



ENGINEERING DESIGN MANUAL

April 21, 2023 - DRAFT



City of Midland
Engineering Services Department
300 N. Loraine
Midland, Texas 79701

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SECTION 1 INTRODUCTION

1.1 Title

- 1.1.1 These standards are hereby adopted as the Engineering Design Manual (Manual), Sections 1 – 11 and Appendices, which will be in full force and effect from and after the effective date of adoption of the Manual.

1.2 Purpose

- 1.2.1 The purpose of the Manual is to protect the health, safety, and welfare of the public by establishing standard engineering practices and minimum engineering criteria for the City of Midland (City), Texas and its Extraterritorial Jurisdiction (ETJ).

1.3 Interpretation

- 1.3.1 In the interpretation and application of the provisions of these regulations, it is the intention of the City that the principles, standards, and requirements provided herein will be the minimum requirements for the design of both public and municipal capital projects in the City and its ETJ. The Engineer of Record (Engineer) is expected to meet all city, county, state, and federal ordinances and regulations. The Manual contains City-specific criteria. Where other city, state, federal, or other jurisdiction regulations are more restrictive than the Manual, such other ordinances or regulations will govern.

- 1.3.2 The City has adopted various ordinances, master plans, policies, and documents which address requirements not explicitly included in the Manual, including, but not limited to, the following below. The Engineer is responsible for requesting additional City requirements, such as corridor-specific or planned development master plans, that may not be included in this list. The Engineer is responsible for understanding and complying with the City's various ordinances and master plans. In order to ensure that the Engineer has the City's latest ordinances and master plans, he/she is directed to the City's website to acquire the latest versions.

- A. City of Midland Standard Details
- B. City of Midland Standard Specifications
- C. Storm Drain Manual
- D. City of Midland Master Drainage Plan
- E. Northeast Feasibility Study
- F. Zoning Ordinance
- G. City of Midland Code of Ordinances
- H. Tall City Tomorrow Comprehensive Plan
- I. SMART Downtown Plan
- J. Thoroughfare Plan
- K. Compatible Land Use Zoning AOZ-4
- L. Flood Damage Prevention Code

- 1.3.3 Any work occurring in City public Right-of-Way (ROW) or Easements is required to comply with

all City standards and requirements, including all work by franchise owners in public ROW or Easements.

- 1.3.4 Any work occurring within Texas Department of Transportation (TxDOT) maintained roadways and/or ROW must comply with TxDOT requirements.
- 1.3.5 Any work occurring within railroad ROW must comply with the requirements set forth by the railroad company owner.
- 1.3.6 Any work occurring within navigable airspace must comply with the Federal Aviation Administration requirements.

1.4 Enforcement

1.4.1 The Manual is issued by the Engineering Services Department. The Engineering Services Director or designee is hereby authorized to enforce the provisions of the Manual. The standards and any updates will be available on the City's website.

1.4.2 The Manual will be in full force and effect immediately upon being filed with the City Secretary. All projects must comply with all of the requirements in this Manual. The Manual includes the various design criteria which are considered minimum requirements for the design of adequate public facilities within the City. The Engineer will bear the sole responsibility for meeting the Engineering Standard of Care for all aspects of the design and providing a design that is required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City's design and construction requirements.

1.4.3 Agency Jurisdiction:

1.4.3.A City of Midland (City) - The City has jurisdiction throughout the City of Midland's city limits and ETJ. Exceptions to this jurisdiction may exist in locations where other government or private entities have jurisdiction. Generally, the City's requirements will still apply in these locations so long as they meet or exceed the requirements of the primary jurisdiction entity.

1.4.3.B Texas Department of Transportation (TxDOT) - Most federal and state highways, and some arterials within the city limits, are owned by the State of Texas and operated by TxDOT, and thus fall under TxDOT jurisdiction. Highway service roads and access ramps also fall under TxDOT jurisdiction. All roadways operated by TxDOT are generically referred to as "state highways". As per the Municipal Maintenance Agreement between the City and TxDOT, the City has permitting authority for access on all state highways within the city limits. City staff is the primary contact for such access and works in coordination with TxDOT during the review and approval process. Maps identifying state highways are available on the City's website.

1.4.3.C Railroad Owner - All existing railroads and railroad ROW within the city limits as of October 1, 2023 are under the jurisdiction of the railroad owners. Any new railroad ROW, or new railroads extended beyond the existing railroad ROW, that are established after this date will be subject to the City of Midland's jurisdiction.

1.4.3.D Federal Aviation Authority (FAA) - All airports and landing pads fall under FAA jurisdiction.

1.4.3.E Private Easements/Infrastructure - Private ROW, easements, and infrastructure are

subject to City of Midland jurisdiction at City owned public ROW, easements, and infrastructure unless the private ROW, easement, or infrastructure was established prior to the City's public ROW, easement, or infrastructure coming into existence. If the private ROW, easement, or infrastructure predates the City's establishment of a public ROW, easement, or infrastructure, then the private ROW, easement, or infrastructure owner has jurisdiction

1.5 Amendment

- 1.5.1 The City may amend the Manual at any time without advanced notice. In order to ensure that the Engineer has the City's latest design standards, he/she is directed to the City's website to acquire the most current Manual. The Manual will include a Record of Revisions to identify any revisions.
- 1.5.2 A formal request to modify current design criteria or add new design criteria may be submitted in writing to the Engineering Services Director or designee for consideration. All revisions to the Manual will require approval by the Mayor and City Council.

1.6 Variance Requests

- 1.6.1 The policies included in this Manual are the standard for all development within the City and its ETJ. Requests for variances to these standard policies will be evaluated case-by-case based on the specific circumstances of the project in question. Any variances requested must be submitted in writing and will be subject to review and approval or denial by the Engineering Services Director or designee, the Director of Development Services or designee, the Fire Code Official or designee, or the Director of Utilities or designee of the City, as appropriate. If a variance request is denied it may be appealed to the City Manager.
- 1.6.2 An Engineer who wishes to request a variance regarding the design of public facilities may do so as long as the request, if granted:
 - 1.6.2.A is not detrimental to the public welfare;
 - 1.6.2.B does not adversely impact the public facility in question;
 - 1.6.2.C is supported by a signed and sealed engineering analysis performed by a Professional Engineer licensed in the State of Texas; and,
 - 1.6.2.D is not based solely on financial interests.
- 1.6.3 All deviations from the requirements included in the Manual must be approved by the appropriate Director, Fire Code Official, or designee prior to implementation. A grant of an alternative material, design, or method of construction will not affect nor relieve the Engineer of the obligation and responsibility of such material, design, or method of construction for the intended purposes.
- 1.6.4 In the event that specific circumstances dictate requirements not already included in the Manual, it will be the responsibility of the Engineer to provide the additional information in writing for review as deemed necessary by the Engineering Services Director or designee.

1.7 Applicability

- 1.7.1 Improvements within the City will be in accordance with the Manual design requirements.
- 1.7.2 The Engineer will be responsible for the applicability of the information contained in the Manual

to the design of his/her project. The Engineer will also be responsible for the applicability and accuracy of the information furnished in his/her design. Acceptance by the City of the study or plans for construction will not be construed to relieve the Engineer of any responsibility.

1.7.3 The City regulates vehicular access to all public roadways and alleys within the City, including city streets, state highways, and federal interstates. Vehicular access includes connections to public roadways from other public roadways, private roadways, alleys, and all types of residential and commercial driveways. The City does not directly regulate access to private roadways, although other building, zoning or fire code issues may exist.

1.7.4 While efforts have been made to ensure that this Manual does not conflict with city codes, zoning regulations, subdivision policies, engineering design standards, or other city, county, or state planning and design regulations or documents, there may be occasions where discrepancies between these policies exist. In such cases, the more substantial and/or restrictive policy, standard, regulation, or code will govern.

1.8 Applicability in ETJ and Various Counties

1.8.1 Improvements within the City ETJ will be in accordance with the Manual and Midland County, Martin County, or Andrews County design requirements, based on the location of the improvements. Refer to the "Midland County Subdivision Regulations" for improvements specifically in Midland County. Refer to the "Andrews County, Texas Subdivision Regulations Approved by Commissioners Court" for improvements specifically in Andrews County.

1.8.2 Midland County requirements differing from the Manual will require County concurrence and/or a Memorandum of Understanding (MOU) between the City and the County prior to acceptance.

1.9 Definitions and Abbreviations

1.9.1 Refer to Appendix A – Definitions and Abbreviations for applicable definitions of terms and abbreviations for the Manual.

SECTION 2 GENERAL DESIGN REQUIREMENTS

2.1 *Accessibility Standards and Requirements*

- 2.1.1 All plans and specifications for construction will be in accordance with Texas Accessibility Standards (TAS), Americans with Disabilities Act (ADA), and Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) regulations. In the event that the accessibility standards conflict with each other, the more restrictive standards will govern.

2.2 *Survey Requirements*

- 2.2.1 *General* – The requirements provided herein will be minimum standards for projects involving a survey. All surveys will be tied to the City's Control Monuments.
- 2.2.2 *Markers* – Markers consisting of minimum 1/2" diameter steel or iron rods at least 24" long with caps identifying responsible surveying firm or Texas Registered Professional Land Surveyor (RPLS) number, will be placed at all:
- 2.2.2.A Property corners
 - 2.2.2.B Lot and block corners (wherever a lot line bearing changes)
 - 2.2.2.C Intersection points of alley and block lines
 - 2.2.2.D Curve and tangent points along block, lot, and ROW lines within the subdivision
 - 2.2.2.E ROW dedications
- 2.2.3 *Permanent Control Monuments* – All permanent control monuments are to be constructed in accordance with the City's Standard Details and Standard Specifications.
- 2.2.3.A All permanent control monuments must have elevations and locations that tie back into the City's control monument system.
 - 2.2.3.B Permanent control monuments are to be located in the public ROW for streets. Whenever possible, a permanent control monument is to be located at the corner of a street intersection.
 - 2.2.3.C A permanent control monument is required at all intersections between two streets that are both arterial or higher classification streets.
 - 2.2.3.D Developments larger than 10 acres that include one or more half-section locations are to set permanent control monuments at the street intersection closest to each half section location.
 - 2.2.3.E The final location of a permanent control monument must be approved by the Engineering Services Director or designee before it is installed.
- 2.2.4 *Resetting and Replacing Survey Markers and Control Monuments* – If construction activity alters, damages, or destroys an existing survey marker or control monument, then the survey marker or control monument must be reset or replaced to its original condition, location, and elevation by a licensed surveyor and be inspected by the City before it is accepted into the City's system.
- 2.2.5 *Final Acceptance* – A new permanent control monument must be inspected and have its construction, elevation, location, and identification information verified by the City before the

control monument will be approved as a new City of Midland permanent control monument.

- 2.2.6 All design submittals must include a note on the design drawings stating the horizontal and vertical datums used for the design and the survey zone the survey was shot in. All design submittals must also include all existing and proposed permanent control monument locations
- 2.2.7 *Plats* – Plats will be developed in accordance with the latest edition of the City Subdivision Code.

2.3 Submittal Requirements for Construction Plans and Drainage Analysis

- 2.3.1 The most current City standards, details, manuals, specifications, and testing requirements are the minimum standard for all development in the City.
- 2.3.2 A sketch, preliminary, or final plat must be included with any construction drawing set submittal before it will be approved by the City.
- 2.3.3 Every plan sheet in a construction drawing set for development or public infrastructure that is submitted to the City for acceptance must be sealed per the Texas Board of Professional Engineers & Land Surveyors. Existing condition, survey, and plat sheets that are part of the submitted construction drawing set may have an authorization note instead of the designer's seal but must have one or the other. Permits for standalone driveways or utility service taps that are not part of a larger development do not fall under this requirement.
- 2.3.4 Any construction drawing set for development or public infrastructure must have an approval stamp from the Engineering Services Department before any work may commence. Redevelopment that doesn't alter the impervious area or drainage conditions, or utility service taps that are not part of a larger development, do not fall under this requirement.
- 2.3.5 All public improvements installed by Developers have a minimum 1-year warranty period from the date of written acceptance by the City.
- 2.3.6 No public infrastructure is to be installed or accepted without being inspected by the Engineering Services Director or designee.
- 2.3.7 All project sites must initialize the stabilization process and show stabilization progress prior to receiving a Certificate of Occupancy or a Temporary Certificate of Occupancy.
- 2.3.8 Other submittal requirements for construction plans can be found within the City Plan Review Development Checklist. It is the responsibility of the Engineer to ensure that all construction plans submitted for review adhere to the current version of the City Checklist. The City reserves the right to specify additional requirements as necessary to facilitate the review.

2.4 Right-of-Way & Easements

- 2.4.1 *Slope easements* – The dedication of easements, in addition to dedicated ROW, will be required whenever, due to topography, additional width is necessary to provide adequate earth slopes. Such slopes will not be in excess of 4' horizontal to 1' vertical.
- 2.4.2 *Temporary Construction Easements* – Temporary construction easements are required for any planned construction activity that will take place on private property outside of the public ROW or a permanent easement. Temporary construction easements must be shown on all design drawing submittals and be secured before work on a development begins.

- 2.4.3 The Property Owner will be required to furnish all easements and ROW required to serve the development. Where reasonable, all public utilities should be located within street or alley ROW. Notwithstanding the above, Developers may offer easements outside of street and alley ROW. All utility facilities existing and proposed throughout the property will be shown on the preliminary plat and accompanying public improvement plans.
- 2.4.4 Easements will be provided for all public, franchise, or other private utilities.
- 2.4.5 All easements must be included on plats, including all public or private drainage easements.
- 2.4.6 All public easements must be labeled as "City of Midland Public Infrastructure Easement" on construction drawing sets, plats, easement dedications, or other legal documents.
- 2.4.7 Private utilities cannot be located in a City of Midland Public Infrastructure Easement. This does not apply to public ROW.
- 2.4.8 The required width of public water easements are to be based upon the depth of the public water mains. The minimum width of public water easements is 20', and if the water main is deeper than 10' at its invert then the minimum width of the public water main easement is to be 30'.
- 2.4.9 The required width of public wastewater easements are to be based upon the depth of the public wastewater mains. The minimum width of public wastewater easements is 20', and if the wastewater main is deeper than 10' at its flow line then the minimum width of the public wastewater easement is to be 30'.
- 2.4.10 The required width of public drainage easements for underground public storm drains are to be based upon the depth of the public storm drains. The minimum width of public drainage easements for underground storm drains is 20', and if the storm drain is deeper than 10' at its flow line then the minimum width of the public storm drain easement is to be 30'.
- 2.4.11 Public utilities are to be centered in public easements unless the public easement covers multiple public utilities, in which case public water mains are to be a minimum 5' from the nearest easement border and all other public utilities are to be a minimum 10' from the nearest easement border.
- 2.4.12 Joint public utility easements are to be at least 5' wider than the standard minimum width required for any individual public utility, or as wide as necessary to maintain all required utility separation distances, whichever results in the widest total easement width. An additional minimum 5' width is to be added for each additional public utility located within the same public utility easement.
- 2.4.13 All public easements will be wider when a need is determined by the Engineering Services Director or designee depending on the depth and size of the utility.
- 2.4.14 The width of franchise or other private utility easements are to be based upon the width determined by the franchise or other private utility Owner.
- 2.4.15 The full width of any easement located along the common line between lots will be provided on one side of the lot line.
- 2.4.16 Proper coordination will be established among the City, Property Owner, and applicable utility companies for the establishment of utility easements on adjoining properties.

2.5 Fees

A listing of the required fees is available on request.

2.6 Martin County Subdivision Regulations

A listing of regulations can be found on the Martin County website.

2.7 Midland County Subdivision Regulations

A listing of regulations can be found on the Midland County website.

2.7.1 Article I – Plats

2.7.2 Article II – Vacations

2.7.3 Article VI – Permits and Certifications

2.7.4 Article VII – Bonding Procedures

2.7.5 Article VIII – Authorization Procedures

2.7.6 Article IX – Lots

2.7.7 Article XI – Enforcement and Penalties

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SECTION 3 ROADWAY AND TRAFFIC DESIGN REQUIREMENTS

3.1 General

- 3.1.1 This Section includes the minimum design requirements and standards associated with the City's streets, alleys, and pedestrian facilities, including roadway geometry, traffic signals, street lighting, new development signage, pavement, and subgrade. Traffic Impact Analysis (TIA) requirements and procedures are also included in this section.
- 3.1.2 All street pavement, alley pavement, driveways, drainage improvements and structures, turnarounds, and sidewalks where applicable will conform to all construction standards and specifications contained or referenced in these regulations and will be incorporated into the development and construction plans required for plat approval.
- 3.1.3 *Roadway and Traffic System Design* – All elements of roadway, traffic, drainage, driveway, and ADA systems and infrastructure must be designed and constructed in compliance with the City's Thoroughfare Plan, Storm Drain Manual, Standard Details, and Standard Specifications. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 3.1.4 *Obligations of Subdividers and City Participation* – The obligation of a subdivider to improve the ROW for all streets, alleys and thoroughfares serving a development is subject to the following policies:
- 3.1.4.A When the proposed subdivision abuts or will abut one or both sides of a substandard street, or where a street does not exist but is identified as a proposed street on the City's Thoroughfare Plan, or is required to serve the subdivision according to the standards specified in this Section, the subdivider will be required to improve the substandard street or proposed street or alley to meet the standards set forth in Section 3.8 (Pavement and Subgrade). Where the width of available ROW, including ROW that the Developer is responsible to dedicate as specified in **Section 3.2.1 (Functional Classification)**, is not sufficient for the full pavement width required, the Developer is responsible for whatever lesser pavement width that the City determines practical within the limitation of the ROW.

3.2 Street Design

- 3.2.1 Functional Classification
- 3.2.1.A *General* – Proposed streets will provide a safe, convenient, and functional system for vehicular and pedestrian circulation and will be properly related to the City's Thoroughfare Plan, Comprehensive Plan and any amendments thereto, and must be appropriate for the particular traffic characteristics of each proposed subdivision or development as well as the overall area of service. In order to provide for streets of suitable location, width and improvement to accommodate prospective traffic and afford satisfactory access to police, firefighting, sanitation, and street maintenance equipment, and to coordinate streets so as to comprise a convenient system and avoid undue hardships to adjoining properties, an adequate street and thoroughfare system within and abutting the subdivision and providing access thereto must be designed and improved in accordance with the standards set forth in these regulations, together with those contained in the City's Thoroughfare Plan,

Comprehensive Plan, Standard Specifications, and the Standard Details as adopted or amended from time to time by the City. In the event of a conflict between the standards and regulations set forth in this Section and those contained in such documents, the more substantial and/or restrictive provisions must be applied. Access to the subdivision and to all lots therein must be suitably improved or secured in accordance with these regulations prior to final plat approval. The Developer must be responsible for the dedication and improvement of all such streets and thoroughfares, subject to participation by other Property Owners utilizing the facilities and subject to participate by the City, where funds are available, in accordance with these regulations. In circumstances where such participation is not feasible, the regulations herein stated must be considered minimum requirements of plat approval.

- 3.2.1.B *Regardless of the layout shown in the City's Thoroughfare Plan, the arrangement of streets must either:*
- 3.2.1.B.i Provide for the continuation or appropriate extension of existing streets in surrounding areas.
 - 3.2.1.B.ii Provide a new street for a subdivision that is not in the Thoroughfare Plan or a continuation of an existing street.
 - 3.2.1.B.iii Conform to a plan for the neighborhood approved or adopted by the City to meet a particular situation where topographic conditions, or other conditions make continuance or conformity to existing streets impracticable.
- 3.2.1.C *Roadway Classification – **Table 3-1** summarizes the typical design criteria for the City's adopted Thoroughfare Plan classifications as well as alleys. Typical sections are depicted in the City's Standard Details. The roadway classifications and their respective roadway types are as follows:*
- 3.2.1.C.i Major Arterial
 - 3.2.1.C.ii Minor Arterial
 - 3.2.1.C.iii Major Collector
 - 3.2.1.C.iv Minor Collector
 - 3.2.1.C.v Local Street
- 3.2.1.D *Dedication of ROW – The Property Owner must provide all ROW required for existing or future streets, including perimeter streets, as shown on the City's Thoroughfare Plan and other applicable development plans approved by the Engineering Services Director or designee. Standard ROW widths for City streets are specifically set forth on the City's Standards Details. In the case of perimeter streets, the total required ROW for such streets must be provided with the exception of a perimeter arterial or collector street. With perimeter arterial and collector streets, a minimum of one-half the total ROW width must be dedicated; however, in some instances more than half will be required depending on the actual or proposed alignment of the street. Dedication of additional ROW beyond those widths specified in the City's Standard Details and Standard Specifications may be required at approaches to intersections,*

where right turn lanes are needed or, in other special circumstances, as designated by the Engineering Services Director or designee.

- 3.2.1.E *Perimeter Streets* – Where the proposed subdivision abuts an existing half street, the Property Owner will dedicate the ROW for the other half of the street. Where the proposed subdivision abuts a new street designated on the City’s *Thoroughfare Plan*, the Property Owner must dedicate the full ROW designated in the **Table 3-1**, except as provided otherwise in **Section 3.2.1.D (Dedication of ROW)**.
- 3.2.1.F *Access Roads* – Where a subdivision abuts or contains an arterial street, the Engineering Services Director or designee may require access roads, or other such treatment as may be necessary for adequate protection of residential property and to afford separation of through and local traffic.

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Table 3-1. Typical Roadway Design Criteria

| Criteria ¹ | Classification ⁹ | | | | | | | | |
|--|-----------------------------|--------------------|--------------------|--------------------|--------------------------|----------------------|----------------------|-------------------|-------------------|
| | Major Arterial | | Minor Arterial | | Major Collector | | Minor Collector | Local | Alley |
| ROW Width | 150' | | 120' | | 100' | 100' | 65' | 60' | 20' |
| Paving Width (B-B) | 2x44' | | 2x32' | | 77' | 2x31' | 47' | 41' | 20' |
| Thru Lane Width | 2x12' ² | 1x13' ² | 1x12' ² | 1x13' ² | 12'/13'/14' ³ | 11'/13' ⁴ | 11'/12' ⁵ | 20' | N/A |
| Preferred Parkway Width | 19' | | 21' | | 12' | | 9.5' | 10' | N/A |
| Minimum Horizontal Inside Radius | 1,050' | | 1,050' | | 540' | | 540' | 210' | N/A |
| Minimum Tangent Between Curves | 100' | | 100' | | N/A | | N/A | N/A | N/A |
| Vertical Crest Curve (K) | 61 | | 61 | | N/A ¹⁰ | | N/A ¹⁰ | N/A ¹⁰ | N/A ¹⁰ |
| Vertical Sag Curve (K) | 79 | | 79 | | N/A ¹⁰ | | N/A ¹⁰ | N/A ¹⁰ | N/A ¹⁰ |
| Design Vehicle ⁶ | WB-67 Truck/Trailer | | | | Fire Truck ⁷ | | | | |
| <p>1. Design parameters will be based on AASHTO's current edition of <i>A Policy on Geometric Design of Highways and Streets</i>.</p> <p>2. 12' for outside lanes, 13' for inside lanes.</p> <p>3. 12' for outside lanes, 13' for inside lanes, and one 14' two-way turn lane for flush median option.</p> <p>4. 11' for outside lanes, and 13' for inside lanes.</p> <p>5. 11' for outside lanes, and one 12' two-way turn lane.</p> <p>6. Design vehicle as it relates to functional classification of the roadway.</p> <p>7. Fire Truck design vehicle will be in accordance with direction from the Fire Marshal.</p> <p>9. Refer to City's <i>Standard Details</i> for Roadway Typical Sections. City's Standard Details have precedence over Table 3-1.</p> <p>10. Intersecting tangents with a maximum net grade change of 2% must be utilized.</p> | | | | | | | | | |

3.2.2 Horizontal Alignment

- 3.2.2.A Roadways must be typically placed in the center of ROW. The Engineering Services Director or designee may require a shift in the horizontal alignment due to the inclusion of significant obstructions, pedestrian elements, drainage elements, connections to existing streets or other public infrastructure.
- 3.2.2.B Horizontal curves must be designed according to AASHTO's current edition of *A Policy on Geometric Design of Highways and Streets* and for a travel speed not less than those specified in **Table 3-1**, without the need for super-elevation.
- 3.2.2.C A tangent at least 100' long must be introduced between reverse curves. When connecting street centerline tangents deflect from each other at any one point by more than ten degrees, they must be connected by a curve with a radius adequate to ensure a minimum sight distance specified in **Table 3-4**, and of such greater distance as the Engineering Services Director or designee must determine for arterial and collector streets.

3.2.3 Vertical Alignment

- 3.2.3.A *Grading and Improvement Plan* – Streets will be graded and improved in conformance with the City's Standard Details and Standard Specifications and must be approved as to the design and specifications by the Engineering Services Director or designee, in accordance with the construction plans required to be submitted prior to final plat or building permit approval, as applicable.
- 3.2.3.B *Topography and Arrangement* – Streets must be related appropriately to the topography. All streets must be arranged so that building sites are above the grades of the streets. Grades of streets must conform as closely as possible to the original topography. A combination of steep grades and curves must be avoided.
- 3.2.3.C *Gradient* – Streets and alleys must be designed with a minimum gradient of 0.2% and a maximum gradient of 10% unless otherwise approved by the Engineering Services Director or designee.
- 3.2.3.D *Vertical Curves for Arterials* – Vertical curves are only permissible for arterials and will be evaluated on a case-by-case basis. The acceptable length of crest and sag curves, as well as the adequate stopping site distance for the vertical curve alignment, must be in compliance with AASHTO's most current edition of *A Policy on Geometric Design of Highways and Streets*. The K values for crest and sag curves provided in **Table 3-1** are target values, not minimums, for streets with curbs. Arterials that do not utilize vertical curves must comply with the same vertical grade requirements as non-arterial streets..
- 3.2.3.E *Vertical Curves for Non-Arterials* – No vertical curves are permitted for public roads classified as collector or local streets, nor for any alleys. Designer must utilize a series of tangents whose net grade change sum between any two tangents does not exceed 2%.
- 3.2.3.F *Arterial to Arterial* – Intersections shall maintain a maximum slope of two percent (2%) a minimum distance of two hundred feet (200') upstream and downstream of the intersection.

3.2.3.G *Non-Arterial Roadway connections to Arterial Thoroughfares* – shall maintain a maximum slope of two percent (2%) a minimum distance of one hundred feet (100') upstream and downstream of the intersection.

3.2.4 Cross-Sectional Elements

3.2.4.A *Pavement Cross-Slopes* – All new streets will be normal crown with a 2% cross-slope. The cross-slope can vary where there is a transition into or out of a maximum 2% straight grade across the entire street width or street intersection. When super-elevation is approved by the Engineering Services Director or designee, the maximum allowable slope is 5%. Super-elevation must be designed in accordance with AASHTO's current edition of *A Policy on Geometric Design of Highways and Streets*.

3.2.4.B *Vertical Clearance* – No point within pavement surface area should have a vertical clearance less than 16.5' from any bridge, structure, and overhead utility. When a proposed bridge or other structures crosses a TxDOT roadway, all applicable TxDOT standards must be satisfied.

3.2.4.C *Clear Zone* – A clear zone must be provided for all streets in accordance with AASHTO's current edition of *Roadside Design Guide*. In general, a minimum clear zone of 4' must be provided from the face of curb on tangent sections and a minimum clear zone of 6' must be provided from the face of curb on curved sections. Where clear zone requirements cannot be met on Major Collectors and Arterials, the Engineer must first seek to remove the obstruction, if removal is not an option, then the Engineer must seek to relocate the obstruction. All other circumstances require approval by the Engineering Services Director or designee.

3.2.4.D *Lateral Offset* – When obstructions exist behind curbs, a minimum lateral offset of 3' should be provided beyond the face of curb to the obstruction at intersections and driveway openings. A minimum lateral offset of 1.5' should be used elsewhere or in accordance with AASHTO's current edition of *Roadside Design Guide*.

3.2.4.E *Structures* – Private fences, walls, screening devices, and other structures must not be erected within the ROW or visibility triangle. Power poles and streetlights are excluded from this restriction provided they do not significantly interfere with driver sight distance. However, power poles and streetlights must not be erected within limits of pedestrian curb ramps.

3.2.5 Partial or Half-Streets

3.2.5.A Wherever a partial or half street has already been provided adjacent to a tract to be subdivided, the remaining width necessary to meet the minimum requirements for full ROW must be platted within such subdivision and the remaining street width must be built to City standards. If the existing street section does not meet City standards, that section must be re-built to meet minimum City standards.

3.2.6 Dead-End Streets/Cul-de-sac

3.2.6.A New streets longer than 150' in length must not dead-end without some means of traffic circulation. Properly designed cul-de-sacs are acceptable. Alleys are not an acceptable means of circulation for a dead-end street.

- 3.2.6.B Maximum length of a cul-de-sac street, measured from the mouth of the street approach to the end of the cul-de-sac pavement, must be:
 - 3.19.1.G.i 650' for single-family development
 - 3.19.1.G.ii 400' for all properties that are not single-family developments
- 3.2.6.C All cul-de-sacs must have a minimum paved surface (asphalt or concrete) diameter of 96' not including curbs. All cul-de-sacs must have a minimum public ROW diameter, measured from the center of the cul-de-sac, of 112', and must include a 5' wide franchise utility easement at the property line outside the public ROW. These requirements only apply to cul-de-sacs whose length exceeds 200', as measured from the mouth of the street approach to the end of the cul-de-sac pavement.
- 3.2.6.D Must not terminate at, or near, alleys at rear lot lines.
- 3.2.6.E Temporary turnarounds, conforming to the minimum radii requirements of **Section 3.2.6.C** above, are to be used at the end of a dead-end section of a street more than 200' long which will be extended in the future. (The following note must be provided on the final plat when a temporary turnaround is used: "Cross-hatched area is temporary easement for turnaround until street is extended by an accepted street dedication.")

3.2.7 Residential Streets

- 3.2.7.A *Residential Frontage* – Residential lots must conform to the City's Subdivision, Zoning Ordinance, and Storm Drain Manual as well as the City Council's plat approval requirements.
- 3.2.7.B *Knuckles* – Knuckles must follow the cul-de-sac radius criteria.

3.3 Intersections

- 3.3.1 *General* – Intersections must be designed to facilitate the safety, convenience, and efficiency of the motor vehicles, bicycles, and pedestrian traveling through them. The intersection of more than two streets at one point must be avoided except where it is otherwise impractical to secure an adequate street system, with approval of the Engineering Services Director or designee.
- 3.3.2 *Offset Streets* – Offset streets are to be avoided whenever possible and are not allowed between arterials. Any offset street must be approved by the Engineering Services Director first. When offset streets cannot be avoided due to unavoidable geographic constraints, offset distances must be greater than 130' between local streets or 270' between collector streets. Centerline distances between offset streets must be shown on preliminary plats.
- 3.3.3 *Grading Plan* – A separate grading plan must be provided for any intersection involving an arterial or collector. The grading plan must include profiles and/or spot elevations for each curb return, curb ramp, crosswalk, and valley gutter when valley gutters are required.
- 3.3.4 *Concrete Valley Gutters* – Concrete valley gutters are required at any intersection where runoff flows across one or more streets at the intersection. Concrete valley gutters are to be located at the street being crossed and convey the runoff flow across that street.

- 3.3.5 *Alignment* – Through lanes must line up across intersections with no offset. Offset streets or through lanes must be approved by Engineering Services or the designee.
- 3.3.6 *Angles* – Arterials must intersect at a 90-degree angle. For collector and local roadway intersections, a 90-degree angle is preferred but a skew of up to 10-degrees is allowable.
- 3.3.7 *Curb Returns* – All intersections require a curb return and radii in accordance with **Table 3-2**. Geometry for curb returns must be such that it results in positive drainage at all intersections.

Table 3-2. Curb Return Radius

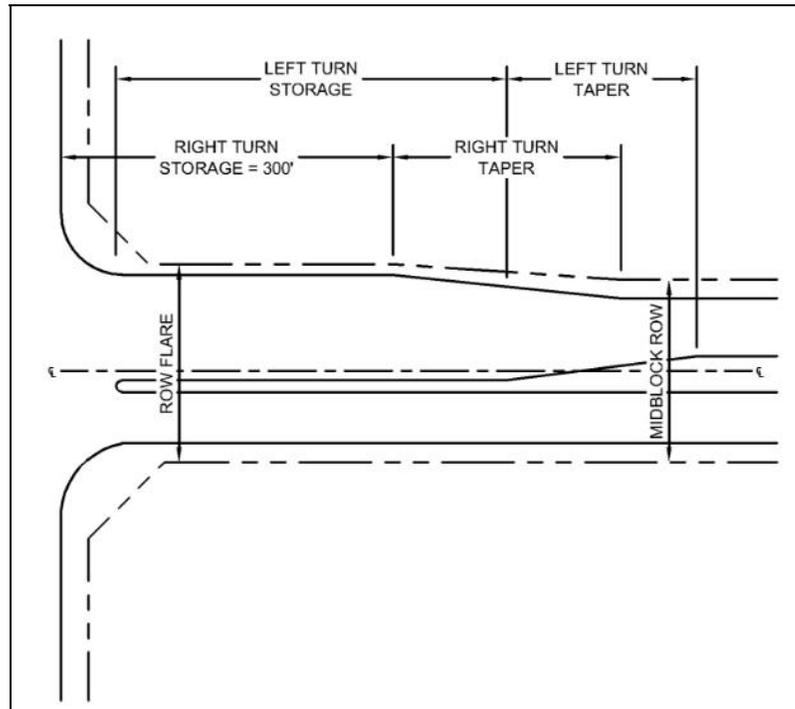
| Highest Classification | Intersecting With | Minimum Curb Return Radius (feet) |
|-------------------------------|-------------------|-----------------------------------|
| Arterial | Arterial | 30 |
| Arterial or Collector | Collector | 25 |
| Arterial, Collector, or Local | Local | 20 |

- 3.3.8 *Cross-Slope* – Street cross-slope must be transitioned to allow for a sloped plane across intersection.
- 3.3.9 *Crosswalks* – Accessible routes and pedestrian crossings must be provided in all four directions. The City’s preference is for crosswalks to pass through intersection prior to the start of the median nose. However, median refuge islands are acceptable. Refer to **Section 3.9 (Traffic Control)** for additional requirements.
- 3.3.10 *Pavement and Subgrade* – Refer to **Section 3.8 (Pavement and Subgrade)** for pavement and subgrade requirements at intersections.
- 3.3.11 *Sight Visibility* – Adequate sight distance are required at intersection. Refer to **Section 3.4 (Sight Visibility)**.
- 3.3.12 *ROW Flare at Intersections* – ROW flares at intersections must be required to accommodate left and right turn lanes for divided and undivided arterials. ROW tapers must occur with respect to left and right turn lane tapers and median widening (if applicable) as shown in **Table 3-3** and **Figure 3-1**.

