	72	12.9	233.9	19.5	12.0	38.6	14.0	8.5	20.7
78	9.4	185.6	14.5	13.0	30.0	10.0	9.5	15.6	78	13.9	274.5	21.5	13.0	49.8	14.5	9.5	25.9
84	10.1	215.3	15.5	14.0	37.1	10.5	10.5	19.5	84	15.0	318.4	23.0	14.0	61.2	15.5	10.5	32.6
90	10.9	247.1	16.5	15.0	45.0	11.5	11.0	23.9	90	16.1	365.5	24.5	15.0	74.5	17.5	10.5	39.6
96	11.6	281.2	18.0	16.0	55.5	12.5	11.5	28.9	96	17.1	415.6	26.0	16.0	89.5	18.5	11.5	48.5

$\Delta = 67.50^\circ$									$\Delta = 90^\circ$								
I.D. (IN.)	G (FT.)	THRUST (TONS)	EARTH			ROCK			I.D. (IN.)	G (FT.)	THRUST (TONS)	EARTH			ROCK		
			A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)				A (FT.)	B (FT.)	VOL. (C.Y.)	A (FT.)	B (FT.)	VOL. (C.Y.)
4,6,8	2.1	5.6	3.0	2.0	0.3	2.0	1.5	0.2	4,6,8	2.7	7.1	5.0	1.5	0.4	2.0	2.0	0.2
10,12	3.1	12.6	5.5	2.5	0.8	3.5	2.0	0.4	10,12	4.0	16.0	6.5	2.5	1.0	3.5	2.5	0.5
16,18	4.7	28.3	7.5	4.0	1.9	5.5	3.0	0.9	16,18	6.0	36.0	9.0	4.0	2.4	4.5	4.0	1.0
20	5.2	34.9	9.0	4.0	2.3	5.5	3.5	1.2	20	6.6	44.4	10.0	4.5	3.1	6.0	4.0	1.5
24	6.2	50.3	11.5	4.5	3.5	6.5	4.0	1.6	24	7.9	64.0	14.5	4.5	5.0	8.0	4.0	2.1
30	7.8	58.9	12.0	5.0	4.8	7.5	4.0	2.2	30	9.9	75.0	15.0	5.0	6.7	10.0	4.0	3.3
36	9.4	84.9	14.5	6.0	8.2	9.5	4.5	3.8	36	11.9	108.0	18.0	6.0	11.4	12.0	4.5	5.3
42	10.9	115.5	17.0	7.0	12.8	11.0	5.5	6.3	42	13.9	147.0	21.0	7.0	17.8	14.0	5.5	8.7
48	12.5	150.9	19.0	8.0	18.4	13.0	6.0	9.2	48	15.9	192.0	24.0	8.0	26.2	16.0	6.0	12.4
54	14.0	191.0	21.5	9.0	26.0	15.0	6.5	12.9	54	17.9	243.0	27.00	9.0	36.9	18.0	7.0	18.1
60	15.6	235.8	24.0	10.0	35.6	16.0	7.5	17.6	60	19.9	299.8	30.0	10.0	50.3	20.0	7.5	24.0
66	17.1	285.3	26.0	11.0	46.0	18.0	8.0	23.0	66	21.8	362.8	33.0	11.0	66.2	22.0	8.5	32.5
72	18.7	339.5	28.5	12.0	57.8	19.0	9.0	28.4	72	23.8	431.8	36.0	12.0	85.6	24.0	9.0	41.0
78	20.2	398.5	31.0	13.0	75.7	21.0	9.5	37.4	78	25.7	506.7	39.0	13.0	108.2	26.0	10.0	53.2
84	21.8	462.1	33.5	14.0	94.7	22.0	10.5	46.5	84	27.7	587.7	42.0	14.0	134.4	28.0	10.5	64.8
90	23.3	530.5	35.5	15.0	114.4	24.5	11.0	58.2	90	29.0	674.6	45.0	15.0	164.9	30.0	11.5	81.2
96	24.9	603.6	38.0	16.0	138.9	25.5	12.0	70.0	96	31.6	767.5	48.0	16.0	199.0	32.0	12.0	95.1



STANDARD CONSTRUCTION DETAIL
HORIZONTAL THRUST BLOCK AT PIPE BEND
SHEET 3 OF 3

SCALE: N.T.S.
REVISED: AUG 2020
W03

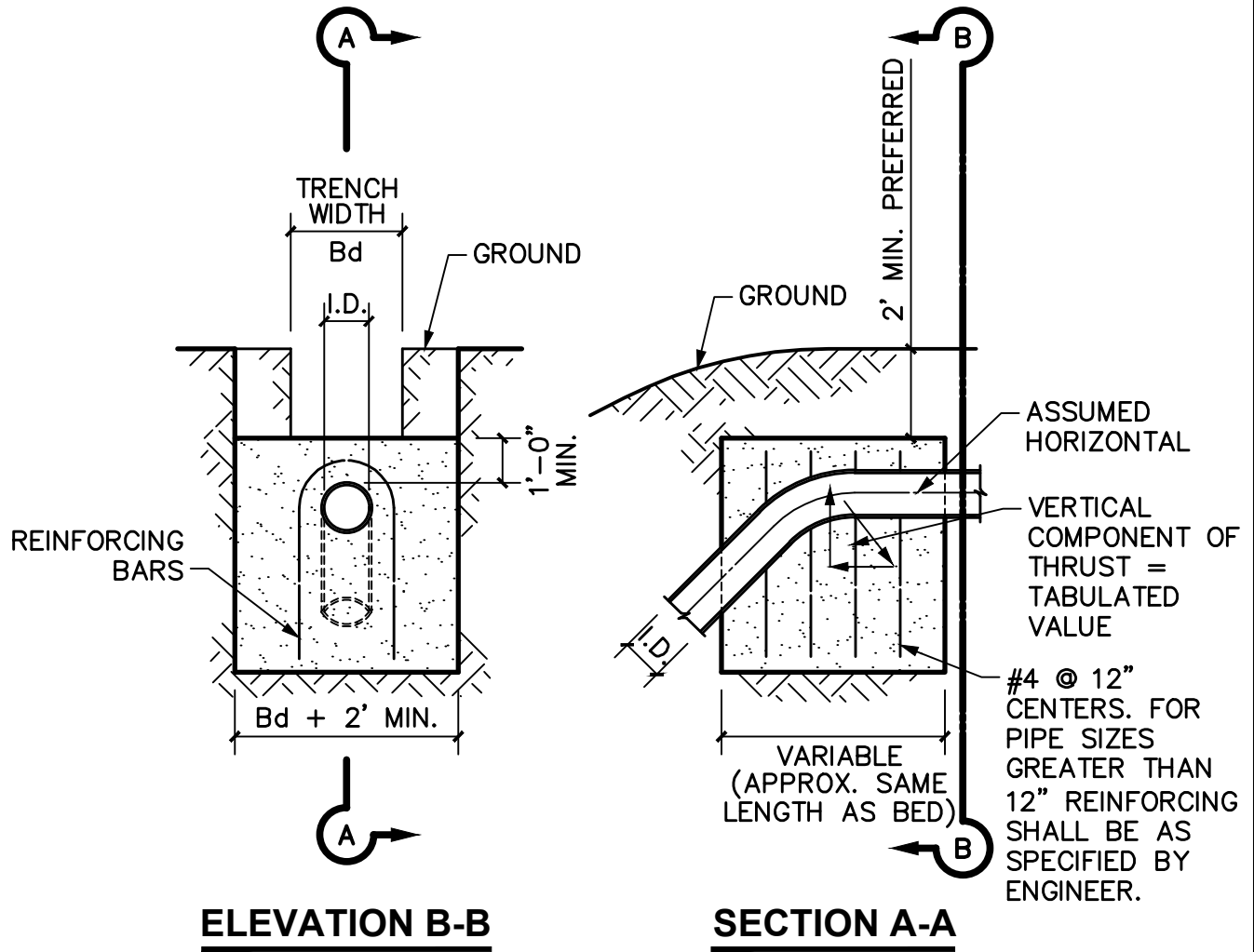


STANDARD CONSTRUCTION DETAIL **THRUST HARNESS**

SCALE: N.T.S.

REVISED: AUG 2020

W04



Δ	11.25°		22.50°		30°		45°		67.50°		90°		Δ
I.D. (IN.)	THRUST (TONS)	VOL. (C.Y.)	THRUST (TONS)	VOL. (C.Y.)	THRUST (TONS)	VOL. (C.Y.)	THRUST (TONS)	VOL. (C.Y.)	THRUST (TONS)	VOL. (C.Y.)	THRUST (TONS)	VOL. (C.Y.)	I.D. (IN.)
4,6,8	1.0	0.5	2.0	1.0	2.5	1.3	3.6	1.8	4.6	2.3	5.0	2.5	4,6,8
10,12	2.2	1.1	4.3	2.2	5.7	2.8	8.0	4.0	10.5	5.2	11.3	5.7	10,12
16,18	5.0	2.5	9.7	4.9	12.7	6.4	18.0	9.0	23.5	11.8	25.5	12.7	16,18
20	6.1	3.1	12.0	6.0	15.7	7.9	22.2	11.1	29.2	14.5	31.4	15.7	20
24	8.2	4.4	17.3	8.7	22.6	11.3	32.0	16.0	41.8	20.9	45.2	22.6	24
30	10.5	5.2	20.3	10.1	26.5	13.3	37.5	18.8	49.0	24.5	53.1	26.5	30
36	14.9	7.5	29.2	14.6	38.2	19.1	54.0	27.0	70.5	35.3	76.4	38.2	36
42	20.3	10.1	39.8	19.9	52.0	26.0	73.5	36.7	96.0	48.0	104.0	52.0	42
48	26.5	13.2	51.9	26.0	67.9	33.9	96.0	48.0	126.0	62.7	136.0	67.9	48
54	33.5	16.8	65.7	32.9	85.9	42.9	122.0	60.7	159.0	79.4	172.0	85.9	54
60	41.4	20.7	81.2	40.6	106.0	53.0	150.0	75.0	196.0	98.0	212.0	106.0	60
66	50.1	25.0	98.2	49.1	128.0	64.2	182.0	90.7	237.0	119.0	257.0	128.0	66
72	59.6	29.8	117.0	58.4	153.0	76.3	216.0	108.0	282.0	141.0	305.0	153.0	72
78	69.9	35.0	137.0	68.6	179.0	90.0	254.0	127.0	331.0	166.0	358.0	179.0	78
84	81.1	40.5	159.0	79.5	208.0	104.0	294.0	147.0	384.0	192.0	416.0	208.0	84
90	93.1	46.5	183.0	91.3	239.0	119.0	337.0	169.0	441.0	221.0	477.0	239.0	90
96	106.0	53.0	208.0	104.0	272.0	136.0	384.0	192.0	502.0	251.0	543.0	272.0	96

NOTE:

1. REFER TO STANDARD DETAIL W06 FOR GENERAL NOTES.



STANDARD CONSTRUCTION DETAIL
VERTICAL THRUST BLOCK AT PIPE BEND

SCALE: 1/4"=1'-0"

REVISED: AUG 2020

W05

GENERAL NOTES FOR ALL THRUST BLOCKS:

1. CONCRETE FOR BLOCKING SHALL BE CLASS B AND SULFATE RESISTANT. RE: TECHNICAL SPECIFICATION 321313.
2. ALL CALCULATIONS ARE BASED ON INTERNAL PRESSURE OF 200 PSI FOR DUCTILE IRON, P.V.C.
3. VOLUMES OF THRUST BLOCKS ARE NET VOLUMES OF CONCRETE TO BE FURNISHED. THE CORRESPONDING WEIGHT OF THE CONCRETE (CLASS B) IS EQUAL TO OR GREATER THAN THE VERTICAL COMPONENT OF THE THRUST ON THE VERTICAL BEND.
4. WALL THICKNESS (T) ASSUMED HERE FOR ESTIMATING PURPOSES ONLY.
5. POUR CONCRETE FOR BLOCK AGAINST UNDISTURBED EARTH.
6. DIMENSIONS MAY BE VARIED AS REQUIRED BY FIELD CONDITIONS WHERE AND AS DIRECTED BY THE ENGINEER. THE VOLUME OF CONCRETE BLOCKING SHALL BE LESS THAN SHOWN HERE.
7. THE SOIL BEARING PRESSURES ARE BASED ON 1000 LBS./S.F. IN SOIL AND 2000 LBS./S.F. IN ROCK.
8. USE POLYETHYLENE WRAP OR EQUAL BETWEEN CONCRETE AND BEND, TEE, OR PLUG TO PREVENT THE CONCRETE FROM STICKING TO IT.
9. FOR STANDARD FITTINGS, CONCRETE SHALL NOT EXTEND BEYOND JOINTS.

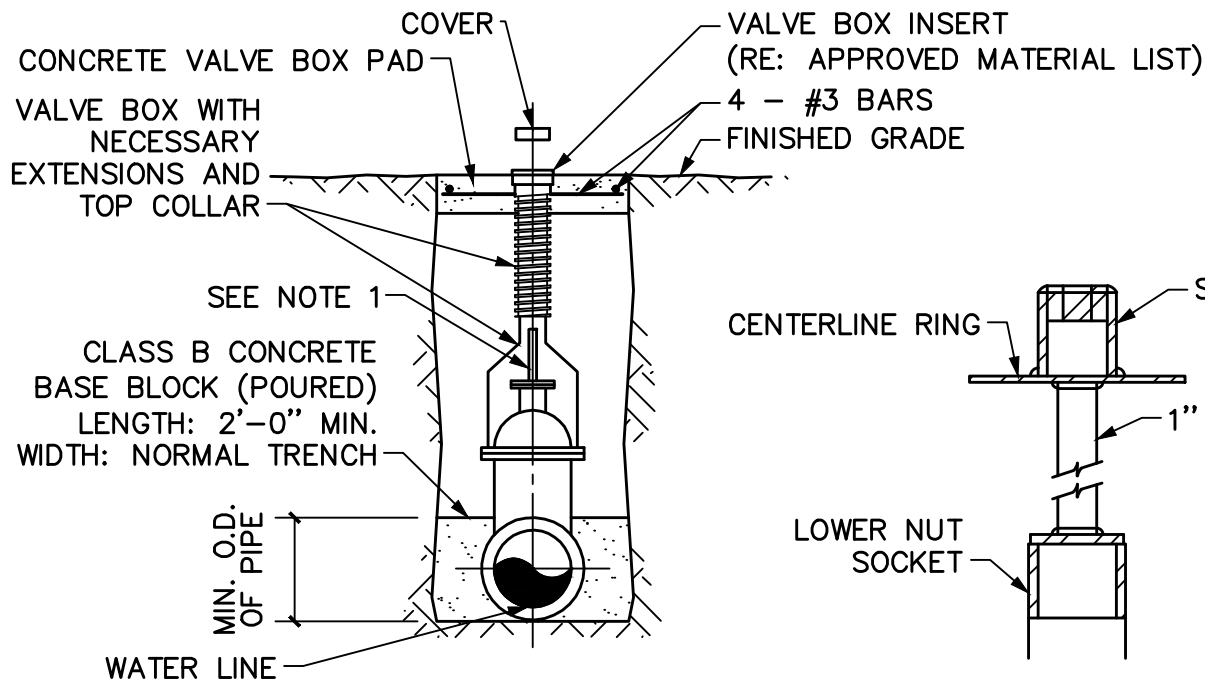


**STANDARD CONSTRUCTION DETAIL
THRUST BLOCK
GENERAL NOTES**

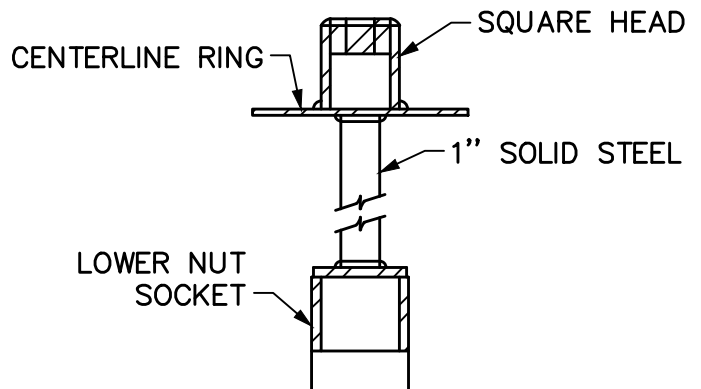
SCALE: N.T.S.

REVISED: AUG 2020

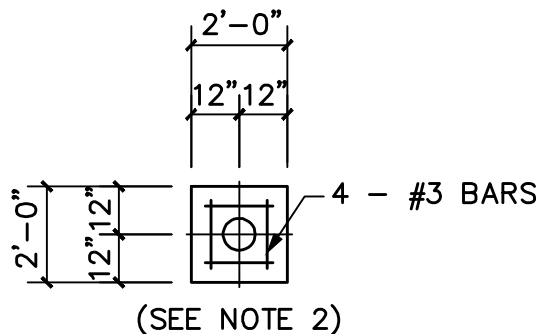
W06



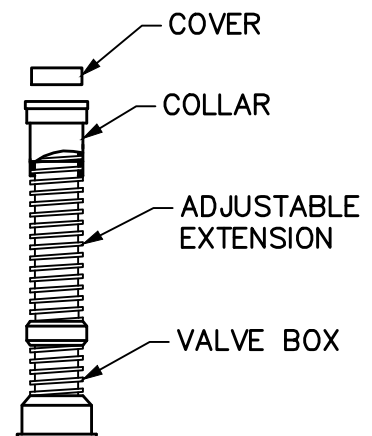
VALVE SETTING & BOX



VALVE EXTENSION



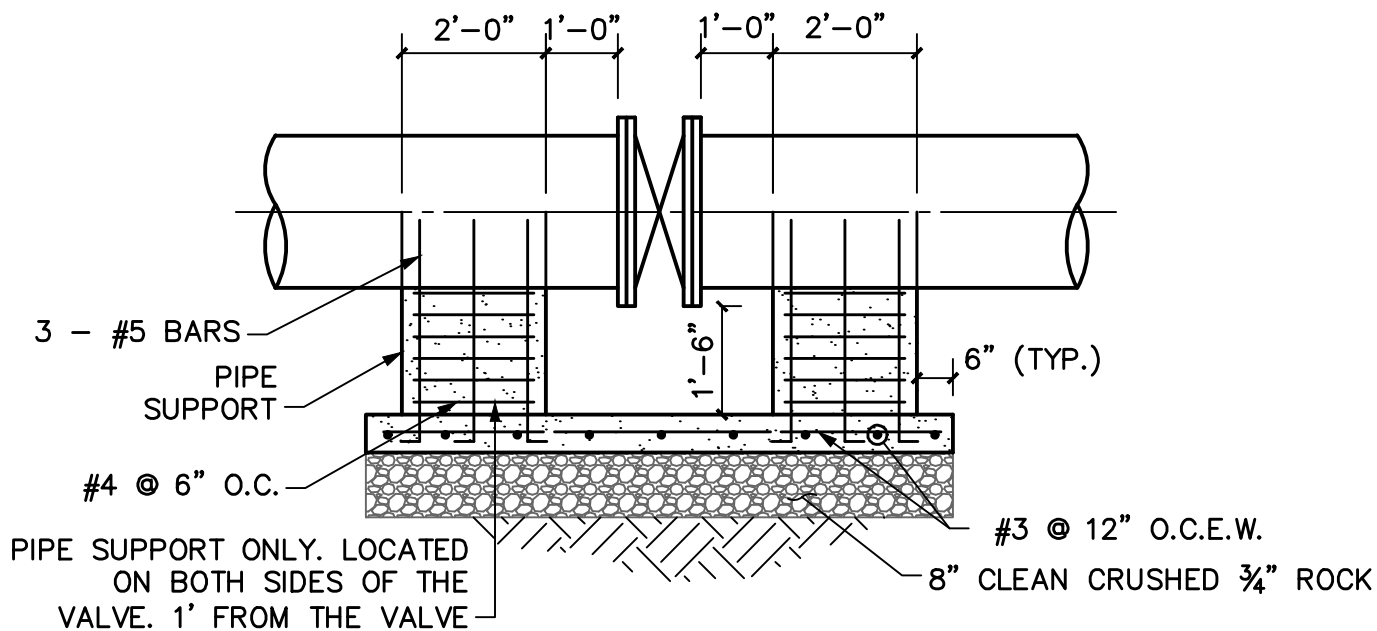
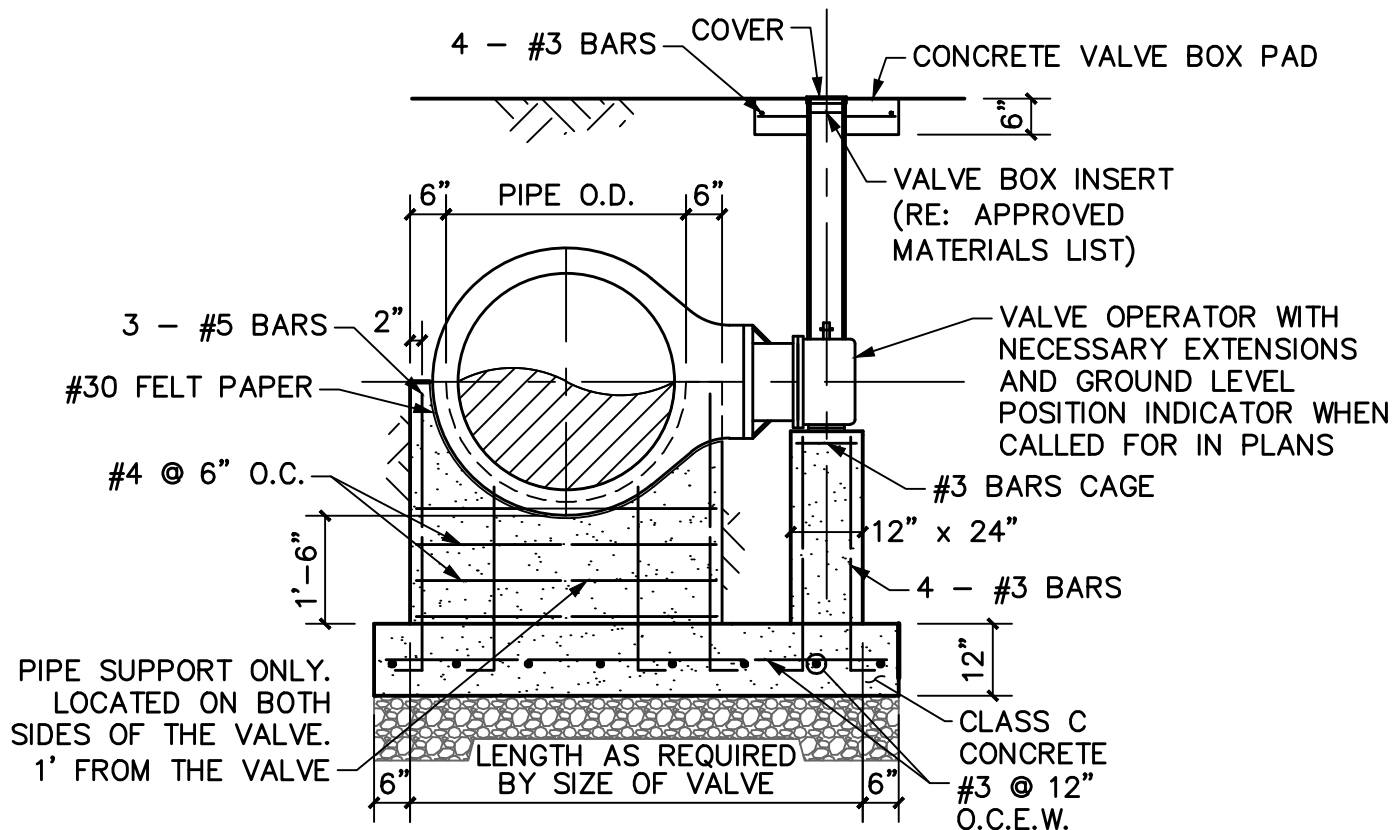
VALVE BOX PAD PLAN



VALVE BOX WITH EXTENSION

NOTES:

1. A VALVE EXTENSION STEM SHALL BE REQUIRED FOR ANY VALVE WHOSE OPERATING NUT IS LOCATED IN EXCESS OF 4' BELOW THE TOP OF VALVE BOX. THIS EXTENSION SHALL BE OF SUFFICIENT LENGTH TO INSURE THAT ITS TOP IS WITHIN 2' OF THE VALVE BOX COVER.
2. CONCRETE PAD 24" SQUARE SHALL BE POURED AROUND ALL VALVE BOXES NOT PLACED WITHIN CONCRETE PAVEMENT. CLASS A CONCRETE, 6" THICK.
3. REFER TO TECHNICAL SPECIFICATION 331217.



NOTES:

1. ALL OPERATING NUTS SHALL BE EXTENDED TO WITHIN 6" OF FINAL GRADE.
2. 6" BYPASS MAY BE REQUIRED BY CITY ON SPECIFIC PROJECTS.
3. REFER TO TECHNICAL SPECIFICATION 331218 BUTTERFLY VALVES.



