CITY OF CORINTH
ENGINEERING STANDARDS MANUAL

Effective Date: 5/20/2013

Time Stamp: 6/28/2013 11:10 AM

FREESE AND NICHOLS

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Section 1. General

Subsection 1.01. Supplement to the Subdivision Regulations in the Unified Development Code

This Article supplements the Subdivision regulations in the Unified Development Code. The following design criteria are primarily intended for use by the Developer's Engineer. There may be special circumstances which would dictate requirements in excess of those outlined; however, in most cases, these exceptions will be apparent to the Developer's Engineer while preparing the Construction Plans and Specifications for the subdivision.

Subsection 1.02. NCTCOG Standards

The "Standard Specification for Public Works Construction, North Central Texas" of the North Central Texas Council of Governments, with all amendments thereto, shall govern and shall constitute the technical specifications except as amended by these design criteria and the Corinth Construction Standards.

Subsection 1.03. Compliance Required for Final Plat Approval

No final plat shall be approved by the City Council, and no completed improvements shall be accepted by the City Engineer, unless and until such improvements conform to Corinth's design criteria and all other applicable standards as prescribed by the City of Corinth. All streets, alleys, sidewalks, drainage ways, water and sewer lines and improvements shall be designed, placed and constructed in accordance with the following design criteria and with the Construction Standards and Details.

Subsection 1.04. City Manager May Authorize a Variance

Where a specific topographic feature or other condition makes a variance necessary to achieve the best interest of the City, then these standards may be modified by the City Manager, upon recommendation from the City Engineer.

Subsection 1.05. Definitions

The definitions set forth in the Subdivision regulations and Unified Development Code shall apply to this Engineering Standards Manual.

Section 2. Minimum Standards

If any required dedication or other exaction exceeds the minimum standards by oversizing or upgrading in any form, the City will determine the impact of the development. A subdivision that requires improvements which meet only the minimum standards will not require a new study but will be based upon prior studies. If the subdivider maintains that he is not responsible for constructing infrastructure at greater than the minimum standard, the subdivider shall submit to the City engineering investigations, studies, and calculations in support of constructing the minimum standard.

Section 3. Stormwater Discharge Permit

In accordance with the Federal Water Pollution Control Act, 33 U.S.C. Para. 1251-1387 (1990), also known as the Clean Water Act, as amended in 1987 and codified as 40 C.F.R., Part 122, the development shall be required to obtain a storm water discharge permit (E.G. NOI) for construction activity from the Texas Commission on Environmental Quality (TCEQ).

Under current regulations, construction activities including clearing, grading and excavation, must be permitted for storm water discharge unless the operations result in the disturbance of less than five (5) acres total land area and the areas are not part of a larger common plan of development. Copies of documentation of the appropriate permit(s) shall be filed with the City at least two (2) days prior to commencement of construction. During construction a copy of the Storm Water Pollution Prevention Plan (SWPPP) shall be available on site in accordance with TCEQ requirements.

The following hyperlink provided additional information regarding City storm water planning requirements and regulations.

1. Storm Water Management Plan
   http://cityofcorinth.com/index.aspx?NID=284
   http://cityofcorinth.com/DocumentView.aspx?DID=79

2. Erosion Control / Illicit Discharge Ordinance
   http://cityofcorinth.com/index.aspx?NID=284
   http://cityofcorinth.com/DocumentView.aspx?DID=86

Section 4. Streets

Subsection 4.01. Concrete Pavement

4.01.01. Concrete Strength Requirements

A. Concrete Curb and Gutter
Concrete shall be constructed of a batch design, providing a twenty-eight (28) day compressive strength of three thousand six hundred (3,600) pounds per square inch (psi).

B. Reinforced Concrete Pavements and Monolithic Curb
Concrete pavement and monolithic curb properly and continuously reinforced shall be constructed of a concrete batch design, providing the appropriate twenty-eight (28) day compressive strength. The minimum reinforcement shall be No. 4 deformed bars spaced at eighteen (18) inches center to center, both ways.