Table 3-3. ROW Flares at Intersections

| Intersection Classification | ROW Flare at Intersection (feet) | Midblock ROW Required (feet) | Additional ROW Required Per Lane (feet) |
|---|----------------------------------|------------------------------|---|
| Arterial-Freeway or Arterial-Arterial | 150 | 120 | +12 |
| Arterial-Major Collector | 150 | 120 | +12 |
| 1. Other ROW widenings may be required as needed per the Engineering Services Director or designee. | | | |

Figure 3-1. ROW Flare at Intersection



3.4 Sight Visibility

- 3.4.1 The sight visibility 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 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 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 (Refer to **Table 3-4**) to its endpoint. To complete the sight line triangle, connect the endpoints of the first two lines as shown in **Figure 3-2** and in **Figure 3-3**. In the case of the sight line triangle to the right, the second imaginary line is parallel and 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 (Refer to **Table 3-4**) to its endpoint. Refer to **Figure 3-2** and **Figure 3-3**.
- 3.4.2 Distance to driver's eye for driveways that intersect a street is 15' from the intersecting curb line that is adjacent to the through lane as shown in **Figure 3-2** and in **Figure 3-3**.
- 3.4.3 In the case where the thoroughfare contains existing horizontal curvature, the distances L and R must be measured along the horizontal curve.
- 3.4.4 Types of sight obstructions are defined within City Code 10.1.10 - *Right-of-way landscaping and development regulations; sight triangles*.

Figure 3-2. Sight Line Triangle for Undivided Thoroughfare

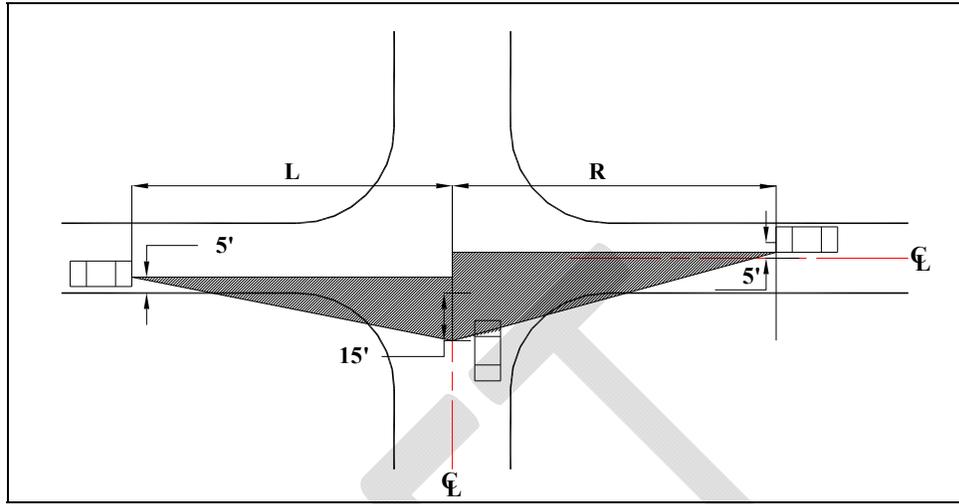


Figure 3-3. Sight Line Triangle for Divided Thoroughfare

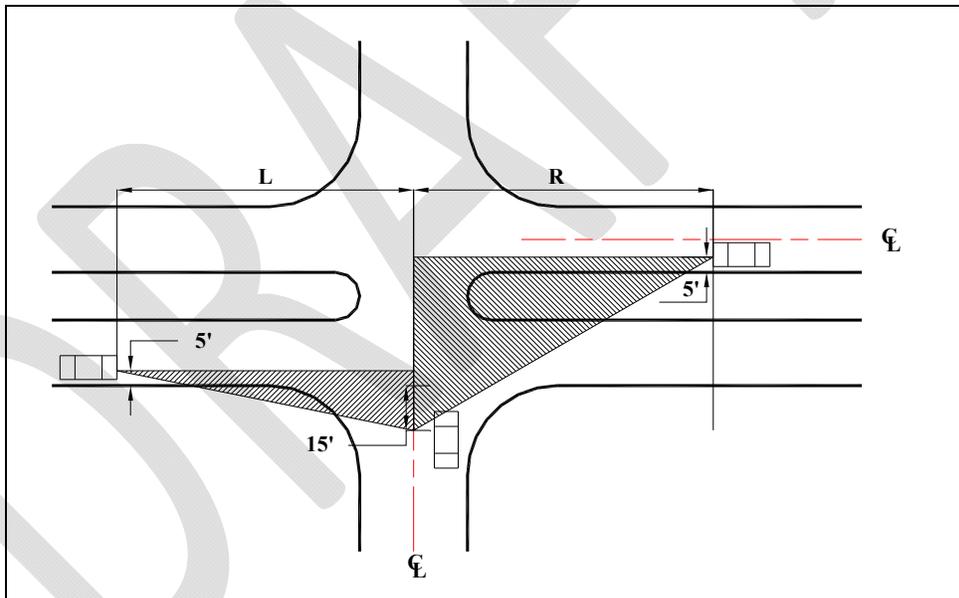


Table 3-4. Sight Visibility Triangle Dimensions¹

| Design Speed (or posted speed if design speed is unknown) V (MPH) ³ | Sight Distance by Lanes in Cross Section (ft) ² | | | |
|--|--|---------|---------|-----------------------------------|
| | Dimensions L and R (Where Left-Turns Are Allowed) | | | Dimension L (Right-Turns Only) |
| | 2 lanes | 4 lanes | 6 lanes | All Cross Sections |
| Alley | 225 | N/A | N/A | 195 |
| 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 |

Refer to AASHTO's *A Policy on Geometric Design of Highways and Streets* – Chapter 9 for speeds greater than 45 MPH.

(1) Source: *AASHTO's 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 Major Arterial)

(3) Roadway segments shall be designed with a consistent design speed from intersection to intersection. Midblock design speed changes are not permitted.

3.4.5 *Traffic Control Devices* – Any tree or landscape requirements in the Engineering Standards, the City's *Subdivision Ordinance*, *Zoning Ordinance*, or any other City ordinance will not interfere with the placement, visibility, or maintenance of traffic control devices, such as markers, signs, and signal devices, under governmental authority and control.

3.5 Corner Clips

3.5.1 *General* – Corner clips are ROW dedications that must be provided on all corners of an intersection between two streets or an intersection between an alley and a street, and on all alleys. The corner clip aids in streets' intersection visibility as well as provides sufficient room for sidewalks, barrier free ramps, utility appurtenances, and other street facilities. The ROW dedication for the corner clip does not necessarily include the sight visibility easement.

3.5.2 *Street Right-of-Way Corner Clip* – A corner clip shall be provided at each corner of all street intersections. The minimum length of the clip along each street's ROW line, starting at the offset distance from the intersection itself, must be a minimum of 30'x30' for arterial intersections and 20'x20' for all other intersections. The corner clip along each street must begin no closer to the intersection than the point of curvature of the curb or edge radius, so that the full parkway width is maintained. Plats may be subject to change after approval of the preliminary plat to conform to this provision and the approved street improvement plans.

3.5.3 *Alley Right-of-Way Corner Clip* - A corner clip shall be provided at each corner of all alley intersection with a street if the street ROW width at the alley intersection is less than 60'. The length of the clip along the street's ROW line, starting at the edge of the alley ROW, must be 5'x5'. Plats may be subject to change after approval of the preliminary plat to conform to this provision and the approved street improvement plans

3.6 Alleys

3.6.1 *General* – Alleys are at the discretion of the developer but must be designed and improved according to the City's *Standard Details* and *Standard Specifications*. Alley systems which will convey drainage that exceeds the local alley drainage area within the block will be required to meet standards and specification for drainage alleys. Refer to the City's *Standard Details* and *Standard Specifications* for additional requirements.

- 3.6.2 *Alignment* – Alleys shall be parallel to the property frontage on the street. Sudden changes in alignment are not allowed. Alley alignment must be consistent with economical design of utilities to be placed within such alley.
- 3.6.3 *Width* – The ROW of an alley must be 20' wide.
- 3.6.4 *Offset* – Where the deflection of alley alignment exceeds 30 degrees, a cutback of a minimum 15' shall be established on the inside property line.
- 3.6.5 *Dead-End Alleys* – Dead end alleys are not allowed. Variance requests will be reviewed on a case-by-case basis through the City's variance request process.
- 3.6.6 Where two alleys intersect, a cutoff or not less than 20' measured in both directions from the intersection point of the alley lines must be provided.
- 3.6.7 *Alley Length* – The maximum length of alleys between outlets may not exceed 600'.
- 3.6.8 *Obstruction* – All alley ROW shall be kept free and clear of unpermitted and unauthorized obstructions.
- 3.6.9 Alley to Street Intersections
 - 3.6.9.A *Intersection with Arterial Streets* – Residential and new development alleys are prohibited from intersecting with arterials. Commercial alleys are to avoid intersection with arterials if at all possible. When an alley must intersect with an arterial, said alley must end at another crossing alley.
 - 3.6.9.B Alleys which run parallel to a major arterial must turn away from the major arterial not less than one subdivision lot width or a minimum of 50' (whichever is greater) from the cross-street intersection.
- 3.6.10 *Access to Alleys* – For any residential lot final platted after June 30, 1994, or any commercial lot, an alley must not provide access to vehicle garages, carports, or parking areas or business loading areas unless it has been constructed with a paved surface, conforming to said standard specifications, to an appropriate point of access to the street system as determined by the Engineering Services Director or designee. Vehicular access to any alley, and any connecting alleys within the same block, from driveways or other parking places on adjoining lots or tracts platted pursuant to an application for final plat filed with the City after June 30, 1994, will be prohibited if either of the following conditions exists:
 - 3.6.10.A If the connected alley system exceeds 1,000' in length; or
 - 3.6.10.B If the connected alley system intersects an arterial street; and
 - 3.6.10.B.i Exceeds 480' adjacent to a SF-1 or lower density residential zoning districts.
 - 3.6.10.B.ii Exceeds 330' adjacent to any other districts or adjacent to an area outside the City.
 - 3.6.10.B.iii The following statement must be placed on applicable plats filed for approval after said date: "Lots abutting on the alleys as indicated herein (by cross-hatching) must not have direct automobile or truck access to said alleys."

3.7 Access Management

3.7.1 General

3.7.1.A *Purpose* – This Section is intended to manage vehicular access to the public roadway network from land in the City in a manner that provides reasonable access for residents and business owners, while also preserving the mobility, safety and capacity of the roadway network. These are based on past city ordinances, as well as state and national engineering standards and access management guidelines.

3.7.1.B *Applicability* – All new development must comply to the access management requirements of this Section. Non-conforming properties must be brought into compliance to the maximum extent possible in the following cases:

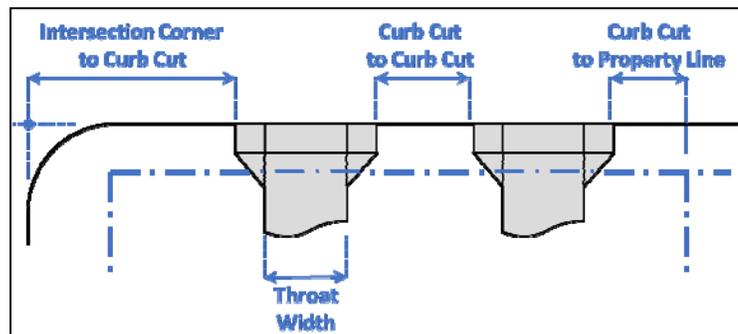
- 3.7.1.B.i When the roadway with the access connection is modified
- 3.7.1.B.ii When a plat or re-plat is required.
- 3.7.1.B.iii When a new development involving a change in use or occupancy from the previous use has the effect of increasing vehicular traffic to/from the site such that it is substantially greater than the traffic attributable to the immediately preceding use.
- 3.7.1.B.iv When the Engineering Services Director or designee has documented a traffic safety concern, including but not limited to speed, traffic volume, sight distance, and spacing, as related to the site access.

3.7.2 Residential

3.7.2.A *Residential Access (Single and Two-Family Lots)* – Residential access consists of driveways that serve single-family or two-family (duplex) dwellings. Other residential uses with three or more connected units, such as townhomes and apartments, are considered to be commercial for the purpose of this Section.

3.7.2.A.i *Residential Driveway Spacing Requirements* – Residential access spacing requirements are measured from the corner of an intersection to the nearest edge of the curb cut when measuring from an adjacent street intersection, or between the nearest edges of the curb cuts for adjacent alleys or driveways.

Figure 3-7. Residential Driveway Measurements



Direct vehicular access from a residential use to an arterial street or highway is prohibited, except as described in **Section 3.7.6.D**. Some neighborhoods may also have additional restrictions on access to other streets as described on their subdivision plat. Driveways must be located such that the spacing criteria in all three of the tables below are satisfied. **Table 3-7** below lists the minimum distance for curb cut placement from an adjacent intersection.

Table 3-7. Residential Driveway Curb Cut Distance from Intersection

| Intersection Type | Distance for Curb Cut Placement (from corner of intersection) |
|--|---|
| Arterial Street / Other Street | Not Allowed / 60' |
| Other Street / Other Street | 40' / 40' |
| Cul-de-sac ¹ / Other Street | 20' / 40' |

¹On blocks where cul-de-sac streets end and traffic from the cul-de-sac street is regulated at the intersection by a stop sign.

Table 3-8 below lists the minimum distance for curb cut placement from an adjacent property line.

Table 3-8. Residential Driveway Curb Cut Distance from Property Line

| Type of Property Line | Distance for Curb Cut Placement (from property line) |
|---|--|
| Property Line with Adjacent Parcel ¹ | 5' |
| Property Line with Alley ROW | 10' |

¹Unless a notarized letter signed by both Property Owners is submitted with the permit application and site plan documenting that both owners have no objection to the driveway placement, or a development plan for a group of residential properties is approved by the Planning and Zoning Commission or City Council.

In some cases, two adjacent lots are proposed to have driveways that are closer to their common property line than the distance needed to allow for construction of the necessary pedestrian ramps and landings between the driveways. In such cases, it is permissible for the nearest edge of the throat of each driveway to be located at 5' from the property line, and for the pedestrian ramps and landings to be omitted on that side. Therefore, each driveway still has a pedestrian ramp on the outside, but the section between the driveways consists of a continuous laydown curb and sidewalk, 10' in length, with no ramps needed. **Table 3-9** lists the minimum distance between curb cuts for multiple driveways along one street located on the same parcel, or on lots which are developed as one single- or two-family dwelling. This includes circle driveways and similar types of connected driveways, as well as multiple independent driveways serving one property. If multiple driveways

serving one property are to be located on different streets, then each street frontage is reviewed independently.

Table 3-9. Multiple Residential Driveway Curb Cut Spacing

| Minimum Distance between Curb Cuts | |
|--|---|
| For Multiple Driveways (serving the same parcel or dwelling) | 20' |
| For Driveways on Adjacent Parcels (serving separate parcels or dwellings) | None (Refer to Table 3-8) |

3.7.2.B *Residential Driveway Construction Details* – Residential driveways will be constructed in accordance with the City’s Standard Details and Standard Specifications. Driveways on streets with existing curb, or with new curb being constructed as part of the same project, will include pedestrian ramps on both sides of the driveway approach. Ramps are required regardless of whether sidewalk is existing or planned in order to accommodate future sidewalk construction. Driveways on streets with no existing curb, and no curb planned as part of the same project, may omit the pedestrian ramps and will include flares instead. Driveways on streets with mountable (or roll-over) curb do not typically need to include flares or pedestrian ramps. However, all other design and spacing standards still apply.

3.7.2.C *Residential Driveway Width* – The curb cut is measured as the distance between the outside edges of the vertical curb that must be removed to construct the driveway, including any required flares or pedestrian ramps. In most cases, the ramp length is 5’, so two ramps typically add 10’ to the length of the curb cut, and the remaining distance is the width of the throat. The minimum width of a residential driveway throat will be 10’. In order to allow for improved access to the larger multi-bay garages that are becoming more common in modern homes, the maximum width of a residential driveway is directly tied to the size of the garage it serves, if the garage faces the street that the driveway is on and is within 75’ of the curb. The throat of the driveway may not exceed the width described in [Table 3-10](#) below. These values are calculated as 12’ per garage bay, plus an additional 12’ for an adjacent parking pad when the garage has four or fewer bays. So, the maximum widths range from 24’ to 60’.

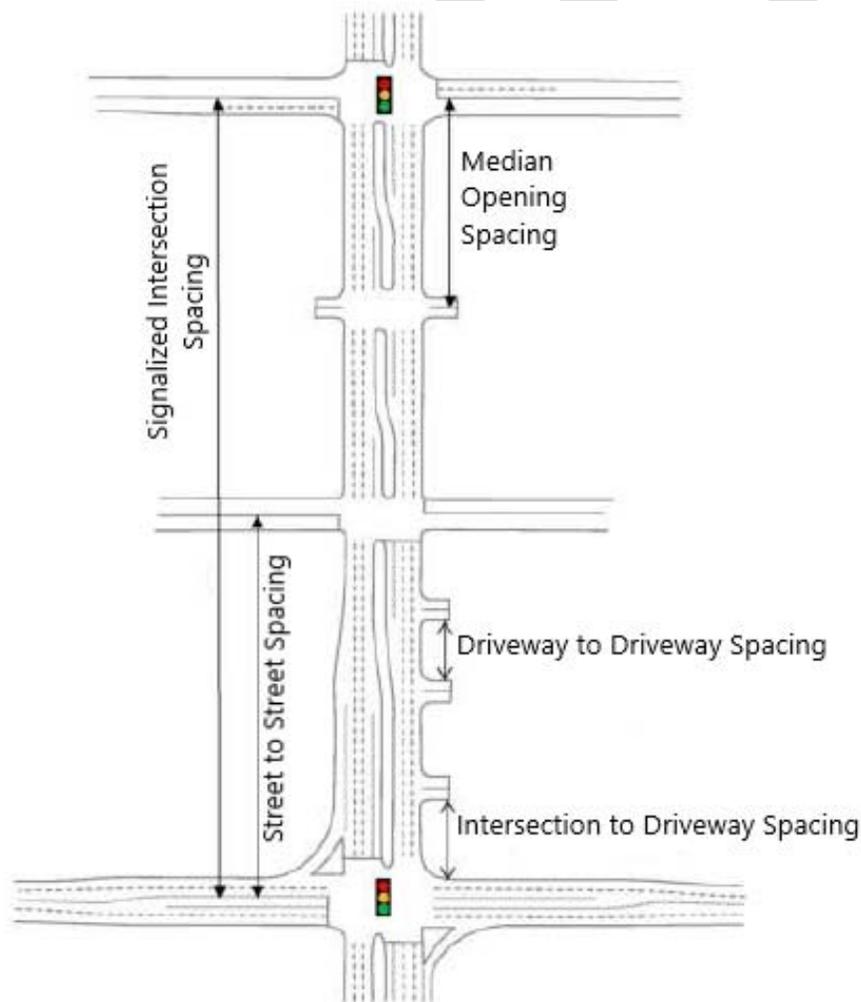
Table 3-10. Residential Driveway Throat Width

| Number of Garage Bays | Maximum Driveway Throat Width |
|-----------------------|-------------------------------|
| No Garage | 24’ |
| 1 bay | 24’ |
| 2 bays | 36’ |
| 3 bays | 48’ |
| 4 or more bays | 60’ |

3.7.3 Commercial

- 3.7.3.A *Commercial Access* – Commercial access consists of all vehicular access connections except those described as residential (single- or two-family dwellings). This includes all other forms of driveways, as well as alleys, private streets, and public streets.
- 3.7.3.B *Commercial Access Spacing Requirements* – Access spacing requirements are measured as shown in **Figure 3-7**. Spacing related to driveways is measured from the nearest edge of the throat of the driveway to the nearest edge of the throat of the adjacent driveway, or to the curb or edge of pavement of the adjacent roadway. Spacing between public roadway access, signalized intersections, or median openings, is measured between the centerlines. For commercial access, measurements are made from the projected extension of the curb or edge of pavement.

Figure 3-7. Spacing Requirement Measurements



New driveways, streets, median openings, or traffic signals must be located such that the spacing criteria described in **Table 3-11** below are satisfied. Alleys are treated as driveways for the purpose of this Section.

A roundabout intersection will generally be treated the same as a standard intersection as per **Table 3-11**, but such cases must be carefully assessed due to the unique geometric design features associated with approaches to roundabouts. Higher driveway spacing values may be required in these cases, as determined by the Engineering Services Director or designee.

Table 3-11. Minimum Street and Access Spacing

| Street Type | Typical Speed Limit (mph) | Typical No. of Travel Lanes | Driveway to Driveway Spacing | Intersection to Driveway Spacing | Signalized Intersection Spacing | Street to Street Spacing | Median Opening Spacing |
|-------------------------------------|---------------------------|-----------------------------|---|----------------------------------|-----------------------------------|--------------------------|----------------------------|
| Freeway Service Road | 45-55 | 2 to 3 | Per the latest edition of TxDOT's <i>Access Management Manual</i> . | | | | |
| State Highway | 40-55 | 4 to 6 | Per the latest edition of TxDOT's <i>Access Management Manual</i> . | | | | |
| Arterial | 40-55 | 4 to 6 | 150' | 150' (typ.) 500' ¹ | 1,320' | 660' | 500' |
| Collector | 30-40 | 2 to 4 | 60' | 60' | Refer to Note ² | 270' | Refer to Note ¹ |
| Local | 25-30 | 2 | 40' | 60' | Refer to Note ¹ | 130' | Refer to Note ¹ |
| Limited Access Parkway ³ | 45-50 | 4 to 6 | 425' | 425' | Pre-determined at roadway design. | | |

¹ NOTE: These situations occur infrequently and shall be designed on a project-specific basis.

² NOTE: New development of full access driveways or street intersections will not be permitted on arterials within 500' of a freeway service road intersection unless it is determined by the Engineering Services Director or designee that no other reasonable access to the property is possible, including potential joint or cross access arrangements, and that the access does not create unreasonable safety or operational problems.

³ NOTE: Fairgrounds Rd north of Loop 250 is planned and designed as a Limited Access Parkway with special access management provisions.

In addition to the above requirements, commercial driveways must also be located at least 10' from the nearest property line with an adjacent parcel or alley ROW, as measured from the nearest edge of the curb cut. This requirement applies only to driveways that will exclusively serve one property and is waived if shared access is existing or planned and is documented with an easement.

- 3.7.3.C *Auxiliary Turn Lanes* – The construction of auxiliary lanes for left or right turns may be required for commercial access points in accordance with **Table 3-12** and **Table 3-13** below:

Table 3-12. Auxiliary Left-Turn Lane Requirements¹

| Road / Median Type | Left Turn Lane |
|----------------------------------|---|
| Any Road with Raised Median | Required if Left-Turn Permitted |
| Any Road with TWLTL ¹ | Existing / No Change Required |
| Local Street, Undivided | No Turn Lane Required |
| Collector Street, Undivided | No Turn Lane Required |
| Arterial, Undivided | Refer to Note ² |
| State Highway, Undivided | Per TxDOT <i>Roadway Design Manual</i> , Table 3-11 |

¹ Roadway Design Manual, Texas Department of Transportation, April 2018

² Two-way left turn lane

³ NOTE: Most arterials under the jurisdiction of the City have existing raised median or TWLTL. For locations that do not, the addition of a left turn lane may be required based on vehicle speeds, roadway volumes, and projected site traffic volumes, at the discretion of the Engineering Services Director or designee.

Table 3-13. Auxiliary Right-Turn Lane Requirements

| Road Type / Characteristics | Right Turn Lane |
|-------------------------------------|--|
| Local Street | No Turn Lane Required |
| Collector Street, ≤ 3 Travel Lanes | No Turn Lane Required |
| Collector Street, ≥ 4 Travel Lanes | Refer to Note ¹ |
| Arterial, Speed Limit ≤ 40 MPH | Refer to Note ¹ |
| Arterial, Speed Limit > 40 MPH | Required if Right Turn Volume > 60 veh/hr ² |
| State Highway, Speed Limit ≤ 45 MPH | Required if Right Turn Volume > 60 veh/hr ² |
| State Highway, Speed Limit > 45 MPH | Required if Right Turn Volume > 50 veh/hr |

¹ NOTE: Required only for very high traffic generating sites at the discretion of the Engineering Services Director or designee.

² NOTE: Requirement may be waived based on roadway geometry, density of other access points, vehicle speeds, roadway volumes, and projected site traffic volumes, at the discretion of the Engineering Services Director or designee.

3.7.3.D **Commercial Shared Access** – Shared Access refers to cases where adjacent properties with unrelated development share the use of one or more common access points. Such properties are typically under different ownership, but they could simply be individual businesses on separate parcels with a common Owner.

3.7.3.D.i There are two types of shared access most often seen in commercial development:

3.7.3.D.ii Joint Access refers to a single access point that is typically located on the common property line between two adjacent parcels. This access serves both parcels and usually requires a small easement on each parcel to ensure that neither Property Owner can obstruct the use of the common area needed for the joint access.

3.7.3.D.iii Cross Access refers to an access point that is located on one parcel but can be used by traffic related to another parcel by allowing that traffic to cross through all or part of the property using an internal private roadway or parking drive aisle.

- 3.7.3.E *Alternate Commercial Access Locations* – It should be noted that access management standards along major roadways are often applied more stringently to corner parcels, or to parcels that have frontage on other, lower classification roadway. The City’s goal is to allow reasonable access for business owners while balancing against the safety and operational needs of the roadway network. When direct frontage or cross access to a side street or backage road behind a property allows for site traffic to circulate to and from a business without the need for as much direct access on a major roadway, this is often the most reasonable compromise between the competing needs of the business owner and the travelling public. When selecting or designing commercial sites, Developers are strongly encouraged to look for opportunities for alternate access to lower classification roadways, which then allow their customers indirect access to the main roads in a safer manner.
- 3.7.3.F *Commercial Driveway Construction Details* – Commercial driveways will be constructed in accordance with the City’s Standard Details and Standard Specifications. Driveways on streets with existing curb, or with new curb being constructed as part of the same project, will include pedestrian ramps on both sides of the driveway approach. Ramps are required regardless of whether sidewalk is existing or planned in order to accommodate future sidewalk construction. Driveways on streets with no existing curb, and no curb planned as part of the same project, may omit the pedestrian ramps and will include flares instead. Driveways on streets with mountable (or roll-over) curb do not typically need to include flares or pedestrian ramps. However, all other design and spacing standards still apply.
- 3.7.3.G *Commercial Driveway Geometric Design*
- 3.7.3.G.i *Throat Width* – The throat width is typically measured between the ends of the curb radii on the side farthest from the roadway. If the driveway cross-section is continuously varying and there is no obvious uniform-width throat to measure, then it will be taken as the maximum width of the driveway where it crosses the ROW line. The width of the throat of a commercial driveway will be no less than 16’ and no greater than 45’. If the driveway is forecast to serve at least 50% large truck or bus traffic, then a maximum width of 60’ may be permitted at the discretion of the Engineering Services Director or designee.
- 3.7.3.G.ii *Median Divided Driveways* – The construction of a physical median between entering and exiting traffic on a driveway is permitted at the option of the Developer. If the median is less than 30’ wide, measured between outside curb faces or edges of pavement, then the entry/exit pair will be treated as one access point. For medians that are 30’ or wider, each side will be considered a separate access point for the purpose of this Section. If a median-divided driveway is used, the maximum width of the throat of each side will be no less than 16’ and no greater than 24’.
- 3.7.3.G.iii *Throat Length* – The throat length is measured as the distance from the roadway face-of-curb or edge of pavement on the exiting side of the

driveway to the projection of the interior curb or edge of pavement for the nearest drive aisle or parking space which conflicts with traffic on either side of the driveway. The minimum length of the throat of a commercial driveway will be as shown in **Table 3-14**, although longer throats are strongly encouraged whenever the site layout allows.

Table 3-14. Minimum Commercial Driveway Length

| Street Type | Minimum Driveway Throat Length |
|--|---|
| Local Street | 20' |
| Collector Street (posted speed limit of 35 MPH or less) | 30' |
| Collector Street (posted speed limit of 40 MPH or higher) | 50' |
| Arterial Street or State Highway | 50' |
| Any access directly served by a traffic signal (existing or planned) | As recommended by a traffic impact study (100' minimum) |

3.7.3.G.iv *Curb Radii* – The curb radii on a commercial driveway will be no less than 5' and no greater than 60', with the following recommendations:

- Curb radii less than 10' are discouraged except in cases of very small, low traffic sites.
- Curb radii greater than 30' are discouraged on local and collector streets.

3.7.3.H *Access Involving Traffic Signal* – Due to the unique issues associated with traffic signal operations, some special conditions apply to any access that proposes the new installation or modification of a traffic signal, as listed below. For the purpose of this Section, modification of an existing signal refers to operational changes that impact traffic capacity or delay, such as the addition of new movements or signal phases. Physical changes to the infrastructure are typically not considered to be modifications requiring study, although approved engineering plans will be required for the work. A traffic impact study must be prepared and submitted by a qualified professional engineer, licensed in Texas. For a new signal, the study must document that the location meets warrants as per the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). For signals that are either new or modified, the study must provide a capacity analysis to demonstrate that there will be no degradation in the Level of Service (LOS) in the peak hour periods below the existing LOS, or LOS 'C', whichever is lower. Such analysis must be provided for the subject intersection(s), the nearest adjacent intersection(s) along the major roadway, and any other intersections as determined necessary by the Engineering Services Director or designee. The study must also consider the effect of signal spacing on queuing and progression along coordinated corridors. For locations on state highways, the traffic impact study must also be approved by TxDOT. It will be the responsibility of the

Engineering Services Director or designee to coordinate with TxDOT and seek concurrence. For a new traffic signal to be approved, all approaches to the intersection must be constructed in accordance with either City or TxDOT standards for public streets. Typical commercial driveway approaches may not be signalized. Also, any approach to a proposed traffic signal must be designed to provide the minimum throat length and number of lanes as recommended by the traffic study. In no case, however, may an access be signalized that has less than 100' of throat or less than two approach lanes (typically a left-turn and thru/right).

3.7.3.1 *Drive-Thru / In-Vehicle Operations* – The City's Zoning Ordinance (Section 6, Table 7) states: "Site plans for all uses that will include drive-thru operations or in-vehicle services must be approved by the Traffic Engineer and the Engineering Services Director, or respective designees." Specific numbers of vehicles that must be accommodated in the queue prior to the service point are not identified in the ordinance. Prior to approval of any site plan for drive-thru or in-vehicle service type uses, including approval of the driveway access related to that use, it must be determined that the proposed design provides reasonable on-site vehicle queuing and circulation as compared to other similar uses in Midland or the surrounding region. It must also be determined that the site plan has been designed such that, if the anticipated queuing has been underestimated and the vehicle storage area overflows during peak periods, that such overflow will occur in the safest and least disruptive manner that is reasonably possible. This means that queue overflow will be contained within the site to the greatest extent possible, and if driveways to public roads are impacted, such impacts will be limited to local or minor collector streets only. Queue overflow onto arterials or state highways must be avoided at all times due to the significant safety and operational impacts associated with such occurrences. These determinations will be the responsibility of the Engineering Services Director or designee, as per the Zoning Ordinance.

3.7.4 Left Turn Lanes and Median Islands

3.7.4.A *Storage Length* – Left turn storage lengths must be sized to store the number of vehicles expected to queue in the lane during an average peak period. At a minimum, left turn storage length must meet the minimum dimensions shown in **Table 3-15** and **Table 3-16**. Additional length may be required based on traffic volumes or TIA storage requirements discussed in **Section 3.14 (Traffic Impact Analysis)**.

3.7.4.B *Taper Length* – Left turn lane tapers must be straight line tapers at least 200' in length as shown in **Table 3-15** and **Table 3-16**. Taper lengths that are less than 100' must be approved by the Engineering Services Director or designee.

3.7.4.C *Minimum Length of Median Islands and Associated Left Turn Lanes at Midblock Openings* – Median island, storage, and taper lengths must be as shown in **Figure 3-8** and **Table 3-15**.

Figure 3-8. Minimum Spacing Between Median Opening or Intersection for Divided Arterials

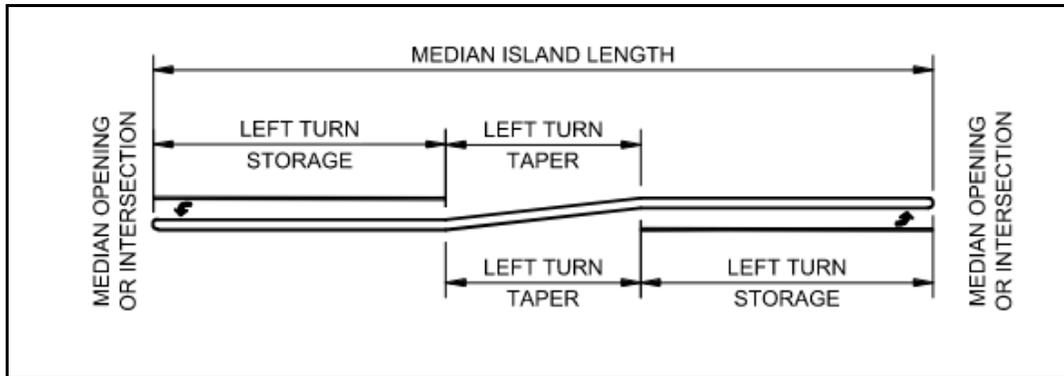


Table 3-15. Minimum Spacing Between Median Opening or Intersection for Divided Arterials

| Classification | Minimum Median Island Length | Left Turn Lane Lengths ¹ | | |
|----------------------|--|-------------------------------------|--------------|---------------------------|
| | | Upstream Storage (feet) | Taper (feet) | Downstream Storage (feet) |
| Arterial Single Left | Refer to Section 3.7 (Access Management) | 150 | 200 | 150 (100) |
| Arterial Dual Left | | 250 | 200 | 150 (100) |
| Major Arterial | | 150 | 100 | 150 |
| | | 150 | 100 | 100 |
| | | 100 | 100 | 100 |

1. Values in Table 3-15 are minimum requirements unless a volume study is conducted

3.7.4.D *Minimum Length of Left Turn Lanes for Undivided Arterials* – Turn lane storage and taper lengths must be as shown in **Table 3-16**.