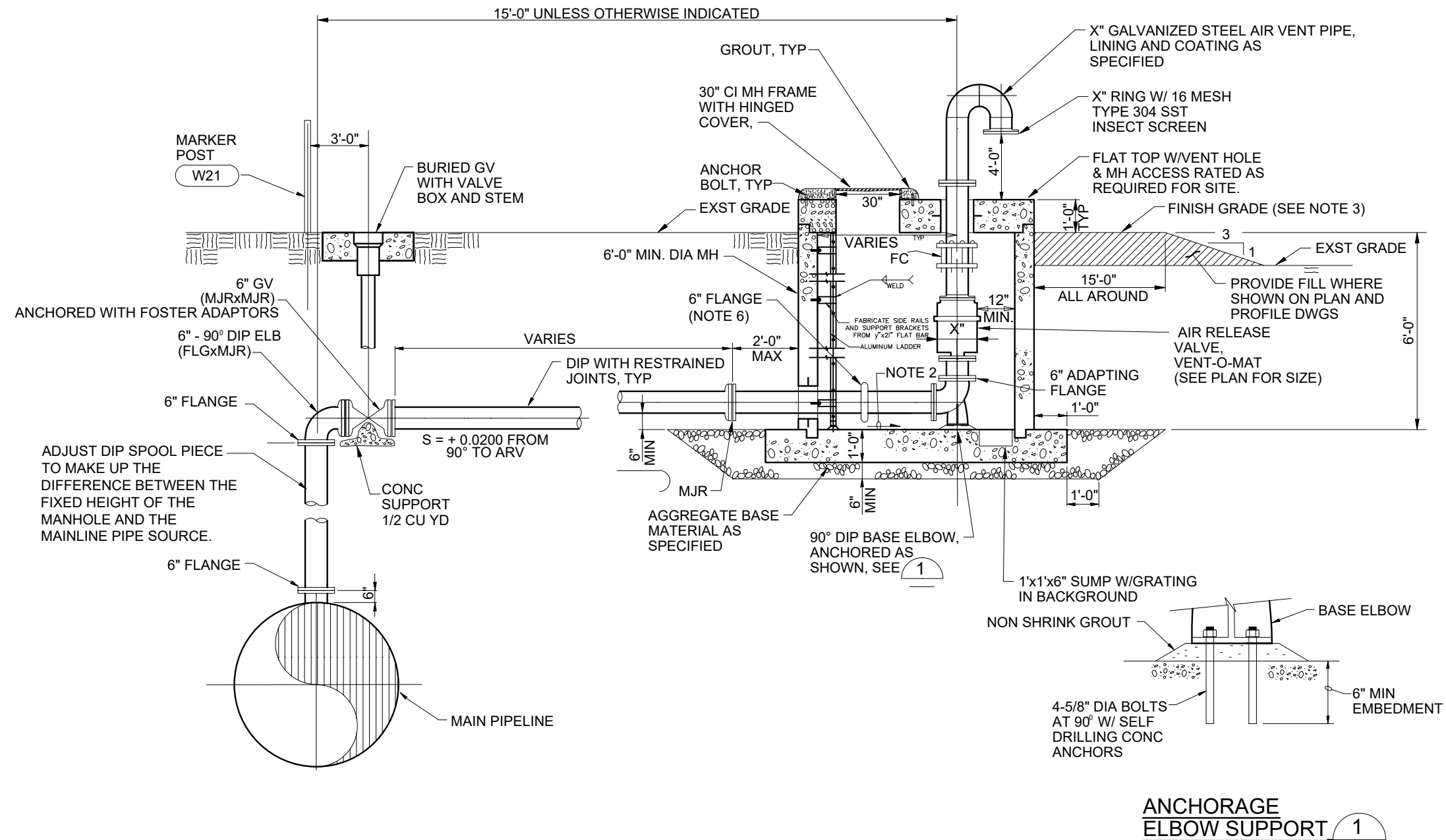
STANDARD CONSTRUCTION DETAIL

BUTTERFLY VALVE

SCALE: 3/8"=1'-0"

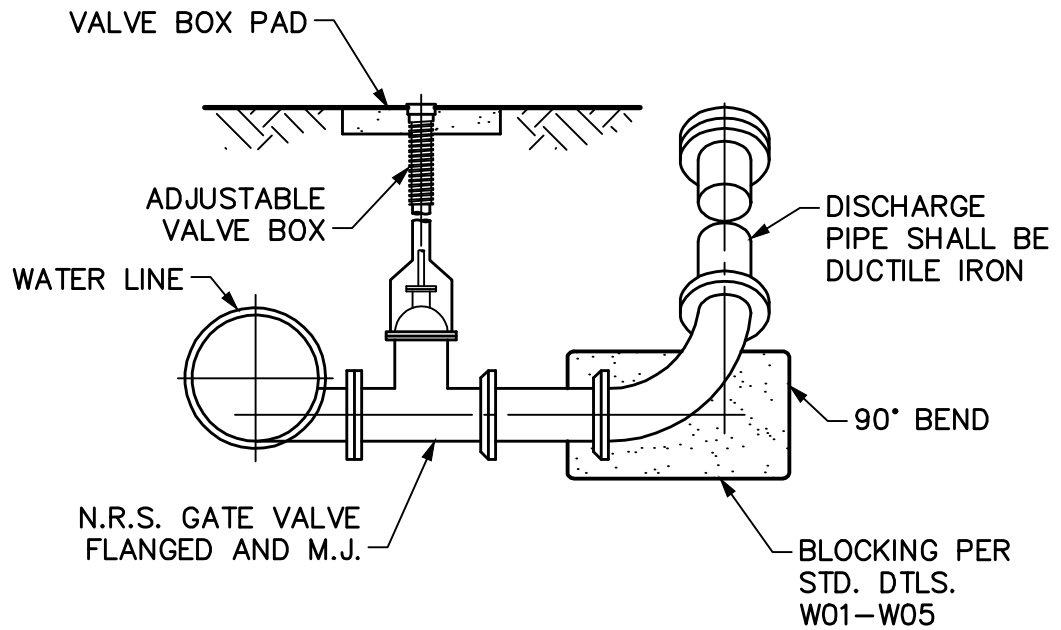
REVISED: AUG 2020

W08



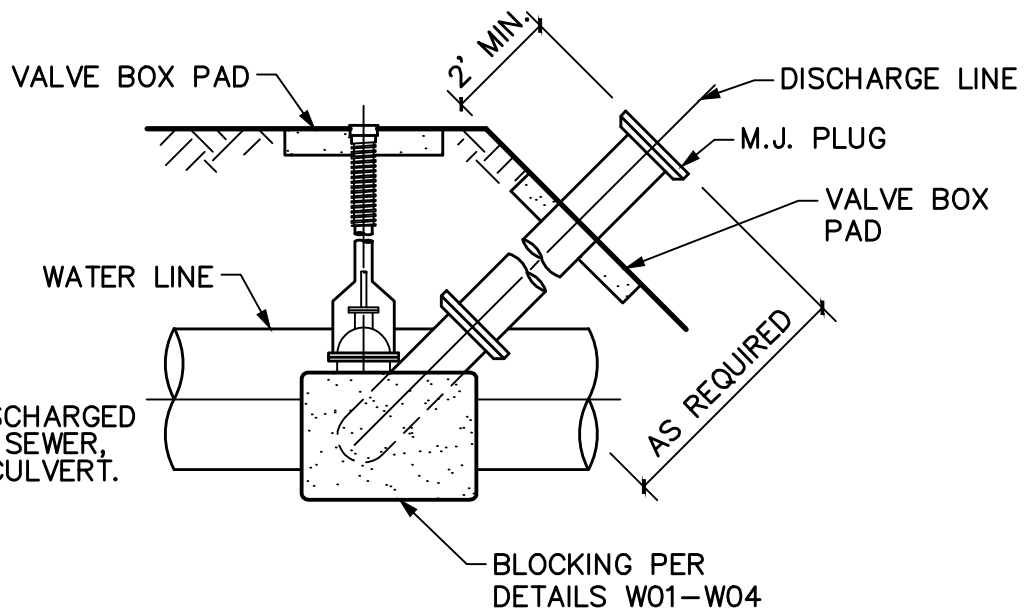
NOTES:

1. SEE CITY TYPICAL HINGED MANHOLE DETAIL.
2. PROVIDE 2% MIN SLOPE TOWARDS SUMP.
3. CONTRACTOR SHALL COORDINATE FINAL GRADING AND TOP OF MANHOLE ELEVATIONS WITH THE CITY OF FRISCO, BASED UPON ACTUAL FIELD CONDITIONS.
4. WHEN NOT ON PAVING OR SIDEWALK, A CONCRETE PAD IS REQ'D, REINFORCED WITH #3 @ 12" EW, CTRD. PAD SHALL EXTEND A MINIMUM OF 2'-0" AROUND THE MANHOLE AND VENT PIPE AND SHALL BE A MINIMUM OF 4" THICK.
5. REFER TO TECHNICAL SPECIFICATION 331216 "AIR VALVES FOR POTABLE WATER SYSTEMS".
6. FOR WASTEWATER SYSTEMS ONLY; PROVIDE 20 MESH STAINLESS SCREEN BRASS Y-STRAINER WITHIN THE MANHOLE PRIOR TO THE DIP BASE ELBOW. REQUIREMENT FOR STRAINER IS APPLICABLE TO TYPE 1 AND TYPE 2 COMBINATION AIR VACUUM AND AIR VENT VALVES.



NOTE:

1. MUST BE DISCHARGED INTO STORM SEWER, BRIDGE OR CULVERT.



STANDARD CONSTRUCTION DETAIL

BLOW OFF VALVE

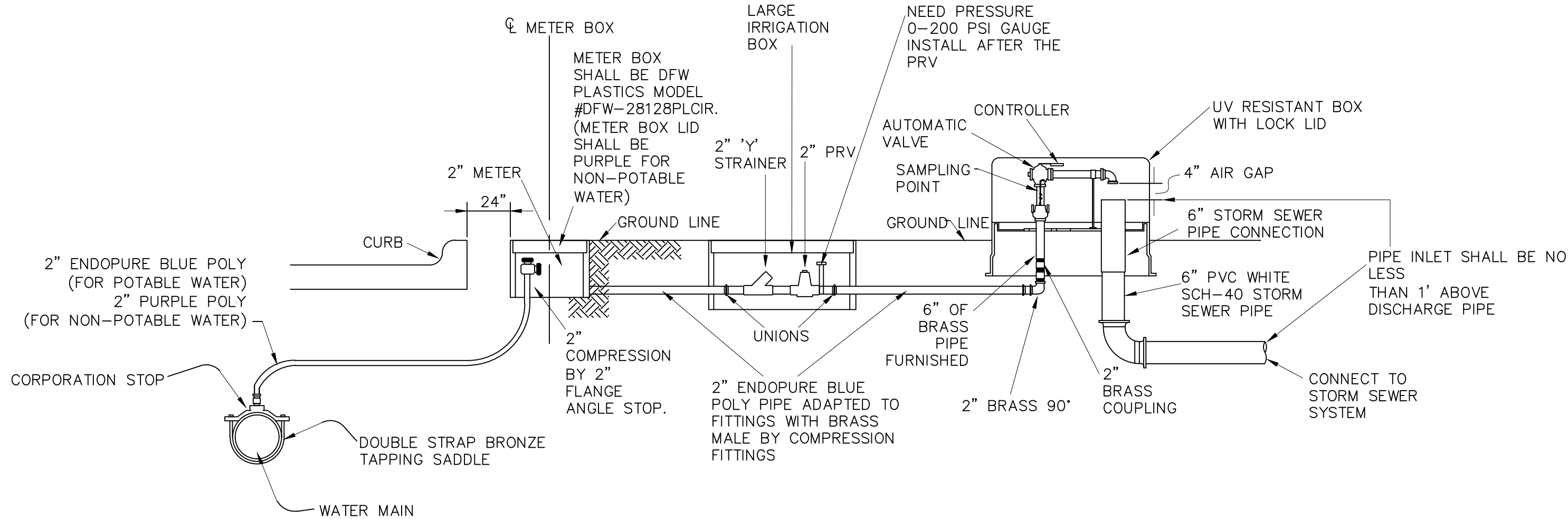
SCALE: 1/4"=1'-0"

REVISED: AUG 2020

W10

NOTES:

1. TUBING SHALL BE EMBEDDED IN SAND FROM CORPORATION STOP TO CURB STOP.
2. THE AUTOMATIC FLUSHING DEVICE SYSTEM SHALL BE INSTALLED PARALLEL TO THE CURB LINE.
3. UNIT SHALL NOT BE INSTALLED FRONT OF A RESIDENTIAL LOT.
4. IRRIGATION BOX SHALL BE NO LESS THAN 17" WIDE X 30" LONG X 18' DEEP X 2 BOLT DOWN. BOLTS MODEL #J-19-R.
5. CONTRACTOR TO OBTAIN PERMIT AT CITY OF FRISCO PERMIT OFFICE AND REQUEST 2" TURBINE METER SET AT PUBLIC WORKS DEPARTMENT.



AUTOMATIC FLUSHING VALVE SHALL HAVE A 2" BRASS FIP INLET LEADING VERTICALLY INTO A 2" AUTOMATIC SOLENOID VALVE. AUTOMATIC SOLENOID VALVE SHALL HAVE AN INTERNAL, SELF-CLEANING DEBRIS SCREEN AND HAVE A 220 PSI RATING. EACH UNIT SHALL BE FURNISHED WITH A STAND-ALONE CONTROLLER. VALVE CONTROLLER WILL NOT REQUIRE A SECOND HAND-HELD DEVICE FOR PROGRAMMING. CONTROLLER MUST HAVE A MINIMUM OF 9 POSSIBLE FLUSHING CYCLES PER DAY. SHALL BE SUBMERSIBLE TO 12 FEET. OPERATE WITH A 9 VOLT BATTERY AND HAVE RESIN-SEALED ELECTRICAL COMPONENTS. SOLENOID SHALL HAVE NO LOOSE PARTS WHEN REMOVED FROM VALVE. EACH UNIT SHALL HAVE A DOUBLE VALVE, ALL BRASS SAMPLING POINT. REMOVAL OF 2" SOLENOID VALVE SHALL BE POSSIBLE VIA A QUICK DISCONNECT BELOW THE VALVE. ALL ABOVE-GROUND COMPONENTS SHALL BE CONTAINED WITHIN A UV-RESISTANT LOCKING COVER AS MANUFACTURED BY KUPFERLE FOUNDRY COMPANY. MODEL 9800WC ST. LOUIS, MO. 1-800-231-3990, OR APPROVED EQUAL.

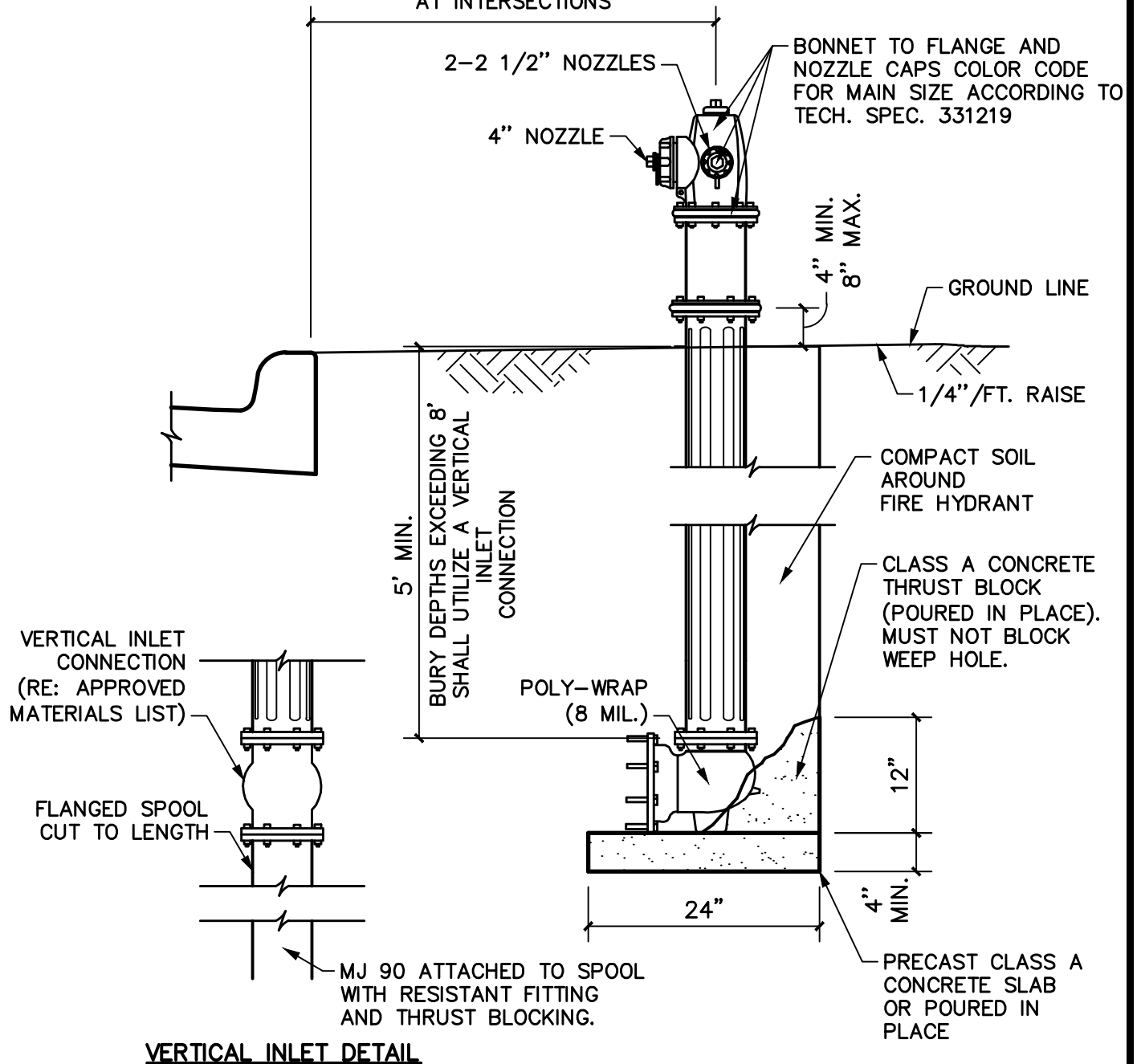


STANDARD CONSTRUCTION DETAIL
AUTOMATIC FLUSHING DEVICE

SCALE: N.T.S.
REVISED: AUG 2020
W11

*3.5' MIN WHERE ROW
NARROWS TO 9.5'

4.5' MIN. 6' MAX.*
10' FROM CURB RETURNS
AT INTERSECTIONS



NOTES:

1. A BLUE STEMSONITE (OR APPROVED OTHER) MODEL 88-SSA FIRE HYDRANT MARKER WILL BE INSTALLED OPPOSITE FIRE HYDRANTS JUST OFF CENTER TO THE SIDE OF THE STREET ADJACENT TO THE HYDRANT.
2. CONTRACTOR SHALL UTILIZE VERTICAL INLET CONNECTION WHEN BURY DEPTHS EXCEED EIGHT (8) FEET.
3. NO MORE THAN 1 EXTENSION IS ALLOWED PER ASSEMBLY AND IS LIMITED TO 3'.



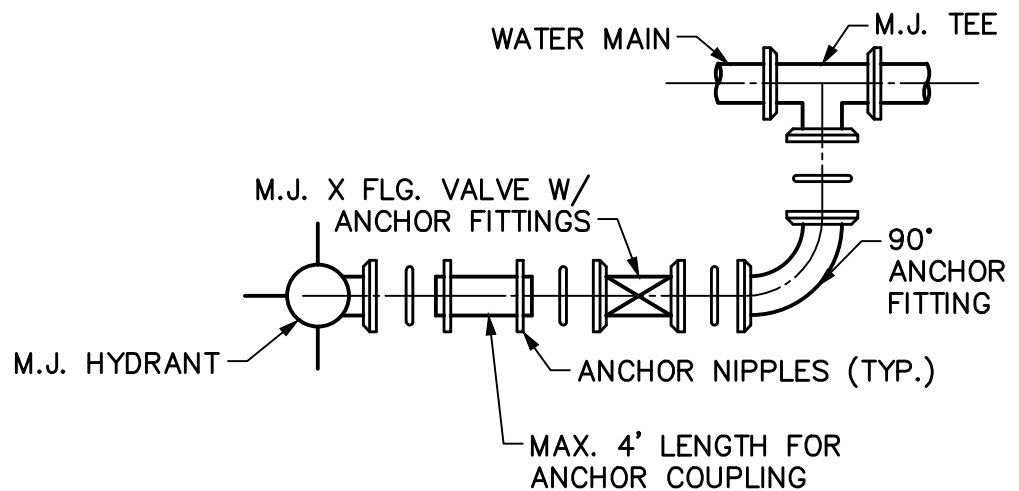
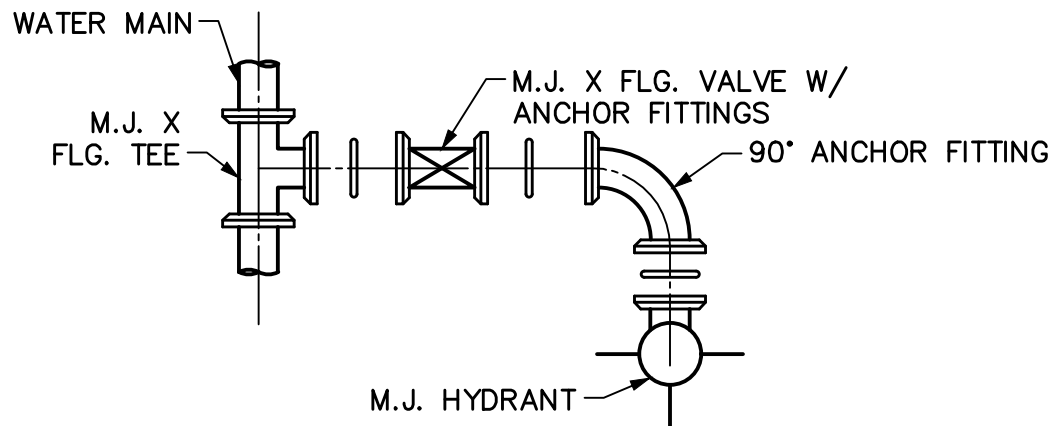
STANDARD CONSTRUCTION DETAIL

FIRE HYDRANT

SCALE: 3/4"=1'-0"

REVISED: AUG 2020

W12



NOTES:

1. ALL FIRE HYDRANTS MUST BE ANCHORED TO MAIN BY USE OF ANCHOR FITTINGS.
2. ANCHOR TEES ALLOWED.
3. REFER TO TECHNICAL SPECIFICATION 331219 FIRE HYDRANTS.



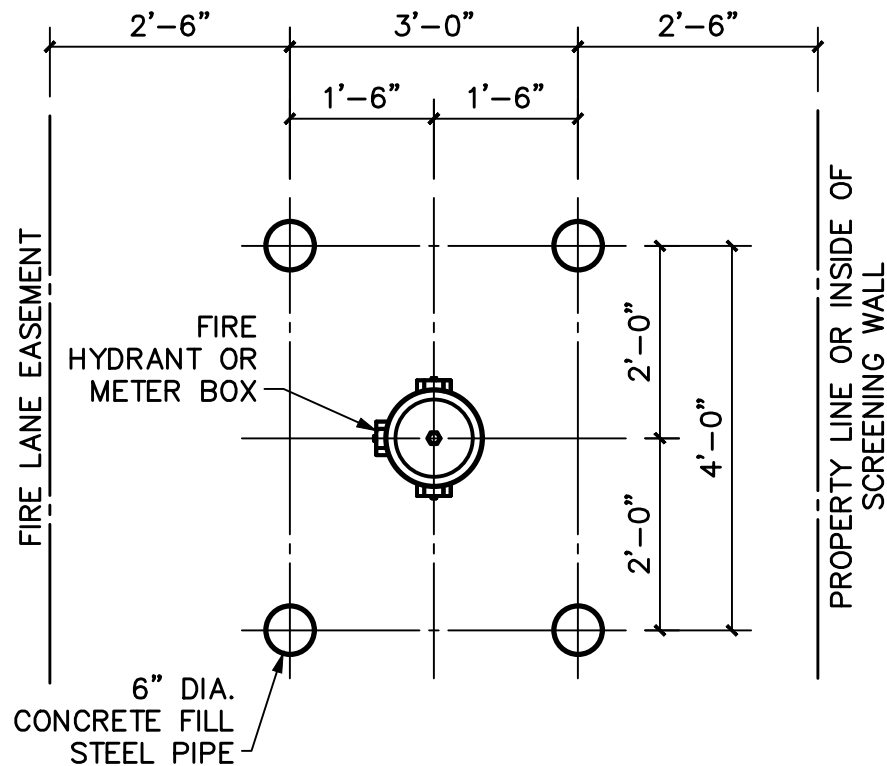
STANDARD CONSTRUCTION DETAILS

FIRE HYDRANT INSTALLATION

SCALE: 1/8"=1'-0"

REVISED: AUG 2020

W13



NOTES:

1. FOR USE WHERE CURBS ARE NOT POSSIBLE OR AS SPECIFIED BY THE CITY.
2. FIRE HYDRANTS SHALL BE 35' CLEAR OF ALL BUILDINGS.
3. GUARD POSTS SHALL BE 6 LINEAR FEET OF 6" DIAMETER STEEL PIPE (3' ABOVE & BELOW GROUND LEVEL). POST SHALL BE ENCASED IN 16" DIAMETER CONCRETE PIER TO A DEPTH OF 12" BELOW POST BOTTOM. REINFORCED CONCRETE PIER WITH 2 - #6 BARS (12" LONG) THROUGH POST INTO PIER. POST ABOVE GROUND LEVEL SHALL BE PAINTED SAFETY YELLOW.