4.01.02. Pavement Thickness Requirements

A. Local Street and Alley Construction

1. A six inch (6") thickness of three thousand (3,600) psi reinforced concrete pavement on a compacted sub-base shall be required. Said six inch (6") thickness will be acceptable without performing additional soils investigation or design calculations.
2. All steel reinforcing shall be deformed No. 4 bars on twenty-four inch (24") centers both ways.
3. Stabilization of the subgrade, six inches (6") thick with six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization), shall be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.

B. Collector Street

1. Collector streets shall be designed and constructed with eight inch (8") thickness of three thousand (3,000) psi reinforced concrete pavement on a compacted sub-base.
2. All steel reinforcing shall be deformed No. 4 bars on twenty-four inch (24") centers both ways.
3. Stabilization of the sub-base with a six inch (6") thickness of six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization) will be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.

C. Arterial Street Construction

1. Arterial streets shall be designed and constructed with an eight inch (8") thickness of three thousand (3,600) psi reinforced concrete pavement on a compacted sub-base.
2. All steel reinforcing shall be deformed No. 4 bars at twenty-four inch (24") centers both ways.
3. Stabilization of the subgrade, six inches (6") thick with six percent (6%) hydrated lime by weight or cement (if geo-tech study is provided showing recommended stabilization), shall be required. Compaction of the lime stabilized subgrade shall be to 95% standard proctor density.

Subsection 4.02. Miscellaneous

4.02.01. Reinforcing Steel

Steel for street and alley paving shall meet ASTM designation A 15, A 16, or A 408 and be deformed bars.

4.02.02. Sawed Dummy Joints

A. Sawed Dummy Transverse Joints

Sawed dummy transverse joints shall be not greater than 20'-0" apart or as required by the City at intersections.

B. Longitudinal Sawed Dummy Joints

Longitudinal sawed dummy joints shall be required in all pavements where the concrete is poured in a continuous width of 30 feet or more. The longitudinal dummy joints shall be located at one-third point of the width or as directed by the City.

4.02.03. Expansion Joints

Expansion joints shall be placed at distances no greater than 600 feet and shall be constructed in accordance with the **City's standards**. Construction joints shall be constructed in accordance with the expansion joint standard.

Expansion joints shall have dowels #5 smooth at 18-inch centers. Construction joints shall have the reinforcing bars continuous through the joint.

4.02.04. Longitudinal Pavement Slopes

The minimum longitudinal standard alley pavement slopes shall be as follows.

A. The maximum longitudinal slopes are as follows:

Table 1: Maximum Longitudinal Slopes

Type of Street	Maximum Slop
Arterial	6%
Collector	8%
Local	10%
Maximum grades for alleys shall be 8% within 30 feet of its intersection with a street and 14% elsewhere.	

4.02.05. Transverse Pavement Slopes

The transverse pavement slope for all non-divided streets shall consist of a parabolic curve from the pavement centerline to the gutter. The crown of the parabolic curve shall be five (5) inches above the gutter grade on local streets and six (6) inches on collector streets. For divided streets, the transverse slope shall be as required by the City.

4.02.06. Lime Stabilization

Hydrated lime shall be spread uniformly over the soil to be treated and sprinkled to the proper moisture content dictated by a geotechnical engineering report. The soil, lime, and water shall be mixed until a homogeneous product is obtained that is free of clods and lumps. The mixture shall then be immediately rolled to the required compaction. In the event that non-cohesive soils are encountered, then subgraded stabilization will be obtained by cement, applied in the amounts and according to methods suitable for the soil and approved by the City Engineer.

Section 5. Drainage and Storm Sewer

Subsection 5.01. General

5.01.01. Storm Water Flows ≤ 200 cfs

An enclosed storm sewer shall be provided in all areas where the quantity of the accumulated storm runoff does not exceed two hundred (200) cubic feet per second (cfs).