Table 3-16. Minimum Left Turn Lane Lengths for Undivided Arterials

| Classification | Intersecting Classification | Left Turn Lane Lengths ¹ | |
|--------------------------|---|-------------------------------------|--------------|
| | | Storage (feet) | Taper (feet) |
| Major Arterial | Arterial | 200 | 100 |
| | Non-Residential Collector, Local, or Driveway | 150 | 100 |
| | Residential Local | 100 | 100 |
| Major or Minor Collector | Arterial | 150 | 100 |
| | Non-Residential Collector, Local, or Driveway | 100 | 100 |
| | Residential Local | 100 | 100 |

1. Values in Table 3-16 are minimum requirements unless a volume study is conducted.

3.7.5 Right Turn Lanes

3.7.5.A *Requirement* – Right turn lanes must be constructed to the same standard as the adjoining street. Right turn lanes must be provided at all intersections with arterials, and at all non-residential driveways where peak turning movement exceeds 100 vehicles per hour. Right turn lanes must be installed by the Owner along arterial streets, including freeway frontage roads, as follows:

3.7.5.A.i At all approaches to other arterial streets and at major driveways, all tracts which are subject to site plan review as provided herein, except when determined unnecessary by the Engineering Services Director or designee.

3.7.5.A.ii At all other street intersections when required by the Engineering Services Director or designee that would not require the loss of a necessary through lane to accommodate the right turn lane.

3.7.5.B Placement

3.7.5.B.i *Upstream Right Turn Lanes* – A minimum tangent section of 30’ must be provided between the preceding driveway or cross-street curb return and the taper of a right turn lane as shown in **Figure 3-9**.

3.7.5.B.ii *Downstream Right Turn Lanes* – Refer to **Section 3.7 (Access Management)** for corner clearance required at driveways.

3.7.5.B.iii *Continuous Right Turn Lanes* – Where several successive driveways require exclusive right turn lanes, and the driveway spacing is not adequate to avoid encroachment of the right turn lane on another driveway, a continuous right turn lane must be used.

- 3.7.5.C *Storage Measurement* – Right turn storage length must be measured from the end of the right turn taper to the point of curvature of the curb return radius into the driveway or intersection as shown in **Figure 3-9**.
- 3.7.5.D *Storage Length* – Right turn storage lengths must be sized to store the number of vehicles expected to queue in the lane during an average peak period. At a minimum, right turn storage length must meet the minimum dimensions shown in **Table 3-17**. Additional length may be required based on traffic volumes as determined by a traffic study or TIA storage requirements discussed in **Section 3.14**.
- 3.7.5.E *Width* – Right turn lanes widths are as follows:
 - 3.7.5.E.i 12’ in width on arterials
 - 3.7.5.E.ii 12’ in width on collectors with a flushed or raised median
 - 3.7.5.E.iii All other right turn lanes must be 11’ in width
- 3.7.5.F *Taper Length* – Right turn lane tapers must be straight line tapers and 100’ in length as shown in **Table 3-17**. Taper lengths that are less than 100’ must be approved by the Engineering Services Director or designee. A drop transition at the nearest driveway 100’ or more upstream from the start of the required right turn lane length is also acceptable.

Figure 3-9. Minimum Right Turn Lane Lengths

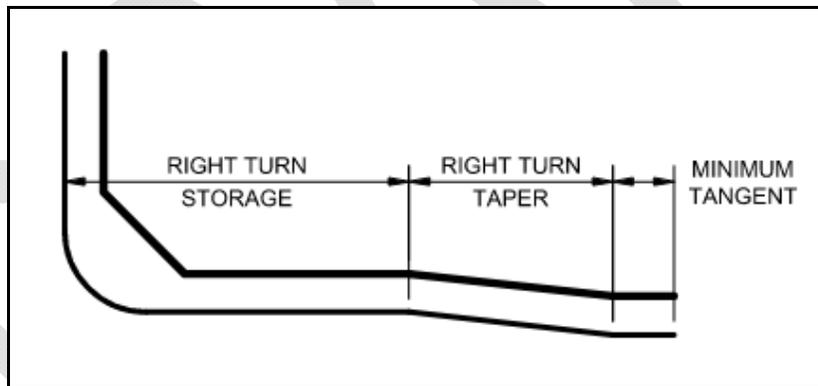


Table 3-17. Minimum Right Turn Lane Lengths

| Classification | Intersecting With | Right Turn Lane Lengths ¹ | |
|--|---|--------------------------------------|--------------|
| | | Storage (feet) | Taper (feet) |
| Major Arterial, Minor Arterial, or Collector | Arterial, Non-Residential Collector, Local, or Driveway | 150 | 100 |
| | Residential Local | 100 | 100 |

1. Values in Table 3-17 are minimum requirements unless a volume study is conducted.

3.7.6 Access Permitting Process

- 3.7.6.A *Approval Requirements* – Permitting by the City of Midland is required for all vehicular access regulated under this Section. Access approval is granted only for a specific site, with the specific scope and type of land use proposed when the permit application is submitted. If the land use for which access was previously approved is permanently closed, or if the site is abandoned, then the approval of access automatically terminates. Access points which have been abandoned shall be removed in accordance with City Code Section 9-4-8. If the scope or type of land use is substantively changed, or if the size or nature of the site layout changes significantly, then approval of access automatically terminates, and a new approval must be obtained. There are some cases where the existing access may be re-approved and may remain in place after a review of the new or modified land use. However, there is no assumed right to “grandfathering in” any existing access.
- 3.7.6.B *Pre-Development Review* – Formal access approval can be issued by the City only through the building or driveway permit process described below. However, the City encourages residents, business owners, and Developers to coordinate with city staff early in the site selection or design process to determine what will be acceptable for access, and to seek input on possible alternative access scenarios that may be considered.
- 3.7.6.C *Permitting Process* – Vehicular access to any public roadway under this Section is formally authorized only through the building or driveway permit process, administered by the Development Services Department. Building permit applications that include site plans, civil engineering plans, or similar drawings showing the details and dimensions of the proposed access also serve as the application for access approval. Following review, the approved building permit drawing set (displaying an Engineering Services Department approval stamp) serves as the City’s driveway permit. No separate permit document is issued. If no building permit application is needed for other site or civil work, then a standalone driveway permit application can also be made through Development Services. The approved driveway permit drawing(s) (displaying an Engineering Services Department approval stamp) serves as the City’s driveway permit. No separate permit document is issued.
- 3.7.6.D *Nonconforming Sites and Deviations from Standards* – The City of Midland encourages infill development and the redevelopment of older, dilapidated, or underutilized properties. In areas that are already substantially developed, it is often not possible to meet the minimum access spacing and other design requirements described in this Section in order to allow such infill or redevelopment activity. In such cases, the Engineering Services Director or designee will have the authority to approve specific cases that do not meet the minimum standards described herein, with the following conditions:
- 3.7.6.D.i No other reasonable access to the property is possible, including potential joint or cross access arrangements.
- 3.7.6.D.ii Any deviation approved below minimum design standards will be the minimum such deviation needed to allow for reasonable site access

because of the nonconforming conditions on neighboring properties and/or the existing roadway.

- 3.7.6.D.iii The access does not create unreasonable safety or operational problems as determined by the Engineering Services Director or designee.
- 3.7.6.D.iv Any deviations are approved only for that specific access point for that site and land use and should not be assumed to be acceptable in any other case.
- 3.7.6.D.v Any deviations below minimum standards on a state highway must have written concurrence from TxDOT prior to approval by the City. It will be the responsibility of the Engineering Services Director, or the designee, and the developer's engineer of record to coordinate with TxDOT staff to review the site issues and seek concurrence prior to issuing any approvals. If TxDOT staff and the Engineering Services Director or designee do not concur on the proposed deviation(s), access that fails to meet minimum standards will not be permitted.

3.7.7 *Appeals Process* – Refer to **Section 1 (Introduction)** for additional requirements.

3.8 Pavement and Subgrade

- 3.8.1 *General* – Refer to the City's Standard Details and Standard Specifications for minimum pavement and subgrade requirements for local roadways, collectors, arterials, alleys, driveways, and fire lanes.
- 3.8.2 "New pavement" is considered to be any pavement placed within the previous 8 years for roads classified as arterials, or within the previous 5 years for all other road classifications, alleys, or other paved public access. New pavement for streets or alleys cannot be cut for new developments, franchises, or utility taps, unless the Developer or franchise owner, repaves the entire street or alley for the full width of the street or alley and for the entire block where the cut is made. Where streets or alleys are concrete paved, the Developer or franchise owner, may remove and replace only the jointed sections of concrete pavement affected by the work if approval for this option is first obtained in writing from the Engineering Services Director or designee.
- 3.8.3 A vehicle access route must have an all-weather surface. All-weather surfaces are considered to be concrete or asphalt surfaces.
- 3.8.4 Extensions of existing concrete streets are to also utilize concrete pavement sections throughout unless a written variance is first obtained from the Engineering Services Director or designee. This requirement does not apply to streets that only have concrete intersections with asphalt pavement sections between the intersections.
- 3.8.5 Concrete transition slabs are to be used at the joints of all concrete and asphalt pavement sections on arterials or collector roadways, but are not required on local roadways or at valley gutters, fillets, curbs, or flumes.
- 3.8.6 *Street Improvements and Paving Standard* – After wastewater and water utilities have been installed by the Property Owner, all streets and thoroughfares will be improved and paved to the widths as shown on the typical sections in accordance with City standards or as approved

by the Engineering Services Director or designee. Streets (including sidewalks) which are intended for future extension across power lines, railroads, or similar rights-of-way must be constructed in the full ROW as required by the City's Thoroughfare Plan for half the distance across such ROW for each side.

3.9 Traffic Control

- 3.9.1 *General* – All permanent and temporary traffic control shall be in accordance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD) (latest edition as adopted by the Texas Department of Transportation and this section. General requirements for traffic control devices in the City are described in the following sections. Refer to the Approved Materials List and the City's Standard Details and Standard Specifications.
- 3.9.2 *Pavement Marking* – Pavement markings are to conform to the current standards in the Texas Manual on Uniform Traffic Control Devices (MUTCD) and TxDOT standards as applicable. Pavement markings are required per street classification in accordance with the City's Standard Details and Standard Specifications.
- 3.9.3 *Traffic Control Signs Requirements* – Traffic control and street name signs must be installed as needed in association with the construction or modification of public streets and are the responsibility of the City. This also includes traffic control and street name signs at the intersection of a private street with a public street if the intersection occurs within the public right-of-way and the private street has been platted and named. Traffic control and street name signs located along private roadways entirely outside of public right-of-way will be the responsibility of the Developer. Traffic control signs required specifically in association with public access to private driveways or parking lots will be the sole responsibility of the Developer.
- 3.9.3.A *Ornamental Signage* – Ornamental sign panels are not permitted, but standard traffic control and street name signs may be installed on ornamental supports with prior approval of the Engineering Services Director or designee. Standards for ornamental sign supports are determined on a case-by-case basis. All costs related to ornamental supports, including sign panel replacements when needed, will be the responsibility of the Developer. Ornamental signage that will be attached to existing utility poles must require prior approval from the electric provider. Refer to **Section 3.11 (Street and Roadway Lighting)**.
- 3.9.3.B *Engineering and Installation* – In order to remain uniform and consistent with design standards, materials and workmanship throughout the City, the Engineering Services Department must fabricate, locate, and install all traffic control signs for public streets within the City. The signs will be installed by the City when street construction has met final approval.
- 3.9.4 *Temporary Traffic Control*
- 3.9.4.A *General* – When any persons are working in public right-of-way in a manner that may, in any way, impact the safety or movements of pedestrian, bicycle, or motor vehicle traffic, or when the normal function of the roadway is suspended through closure of any portion of the ROW, temporary construction work zone traffic control devices must be installed to guide the motoring public through the area and protect

the work area. Consideration for roadway user safety, worker safety, and the efficiency of roadway user flow is an integral element of every traffic control zone.

3.9.4.B All temporary traffic control will be in general conformance with the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD) (latest edition as adopted by the Texas Department of Transportation), except as specifically directed by the, Engineering Services Director or designee.

3.9.4.C All temporary traffic control will be designed, installed, and maintained by competent and qualified personnel with adequate experience in traffic control.

3.10 Neighborhood Traffic Management

3.10.1 Refer to the City of Midland most current Neighborhood Traffic Management Program for additional design guidelines.

3.11 Street and Roadway Lighting

3.11.1 General

3.11.1.A This section includes street lighting and conduit system requirements for illumination on all roadway classifications. Continuous lighting is required on arterials. On collectors and residential local roadways, streetlights are installed at intersections, cul-de-sacs, and curves as specified in this section.

3.11.1.B *Streetlights* – Installation of streetlights must be in accordance with design and specification standards of the utility provider subject to City approval. The Developer must be responsible for the installation and cost of such street lighting. The Developer will be responsible for coordinating the procurement and installation of all streetlight-related infrastructure with the electric provider and for payment of all associated costs. Following construction and acceptance, the City will assume responsibility for the recurring operation costs owed to the electric provider for all streetlights located in public ROW.

3.11.1.C Street lighting must be inspected and approved by the electric provider prior to final acceptance of the construction of a roadway by City staff.

3.11.1.D *Spacing Measurement* – Streetlight spacing must be measured along the ROW from center of pole to center of pole and be inspected by the electric provider.

3.11.2 *Lighting Plan* - A lighting plan must be required for all new street lighting or street lighting modifications. The lighting plan must be reviewed and approved by the Engineering Services Director or designee prior to construction. At a minimum, the submittal must include the following:

3.11.2.A Plans indicating the location of the lighting, and the type of illuminating devices, fixtures, lamps, supports, reflectors, and other devices.

3.11.3 Continuous Arterial Lighting – Continuous arterial lighting must be provided based on the following standards:

3.11.3.A *Luminaires* – Luminaires must be as required by the utility provider subject to City approval.

3.11.3.B *Poles* – Poles must be as required by the utility provider subject to City approval.

- 3.11.3.C Spacing – Streetlights must be spaced as required by the utility provider subject to City approval.
- 3.11.3.D *Intersections* – At intersections with median openings, any pole installed in the median must be located 20’ from the median nose.
- 3.11.3.E *Orientation* – Orientation must alternate for the single luminaire (left to right) in the parkway along the arterial if there is no median present. For divided arterials, dual-arm light poles may be placed in the median with approval of the Engineering Services Director.
- 3.11.4 *Collector and Local Roadway Lighting* – Street lighting must be provided on collectors and residential local roadways based on the following standards:
 - 3.11.4.A *Luminaires* – Luminaires must be cobra head style with 150 W LED equivalent lamps. Streetlights must have a single luminaire.
 - 3.11.4.B *Poles* – Poles must be 25’ or 30’ tall round galvanized steel pole.
 - 3.11.4.C *Spacing* – Streetlights must be spaced no further apart than 700’ along tangent sections streets and must be placed along horizontal curves where the road centerline changes by 30-degree or more.
 - 3.11.4.D *Intersections* – Streetlights must be placed at all intersections.
 - 3.11.4.E *Cul-de-sac* – Must be placed at the end of all cul-de-sacs except if the cul-de-sac is less than 250’ from the streetlight at an intersection.
- 3.11.5 *Decorative Poles and Luminaires* – Decorative poles may be approved by the Engineering Services Director or designee.
- 3.11.6 *Exceptions* – The following are exempt from these requirements:
 - 3.11.6.A Temporary lighting approved in writing by the Engineering Services Director or designee and at the expense of the requesting party.
 - 3.11.6.B Lighting luminaires in existence on the effective date of these requirements must be exempt from these standards and must 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 must comply with these requirements.

3.12 Traffic Signals

- 3.12.1 General
 - 3.12.1.A All traffic signals must be designed in accordance with this Section.
 - 3.12.1.B *Warrant Criteria* – New traffic control signals are to be installed:
 - 3.12.1.B.i If one or more of the signal warrants are met in accordance with TMUTCD.
 - 3.12.1.B.ii If the signal will be warranted within the next two (2) to three (3) years. The satisfaction of a warrant or warrants is not in itself justification for a signal.

3.12.1.B.iii Refer to the Traffic Signal Design and Construction Guidelines for specific design requirements.

3.13 Conduit Systems

- 3.13.1 Conduit systems must be installed for future irrigation, traffic signals, communications, and arterial roadway lighting on designated roadway segments. Refer to the City's Standard Details and Standard Specifications for additional information.
- 3.13.2 Traffic signal conduit and ground boxes for future traffic signals must be installed at all arterial-arterial and arterial-major collector intersections when designated by the Engineering Services Director. Refer to the Traffic Signal Design and Construction Guidelines for specific conduit requirements.
- 3.13.3 Divided arterial roadways that are specifically designed by the City of Midland must be built with a conduit system in the median. The conduit system may be used for traffic signal communications, other city communications, and/or street lighting. The median conduit systems will consist of two each – 3” schedule 40 PVC conduits installed in accordance with the City's Standard Details and Standard Specifications.
- 3.13.4 Roadway lighting conduit systems may be required with the construction of new roadways. Engineer should consult with the electric provider and the Engineering Services Department prior to performing design of these systems.

3.14 Traffic Impact Analysis

- 3.14.1 General
 - 3.14.1.A This section includes the general requirements for the preparation of a TIA.
 - 3.14.1.B *Applicability* – A TIA report may be required as part of the approval process for zoning changes, development plan, agreement approvals, building permit applications, subdivision platting, or changes of occupancy. If the TIA indicates traffic volumes that will significantly impact the capacity and/or safety of the transportation network, it may be necessary to obtain ROW and/or construct off-site, abutting, and/or internal roadway facilities and traffic control improvements to support and mitigate the impacts of new development at the time of platting or development of the land.
 - 3.14.1.C *Preparation* – The TIA report must be prepared, signed, and sealed by a licensed Professional Engineer in the State of Texas trained and qualified to provide transportation planning, engineering, and preparation of similar analyses.
 - 3.14.1.D *Purpose* – The purpose of the TIA is to:
 - 3.14.1.D.i Identify the existing and future level of service (LOS) and ensure it is not degraded by the new development below LOS C, or one grade below the existing LOS, whichever is lower, along street segments and at intersections without recommended mitigation.
 - 3.14.1.D.ii Ensure that both development impacts on-site and off-site are mitigated through contributions and/or improvements of thoroughfare ROW.

3.14.1.D.iii Ensure that new development is not required to contribute more than their proportionate share of costs or construction of improvements and only contributes that which is necessary and attributable to the development.

3.14.2 Determining Traffic Impact Analysis Requirements

3.14.2.A *When Traffic Impact Analyses Are Required* – At the discretion of the Engineering Services Director or designee, a TIA may be required for any development proposal expected to generate traffic volumes that will significantly impact the capacity and/or safety of the transportation network. A TIA may also be required for a proposed development located near a sensitive area, a high accident location, or an area already suffering from congestion. Additionally, a queuing analysis must be required for sites such as schools or drive-through restaurants to demonstrate that the anticipated peak queuing will be accommodated on-site and not queued back onto public streets.

3.14.2.B *City Staff Review* – To determine if a TIA may be required, the Developer should present a proposed development project to the Engineering Services Director or designee for review at the pre-development meeting. The review should include information about the proposed land use or business type, location and conceptual site plan, proposed access locations, proposed traffic mitigation or improvements (if any), and any other information that the Developer determines to be relevant. Based on this information and discussion with the Developer, the Engineering Services Director will determine if submittal of a TIA is necessary.

3.14.2.C *Preliminary Trip Generation Assessment* – If the Engineering Services Director or designee requests submittal of a TIA, the Developer may, at his/her option and expense, conduct a preliminary trip generation assessment of the proposed development based on Institute of Transportation Engineers' (ITE) current edition of Trip Generation Manual. If the preliminary assessment indicates the proposed development is forecast to generate more than 3,000 total vehicle trips per average weekday, the Developer must proceed with preparation and submittal of the TIA. If the preliminary assessment indicates that the proposed development is not forecast to meet the minimum trip generation threshold, then the Developer will submit the results of the preliminary trip generation assessment along with a description of the measures being taken to address any concerns raised by the Engineering Services Director when initially requesting the TIA. Preparation and submittal of a complete TIA will not be required in this case.

3.14.2.D *Preliminary Scoping Meeting* – Prior to beginning a TIA, the Engineer must contact the Engineering Services Director or designee to schedule a preliminary meeting. The purpose of this meeting is to discuss the project concepts and to establish the analysis requirements and identify issues pertinent to the TIA. The following items must be determined during the preliminary meeting:

3.14.2.D.i The level of detail needed for the analysis.

3.14.2.D.ii Identification of the study area, land uses, key intersections, and driveways.

- 3.14.2.D.iii The study horizon.
 - 3.14.2.D.iv Trip generation rates to be used.
 - 3.14.2.D.v If pass-by or modal split analysis is appropriate.
 - 3.14.2.D.vi The need for internal circulation and queuing analysis.
 - 3.14.2.D.vii Reductions to trips due to internal circulation, if appropriate.
 - 3.14.2.D.viii List of committed developments near the proposed site to be considered.
 - 3.14.2.D.ix Assumptions for area-wide growth (appropriate background traffic calculation methods).
 - 3.14.2.D.x Consideration of phased development and transportation improvements.
 - 3.14.2.D.xi Identification of existing high accident areas.
 - 3.14.2.D.xii If consideration of pedestrian or bicycle impacts are needed.
 - 3.14.2.D.xiii Acceptable trip distribution methods to be used.
 - 3.14.2.D.xiv Approval of traffic analysis software to be used (any capacity analysis must be performed with traffic analysis software that applies the Transportation Research Board's (TRB) current edition of the Highway Capacity Manual).
 - 3.14.2.D.xv Analysis period and typical peak hours for the proposed land use.
 - 3.14.2.D.xvi If traffic counts should be collected on typical weekdays (Tuesdays, Wednesdays, or Thursdays), or weekends.
 - 3.14.2.D.xvii If any traffic counts should be taken in addition to those listed herein.
 - 3.14.2.D.xviii If any additional requirements are anticipated by the City.
- 3.14.2.E *Level of Analysis* – Three levels of analyses have been identified based on the number of trips that a development is projected to generate in a 24-hour period (ADT) and during peak hours (AM and PM). **Table 3-18** includes typical requirements. The Engineering Services Director or designee may refine the requirements based on site-specific conditions.

Table 3-18. Levels of Traffic Impact Analyses

| Level of Analysis | Criteria | Study Horizon | Study Area |
|-------------------|---|--|---|
| I | Projected site-generated peak-hour trips of up to 300 per hour AND No significant modification of traffic signals or roadway geometry proposed | Year of completion, assuming full build-out and occupancy | All driveway access points, adjacent roadways, and adjacent major intersections. All signalized intersections on each street serving the site within 1/4 mile. |
| II | Projected site-generated peak-hour trips of 301-500 per hour OR Installation or modification of traffic signals or roadway geometry proposed, regardless of project size | Year of completion, assuming full build-out and occupancy AND Five years after completion | All driveway access points, adjacent roadways, and adjacent major intersections. All signalized and major unsignalized intersections on each street serving the site within 1/4 mile. |
| III | Projected site-generated peak-hour trips 501+ per hour OR Installation or modification of two or more traffic signals, addition of travel lanes, or modification of interchange proposed, regardless of project size | Year of completion, assuming full build-out and occupancy AND Five years after completion | All driveway access points, adjacent roadways, and adjacent major intersections. All signalized and major unsignalized intersections on each street serving the site within 1 mile. |

3.14.3 Submittal and Review Procedures

3.14.3.A A copy of the TIA report, including all necessary backup data, are required for review.

3.14.3.B The Traffic Engineer or designee must review the TIA in conjunction with the other elements of the development application. If the TIA is not of the proper scope or is executed improperly, the Developer must be notified of the deficiencies and be required to submit corrections on the same schedule that applies to the other elements of the development application. Failure to submit corrections in a timely fashion may lead to a postponement of the application.

3.14.3.C The Engineering Services Director or designee approval is valid for one year, provided significant changes in the development proposal or surrounding conditions have not occurred. At the discretion of the Engineering Services Director or designee, the TIA must be revised if the proposed land use is changed by type or size, if existing conditions have changed enough to invalidate the TIA results, or if the initial TIA assumptions are no longer valid.

3.14.3.D In accordance with **Section 3.14.5**, if the site plan changes after initial TIA approval, the TIA must be revised accordingly and resubmitted for the Engineering Services Director or designee approval.

3.14.4 Mitigation and Mitigation Funding

3.14.4.A The TIA may take into account City, State, and/or County approved traffic improvements with dedicated funding. The Engineering Services Director or designee will determine which approved traffic improvements may be considered. Prior to the issuance of a Certificate of Occupancy, the Developer must complete any

required traffic improvements which have not been funded or otherwise completed by government agencies.

3.14.4.B When it can be demonstrated that a development will only partially contribute to the need for additional off-site improvements, the City may require the Developer to provide a contribution based on the determined impacts of traffic added by the development.

3.14.4.C Traffic levels exceeding Level of Service C, where the development is contributing five percent or more of the total trips should be mitigated if possible. Mitigation measures are limited to the following:

3.14.4.C.i Requirements in addition to those provided in this *Manual* relating to driveway and median opening location design and distance between drives.

3.14.4.C.ii Onsite improvements including access controls and site circulation adjustments.

3.14.4.C.iii Offsite improvements including the construction of additional lanes where the surrounding thoroughfares are not fully developed or intersection improvements where the surrounding area is approaching full development. This may also include offsite traffic control improvements, up to and including the installation of traffic signals, if warranted.

3.14.5 Traffic Impact Analysis Report Requirements

3.14.5.A *Introduction* – Include a description of the site location and study area, including a location map identifying key intersections and other approved projects in the vicinity.

3.14.5.A.i *Development Description* – Include type of land use and the following information where applicable:

- If residential, number and type of dwelling units
- If commercial or industrial, square footage and type of development
- Detailed site plan
- Development phasing and timing

3.14.5.A.ii *Analysis Period* – Selection of analysis period must be based on the proposed land use and the typical peak hours.

3.14.5.B *Site Conditions* – Include a description of site conditions for the study area, including the following:

3.14.5.B.i Existing and proposed land use and zoning

3.14.5.B.ii Site access

3.14.5.B.iii Posted speed limits on all existing, adjoining, or impacted roadways.

- 3.14.5.B.iv Distances from existing streets, driveways, and/or median cuts to the proposed development.
- 3.14.5.B.v Alignment of existing streets, driveways, and/or median cuts to the proposed development.
- 3.14.5.B.vi Intersection layout, lane usage, lane widths, and roadway configuration.
- 3.14.5.B.vii Traffic control devices.
- 3.14.5.B.viii Traffic signal timing and phasing. Offset times should be shown if any coordination with adjacent signals is being used (contact Engineering Services Director or designee for timing data for existing signals).
- 3.14.5.B.ix ROW widths for all existing roadways that may be impacted by the development.
- 3.14.5.B.x Daily (ADT) and peak-hour (AM and PM) traffic counts (collected at the specified days of week based on the preliminary meeting), peak-hour intersection turning movement counts at key intersections taken at 15-minute increments, and any additional required traffic counts. Traffic counts used in a TIA must be less than one year old. The existing counts must be presented in diagrammatic form for each intersection counted.
- 3.14.5.B.xi Pedestrian facilities and volumes.
- 3.14.5.B.xii LOS of existing roadways and intersections as defined by TRB's current edition of Highway Capacity Manual.
- 3.14.5.B.xiii Photographs documenting existing transportation conditions.
- 3.14.5.C *Projected Traffic* – The calculation of the projected traffic must be shown in sufficient detail so that all calculations can be verified. Descriptions and figures of the following items must be included in the report.
 - 3.14.5.C.i *Site Traffic* – Site traffic (daily and peak periods) must include trip generation, trip distribution methods, and assignments. Include a list of trip rates and sources of rates used for the study. ITE's current edition of Trip Generation Manual must be used. Calculate trip ends assuming 100% occupancy and development.
 - 3.14.5.C.ii *Background Traffic* – Background traffic (daily and peak periods) must account for all approved developments in the study area as well as area growth beyond study area.
 - 3.14.5.C.iii *Reassignment Rates* – Reassignment rates for pass-by, diverted trips, and internal capture must follow ITE's current edition of Trip Generation Manual based on different land use classifications. Reduction for any other land use types must be thoroughly documented and approved by the Engineering Services Director or designee.

- 3.14.5.C.iv *Total Traffic* – Total traffic must be shown combining site and background traffic for each intersection and driveway.
- 3.14.5.C.v *Future Traffic* – If required, future traffic must be calculated using background traffic volumes adjusted for the TIA horizon year.
- 3.14.5.D *Traffic Analysis* – The following information must be included in the report describing the detailed analyses performed.
- 3.14.5.D.i Projected volume to capacity (V/C) ratios, vehicular delays, and LOS (background traffic and total traffic) for the study horizon must include the following:
- Identification of any traffic analysis software used.
 - Signalized intersection analysis.
 - A LOS analysis using projected traffic volumes must be conducted using the TRB’s current edition of *Highway Capacity Manual*.
 - If signalization is warranted by the traffic signal warrants set forth in TxDOT’s current edition of TMUTCD, conduct a complete warrant analysis and analyze the intersections as signalized intersections.
 - Impacts to LOS on arterials must be determined.
 - Turning vehicle storage space needed or the adequacy of storage space for turning vehicles at intersections in the study area must be analyzed. This analysis must consider signal phasing and overall signal cycle length as well as vehicle volumes. Analysis of queuing on-site may also be required.
- 3.14.5.D.ii A table for each of the following must be provided. All peak-hour data must be shown.
- Existing LOS, delay, and V/C ratios.
 - Background LOS, delay, and V/C ratios without development.
 - Future LOS, delay, and V/C ratios with development.
 - Net changes in LOS, delay, and V/C ratios between future and background scenarios, both with and without mitigation.
- 3.14.5.D.iii Intersections, turn lanes, median openings, and driveways must comply with **Section 3.3 (Intersections)** and **Section 3.7 (Access Management)**.
- 3.14.5.D.iv Determine impacts to nearby neighborhoods.
- 3.14.5.D.v Accident analysis covering the past three years may be required at intersections that currently have more than four property and/or injury accidents per year. The Engineering Services Director or designee must provide recent reportable accident history for evaluation.
- 3.14.5.D.vi The analysis should take additional facilities into account, such as sidewalks, crosswalks, school bus stops, and railroad crossings.

- 3.14.5.E *Traffic Management Plan* – A TMP may be required for any school and must be based on the current site plan. If the site plan changes after the TIA is approved, the TMP must be revised to demonstrate the final site plan and resubmitted to the Traffic Engineer or designee for approval.
- 3.14.5.F *Conclusions and Recommendations* – The final section of the report must summarize the overall impact of the development and include the following:
- 3.14.5.F.i Site Access, Driveway, and Circulation Plan
- 3.14.5.F.ii Adjacent intersection and driveway improvements addressing, at a minimum, the following:
- Traffic control devices – modify existing or need for new
 - Additional lanes needed (left, right, or thru)
 - Median openings
 - Intersection channelization
 - Acceleration and/or deceleration lanes
 - Length of storage bays
 - A detailed drawing of any intersection improvements
 - Implementation schedule
- 3.14.5.F.iii Off-site capital improvements and Transportation System Management (TSM) improvements to be programmed by the City may include the following:
- Modifications to existing traffic control devices
 - Additional traffic control devices, additional lane at major intersections, and additional roadways
 - Other improvements, if applicable
- 3.14.5.G *Appendix* – The following appendices must be included in the report:
- 3.14.5.G.i Raw traffic count data
- 3.14.5.G.ii Printouts of analysis results
- 3.14.5.G.iii Photographs of site
- 3.14.5.G.iv Additional tables or figures not included in the report

3.15 Martin County Subdivision Regulations

- 3.15.1 Coordinate with Engineering Services Director or designee to address any applicable Martin County regulations.

3.16 Midland County Subdivision Regulations

- 3.16.1 Article III – Street Construction
- 3.16.2 Article IV – Access Driveways to County Roads

3.17 TxDOT Regulations

- 3.17.1 Coordinate with Engineering Services Director or designee to address any applicable TxDOT regulations.

3.18 Airport Requirements

- 3.18.1 Coordinate with Engineering Services Director or designee to address any applicable Airport regulations.

3.19 Railroad Requirements

- 3.1.1 Abutting Railroad or Limited Access Highways – Where a subdivision borders on or contains a railroad ROW or limited access highway ROW, the commission may require a street approximately parallel to and on each side of such ROW, at a distance suitable for the appropriate use of the intervening land. Such distances must also be determined with due regard for the requirements of approach grades and future grade separations.

Extensions of existing concrete streets are to utilize concrete pavement sections throughout unless a written variance is first obtained from the Engineering Services Director or the designee. This requirement does not apply to streets that only have concrete intersections with asphalt pavement sections between the intersections.

A vehicle access route must have an all-weather surface. All-weather surfaces are considered to be concrete or asphalt paved surfaces.

SECTION 4 PEDESTRIAN FACILITIES DESIGN REQUIREMENTS

4.1 General

- 4.1.1 This Section includes the minimum design requirements and standards associated with the City's pedestrian facilities.
- 4.1.2 Pedestrian facilities will be designed to promote pedestrian safety and efficiency, minimize conflicts with motorized and non-motorized vehicle traffic, minimize tripping hazards and protruding objects, and accommodate accessibility needs of pedestrians. All pedestrian facilities must conform to current Federal, State, and Local ADA requirements and to the criteria in this Section. For the purpose of this Section, pedestrian facilities include hike and bike routes, sidewalks, barrier free ramps, and pedestrian handrails.
- 4.1.3 *Pedestrian Design* – All elements of pedestrian and ADA systems and infrastructure must be designed and constructed in compliance with the City's Standard Details and Standard Specifications. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.

4.2 Pedestrian Design Guidelines

- 4.2.1 Pedestrian facilities will comply with the current edition of the following standards:
 - 4.2.1.A Texas Accessibility Standards (TAS);
 - 4.2.1.B Americans with Disabilities Act (ADA) Standards;
 - 4.2.1.C Proposed Accessibility Guidelines for Pedestrian Facilities in Public Right-of-Way (PROWAG); and,
 - 4.2.1.D Texas Manual on Uniform Traffic Control Devices (TMUTCD).

4.3 Hike and Bike Routes

- 4.3.1 To create a network of trails and sidewalks, the Hike and Bike Master Plan specifies a network of enhanced sidewalks and trails throughout the City. Refer to the Hike and Bike Master Plan for the location of these improvements. The placement and location of these enhanced sidewalks will be determined by the Engineering Services Director or designee. Additional ROW and easements may be needed to accommodate these improvements.

4.4 Sidewalks

- 4.4.1 In subdivisions prior to acceptance of the public improvements by the City, the developer will be responsible for constructing sidewalk along the frontage of all arterials, collectors, common areas, designated drill sites, and drainage easements. All other sidewalks will be required as the time of the building permit.
- 4.4.2 The minimum width for sidewalk in the public ROW along arterial or higher classification roads is 6', and the sidewalk is to be detached sidewalk located adjacent to the ROW boundary. The minimum width for sidewalk at all other locations in public ROW or public easements is 5', and the sidewalk is to be attached sidewalk located adjacent to the back-of-curb.
- 4.4.3 Pedestrian access ramps must be constructed as part of any new road improvement and must be completed prior to City acceptance of the road improvements.