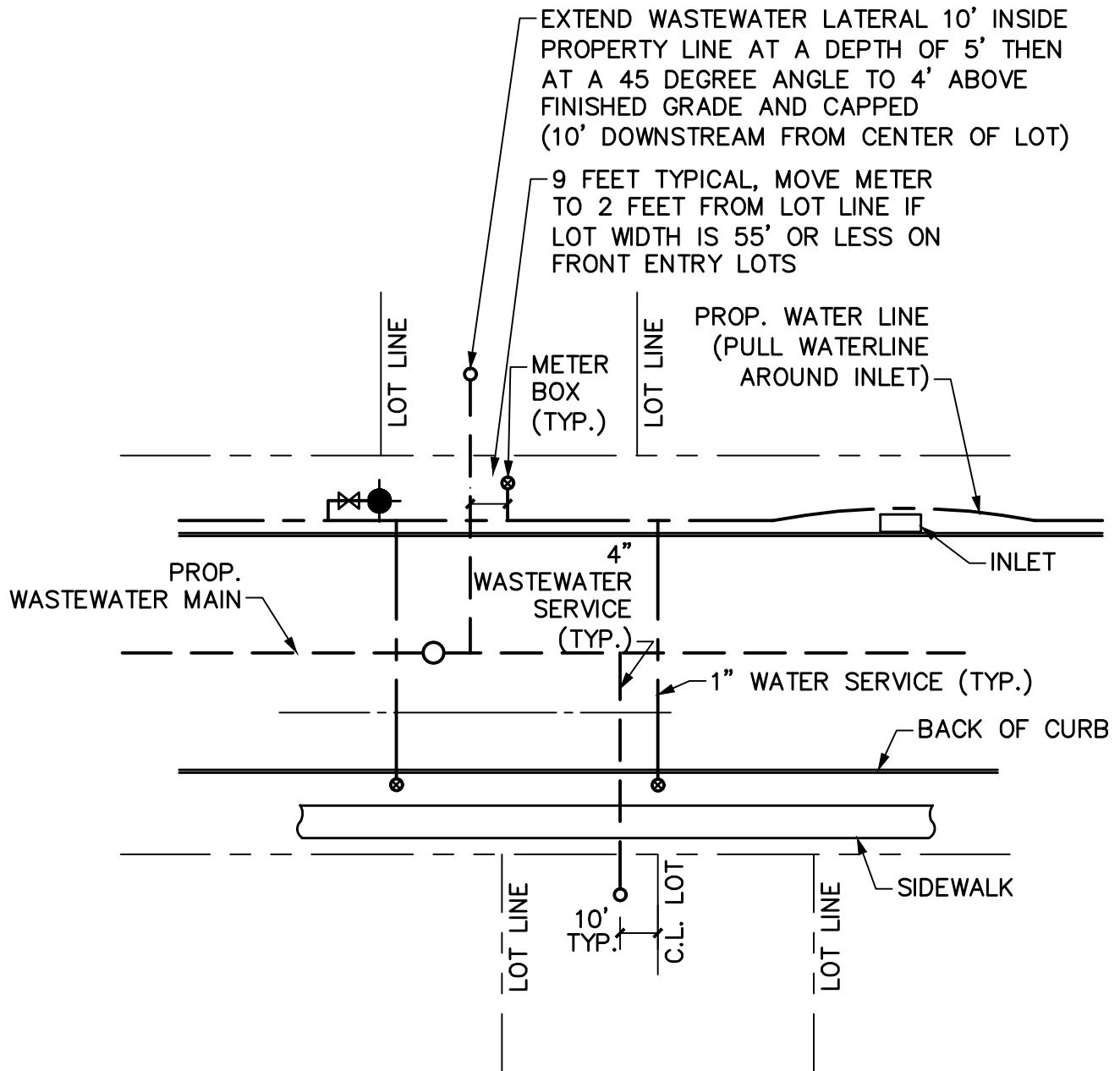
STANDARD CONSTRUCTION DETAIL

PIPE BOLLARD

SCALE: 1/2"=1'-0"

REVISED: AUG 2020

W14

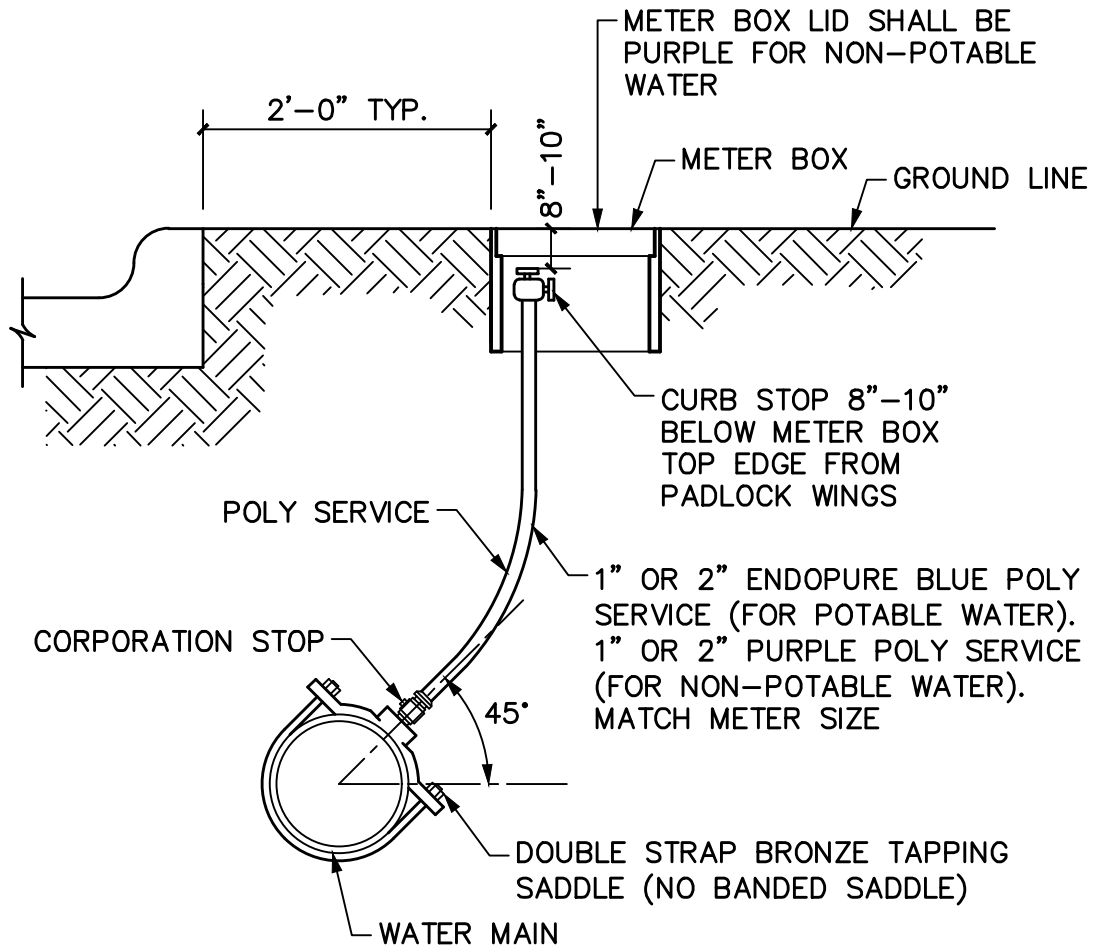


STANDARD CONSTRUCTION DETAIL RESIDENTIAL SERVICE LOCATIONS

SCALE: 1"=20'

REVISED: AUG 2020

W15



NOTES:

1. WATER SERVICES SHALL NOT BE CONNECTED TO FIRE HYDRANT LINES OR TO FIRE SERVICE MAINS.
2. METER BOX SHALL BE LOCATED OUT OF ALL FLATWORK, SIDEWALKS AND APPROACHES.
3. REFER TO TECHNICAL SPECIFICATION 331213 WATER SERVICE CONNECTIONS.
4. TRACER WIRE MUST BE OUT OF GROUND AND WRAPPED ON CURB STOP.



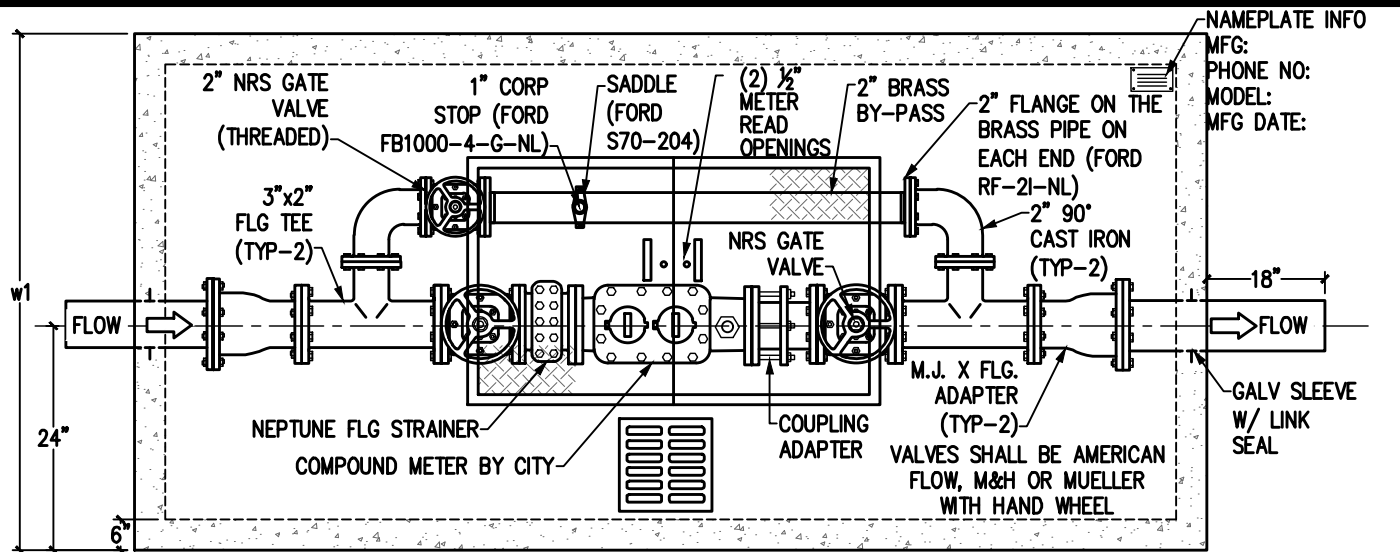
STANDARD CONSTRUCTION DETAIL

TYPICAL SERVICE CONNECTION

SCALE: 3/4"=1'-0"

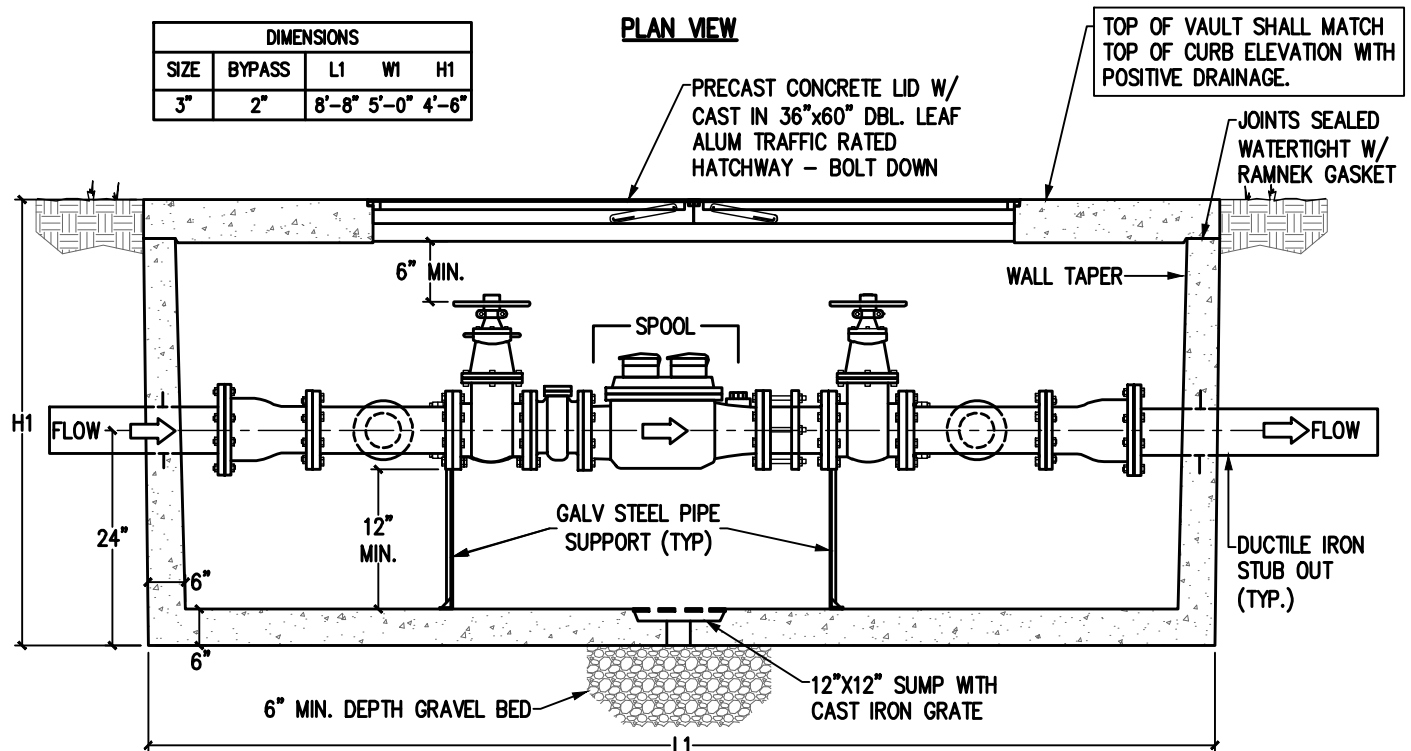
REVISED: AUG 2020

W16



DIMENSIONS				
SIZE	BYPASS	L1	W1	H1
3"	2"	8'-8"	5'-0"	4'-6"

PLAN VIEW



ELEVATION

NOTES:

1. UNIT OF MONOLITHIC CONSTRUCTION AT FLOOR AND FIRST STAGE OF WALL WITH SECTIONAL RISER TO REQUIRED DEPTH.
2. REINFORCEMENT: GRADE 60 REINFORCED. STEEL BAR CONFORMING TO ASTM A615 ON REQUIRED CENTERS OR EQUAL.
3. HATCHWAY: 3' X 5' ALUMINUM HATCH DOUBLE LEAF SPRING ASSISTED AUTO-LOCKING 316 STAINLESS STEEL WITH RELEASE HANDLE. HATCHWAY SHALL BE TRAFFIC RATED.
4. PRE-CAST VAULT AND INTERNAL PARTS SHALL BE FROM THE APPROVED MATERIALS LIST.
5. PIPE FITTINGS SHALL BE DUCTILE IRON UNLESS OTHERWISE SPECIFIED.
6. MINIMUM 6" WATER LINE OFF THE WATER MAIN WITH MINIMUM 6" GATE VALVE PRIOR TO REDUCING IN SIZE. LINE REDUCTION REDUCER SHALL BE PLACED ON THE VAULT STUBOUT PIPING.

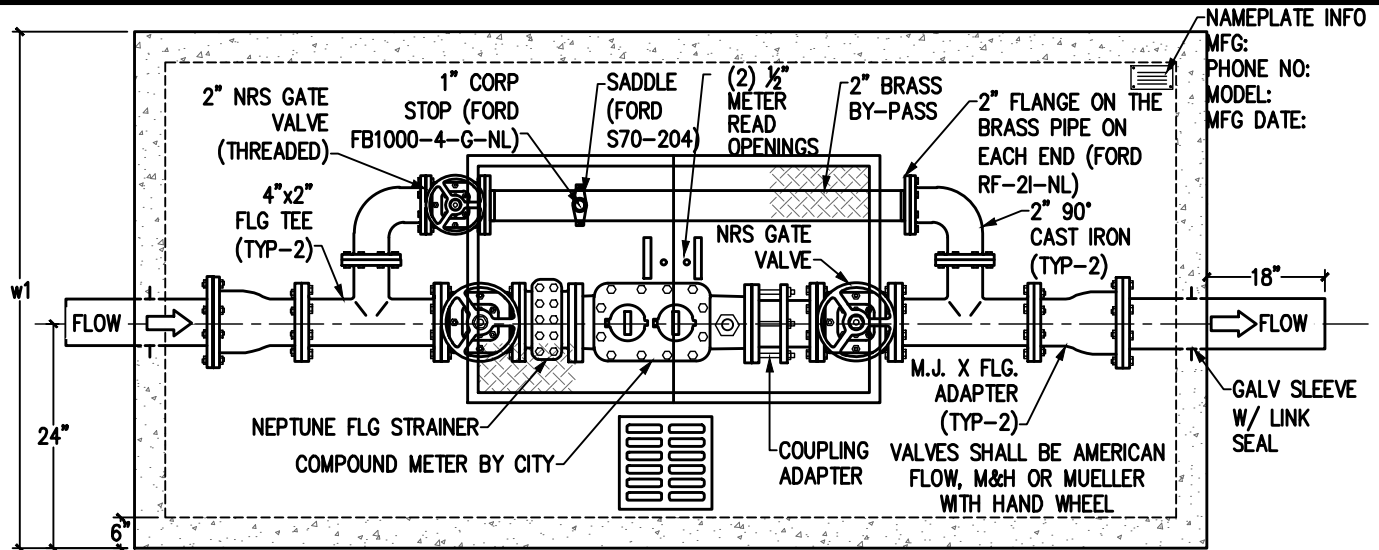


STANDARD CONSTRUCTION DETAIL DOMESTIC 3" WATER METER VAULT

SCALE: N.T.S.

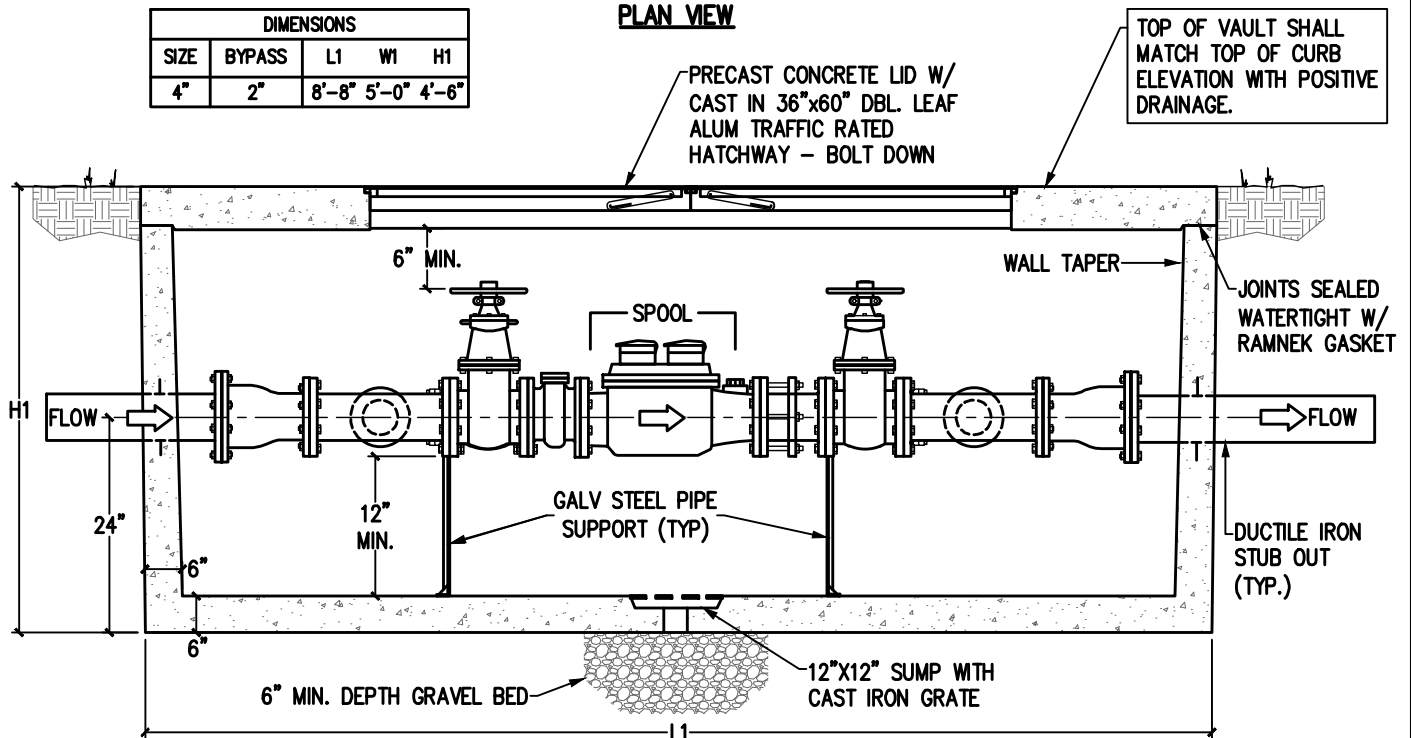
REVISED: AUG 2020

W17



DIMENSIONS				
SIZE	BYPASS	L1	W1	H1
4"	2"	8'-8"	5'-0"	4'-6"

PLAN VIEW



ELEVATION

NOTES:

1. UNIT OF MONOLITHIC CONSTRUCTION AT FLOOR AND FIRST STAGE OF WALL WITH SECTIONAL RISER TO REQUIRED DEPTH.
2. REINFORCEMENT: GRADE 60 REINFORCED. STEEL BAR CONFORMING TO ASTM A615 ON REQUIRED CENTERS OR EQUAL.
3. HATCHWAY: 3' X 5' ALUMINUM HATCH DOUBLE LEAF SPRING ASSISTED AUTO-LOCKING 316 STAINLESS STEEL WITH RELEASE HANDLE. HATCHWAY SHALL BE TRAFFIC RATED.
4. PRE-CAST VAULT AND INTERNAL PARTS SHALL BE FROM THE APPROVED MATERIALS LIST.
5. PIPE FITTINGS SHALL BE DUCTILE IRON UNLESS OTHERWISE SPECIFIED.
6. MINIMUM 6" WATER LINE OFF THE WATER MAIN WITH MINIMUM 6" GATE VALVE PRIOR TO REDUCING IN SIZE. LINE REDUCTION REDUCER SHALL BE PLACED ON THE VAULT STUBOUT PIPING.

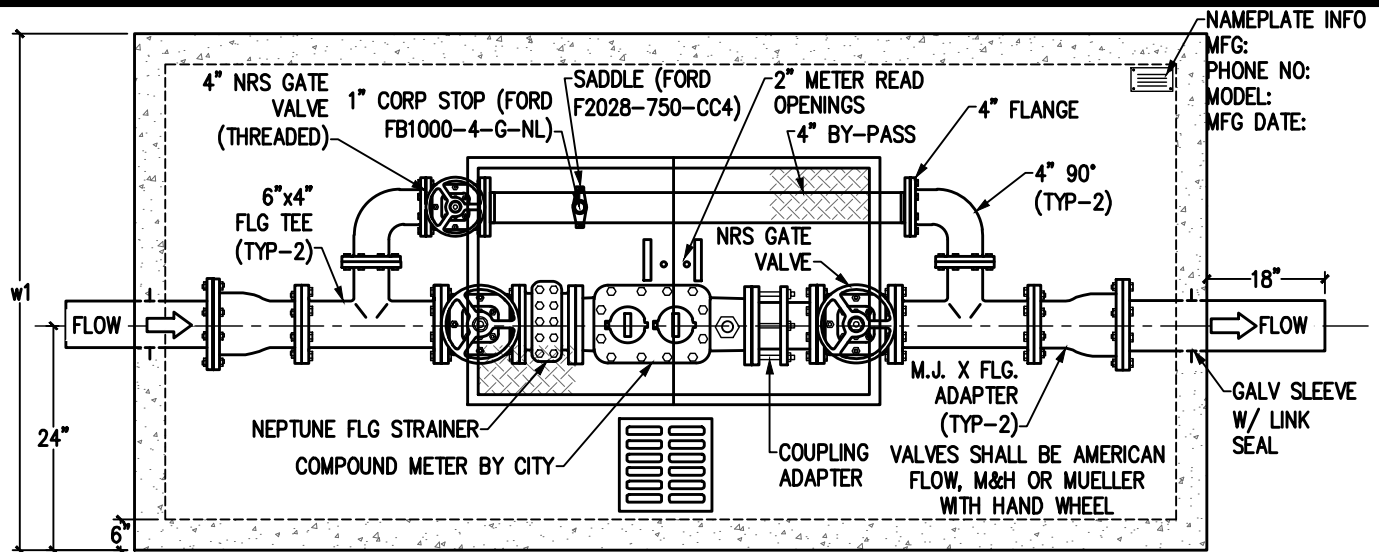


STANDARD CONSTRUCTION DETAIL DOMESTIC 4" WATER METER VAULT

SCALE: N.T.S.

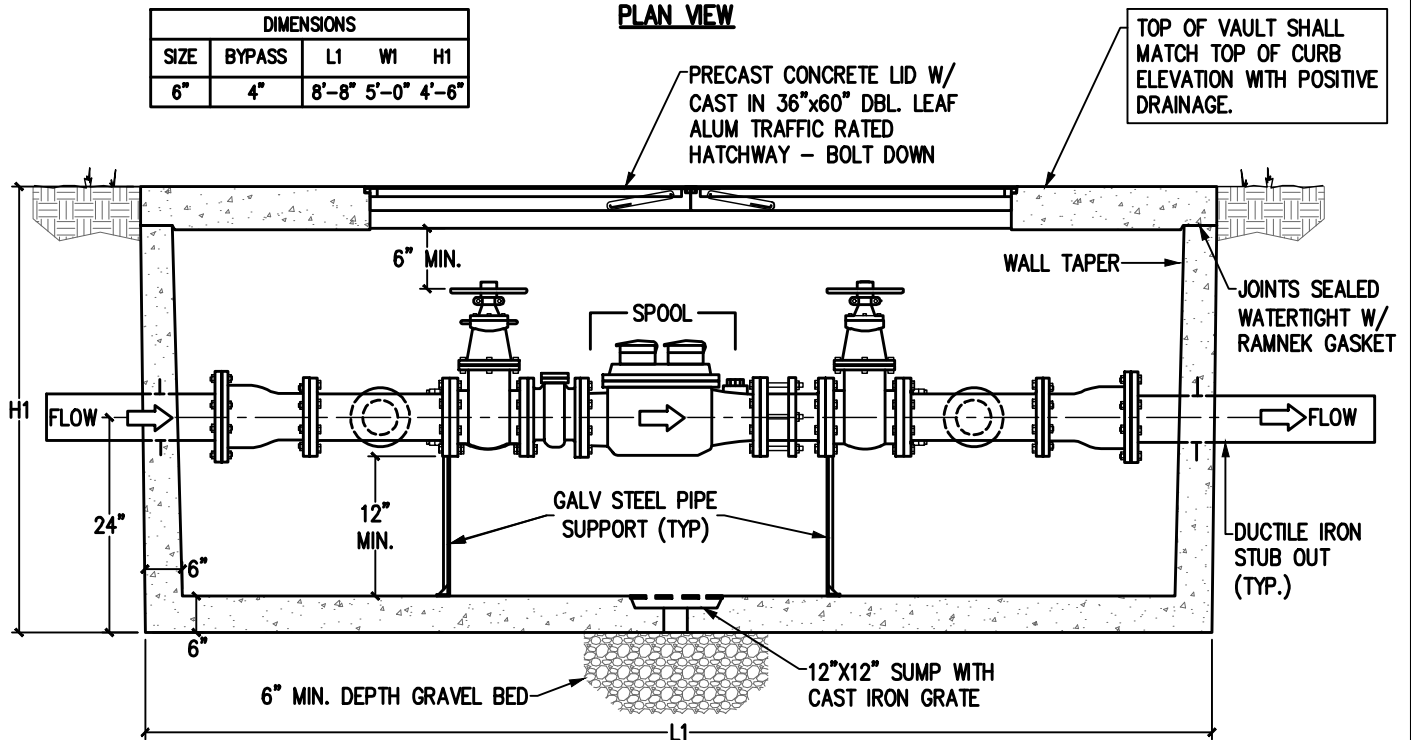
REVISED: AUG 2020

W18



DIMENSIONS				
SIZE	BYPASS	L1	W1	H1
6"	4"	8'-8"	5'-0"	4'-6"

PLAN VIEW



ELEVATION

NOTES:

1. UNIT OF MONOLITHIC CONSTRUCTION AT FLOOR AND FIRST STAGE OF WALL WITH SECTIONAL RISER TO REQUIRED DEPTH.
2. REINFORCEMENT: GRADE 60 REINFORCED. STEEL BAR CONFORMING TO ASTM A615 ON REQUIRED CENTERS OR EQUAL.
3. HATCHWAY: 3' X 5' ALUMINUM HATCH DOUBLE LEAF SPRING ASSISTED AUTO-LOCKING 316 STAINLESS STEEL WITH RELEASE HANDLE. HATCHWAY SHALL BE TRAFFIC RATED.
4. PRE-CAST VAULT AND INTERNAL PARTS SHALL BE FROM THE APPROVED MATERIALS LIST.
5. PIPE FITTINGS SHALL BE DUCTILE IRON UNLESS OTHERWISE SPECIFIED.
6. MINIMUM 6" WATER LINE OFF THE WATER MAIN WITH MINIMUM 6" GATE VALVE PRIOR TO REDUCING IN SIZE. LINE REDUCTION REDUCER SHALL BE PLACED ON THE VAULT STUBOUT PIPING.