5.01.02. Storm Water Flows > 200 cfs and ≤ 500 cfs

In drainage courses where the accumulated storm runoff is more than two hundred (200) cfs and less than or equal to five hundred (500) cfs, either an enclosed storm sewer system or an open -lined channel shall be constructed.

5.01.03. Storm Water Flows > 500 cfs

In drainage courses where the accumulated storm runoff is more than five hundred (500) cfs, the drainage improvements may be either an enclosed storm sewer system, or an open channel. Earthen channels shall be designed according to the criteria as set forth herein for open channel sections. All earthen channels shall be located within an easement outside of the right-of-way or the right-of-way shall be widened to accommodate the open channel.

Subsection 5.02. Runoff Calculations

5.02.01. Runoff Calculations

A. Selection of Calculation Method

1. The selection of which method to use for calculating runoff depends upon the size of the contributing drainage area at the most downstream point of the project.
2. The "Rational Method" is acceptable for designing projects in which the drainage area is less than 160 acres.
3. A unit hydrograph method is required for projects with larger drainage areas, 160 acres or greater.

B. One (1) Acre Requirement

A developer or builder of property greater than one acre in size, or any property that was platted as a part of an overall tract which was greater than one acre in size (including churches and schools), shall match current outfall conditions at the boundary or tract property or other drainage point.

C. Runoff computations

Runoff computations shall be based upon fully developed watershed conditions in accordance with the land use projections in the latest Comprehensive Land Use Plan for the City of Corinth.

1. The design engineer shall size drainage facilities by disregarding the detention effects of upstream property and calculating the runoff as if the off-site property were developed without any detention.
2. If an approved regional detention/retention facility is in operation, the design engineer may size downstream drainage facilities based on consideration of the detention effects of the regional facility.

5.02.02. Procedure for drainage area less than 160 acres

Computation of storm water runoff for drainage areas less than 160 acres may be by the "Rational Method" which is based on the principle that the maximum rate of runoff from a given drainage area for an assumed rainfall intensity occurs when all parts of the area are contributing to the flow at the point of discharge. The formula for calculation of runoff by the "Rational Method" is: Q = CIA

A. "Q" Value

Where Q = the maximum rate of discharge or flow rate, at a given point, expressed in cubic feet per second.

B. "C" Value

Where C = Coefficient of Runoff. The runoff coefficient which considers the slope of the terrain, the character of the land use, the length of overland flow, and the imperviousness of the drainage area, shall be determined from the ultimate land development plan of the City. Typical "C" values are listed in the table below:

Table 2: Typical "C" Values

Land Use	"C"
Undeveloped Property	0.30
Park Areas - No Developed Land	0.35
Developed Park Sites	0.40
Single Family Residential	0.55
Multiple Family (i.e., Townhomes, Apartments, etc.)	0.70
Schools	0.70
Churches	0.70
Neighborhood Commercial	0.80
Office Commercial	0.80
Commercial	0.90
Industrial	0.85

C. "I" Value

Where I = Intensity of Runoff in Inches per Hour. The rainfall intensity - frequency curves, which are shown on **Plate 1**, are plotted from data published by the U.S. Department of Commerce Weather Bureau, Technical Paper No. 40. The intensity, I, in the formula Q = CIA, is determined from these curves by arriving at a time of concentration and adapting a storm frequency upon which to base the drainage improvements.

D. "A" Value

Where A = Drainage Area in Acres. The area used in determining flows by the "Rational Method" shall be calculated by subdividing a map into drainage areas within the basin contributing stormwater runoff to the system.

E. Time of Concentration

1. Time of concentration is the longest time, without interruption of flow by detention devices, that a drop of water takes to flow from the farthest point of the drainage area to the point of concentration (i.e., the point of design). The time of concentration is composed of the inlet time and the flow time in a conduit or channel to the point of design. A nomograph shown on **Plate 2** is attached for estimating the time of concentration.