- 4.4.4 Elevated pedestrian crossings are to be used when pedestrian routes and traffic, such as sidewalks, cross surface drainage that passes through street curb.
 - 4.4.4.A Elevated crossings are only required to pass the 5-year storm event beneath the crossing structure but may pass more than the 5-year storm event if desired by the developer.
 - 4.4.4.B Scuppers are to be used when surface drainage exits the street while passing through the street curb.
 - 4.4.4.C Steel plates may be used for elevated pedestrian access crossings in place of scuppers if all of the following criteria are met:
 - 4.4.4.C.i The plates are no longer than 3' each along the pedestrian access route.
 - 4.4.4.C.ii There will be a minimum 4" of concrete surface, broom finished, between any two plate edges at the vertical concrete supports for the elevated crossing.
 - 4.4.4.C.iii The crossing will consist of no more than 4 steel plates in a series.
 - 4.4.4.C.iv Steel plates will be diamond plate and no less than 3/8" thick.
 - 4.4.4.C.v Steel plates will be secured with countersunk bolts or an equivalent method approved by the City.
- 4.4.5 Developers will be responsible for constructing sidewalk along the frontage of all arterials, collectors, common areas, designated drill sites, and drainage easements. All other sidewalks will be required at the time of the building permit. Sidewalk construction may be coordinated with the Developer's construction activities to minimize damage to sidewalks.
- 4.4.6 Sidewalks along arterial roads in the City are to be set adjacent to the ROW line. Sidewalks along non-arterial roads are to be constructed adjacent to the barrier curb.
- 4.4.7 Sidewalks along non-arterial roads in the City with mountable curb are to be set a minimum of 2' back from the back-of-curb.
- 4.4.8 Sidewalks are not required if a roadway will not have a curb. If a curb is present, refer to the City's Standard Details for when sidewalks are required.
- 4.4.9 Sidewalks in the Central Business District as defined in the Zoning Ordinance may be required to be installed wider than typical to match existing pedestrian walkways or to support the enhancement of the City's downtown area.
- 4.4.10 Sidewalks must maintain positive drainage with a maximum cross-fall (cross-slope) of the sidewalk and parkway of 2%. The least possible running slope should be used to maximize accessibility. The running slope of pedestrian facilities and crosswalks within the ROW may follow the grade of the parallel roadway.
- 4.4.11 Sidewalk widths vary depending on the roadway classification. The sidewalk width will be equal to the requirement as shown in the City's Standard Details and Standard Specifications.
- 4.4.12 The sidewalks must be located within the street ROW unless pre-existing physical encroachments (e.g., utility infrastructure or trees) dictate otherwise. Sidewalks may be

allowed in landscape areas and pedestrian access easements with the approval of the Engineering Services Director or designee.

4.4.12.A *Sidewalks on Bridges and Culverts* – All street bridges and culverts must have a sidewalk constructed on each side. Where a pedestrian rail will not be installed in addition to the bridge rail, the sidewalk must be at least 6’ wide which will provide a buffer of 2’ behind the curb of the bridge deck. A standard pedestrian bridge rail protecting the sidewalk will be provided on the outside edge of the bridge. Refer to **Section 8 (Structural)** of this Manual for additional railing requirements on bridges.

4.4.12.B *Sidewalks Under Bridges* – When new bridges are built as a part of the construction of any roadway or the reconstruction of a divided arterial roadway and a pedestrian crossing for a hike and bike trail is needed, a 12’ sidewalk will be built as a part of the embankment design underneath the bridge structure. The bridge structure should provide a minimum vertical clearance of 10’ above the sidewalk for pedestrian access.

4.4.12.B.i Water depth markers are required for any sidewalk, hike or bike trail, or similar pedestrian path passing under a bridge. Water depth markers are to be placed, at a minimum, in easy view of the pedestrian route on both sides of the bridge structure being passed under.

4.4.12.C *Sidewalks Along Frontage* – The timing of the sidewalk construction may be coordinated with the Developer’s activities to minimize damage to sidewalks.

4.4.12.D Temporary Sidewalks

4.4.12.D.i Pedestrians may be required to be accommodated during time of construction at the discretion of the Engineering Services Director or designee. If the construction zone affects the movement of pedestrians, adequate pedestrian access and walkways meeting ADA requirements may be provided. All Pedestrian Accommodation Plans will be reviewed and approved by the Engineering Services Director or designee.

4.4.12.D.ii If Temporary Sidewalks are required the material must be an all-weather material, specified on the plans and approved by the Engineering Services Director or designee.

4.4.12.E *Access to Cul-de-Sacs from Adjacent Streets* – When a cul-de-sac ROW abuts the ROW of another thoroughfare, a minimum 5’ wide sidewalk will be provided between the cul-de-sac and adjacent street. All screening and/or fencing requirements must be met in addition to this requirement.

4.5 Barrier Free Ramps

4.5.1 Barrier free ramps for sidewalk crossings at intersections of all streets and thoroughfares and at all alley approaches and driveways must conform to the City’s Standard Details and Standard Specifications. Barrier free ramps will be constructed in a manner to be safely negotiated by the physically disabled. Barrier free ramps must be constructed as part of any new road improvement and must be completed prior to the City acceptance of the road. All barrier free ramps must be installed for new developments before the street will be accepted

or street signage will be installed. The timing of the sidewalk construction may be coordinated with the Developer's activities to minimize damage to sidewalks.

4.5.2 Detectable warnings at alley or driveway approaches are not required.

4.6 Pedestrian Handrails

4.6.1 Pedestrian handrail of a height not less than 42" will be required when any of the following conditions are located within 5' of an existing or sidewalk, or as directed by the Engineering Services Director or designee:

4.6.1.A A permanent or intermittent body of water. Refer to **Section 5 (Storm Drain)** of this Manual for additional requirements.

4.6.1.B Top of slope steeper than 6H:1V with bottom of slope ending at a body of water.

4.6.1.C Top of slope steeper than 3H:1V with a total depth greater than 1.5'; or,

4.6.1.D Vertical surface with a total depth greater than 1.5'.

4.6.2 Exemptions to this requirement may be considered by the Engineering Services Director or designee when:

4.6.2.A The depth of a permanent or intermittent body of water is less than 1'.

4.6.2.B The sidewalk provides recreational access to a body of water.

4.6.2.C The handrail would irreversibly spoil the natural landscape; or

4.6.2.D Alternative means of protection are approved.

4.6.3 Pedestrian handrails located on sidewalks will be designed and constructed in accordance with the City's *Standard Details* and *Standard Specifications*. The grip rail may be eliminated unless required by the *Pedestrian Design Guidelines*, or by approval from the Engineering Services Director or designee. Any required concrete foundation must be in addition to the minimum sidewalk width. All rail surfaces will be painted with industrial-grade exterior paint, with the color approved by the Engineering Services Director or designee.

4.7 Elevated Pedestrian Crossings

4.7.1 Elevated pedestrian crossings are required to be installed where pedestrian routes, usually sidewalks, cross surface drainage passing through street curb openings.

4.7.1.A Elevated crossings must be designed to pass the minimum of the 5-year storm event beneath the crossing structure but may pass more than the 5-year storm event if desired by the developer.

4.7.1.B Elevated crossings are to be used when surface drainage exits the street while passing through the street curb.

4.7.1.C Steel plates may be used for elevated pedestrian access crossings in place of scuppers if the steel plates meet the City's *Standard Details* and *Standard Specifications*.

SECTION 5 STORM DRAINAGE DESIGN REQUIREMENTS

5.1 General

- 5.1.1 This Section includes the minimum design requirements and standards associated with the City's storm drain system.
- 5.1.2 Storm Drain System Design - All elements of storm drain systems and infrastructure must be designed and constructed in compliance with the City's *Storm Drain Manual*, *Standard Details*, and *Standard Specifications*. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 5.1.3 Refer to current version of City's *Drainage Analysis Manual (DAM)* for information on drainage analysis and calculation standards and requirements.
- 5.1.4 Refer to **Section 8 (Structural)** of this Manual for information on bridge requirements.
- 5.1.5 Refer to **Section 10 (Environmental and Erosion Control Requirements)** of this Manual for information on temporary erosion control requirements.
- 5.1.6 Refer to **Section 11 (Floodplains)** of this Manual for information on floodplain requirements.
- 5.1.7 *General Design Criteria* – It is the responsibility of the Engineer to ensure that all storm drain construction plans are in conformance with the most current editions of the following:
 - 5.1.7.A Federal Emergency Management Agency (FEMA)
 - 5.1.7.B United States Army Corps of Engineers (USACE)
 - 5.1.7.C Texas Commission on Environmental Quality (TCEQ) Rules and Regulations
 - 5.1.7.D 30 Texas Administrative Code (TAC) Chapter 290 – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems
 - 5.1.7.E American Water Works Association (AWWA) Standards
 - 5.1.7.F Clean Water Act
 - 5.1.7.G City of Midland Flood Damage Prevention Code
- 5.1.8 The Developer will construct all storm drain improvements and appurtenances, including major collection or distribution facilities, necessary to address the drainage needs of their development and to mitigate any impact to adjacent properties, ROW, etc. in compliance with an approved drainage study and design.
 - 5.1.8.A The Developer is to construct all storm drain improvements necessary to connect the development with the existing storm drain system if such a connection is called for by the approved drainage study.
 - 5.1.8.B Where the storm drain improvements to be constructed will be connected to by future development, the storm drain improvements for the current development must be extended to the limits of the current platted property.
 - 5.1.8.C Where the storm drain improvements to be constructed constitute part of a larger regional drainage system, the Developer will be required to construct any off-site improvements required by an approved drainage study to address any interim or ultimate condition the development falls under per the approved drainage study.

- 5.1.9 There is to be no standing runoff in the public ROW on public pavement or sidewalks. All drainage improvements are to ensure a continuous movement of storm runoff within public ROW until the runoff discharges from the public ROW into a drainage structure such as a channel or basin.
- 5.1.10 No other utilities are ever to be installed in the same ditch as public utilities.
- 5.1.11 All new NON-METALLIC buried public utility mains must have both locator (i.e. detector) tape and wire installed over and parallel to the pipe. Metallic buried public utility mains must have locator tape installed over and parallel to the pipe.
- 5.1.12 When required, the required accuracy for storm drainage Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual locations. GPS coordinates are required on all as-built drawings at all headwalls, junction boxes, manholes, valves, taps, appurtenances, and at no less than 50' intervals along all public storm drains.
- 5.1.13 Underground public infrastructure such as storm drain must be designed and sized for the ultimate needs of the region they provide service to.
- 5.1.14 When required, the required accuracy for water Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual location. GPS coordinates are required on all as-built drawings at all junction boxes, manholes, inlets, outlets, valves, taps, appurtenances, and at no less than 50' intervals along all public storm drains.
- 5.1.15 *Conformance to Plans and Regulations* – Proposed public drainage improvements will conform to and be properly related to the City of Midland's Master Drainage Plan, Storm Drain Manual, and to all requirements of the subdivision regulations.
- 5.1.16 *Inverted Siphons* – Inverted siphons will not be allowed within public ROW.

5.2 **Design Flow**

- 5.2.1 Storm drain design flows will be established based on an approved drainage study in compliance with the Storm Drain Manual.

5.3 **Sizing and Spacing**

- 5.3.1 *Storm Drain Sizing* – The storm drain culvert or pipe size will be determined by the Design Engineer and approved by the Engineering Services Director or designee. The sizing of the proposed storm drain culvert or pipe should consider future extensions to serve the entire watershed area. Capacity calculations showing that the proposed storm drain culvert or pipe can convey the flow required by the approved drainage study must be provided by the Design Engineer to the Engineering Services Director or designee.
 - 5.3.1.A *Minimum and Maximum Velocity* – Storm drain culverts and pipes must obtain a minimum cleansing velocity of 2' per second (fps) with maximum design flows. Storm drains maximum velocity will not exceed 10 fps.
 - 5.3.1.B *Minimum and Maximum Slopes* – The minimum and maximum design slopes allowed for storm drain culverts and pipes are shown in **Table 5-1**.

Table 5-1. Minimum and Maximum Velocity and Slopes

| Size of Main (Inches) | Minimum Slope (Percent) | Maximum Slope (Percent) |
|-----------------------|-------------------------|-------------------------|
| 18 | 0.115 | 2.83 |
| 21 | 0.095 | 2.30 |
| 24 | 0.08 | 1.93 |
| 27 | 0.07 | 1.65 |
| 30 | 0.06 | 1.43 |
| 33 | 0.055 | 1.26 |
| 36 | 0.045 | 1.12 |
| 39 | 0.04 | 1.01 |
| > 39 | * | * |

* For pipes larger than 39 inches in diameter, the slope is determined by Manning’s formula to maintain a velocity greater than 2.0 feet per second and less than 10.0 feet per second when flowing full.

- 5.3.1.C Storm drain culverts and pipes are to be the same size from structure to structure, whether those structures are headwalls, junction boxes, manholes, etc.
- 5.3.1.D The minimum size for storm drain box culverts is 2’x2’ inside opening.
- 5.3.1.E The minimum size for storm drain trunk pipe is 24” diameter.
- 5.3.1.F The minimum size for storm drain lateral pipe is 18” diameter.
- 5.3.2 Unless the ultimate end of a public gravity storm drain culvert or pipe is known at the time of design, the public gravity storm drain culvert or pipe must be designed and built as deep as possible to ensure it can be extended as far as possible to support future development.
- 5.3.3 Downstream culverts and pipes are to always be equal in size or larger than upstream culverts or pipes on the same system.

5.4 Materials

- 5.4.1 *Culvert and Pipe Materials* – Culvert and pipe materials are to meet the requirements of the City *Standard Details* and *Standard Specifications* unless the Engineer determines that the needs of the specific project exceed the typical City standards, in which case it is the responsibility of the Engineer to submit alternate material specifications meeting the needs of the specific project to the Engineering Services Director or designee for approval.
- 5.4.2 Storm drain culverts and pipes are to be the same material from structure to structure, whether those structures are headwalls, junction boxes, manholes, etc.

5.5 Surface Infrastructure

- 5.5.1 Drainage Alleys
 - 5.5.1.A All drainage alleys are to be constructed in accordance with the City’s *Standard Details and Standard Specifications*.

5.5.2 Basins

- 5.5.2.A *General* – Basin designs must include all standard construction drawing elements, including complete design layouts, cross-sections, grades and contours, dimensions, etc.
- 5.5.2.B Basin designs must be in compliance with an approved drainage study.
- 5.5.2.C Detention basins must have a designed outfall.
- 5.5.2.D *Freeboard* – A minimum 1.0' of freeboard is required for basins with a design storage of less than 5 acre-ft, and a minimum 0.5' of freeboard is required for basins with a designed storage equal to or greater than 5 acre-ft. (*Excluding designed discharge openings such as weirs.*)
- 5.5.2.E *Emergency Spillway* – All basin designs are to include and identify an emergency spillway for the basin for a storm event that exceeds the 100-year event. (*Basins with a designed surface outfall such as a weir may also designate it to function as the emergency outfall.*)
- 5.5.2.F Side-Slopes
- 5.5.2.F.i The maximum side-slopes of a basin will be based on slope stability. Engineers must provide slope stability calculations for side-slope designs steeper than 7H:1V for rock rip-rap side slopes, steeper than 4H:1V for fully vegetated side-slopes, steeper than 3H:1V for concrete side-slopes, or for any other proposed side slope stabilization.
- 5.5.2.G Any drainage basin deeper than 3' with side slopes steeper than 4:1 must include a perimeter safety fence and access gate no less than 5' tall. Any drainage basin deeper than 3' with side slopes of 1:1 or steeper must include a perimeter safety fence and access gate no less than 8' tall.
- 5.5.2.H Pilot Channel – A pilot channel must be constructed for all detention basins per **Section 5.5.7 (Pilot Channels)**.
- 5.5.2.I *Access Routes* – Access routes are to be included along at least one full side of a basins frontage and may either include a paved access road in the ROW running parallel with one side of the basin, or else the access route must extend from the nearest ROW. Access routes are to be a minimum 15.0' wide with a maximum 4H:1V running slope and a maximum 6H:1V cross-slope. Access routes are to be kept clear of structures and equipment. Any fence across an access route must first be approved by the Engineering Services Director or designee in writing, and the fence Owner must install a vehicle access gate at the crossing, and the gate cannot be locked.

5.5.3 Open Channels and Named Draws

- 5.5.3.A *General* – Open channel designs must include all standard construction drawing elements, including complete design layouts, plan and profiles, cross-sections, grades and contours, stations, dimensions, etc.

- 5.5.3.B Open channel designs must be in compliance with an approved drainage study and the City's Standard Details and Standard Specifications.
- 5.5.3.C Improvements to named draws, or that impact named draws by crossing or otherwise encroaching into the draw area, will be subject to the same City standards and requirements as if the draw were an open channel. Named draws in the City of Midland include the Industrial Channel, Jal Draw, Midland Draw, Mulberry Draw, Scharbauer Draw, and South Channel.
 - 5.5.3.C.i *Typical Cross-Section* – Typical open channel cross-sections will be trapezoidal with a minimum 10' wide bottom.
 - 5.5.3.C.ii The minimum longitudinal slope for open channels will be 0.5% unless a concrete pilot channel is installed.
 - 5.5.3.C.ii.a If a concrete pilot channel is installed, the minimum longitudinal slope for an open channel will be 0.2%.
 - 5.5.3.C.iii *Maximum Side-Slopes* – The maximum side slopes of an open channel will be based on slope stability. Engineer must provide slope stability calculations for side-slope designs steeper than 7H:1V for rock rip-rap side slopes, steeper than 4H:1V for fully vegetated side-slopes, steeper than 3H:1V for concrete side-slopes, or for any other proposed side slope stabilization.
 - 5.5.3.C.iii.a If the edge of a channel side-slope is closer than 10' to any edge of pavement or pedestrian access route, then additional safety measures, including pedestrian rails or vehicle barriers, may be required.
- 5.5.3.D *Freeboard* – Channels must have a minimum 1.0' of freeboard above the designed 100-year storm event flow they will convey.
- 5.5.3.E *Access Routes* – Access routes are to be included along open channels and may either include a paved street in an adjacent ROW or extend from the ROW for the full extent of the channel. Access routes are to be a minimum 15.0' wide with a maximum 4H:1V running slope and a maximum 6H:1V cross-slope. Access routes are to be kept clear of structures and equipment. Any fence across an access route must first be approved by the Engineering Services Director or designee in writing, and the fence Owner must install a vehicle access gate at the crossing, and the gate cannot be locked.
- 5.5.3.F When an open channel is crossed by a street, the crossing should be at a 90° angle.
- 5.5.3.G Channels are never to be crossed by low water crossings. Instead, channel crossings for vehicles and pedestrians are to be achieved with Engineer designed elevated crossing structures that ensure the vehicle or pedestrian travel surface remains above the surface of the storm event runoff carried by the channel.
- 5.5.3.H *Rock Rip-Rap* – Design submittals that include rock rip-rap or similar methods must include a gradation size and mixture design for the rock material used.
 - 5.5.3.H.i Rock rip-rap must be 6" or larger crushed stone when used.

5.5.3.H.ii Erosion control filter fabric is required beneath all rock rip-rap.

5.5.4 Ditches

5.5.4.A It is the intent of the City to have full City standard streets installed whenever new streets are constructed, including curb and gutter. Ditches will only be allowed along streets in the rare event that a full City standard street section with curb and gutter is not feasible, that the final road section installed will not have curb and gutter, and if the Developer first obtains a waiver from the Engineering Services Director or designee.

5.5.4.B *Ditch Design* – All components of the storm drain system will be designed as specified in the City’s Standard Details and Standard Specifications.

5.5.4.C *General* – Where ditches are allowed, ditch designs must include all standard construction drawing elements, including complete design layouts, plan and profiles, cross-sections, grades and contours, stations, dimensions, etc.

5.5.4.C.i *Typical Cross-Section* – Typical ditch cross-sections will be trapezoidal or triangular.

5.5.4.C.ii *Maximum Depth* – A ditch will be considered to have a maximum depth of 3.0’ measured from the top of the ditch side-slope to the ditch flowline. Once a depth of 3.0’ has been exceeded, the ditch will be considered a channel and must meet the requirements of Section 5.5.3 (Open Channels and Named Draws).

5.5.4.C.iii The minimum longitudinal slope for a ditch will be 0.2%.

5.5.4.C.iv *Maximum Side-Slopes* - The maximum side-slope of a ditch will be based on slope stability, and also whether the ditch is located adjacent to a parallel street. The maximum side-slope for a ditch will be 4H:1V when located adjacent to a parallel street. The maximum side-slope for a ditch will be 3H:1V when not adjacent to a parallel street and more than 1.5' deep. There is no maximum slope for a ditch that is not adjacent to a parallel road and that has a maximum depth of 1.5' so long as the stability of the ditch side-slopes is ensured..

5.5.4.C.v *Maximum Side-Slope Calculations* - The Engineer must provide slope stability calculations for side-slopes steeper than 4H:1V for fully vegetated side-slopes, steeper than 3H:1V for rock-rip-rap or gabion side slopes, steeper than 2H:1V for concrete side-slopes, or for any other proposed side slope stabilization.

5.5.4.C.vi When a ditch is crossed by a street the crossing should be at a 90° angle.

5.5.4.C.vii Protective vehicle barriers will only be required if deemed necessary by the Engineering Services Director or designee.

5.5.4.D Where ditches are allowed along the side of a parallel street or other paved surface, the upper edge of the ditch will be judged the same as the top-of-curb for a standard street section.

- 5.5.4.E *Freeboard* – A minimum 3” of freeboard is required for a ditch that is not along the side of a parallel street or other paved surface.
- 5.5.4.F Ditches cannot be crossed by low water crossings for streets and alleys if the ditch is deeper than 1.0’, or if the street or alley crossing cannot meet the City’s Standard Details and Standard Specifications for street and alley slopes. Ditches may be crossed by low water crossings for driveways if the ditch is not deeper than 0.5’ measured from the edge of street pavement.
- 5.5.4.G *Rock Rip-Rap* – Design submittals that include rock rip-rap or similar methods must include a gradation size and mixture design for the rock material used.
 - 5.5.4.G.i Rock rip-rap must be 6” or larger crushed stone when used.
 - 5.5.4.G.ii Erosion control filter fabric is required beneath all rock rip-rap.
- 5.5.5 Valley Gutters
 - 5.5.5.A All valley gutters are to be constructed in accordance with the City’s Standard Details and Standard Specifications.
 - 5.5.5.B An arterial or major collector street should not be crossed with a valley gutter.
 - 5.5.5.C Wherever feasible, a minor collector should not be crossed with a valley gutter.
 - 5.5.5.D At any intersection, perpendicular valley gutters will not be permitted and parallel valley gutters should cross only the lower classification street.
 - 5.5.5.E Valley gutters are required in alleys with longitudinal slopes of less than 0.5% and are to be constructed per the City’s Standard Details and Standard Specifications.
- 5.5.6 Flumes
 - 5.5.6.A All flumes are to be constructed in accordance with the City’s Standard Details and Standard Specifications.
 - 5.5.6.B Flumes are required to convey any point discharge storm runoff from a paved surface down the side-slope of a basin, channel, or ditch. Flumes are not required on a basin, channel, or ditch side-slope that is accepting point discharge storm runoff from an unpaved channel, ditch, weir, or similar unpaved outfall structure.
 - 5.5.6.C Flumes and outfalls are required to convey any runoff from the end of a cul-de-sac across private property to a street located on the opposite side of the private property being crossed.
 - 5.5.6.D Flumes must be sized to contain all 100-year runoff that it will convey within the flume structure.
 - 5.5.6.E Flume openings on the receiving end of the structure must match or exceed the width of the discharge opening they are adjacent to, whether that discharge opening is for a channel, ditch, scupper, curb opening, etc.
 - 5.5.6.F Where a flume received flow that passes over the top-of-curb and/or sidewalk, the opening width on the receiving end of the flume will match or exceed the width of the flow it will receive.

- 5.5.6.G *Rock Rip-Rap* – Rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee are required along the perimeter of all flume structures in or on the side slopes of drainage basins, drainage channels, etc. Design submittals that include rock rip-rap or similar methods must include a gradation size and mixture design for the rock material used.
 - 5.5.6.G.i Rock rip-rap must be 6” or larger crushed stone when used.
 - 5.5.6.G.ii Erosion control filter fabric is required beneath all rock rip-rap.
 - 5.5.6.G.iii 70% established vegetation for the entire drainage basin, drainage channel, etc. including all side slopes would be accepted in lieu of rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee along the side slopes of flume structures. (Note that this does not remove the requirement for rock rip-rap at the toe of all drainage structures.)
- 5.5.7 Pilot Channels
 - 5.5.7.A All pilot channels are to be constructed in accordance with the City’s Standard Details and Standard Specifications.
 - 5.5.7.B *Basin Pilot Channels* – Pilot channels are required in all detention basins. Pilot channels in detention basins are to be concrete, no less than 2’ wide, and are to connect any sub-surface outfall structure with the inlet structure for the detention basin.
 - 5.5.7.C *Channel Pilot Channels* – When placed in a channel, pilot channels are to be concrete, no less than 10’ wide, and centered on and match the elevation of the channel flowline.
 - 5.5.7.D Pilot channels are not required in ditches.
 - 5.5.7.E Pilot channels should be set at the flowline alignment of any detention basin or channel they are placed in.
- 5.5.8 Headwalls and Safety-End-Treatments
 - 5.5.8.A All headwalls are to be constructed in accordance with the City’s Standard Details and Standard Specifications.
 - 5.5.8.B Headwalls are to be constructed at the outfall of all storm drain culvert or pipe systems into open basins, channels, or ditches.
 - 5.5.8.B.i If a storm drain culvert or pipe discharge ends in a flume, the end of the culvert or pipe can be set flush with the surface of the flume and a separate headwall structure is not required.
 - 5.5.8.B.ii If a storm drain culvert or pipe discharge ends in a side-slope that is concrete paved and includes a concrete footing, the end of the culvert or pipe can be set flush with the surface of the concrete side- slope and a separate headwall structure is not required.
 - 5.5.8.C *Safety-End-Treatments* – Headwalls at the ends of storm drain culverts or pipes where the culvert or pipe size opening exceeds 24” must have safety-end-

treatments. Headwalls at the ends of storm drain culverts within 5' of a pavement edge or set into a side-slope that starts within 10' of a pavement edge must have safety-end-treatments.

5.5.8.D *Rock Rip-Rap* – Rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee are required along the perimeter of all headwall and safety-end-treatment structures in or on the side slopes of drainage basins, drainage channels, etc. Design submittals that include rock rip-rap or similar methods must include a gradation size and mixture design for the rock material used.

5.5.8.D.i Rock rip-rap must be 6" or larger crushed stone when used.

5.5.8.D.ii Erosion control filter fabric is required beneath rock rip-rap.

5.5.8.D.iii 70% vegetation for the entire drainage basin, drainage channel, etc. including all side slopes would be accepted in lieu of rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee along the side slopes of headwall and safety-end-treatment structures. (Note that this does not remove the requirement for rock rip-rap at the toe of all drainage structures.)

5.6 *Sub-Surface Infrastructure*

5.6.1 Underground Storage

5.6.1.A All underground storage is to be submitted for review and approval by the Engineering Services Director or designee.

5.6.1.B Underground storage is not allowed in public ROW.

5.6.2 Pipes

5.6.2.A Gravity Pipes

5.6.2.A.i All gravity pipes are to be constructed in accordance with the City's *Standard Details* and *Standard Specifications*.

5.6.2.A.ii Gravity pipes discharging into open basins, channels, or ditches will discharge at an elevation no more than 1.0' above the flowline of the basin, channel, or ditch at the point of discharge.

5.6.2.B Force Main Pipes

5.6.2.B.i All force main pipes are to be constructed in accordance with the City's *Standard Details* and *Standard Specifications*.

5.6.2.B.ii Force main pipes discharging into a junction box or manhole at an elevation greater than 24" above the invert of the junction box or manhole must have a drop structure. Drop structures are to be external drop structures unless otherwise approved by the Engineering Services Director or designee.

5.6.3 Culverts

- 5.6.3.A All culverts are to be constructed in accordance with the City's Standard Details and Standard Specifications.
- 5.6.3.B Culverts placed at channel or ditch crossings should always be aligned with the alignment of the channel or ditch that is being crossed and should always match the flowlines of the channel or ditch.
- 5.6.4 Junction Boxes and Manholes
 - 5.6.4.A All junction boxes and manholes are to be constructed in accordance with the City's Standard Details and Standard Specifications.
 - 5.6.4.B Junction boxes and manholes will be placed at all points of change in alignment, grade, size, pipe material, or inside diameter or size of the storm drain. Junction boxes and manholes will be placed at an intersection of two or more storm drain trunks, at the connection of all storm drain trunks and laterals, at the end of a dead-end system, and at any locations required to provide access for maintenance. Junction boxes and manholes will not be located within residential driveways or access points, or within vehicle wheel paths. Junction box and manhole rings and covers should be designed so they do not project into curb lines, sidewalks, retaining walls, guardrails, or other facilities sharing the same ROW or easement.
 - 5.6.4.C *Junction Box and Manhole Spacing* – junction boxes and manholes are to have a maximum separation distance of 500'.
 - 5.6.4.D *Junction Box and Manhole Sizing* – In accordance with the City's Standard Details and Standard Specifications.
 - 5.6.4.E Where the depth of a proposed storm drain system is sufficient and the storm drain size requires the use of a junction box rather than a manhole, a junction box with a manhole riser is to be used rather than an oversized junction box extending to the surface.
 - 5.6.4.F Offset junction boxes and manholes are not allowed unless approved by the Engineering Services Director or designee, in writing.
 - 5.6.4.G Any junction box or manhole set within a paved area must be set flushed with the adjacent paved surface.
 - 5.6.4.H *Junction Box Connection Spacing* – All connections to junction boxes will be made to a single face of the junction box, and no junction box face will have more than one culvert, pipe, or lateral connection made to it.
 - 5.6.4.H.i Any junction box face that does not have a culvert, pipe, or lateral connection made to it must be a full-thickness wall, and cannot be a thinner cut-out wall.
 - 5.6.4.I *Manhole Connection Spacing* – All connections to manholes should provide a minimum 1.0' outside separation between storm drain culverts, pipes, and laterals entering a manhole.
 - 5.6.4.J *Manholes with Culverts or Pipes of Different Sizes* – In manholes with culverts or pipes of different sizes (diameter, shape, etc.), the culvert or pipe inverts (flow lines)

will be placed at the same elevation unless the system hydraulics require the tops of the culverts or pipes to be set at the same elevation instead.

- 5.6.4.K Junction boxes and manholes deeper than 15' must be designed by a Professional Engineer. If the City's Standard Details and Standard Specifications are used for junction boxes or manholes deeper than 15', then the Professional Engineer must acknowledge on the design drawings that they have performed the necessary evaluations to establish that the City's Standard Details and Standard Specifications are adequate for a junction box or manhole placed at or deeper than 15' for the specific project.

5.6.5 Inlets and Outlets

- 5.6.5.A All inlets and outlets are to be constructed in accordance with the City's Standard Details and Standard Specifications.

5.6.5.B Curb Opening Inlets

- 5.6.5.B.i Curb inlets are the preferred drainage inlet for crowned streets with curb and gutter, and are the only inlet type allowed in the curb and gutter flowline.
- 5.6.5.B.ii Curb inlets are the preferred drainage inlet for raised medians that do not include a channel or ditch at their center.
- 5.6.5.B.iii Curb inlets at intersections are to be placed on the upstream approach to the intersection unless an alternate location is approved by the Engineering Services Director or designee in writing.
- 5.6.5.B.iv Curb inlets should not be located in conflict with driveways, ramps, or similar vehicle or pedestrian access routes.
- 5.6.5.B.v Curb inlets will be sized in multiples of 5' based on the width of the curb opening along the length of the curb flowline. The maximum continuous curb opening width at any one location will be 20' unless a wider opening is approved by the Engineering Services Director or designee.
- 5.6.5.B.vi The maximum approved vertical inlet opening is 6" unless a taller opening is approved by the Engineering Services Director or designee. If an opening taller than 6" is approved, then a bar or some other form of debris restraint across the curb opening will be required.
- 5.6.5.B.vii All curb inlets will have a 3" depression in addition to the maximum 6" vertical inlet opening.
- 5.6.5.B.viii All curb inlets are to be set flush with the adjacent curb and sidewalk.

5.6.5.C Scuppers

- 5.6.5.C.i Scuppers are to be designed in accordance with City's Standard Details and Standard Specifications.
- 5.6.5.C.ii Scupper curb opening sizes and depressions are to meet the same design requirements as curb opening inlets.

- 5.6.5.C.iii All scuppers are to be set flush with the adjacent curb and sidewalk.
- 5.6.5.D Grate Inlets
 - 5.6.5.D.i Grate inlets cannot be used in gutter flowlines.
 - 5.6.5.D.ii Grate inlets located in inverted streets should be located at the street invert flowline unless the street has a raised median or a divided median with a ditch or channel running through its center.
 - 5.6.5.D.iii Grate inlets located in paved surfaces must be set flush with the adjacent paved surface.
 - 5.6.5.D.iv Grate inlets must connect to a manhole, junction box, or catch basin. Grate inlets cannot connect directly to a storm drain pipe or culvert unless approved by the Engineering Services Director or designee in writing.
 - 5.6.5.D.v Grate inlet covers for manholes are to match the City's Standard Details and Standard Specifications.
 - 5.6.5.D.vi Grate inlet covers should be oriented so that the grate openings are aligned 90° to the vehicle or bicycle travel lane.
- 5.6.5.E Drop Inlets
 - 5.6.5.E.i Drop inlets will only be allowed in non-paved areas.
- 5.6.5.F *Linear Drains* – Linear drains, including slotted drains and trench drains, will not be allowed.
- 5.6.5.G *Combination Inlets* – Combination inlets, including curb and grate combinations, will not be allowed unless approved by the Engineering Services Director or designee in writing.
- 5.6.5.H *Rock Rip-Rap* – Rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee are required along the perimeter of all inlet and outlet structures in or on the side slopes of drainage basins, drainage channels, etc. Design submittals that include rock rip-rap or similar methods must include a gradation size and mixture design for the rock material used.
 - 5.6.5.H.i Rock rip-rap must be 6" or larger crushed stone when used.
 - 5.6.5.H.ii Erosion control filter fabric is required beneath rock rip-rap.
 - 5.6.5.H.iii 70% established vegetation for the entire drainage basin, drainage channel, etc. including all side slopes would be accepted in lieu of rock rip-rap or other suitable methods as approved by the Engineering Services Director or designee along the side slopes of all inlet and outlet structures. (Note that this does not remove the requirement for rock rip-rap at the toe of all drainage structures.)
- 5.6.6 Catch Basins
 - 5.6.6.A All catch basins are to be constructed in accordance with the City's Standard Details and Standard Specifications.