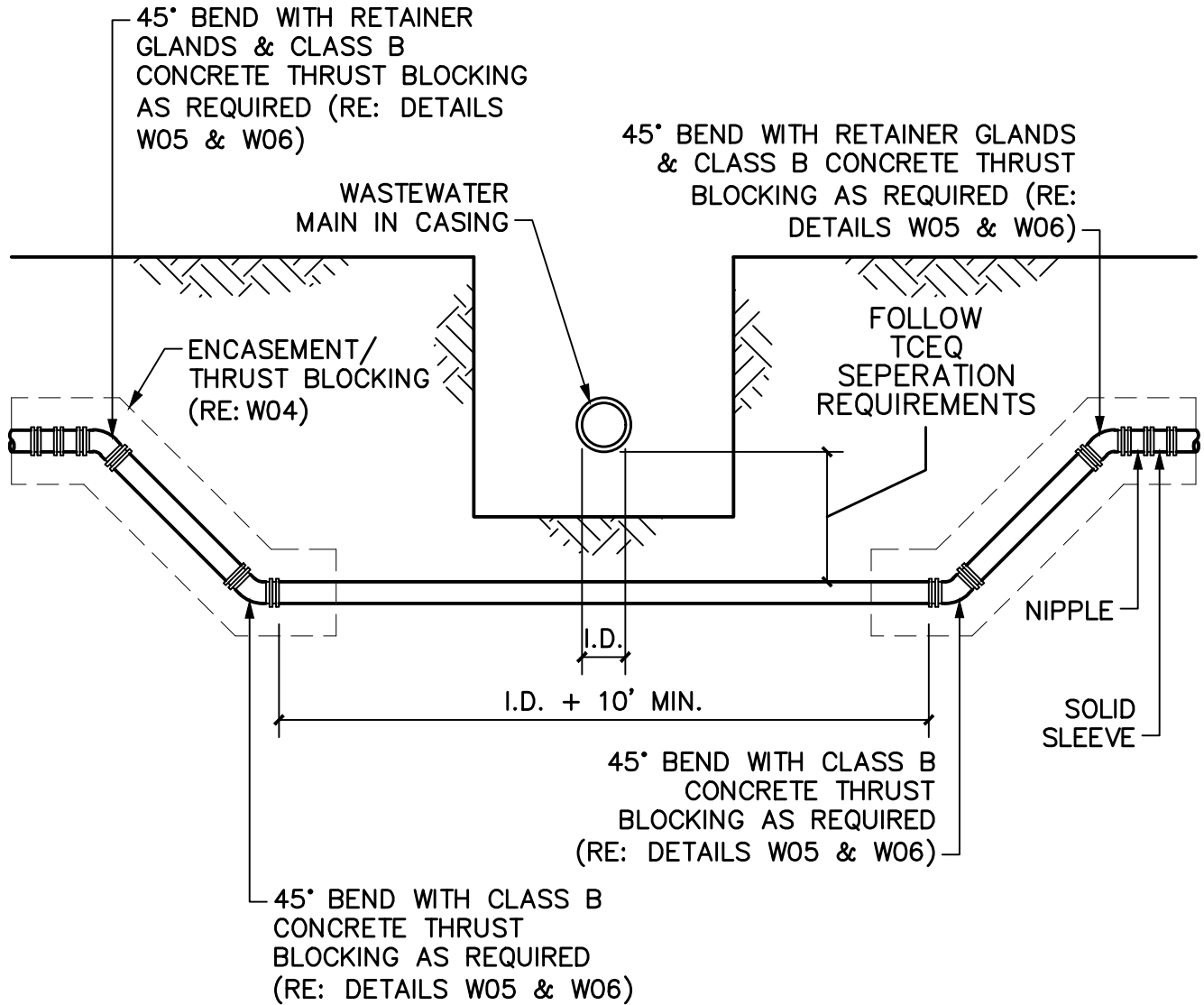


STANDARD CONSTRUCTION DETAIL DOMESTIC 6" WATER METER VAULT

SCALE: N.T.S.

REVISED: AUG 2020

W19

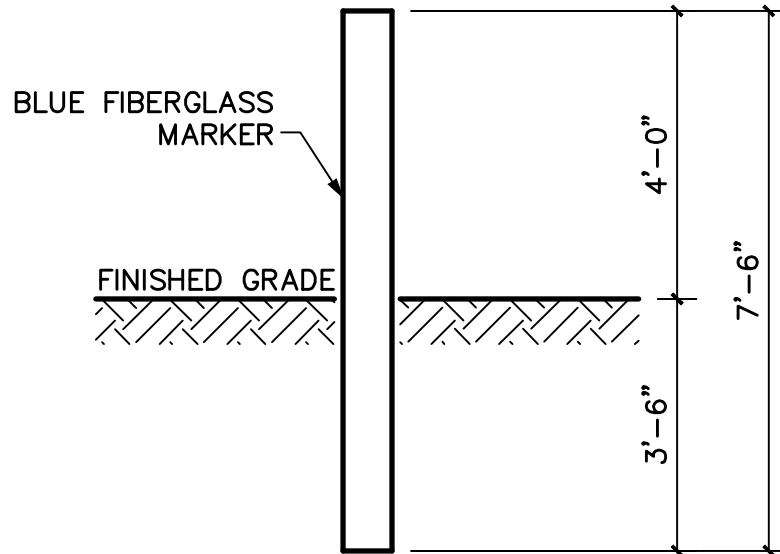


STANDARD CONSTRUCTION DETAIL
WATER MAIN LOWERING
BELOW WASTEWATER MAIN

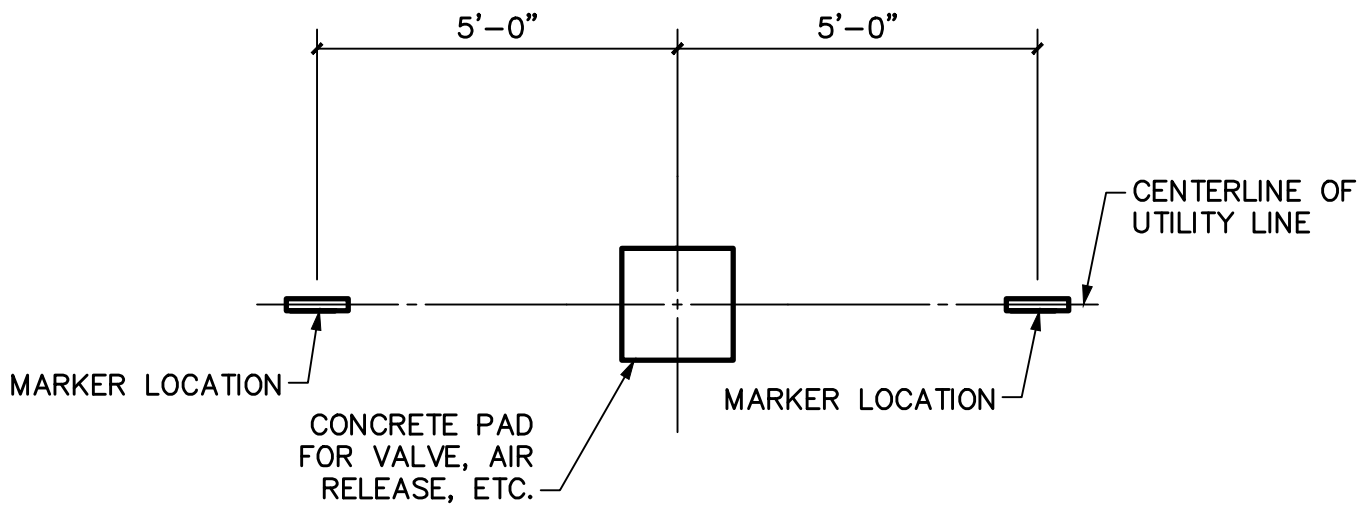
SCALE: 3/8"=1'-0"

REVISED: AUG 2020

W20



ELEVATION



FIELD INSTALLATION DETAIL

NOTE:

1. ALL OFFSITE CITY OF FRISCO MAINS WITH VALVES, AIR RELEASE VALVES, ETC. SHALL BE MARKED AS DETAILED ON THIS SHEET.



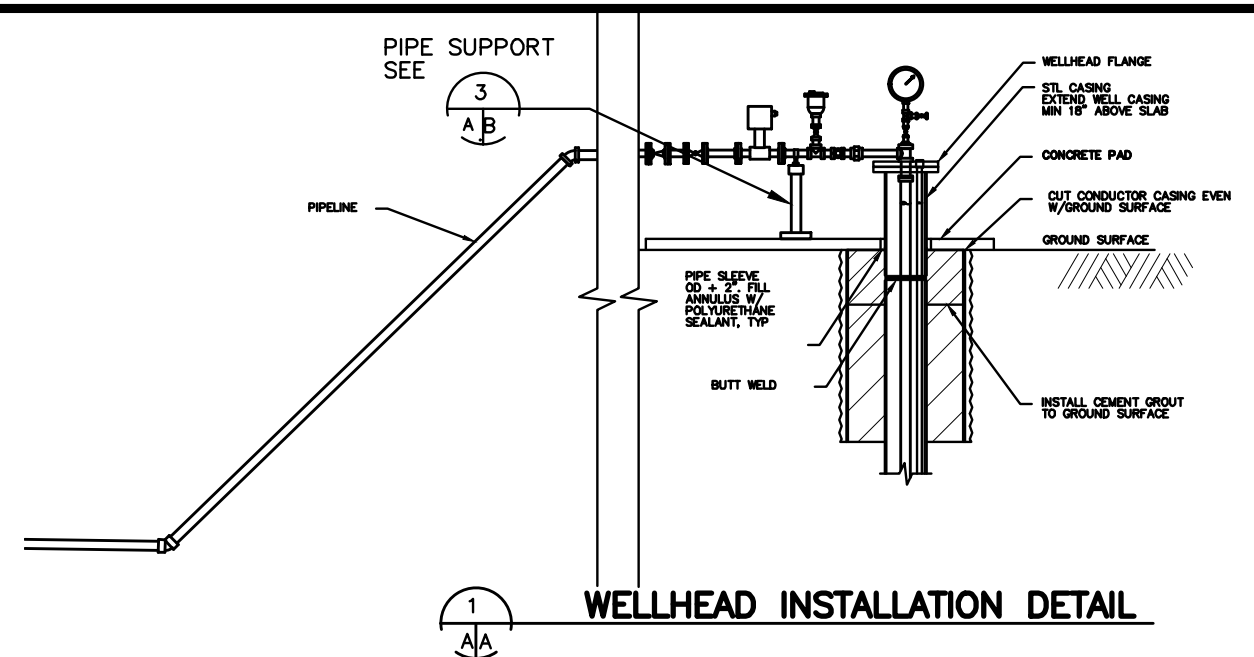
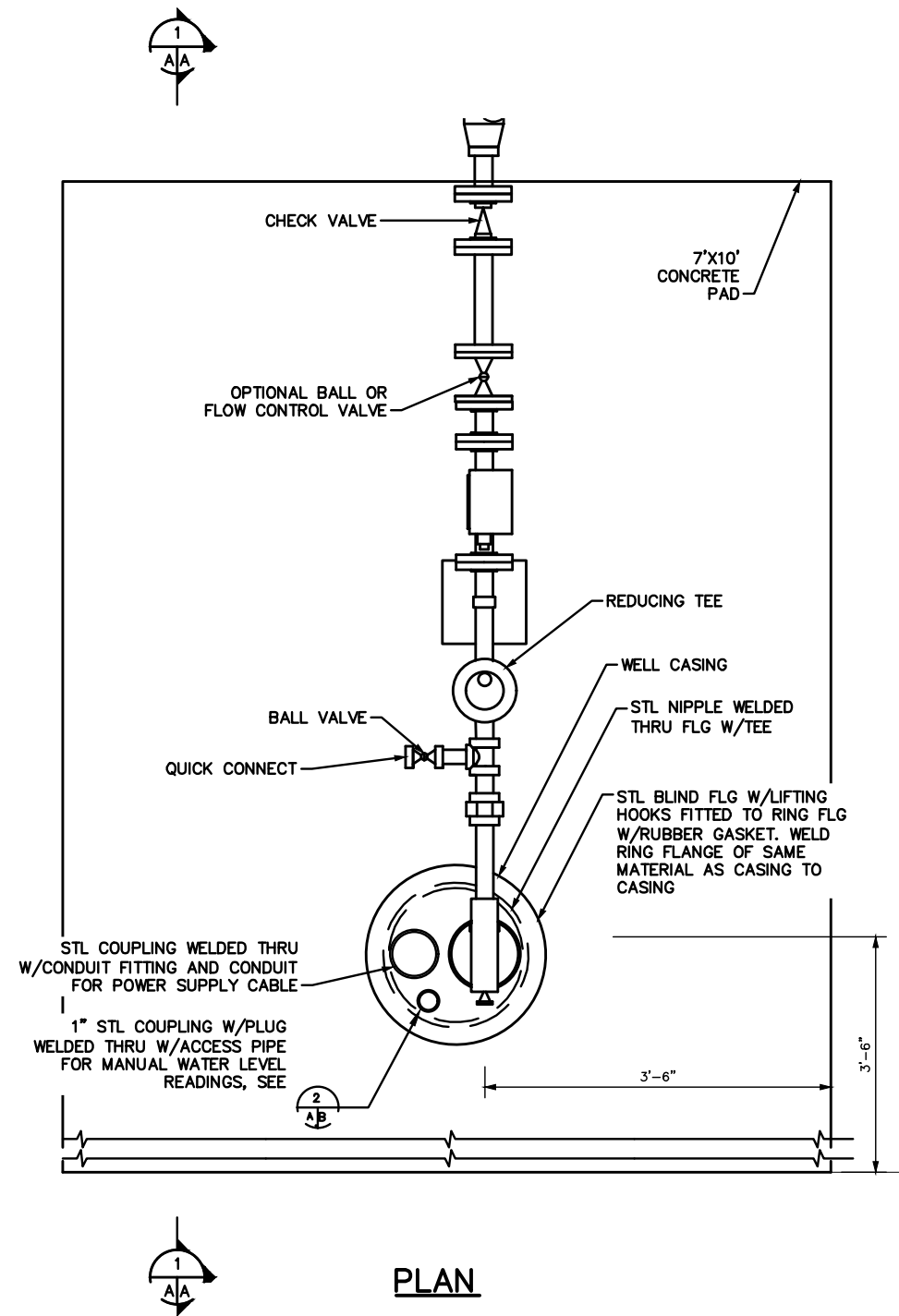
STANDARD CONSTRUCTION DETAIL

OFFSITE WATER MAIN MARKER

SCALE: 3/8"=1'-0"

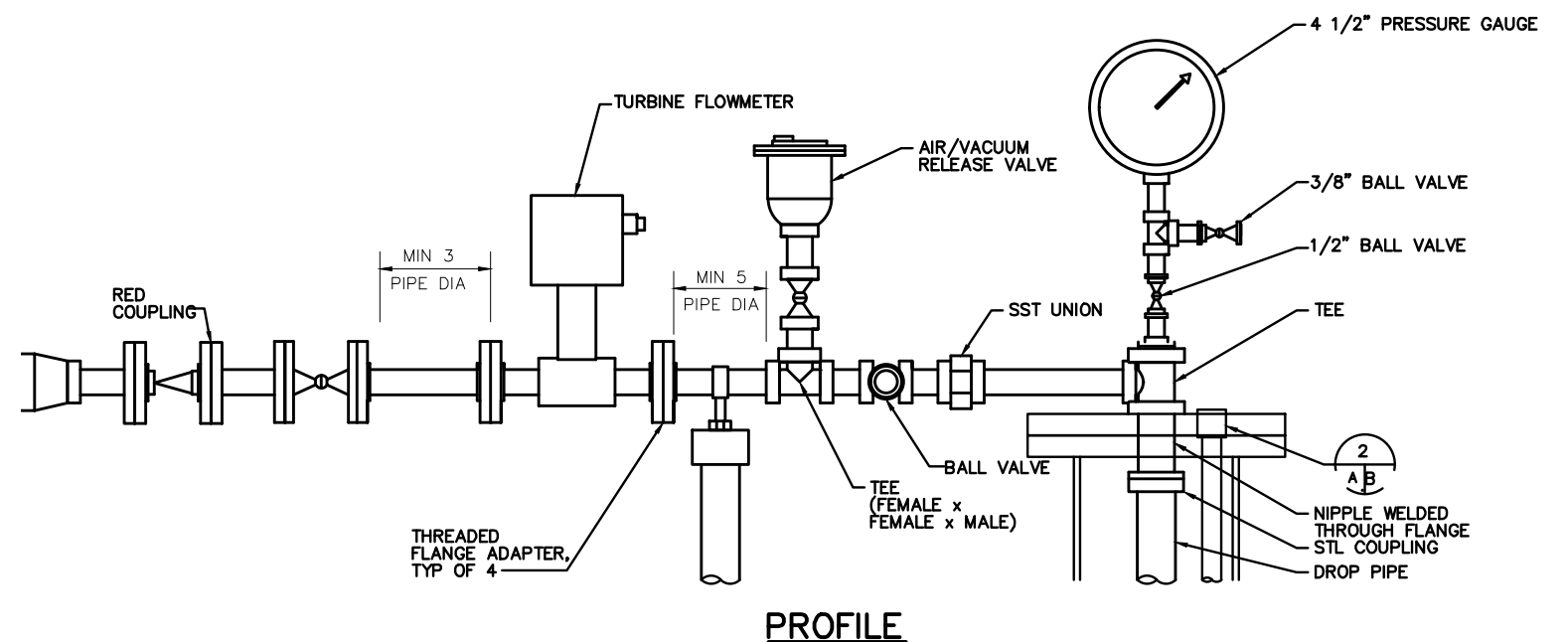
REVISED: AUG 2020

W21



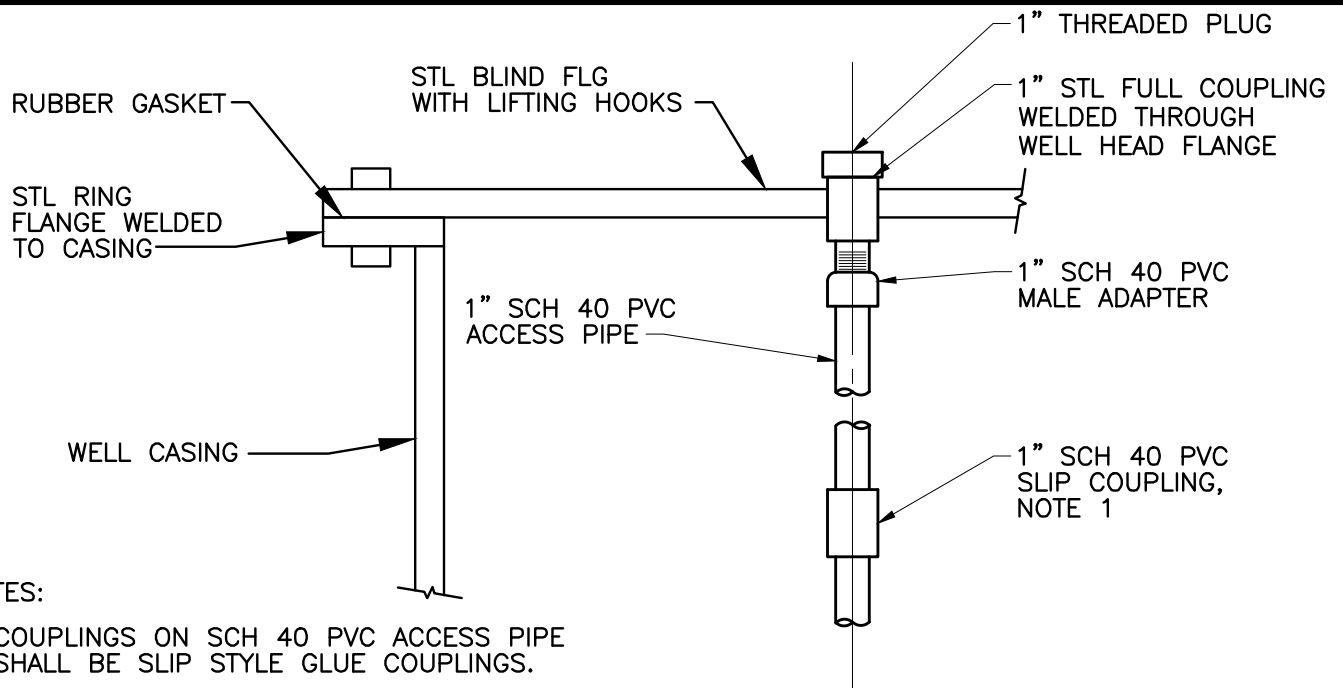
NOTES:

1. DISCHARGE PIPE AND VALVES SELECTED TO LIMIT MAX FLOW VELOCITY TO 6 FT/S AT DESIGN RATE.
2. CASING OD MIN 8 5/8" FOR DESIGN RATE UP TO 75 GPM: 9 5/8" MIN OD FOR DESIGN RATE GREATER THAN 75 GPM AND UP TO 200 GPM. STRAP PVC ACCESS PIPES AND PUMP POWER SUPPLY CABLE TO THE DROP PIPE EVERY 20' USING 20 MIL PVC PIPE WRAP.
3. ALL EXPOSED PIPING SHALL BE INSULATED AND HEAT TRACED.
4. ALL STL TO CONFORM WITH ASTM A53. MIN WORKING PRESSURE TO BE SET BY PROJECT DEVELOPER'S ENGINEER.
5. TURBINE FLOWMETER SHALL BE CITY STANDARD MAKE AND MODEL, W/STRAINER, AS INDICATED BY CITY OF FRISCO UTILITY OPERATIONS SUPERINTENDENT.
6. ADDITIONAL FLOW AND PRESSURE CONTROL VALVES MAY BE NEEDED, AS DETERMINED BY THE PROJECT DEVELOPER'S ENGINEER.
7. AIR/VACUUM RELEASE VALVE SHALL BE VENT-O-MAT SERIES RBX, OR APPROVED EQUAL, AND INSTALLED IN CONFORMANCE W/MFR AND CITY STANDARDS.
8. ALL CONTROLS SHALL BE MFR BY ALLEN-BRADLEY, SIEMENS, OR CUTLER-HAMMER/EATON. ALL ELECTRICAL ENCLOSURES SHALL BE SSTL, NEMA 4X. ALL SCADA COMPONENTS SHALL CONFORM TO CITY STANDARDS AND BE INSTALLED BY CITY DESIGNATED SCADA MAINTENANCE CONTRACTOR.



STANDARD CONSTRUCTION DETAIL

WELLHEAD INSTALLATION



NOTES:

1. COUPLINGS ON SCH 40 PVC ACCESS PIPE SHALL BE SLIP STYLE GLUE COUPLINGS.
2. BOTTOM 10' OF ACCESS PIPE TO BE SLOTTED. PROVIDE GLUED END CAP ON ACCESS PIPE.
3. ACCESS PIPE TO TERMINATE WITHIN 5' OF PUMP.



MANUAL ACCESS PIPE DETAIL

PRE-ENGINEERED
U-BOLT

2 1/2" THRU 5" PIPE

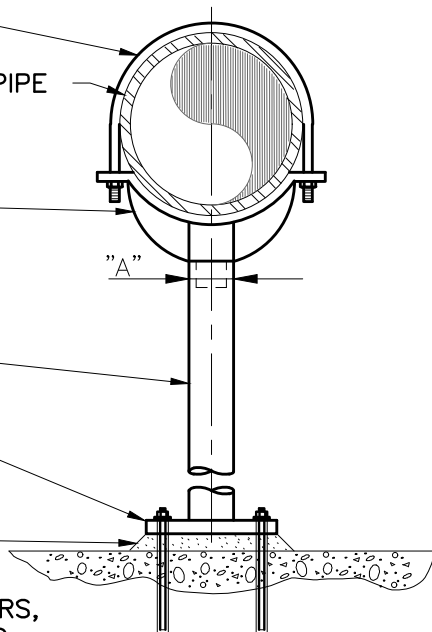
PRE-ENGINEERED
PIPE SUPPORT

SIZE AS REQUIRED
BY CALCULATIONS,
STANDARD WALL
PIPE MINIMUM

STANDARD
PIPE FLANGE

MINIMUM 1 1/2"
NON-SHRINK
GROUT

CONCRETE ANCHORS,
SIZE AND NUMBER
AS REQUIRED BY
CALCULATION



DIMENSION TABLE	
PIPE SIZE	"A" MINIMUM NOMINAL PIPE SIZE
2-1/2"	2-1/2"
3"	2-1/2"
4"	3"
5"	3"



PIPE SUPPORT



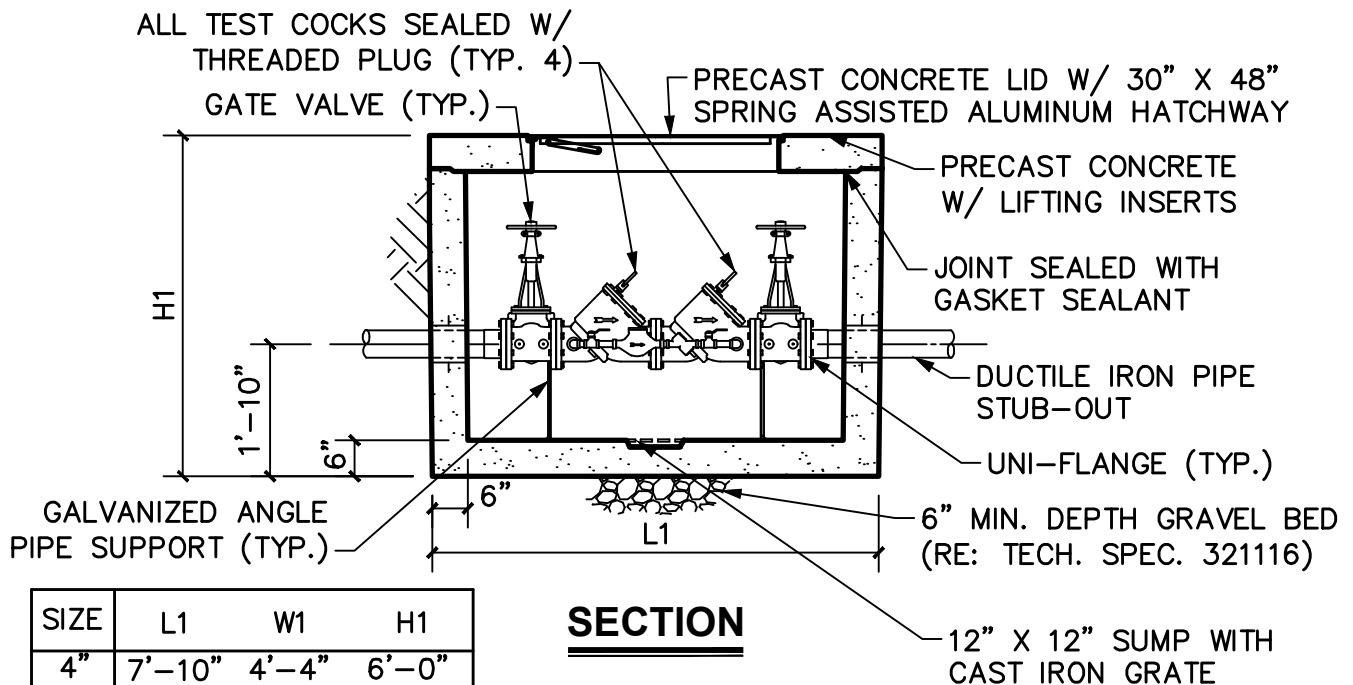
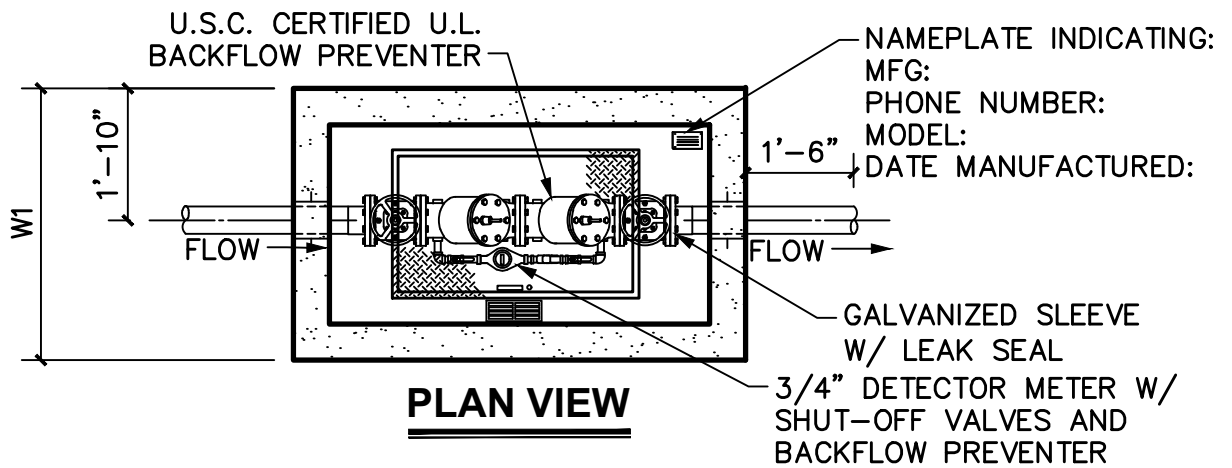
STANDARD CONSTRUCTION DETAIL

MANUAL ACCESS PIPE / PIPE FLOOR SUPPORT

SCALE: N.T.S.