2. When designing inlets and laterals, the time of concentration is equal to the inlet time. The design engineer will compare the above specified inlet times to the actual calculated inlet time by computing the flow time overland and along the gutter to the first inlet. Manning's equation shall be used to determine flow time to the inlet. The design engineer may use the actual calculated or specified inlet

time. In no case shall a longer inlet time than 10 minutes be used for multiple family, commercial, churches, schools, industrial and business areas and 15 minutes for parks, cemeteries, agricultural, and single-family areas.

5.02.03. Procedures for Drainage Areas greater than 160 acres

A. Unit Hydrograph Method

For drainage areas in excess of 160 acres where the use of the "Rational Method" does not provide reliable results, the use of a unit hydrograph method shall be made. The use of a unit hydrograph calculation will be based upon standard and accepted engineering principles subject to the approval of the City Engineer. Acceptable methods include the Soil Conservation Service (SCS) Technical Release Number 55 for drainage areas from 100 acres to 2,000 acres, and SCS's TR20 or the Corps of Engineers HEC-1 models for drainage areas 160 acres or more.

B. Fully Developed Watershed Conditions

The unit hydrograph method shall be based upon fully developed watershed conditions assuming no effects from the small on-site detention facilities for maintaining the rate of runoff as if the property were developed as single family residential use. The detention effects of large regional detention facilities can be taken into account in unit hydrograph methods.

C. Circumstances

Circumstances that may require the use of a unit hydrograph method include sizing open channels, reclaiming floodplains, creating lakes, or building other types of drainage-related facilities on major drainage courses. Design engineers of these types of facilities should be aware that the requirement of designing for fully developed watershed conditions will mean that they will have to calculate these fully developed flows instead of using the flows calculated in the Federal Emergency Management Agency's (FEMA) flood insurance studies for Corinth.

Subsection 5.03. Design Storm Frequencies

5.03.01. Drainage Facility and Corresponding Recurrence Interval

Table 3: Drainage Facility and Corresponding Recurrence Interval	
Drainage Facility	Design Recurrence Interval
Right-of-way & Drainage Easement Boundaries	The 100-year storm (ultimate conditions) must be contained herein.
Curb and Gutter and Borrow Ditches	The 50 year storm must be contained between the curbs or within the borrow ditches.
Streets	One lane of traffic must remain unflooded on local streets. Two lanes of traffic (one each direction) must remain unflooded on collector and arterial streets.
Closed Storm Sewer Systems	25-year with 100-year positive overflow for Inlets on Grade in streets such that the depth of flow in the street does not exceed the top of curb.
Closed Storm Sewer Systems and Inlets at Street Low Point or Sag	100-year
Culverts and Bridges	100-year
Concrete-lined Channels	100-year
Earthen Channels	100-year

5.03.02. Approved Drainage System and Positive Overflow

The approved drainage system shall provide for positive overflow at all low points. The term "positive overflow" means that when the inlets do not function properly or when the design capacity of the conduit or inlet is exceeded, the excess flow can be conveyed overland along a grassed or paved course. Normally, this would mean along a street or alley, or shall require the dedication of drainage easements as required to provide for the flows.

5.03.03. Recommended Design Storm Frequencies

Recommended design storm frequencies for the storm drainage improvements in the City are shown in a table as follows:

Table 4: Recommended Design Storm Frequencies

Type of Facility		Description of Drainage Area	Maximum Time of Concentration (Minutes)	Design Frequency (Years)
(1)(3)	Storm Sewers	Residential, Commercial, and Industrial	30	25
(2)	Culverts, Bridges, Channels and Creeks	Any type of area less than 100 acres	30	100
(3)	Culverts, Bridges, Channels and Creeks	Any type of area greater than 100 acres but less than 1,000 acres	45	100
(4)	Culverts, Bridges, Channels and Creeks	Any type of area great than 1,000 acres	60	100