- 5.6.7 Check Valves and Vaults
 - 5.6.7.A All check valves and vaults are to be constructed in accordance with the City's Standard Details and Standard Specifications.

5.7 Typical Layout

- 5.7.1 *General* – Refer to City Standard Details and Standard Specifications for typical storm drain trunk, storm drain lateral, and appurtenance locations and depths as well as other storm drain design standards.
- 5.7.2 The typical drainage pattern will be from lot to alley to street to drainage infrastructure to basin or channel. Cul-de-sac to street or street to cul-de-sac drainage patterns through a flume structure are allowed.
- 5.7.3 Public surface and sub-surface drainage systems cannot discharge onto private property unless a public drainage easement and all necessary receiving infrastructure exists on the portion of the private property being discharged to.
- 5.7.4 Surface Drainage System
 - 5.7.4.A All flow conveyed by a surface drainage system must be contained within the limits of the surface drainage system. Storm runoff conveyed through public ROW or drainage easements cannot extend beyond the limits of the public ROW or drainage easement.
 - 5.7.4.B Cul-de-sacs are not allowed to discharge storm runoff onto arterial or collector streets.
 - 5.7.4.C Where surface storm runoff is forced to make a turn at a street intersection, cul-de-sac, or knuckle the pavement section of the street intersection, cul-de-sac, or knuckle is to be concrete pavement.
 - 5.7.4.D Where surface storm runoff crosses a paved street or alley at a location other than an intersection, the street or alley pavement section is to be concrete paved for the full width of the designed discharge and receiving openings on either end of the crossing, whichever is wider, plus a minimum 5' of additional concrete paving to either side.
 - 5.7.4.E Any alley conveying runoff from a street, drainage structure, basin, or channel must be constructed as a drainage alley with concrete pavement for the full width of the alley as well as concrete curbs. (Note that this doesn't apply when runoff is merely conveyed across an alley.)
- 5.7.5 Sub-Surface Drainage System
 - 5.7.5.A *Horizontal Curves* – Horizontal curves will only be allowed for flexible pipe approved per the City's Standard Specifications as long as the curve does not exceed 50% of the manufacturer's recommendation for the pipe joint deflection. Horizontal curves will not be allowed for rigid pipe or culverts. Where horizontal curves are allowed, manholes will be located at the point of curvature (PC) and point of tangency (PT) of the horizontal curve. Vertical curves are not allowed. No bending of pipe is allowed.

- 5.7.5.B *Depth of Cover* – The design engineer is responsible for ensuring that sufficient depth and grade are maintained for all subsurface storm drains to serve all necessary regions in the drainage area, and in accordance with the City’s Standard Details and Standard Specifications.
- 5.7.5.C The minimum required cover at the upstream end of a dead-end storm drain is to be no less than 42”, i.e. 3.5’.
- 5.7.5.D A minimum vertical separation of 2.0’ is to be maintained for all crossings with public utilities unless written approval for a variance is first obtained from the Utilities Director or designee.
- 5.7.5.E Water mains are to be located over wastewater mains, storm drains, gas lines, oil lines, buried electric lines, and buried franchise lines at all utility crossings. Other utilities or lines are to be lowered beneath water mains at crossings unless a variance is first obtained from the Utilities Director or designee.
- 5.7.5.F Storm drains are to utilize a junction box, manhole or inlet box at all storm drain culvert or pipe intersections, grade changes, and alignment changes.
 - 5.7.5.F.i Storm drain junction boxes, manholes, or inlets should be located at the tie-in points for any future storm drain extensions.
 - 5.7.5.F.ii When possible storm drain junction boxes or manholes should be located at street intersections so future extensions along side streets can be made without needing to set additional junction boxes or manholes.
- 5.7.5.G Storm drain laterals are to connect to storm drain culverts and trunk pipes at a junction box or manhole. Whenever possible storm drain laterals are to connect to storm drain culverts and trunk pipes at 90° angles.
- 5.7.5.H All inlets are to be located in accordance with the requirements of the Drainage Analysis Manual.
 - 5.7.5.H.i Inlets placed at street intersections should be located on the upstream end of the intersection.
 - 5.7.5.H.ii Inlets cannot be located in pedestrian access routes.

5.8 Separation of Storm Drain from Water Main

- 5.8.1 *Minimum Separation of Storm Drain from Water Main* – Minimum horizontal and vertical clearances between storm drains and water mains are to meet the same standards as between water and wastewater mains in accordance with the City Standard Details and TCEQ requirements.
- 5.8.2 *TCEQ Requirements* – When the minimum separation distance cannot be achieved, water mains and storm drains will be separated per TCEQ Rules and Regulations and City Standard Details and Standard Specifications. Refer to the following:
 - 5.8.2.A *30 TAC Chapter 290* – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems

5.8.2.B 30 TAC Chapter 217 – Design Criteria for Domestic Wastewater Systems Subchapter C: Conventional Collection Systems

5.9 Trenching and Bedding

- 5.9.1 *General* – Refer to the City’s Standard Details and Standard Specifications for typical storm drain culvert and pipe embedment requirements.
- 5.9.2 Trench walls for new utilities must maintain at least 2.0’ horizontal separation from existing utility trench walls.

5.10 Stabilization

- 5.10.1 All drainage system surfaces that are not paved must be fully stabilized.
- 5.10.2 Refer to **Section 10 (Environmental and Erosion Control Requirements)** of this Manual for information on permanent stabilization requirements.

5.11 Removal or Abandonment of Storm Drain Infrastructure

- 5.11.1 *General* – All existing storm drain infrastructure that is to be replaced within the City will be removed unless approved by the Engineering Services Director or designee.
- 5.11.2 *Removal of Existing Valley Gutters, Flumes, and Pilot Swales* – All existing storm drain valley gutters, flumes, and pilot swales that are to be removed are to be removed in their entirety. Any existing infrastructure the removed storm drain valley gutters, flumes, and pilot swales connected to, that will remain, is to be replaced or repaired as needed to City’s current standards. Any unpaved surface left after the removal of a valley gutter, flume, or pilot swale must be stabilized per **Section 5.10 (Stabilization)** in this Manual.
- 5.11.3 *Removal of Existing Storm Drain Culverts, Pipes, and Laterals* – All existing storm drain culverts, pipes, and laterals that are to be removed are to be removed in their entirety. Any existing storm drains that dead-end as a result of the existing storm drain culverts, pipes or laterals being removed are to be plugged. Any existing infrastructure the removed storm drain culverts, pipes, or laterals connected to, that will remain, are to be replaced or repaired as needed to City’s current standards. Existing storm drain culverts, pipes, and laterals are never to be abandoned in place, only removed.
- 5.11.4 *Removal of Existing Storm Drain Headwalls, Junction Boxes, Manholes, and Inlets* – All existing storm drain headwalls, junction boxes, manholes, and inlets that are to be removed are to be removed in their entirety. Any existing infrastructure the removed storm drain headwalls, junction boxes, manholes, or inlets connected to, that will remain, is to be replaced or repaired as needed to City’s current standards. Existing storm drain headwalls, junction boxes, manholes, and inlets are never to be abandoned in place, only removed.
- 5.11.5 *Removal of Existing Storm Drain Lift Station* – All existing storm drain lift stations that are removed are to be removed in their entirety, including the removal of all pads, fencing, electrical, etc. Any existing infrastructure the removed storm drain lift station connected to, that will remain, is to be replaced or repaired as needed to City’s current standards. Any unpaved surface left after the removal of a storm drain lift station must be stabilized per **Section 5.10 (Stabilization)** in this Manual. Existing storm drain lift stations are never to be abandoned in place, only removed.

5.12 Easements

- 5.12.1 Refer to **Section 2 (General)** of this Manual for easement information.
- 5.12.2 Where a development proposes to create a point flow discharge condition onto a neighboring property where no point flow condition previously existed, the Developer must obtain a drainage easement on the adjacent property and install all improvements necessary to return the storm runoff condition to either a sheet flow or no flow condition by the time the runoff reaches the limits of the easement.

5.13 Trenchless Requirements

- 5.13.1 *Design Requirements* – Engineers are to design all trenchless utility installations, rehabilitations, replacements, etc., including all pipe bursting, slip lining, cured-in-place, tunneling, jacking, boring, etc. in compliance with all applicable standards and requirements, including the City's *Standard Details*, and *Standard Specifications*. The design and specification submittal requirements for trenchless installations, rehabilitations, and replacements are the same as for open trenching design submittals, including plan and profile sheets, designs for boring and receiving pits, etc.
- 5.13.2 *Trenchless Installations for New Pipe* – Trenchless installations for new pipe are to only be utilized for straight pipe alignments with no horizontal or vertical deviations. When crossing a ROW, easement, street, utility, etc. the crossing is to be as close as possible to 90°.
- 5.13.3 *Trenchless Replacement or Rehabilitation of Existing Pipe* – Trenchless replacement or rehabilitation of existing pipe are to match the existing pipe alignment.
- 5.13.4 *Boring and Receiving Pits* – Whenever possible boring and receiving pits are to be located behind the back-of-curb or, where curb does not exist, behind the edge-of-pavement. Additional setback distances may be required for public and construction crew safety as well as to maintain the integrity of any existing street or alley being crossed.
- 5.13.5 *Trenchless Casing Pipe* – Casing pipe is required for all trenchless installations for new pipe installed by tunneling, jacking, or boring per the City *Standard Details* and *Standard Specifications*.

5.14 Storm Drain Lift Stations

- 5.14.1 It is the intent of the City to provide storm drain service by gravity storm drain systems. In the rare occasion that a gravity storm drain system is not a feasible service alternative, the City may require design and construction of a lift station and force main to serve a development. Lift stations and force mains are discouraged due to their higher risk of causing storm runoff overflow and increased maintenance costs. If service by a gravity storm drain system and all other design alternatives have been evaluated and determined to be unfeasible by the Engineering Services Director or designee, then lift stations and force mains will be designed with the criteria described in the following sections.
- 5.14.2 *Design Considerations* – Lift stations and force mains must be designed in accordance with requirements as determined by the Engineering Services Director or designee. The following will be considered in the design of a lift station:
 - 5.14.2.A Site selection
 - 5.14.2.B Wet well and valve vault design

- 5.14.2.C Pumps' lift station piping, and valves
- 5.14.2.D Force mains
- 5.14.2.E Electrical requirements
- 5.14.2.F Emergency provisions
- 5.14.3 *Materials and Specifications* – Refer to City's *Standard Details* and *Standard Specifications* about specific requirements for pump types, power, controllers, etc.
- 5.14.4 *Emergency Provisions* – A lift station must include an audiovisual alarm system. The audiovisual alarm system must transmit alarm conditions through use of an auto-dialer system approved by the Engineering Services Director or designee and be connected to a continuously monitored location. At a minimum, the alarm system must automatically activate to give warnings for power outages, pump failures, and high-water levels. Audiovisual alarms are not required if the auto-dialer system alerts the operator about communication loss, in addition to the alarm conditions.
- 5.14.5 All pipes used within lift stations are to be true-flanged pipe. Flanged fittings will not be accepted as an alternative.
- 5.14.6 Any public lift station must include a concrete pad at the lift station, an asphalt or concrete paved access path to the lift station, and a security fence and gate around the lift station.
- 5.14.7 The lift station concrete pad must be located a minimum of 1' above either the Base Flood Elevation (BFE) or the 100-year storm event, whichever has the higher elevation.

SECTION 6 WASTEWATER DESIGN REQUIREMENTS

6.1 General

- 6.1.1 *General Design Criteria* – It is the responsibility of the Engineer to ensure that all wastewater construction plans are in conformance with the current edition of the following:
- 6.1.1.A Texas Commission on Environmental Quality (TCEQ) Rules and Regulations
 - 6.1.1.B 30 Texas Administrative Code (TAC) Chapter 290 – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems
 - 6.1.1.C 30 TAC Chapter 217 – Design Criteria for Domestic Wastewater Systems Subchapter C: Conventional Collection Systems
 - 6.1.1.D American Water Works Association (AWWA) Standards
 - 6.1.1.E Clean Water Act (CWA) 1972
- 6.1.2 All wastewater system designs are to meet the requirements set forth in adopted ordinances and City utility standards.
- 6.1.3 This Section includes the minimum design requirements and standards associated with the City's wastewater system.
- 6.1.4 *Wastewater System Design* – All elements of wastewater systems and infrastructure must be designed and constructed in compliance with the City's Standard Details and Standard Specifications. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 6.1.5 *Wastewater Plan Requirements* – Construction plan and profiles are required for all wastewater mains. A profile is not required for wastewater service laterals.
- 6.1.6 Public wastewater mains are to be extended across the full limits of all platted property unless approved by the Utilities Director.
- 6.1.7 The developer will construct all wastewater mains and appurtenances, including major distribution facilities, necessary to connect the development with the approved wastewater collection and disposal system.
- 6.1.8 No other utilities are ever to be installed in the same ditch as public utilities.
- 6.1.9 All new NON-METALLIC buried public utility mains must have both locator (i.e. detector) tape and wire installed over and parallel to the pipe.
- 6.1.10 All new METTALIC buried public utility mains must have locator (i.e. detector) tape installed over and parallel to the pipe.
- 6.1.11 When required, the required accuracy for wastewater Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual location. GPS coordinates are required on all as-built drawings at all manholes, valves, taps, appurtenances, and at no less than 50' intervals along all public wastewater mains.

- 6.1.12 The required accuracy for utility Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual locations. GPS coordinates are required on all as-built drawings at all manholes, valves, taps, appurtenances, and at no less than 50' intervals along all public mains.
- 6.1.13 Residential lots are to only have one wastewater tap unless written justification is provided to and accepted by The Utilities Director or their designee.
- 6.1.14 Commercial lots are to only have one wastewater tap unless written justification is provided to and accepted by The Utilities Director or their designee.
- 6.1.15 Domestic wastewater laterals and cleanouts must all be shown on construction drawing set submittals, including those for both building permits and subdivisions. Cleanouts are private, not public, and are required at building permit.
- 6.1.16 Underground wastewater public infrastructure must be designed and sized for the ultimate needs of the region they provide service to.
- 6.1.17 *Odor Control Units* – The Utilities Director or designee may require the installation of odor control units at force mains and lift stations. Odor control units must be designed in accordance with requirements as determined by the Utilities Director or designee and be compatible with existing odor control units within the City.
- 6.1.18 *Inverted Siphons* – Inverted siphons will not be allowed.

6.2 **Design Flow**

- 6.2.1 *Wastewater Demand and Supply* – Residential development submittals will include the total number of units and the total acres of the proposed development. Non-residential development submittals will include estimated wastewater use records showing the minimum hourly demand, maximum hourly demand, maximum daily demand, total building square footage, and the total acres for the proposed development. The projected maximum daily demand and maximum hourly demand will be calculated and shown in million gallons per day (MGD).

6.3 **Pipe Sizing and Spacing**

- 6.3.1 *Wastewater Main Sizing* – The wastewater main size will be determined by the Design Engineer and approved by the Utilities Director or designee. The sizing of the proposed wastewater main should consider future extensions to serve the entire wastewater collection basin. The Utilities Director or designee may require capacity calculations from the Developer to verify main sizing and adequate capacity prior to approval of the construction plans or building permits. Refer to **Table 6-1**, **Section 6.3.2**, **Section 6.3.3** and **Section 6.3.4** for wastewater pipe sizes.
 - 6.3.1.A *Minimum and Maximum Velocity* – Wastewater mains must obtain a minimum cleansing velocity of 2' per second (fps) with maximum design flows. Wastewater main maximum velocity will not exceed 10 fps when pipe is full.
 - 6.3.1.B *Minimum and Maximum Slopes* – In accordance with the TCEQ requirements, maximum design flow velocity will be determined using the Manning's Equation.
 - 6.3.1.B.i Manning's coefficient for design purposes will be $n=0.013$ for all sizing calculations regardless of pipe material.

Manning’s Equation

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

Where:

- V = Velocity (fps)
- n = Manning’s roughness coefficient (n = 0.013)
- R = Hydraulic radius of the conduit (R = A/P) (feet)
- A = Cross section flow area (square feet)
- P = Wetted perimeter (feet)
- S = Slope (feet per foot)

6.3.1.C Minimum and maximum slopes allowed for wastewater mains, per 30 TAC Chapter 217, are shown in Table 6-1. Increasing the main diameter to obtain a flatter slope will not be allowed unless the maximum design flows will fill the main greater than half-full.

Table 6-1. Minimum and Maximum Velocity and Slopes

| Size of Main (Inches) | Minimum Slope (Percent) | Maximum Slope (Percent) |
|-----------------------|-------------------------|-------------------------|
| 6 | 0.50 | 12.35 |
| 8 | 0.33 | 8.40 |
| 10 | 0.25 | 6.23 |
| 12 | 0.20 | 4.88 |
| 15 | 0.15 | 3.62 |
| 18 | 0.115 | 2.83 |
| 21 | 0.095 | 2.30 |
| 24 | 0.08 | 1.93 |
| 27 | 0.07 | 1.65 |
| 30 | 0.06 | 1.43 |
| 33 | 0.055 | 1.26 |
| 36 | 0.045 | 1.12 |
| 39 | 0.04 | 1.01 |
| > 39 | * | * |

* For pipes larger than 39 inches in diameter, the slope is determined by Manning’s formula to maintain a velocity greater than 2.0 feet per second and less than 10.0 feet per second when flowing full.

- 6.3.2 Wastewater main pipes must be the same pipe size and laid with uniform slope from manhole to manhole.
- 6.3.3 The minimum size for wastewater main pipe is 6” in diameter.
- 6.3.4 Laterals connecting to public wastewater manholes must be at least 6" diameter and installed within the public Right-of-Way (ROW) to the same standards as a public wastewater main.

- 6.3.5 Wastewater service laterals are not to connect to 15" or larger wastewater mains unless there is no other option and written permission is first given by The Utilities Director or their designee. Such connections must be made at a wastewater manhole.
- 6.3.6 Unless the ultimate end of a public gravity main is known at the time of design, the public gravity main must be designed and built as deep as possible to ensure it can be extended as far as possible to support future development.
- 6.3.7 Whenever possible wastewater laterals are to connect to wastewater mains at 90° angles.

6.4 Pipe Materials

- 6.4.1 *Pipe Materials* – Pipe materials are to meet the requirements of the City’s Standard Details and Standard Specifications unless the design Engineer determines that the needs of the specific project exceed the typical City standards, in which case it is the responsibility of the Design Engineer to submit alternate pipe material specifications meeting the needs of the specific project to the Utilities Director for their designee for approval.
- 6.4.2 Wastewater main pipes must be the same pipe material from manhole to manhole.
- 6.4.3 The minimum pipe wall thickness for wastewater mains deeper than 15’ must meet or exceed SDR26 ASTM D3034 pipe. It is the responsibility of the design engineer to determine if a higher rated (thick wall) pipe than SDR26 ASTM D3034 is required for the conditions of a specific project.

6.5 Manholes

- 6.5.1 *Manhole Locations* – Manholes will be placed at all points of change in alignment, grade, size, pipe material, or inside diameter of the wastewater main. In addition, manholes will be placed at an intersection of two or more wastewater mains, at the end of the main (after the last service), and any locations required to provide accessibility for maintenance. Manholes will not be located within a residential driveway or access point. Manhole location should not be within the wheel path. Manhole rings and covers should be designed so they do not project into curb lines, sidewalks, retaining walls, guardrails, or other facilities sharing the same ROW or easement.
- 6.5.2 *Manhole Spacing* – Manholes are to have the following spacing:

Table 6-2. Maximum Manhole Spacing

| Largest Main Size at Manhole | Maximum Manhole Spacing (Feet) |
|------------------------------|--------------------------------|
| 6-inch to 15-inch | 500 |
| 15-inch and larger | 800 |

- 6.5.3 *Manhole Sizing*– In accordance with the City’s Standard Details and Standard Specifications.
- 6.5.4 *Drop Manholes* – All drop manholes require approval by the Utilities Director or designee. Drop Manholes will be installed if there is an incoming main with a vertical drop of more than 24” measured from flowline to flowline. New wastewater mains connecting no more than 24” above the flowline invert of a manhole don’t have to provide a drop structure.

6.5.4.A Drop connections to new manholes will always be external drop connections. External drop connections to existing manholes are to be used unless a variance is approved by the Director of Utilities.

6.5.5 *Vertical Drops Across Manholes* - To maintain proper flow, manholes for all wastewater mains will be designed with a vertical drop matching the slope of the downstream pipe connected to the manhole..

6.5.6 *Manhole Surface Elevation* – The top of a manhole located outside of paving within the 100-year floodplain will be required to have a minimum elevation of 1’ above the ultimate 100-year water surface elevation as well as a concrete collar and watertight manhole cover. The tops of all other manholes will be set to the grade of adjacent land or paving, and will include a concrete apron constructed at grade per the City’s Standard Details and Standard Specifications. Manholes located within a street in a floodplain will require a water-tight cover.

6.5.7 *Manhole at the End of a Main* – In accordance with 30 TAC Chapter 217, all wastewater mains that may be extended at a future date, and laterals, will end (highest point) with a manhole. The manhole should be placed after the last service.

6.5.8 *Connection Spacing* – All connections to a manhole should include a minimum 1’ of outside separation between the wastewater mains/service lines entering a manhole. All residential service line connections to wastewater mains must maintain a minimum 5’ separation from the outside edge of any manhole.

6.5.9 *Manholes with Pipe of Different Sizes* – In manholes with pipes of different sizes (diameters), the pipe inverts (flow lines) will be placed at the same elevation.

6.6 **Cleanouts**

6.6.1 Cleanouts are required at the property line for all residential lots tying into the public wastewater system. Cleanouts are to be constructed as part of the building permit by the property owner.

6.7 **Wastewater Services**

6.7.1 *General* – Wastewater services and service markers will be designed and constructed in accordance with the City Standard Details and Standard Specifications within public ROW and public easements.

6.7.2 *Connections to a Manhole* – Wastewater service laterals that connect to public manholes must be no less than 6” diameter and constructed in the public ROW, to the same standards as a public wastewater main.

6.7.3 *Private Wastewater Services* – Private wastewater service lines outside the public ROW or public easements will be designed, permitted and inspected per the International Plumbing Code. Delineate the boundary between the public and private portions of the wastewater service on the construction plans.

6.7.4 *Single-Family Residential Service Line Size* – 4” minimum diameter service lines are required for all single-family residential services. Each residence will be served by an individual service.

6.7.5 Wherever possible, wastewater laterals are to connect to wastewater mains at 90° angles.

6.9 **Typical Layout**

- 6.9.1 *General* – Refer to the City Standard Details and Standard Specifications for typical wastewater main, service line, appurtenance locations, and depths.
- 6.9.2 *Horizontal Curves* – Horizontal curves will be allowed as long as the curve does not exceed 50% of the manufacturers' recommendation for the pipe joint deflection. Manholes will be located at the point of curvature (PC) and point of tangency (PT) of horizontal curve. Vertical curves are not allowed. No bending of pipe is allowed.
- 6.9.3 *Depth of Cover* – The design engineer is responsible for ensuring that sufficient depth and grade is maintained for all wastewater mains to serve all necessary tracts and parcels upstream in the drainage area, and in accordance with the City's Standard Details and Standard Specifications. The minimum cover required at the end of a dead-end wastewater main is to be no less than 30", i.e. 2.5'.
- 6.9.4 A minimum vertical separation of 2.0' is to be maintained for all crossings with public utilities unless written approval for a variance is first obtained from The Utilities Director or designee.
- 6.9.5 Wastewater mains will be located under water mains.

6.10 **Separation of Wastewater Main from Water Mains**

- 6.10.1 *Minimum Separation of Wastewater Mains from Water Mains* – Minimum horizontal and vertical clearances will be in accordance with TCEQ and City Standard Details and Standard Specifications.
- 6.10.2 *TCEQ Requirements* – When the minimum separation distance cannot be achieved, water mains and wastewater mains will be separated per TCEQ Rules and Regulations and City's Standard Details and Standard Specifications. Refer to the following:
 - 6.10.2.A 30 TAC Chapter 290 – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems; and,
 - 6.10.2.B 30 TAC Chapter 217 – Design Criteria for Domestic Wastewater Systems Subchapter C: Conventional Collection Systems.

6.11 **Trenching and Bedding**

- 6.11.1 *General* – Refer to the City Standard Details and Standard Specifications for typical wastewater main pipe embedment requirements.
- 6.11.2 Trench walls for new utilities must maintain at least 2' horizontal separation from existing utility trench walls.

6.12 **Removal or Abandonment of Wastewater Infrastructure**

- 6.12.1 *General* – Any existing wastewater mains, manholes, service laterals, or other infrastructure that are to be replaced within the City will be removed unless approved by the Utilities Director or designee.
- 6.12.2 *Removal of Existing Wastewater Mains and Laterals* – All existing wastewater mains and laterals that are to be removed are to be removed in their entirety. Any existing wastewater mains that dead-end as a result of the existing wastewater main being removed are to be plugged. Any

existing infrastructure the removed wastewater main or lateral connected to that will remain is to be replaced or repaired as needed to City standards.

6.12.3 *Abandonment of Existing Wastewater Mains and Laterals* – All existing wastewater mains and laterals that are to be abandoned are to be abandoned in place, filled with flowable fill 2-sack (2-sack = 188 lbs Portland Cement / cubic yards of concrete), and plugged. Any existing wastewater mains that dead-end as a result of the existing wastewater main being removed are to be plugged. Any existing infrastructure that abandoned wastewater main or lateral connected to that will remain is to be replaced or repaired as needed to City standards.

6.12.4 *Removal of Existing Wastewater Manholes* – All exiting wastewater manholes that are to be removed are to be removed in their entirety. Any existing infrastructure the removed wastewater manholes connected to that will remain is to be replaced and repaired as needed to City standards.

6.12.5 *Abandonment of Existing Wastewater Manholes* – Existing wastewater manholes are never to be abandoned in place, only removed.

6.13 Easements

6.13.1 *Utility Easements* – Refer to **Section 2 (General)** of this Manual for easement information.

6.14 Trenchless Requirements

6.14.1 *Design Requirements* – Engineers are to design all trenchless utility installations, rehabilitations, replacements, etc., including all pipe-bursting, slip lining, cured-in-place, tunneling, jacking, boring, etc. in compliance with all applicable standards and requirements, including City's Standard Details and Standards Specifications. The design and specification submittal requirements for trenchless installations, rehabilitations, and replacements are the same as for open trench design submittal, including plan and profile sheets, design for boring and receiving pits, etc.

6.14.2 *Trenchless Installation for New Pipe* – Trenchless installations for new pipe are to only be utilized for straight pipe alignments with no horizontal or vertical deviations. When crossing a ROW, easement, street, utility, etc. the crossing is to be as close as possible to ninety degrees (90°).

6.14.3 *Trenchless Replacement or Rehabilitation of Existing Pipe* – Trenchless replacement or rehabilitation of existing pipe are to match the existing pipe alignment.

6.14.4 *Boring and Receiving Pits* – Whenever possible boring and receiving pits are to be located behind the back-of-curb or, where curb does not exist, behind the edge-of-pavement. Additional setback distances may be required for public and construction crew safety as well as to maintain the integrity of any existing street or alley being crossed.

6.14.5 *Trenchless Casing Pipe* – Casing pipe is required for all trenchless installations for new pipe installed by tunneling, jacking, or boring per the City's Standard Details and Standard Specifications.

6.16 Wastewater Lift Stations

- 6.16.1 It is the intent of the City to provide wastewater service by main extensions. In the rare occasion that a wastewater main extension is not a feasible service alternative, the City may require design and construction of a lift station and force main to serve a development. Lift stations and force mains are discouraged due to their higher risk of causing a wastewater overflow and increased maintenance costs. If service by a gravity wastewater main and all other design alternatives have been evaluated and determined to be unfeasible by the Utilities Director or designee, lift stations and force mains will be designed with the criteria described in the following sections.
- 6.16.2 *Design Considerations* – Lift stations and force mains must be designed in accordance with TCEQ requirements and requirements as determined by the Utilities Director or designee. The following will be considered in the design of a lift station:
- 6.16.2.A Site selection
 - 6.16.2.B Wet well and valve vault design
 - 6.16.2.C Pumps, lift station piping, and valves
 - 6.16.2.D Force mains
 - 6.16.2.E Electrical requirements
 - 6.16.2.F Emergency provisions
- 6.16.3 *Emergency Provisions* – In accordance with 30 TAC Chapter 217, a lift station must include an audiovisual alarm system. The audiovisual alarm system must transmit alarm conditions through use of the AutoDialer system or connected to a continuously monitored location. At a minimum, the alarm system must automatically activate to give warnings for power outages, pump failures, and high-water levels. Audiovisual alarms are not required if the AutoDialer system alerts the operator about communication loss, in addition to the alarm conditions.
- 6.16.4 All pipes used within lift stations are to be true-flanged pipe. Flanged fittings will not be accepted as an alternative.
- 6.16.5 Any public lift station must include a concrete pad at the lift station, an asphalt or concrete paved vehicle access path to the lift station, and a security fence and gate around the lift station. All lift stations must come with a water spigot.
- 6.16.6 Lift station concrete pad must be located minimum 1' above either the Base Flood Elevation (BFE) or the 100-year storm event, whichever has the higher elevation.

SECTION 7 WATER DESIGN REQUIREMENTS

7.1 General

- 7.1.1 This Section includes the minimum design requirements and standards associated with the City's water system.
- 7.1.2 *General Design Criteria* – It is the responsibility of the Engineer to ensure that all water construction plans are in conformance with the current edition of the following:
 - 7.1.2.A Texas Commission on Environmental Quality (TCEQ) Rules and Regulations
 - 7.1.2.B 30 Texas Administrative Code (TAC) Chapter 290 – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems
 - 7.1.2.C 30 TAC Chapter 217 – Design Criteria for Domestic Wastewater Systems Subchapter C: Conventional Collection Systems
 - 7.1.2.D American Water Works Association (AWWA) Standards
 - 7.1.2.E Clean Water Act (CWA) 1972
- 7.1.3 No other utilities are ever to be installed in the same ditch as public utilities.
- 7.1.4 All new NON-METALLIC buried public utility mains must have both locator (i.e. detector) tape and wire installed over and parallel to the pipe.
- 7.1.5 All new METTALIC buried public utility mains must have locator (i.e. detector) tape installed over and parallel to the pipe.
- 7.1.6 When required, the required accuracy for water Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual location. GPS coordinates are required on all as-built drawings at all manholes, valves, taps, appurtenances, and at no less than 50' intervals along all public water mains.
- 7.1.7 GPS coordinates are required on all as-built drawings at all manholes, valves, taps, appurtenances, and at no less than 50' intervals along all public mains. The required accuracy for utility Global Positioning System (GPS) coordinates will be within 1" to 3" of the actual locations.
- 7.1.8 Residential lots are to only have 1 domestic water tap unless written justification is provided to and accepted by The Utilities Director or their designee. The domestic water tap will also be used for irrigation.
- 7.1.9 Commercial lots are to only have 1 domestic water and 1 irrigation tap unless written justification is provided to and accepted by The Utilities Director or their designee. The domestic water and irrigation taps must be separately metered taps.
- 7.1.10 Domestic, irrigation, and fire laterals as well as meters and vaults must all be shown on construction drawing set submittals, including those for both building permits and subdivisions.
- 7.1.11 Underground public infrastructure such as water drains must be designed and sized for the ultimate needs of the region they provide service to.

- 7.1.12 All water system designs will meet the criteria of the adopted International Fire Code (IFC) as amended and all applicable requirements of the most recent edition of National Fire Protection Association (NFPA) 24. NFPA standards are effective on the January 1st of the year following the effective date printed in the standard. All water system designs will also meet the requirements set forth in adopted ordinances and City of Midland (COM) utility standards.
- 7.1.13 *Water System Design* – Water System Design - All elements of water systems and infrastructure must be designed for the system's working pressure, and designed and constructed in compliance with the City's Standard Details, and Standard Specifications. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 7.1.14 *Water Plan Requirement* – Construction plans are required for all water mains. A profile is required for all water mains. A profile is not required for water service laterals.
- 7.1.15 Public water mains are to be extended across the full limits of all platted property unless approved by the Utilities Director or designee.
- 7.1.16 The developer will construct all water mains and appurtenances, including major distribution facilities, necessary to connect the development with the approved water supply and distribution system.

7.2 Design Flow

- 7.2.1 *Water Demand and Supply* – Residential development submittals will include the total number of units and the total acres of the proposed development. Non-residential development submittals will include estimated water use records showing the minimum hourly demand, maximum hourly demand, maximum daily demand, total building square footage, and the total acres for the proposed development. The projected maximum daily demand and maximum hourly demand will be calculated and shown in million gallons per day (MGD).

7.3 Pipe Sizing and Spacing

- 7.3.1 Water main pipes must be the same pipe size from fitting to fitting.
- 7.3.2 The minimum size for water mains in residential and retail development is 6" in diameter, and the minimum size for water mains in non-residential and non-retail development is 8" in diameter.

7.4 Pipe Materials

- 7.4.1 *Pipe Materials* – Pipe materials are to meet the requirements of the City Standard Details and Standard Specifications unless the design Engineer determines that the needs of the specific project exceed the typical City standards, in which case it is the responsibility of the design Engineer to submit alternate pipe material specifications meeting the needs of the specific project to the Utilities Director or their designee for approval.
- 7.4.2 Water main pipes must be the same pipe material from fitting to fitting.

7.5 Design Pressure

- 7.5.1 Minimum pressure under normal conditions should exceed 35 pounds per square inch (psi) while pressure during extreme events, such as fire flow events, will not drop below 20 psi.

7.7 Methods of Connection

- 7.7.1 *Cut-in Tees* – When connecting to existing water mains, the City preference is that the connection be made with a cut-in tee fitting when possible rather than a tapping sleeve and valve. Size on size connections must always be made with a cut-in tee. When a new main connects with an existing main and the City determines that a new in-line valve is needed on the existing water main, a cut-in tee connection will be required. Any cut-in tee connection is to meet the requirements of the City's *Standard Details* and *Standard Specifications*.
- 7.7.2 *Tapping Sleeves and Valves* – Tapping sleeves and valves are allowed for connections to existing water mains 6” through 12” in size. Connections to existing water mains larger than 12” are only allowed with written approval by the Utilities Director or designee.
- 7.7.3 Water service laterals are not to connect to 16” or larger water mains unless there is no other option and written permission is given by the Utilities Director or designee.
- 7.7.4 *Cross* - When connecting crossing pipes, a cross fitting connection is to be used rather than two offset tee or tapping sleeve connections whenever possible. When connecting a new main to an existing main next to an existing tee, replace the existing tee with a new cross fitting connection.