REVISED: AUG 2020

W23



NOTES:

1. UNIT IS OF MONOLITHIC CONSTRUCTION AT FLOOR AND FIRST STAGE OF WALL WITH SECTIONAL RISER TO REQUIRED DEPTH.
2. REINFORCEMENT: GRADE 60 REINFORCED. STEEL BAR CONFORMING TO ASTM A615 ON REQUIRED CENTERS OR EQUAL.
3. HATCHWAY: 1/4" ALUMINUM DIAMOND PLATE COVER WITH EXTRUDED ALUMINUM FRAME. HATCH TO BE FURNISHED WITH 316 STAINLESS STEEL SNAP LOCK & BRASS FINISH HINGES.
4. PRECAST VAULT SHALL BE FROM APPROVED MATERIALS LIST.
5. PIPE AND FITTINGS SHALL BE DUCTILE IRON.



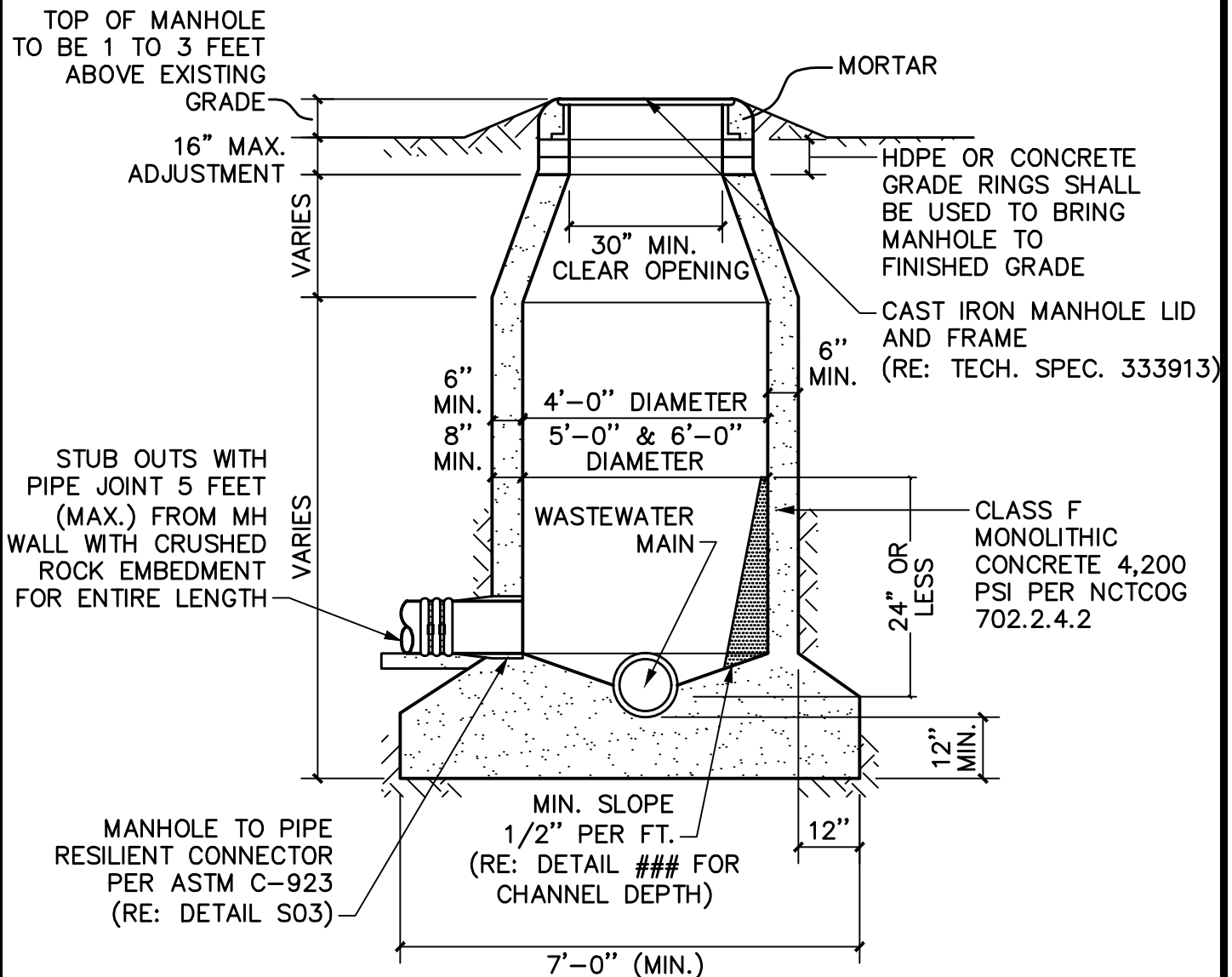
STANDARD CONSTRUCTION DETAIL

DOUBLE DETECTOR CHECK FIRE VAULT

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

W24



NOTES:

1. MANHOLES DEEPER THAN FIFTEEN FEET (15') SHALL BE A MINIMUM OF FIVE-FOOT (5') DIAMETER.
2. DROP MANHOLES SHALL BE REQUIRED WHEN THE INFLOW ELEVATION IS MORE THAN TWENTY-FOUR INCHES (24") ABOVE THE OUTFALL ELEVATION.
3. IF THE INLET PIPE IS 24" OR LESS ABOVE THE OUTLET PIPE, CONSTRUCT A RAMP FROM THE INLET PIPE TO THE MANHOLE INVERT.
4. WHERE UNEQUAL PIPES ENTER A MANHOLE, THE CROWN OF THE PIPES SHALL BE SET AT THE SAME ELEVATION.
5. REFER TO TECHNICAL SPECIFICATION 333914.
6. SET MANHOLE BASE ON 8" OF CLEAN CRUSHED ROCK.



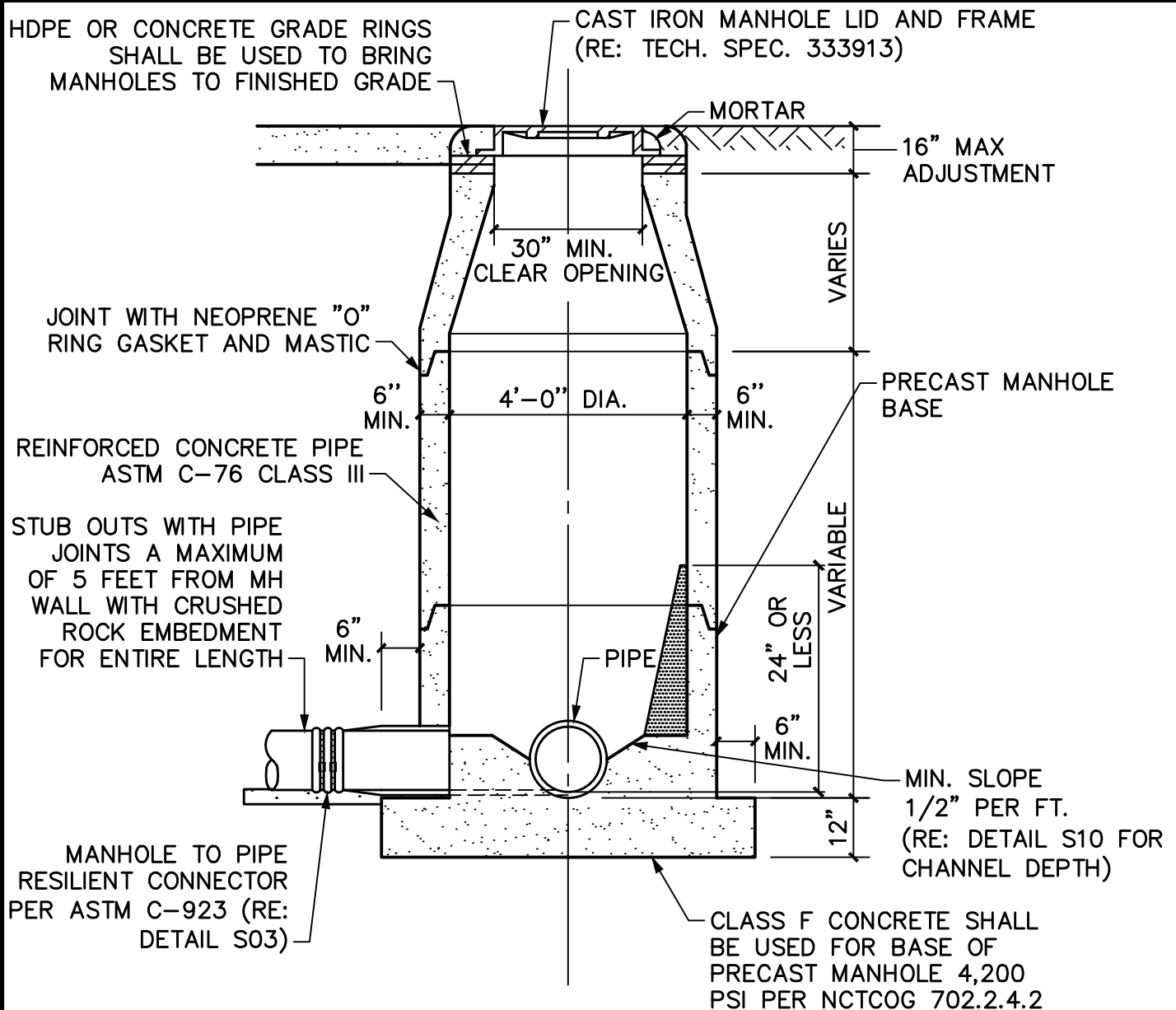
STANDARD CONSTRUCTION DETAIL

STANDARD CAST-IN-PLACE MANHOLE

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

S01



NOTES:

1. MANHOLES DEEPER THAN FIFTEEN FEET (15') SHALL BE A MINIMUM OF FIVE-FOOT (5') DIAMETER. USE MANHOLE WRAP AT EACH MANHOLE JOINT.
2. DROP MANHOLES SHALL BE REQUIRED WHEN THE INFLOW ELEVATION IS MORE THAN TWENTY-FOUR INCHES (24") ABOVE THE OUTFALL ELEVATION.
3. IF THE INLET PIPE IS 24" OR LESS ABOVE THE OUTLET PIPE, CONSTRUCT A RAMP FROM THE INLET PIPE TO THE MANHOLE INVERT.
4. WHERE UNEQUAL PIPES ENTER A MANHOLE, THE CROWN OF THE PIPES SHALL BE SET AT THE SAME ELEVATION.
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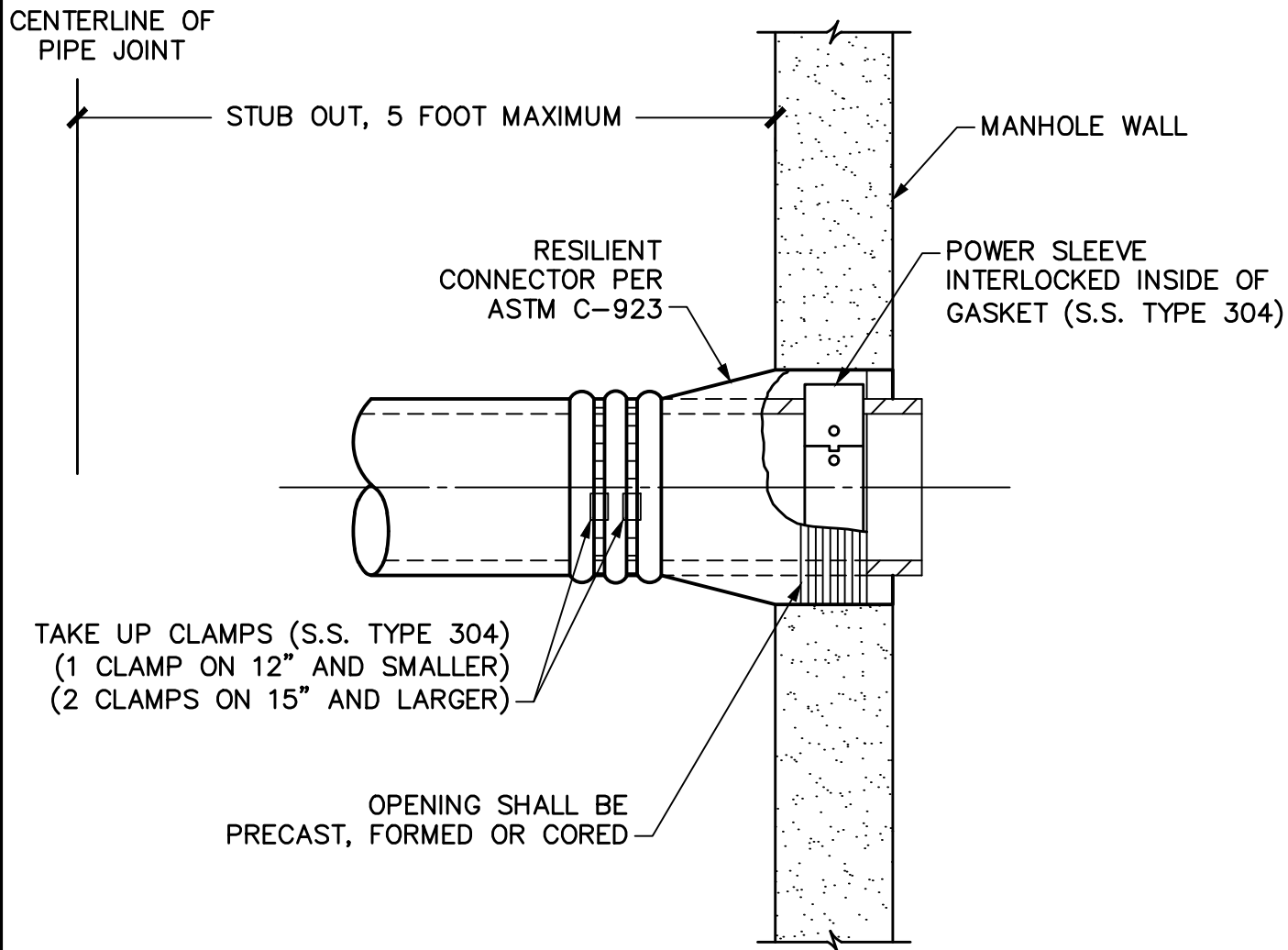
STANDARD CONSTRUCTION DETAIL

PRECAST CONCRETE MANHOLE

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

S02



NOTE:

1. REFER TO APPROVED MATERIALS LIST.



STANDARD CONSTRUCTION DETAIL

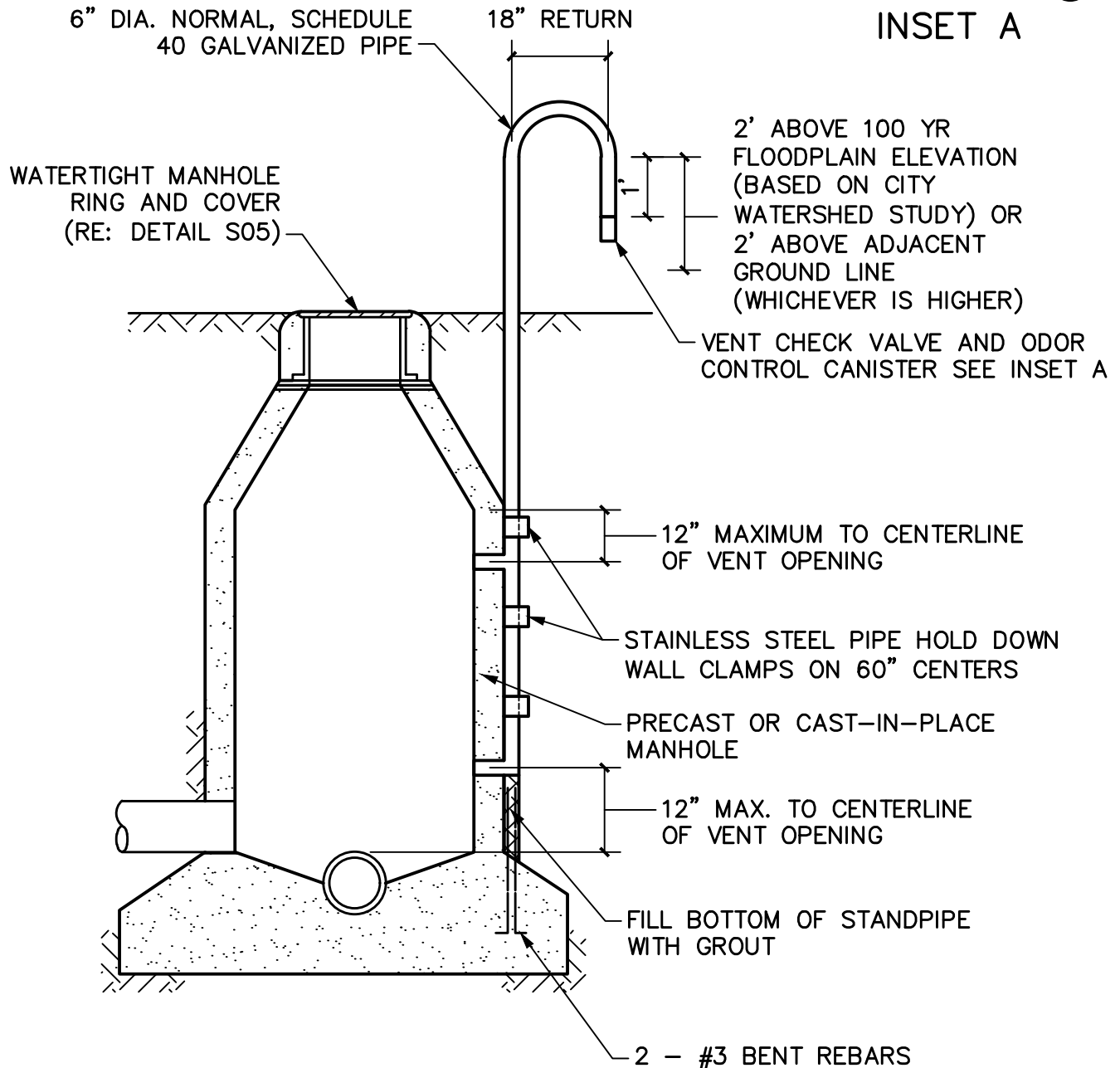
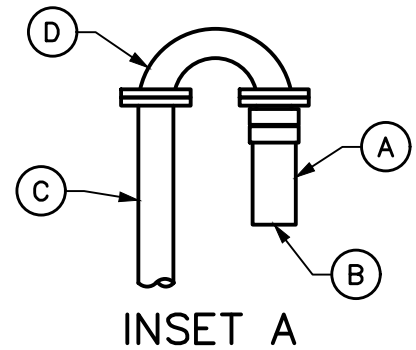
MANHOLE TO PIPE RESILIENT CONNECTOR

SCALE: 1"=1'-0"

REVISED: AUG 2020

S03

- A - 6" SEWER VENT VALVE WITH ODOR CONTROL ROBERT H. WAGER CO. MODEL 1850 OR APPROVED EQUAL
- B - 1/4"X1/4" STAINLESS STEEL MESH SCREEN
- C - 6" DIA. SCHEDULE 40 GALVANIZED PIPE WITH THREADED FLANGE
- D - 6" DIA. SCHEDULE 40 GALVANIZED PIPE WITH THREADED FLANGE 180 DEGREE BEND OR TWO 90 DEGREE BENDS



NOTE:

1. REFER TO STANDARD DETAIL S01 AND S02 FOR MANHOLE DETAILS.



STANDARD CONSTRUCTION DETAIL

VENTED TYPE S MANHOLE

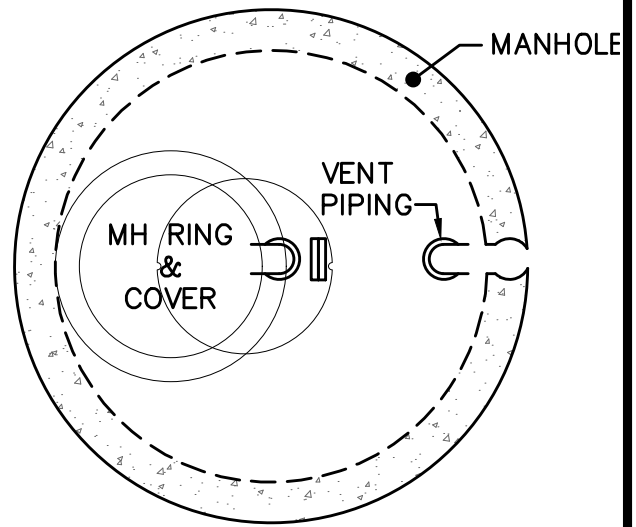
SCALE: 3/8"=1'-0"

REVISED: AUG 2020

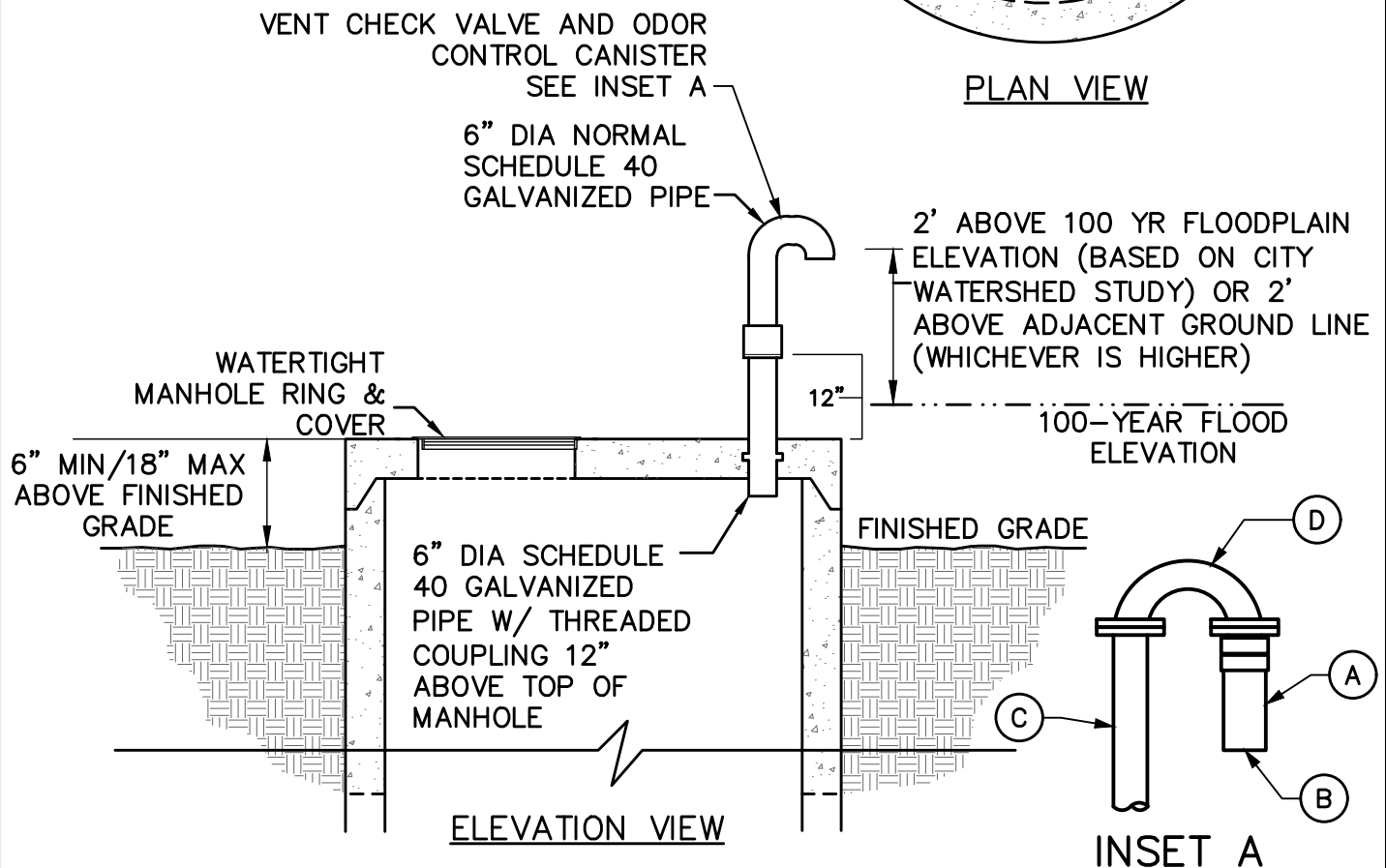
S04

NOTES:

1. VENT PIPE OPENING IN PRECAST POLYMER CONCRETE MANHOLE WALL SHALL BE PRECAST BY MANHOLE MANUFACTURER.
2. LOCATION OF VENT PIPE SHALL BE OPPOSITE THE MANHOLE OPENING WITH WATERTIGHT RING AND COVER VENT TOP TO BE ELEVATED AT LEAST 24 INCHES ABOVE THE 100 YEAR FLOOD PLAIN ELEVATION OR 2' ABOVE ADJACENT GROUND LEVEL (WHICHEVER IS GREATER).



PLAN VIEW



- A – 6" SEWER VENT VALVE WITH ODOR CONTROL ROBERT H. WAGER CO. MODEL 1850 OR APPROVED EQUAL
- B – 1/4"x1/4" STAINLESS STEEL MESH SCREEN
- C – 6" DIA. SCHEDULE 40 GALVANIZED PIPE WITH THREADED FLANGE
- D – 6" DIA. SCHEDULE 40 GALVANIZED PIPE WITH THREADED FLANGE 180 DEGREE BEND OR TWO 90 DEGREE BENDS



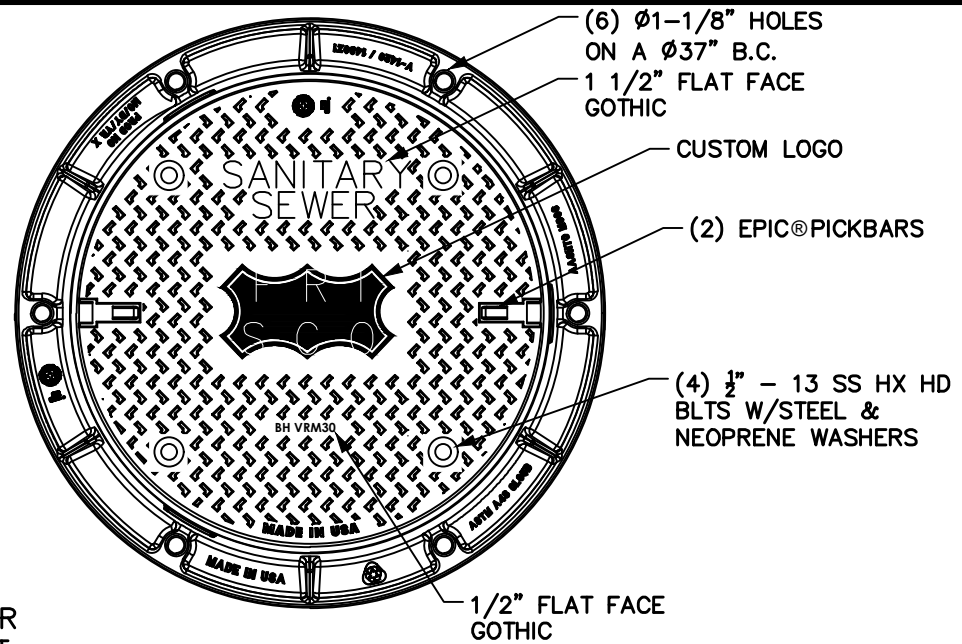
STANDARD CONSTRUCTION DETAIL

VENTED FLAT TOP MANHOLE

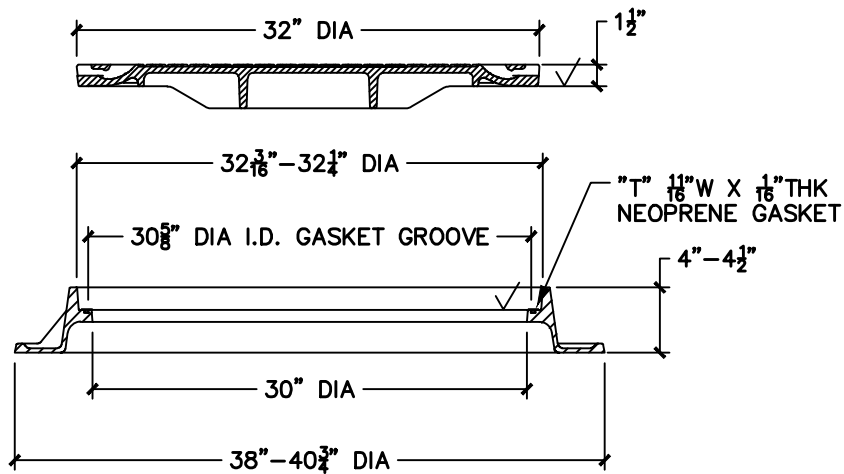
SCALE: N.T.S.

REVISED: AUG 2020

S05



LID AND FRAME:
BH VRM-30 WTBF OR
EJ 1480ZPT 1495APT.



SECTION VIEW

NOTES:

1. THE HORIZONTAL BEARING SURFACES ARE TO BE MACHINE FINISHED.
2. FOR A SEAL BETWEEN THE RING FRAME AND COVER A $1/4$ " DIA. NEOPRENE "O-RING" GASKET SHALL BE INSTALLED BY THE MANUFACTURER. THE LOCATION SHALL BE AS PER THE MANUFACTURER'S STANDARDS BUT SHALL BE SUBJECT TO THE APPROVAL OF THE CITY.
3. THE SOLID LID WILL BE PROVIDED WITH MANUFACTURER'S STANDARD LETTERING SHOWING "SANITARY SEWER" AND CITY LOGO.
4. NOT ALLOWED IN TRAFFIC AREA.

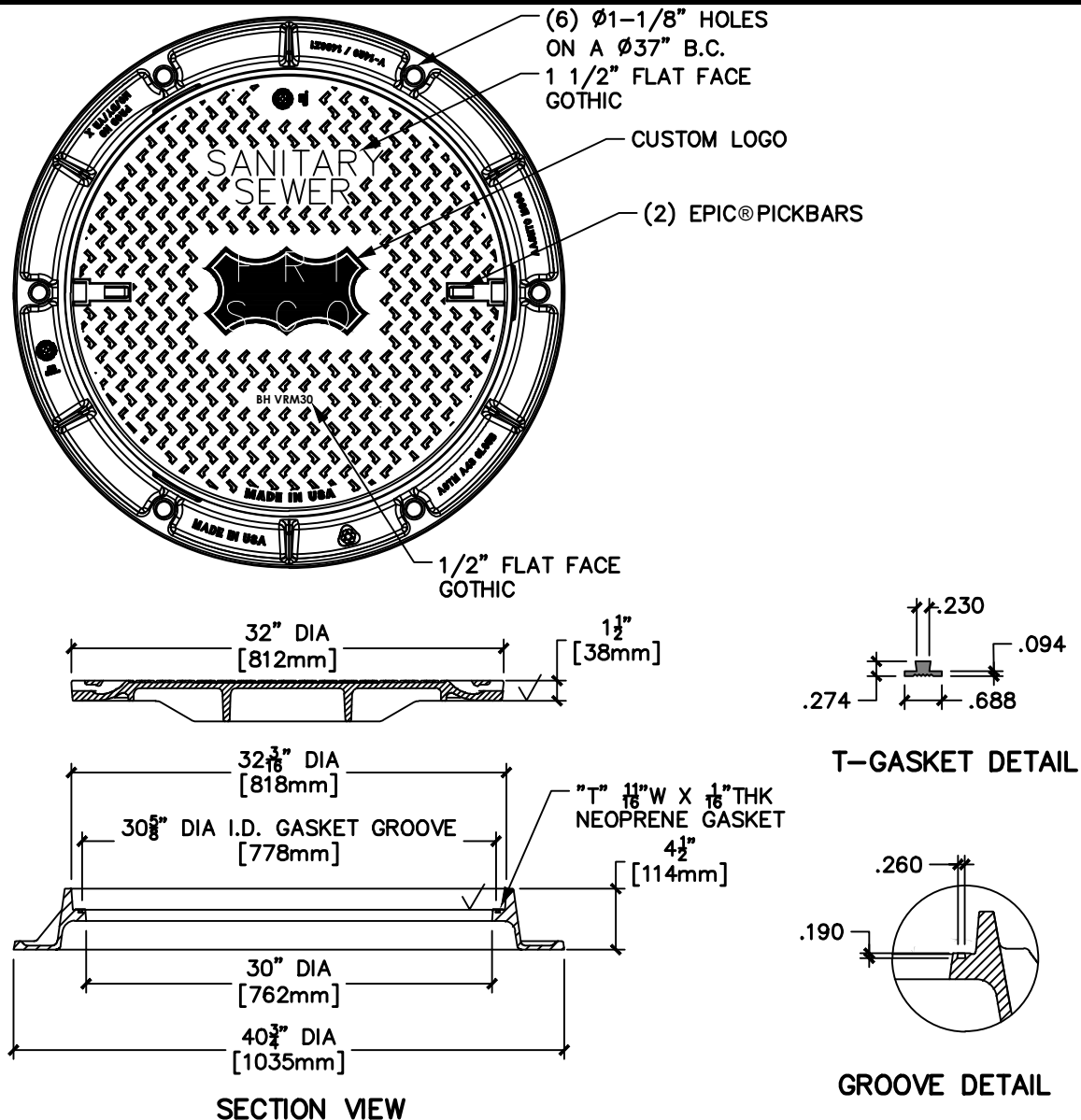


STANDARD CONSTRUCTION DETAIL PRESSURE MANHOLE LID AND FRAME

SCALE: 1"=1'-0"

REVISED: AUG 2020

S06



NOTES:

1. THE HORIZONTAL BEARING SURFACES ARE TO BE MACHINE FINISHED.
2. FOR A SEAL BETWEEN THE RING FRAME AND COVER A 1/4" DIA. NEOPRENE "O-RING" GASKET SHALL BE INSTALLED BY THE MANUFACTURER. THE LOCATION SHALL BE AS PER THE MANUFACTURER'S STANDARDS BUT SHALL BE SUBJECT TO THE APPROVAL OF THE CITY.
3. THE SOLID LID WILL BE PROVIDED WITH MANUFACTURER'S STANDARD LETTERING SHOWING "SANITARY SEWER" AND CITY LOGO.
4. NOT ALLOWED IN TRAFFIC AREA.

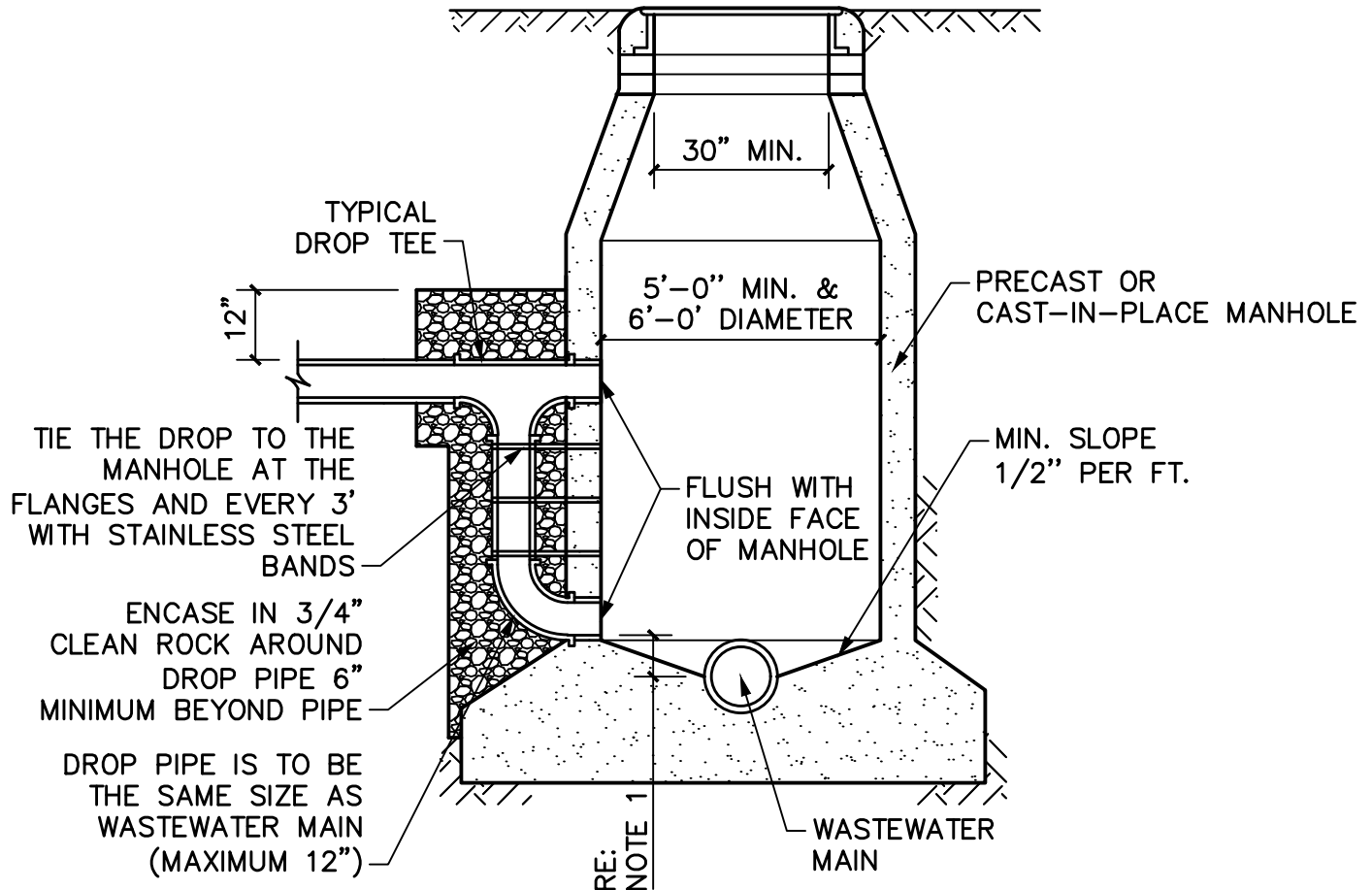


STANDARD CONSTRUCTION DETAIL STANDARD MANHOLE LID AND FRAME

SCALE: 1"=1'-0"

REVISED: AUG 2020

S07



- * WHEN A DROP MANHOLE IS USED IN CONJUNCTION WITH A PARALLEL LINE, REFER TO DETAIL S06-A.

NOTES:

1. FLOWLINE OF DROP SHALL BE LOCATED BETWEEN THE CENTERLINE AND TOP OF WASTEWATER MAIN.
2. THERE SHALL BE A MINIMUM OF TWO-TENTHS OF A FOOT (0.2') DROP BETWEEN INVERTS OF PIPES IN AND OUT OF MANHOLES.
3. WHERE UNEQUAL PIPES ENTER A MANHOLE, THE CROWN OF THE PIPES SHALL BE SET AT THE SAME ELEVATION.
4. REFER TO TECHNICAL SPECIFICATIONS 333914 AND 333915.



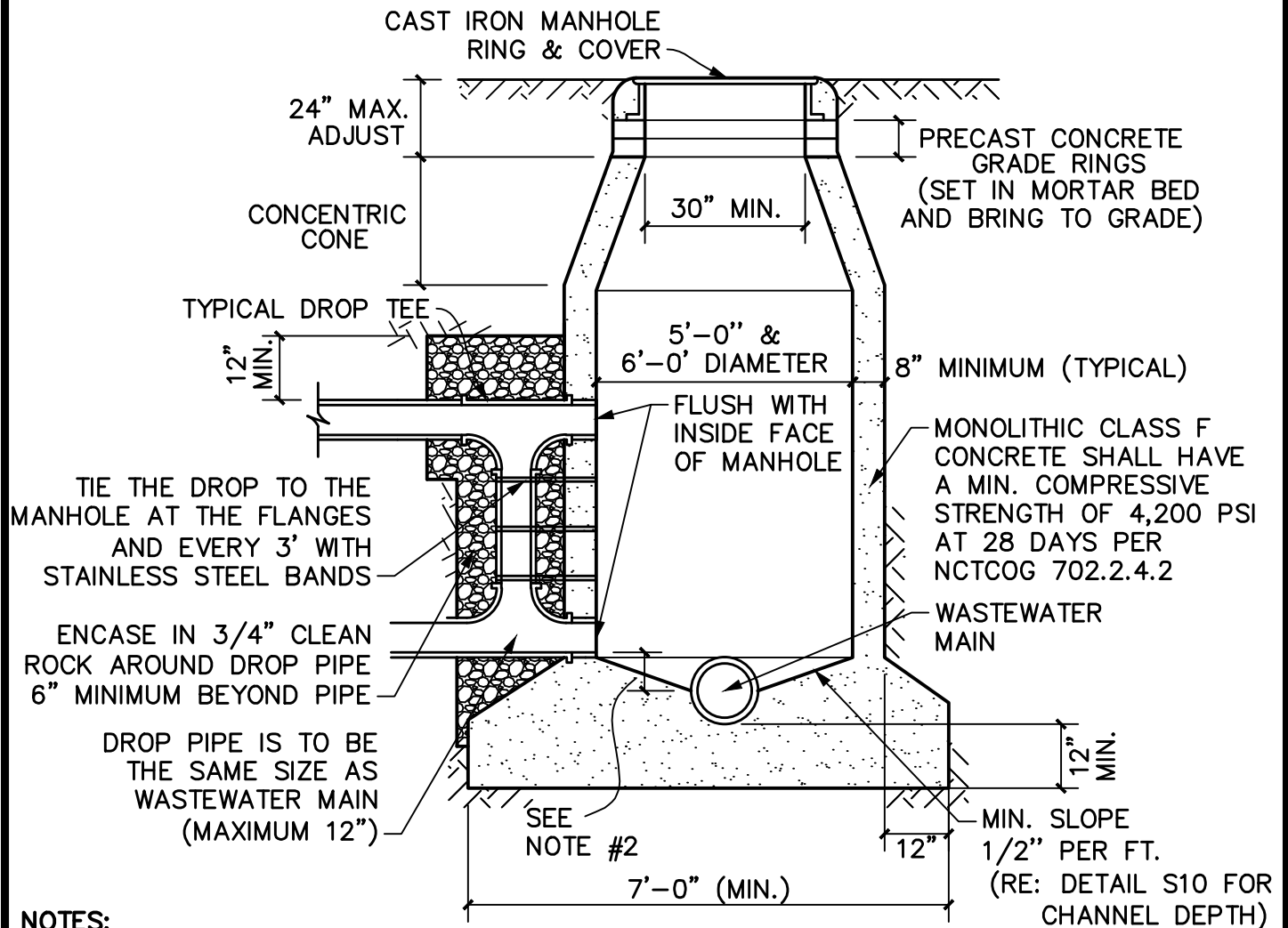
STANDARD CONSTRUCTION DETAIL

MANHOLE DROP CONNECTION

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

S08



NOTES:

1. THE DIAMETER OF A MANHOLE CONSTRUCTED OVER THE CENTER OF A SEWER SHOULD VARY WITH THE SIZE OF THE SEWER. FOR EIGHT-INCH (8"), TEN-INCH (10"), TWELVE-INCH (12"), FIFTEEN-INCH (15"), EIGHTEEN-INCH (18"), TWENTY-ONE INCH (21"), TWENTY-FOUR INCH (24") AND TWENTY-SEVEN INCH (27") SHALL BE FIVE-FOOT (5') MINIMUM DIAMETER; THIRTY-INCH (30") AND THIRTY-SIX INCH (36") SHALL BE SIX-FOOT (6') MINIMUM DIAMETER. MANHOLES DEEPER THAN FIFTEEN FEET (15') SHALL BE A MINIMUM OF FIVE-FOOT (5') DIAMETER.
2. FLOWLINE OF DROP SHALL BE LOCATED BETWEEN THE CENTERLINE AND TOP OF SEWER MAIN.
3. THERE SHALL BE A MINIMUM OF TWO-TENTHS OF A FOOT (0.2') DROP BETWEEN INVERTS OF PIPE INLET AND PIPE OUTLETS.
4. WHERE UNEQUAL PIPES ENTER A MANHOLE, THE CROWN OF THE PIPES SHALL BE SET AT THE SAME ELEVATION.
5. CONCRETE SHALL BE A MONOLITHIC POUR.
6. FOLLOW NORMAL COMPACTION PROCEDURE ON EACH LINE.

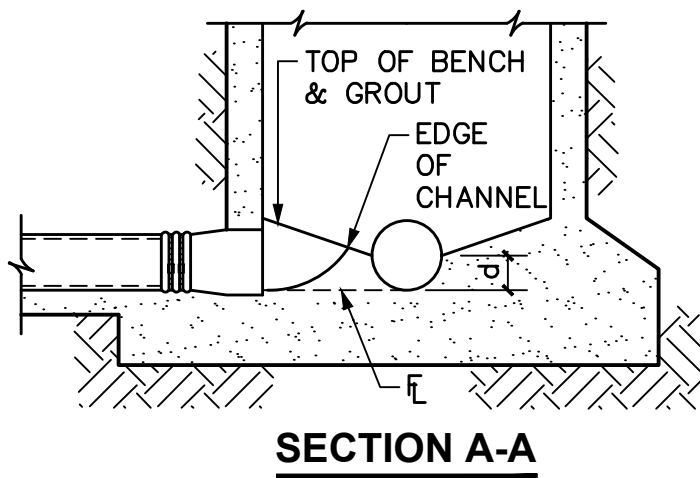
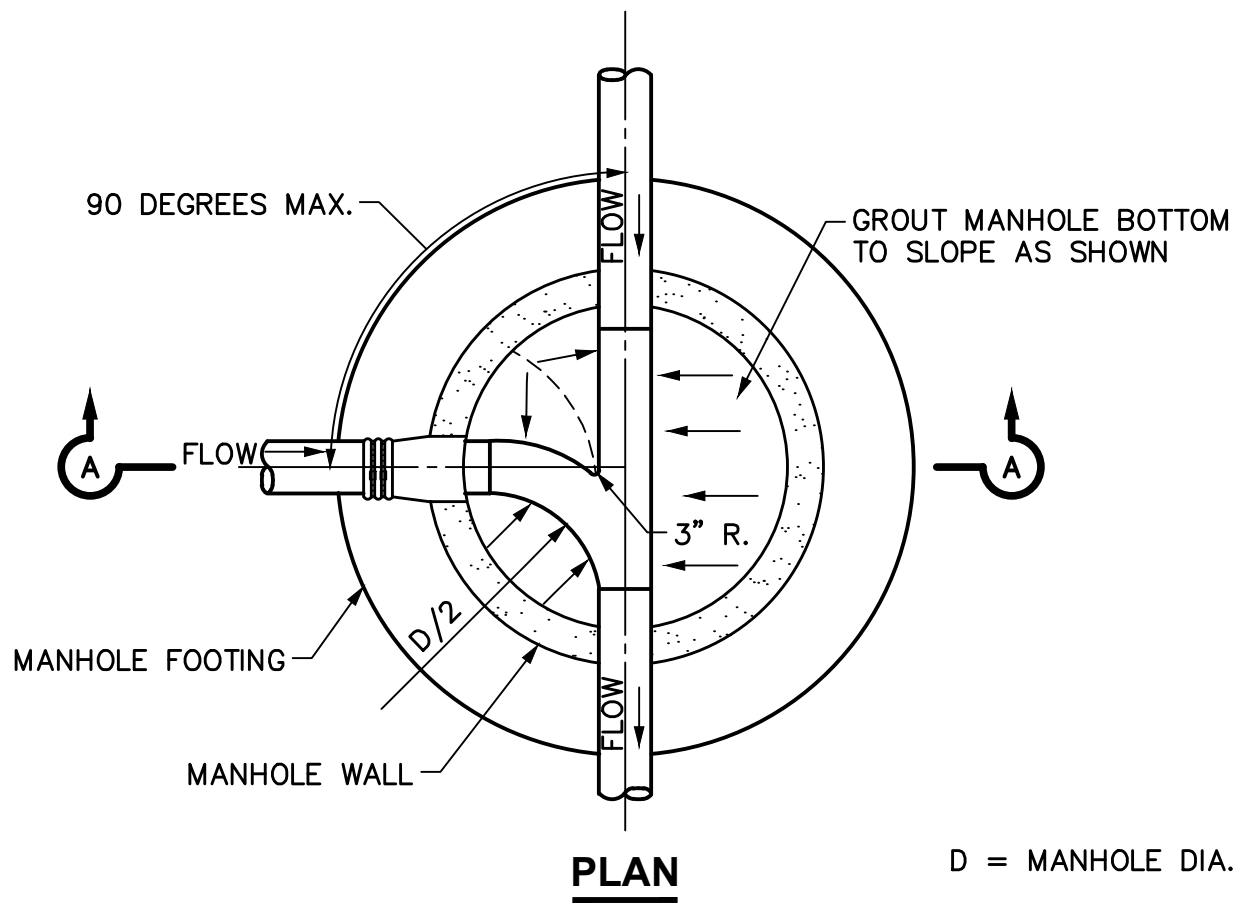


STANDARD CONSTRUCTION DETAIL MANHOLE DROP CONNECTION FOR A PARALLEL LINE

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

S09



d (CHANNEL DEPTH)	PIPE DIA.
$\frac{1}{2}$ PIPE DIA.	< 15"
$\frac{3}{4}$ PIPE DIA.	15" – 24"
1 PIPE DIA.	> 24"

NOTES:

1. REFER TO MANHOLE STANDARD DRAWINGS FOR ADDITIONAL DETAIL OF MANHOLE (RE: DETAILS S01 & S02).
2. MINIMUM SLOPE OF BENCH IS 0.5 INCH PER FOOT.