7.8 Looped Water Main Systems and Dead-End Water Mains

- 7.8.1 All public water mains must be looped. Water service to each lot included on the final plat will be from a looped water main. In addition, the water supply to the subdivision as a whole will be based on a plan for an area-wide looped system of trunk lines which will supply water flow from two directions or sources.
- 7.8.2 Dead-end water mains will not be allowed if a looped or interconnected water main system is feasible or if the dead-end water main proposed would be longer than 300'. If a looped or interconnected water main system is not feasible, then a dead-end water main will be allowed only if infrastructure is in place to allow for routine flushes of the water main and a written approval by the Utilities Director or their designee is obtained.
- 7.8.3 *Flushing Requirements* – Where dead-end mains are approved, the design will allow for routine flushing of stagnant water through a flushing device in accordance with **Table 7-1**.

Table 7-1. Flushing Requirements

| Dead-End Length (Feet) | Flushing Requirement |
|---------------------------|-------------------------------------|
| Less than 200 | Fire Hydrant |
| 200 – 300 | Chlorine Analyzing Flushing Station |
| More than 300 | Not allowed |

- 7.8.4 *Temporary Dead-End Mains* - Where temporary dead-end water mains are approved by the Utilities Director or their designee, the dead-end water main will extend a minimum of 5' beyond the edge of pavement for a future water main extension to connect to. If the end of a temporary dead-end water main is adjacent to a fitting, the dead-end water main that is 12" in diameter or smaller must extend a minimum 20' (one full pipe joint) beyond the fitting, and a

dead-end water main that is 16" in diameter or larger must extend a minimum 40' (two full pipe joints) beyond the fitting.

7.8.5 Water mains serving two (2) or more fire hydrants must be on a looped water system.

7.8.6 Private water systems looped through a site connecting to the public water system must be connected to two different existing public water mains to provide system redundancy.

7.9 Fire Protection Requirements

7.9.1 Fire flow requirements may be ascertained by applying Appendix B of the adopted IFC to the building in question.

7.9.2 Fire flow data older than one year will not be accepted.

7.9.3 Fire Hydrants

7.9.3.A *General* – All fire hydrants supplied will comply with AWWA C-502 and the City Standard Details and Standard Specifications.

7.9.3.B Fire Hydrant Placement

7.9.3.B.i Fire Hydrants should be placed at intersections for increased flexibility. Where this not possible, a hydrant may be placed along a curb. Access turning radius must always be in consideration.

7.9.3.B.ii Fire Hydrants should be located on the same side of the street as the building.

7.9.3.B.iii Hydrants will be located so the center of the larger diameter outlet is not less than 18" above final grade.

7.9.3.B.iv Fire Hydrant coverage does not extend across arterial or major collector streets.

7.9.3.B.v Fire hydrants will be located within public street rights-of-way (ROW) and water main easements.

7.9.3.B.vi Fire Hydrants will be spaced in accordance with the City's current adopted edition of the IFC, Appendix C: Fire Hydrant Locations and Distribution and current City standards, whichever is more restrictive.

7.9.3.B.vii Fire Hydrant coverage along frontage is 250' as the hose lies off the truck.

7.9.3.C Spacing and Location

7.9.3.C.i Fire hydrants will be located within public street rights-of-way (ROW) and water main easements and be spaced in accordance with the City's current edition of the IFC, Appendix C: Fire Hydrant Locations and Distribution, with adopted City amendments. Refer to the City Standard Details and Standard Specifications for typical fire hydrant locations.

7.9.3.D Public fire hydrants are to be yellow, and private fire hydrants are to be red. All fire hydrants are to be coated (not painted) at the factory prior to delivery.

7.9.3.D.i *Public Fire Hydrant* - A fire hydrant that has been installed by or on behalf of the City and is located on a street or is located on private property

pursuant to an easement or other right of use agreement in favor of the City.

7.9.3.D.ii *Private Fire Hydrant* - A fire hydrant that has been installed on private property, which are owned and maintained by the owner of the private property.

7.9.3.E If a fire hydrant needs to be set to meet the distance requirement to a Fire Department Connection (FDC) and the fire hydrant cannot be set at a typical, common location (e.g. street corner, lot line, etc.), then the fire hydrant needs to be set on site as a private fire hydrant and will be coated red.

7.9.4 Fire Department Connection (FDC)

7.9.4.A FDCs are to be installed per the City's currently adopted version of the IFC and as directed by the City's Fire Marshal.

7.9.4.B If a FDC is required, a hydrant will be installed within 100' of the FDC as a hose would lay off the truck and 50' from a fire lane.

7.9.4.C Consult with the City's Fire Marshal and the IFC concerning maximum distance from an FDC to a fire hydrant as measured along a route approved by the City's Fire Marshal.

7.9.5 Post Indicator Valves (PIV)

7.9.5.A PIVs will be installed on fire lines according to NFPA-13 and NFPA-24. All PIV's will be secured by a KNOX® padlock #3770. All PIV's will be Fire Department Red in color.

7.9.6 Fire Lines

7.9.6.A *Fire Line* – That portion of the pipe from the PIV to a building dedicated to a fire sprinkler or standpipe system.

7.9.6.B Dedicated fire lines must be separate from domestic lines.

7.9.6.C Fire lines will be installed by a licensed underground contractor registered for "Underground Fire Main", Texas Insurance Code Chapter 6003, Section 34.710 (i) (3).

7.9.6.D Each fire line underground contractor will have a registered Responsible Managing Employee (RME Underground Fire Main), Texas Insurance Code 6603 Section 34.716(3).

7.9.6.E Each fire line will be hydrostatically tested and flushed according to NFPA-24 Chapter 10 Underground Piping.

7.9.6.F Thrust blocks will be approved by the Fire Marshall prior to backfilling. All trench depth, bedding and backfill will meet NFPA 24 standards and the City's Standard Details and Standard Specifications.

7.9.6.G Where meters are required by other authorities, they will be listed for fire service.

7.9.6.H Non-residential developments with fire lines must provide a 6" or 8" manifold from the existing or proposed water main in the public ROW and tap all fire, water, and irrigation service laterals off the manifold pipe.

7.10 Fittings and Pipe Restraints

- 7.10.1 *Joint Restraint* – All fittings must be restrained with either mechanical or flanged joint restraints as per the City Standard Details and Standard Specifications.
- 7.10.2 *Thrust Blocking* – All fittings, valves, hydrants, and other appurtenances will be blocked with concrete. Sizing and construction of blocking will be in accordance with City Standard Details and Standard Specifications.
- 7.10.3 All fittings must be wrapped in an approved plastic wrap or equivalent material.

7.11 Gate Valves

- 7.11.1 *General* – All valves for public water mains will be gate valves in accordance with the City Standard Details and Standard Specifications.
- 7.11.2 *Large Gate Valve Requirements* – Valves 16” and larger require horizontal gate valves and will be placed within a valve vault as per the City’s Standard Details and Standard Specifications.
- 7.11.3 All valves must be restrained with either mechanical or flanged joint restraints as per the City Standard Details and Standard Specifications. Valves will be anchored to adjacent fittings at tee and cross fittings and on fire hydrant leads as per the City’s Standard Details and Standard Specifications. Valves will not be used at the dead end of mains as a cap.
- 7.11.4 *Valve Orientation* – All valves must be placed perpendicular to the ground elevation as per the City’s Standard Details and Standard Specifications.

7.12 Air Valve Assemblies

- 7.12.1 *General* – Air relief valves will be installed in locations such to exhaust trapped air from the water distribution system.
- 7.12.2 *Installation Requirements* – Air relief valves will be installed in accordance with the City Standard Details and Specifications.

7.13 Backflow Prevention

- 7.13.1 *General* – As a condition of water service, all customers will install, maintain, and operate their piping and plumbing systems in accordance with City Standard Details and Standard Specifications. Irrigation will have a backflow prevention device to protect the public water system from cross contamination. Looped private systems with more than one meter will have a backflow at connection points
- 7.13.2 *Circumstances Requiring Use of Backflow* – An approved backflow preventer will be installed before the first branch line leading off the service line wherever the following conditions exist:
 - 7.13.2.A When the nature and extent of any activity at a premise, or the materials used in connection with any activity at a premise, or materials stored at a premise, could contaminate or pollute the potable water supply.
 - 7.13.2.B When a premise has one or more cross connections.
 - 7.13.2.C When an auxiliary water supply that is not, or may not be, of safe bacteriological or chemical quality.

- 7.13.2.D When industrial fluids or any other objectionable substances are handled in such a fashion as to create an actual or potential hazard to the public water system. This will include the handling of processed waters and waters originating from the utility system that have been subject to deterioration in quality.
- 7.13.2.E When internal cross connections are present that are not correctable; and/or,
- 7.13.2.F When intricate plumbing arrangements are present that make it impractical to ascertain whether cross connections exist.
- 7.13.3 *Location* – An approved backflow preventer will be set in vault per the City’s Standard Details and Standard Specifications.
- 7.13.4 *Type of Backflow Preventer* – Any backflow prevention assembly that is required will be an approved backflow assembly of a model and size approved by the Utilities Director or designee that has been manufactured in full conformance with the AWWA C510-89 – Standard for Double Check Valve Backflow Prevention Assembly and AWWA C511-89 – Standard for Reduced-Pressure Principal Backflow Prevention Assembly. The type of backflow preventer required will depend upon the degree of hazard that exists as follows:
 - 7.13.4.A In the case of any premises where there is an auxiliary water supply and it is not subject to any of the following rules, the public water system will be protected by an approved air-gap separation or an approved reduced-pressure backflow prevention assembly.
 - 7.13.4.B In the case of any premises where there is water or a substance that would be objectionable, but not a health hazard, if introduced into the public water system, an approved double check valve assembly will protect the public water system.
 - 7.13.4.C In the case of any premises where there is any material dangerous to health that is handled in such a fashion as to create an actual or potential hazard to the public water system, the public water system will be protected by an approved air-gap separation or an approved reduced-pressure backflow prevention assembly. Examples of premises where these conditions may exist include sewage treatment plants, sewage pumping stations, chemical manufacturing plants, hospitals, mortuaries, and plating plants.
 - 7.13.4.D In the case of any premises where there are "uncontrolled" cross connections, either actual or potential, the public water system will be protected by an approved air-gap separation or an approved reduced-pressure backflow prevention assembly at the service connection.
 - 7.13.4.E In the case of any premises where, because of security requirements or other prohibitions or restrictions, it is impossible or impractical to make a complete in-plant cross connection survey, the public water system will be protected by either an approved air-gap separation or an approved reduced-pressure backflow prevention assembly on each service to the premises.
 - 7.13.4.F In the case of any premises where, in the opinion of the Utilities Director, an undue health hazard exists because of the presence of extremely toxic substances, the Utilities Director may require an air-gap at the service connection to protect the

public water system. This requirement will be at the discretion of the City Official and is dependent on the degree of hazard.

7.13.5 *Installation Requirements* – Backflow prevention assemblies will be installed in accordance with the City standards. The assembly installer will obtain the required plumbing permits prior to installation and will have the assembly inspected annually by a certified cross connection inspector.

7.13.5.A All assemblies will be readily accessible with adequate room for maintenance and testing.

7.14 Water Services

7.14.1 *General* - All water service laterals and fittings will be designed and constructed in accordance with the City Standard Details and Standard Specifications within public ROW and public easements.

7.14.2 *Private Water Services* – Private water service lines outside the public ROW or public easements will be designed, permitted, and inspected per the International Plumbing Code. The public water meter is the boundary between the public and private portions of the water service.

7.14.3 *Single-Family Residential Service Line Size* – 1” minimum diameter service lines are required for all single-family residential services. Each residence will be served by an individual service.

7.14.4 Meter and Service Location

7.14.4.A Meters and services must be located within ROW or easements in accordance with City Standard Details and Standard Specifications.

7.14.4.A.i Meters must be placed to enable meter reading without hazards and be in ROW or an easement accessible from the ROW to allow for vehicle access.

7.14.4.B Water meters are to only be located in unpaved areas.

7.14.5 *Meter Size* – Bullheaded or “split” ganged meters are not allowed in lieu of a larger meter. The Utilities Director or designee may require meter sizing calculations in accordance with the *International Plumbing Code* or *AWWA Manual of Water Supply Practices M22 –Sizing Water Service Lines and Meters*.

7.14.6 Irrigation service laterals and meter locations will be shown on all construction drawing submittals, including residential developments that choose to have separate domestic and irrigation service laterals and meters rather than joint domestic and irrigation service laterals and meters.

7.14.7 Commercial developments are required to have separate irrigation meters or a water well to be used for irrigation.

7.14.8 Wherever possible water service laterals are to connect to water mains at 90° angles.

7.15 Typical Layout

7.15.1 *General* – Refer to the City Standard Details and Standard Specifications for typical water main, service line, appurtenance locations, and depths.

- 7.15.2 *Radius of Curvature/Joint Deflection* – Minimum radius of curve and maximum deflection angle of pipe joints will be restricted to 50% of manufacturer’s recommendation, after which the use of horizontal or vertical bend fittings will be required. No bending of pipe is allowed.
- 7.15.3 *Bends* – All bends will be 90 degrees or less and designed for industry standard fittings sizes and angles. Designs should avoid excessive bends in the pipe system when possible.
- 7.15.4 *Depth of Cover* – The design engineer is responsible for ensuring that sufficient depth is maintained for all water mains in accordance with the City’s Standard Details and Standard Specifications.
- 7.15.5 A minimum vertical separation of 2.0' is to be maintained for all crossings with public utilities unless written approval for a variance is first obtained from the Utilities Director or their designee.
- 7.15.6 Water mains are to be located over wastewater mains, storm drains, gas lines, oil lines, buried electric lines, and buried franchise lines at all utility crossings. Other utilities or lines are to be lowered beneath water mains at crossings unless a variance is first obtained from the Utilities Director or their designee.
- 7.15.7 All metal pipes must be wrapped in an approved plastic wrap or equivalent material.
- 7.15.8 Where it facilitates a water main crossing over another underground utility, a water main may have a minimum cover of 30" at the crossing with other utility while maintaining all other minimum required vertical separations. Water mains are to return to the standard cover depth shown in the City's Standard Details and Standard Specifications once they have completed any such utility crossing.

7.16 Separation of Water Main from Wastewater Mains

- 7.16.1 *Minimum Separation of Water Mains from Wastewater Mains* – Minimum horizontal and vertical clearances will be in accordance with TCEQ and City’s Standard Details and Standard Specifications.
- 7.16.2 *TCEQ Requirements* – When minimum separation distance cannot be achieved, water mains and wastewater mains will be separated per TCEQ Rules and Regulations and City Standard Details and Standard Specifications. Refer to the following:
 - 7.16.2.A 30 TAC Chapter 290 – Public Drinking Water Subchapter D: Rules and Regulations for Public Water Systems; and,
 - 7.16.2.B 30 TAC Chapter 217 – Design Criteria for Domestic Wastewater Systems Subchapter C: Conventional Collection Systems.

7.17 Trenching and Bedding

- 7.17.1 *General* – Refer to the City’s Standard Details and Standard Specifications for the typical water main pipe embedment requirements.
- 7.17.2 Trench walls for new utilities must maintain at least 2.0' horizontal separation from existing utility trench walls.

7.19 Removal or Abandonment of Water Infrastructure

- 7.19.1 *General* – All existing water mains, valves, service laterals, or other infrastructure that are to be replaced within the City will be removed unless approved by the Utilities Director or designee.
- 7.19.2 *Removal of Existing Water Mains and Laterals* – All existing water mains and laterals that are to be removed are to be removed in their entirety. Any existing water mains that dead-end as a result of the existing water main being removed are to be capped. Any existing infrastructure the removed water main or lateral connected to that will remain is to be replaced or repaired as needed to City standards.
- 7.19.3 *Abandonment of Existing Water Mains and Laterals* – All existing water mains and laterals that are to be abandoned are to be abandoned in place, filled with flowable fill 2-sack (2-sack = 188 lbs Portland Cement / cubic yard of concrete), and capped. Any existing water mains that dead-end as a result of the existing water main being abandoned are to be capped. Any existing infrastructure the abandoned water main or lateral connected to that will remain is to be replaced or repaired as needed to City standards.
- 7.19.4 *Abandonment of Existing Water Valves* – Existing water valves are never to be abandoned in place if the existing water main is removed. If the existing water main is abandoned in place, then the existing water valves are to be closed, the valve nut is to be broken off, and the valve box is to be filled with concrete meeting or exceeding City standards for concrete pavement.
- 7.19.5 *Removal of Existing Fire Hydrants* – Existing fire hydrants that are removed are to be returned to the City of Midland. Fire hydrants are never to be abandoned in place.
- 7.19.6 *Removal of Existing Water Meters* – Existing water meters that are removed are to be returned to the City of Midland. Water meters are never to be abandoned in place. When a water meter is removed from an active lateral, the angle stop on the lateral must be closed and locked before the meter is removed.

7.20 Easements

- 7.20.1 See **Section 2 (General)** of this Manual for easement information.

7.21 Trenchless Requirements

- 7.21.1 *Design Requirements* – Engineers are to design all trenchless utility installations, rehabilitations, replacements, etc., including all pipe-bursting, slip lining, cured-in-place pipe, tunneling, jacking, boring, etc. in compliance with all applicable standards and requirements, including City Standards, Details, and Specifications. The design and specification submittal requirements for trenchless installations, rehabilitations, and replacements are the same as for open trench design submittals, including plan and profile sheets, designs for boring and receiving pits, etc.
- 7.21.2 *Trenchless Installations for New Pipe* – Trenchless installations for new pipe are to only be utilized for straight pipe alignments with no horizontal or vertical deviations. When crossing a ROW, easement, street, utility, etc. the crossing is to be as close as possible to ninety degrees (90°).
- 7.21.3 *Trenchless Replacement or Rehabilitation Of Existing Pipe* – Trenchless replacement or rehabilitation of existing pipe are to match the existing pipe alignment.
- 7.21.4 *Boring and Receiving Pits* – Whenever possible boring and receiving pits are to be located behind the back-of-curb or, where curb does not exist, behind the edge-of-pavement.

Additional setback distances may be required for public and construction crew safety as well as to maintain the integrity of any existing street or alley being crossed.

- 7.21.5 *Trenchless Casing Pipe* – Casing pipe is required for all trenchless installations for new pipe installed by tunneling, jacking, or boring per the City Standard Details and Standard Specifications.

7.22 Midland County Subdivision Regulations

- 7.22.1 Article X – Water

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SECTION 8 STRUCTURAL DESIGN REQUIREMENTS

8.1 General

- 8.1.1 This Section includes the minimum design requirements and standards associated with the City's structures.
- 8.1.2 *Structural Design* - All elements of structural systems and infrastructure must be designed and constructed in compliance with the City's Standard Details, and Standard Specifications when applicable. A qualified Professional Engineer licensed in the State of Texas must determine when the City's Standard Details and Standard Specifications are applicable or not and provide written justification for the latter. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 8.1.3 Responsibility
- 8.1.3.A The Engineer must bear the sole responsibility for meeting the engineering standard of care for all aspects of the design and providing a design that is appropriate for the site-specific conditions and intended use of the facilities.
- 8.1.3.B The structural design must be signed and sealed by a Professional Engineer competent in structural engineering and licensed in the State of Texas. The Engineer is responsible for all engineering of the structure and recognizes that specific site circumstances or conditions may require improvements that exceed minimum standards contained in the *Engineering Design Manual*. The Engineer is responsible for evaluating and applying appropriate standards and specifications.
- 8.1.3.C The Engineer must rely on the geotechnical investigation recommendations as minimum design criteria. If in the Engineer's judgment, the structural design needs to be based upon more conservative geotechnical design criteria, the Engineer must provide the more conservative design.
- 8.1.4 *Structures* – For this section of the *Engineering Design Manual*, structures will include the following items, but not be limited to: bridges, foundations, retaining walls, headwalls and wingwalls, bridge-class culverts, slopes and embankments, creek and channel structures, elevated (aerial) crossings, and other civil structures.
- 8.1.5 *Temporary Shoring* – Temporary shoring must be provided as applicable to protect adjacent infrastructure during construction. Infrastructure is defined as structures, pavement, utilities, hardscaping, or any other structure or facility. Design calculations and details sealed by a Professional Engineer licensed in the State of Texas must be submitted to the City of Midland and filed for record purposes before constructing the shoring.
- 8.1.6 *Right-of-Way (ROW)* – All private development structures including foundations, walls, slabs, beams, etc. will not extend inside the City's public ROW.
- 8.1.7 *Inspections* – Inspections of structures must be performed in accordance with this section. Inspection for structures not performed directly by the City must be performed by a third-party and include a letter signed and sealed by a qualified Professional Engineer licensed in the State of Texas stating that the structure was constructed in general compliance with the City's Standard Details and Standard Specifications. Any structure outside the public ROW and any

structure constructed with non-City funds whether inside or outside the public ROW or public easements, must require third-party inspection and be provided to the City.

8.1.7.A Non-Bridge Construction Inspection

8.1.7.A.i Inspections of non-bridge structures must be performed during construction and reports provided to the City. The inspections and reports must be performed at the following stages of construction (at a minimum):

- *Subgrade/Foundation preparation* – including but not limited to slabs, strips, and drilled shaft foundations prior to concrete placement
- *Formwork* – including but not limited to formwork for footings, walls, slabs, and other elements requiring formwork prior to concrete placement
- Reinforcing placement
- Drainage system construction (if applicable)
- Concrete/Masonry/Mortar placement
- *Completion* – post concrete placement

8.1.7.A.ii Third-party inspector must verify and document that construction inspections were performed at the prescribed stages of construction. The inspection reports and final certificate of compliance must be submitted to the City and include the following:

- Specific reference to the City's Standard Details and Standard Specifications.
- Specific reference to the address and/or legal description for the construction location.
- Specific reference to the name and date of the project-specific geotechnical engineering report.
- A letter signed and sealed by a Licensed Professional Engineer in the State of Texas, that includes a statement that the structure was constructed in general compliance with the geotechnical design reviewed and approved by the Engineering Services Director or designee and in accordance with the City's Standard Details and Standard Specifications.

8.1.7.B Bridge Construction Inspection

8.1.7.B.i Third-party inspector must verify and document that bridge construction inspections were performed at the prescribed stages of construction in accordance with the Bridge Construction Inspection Checklist in Appendix B (City Checklists).

8.1.7.B.ii The inspection reports and final compliance documentation must be submitted to the City.

8.1.8 *TxDOT Standard Sheets* – If TxDOT standard sheets pertaining to structures are utilized, the Engineer must ensure the loading, geometry, and allowable soil pressures are applicable to the standard design selected. The Engineer must ensure that interruptions to the structure (i.e., wall stem or footing reinforcement altered by openings, utilities, geometric changes, or curved sections of the wall) do not compromise the design and performance of the structure. Consideration must be given to the site-specific geotechnical requirements and whether a TxDOT standard design is applicable. No TxDOT standard sheets will be modified unless the Engineer designs, draws, signs, and seals the modified standard. If TxDOT standard sheets are not applicable, a custom structural design must be provided. The responsible Engineer must provide design calculations validating that TxDOT details used are applicable.

8.1.9 Structural Plan Requirements

8.1.9.A Construction plans and specifications must be prepared and submitted to the Engineering Services Director or designee in accordance with **Section 2.3 (Submittal Requirements for Construction Plans and Drainage Analysis)**.

8.1.9.B Calculations pertinent to the design of all structures must be submitted to the City along with the construction plans and will be filed for record purposes by the City. The Engineer remains responsible for the design of the structure(s).

8.2 **Structural Code Requirements and Criteria**

8.2.1 At a minimum, all structures must be designed using the City's *Standard Details* and *Standard Specifications* and must meet all applicable Local, State, and Federal standards. For other applicable standards not adopted by the City, the current version of that standard must be utilized.

8.2.2 The design and construction of roadway bridges and bridge-class culverts must be provided in accordance with the requirements of the AASHTO's current edition of the *Standard Specifications for Highway Bridges* and supplemented using TxDOT standards and guidelines as applicable.

8.2.3 Specifications for bridge construction must be in accordance with TxDOT's current edition of *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*.

8.2.4 All bridge railing must be in accordance with TxDOT's current edition of the *Bridge Railing Manual* and must meet the specifications outlined in AASHTO's current edition of the *Manual for Assessing Safety Hardware (MASH)* and the *National Cooperative Highway Research Program (NCHRP) Report 350*. All railing must be appropriately rated railing based on site and design conditions. Guardrail, end treatments, or other features associated with bridge construction must be in accordance with AASHTO's current edition of the *Policy on Geometric Design of Highways and Streets*, AASHTO's current edition of *Roadside Design Guide*, and current TxDOT standards. All bridge railing must meet applicable sight distance requirements.

8.2.5 For all bridges and bridge-class culverts adjacent to or in conjunction with roadways, sight visibility exhibits must be submitted to the City for review and approval in accordance with **Section 3.4 (Sight Visibility)**.

- 8.2.6 More stringent requirements must be utilized as required for unusual designs such as rehabilitations, reconstructions, or for unusual site conditions. The codes cannot replace sound engineering knowledge, experience, and judgment.
- 8.2.7 For any structure, the City or the Engineer may require the quality of materials and construction to be higher than the minimum requirements based on structure usage or site conditions.

8.3 Excavation Support

- 8.3.1 Trench excavation protection must 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's (OSHA) current *Standards and Interpretations, 29 CFR 1926, Subpart P (Excavations)*. 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 OSHA's current Standards and Interpretations, 29 CFR 1926, Subpart P, Excavations.
- 8.3.2 Temporary shoring (including trench excavation discussed in Section 8.3.1 above) must be used for installations of walls, footings, and other structures that require excavations deeper than 5'. Temporary shoring must be designed and constructed to hold the surrounding earth, water, or both out of the work area. Options may include, but not be limited to, 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 shoring systems is included in the construction plans, the Contractor is responsible for the design of the temporary 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 OSHA's current *Standards and Interpretations, 29 CFR 1926, Subpart P (Excavations)*.

8.4 Geotechnical Performance Specifications

- 8.4.1 Field investigation, geotechnical testing, and geotechnical engineering will be performed in accordance with this *Engineering Design Manual* considering local experience and conditions. The geotechnical recommendations will establish the minimum design criteria upon which the Engineer can rely.
- 8.4.2 A ROW Permit must be obtained prior to performing any boring, coring, trenching, or excavation within the City's ROW or public easements.
- 8.4.3 The complexity of geological conditions and the type, length, and width of the structure will determine the number and locations of test holes required. The following should be considered by the Engineer in coordination with the Geotechnical Engineer:
 - 8.4.3.A Depth of test hole
 - 8.4.3.B Location of proposed grade relative to existing grade
 - 8.4.3.C Location of groundwater
 - 8.4.3.D Channel relocations and/or channel widening

- 8.4.3.E Scour
- 8.4.3.F Foundation loads
- 8.4.3.G Foundation types
- 8.4.4 Test holes will be located in an accessible area. Identify test hole locations on the construction plans.
- 8.4.5 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 will be shown on the coring logs.
- 8.4.6 Perform the appropriate field and laboratory tests necessary to determine the soil properties for geotechnical design criteria. The Geotechnical Engineer will consider both the short-term and long-term conditions.
- 8.4.7 Ground water elevations will be included as part of the data acquisition. Site conditions may require the installation of piezometers to establish a true groundwater surface elevation and a method of monitoring water surface fluctuations.
- 8.4.8 *Coring Requirements* – Minimum coring requirements are specified below. Based on the Geotechnical Engineer's experience and engineering judgment, if competent rock is encountered, the minimum coring depths specified below may be reduced with approval from the Engineering Services Director or designee.
 - 8.4.8.A *Slopes and Embankments including Bridge Approaches* – Obtain soil coring for cuts greater than 10' or embankments taller than 10'. The exploration will include the following:
 - 8.4.8.A.i *The Soil Under Future Embankments* – Advance coring 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.
 - 8.4.8.A.ii *Soil in Proposed Cuts* – Advance coring to a depth of at least 15' below the bottom of the proposed cut, unless a greater depth is recommended by the Geotechnical Engineer.
 - 8.4.8.B Bridges
 - 8.4.8.B.i In general, drill test holes will penetrate a minimum of 15' into proposed bearing strata. Where depth of bearing strata becomes impractical, the Engineering Services Director or designee may determine minimum core depth.
 - 8.4.8.B.ii Test holes will be drilled near each abutment and bent location of the proposed structure plus a sufficient number of intermediate holes to determine depth and location of all significant soil and rock strata.
 - 8.4.8.B.iii A site inspection by the driller or logger will be performed to evaluate site accessibility and special equipment needs.
 - 8.4.8.B.iv *Grade Separations* – If the coring indicates soft surface soils (fewer than 10 blows per foot), additional coring and testing will be required for the design of the bridge approach embankments.

- 8.4.8.C *Retaining Walls* – Obtain soil coring for walls taller than 4'. Soil coring will also be obtained for any retaining wall (regardless of height) under unusual circumstances, such as live loading or other surcharges.
- 8.4.8.C.i *Minimum Number/Spacing* – Obtain a minimum of two soil coring within limits of wall footprint. For walls longer than 200', coring will be obtained at a maximum spacing of 200' unless site conditions or the Engineer requires alternate spacing. A greater spacing may be allowed by the Engineering Services Director or designee only if recommended in writing by the Geotechnical Engineer.
- 8.4.8.C.ii *Fill Walls* – For spread footing walls and Mechanically Stabilized Earth (MSE) walls, the depth of the coring will be at least equal to the wall height depending on the wall type. The minimum coring depth is 10' below the bottom of the proposed wall unless rock is encountered (Refer to Section 8.4.8). Extend coring at least 5' into rock for fill walls unless additional depth is recommended by the Geotechnical Engineer.
- 8.4.8.C.iii *Cut Walls* – For drilled shaft walls, tied-back walls, and soil and rock nail walls, the depth of the coring will be based on the proposed ground line. Cantilever drilled shaft walls require the depth of coring to extend to 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. Coring for soil nails, tiebacks, and rock nailed walls will be advanced through the material that is to be nailed. The minimum coring depth is 15' below the bottom of the proposed wall. Coring for proposed cut walls may need to penetrate bearing strata significant distances depending on the depth of the cut and wall height.
- 8.4.8.C.iv *Additional Testing/Modeling* – Additional testing and modeling will be provided for taller walls, walls on slopes, or walls on soft founding strata as necessary or as recommended by the Geotechnical Engineer to completely evaluate wall stability.

8.5 **Bridges**

- 8.5.1 The Engineer must be responsible for selecting the appropriate bridge foundation. The Engineer must consider the following factors in that selection:
- 8.5.1.A *Design Load* – The magnitude of the design load and existing geotechnical conditions dictate the required size of the foundation.
- 8.5.1.B *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 are the preferred foundation type subject to concurrence from the Geotechnical Engineer. Alternative foundation types require approval in writing from the Engineering Services Director or designee.
- 8.5.2 Disregard surface soil in the design of drilled shaft foundations. The discounted 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, disturbed material or fill, and recommendations of the geotechnical investigation.

- 8.5.3 Drilled shaft capacity relies upon penetrating a specific stratum a specified depth. The construction plans must provide a note instructing the contractor and field personnel of the penetration requirement. The construction plans must 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 willower depth, and it requires the shaft to be lengthened if the founding stratum is not encountered at the expected elevation.
- 8.5.4 *Railing* – In addition to the requirements in **Section 8.2.4**, the following bridge railing criteria must be met:
- 8.5.4.A The face of railing must be a minimum of 2' beyond edge of outside travel lane.
 - 8.5.4.B Traffic rails must be provided on all Major and Minor Arterial bridges. Traffic rails will not be required on Collectors or Local streets, or on culverts where the sidewalk is not located adjacent to the back of curb.
 - 8.5.4.C *Concrete Rail Finish* – Stain and color(s) must be approved by the Engineering Services Director or designee. When utilized, formliners must meet the requirements as described in **Section 8.2.4**.
 - 8.5.4.D *Steel Rail Finish* – All rail surfaces must be hot-dipped galvanized. Color must be approved by the Engineering Services Director or designee.
 - 8.5.4.E All rail coatings, coloration, etc. must be done by the supplier before rails are delivered to the project site.
- 8.5.5 *Pedestrian Bridges* – Pedestrian bridges must be designed in accordance with AASHTO's current edition of the LRFD Guide Specifications for the Design of Pedestrian Bridges and AASHTO's current edition of Guide for the Development of Bicycle and Pedestrian Facilities, and must meet the following additional criteria:
- 8.5.5.A *Design Requirements* – Refer to **Section 4 (Pedestrian Facilities)** for applicable design requirements.
 - 8.5.5.B *Loading* – Design loads must be in accordance with the applicable codes outlined in this section and must include, but not be limited to, construction loads, surcharge loads, slopes, wind, stream loads, and other structures. Loading must conform to the specified use (i.e., bicycle, pedestrian, emergency vehicle traffic, and/or maintenance vehicle traffic).
 - 8.5.5.C *Construction Plans* – Cast-in-place bridge foundations must be designed for a specified pre-cast bridge structure. The foundation plans and shop drawings for the pre-cast bridge structure must be submitted for review and approval.
 - 8.5.5.D *Hydraulics* – Refer to **Section 11.2 (Floodplain Alterations)** for design flood, freeboard, and flood study requirements associated with pedestrian bridge design.

8.6 Retaining Walls

8.6.1 The Engineer is responsible for ensuring that the type of retaining wall selected for a given location is appropriate. The retaining wall selection process must consider the following:

8.6.1.A Height

8.6.1.A.i Walls must be measured from the top of wall footing to the top of the wall (not the top of the retained fill). An engineered design by a licensed Texas Professional Engineer is required for all walls 4' in height or greater (designed to ensure stability against overturning, sliding, bearing failure, excessive differential movement, and water uplift). For commercial and multi-family applications, all walls require an engineering design regardless of height.

8.6.1.A.ii For a wall that has a variable height where part of the wall is under 4' and part of the wall is over 4', an engineering design will be necessary for the entire wall.

8.6.1.A.iii Factors of safety for design must be as described in the current edition of the *International Building Code (IBC)* and *International Residential Code (IRC)* adopted by the City but at a minimum must meet the following:

- Overturning: 2.0
- Sliding: 1.5
- Bearing: 2.0

8.6.1.A.iv If any wall has embedded posts, poles, or other structures anchored directly into the wall structure, wall design must also take into consideration the additional loadings due to these structures (axial, lateral, and wind). The structural design must be provided in accordance with the geotechnical recommendations and minimum design criteria provided herein.

8.6.1.B *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.

8.6.1.C *Maintenance* – Consider long-term maintenance requirements. Identify necessary excavation requirements (including shoring), required utility adjustments, construction phasing requirements, and these effects on the wall design and construction.

8.6.1.D *Global Stability* – The Engineer is responsible for the global stability design of the wall. Evaluate all walls to ensure that the minimum applicable factors of safety are met, if not exceeded. Walls will not be placed on slopes if avoidable.

- 8.6.1.E *Passive Resistance to Sliding* – The Engineer must follow the Geotechnical Engineer’s guidance for use of passive resistance. If there is a slope in front of the wall, passive resistance must be neglected.
- 8.6.1.F *Drainage* – Design the wall to prevent the build-up of hydrostatic pressure behind the wall. If conditions warrant, such as but not limited to, the inability to include a drainage system or situations of rapid drawdown, the City may require the wall design to withstand full hydrostatic pressure load. The wall design must consider potential deleterious short- and long-term effects of water inundation including scour and rapid draw down.
- 8.6.1.G *Loading* – Design loads must be in accordance with the *Engineering Design Manual*, including construction loads and surcharge loads from slopes, structures, and vehicles.
- 8.6.1.H *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.
- 8.6.2 Analyze and design walls following accepted geotechnical engineering industry standards for the area and in accordance with the *Manual*. 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.
- 8.6.3 The Engineer must ensure that the retaining wall system is appropriate for its location and application. The Engineer must design for all potential modes of wall system failure; including sliding, overturning, bearing pressure, global stability, and structural capacity of the wall itself. Placement of walls adjacent to roadways must comply with AASHTO’s current edition *Roadside Design Guide* unless otherwise approved by the Engineering Services Director or designee.
- 8.6.4 Perched walls will not be placed on slopes steeper than 8H:1V. When walls must be placed on slopes, or the retaining wall height or the combined wall and slope heights exceed 8’, the Geotechnical Engineer must conduct a short-term and long-term global stability analysis using applicable soil strength characteristics, geometry, and loading conditions (including load surcharge and hydrostatic). The Engineer is responsible for the design of the wall system, including its global stability.
- 8.6.5 Perched walls must be analyzed as both independent structures and as a single unit for all design parameters.
- 8.6.6 If barriers, fences, or other structures are to be installed on top of walls, connection details must be included in the construction plans and taken into account during design as a part of the calculation package.
- 8.6.7 Tree placement within the zone of influence of a retaining wall must be avoided. Any trees placed within zone of influence must be addressed in the structural design of the wall and submitted as a part of the calculation package.
- 8.6.8 Swimming pools, pergolas, and other structures placed within the zone of influence of a retaining wall must be avoided. Any of these placed within the zone of influence must be addressed in the structural design of the wall and submitted as a part of the calculation package.

8.7 Slope Stability

8.7.1 All slopes exceeding 8' in height with a steepness greater than 4H:1V, regardless of soil type, cut, or fill, must 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' or slope angle greater than 6H:1V must 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 must be submitted with the construction plans when required by the City.

8.7.2 Use the following data to analyze global stability of a slope:

- Geometry (cross section and loading conditions)
- Location of the water table
- Soil/rock stratigraphy
- Soil/rock properties (unit weight, Atterberg Limits, undrained and drained shear strength)

8.7.3 For global stability of a slope, minimum factors of safety must be met for long-term and short-term stability.

8.8 Culverts, Headwalls, and Wingwalls

8.8.1 All headwalls and wingwalls must be reinforced concrete. Approach and discharge aprons must be provided for all culvert headwall designs.

8.9 Vertical Runoff Adjustment Structures

8.9.1 The design of vertical runoff adjustment structures must be based on the height of the drop, the flow depths upstream and downstream of the vertical runoff adjustment structure, and the flow rate. All vertical runoff adjustment structures must be constructed of reinforced concrete, gabions, or other material approved by the Engineering Services Director or designee. To facilitate maintenance, vertical runoff adjustment structures should be accessible to equipment normally used for maintenance, as approved by the Engineering Services Director or designee.

8.9.2 An apron must be provided immediately upstream and downstream of a vertical runoff adjustment structures to protect against scour caused by the increasing velocities and turbulence at each vertical runoff adjustment structure. Apron dimensions must be site specific and based on velocities. At a minimum, the upstream apron must extend at least 10' upstream from the point where flow becomes supercritical and must include a cutoff wall into the ground sufficient to protect the structure from scour and hydraulic uplift. The downstream apron must extend a minimum of 20' beyond the anticipated location of the jump and must include a cutoff wall into the ground. The cutoff wall at each end must extend below the calculated scour depth or sound bedrock (in accordance with FHWA's current edition *Hydraulic Engineering Center No. 18 (HEC-18)*) but must be a minimum of 3' below channel flowline.

SECTION 9 LANDSCAPING AND IRRIGATION DESIGN REQUIREMENTS

9.1 General

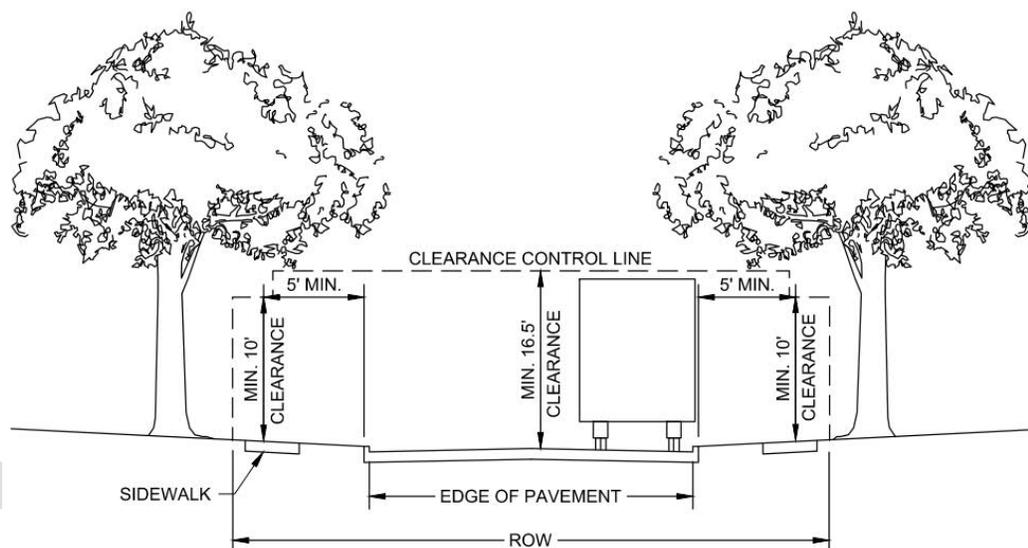
- 9.1.1 This Section includes the minimum design requirements and standards associated with the City's landscaping and irrigation within the public ROW, easements, medians, and islands.
- 9.1.2 *Landscaping and Irrigation Design* - All elements of landscaping and irrigation systems and infrastructure must be designed and constructed in compliance with the City's *Standard Details*, and *Standard Specifications*. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 9.1.3 Where required, landscape and irrigation construction plans must be prepared and sealed by a Registered Landscape Architect (RLA), and a Licensed Irrigator (LI) with a license to practice within the State of Texas, unless otherwise directed by the Engineering Director or designee.
- 9.1.4 It is the responsibility of the individual or entity who constructs within the City ROW or public easement to ensure that all landscaped areas that are disturbed during construction as a result of the proposed project are restored back to its existing vegetative condition.

9.2 Landscaping Requirements within Right-of-Way

- 9.2.1 General – This section includes the general requirements for tree and shrub plantings located within the public ROW.
- 9.2.1.A Sight Distance and Visibility
- 9.2.1.A.i Compliance with these landscaping requirements is required unless such compliance would result in visibility obstructions and/or blind corners at intersections and median openings.
- 9.2.1.A.ii When two or more streets or driveways intersect, a sight visibility triangle is created in accordance with **Section 3.4 (Sight Visibility)**. Landscaping within the sight visibility triangle must be designed to provide unobstructed cross-visibility between 2' and 9' in height above the gutter elevation. Shade trees may be permitted in this area provided they are trimmed so that no limbs or foliage extend into the cross-visibility area, and the trees are not planted, aligned, or grouped so that the trunks of the trees provide a visibility obstruction.
- 9.2.1.A.iii All trees must be planted outside sight visibility triangles.
- 9.2.1.B Clearance and Setbacks
- 9.2.1.B.i If trees are planted in the Right-of-Way, then they must be planted along existing and proposed sidewalks and roadways in an effort to limit conflicts with pedestrian and vehicular traffic.
- 9.2.1.B.ii If trees are planted in the Right-of-Way, then they must be planted a minimum 5' distance from adjacent paving, back of roadway curbs, and utilities. Root barrier may be required for shade trees planted within 5' to 10' of any paving, back of roadway curbs, and utilities, as approved by the Engineering Director or designee.

- 9.2.1.B.iii Tree canopies and limbs are prohibited from overhanging arterial roadways.
- 9.2.1.B.iv Tree canopies and limbs overhanging non-arterial roadways must be maintained in an effort to limit conflicts with vehicular traffic and a minimum 16.5' vertical clearance must be provided along all vehicular pavement. Refer to **Figure 9-1**.
- 9.2.1.B.v Tree canopies and limbs overhanging pedestrian routes must be maintained in an effort to limit conflicts with pedestrian traffic, and must provide a minimum 10' vertical clearance along all pedestrian routes (sidewalks, trail, etc.)

Figure 9-1. Tree Clearance



9.2.1.C Planting Requirements

- 9.2.1.C.i Trees will not be installed on slopes steeper than 4H:1V. All trees and planting areas must have soils prepared prior to seeding, planting, or installation.
- 9.2.1.C.ii If trees are planted within medians and parkways, then they should be planted in an effort to provide the appearance of natural planting and grouping. Trees may not be planted with formal or on-center spacing, unless otherwise directed by the Parks and Recreation Manager.
- 9.2.1.C.iii All median landscape areas designated as lawn planting areas must receive solid sod. Sod must be placed within the parkway along curbs and sidewalks for a minimum distance of 4'. All sod must be placed after properly preparing the ground as designated on the construction plans

and in accordance with the City's Standard Details and Standard Specifications.

- 9.2.1.C.iv Areas not required to be sodded must be treated (seeded, mulched, etc.) after properly preparing the ground as designated on the construction plans and in accordance with the City's Standard Details and Standard Specifications.
- 9.2.1.C.v All landscape areas must be planted with materials in living and thriving condition. Placement of artificial or non-living plant materials is prohibited.
- 9.2.1.C.vi No trees will be installed in the locations of future travel or turn lanes, or future sidewalks. Refer to the City's Standard Details and Standard Specifications for roadway typical sections.
- 9.2.1.C.vii Topsoil must be preserved on all development sites for final stabilization or must be replaced with new topsoil material of equal or better quality. Topsoil is considered to be the first 4"-6" of surface material on an undeveloped site before any construction activity occurs.

9.3 Irrigation Requirements within Right-of-Way

- 9.3.1 Irrigation system must be designed and installed to minimize runoff onto paved surfaces. Overspray on streets, alleys, and sidewalks is prohibited. All irrigation systems must be installed in accordance with the current and published laws and regulations of the Texas Commission on Environmental Quality (TCEQ).
- 9.3.2 Irrigation will be required as follows:
 - 9.3.2.A Irrigation service laterals and meter locations must be shown on all construction drawings submittals, including residential developments.
 - 9.3.2.B Commercial developments are required to have irrigation meters or a water well to be used for irrigation.
 - 9.3.2.C All proposed landscape areas must be irrigated, unless otherwise directed by the Engineering Director or designee.

SECTION 10 ENVIRONMENTAL AND EROSION CONTROL REQUIREMENTS

10.1 General

- 10.1.1 This Section includes the minimum design requirements and standards associated with the City's environmental and erosion control for development and construction activity within the City of Midland and its Extra Territorial Jurisdiction.
- 10.1.2 *Environmental And Erosion Control Design* - All elements of environmental and erosion control systems and infrastructure must be designed and constructed in compliance with the City's *Standard Details*, and *Standard Specifications*. All TCEQ standards and requirements must also be complied with. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.
- 10.1.3 The Owner must provide proof of compliance with applicable federal, state, and local environmental regulations upon request by the City. Potential applicable regulations and permits may include, but are not limited to:
- 10.1.3.A Section 404 of the Clean Water Act (33 USC 1344)
 - 10.1.3.B Section 106 of *NHPA*
 - 10.1.3.C Water Rights
 - 10.1.3.D Section 303(d) impaired waters
 - 10.1.3.E Migratory Bird Treaty Act
 - 10.1.3.F Water Well Drilling
 - 10.1.3.G Threatened and Endangered Species Act
 - 10.1.3.H The Texas Archeological and Research Laboratory Requirements
 - 10.1.3.I The Antiquities Code of Texas
 - 10.1.3.J Air Quality
 - 10.1.3.K TCEQ Dam Requirements
- 10.1.4 *Erosion Control Plan* – An Erosion Control Plan (ECP) is required for all sites regardless of size. The ECP shall consider areas where development activities, construction activities, or channel improvements occur and shall protect these areas from site erosion. Sediment carried by stormwater runoff through these areas shall be prevented from entering storm drain systems and natural watercourses through applicable Best Management Practices (BMPs). The owner should refer to City's *Standard Details* and *Standard Specifications* for ECP requirements. It is the responsibility of the Engineer of Record (Engineer) to select and design appropriate construction controls for each site. Some acceptable forms of site erosion control devices include, but are not limited to, silt fences, silt traps, geo-netting, and geo-textiles. The minimum design storm for temporary BMPs is the 2-year, 24-hour storm event.
- 10.1.5 If the originally installed Best Management Practices (BMPs) prove insufficient to address the needs of a site, then the City maintains the right to require that more extensive BMPs be added or installed.

10.2 Texas Construction General Permit and City Requirements

- 10.2.1 Although Environmental Protection Agency (EPA) Region 6 still has regulatory authority concerning stormwater discharges in Texas and surrounding states, the Texas Commission on Environmental Quality (TCEQ) has issued Construction General Permit (CGP) TXR150000 to regulate stormwater discharges from construction sites. These requirements are modified and amended from time to time. Prior to beginning construction on any site, the engineer, developer, and contractor should make themselves aware of the current EPA, TCEQ, and City requirements. Construction activities are regulated according to the area of land disturbed. Refer to the CGP for definitions of the Primary Operator and Secondary Operator.
- 10.2.2 Large construction activities:
- 10.2.2.A For sites that disturb 5 or more acres, or are part of a larger common plan of development that will disturb 5 or more acres, the following applies:
- 10.2.2.A.i Prepare and implement a Stormwater Pollution Prevention Plan (SW3P).
 - 10.2.2.A.ii Submit a Notice of Intent (NOI) to TCEQ.
 - 10.2.2.A.iii Submit a copy of the NOI or Construction Site Notice (CSN) to the Engineering Services Department at least seven days prior to construction and must include TXR operator number on the NOI and CSN.
 - 10.2.2.A.iv Post a Large CSN where it is readily viewed by the general public during all construction activities.
 - 10.2.2.A.v Submit a Notice of Termination (NOT) to both the State of Texas and the Engineering Services Department upon permanent stabilization and BMP removal.
- 10.2.3 Small construction activities:
- 10.2.3.A For sites that disturb at least 1 acre, but less than 5 acres, or are part of a larger common plan of development that will disturb at least 1 acre, but less than 5 acres, the following applies:
- 10.2.3.A.i Prepare and implement a SW3P.
 - 10.2.3.A.ii Submit a copy of the CSN to the Engineering Department at least seven days prior to construction.
 - 10.2.3.A.iii Post a Small CSN where it is readily viewed by the general public during all construction activities.
 - 10.2.3.A.iv Once the site is permanently stabilized and BMPs have been removed, the CSN shall be signed and dated. A copy of this shall be provided to the Engineering Services Department.
- 10.2.4 Less than 1-acre construction activities:
- 10.2.4.A Projects that disturb less than 1 acre do not require an NOI or a TCEQ CSN but are still required to provide a City of Midland CSN and associated ECP. These must be

approved by the Engineering Services Director or designee at least seven days prior to initiation of construction activities.

10.3 Source of Pollutants

10.3.1 The following is a discussion of the principal sources of pollutants that are discharged from municipal storm water collection and conveyance systems:

10.3.1.A *Atmospheric Deposition* – Atmospheric Deposition in the form of wetfall and dryfall is a significant source of pollution in urban areas and some industrial sites. A portion of the atmospheric pollutants attach to and remain on urban surfaces, but a significant fraction may be removed from the surfaces during storm events and are carried to the receiving waters with the runoff.

10.3.1.B *Erosion* – Erosion can result from natural activity such as eroding stream banks or from human activity such as construction or renovation. Without adequate erosion control, large quantities of sediment, which typically carries attached nutrients, organic matter, and often other absorbed pollutants, can be deposited into storm sewers, drainage channels, streams, and receiving waters.

10.3.1.C *Construction Materials* – Materials used in construction and maintenance of buildings are major sources of pollution. Many heavy metals are common materials in many structures. Over time, surfaces including those of flashing, gutters, paints, copper and metal piping, etc. dissolve, decay, or are subject to leaching and thus are susceptible to being carried away in urban runoff. This process can be exacerbated if the rainfall is acidic in nature.

10.3.1.D *Manufactured Products* – Heavy metals and synthetic organic compounds are present in the following types of products: fertilizers, insecticides, algicides and fungicides, automobile brake linings, clutch facings, tire compounds, lubricants and hydraulic fluids. All can be deposited to urban surfaces and are susceptible to deposition through urban runoff.

10.3.1.E *Plants and Animals* – Other sources of pollutants that accumulate and are washed off of urban surfaces are plant debris and animal excrement. During the growing season, nutrients leach from tree leaves and stems during storms and ultimately are deposited into the receiving waters. Also, trees and other plants deposit leaves, branches, and fruits that are washed away by storm runoff.

10.3.1.F *Accidental Spills and Unintended Discharges* – Other sources of pollution in storm water are accidentally spilled pollutants that are not contained. These could be from a number of sources such as leaking underground storage tanks, faulty septic systems, and sanitary landfills.

10.3.1.G There are two other sources of pollution that are carried through urban conveyance systems. These are designated by the EPA as illicit connections and illegal dumping. Illicit connections include both deliberate and inadvertent discharges of sewage or industrial flows to storm drains. Illegal dumping refers to the dumping of solid or liquid wastes. These types of pollutants have been identified as a widespread problem and the detection and elimination of such discharges are major focuses of the National Pollutant Discharge Elimination System (NPDES) storm water permits.

10.4 Storm Water Pollutants

10.4.1 The principal types of pollutants found in storm water and their potential adverse effects on receiving waters are the following:

10.4.1.A *Sediment* – Suspended sediment can lead to numerous adverse effects on aquatic ecosystems. Reduced sunlight penetration, clogging of gills and filter systems in aquatic organisms, interference with egg deposition and hatching, and the potential of the sediment to transport trace amounts of pesticides and other chemicals are all potential adverse effects caused by sedimentation.

10.4.1.B *Organics* – Decomposition of organic materials depletes the dissolved oxygen levels in receiving waters. This is especially true in slower moving waters, estuaries, and lakes.

10.4.1.C *Nutrients* – Increased levels of phosphorous and nitrogen, from such things as fertilizers, in runoff can lead to accelerated eutrophication in receiving waters. Among the problems associated with high nutrient levels are surface algal scums, algal blooms, water discoloration, unpleasant tastes and odors, depressed oxygen levels and the release of toxins.

10.4.1.D *Toxic Substances* – Heavy metals and organic toxic compounds are both concerns because of their potential for contaminating drinking water supplies. Heavy metals, such as copper, lead, zinc, and cadmium, are generally found in storm water in the highest concentrations. Organic toxins found in storm water are generally those associated with pesticides and fertilizers.

10.4.1.E *Oil and Grease* – The oil and grease category includes a wide variety of hydrocarbon compounds, some of which are known to accumulate in sediments and are toxic to aquatic life in low concentrations.

10.4.1.F *Bacteria* – Fecal coliform levels in urban runoff can usually be expected to exceed standards for water contact, recreation, and shellfish harvesting. Also, if the concentration of coliforms is in excess of public health standards, water cannot be used for these purposes.

10.5 Stormwater Pollution Prevention Plan – Temporary Controls

10.5.1 One of the requirements of the CGP is to develop a SW3P. The purpose of the SW3P 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 of the U.S. during construction. The plan must also address the principal activities known to disturb significant amounts of ground surface during construction.

10.5.2 The stormwater management controls included in the SW3P should focus on providing control of pollutant discharges with practical approaches that use readily available techniques, expertise, materials, and equipment. The SW3P must be implemented prior to the start of construction activities.

10.5.3 *Construction Controls* – Structural controls and general site practices may be used for controlling pollutants for stormwater discharges from small and large sites. Structural controls shall comply with details and specifications in the current edition of the City's Standard Details and Standard Specifications. The following are acceptable temporary controls for use during

construction:

10.5.3.A General Site Practices

10.5.3.A.i Minimizing the area of disturbance

10.5.3.A.ii Preserving existing vegetation

10.5.3.B Structural Controls

10.5.3.B.i Filter Socks

10.5.3.B.ii Concrete Washouts

10.5.3.B.iii Wind Row Perms

10.5.3.B.iv Drainage Swale Buffers

10.5.3.B.v Erosion Control Blankets

10.5.3.B.vi Gravel or Sand Bags

10.5.3.B.vii Silt fence

10.5.3.B.viii Inlet protection

10.5.3.B.ix Rock filter dams

10.5.3.B.x Stabilized construction entrances

10.5.3.B.xi Sediment traps

10.5.3.B.xii Vegetated buffer strips

10.5.3.B.xiii Temporary detention structures

10.5.3.C Temporary controls must include methods to reduce dust from the construction site. This may include wetting haul roads, un-stabilized lot surfaces or areas of excavation prior to beginning work.

10.5.3.D Contractor may submit other methods of construction control to the Engineering Services Director or designee for consideration and review.

10.5.4 *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 SW3P 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 the Engineering Services Director or designee of all spills and releases to the storm drainage system.

10.5.5 Temporary Stabilization

10.5.5.A 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 after soil disturbance activities have ceased, except when precluded by seasonal arid conditions or prolonged drought.

- 10.5.5.B 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, hydromulch, and other techniques that cover 70% of the disturbed areas until either final stabilization can be achieved or until further construction activities take place.
- 10.5.5.C 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.
- 10.5.5.D It is the responsibility of the individual or entity who constructs within the ROW, easement, common area, or other project work area to ensure that all temporary erosion controls are removed at the project's completion.
- 10.5.6 Inspection and maintenance during construction:
- 10.5.6.A The Owner must construct all controls required by the SW3P. The Owner must have qualified personnel inspect the controls at least every two weeks during construction and within 24 hours after a storm event of 0.5", or greater.
- 10.5.6.B Certified inspection reports shall be retained as part of the SW3P. Within 24 hours 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.
- 10.5.6.C Changes or additions to the SW3P or ECP by the Operator shall be implemented within 24 hours 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, and ponds.
- 10.5.6.D Notes requiring the inspection and maintenance shall be placed on SW3P drawings. The SW3P shall identify the responsible party for inspecting and maintaining each control. If no party is identified, each owner and Operator that submitted an NOI for the site shall be fully responsible for implementing all requirements of the SW3P.
- 10.5.7 *Final Site Stabilization* – Stabilization measures that provide a protective cover must be initiated immediately in portions of the site where construction activities have permanently ceased. Final stabilization consists of soil cover such as perennial vegetation, geo-textiles, mulch, rock, or placement of pavement or concrete. 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 Post Construction Stormwater Quality Plan (PCSQP) (see Section 10.6) and with the landscaping plan {Refer to **Section 9 (Landscape and Irrigation)**}, if applicable.
- 10.5.7.A *Construction Plan Requirement* – The following sheet note is required on all construction plan sets regarding final site stabilization: In accordance with Parts III.G.1 and III.G.2 of the Construction Stormwater General Permit, stabilization of all disturbed areas must, at a minimum, be initiated immediately (i.e., as soon as practicable, but no later than the end of the next workday) whenever any earthwork activities have permanently ceased on any portion of the site. The City will not

support acceptance of any public infrastructure or a C.O. unless this requirement has been fulfilled. CONTRACTOR BEWARE: THIS REQUIREMENT WILL BE STRICTLY ENFORCED.

- 10.5.8 *Notice of Termination* – All parties that submitted an NOI must submit a NOT within 30 days after final stabilization is established. Temporary controls must be removed, and permanent stabilization shall be established and accepted by the City prior to submitting a NOT. When the owner of a residential subdivision transfers ownership of individual lots to builders before final stabilization is achieved, the SW3P shall include controls for each individual lot in lieu of final stabilization. These controls must consist of stabilization of the ROW and placement of structural controls at the low point of each individual lot or equivalent measures to retain soil on each lot during construction. Additionally, the builder must submit a valid NOI before a NOT can be submitted by the owner.

10.6 *Erosion and Sediment Controls*

- 10.6.1 *Floodplain Permit* – No person will fill, grade, excavate, or otherwise disturb the surface of real property within the City without first having secured a Floodplain Permit. No Owner of real property will knowingly permit another person to fill, grade, excavate or otherwise disturb the surface of real property within the City without first having secured a permit from the Engineering Services Director or designee. The following will be submitted with permit application:

10.6.1.A Submission by the applicant of a Stormwater Pollution Prevention Plan (SWP3) for all work disturbing 1 acre of land or more. This SWP3 must be prepared by a licensed Professional Engineer in accordance with applicable Environmental Protection Agency (EPA) and TCEQ regulations and approved by the Engineering Services Director or designee prior to issuing the grading permit.

10.6.1.B Submission by the applicant of a copy of Notice of Intent (NOI) and/or a Construction Site Notice (CSN) as required by the TCEQ regulations for all work disturbing 1 acre of land or more.

10.6.1.C The Engineering Services Director or designee may exclude that portion of tracts in excess of 10 acres that he determines to be so situated as to not contribute to erosion due to location and topography.

- 10.6.2 *Construction Permitting* – Construction permitting will be in accordance with the TCEQ's *Construction General Permit (TXR150000)*. Temporary erosion control BMPs will be provided to control and reduce the discharge of sediment, silt, soil, and other materials to the Municipal Separate Storm Sewer System (MS4) and to waters of the United States during construction activities. Proof of compliance with applicable Local, State, and Federal environmental regulations will be provided to the City upon request.

- 10.6.3 *Temporary Erosion Control BMPs* – The following temporary erosion control BMPs will be designed to retain soil in place and to minimize the amount of sediment in runoff. Refer to the *FHWA Hydraulic Engineering Circular No. 22 (HEC-22)* for applicable design criteria.

10.6.3.A *Temporary Stabilization* – Portions of a site that have been disturbed but where no work will occur for more than 21 days will be temporarily stabilized as soon as possible, and no later than 14 days from cessation of work, except when precluded

by seasonal arid conditions or prolonged drought. Temporary stabilization will consist of providing a protective cover, without large bare areas, that is designed to reduce erosion on disturbed areas. Temporary stabilization may be achieved using the following BMPs: temporary seeding, soil retention blankets, fibrous mulches, hydro-mulches, and other techniques that cover 100% of the disturbed areas until final stabilization can be achieved or until further construction activities take place.

- 10.6.3.B *Slope Protection* – Slope protection will be provided for disturbed or cut/fill slopes that are steeper than 4H:1V, 50' in length or longer, or on highly erodible soils. The location and type of BMPs will be shown on the plans.
- 10.6.3.C *Channel Protection* – Show the location and type of BMPs used to prevent the erosion of channels, drainage ways, streambanks, and outfalls until permanent structures and final stabilization measures are installed.
- 10.6.3.D *Sediment Controls* – Sediment control BMPs will be designed to capture sediment on the site when preventing erosion is not feasible due to ongoing construction activity. Sediment control BMPs and their locations will be designed to change with the different phases of construction as site conditions and drainage patterns change. Sediment controls for the initial phase of construction will be installed before any site disturbing activities begin. Sediment barriers may be linear controls, check dams, berms, sediment basins, sediment traps, active treatment systems, and other structural BMPs designed to capture sediment suspended in stormwater.
- 10.6.3.E *Perimeter Controls* – A linear BMP will be provided at all down slope boundaries of the construction activity and side slope boundaries where stormwater runoff may leave the site. Linear sediment barriers may be used to satisfy the requirement for perimeter controls.
- 10.6.3.F *Storm Drain Inlet Protection* – Storm drain inlet protection will not be used as a primary sediment control BMP unless all other primary controls are infeasible due to site configuration or the type of construction activity. Inlet protection is intended to be a last line of defense in the event of a temporary failure of other sediment controls.
- 10.6.3.G *Construction Access Controls* – BMPs will be provided to prevent off-site vehicle tracking of soil and pollutants.
- 10.6.3.H *Dewatering Controls* – Water pumped from foundations, vaults, trenches and other low areas will be discharged through a BMP or treated to remove suspended soil and other pollutants before the water leaves the site. The plans will include notes that prohibit discharging the water directly into flumes, storm drains, creeks or other drainage ways. Where State or Local discharge permit requirements exist for the pollutant(s) suspected of being in the water, the plan will include the discharge permit conditions.
- 10.6.3.I *Concrete Washout* - All construction sites that place concrete must maintain a concrete washout. Location of washout must be within the project site, its initial location shown on the plans, and be approved by the Engineering Services director or designee. Under no circumstances are concrete trucks ever permitted to washout in any excavation or trench within public ROW or easements.

10.6.3.J *Final Stabilization* – Final stabilization practices will be specified for disturbed areas that are not covered by buildings, pavement or other permanent structures upon completion of construction. Final stabilization measures will be coordinated with the construction plans. Existing topsoil to be preserved and reused when applicable on site.

10.6.4 *Post-Construction Requirements* – Post-construction stabilization will be provided in accordance with the EPA’s NPDES and TCEQ’s TPDES regulations for all new development and redevelopment.

10.6.4.A *Construction and Maintenance Requirements* – The Owner will construct all permanent controls in accordance with this section and is responsible for maintenance of the controls. When the control falls within a drainage easement, the plat or separate instrument dedicating the easement will include a statement of the Owner’s responsibility for maintenance. Refer to **Section 2.4 (Right-of-Way & Easements)**. Refer to the *FHWA Hydraulic Engineering Circular No. 22 (HEC-22)* for permanent control options.

10.6.4.B *Operations and Maintenance Form* – Submittal of an Operations and Maintenance Form in **Appendix B (City Checklists)** is required to demonstrate the long-term maintenance of the permanent controls. The Operations and Maintenance Form must be accepted by the City before the final Engineering Plans are approved for construction. The Owner will agree to the operations and maintenance procedures and frequency of maintenance for each permanent control specified on the form.

10.7 **Best Management Practices**

10.7.1 Best Management Practices (BMPs) are defined by the EPA as structural or non-structural controls, or a combination of both, designed to reduce the amount of pollution in storm water runoff.

10.7.1.A *Structural BMPs* – Structural controls collect and treat runoff pollution in order to decrease the amount of pollution reaching receiving waters. Typical structural BMPs include infiltration devices, wet detention basins, and extended dry detention basins. Also, locating and removing illegal sanitary sewer connections, overflow structures, and industrial drains are considered structural BMPs.

10.7.1.A.i Infiltration devices capture the storm water and allow it to percolate through the soil profile. Pollutants are removed by the natural filtration process of the soil. Even though these devices are the most effective structural storm water controls, they are effective only where soil conditions allow the captured volume of water to percolate through the profile before the next storm event.

10.7.1.A.ii Wet detention basins consist of a permanent water pool, and overlying zone that can hold the design runoff volume temporarily so that it can be discharged at the design discharge rate, and a shallow vegetated zone which serves as a biological filter during discharge. For wet detention basins, the storm water runoff is treated by allowing suspended particles to settle and by removing dissolved pollutants through biological processes such as the uptake by aquatic plants.

10.7.1.A.iii An extended dry detention basin captures the storm water and detains it long enough to allow suspended pollutants to settle. In order to remove the suspended pollutants, relatively long detention times of 20 to 40 hours are required. Unlike wet detention basins, dry detention basins do not remove dissolved pollutants.

10.7.1.B *Non-Structural BMPs* – Non-structural BMPs are developed primarily to reduce pollution resulting from construction and to reduce pollutants from roadways; commercial, industrial and residential areas; flood management projects; landfills and other municipal waste facilities; and areas associated with the application of herbicides, pesticides, and other potentially harmful chemicals. Non-structural BMPs include such practices as street cleaning, fertilizer application control, and limiting population densities through use of zoning restrictions. An example of the non-structural BMP approach is the requirement of either a minimum lot size for a single-family residential development or the development of an area of greater population density balanced by a large portion of the site being designated as natural open space.

10.8 *Post Construction Stormwater Quality Plan – Permanent Controls*

10.8.1 *General Requirements* – A Post Construction Stormwater Quality Plan (PCSQP) must be prepared for all developments that disturb a surface area of 1 acre or greater. The PCSQP must be in accordance with the City’s checklist and must be developed and coordinated with the site drainage plan and may be shown on the same sheet. The PCSQP must identify permanent site features and BMPs that will be constructed with the project to minimize and mitigate the project’s long-term effects on stormwater quality and quantity. The PCSQP should also be coordinated with the landscaping plan {Refer to **Section 9 (Landscape and Irrigation)**} to prevent conflicts and ensure compatible land use.

10.8.2 If the originally installed BMPs prove insufficient to address the needs of a site, then the City maintains the right to require that more extensive BMPs be added or installed.

10.8.3 *Permanent Site Development Controls* – It is the responsibility of the Engineer to design permanent controls, or BMPs, that address site specific conditions.

10.8.3.A Some of the factors to be considered when evaluating and selecting controls for a development are as follows:

10.8.3.A.i Impact of the development on runoff volumes and rates

10.8.3.A.ii Potential pollutants from the development

10.8.3.A.iii Percent of site treated by the control

10.8.3.A.iv On-site natural resources

10.8.3.A.v Configuration of site (including existing waterways and topography)

10.8.3.A.vi Maintenance requirements for the control

10.8.3.B *Permanent Control Examples:*

10.8.3.B.i Established Vegetation

10.8.3.B.ii Sod

- 10.8.3.B.iii Seeded Erosion Control Mats
 - 10.8.3.B.iv Seeded Hydro-mulching
 - 10.8.3.B.v Other methods approved by the Engineering Director or designee.
- 10.8.3.C *Construction and Maintenance* – The Owner shall construct all permanent controls in accordance with this Section and is responsible for maintenance of the controls. When the control falls within a drainage easement, the plat or separate instrument dedicating the easement must include a statement of the Owner’s responsibility for maintenance.