**STANDARD CONSTRUCTION DETAIL
WASTEWATER MANHOLE
MAIN INTERSECTION**

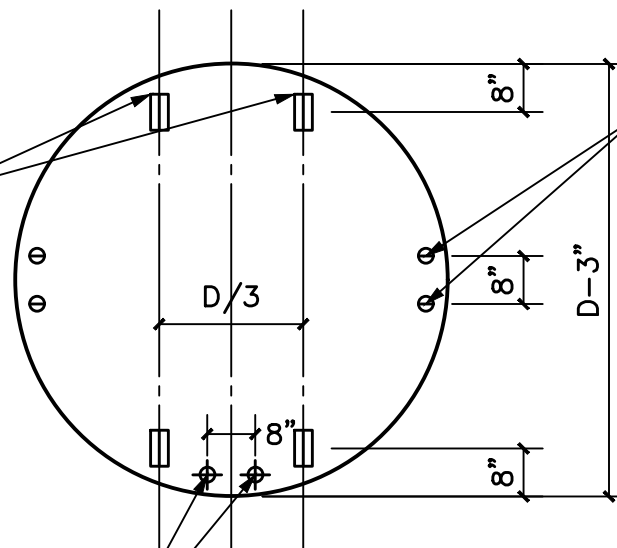
SCALE: $\frac{3}{8}"=1'-0"$

REVISED: AUG 2020

S10

METAL STRAP
HINGES (MIN. 3"
LONG) W/BOLTS

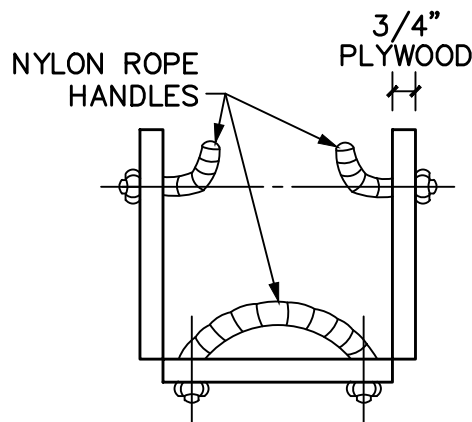
5/8" HOLES FOR 1/2"
NYLON ROPE HANDLES



5/8" HOLES FOR 1/2"
NYLON ROPE HANDLES

D = INSIDE DIAMETER
OF MANHOLE

PLAN VIEW



INSTALLATION AND REMOVAL POSITION

INSTALLATION

FALSE MANHOLE BOTTOM SHALL BE FURNISHED AND INSTALLED IN ALL MANHOLES CONSTRUCTED IN ADVANCE OF PAVING. THESE FALSE MANHOLE BOTTOMS WILL BE INSTALLED AT A TIME DIRECTED BY THE CITY BUT WILL USUALLY BE AFTER ALL WORK IS COMPLETED ON THE WASTEWATER SYSTEM INCLUDING THE AIR TEST, BUT PRIOR TO THE FINAL INSPECTION.

REMOVAL

FALSE MANHOLE BOTTOM SHALL BE REMOVED AFTER THE FINAL APPURTENANCE ADJUSTMENT INSPECTION. THE PAVING CONTRACTOR AND CITY INSPECTOR WILL COORDINATE THE REMOVAL OF THE FALSE MANHOLE BOTTOMS.

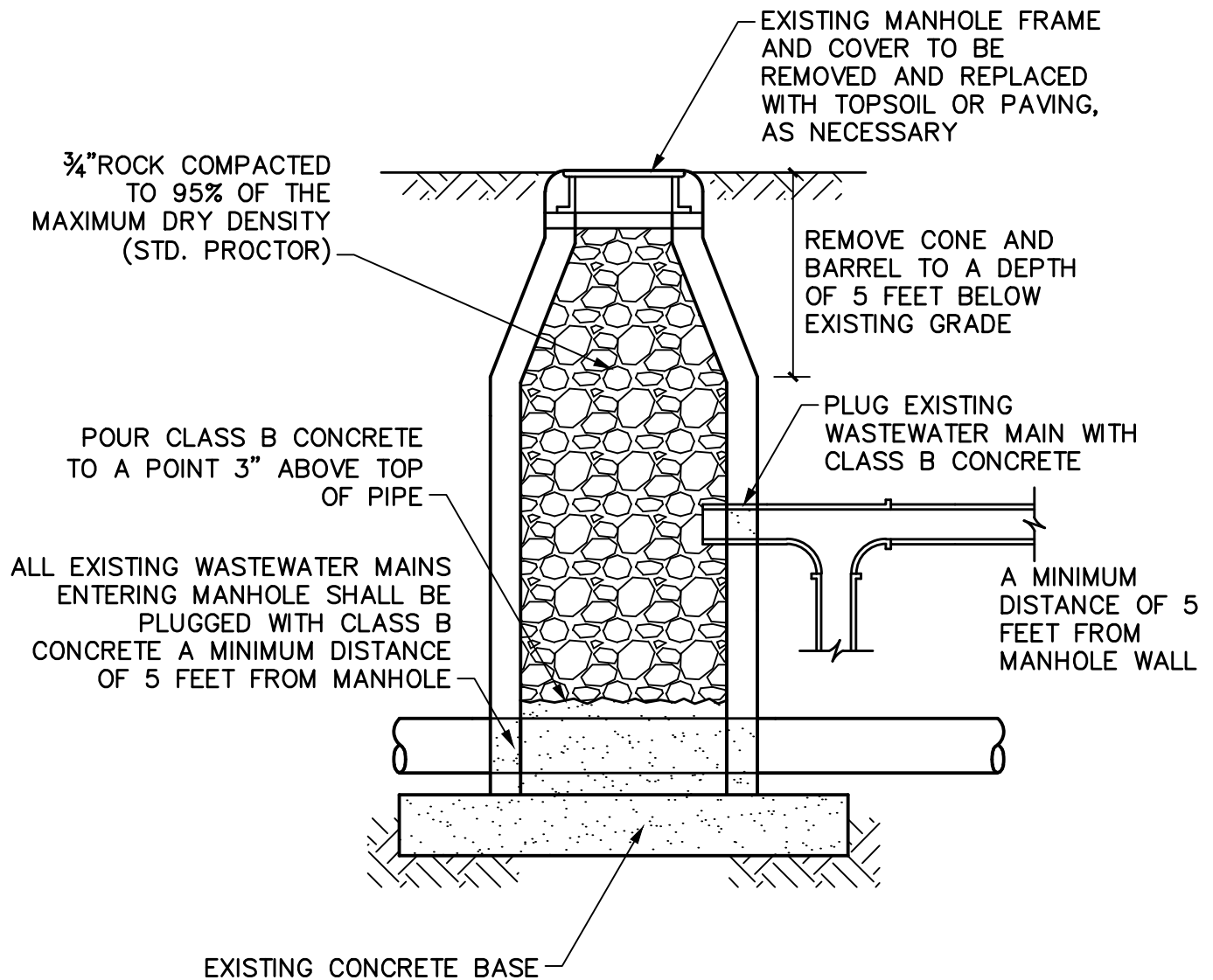


STANDARD CONSTRUCTION DETAIL WASTEWATER MANHOLE FALSE BOTTOM

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

S11



NOTE:

1. CLASS B CONCRETE TO BE 2,000 PSI PER NCTCOG 702.2.4.2.



STANDARD CONSTRUCTION DETAIL

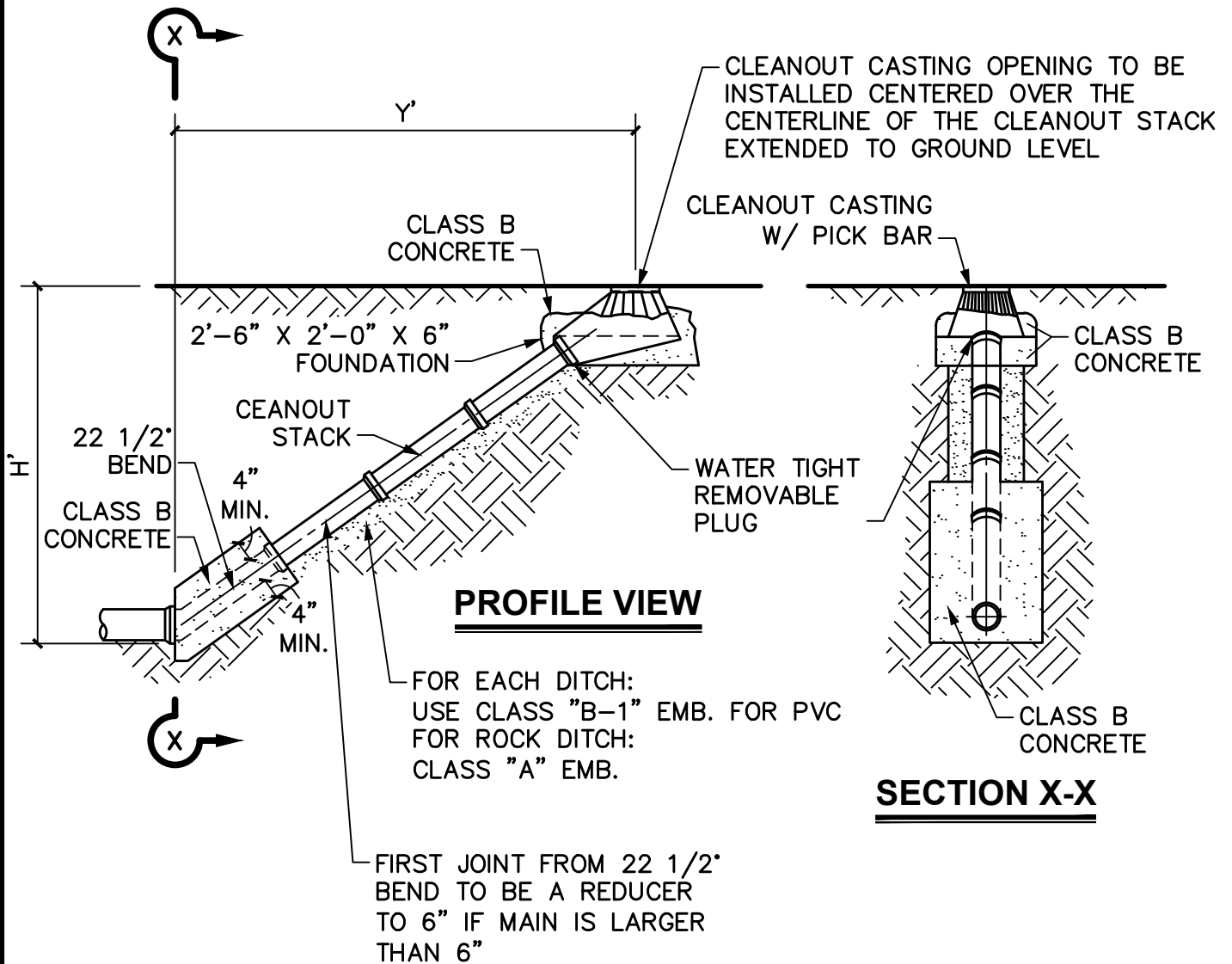
MANHOLE ABANDONMENT

SCALE: N.T.S.

REVISED: AUG 2020

S12

H'	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	H'
Y'	10	12	14	17	19	22	24	27	29	31	34	36	39	41	43	46	48	Y'



NOTES:

1. IF CLEANOUT IS PLACED IN ADVANCE OF PAVEMENT PLACE SAND AROUND CLEANOUT CASTING IN LIEU OF CLASS B CONCRETE.
2. IF CLEANOUT IS OUTSIDE OF PAVEMENT, CENTER CASTING IN 24" X 24" CLASS A CONCRETE PAD 6" THICK WITH FOUR #3 BARS.
3. CLASS A CONCRETE IS 3,000 PSI AND CLASS B CONCRETE IS 2,000 PSI PER NCTCOG 702.2.4.2.

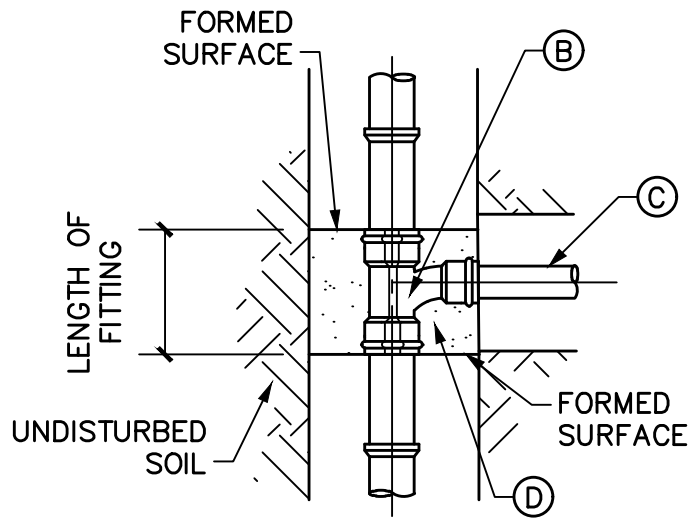


STANDARD CONSTRUCTION DETAIL WASTEWATER MAIN CLEANOUT

SCALE: 3/8"=1'-0"

REVISED: AUG 2020

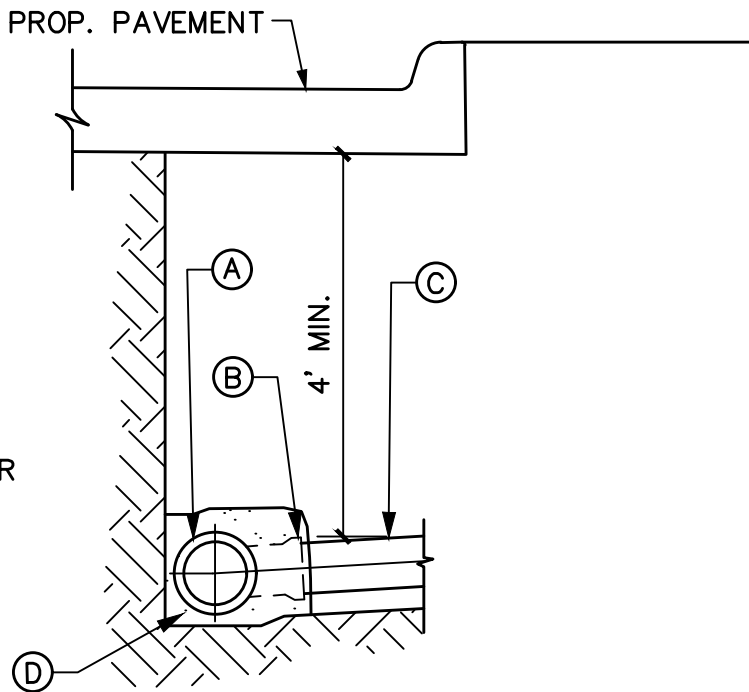
S13



PLAN VIEW

KEY:

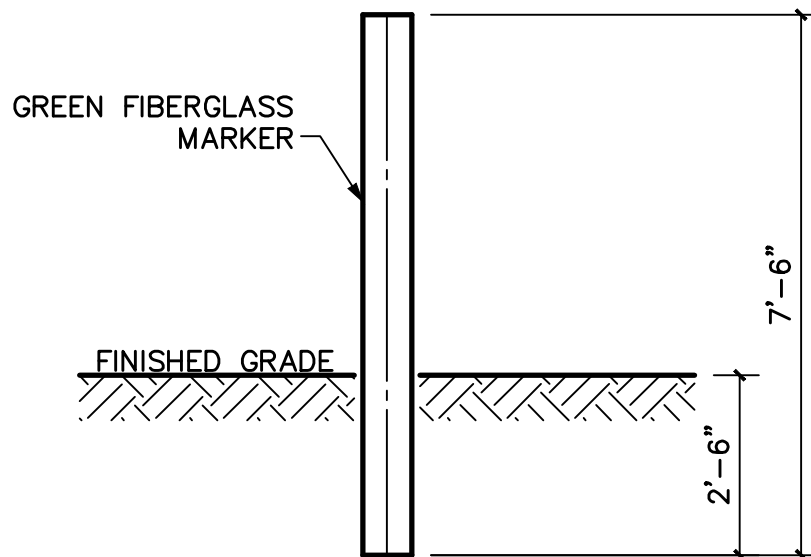
- Ⓐ WASTEWATER MAIN
- Ⓑ 4" WYE
- Ⓒ 4" WASTEWATER LAT. (LENGTH VARIES)
- Ⓓ CLASS B CONCRETE 2,000 PSI CONCRETE PER NCTCOG 702.2.4.2



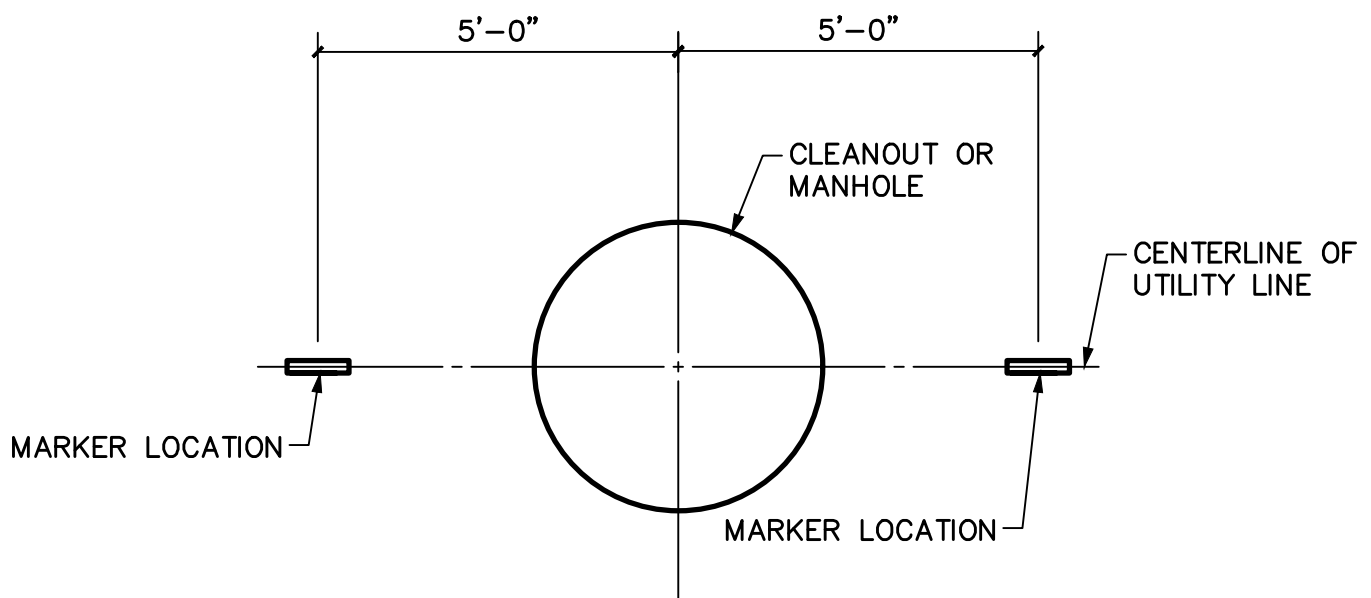
SECTION VIEW

NOTES:

1. THE CLEANOUT MAY BE PLACED IN THE PARKWAY OR SIDEWALK, IF NECESSARY.
2. REFERENCE TECHNICAL SPECIFICATION 333109.



ELEVATION



FIELD INSTALLATION DETAIL

NOTES:

1. ALL OFFSITE CITY OF FRISCO MAINS WITH CLEANOUTS AND MANHOLES SHALL BE MARKED AS DETAILED ON THIS SHEET.
2. THE OFFSITE SANITARY SEWER MARKER SHALL HAVE THE FOLLOWING WRITING: "CITY OF FRISCO SANITARY SEWER".



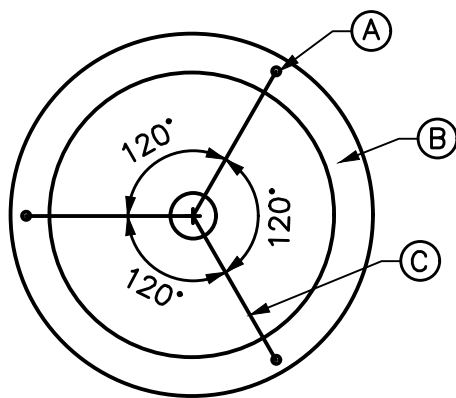
STANDARD CONSTRUCTION DETAIL

OFFSITE WASTEWATER MARKER

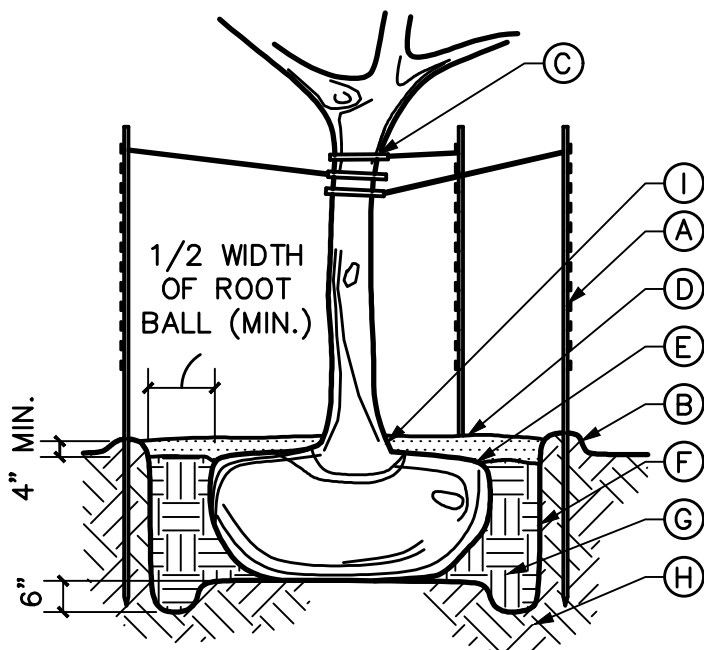
SCALE: 3/8"=1'

REVISED: AUG 2020

S15



PLAN



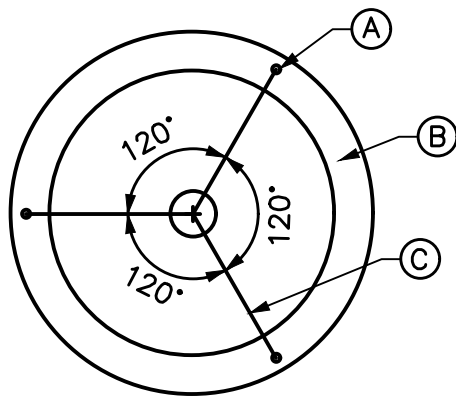
SECTION

LEGEND:

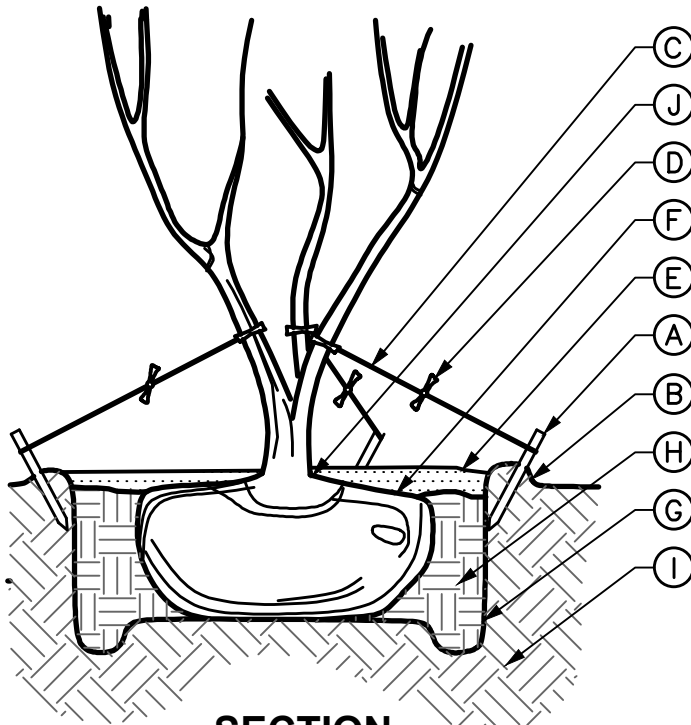
- (A) 2"x2"x8' STEEL POST
APPROVED STAKES, 3 PER
TREE, SPACED EQUALLY,
DRIVEN 2' INTO GROUND
- (B) 4" EARTH SAUCER (12" WIDE)
- (C) ArborTie PRODUCT BY DEEP
ROOT PARTNERS, L.P. OR
APPROVED EQUAL INSTALLED
PER CITY-APPROVED
MANUFACTURER'S
SPECIFICATIONS
- (D) 1" COMPOST & 3" CYPRESS
MULCH, KEEP 3-4" BACK FROM
ROOT FLARE.
(RE: TECH. SPEC. 329301)
- (E) ROOT BALL: REMOVE BURLAP,
BURLAP TIES, AND WIRE
BASKET FROM TOP 1/3 OF
ROOT BALL. REMOVE ALL NYLON
STRINGS, PLASTIC LINERS, AND
OTHER SYNTHETIC MATERIALS
FROM THE ENTIRE ROOT BALL.
- (F) PLANTING PIT SHALL BE
EXCAVATED TWO TIMES WIDTH
OF ROOT BALL. PIT DEPTH
SHALL BE AS NEEDED TO SET
ROOT BALL COLLAR AT
PROPOSED FINISHED GRADE.
PLACE ROOT BALL ON SOLID
SOIL AND NOT LOOSE BACKFILL.
- (G) PIT BACKFILL SOIL (RE: TECH.
SPEC. 329301)
- (H) UNDISTURBED EARTH
- (I) EXPOSE ROOT FLARE

NOTES:

1. EDGE OF ROOT BALL SHOULD BE 4' MIN. FROM WATER METER.
2. PLANT TREES AT LEAST 4' FROM OUTSIDE EDGE OF PIPELINE.
3. REFER TO TECHNICAL SPECIFICATION 329300.



PLAN



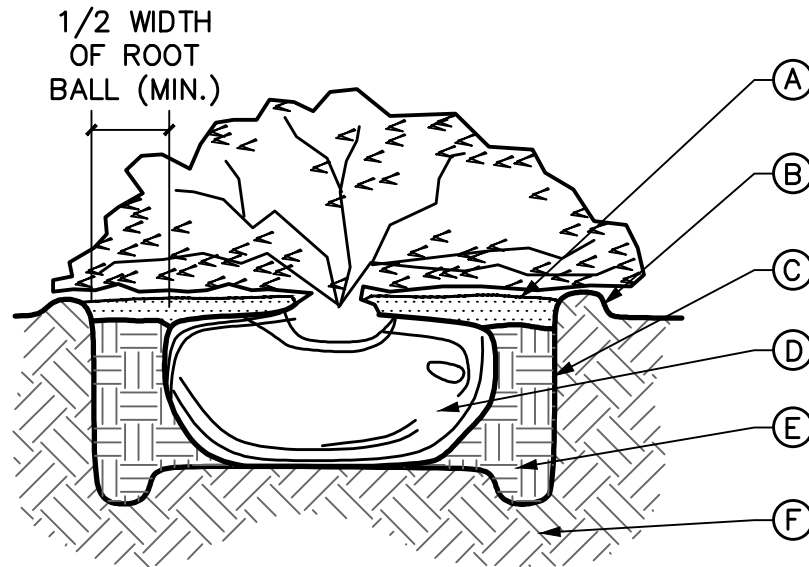
SECTION

LEGEND:

- (A) 2"x2"x24" WOOD STAKE, 3 PER TREE, SPACED EQUALLY
- (B) 4" EARTH SAUCER (12" WIDE)
- (C) ArborTie PRODUCT BY DEEP ROOT PARTNERS, L.P. OR APPROVED EQUAL INSTALLED PER CITY-APPROVED MANUFACTURER'S SPECIFICATIONS
- (D) WARNING FLAGS
- (E) 1" COMPOST & 3" CYPRESS MULCH, KEEP 3-4" BACK FROM ROOT.
(RE: TECH. SPEC. 329301)
- (F) ROOT BALL: REMOVE BURLAP, BURLAP TIES, AND WIRE BASKET FROM TOP 1/3 OF ROOT BALL. REMOVE ALL NYLON STRINGS, PLASTIC LINERS, AND OTHER SYNTHETIC MATERIALS FROM THE ENTIRE ROOT BALL.
- (G) PLANTING PIT SHALL BE EXCAVATED TWO TIMES WIDTH OF ROOT BALL. PIT DEPTH SHALL BE AS NEEDED TO SET ROOT BALL COLLAR AT PROPOSED FINISHED GRADE. PLACE ROOT BALL ON SOLID SOIL AND NOT LOOSE BACKFILL.
- (H) PIT BACKFILL SOIL (RE: TECH. SPEC. 329301)
- (I) UNDISTURBED EARTH
- (J) EXPOSE ROOT FLARE

NOTES:

1. EDGE OF ROOT BALL SHOULD BE 4' MIN. FROM WATER METER.
2. PLANT TREES AT LEAST 4' FROM OUTSIDE EDGE OF PIPELINE.
3. REFER TO TECHNICAL SPECIFICATION 329300.



LEGEND:

- (A) 1" COMPOST & 3" CYPRESS (RE: TECHNICAL SPECIFICATION 329301)
- (B) 4" EARTH SAUCER (12" WIDE)
- (C) PLANTING PIT SHALL BE EXCAVATED TWO TIMES WIDTH OF ROOT BALL. PIT DEPTH SHALL BE AS NEEDED TO SET ROOT BALL COLLAR AT PROPOSED FINISHED GRADE. PLACE ROOT BALL ON SOLID SOIL AND NOT LOOSE BACKFILL. SCARIFY SIDES OF PIT. PROVIDE CONTINUOUS PIT FOR MASS BED PLANTINGS.
- (D) ROOT BALL: REMOVE BURLAP, BURLAP TIES, AND WIRE BASKET FROM TOP 1/3 OF ROOT BALL. REMOVE ALL NYLON STRINGS, PLASTIC LINERS, AND OTHER SYNTHETIC MATERIALS FROM THE ENTIRE ROOT BALL.
- (E) PIT BACKFILL SOIL (RE: TECHNICAL SPECIFICATION 329301)
- (F) UNDISTURBED EARTH

NOTES:

1. PROVIDE STEEL EDGING WHERE BED MEETS LAWN (RE: DETAIL P07).
2. REFER TO TECHNICAL SPECIFICATION 329300.



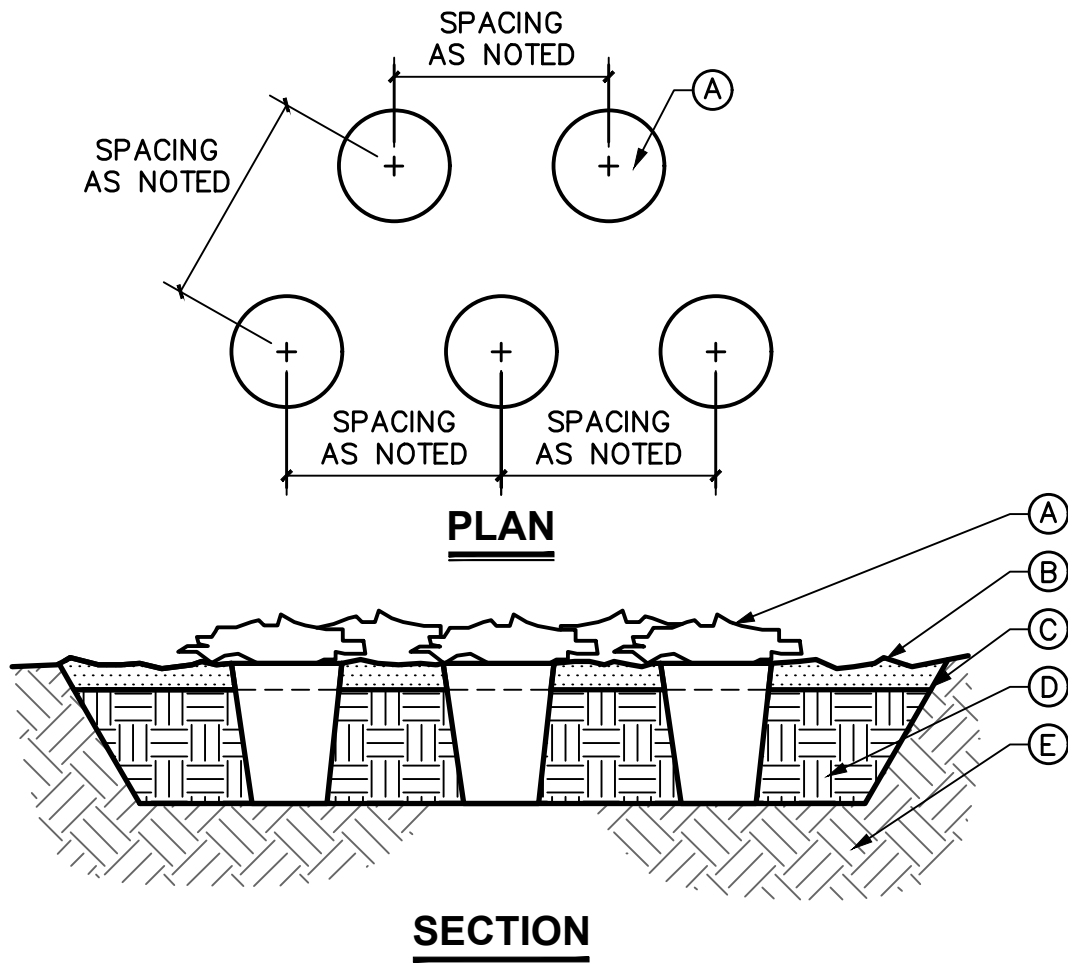
STANDARD CONSTRUCTION DETAIL

SHRUB PLANTING

SCALE: N.T.S.

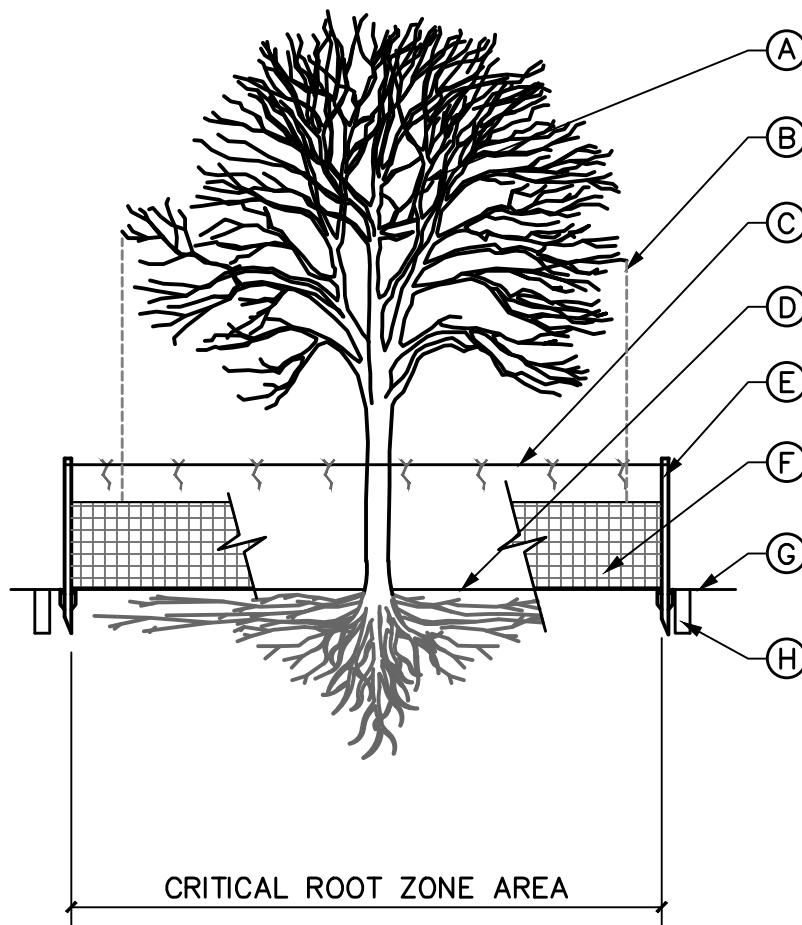
REVISED: AUG 2020

L03



LEGEND:

- (A) GROUNDCOVER PER PLAN (RE: TECHNICAL SPECIFICATION 329300)
- (B) 1" COMPOST & 3" CYPRESS MULCH (RE: TECHNICAL SPECIFICATION 329301)
- (C) STEEL EDGING WHERE BEDS MEET LAWN (RE: DETAIL L07)
- (D) PIT BACKFILL SOIL (RE: TECHNICAL SPECIFICATION 329301)
- (E) UNDISTURBED EARTH



LEGEND:

- (A) EXISTING TREE(S) TO REMAIN
- (B) DRIP LINE OF EXISTING TREE (TYP.)
- (C) CONTINUOUS NYLON TIE STRING TIED TO STAKE TOPS W/ 2' TUNDRA WEIGHT ORANGE STREAMERS AT 3' O.C.
- (D) EXISTING GRADE TO REMAIN
- (E) 2"x2"x8' STEEL POST T-STAKES, 8' O.C. MIN., DRIVEN 2' INTO GROUND AT (OR OUTSIDE) TREE DRIP LINE
- (F) 4' MIN HEIGHT ORANGE PLASTIC FENCING INSTALLED PER CITY-APPROVED MANUFACTURER'S SPECIFICATIONS
- (G) EXISTING GRADE TO BE DISTURBED
- (H) ROOT PRUNING TRENCH 12" OUTSIDE FENCE

NOTES:

1. PERFORM ROOT PRUNING ON ALL EXISTING TREES TO REMAIN WHERE CONSTRUCTION ACTIVITY FALLS WITHIN DRIP LINE OF EXISTING TREES.
2. NO GRADING, PARKING, STORAGE OR ANY OTHER CONSTRUCTION ACTIVITY WITHIN FENCED AREA.
3. REFER TO TECHNICAL SPECIFICATION 329600.
4. TREE PRUNING BY CERTIFIED TREE TRIMMER OR ARBORIST.



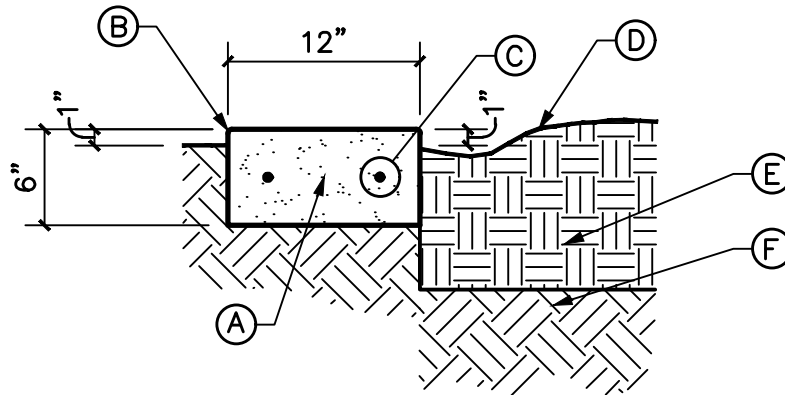
STANDARD CONSTRUCTION DETAIL

TREE PROTECTION

SCALE: N.T.S.

REVISED: AUG 2020

L05



LEGEND:

- (A) CLASS A CONCRETE (RE: TECHNICAL SPECIFICATION 321313) WITH SAWCUTS 1/8" TO 3/16" WIDE AND ONE-THIRD THE DEPTH OF THE ACTUAL THICKNESS AT 6' O.C. (MAXIMUM)
- (B) 1/2 " TOOLED RADIUS EDGE (TYP.)
- (C) 2 - #4 BAR CONTINUOUS
- (D) PLANTING BED OR SOD
- (E) PIT BACKFILL SOIL (RE: TECHNICAL SPECIFICATION 329301)
- (F) UNDISTURBED EARTH



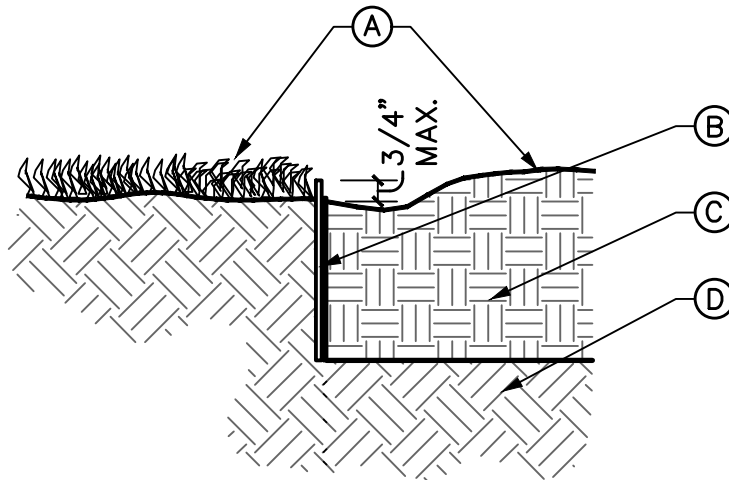
STANDARD CONSTRUCTION DETAIL

CONCRETE MOW STRIP

SCALE: 1"=1'-0"

REVISED: AUG 2020

L06



LEGEND:

- (A) DIFFERENT PLANTING TREATMENTS
- (B) STEEL EDGING WHERE BEDS MEET LAWN PER CITY-APPROVED MANUFACTURER'S INSTRUCTIONS
- (C) PIT BACKFILL SOIL (RE: TECHNICAL SPECIFICATION 329301)
- (D) UNDISTURBED EARTH



STANDARD CONSTRUCTION DETAIL

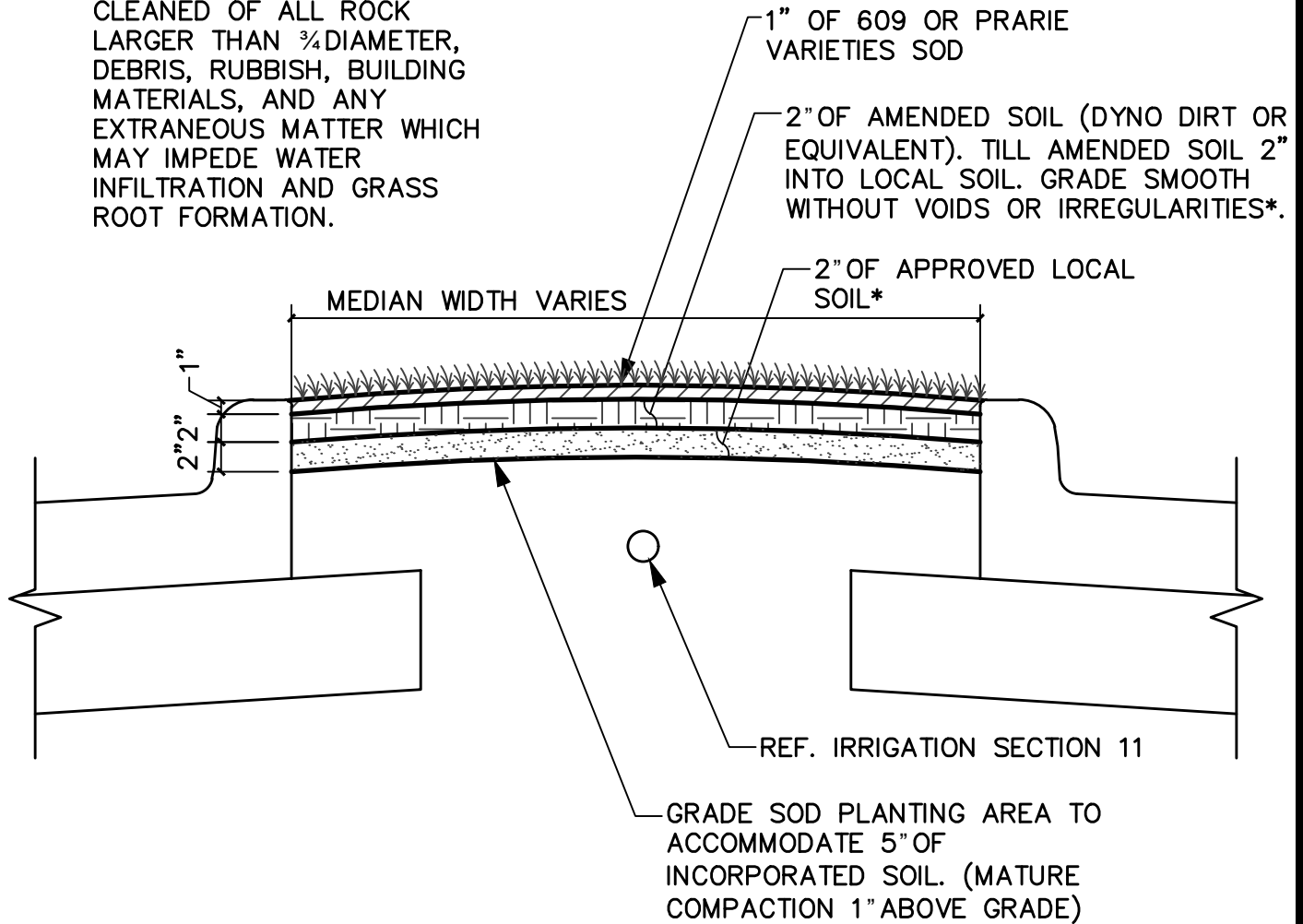
STEEL EDGING

SCALE: 1"=1'-0"

REVISED: AUG 2020

L07

* SUB-BASE SOIL SHALL BE CLEANED OF ALL ROCK LARGER THAN $\frac{3}{4}$ DIAMETER, DEBRIS, RUBBISH, BUILDING MATERIALS, AND ANY EXTRANEOUS MATTER WHICH MAY IMPEDE WATER INFILTRATION AND GRASS ROOT FORMATION.



NOTES:

1. GRADE MEDIAN TO PROVIDE POSITIVE DRAINAGE WITHIN MEDIAN WITH 2% MAXIMUM SLOPE.
2. PLANTING TIME IS MARCH TO SEPTEMBER.
3. PLANTING OCTOBER TO FEBRUARY SHALL BE ONLY ALLOWED WITH WRITTEN PERMISSION OF THE DIRECTOR OF ENGINEERING SERVICES.
4. SOD MUST BE KEPT MOIST. MANAGE SOD MOISTURE TO ENSURE ESTABLISHMENT.



STANDARD CONSTRUCTION DETAIL

MEDIAN GRASS PLANTING

SCALE: N.T.S.

REVISED: AUG 2020

L08

APPENDIX A

DEFINITIONS AND ABBREVIATIONS

Definitions

The definitions within this Section are intended to provide descriptions for words and terms used within the Engineering Standards. When words and terms are defined herein, and are also defined in other ordinance(s) of the City, they shall be read in harmony unless there exists an irreconcilable conflict, in which case the definition contained in this Section shall control for the Engineering Standards. Where no definition appears, then the term should be interpreted according to their customary usage in the practice of municipal planning and engineering. The City has the final determination of interpretation.

Words used in the present tense include the future; words in the singular number include the plural number, and words used in the plural number include the singular number. The word shall is mandatory and not directory. The word may is directory and not mandatory.

Approved, Accepted, Directed, Required, and Words of Like Import: Whenever they apply to the work or its performance, the words "directed," "accepted," "required," "permitted," "ordered," "designated," "established," "prescribed" and words of like shall imply the direction, requirement, permission, order, designation or prescription of the City; and "approved," "acceptable," "satisfactory" and words of like import shall mean approved by, acceptable to or satisfactory to the City.

Backfill: The term means the following (1) the placement of new dirt, fill, or other material to refill an Excavation; or (2) the return of excavated dirt, fill or other material to an Excavation.

City: The term City means the City of Frisco or its authorized representative(s).

Compaction: The term refers to consolidating material to prevent future settlement

Contract or Contract Documents: Contract documents are all of the written, printed, typed, drawn instruments, plans, and specifications that comprise and govern the performance of the contract between the Owner and the Contractor.

Contractor: The person, persons, partnership, firm, corporation, association or organization, or any combination thereof, as an independent contractor entering into the contract for the execution of the work, acting directly or through a duly authorized representative. Contractor does not refer to the City.

Development: Refers to the project being designed or constructed. (see also Subdivision Ordinance)

Director of Engineering Services: The Director of Engineering Services or their authorized representative. (see also Subdivision Ordinance)

Easement: A property right giving an entity other than the owner permission to use a property for a specific purpose stated in the easement document. (see also Subdivision Ordinance)

Emergency Operations: Those operations and repairs necessary to prevent damage or injury and to protect the health or safety of the public or any person and the work necessary to address or prevent an immediate service interruption. Upgrading of facilities, new service installation and neighborhood improvement projects are not emergency operations.

Engineer, Owner's Engineer, Design Engineer: The Engineer or its duly authorized representative means the Engineer of the Owner, who is the Engineer of Record of the Contract Documents.

Equal: Materials, articles or methods that are of equal or higher quality than those specified or shown on the drawings, as determined by the City's sole discretion.

Excavation: Excavation means any activity that removes or otherwise disturbs soil, pavement, driveways, curbs, or sidewalks in the right-of-way or an easement.

100-Year Floodplain: The flood having a one percent (1%) chance of being equaled or exceeded in any given year, based upon a fully developed watershed and the City's criteria to accommodate a 100-year storm in a Major Creek.

Owner: For the purposes of this manual, the term Owner refers to the entity that is financially responsible for developing and maintaining a particular site or project, either the City for public projects or the developer for private projects.

Plan or Plans: The plans are the drawings or reproductions therefrom made by or approved by the Owner showing in detail the location, dimension and position of the various elements of the project, including such profiles, typical cross-sections, layout diagrams, working drawings, preliminary drawings and such supplemental drawings as the Owner's Engineer may issue to clarify other drawings or for the purpose of showing changes in the work hereinafter authorized by the Owner.

Private Facilities or Improvements: Any improvements on private property where a public entity (i.e. the City) is not considered the Owner.

Public Facilities or Improvements: Public facilities and/or improvements include streets (including streetlights, street signs, signals and pavement markings), storm drainage systems, water lines, sanitary sewer lines, pedestrian improvements, or other similar improvements constructed within public right-of-way or easements. Typically, the City maintains public improvements after expiration of any applicable maintenance bonds.

Private Fire Service Main: Pipe and its appurtenances on private property beyond the meter supplying water for fire protection facilities such as automatic sprinkler systems

Private Water Line: Pipe and its appurtenances beyond the meter supplying potable water on private property.

Right of Way or Public Right of Way (ROW): A use of land dedicated by plat or metes and bounds to and for use by the public, which is separate and distinct from the lots and parcel abutting it, and which is not included within the dimensions or areas of such lots or parcels. Generally describes an area used for the provision of streets and utilities. Unless otherwise specified, the term right-of-way shall refer to a public right-of-way.

Specifications or Technical Specifications: Document giving a detailed description of the quantitative and qualitative requirements for products, materials, and workmanship

Utility Easement: A water, wastewater, or reuse water easement granted to the City.

Abbreviations and Acronyms

Wherever the abbreviations defined herein occur in the Engineering Standards, the intent and meaning shall be as follows:

%	Percent
'	Foot or Feet
"	Inch or Inches
#, lbs	Pound or pounds
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
am, a.m.	Before noon
ANSI	American National Standards Institute
Asph.	Asphalt
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
APWA	American Public Works Association
AWS	American Welding Society
AWWA	American Water Works Association
B/L	Base Line
cc	Cubic Centimeter
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CI	Cast Iron
C/L	Center Line
cm	Centimeter
CO	Cleanout
Conc	Concrete
Cond	Conduit
Corr	Corrugated
Cu	Cubic
cy, CY, C.Y.	Cubic Yard
DES	Director of Engineering Services
DI	Ductile Iron
Dia	Diameter
Elev	Elevation
F	Fahrenheit
fps	Feet per second
ft	Foot or Feet
Gal	Gallon
g, gm	Gram
HDPE	High Density Polyethylene
HP	Horsepower
hr	Hour
ID	Inside Diameter
in	Inch or Inches
Kg or kg	Kilogram
kPa	Kilopascals
L	Liter
LDPE	Low Density Polyethylene

LF	Linear foot or feet
LL	Liquid Limit
LLDPE	Linear Low Density Polyethylene
LMDPE	Linear Medium Density Polyethylene
m	Meter
Max	Maximum
MH	Manhole
Min	Minimum or Minute
MJ	Mechanical Joint
mm	Millimeter
Mono	Monolithic
mph	Miles per hour
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
MPa	Megapascal
NACE	National Association of Corrosion Engineers
Nat'l	National
NCTCOG	North Central Texas Council of Governments
NEMA	National Electrical Manufacturers Association
No.	Number
NPT	National Pipe Thread
NRMCA	National Ready-mixed Concrete
NTTA	North Texas Tollway Authority
o.d., OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
oz	Ounce
PCC	Portland Cement Concrete
PI, P.I.	Plasticity Index
pm, p.m.	Afternoon
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
R	Radius
RAP	Recycled/Reclaimed Asphalt Pavement
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
Reinf	Reinforced or reinforcing
ROW	Right-of-Way
SS	Sanitary Sewer
Sec	Second
S.F. or sf	Square Foot
Sq	Square
SSPC	The Society for Protective Coatings [formerly Steel Structures Painting Council]
Std	Standard
Str	Strength
SWPPP, SW3P	Storm Water Pollution Prevention Plan
SY	Square Yard
TAC	Texas Administrative Code
Tex-###-X	Refer to TxDOT <i>Manual of Testing Procedures</i>
TCEQ	Texas Commission on Environmental Quality [formerly Texas Natural Resource Conservation Commission (TNRCC)]
TMUTCD	Texas Manual on Uniform Traffic Control Devices

TxDOT	Texas Department of Transportation
TxDOT Item #	Refer to 2004 TxDOT <i>Standard Specifications for Construction of Highways, Streets and Bridges</i>
UL	Underwriter's Laboratory
um,µm	Micrometers
US, U.S.	United States
USACE	United States Army Corps of Engineering
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
Vert	Vertical
Vol	Volume
Wt	Weight
WW	Wastewater
Yd	Yard