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SECTION 11 FLOODPLAIN REQUIREMENTS

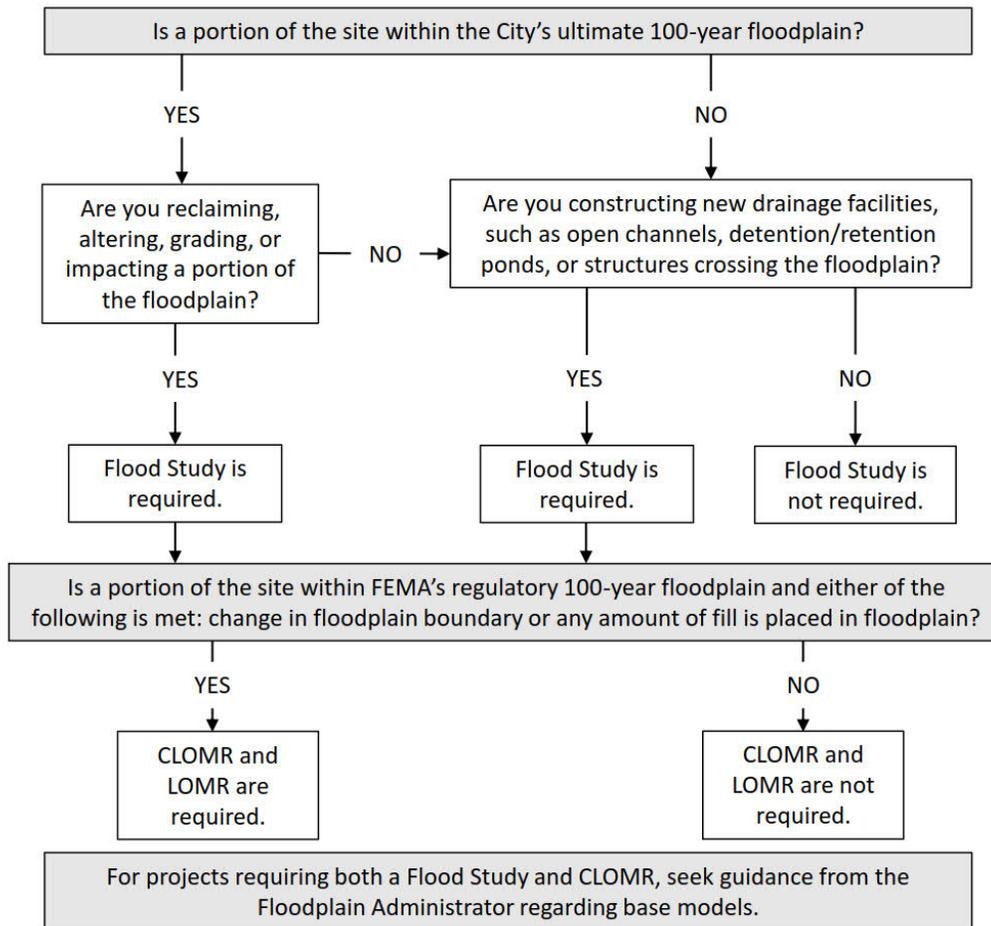
11.1 General

- 11.1.1 This Section includes the minimum design requirements and standards associated with the City's floodplains. All floodplain alterations, floodplain improvements, and construction permitted in the floodplain must comply with the City of Midland Flood Damage Prevention Code. The design and submittal requirements that are affected by these regulations are discussed in the sections below.
- 11.1.2 *Playa* – Natural ground surface depressions as defined in **Appendix A (Definitions and Abbreviations)**. Playas are typically located in floodplains and are subject to most standards and requirements governing developments that are located within a floodplain or that will impact a floodplain. However, when a playa acts in a retention capacity rather than merely a detention capacity with regards to storm water runoff, standards and requirements that would apply to situations where storm water moves through a drainage feature rather than being retained by it may not always apply if approved by the Engineering Services Director or designee.
- 11.1.3 *Floodplain Design* - All elements of floodplain systems and infrastructure must be designed and constructed in compliance with the City's Storm Drain Manual, Master Drainage Plan, Standard Details, and Standard Specifications when applicable. All applicable design standards and requirements are to be incorporated into the design and construction plans submitted to the City.

11.2 Floodplain Alterations

- 11.2.1 *Terminology* – The terms “floodplain” and “floodplain areas” include fully developed watersheds and FEMA floodplain limits. The term “fully developed watersheds” means the entire geographic area subject to flooding resulting from the 100-year design flood (based on fully developed watershed conditions). This differs from the regulatory FEMA floodplain and floodway. The term “FEMA floodplain” means the entire geographic area delineated by FEMA as Special Flood Hazard Areas (SFHA) within FEMA's current effective Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM). Refer to **Section 5.2 (Design Flow)** and **Appendix A (Definitions and Abbreviations)** for additional information.
- 11.2.2 *Floodplain Alterations Policy* – At a minimum, floodplain alterations will comply with all FEMA requirements and the City's current edition of the City of Midland Flood Damage Prevention Code. Refer to **Figure 11-1** to determine whether a Flood Study, Conditional Letter of Map Revision (CLOMR), and/or Letter of Map Revision (LOMR) are required. No new construction is allowed in the ultimate floodway. However, portions of the floodway may be reclaimed provided that the following criteria are met.

Figure 11-1. Floodplain Alterations Flow Chart



11.2.2.A *Flood Study* – A Flood Study meeting the requirements of this Section has been approved by the Engineering Services Director or designee. Note that a flood study or other drainage analysis/report may still be required by other City of Midland standards and requirements even if one is not required under Section 11 of this Manual.

11.2.2.B *Floodplain Permit* – A Floodplain Development Permit has been granted.

11.2.2.C *FEMA Compliance* – Alterations will be in compliance with FEMA guidelines.

11.2.2.D *Freeboard* – Freeboard requirements for drainage basin, channels, ditches, etc. are addressed in **Section 5.2 (Design Flow)** of this manual. Freeboard requirements for structures are addressed in the City Code.

11.2.2.E *Water Surface Elevations* – The ultimate 100-year water surface elevations on- or off-site will not increase by more than 0.01’.

11.2.2.F *Velocities* – Existing erosive average and maximum subsection velocities may not be increased above the maximum permissible velocity for the channel per **Table 11-1**

and mitigation may be required at the discretion of the Engineering Services Director or designee. Alterations of the floodplain will not create erosive velocities on- or off-site for average or maximum subsection velocities as follows:

- *Average Velocities* – Acceptable ultimate 100-year average velocities will be achieved in accordance with **Table 11-1**.
- *Maximum Subsection Velocities* – Acceptable ultimate 5-year and ultimate 100-year maximum subsection velocities will be achieved in accordance with **Table 11-1**.

Table 11-1. Roughness Coefficients and Allowable Velocities for Channels

| Channel Description | Manning’s Roughness Coefficient (n value) | Maximum Permissible Velocity ¹ (feet per second) |
|--|---|---|
| NATURAL CHANNELS | | |
| Floodplain – Vegetated | | |
| Short grass | 0.030 | 6.0 |
| Tall grass | 0.035 | 6.0 |
| Mature field crops | 0.040 | 6.0 |
| Heavy weeds scattered brush | 0.050 | 6.0 |
| Wooded | 0.120 | 6.0 |
| Floodplain – Non-Vegetated | | |
| Sand/Silt | 0.030 | 3.0 |
| Clay | 0.030 | 5.0 |
| Coarse Gravel | 0.030 | 6.0 |
| Shale | 0.030 | 10.0 |
| Rock | 0.025 | 15.0 |
| IMPROVED CHANNELS | | |
| Concrete | 0.013 | 15.0 |
| Precast Manufactured Block | 0.013 | ² |
| Articulated Concrete Block (ACB) | 0.015 | ² |
| Rock Riprap ³ | 0.040 | ⁴ |
| Stone Masonry | 0.032 | 10.0 |
| Gabion | 0.030 | 12.0 |
| 1. The values apply to average, uniform stands of each type of cover. Velocities exceeding 6.0 feet per second are permissible only where good cover and proper maintenance can be obtained. 2. Maximum permissible velocities for manufactured block and articulated concrete block based on manufacturer’s specifications. 3. Refer to Section 5.5.3.C.iii.b for rock riprap requirements. 4. Maximum permissible velocities for rock riprap based on gradation and depth. | | |

11.2.2.G *Channel Armoring* – Acceptable channel armoring has been provided at all locations that subsection velocities exceed 6 fps in accordance with **Section 5.5.3 (Open Channels and Named Draws)**.

- 11.2.2.H *Valley Storage* – Floodplain alterations will result in no loss of valley storage. HEC-RAS output tables must show no decrease in cumulative valley storage at every cross section. If the water surface elevation is decreased, hydrologic computation using the Modified Puls Routing Method may be used to evaluate impacts on flood discharges to prove no decrease in valley storage. Alternatively, a cut/fill balance that accounts for inundation reduction may be presented to show that no decrease in valley storage has been achieved within the ultimate floodplain limits.
- 11.2.2.I *Equal Conveyance* – The floodplain will be altered only to the extent permitted by equal conveyance on both sides of the natural channel, as defined by the USACE. Fill slopes, vertical walls, terracing, and other slope treatments may only be considered if no unbalancing of stream flow occurs.
- 11.2.2.J *Basin & Developed Playa Design Requirements* – All basin design requirements in **Section 5.5.2 (Basins)** are met. Playas that are converted from a natural state to a developed state must also meet these same requirements.
- 11.2.2.K *Open Channel Design Requirements* – All open channel design requirements in **Section 5.5.3 (Open Channels and Named Draws)** are met.
- 11.2.2.L Adverse Impacts
- 11.2.2.L.i Any alteration of floodplain areas will not cause any additional expense in any current or projected public improvements unless first approved by the Engineering Services Director or designee.
- 11.2.2.L.ii Alterations of the floodplain will not adversely impact adjacent, adjoining, upstream, or downstream properties. Adverse impacts will not be allowed unless:
- Full disclosure of the effects of the increase is made to the City.
 - Full disclosure of the effects of the increase is made to all property Owners, governmental agencies and quasi-governmental agencies affected by such increase.
 - The Applicant provides evidence to the City, in a form acceptable to the City, that the Applicant has acquired legal right (capable of being assigned to the City) to encroach upon the affected property which right will take into consideration the effect of such encroachment on the remaining property of the affected Owners.
 - Applicant's delivery to the City of policies of insurance in amounts and containing terms agreeable to the City and which name the City as a named insured or as an additional insured, insuring City against claims by third parties arising as a result of claims which may be made by adjacent, adjoining, upstream or downstream property Owners for damages occasioned, or claimed to be occasioned, as a result of flooding due to development of the property or construction of any improvements upon the property.

- Applicant's delivery to the City of a legally enforceable and binding indemnity agreement containing terms agreeable to the City, indemnifying the City from and against all loss or liability (including attorney's fees) which may be occasioned by the City as a result of claims by third parties arising as a result of claims which may be made by adjacent, adjoining, upstream or downstream property Owners for damages occasioned, or claimed to be occasioned, as a result of flooding due to development of the property or construction of any improvements upon the property.

11.2.2.M *Full Disclosure and Expense* – It will be the duty and obligation of the Applicant to show and establish that there will not be an increase of surface elevation, volume, or velocity, or alternatively the extent of the amount of such increase together with the full disclosure of all property affected by such increase. The matters herein required will be evidenced by submission of drainage plans in form and content satisfactory to the City under seal of a professional registered engineer in the State of Texas. The cost of preparation of such drainage plans will be paid exclusively by the Applicant. The matters required by this Section will be reviewed by an outside consultant of the City's choosing. The cost incurred by the City as a result of outside consultant review will be paid by the Applicant.

11.2.3 *Flood Study Requirements* – Any Engineering Plans for floodplain alterations will be based on engineering hydrologic and hydraulic analyses presented in a Flood Study.

11.2.3.A *Process* – The review process and timeline varies for each project. All initial CLOMR submittals will go through the City before submitting to FEMA.

11.2.3.A.i If a Flood Study is required, a preliminary Flood Study will be submitted to the City to be reviewed by City staff or an engineering consultant. Review comments will be returned to the Engineer. Once comments have been addressed, a final Flood Study will be submitted to the City for acceptance prior to receipt of a Floodplain Permit.

11.2.3.A.ii If a Flood Study and CLOMR are required, a preliminary CLOMR application and Flood Study will be submitted to the City to be reviewed by City staff or an engineering consultant. Review comments will be returned to the Engineer. Once the comments have been addressed, a revised CLOMR application and Flood Study will be submitted to the City for acceptance. The City's Floodplain Administrator must sign the MT-2 Form 1 prior to the Engineer submitting to FEMA. Once the CLOMR application is submitted to FEMA, review comments will be returned to the Engineer. Comments should be addressed and returned to FEMA and the City. All projects within the FEMA floodplain will receive acceptance from FEMA prior to issuance of a Floodplain Permit.

11.2.3.B *Report* – The Flood Study will be prepared, signed, and sealed by a Professional Engineer in the State of Texas trained and qualified to provide similar analyses. At a minimum, the Flood Study will include the following:

- 11.2.3.B.i Project description
- 11.2.3.B.ii Vicinity map
- 11.2.3.B.iii *Data Collection* – Describe type of data collected (previous studies, record drawings, topographic data, survey, field observations, etc.).
- 11.2.3.B.iv *Methodology* – Description of the hydrologic and/or hydraulic analyses used, including method used to determine historic rainfall and stream data, soils reports, selection of variables (such as Manning’s roughness coefficients), base models, and discharges and water surface elevations for the ultimate design floods and FEMA base floods.
- 11.2.3.B.v *Scour Analysis* – Results of a scour analysis in accordance with USACE’s current edition HEC-RAS (River Analysis System) User’s Manual for structures within the floodplain, including bridges, culverts, aerial crossings, drop structures, and retaining walls.
- 11.2.3.B.vi *Comparison Tables* – Comparison tables between existing and proposed conditions for water surface elevations, freeboard, discharge, valley storage, average velocities, and maximum subsection velocities in accordance with this section.
- 11.2.3.B.vii *Results* – Documentation that the principles of equal conveyance and channel stability have been achieved.
- 11.2.3.B.viii *Hydrologic Exhibits* – Drainage area maps, land use and soil data exhibits, and time of concentration calculations, if applicable.
- 11.2.3.B.ix *Hydraulic Workmaps* – Exhibits showing the fully developed watershed limits for the design flood for existing and proposed conditions. If applicable, FEMA floodplain and FEMA floodway limits will also be shown.
- 11.2.3.B.x *Detention* – If applicable.
- 11.2.3.B.xi *Appendix* – Additional tables or figures not included in the report.
- 11.2.3.B.xii *Printouts* – Printouts from HEC-RAS and HEC-HMS, as applicable. At a minimum, HEC-RAS printouts should include: summary results table for existing and proposed conditions; stream profile for existing and proposed conditions; and, cross section plots for existing and proposed conditions. Cross section plots will at a minimum include the following variables: ultimate 100-year water surface elevation, subsection velocity distribution, Manning’s roughness coefficients, and legend. Cross section plots will at a minimum include the following labels: project title, plan title, run date, x and y axis titles, and cross section description.
- 11.2.3.B.xiii *Input and Output Data* – Copies of hydrologic and hydraulic modeling program input and output data for existing and proposed conditions for the ultimate design floods and FEMA base floods.
- 11.2.3.B.xiv *Digital Files* – Digital files of hydrologic and hydraulic models.

- 11.2.3.C *Base Models* – The Engineer will use the City’s current effective base models for development along ultimate floodplain areas. If a model is not available, the Engineer will be required to develop floodplain hydrologic and hydraulic models in accordance with these standards. Modeling must be performed for the ultimate design floods. In some cases, FEMA flow rates and ultimate flow rates are the same. If a CLOMR or LOMR is required, FEMA flows will also be used. For projects requiring both a Flood Study and CLOMR, seek guidance from the Floodplain Administrator regarding base models.
- 11.2.3.D *Modeling Programs* – In general, the information needed for the Flood Study will be obtained by running a flood routing model, such as USACE’s HEC-HMS, and a backwater model, such as USACE’s HEC-RAS. Unless an existing base model is in place, HEC-HMS, HEC-RAS, ICPR, or another model method approved by the Engineering Services Director or designee will be used.
- 11.2.4 *CLOMR and LOMR Requirements* – CLOMR and LOMR applications will meet current FEMA requirements. For any FEMA floodplain alterations, a CLOMR must be approved before a Floodplain Permit will be granted. A LOMR will be submitted within 6 months after the completion of any FEMA floodplain alterations.
- 11.2.5 Verification of Floodplain Alterations
- 11.2.5.A Prior to final acceptance by the City of utilities and street construction for projects involving floodplain alterations or adjacent to defined floodplains, draws, channels and drainageways, a certified statement will be prepared by a registered public surveyor showing that all lot elevations, as developed within the subject project, meet or exceed the required minimum finished floor elevations shown on the approved grading of the subdivision. This certification will be filed with the Engineering Services Director or designee.
- 11.2.5.B In addition, at any time in the future when a building permit is desired for existing platted property which is subject to flooding or carries a specified or recorded minimum finished floor elevation, a registered public surveyor will survey the property prior to obtaining a building permit. The certified survey data showing the property to be at or above the specified elevation will be furnished to the Engineering Services Director or designee for approval. Certificate of compliance with the provisions of this article pertaining to specified finished floor elevations will be required. Elevation Certificate will be required prior to final inspection and final walk-through being conducted for C.O. or acceptance.
- 11.2.5.C The Owner/Developer will furnish, at his/her expense, to the Engineering Services Director or designee sufficient engineering information to confirm that the minimum floor elevations proposed are as required by this section. Construction permits will not be issued until:
- A CLOMR or amendment has been issued by FEMA

APPENDIX A DEFINITIONS AND ABBREVIATIONS

1.1 Definitions

The definitions within this section are intended to provide descriptions for terms used within the Manual. When words and terms are defined herein and in other City ordinances, they shall be read in harmony. If an irreconcilable conflict exists, the definition contained herein shall control in the construction and application of this Manual. Where no definition appears, the term should be interpreted according to their customary usage in the practice of municipal planning and engineering. The Engineering Services Director or his/her designee has the final determination of interpretation.

Words used in the present tense include the future tense. Words in the singular tense include the plural tense. The word “will” is mandatory and not directory.

100-year flood– A flood event that statistically has a recurrence interval (return period) of 100 years and a one percent chance of being equaled or exceeded in any given year. The event shall be based upon fully developed watershed conditions unless otherwise specified.

Alley – A public right-of-way, not intended to provide the primary means of access to abutting lots, which is used primarily for vehicular service access to the back or sides of properties otherwise abutting on a public way.

Applicant – Any firm, entity, partnership, company, public utility company, or individual submitting a formal request or application.

Arterial – A roadway designed to carry large volumes of traffic of a local nature to the freeway or expressway systems. Interchange of traffic from freeway systems to the local streets occurs via the arterial street.

Average Daily Traffic (ADT) – A volume that represents the total two-way traffic on a roadway for a period of less than a year, divided by the total number of days it represents, and that includes both weekday and weekend traffic. ADT is typically adjusted for day of the week, seasonal variations, and/or vehicle classification.

Base Flood – The flood event having a one percent chance of being equaled or exceeded in any given year based on existing watershed conditions, FEMA guidelines, and SFHA as shown in the current effective FIS and FIRM. Differs from design flood. The resulting water surface elevation from the base flood shall correspond with the FEMA Base Flood Elevation (BFE).

Best Management Practice (BMP) – Schedules of activities, prohibitions of practices, maintenance procedures, structural controls, local ordinances, and other management practices to prevent or reduce the discharge of pollutants. BMPs also include treatment requirements, operating procedures, and practices to control runoff, spills or leaks, waste disposal, or drainage from raw material storage areas. A BMP may be temporary to protect during construction, or permanent to protect from long-term impacts of the development.

Casing Pipe – An exterior protective pipe that encases a carrier pipe for various types of crossings, including roadways, creeks, and railroads. Also known as encasement pipe.

City – City of Midland.

Collector – A roadway designed to pass through neighborhoods collecting traffic from local streets and distributing the traffic to arterial streets. These streets also serve neighborhood facilities.

Connection – The point at which a facility is provided service by the City water or wastewater system.

Corner Clip – Right-of-way dedication at intersection corners to provide sufficient room for intersection visibility, pedestrian access, and other street facilities.

County – Governing agencies located within the City of Midland’s ETJ. Andrews, Martin, and Midland County are all located in the City’s ETJ.

Crown – The highest point of a roadway cross section. Also known as soffit.

Deceleration Lane – A speed-change lane, including tapered areas, which enables a vehicle exiting a roadway to leave the travel lanes and slow before making a turn.

Developer – The person, business, corporation or association responsible for the development of the subdivision or lot, and includes the property owner or subdivider. Also referred to as Owner.

Design Flood – The flood event that is used as the basis for design to provide a stated degree of protection or other specified result.

Design Speed – A selected speed used to determine the various geometric design features of the roadway.

Detention Basin – A basin or depression constructed to temporarily store stormwater runoff and discharge the water over time at a reduced rate or at a later time than would have otherwise occurred.

Director of Development Services – The Director of the Development Services Department or his/her designee.

Director of Public Works – The Director of Public Works or his/her designee.

Director of Utilities – The Director of the Utilities Department or his/her designee.

Distribution System – A system of pipes that conveys potable water from a water treatment plant to consumers. Distribution systems include pump stations, ground and elevated storage tanks, potable water mains, potable water service lines, and all associated valves, fittings, and meters, but excludes potable water customer service lines after the customer meter.

Drainage System – Storm drainage facilities including streets, alleys, ditches, inlets, storm drain systems, creeks, floodplains, bridges, culverts, detention facilities, retention facilities, overflow routes, and any other facility through which or over which stormwater flows.

Emergency Overflow Path – A path stormwater will take when a drainage facility becomes clogged or does not function as designed, or is overwhelmed by a storm event exceeding its design capacity.

Engineer – The Professional Engineer (P.E.) licensed in the State of Texas through the Texas Board of Professional Engineers and Land Surveyors (TBPELS) who is responsible for the signing and sealing of construction plans, studies, calculations, and/or any other engineering documents in accordance with TBPE's requirements for professional practice.

Engineering Services Director – The Director of the Engineering Services Department or his/her designee.

Fire Code Official – Fire Marshall or his/her designee.

Flood or flooding – A general and temporary condition of partial or completed inundation of normally dry land areas from: (a) the overflow of inland or tidal waters; or (b) the unusual and rapid accumulation or runoff of surface water from any source.

Flood Control – The elimination or reduction of stormwater damage by means of land use restrictions, detention storage, erosion control, drainage systems, channel improvements, dikes and levees, bypass channels, and/or other engineering works. Also known as stormwater management.

Floodplain Administrator – The City Engineer or his/her designee appointed to administer and implement the provisions of the Drainage and Flood Hazard Area Regulations Ordinance and other appropriate sections of 44 CFR (Emergency Management and Assistance – NFIP Regulations) pertaining to floodplain management.

Floodplain Reclamation – Reclamation of a portion of the floodplain may be permitted only if it can be demonstrated that there will be no rise in the base flood elevation (BFE) or increase in peak stream flow or stream velocity.

Floodplain – Any land area susceptible to being inundated by water from any source; see "flooding".

Fully Developed Watershed – Base flood elevation (BFE) and floodplain used for design and planning shall be evaluated upon total stormwater discharge quantities that will, through future urbanization, be generated from a fully developed watershed, consistent with any watershed drainage plan adopted by the City.

Floodway – The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

Flowline – The floor, bottom, or lowest elevation of an open channel or closed conduit. Also known as an invert.

Freeboard – The distance between the design flood elevation and the freeboard reference point.

Frontage Road – A local roadway along an arterial highway governed by TxDOT allowing control of access and service to adjacent areas and property. Also known as a service road.

Improved Channel – A channel or area of concentrated drainage that has been cleared, excavated, realigned, lined, graded, stabilized, or created by equipment. Also known as improved creek and improved stream.

Intersection – Any at-grade connection with a roadway. The junction of an alley with a roadway shall not constitute an intersection.

Lateral – Common term for an extension of pipe that carries water, gas, electricity, stormwater, or sewage to or from homes, business's, etc. to or from the main pipeline. Commonly referred to as "Line", "Service Line", or "Service Lateral."

Level of Service (LOS) – A measure of traffic flow and congestion. LOS is a qualitative measure describing operational conditions within a traffic stream, generally described in terms of speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Local Street – A roadway designed to provide the basic function of serving private property with access to other streets. Also known as residential street.

Main – Common term for a principal pipe system that distributes water, gas, electricity, and sewage. Commonly referred to as "Line."

Manual – City of Midland Engineering Design Manual.

Maximum Daily Demand – The total amount of water used during the day of heaviest consumption in any given year and the minimum rate which the high service pumps shall be capable of pumping. Water shall be supplied to the pumps at this rate.

Maximum Hourly Demand – The rate at which water is drawn from the entire system during the hour of maximum consumption on the day of maximum demand. This rate is generally of a short duration and is most economically provided for by the use of elevated storage in addition to water supplied to the system by pumps. The distribution system, including storage and pumping capacity, shall be able to satisfy this demand. Also known as peak flow.

Median – The portion of a divided roadway separating the opposing traffic flows. A median may be traversable or non-traversable.

Median Opening – An opening in a non-traversable median that allows accessing or crossing the opposing traffic lanes.

Minimum Hourly Demand – The rate at which water is drawn from the distribution system during the hour of minimum demand on the day of maximum demand. This rate is used in the water distribution analysis to determine the adequacies of the system to replenish elevated storage.

Municipal – Also referred to as the City of Midland.

Natural Channel – An unlined and unimproved existing drainage channel that has not been graded, modified, cleared, or created by equipment. Also known as natural creek and natural stream.

Non-traversable Median – A physical barrier in a roadway or driveway that separates vehicular traffic traveling in opposite directions, and prohibits movement of traffic across the median. Non-traversable medians include, but are not limited to, concrete barriers, raised concrete curbs and/or islands, and grass or swale medians.

Normal Water Surface Elevation – The typical observed water surface elevation in the absence of a flood event. Also referred to as ordinary high water mark or normal pool level.

Open Channel – A channel in which water flows with a free surface. Includes designed channels or ditches, creeks, lakes, flood control sags, or natural water ways.

Parkway – An area within the right-of-way but outside the edge of pavement which is typically reserved for public use other than vehicular traffic.

Playa – Natural ground surface depressions which retain surface water runoff but lack the ability to sufficiently drain after a storm event.

Post-development – The condition of the given site and drainage area after the anticipated development has taken place. Also known as proposed condition or post-project.

Pre-development – The existing condition of the given site and drainage area prior to development. Also known as existing condition or pre-project.

Public – The term “Public” will generally refer to the community and people of the City of Midland.

Retention Basin – A basin or depression constructed to store stormwater runoff until it evaporates or infiltrates into the ground over time.

Right-of-Way (ROW) – A strip of land dedicated by plat for use of public roadways and/or related facilities. Other facilities include, but are not limited to, utilities, drainage systems, and other transportation uses. Unless otherwise specified, the term right-of-way shall refer to a public right-of-way.

ROW Width – The shortest horizontal distance between the lines which delineate the limits of right-of-way.

Sidewalk – A paved area behind the curb intended for the use of pedestrians.

Sight Distance – The distance visible to the driver of a passenger vehicle measured along the normal travel path of a roadway from a designated location and to a specified height above the roadway when the view is unobstructed by traffic.

Standard of Care – The care and skill ordinarily used by members of the subject profession practicing under similar circumstances at the same time and in the same locality. No provision or requirement of the Engineering Design Manual shall relieve the engineer of his/her responsibility to meet the standards of conduct and ethics established by the Texas Board of Professional Engineers and Land Surveyors (TBPELS).

Storage Length – The portion of a turn lane required to store the number of vehicles expected to accumulate in the lane during an average peak period.

Storm Drain – Infrastructure designed to drain excess rain or groundwater from ground surfaces such as paved streets, parking lots, sidewalks, etc. Commonly referred to as “Storm Sewer.”

Time of Concentration – The estimated time required for runoff to flow from the most hydraulically remote point of the drainage area to the point at which the flow is to be determined. Hydraulically remote refers to the travel path with the longest flow travel time, not necessarily the longest linear distance.

Top Soil – The upper 4”-6” of natural earth material that sustained vegetation before being disturbed by construction activity.

Trunk Line – The main line of a storm drain system. Includes lines extending from manhole to manhole or from manhole to outlet structure.

Watershed – The area contributing stormwater runoff to a stream or drainage system. Also known as drainage area, drainage basin, and catchment area.

Wastewater – Water that has been used in the home, in a business, or as part of an industrial process. Commonly referred to as “Sanitary Sewer.”

1.2 **Abbreviations**

% – Percent.

' – Foot or feet.

” – Inch or inches.

A – Cross Section Flow Area in Manning’s Equation.

AASHTO – American Association of State Highway and Transportation Officials.

ACB – Articulated concrete block.

ACI – American Concrete Institute.

ADA – Americans with Disabilities Act.

ADAAG – Americans with Disabilities Act Accessibility Guidelines.

ADT – Average Daily Traffic.

ASCE – American Society of Civil Engineers.

ASTM – American Society for Testing and Materials.

AWWA – American Water Works Association.

B-B – Back of curb to Back of curb distance.

BFE – Base Flood Elevation.

BMP – Best Management Practice.

C – Collector or Capacity (depending on context).

CAD – Computer-aided Design.

CBR – California Bearing Ratio.

CFR – Code of Federal Regulations.

CFS – Cubic Feet per Second.

CGP – Construction General Permit.

CIP – Cast Iron Pipe.

CLOMR – Conditional Letter of Map Revision.

CLSM – Controlled Low Strength Material.

COM – City of Midland.

CRMWD – Colorado River Municipal Water District.

CSN – Construction Site Notice.

CSS – Concrete Stabilized Sand.

D – Divided.

DIP – Ductile Iron Pipe.

DIPRA – Ductile Iron Pipe Association.

ECP – Erosion Control Plan.

EGL – Energy Grade Line.

EPA – Environmental Protection Agency.

ET – Evapotranspiration.

ETJ – Extraterritorial Jurisdiction.

FDC – Fire Department Connection.

FEMA – Federal Emergency Management Agency.

FFE – Finished Floor Elevation.

FHWA – Federal Highway Administration.

FIRM – Federal Insurance Rate Map.

FIS – Flood Insurance Study.

FL – Flange Joint.

FPS – Feet Per Second.

GPCD – Gallons Per Capita Per Day.

GPS – Global Positioning System.

H – Horizontal or Height (depending on context).

HDPE – High Density Polyethylene.

HEC-HMS – Hydrologic Engineering Center Hydrologic Modeling System.

HEC-RAS – Hydrologic Engineering Center River Analysis System.

HGL – Hydraulic Grade Line.

HMAC – Hot Mix Asphalt Concrete.

IBC – International Building Code.

ICPR – Interconnected Channel and Pond Routing Model.

I.D. – Inside Diameter.

IFC – International Fire Code.

ILSN – Illuminated Street Name Sign.

IN – Inch.

IRC – International Residential Code.

iSWM – Integrated Stormwater Management.

ITE – Institute of Transportation Engineers.

L – Local or Length (depending on context).

lbs – Pound or pounds.

LED – Light-Emitting Diode.

LF – Linear Feet.

LI – Licensed Irrigator.

LL – Liquid Limit.

LOMR – Letter Of Map Revision.

LOS – Level Of Service.

LRFD – Load and Resistance Factor Design.

MASH – Manual for Assessing Safety Hardware.

Max – Maximum.

MGD – Million Gallons per Day.

Min – Minimum or Minutes (depending on context).

MJ – Mechanical Joint.

MOU – Memorandum Of Understanding.

MPH – Miles Per Hour.

MPR – Matched Precipitation Rate.

MS4 – Municipal Separate Storm Sewer System.

MSE – Mechanically Stabilized Earth.

MSL – Mean Sea Level.

NCHRP – National Cooperative Highway Research Program.

NCTCOG – North Central Texas Council of Governments.

NFIP – National Flood Insurance Program.

NFPA – National Fire Protection Association.

NHPA – National Historic Preservation Act of 1966.

NOI – Notice of Intent.

NOT – Notice of Termination.

NPDES – National Pollution Discharge Elimination System.

NRCS – National Resources Conservation Service (formerly SCS).

NTTA – North Texas Tollway Authority.

OSHA – Occupational Safety and Health Administration.

OSSF – On-Site Sewage Facilities.

P – Manning’s equation wetted perimeter.

P.E. – Professional Engineer.

PBMP – Permanent Best Management Practice.

PC – Point of Curvature.

pci – Pounds per cubic inch.

PCSQP – Post Construction Stormwater Quality Plan.

PD – Planned Development.

PE – Plain End pipe.

PI – Plasticity Index or Point of intersection (depending on context).

PIV – Post Indicator Valve.

PL – Plastic Limit.

PMF – Probable Maximum Flood.

ppm – Parts per million.

PROWAG – Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way.

PSI – Pounds per Square Inch.

PSM – Permanent Survey Monument.

PT – Point of tangency.

PTZ – Pan-Tilt-Zoom.

PVC – Polyvinyl Chloride.

PVI – Point of Vertical Intersection.

PVR – Potential Vertical Rise.

QL – Quality Level.

R – Manning’s equation hydraulic radius of conduit.

RCP – Reinforced concrete pipe.

RLA – Registered Landscape Architect.

ROW – Right-of-Way.

RPLS – Texas Registered Professional Land Surveyor.

RRC – Railroad Commission of Texas.

RQ – Reportable Quantity.

S – Slope in Manning’s Equation.

SCS – Soil Conservation Service.

SD – Sight Distance.

SDHAM – Storm Drain Hydraulic Analysis Manual.

SFHA – Special Flood Hazard Area.

SOP – Standard operating procedure.

SPF – Standard Project Flood.

SUE – Subsurface Utility Engineering.

SWMP – Stormwater Management Program.

SWPPP – Stormwater Pollution Prevention Plan.

TAC – Texas Administrative Code.

TAS – Texas Accessibility Standards.

TBPELS – Texas Board of Professional Engineers and Land Surveyors.

TC – Time of Concentration.

TCEQ – Texas Commission on Environmental Quality.

TCP – Traffic Control Plan.

TDLR – Texas Department of Licensing and Regulation.

TIA – Traffic Impact Analysis.

TMP – Traffic Management Plan.

TMUTCD – Texas Manual on Uniform Traffic Control Devices.

TPDES – Texas Pollution Discharge Elimination System.

TRB – Transportation Research Board.

TSM – Transportation System Management.

TxDOT – Texas Department Of Transportation.

U.L. – Underwriters Laboratories

U.S. – United States.

USACE – United States Army Corps of Engineers.

USFCCHR – University of Southern California Foundation for Cross-Connection Control and Hydraulic Research.

V – Vertical, Velocity, or Volume (depending on context).

VIVDS – Video Imagery Vehicle Detection System.

WinPAS – Windows Pavement Analysis Software.

DRAFT