Notes	
(1)	If the maximum time of concentration or area to be drained is exceeded, the design shall be based on a fifty (50) year frequency.
(2)	If the maximum time of concentration or area to be drained is exceeded, the design shall be based on a one hundred (100) year frequency.
(3)	Whenever, in a storm sewer system, an inlet is located at a low point so that flow in excess of the storm sewer capacity would be directed onto private property, the design frequency shall be increased beyond twenty-five (25) years. If the inlet location is such that overflow could cause damage or serious inconvenience, it may be desirable to increase the design frequency to as much as one hundred (100) years.
(4)	When the maximum time of concentration of sixty (60) minutes is exceeded on any area to be drained, the design shall be based on a one hundred (100) year frequency having a maximum time duration of 60 minutes.

Subsection 5.04. Street and Alley Capacity

5.04.01. Streets

The 50 year storm shall be contained within the outermost curbs or within the borrow ditches for any street section and the 100 year storm shall be contained within the street right-of-way.

5.04.02. Alleys

A. Flows Contained

The flows created by the 100-year storm shall be contained within the limits of all paved alleys.

B. First floor elevations

1. The first floor elevations of all residential and other structures shall be set at a minimum elevation of one foot above the top of the street curb elevation or the alley invert at the lowest point along the property frontage, and with positive drainage provided away from the structure.
2. Positive overflow sections shall provide a minimum of 1 foot of freeboard from the overflow invert adjacent to structures and the corresponding first floor elevation of all residential and other structures.

5.04.03. Spread of Water

A. Quantity of Storm Water

During the design storm, the quantity of storm water that is allowed to collect in the streets before being intercepted by a storm drainage system is referred to as the "spread of water". In determining the limitations for carrying the storm water in the street, the ultimate development of the street shall be considered. The use of the street for carrying storm water shall be limited to the following:

Table 5: Quantity of Storm Water

Street	Quantity Standard
Arterial Streets (divided)	One (1) traffic lane each direction to remain clear.
Collector Streets	One (1) traffic lane each direction to remain clear.
Local Streets	Six-inch (6") depth of flow at curb, and one lane completely clear.

B. Formulas

Formulas are provided on **Plate 3** for determining the flow in parabolic street sections. Also provided are gutter flow curves, **Plate 4** and **Plate 5**, for determining the capacity of parabolic gutters for various street widths and a curve for determining the curb inlet opening length in slumps (**Plate 6**).

C. Length of On Grade Inlet Opening

The length of on grade inlet opening for each cubic foot per second of gutter flow is:

Table 6: Length of On Grade Inlet Opening

Street Grade	Length of Inlet Opening in Feet per CFS
Less than 2%	1.0
2% to 3.5%	1.5
Greater than 3.5%	2.0

Subsection 5.05. Storm Sewer Design

Storm water runoff in excess of that allowed to collect in the streets shall be intercepted in inlets and carried away in a storm sewer system.

5.05.01. Calculating Storm Water Capacity

Storm sewer capacity shall be calculated by Manning's formula.

Table 7: Manning's Formula
$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$, where n
Q is the discharge in cubic feet per second;
A is the cross-sectional area of flow in square feet;
R is the hydraulic radius in feet;
S is the slope of the hydraulic gradient in feet per foot; and,
n is the coefficient of roughness (n=0.013 for concrete pipe and 0.015 for poured concrete culverts).

5.05.02. Elevation of the Hydraulic Gradient

In the design of the storm sewer system, the elevation of the hydraulic gradient of the storm sewer shall be a minimum of one and one-half feet (1.5') below the elevation of the adjacent street gutter.

5.05.03. Storm Sewer Pipe Sizes

Storm sewer pipe sizes shall be so selected that the average velocity in the pipe will not exceed fifteen feet (15') per second and shall not be less than three feet (3') per second.

5.05.04. Storm Sewer Pipe Standards

Storm sewer pipe shall be reinforced concrete culvert pipe conforming to ASTM designation C76 Class III and shall be a minimum of eighteen inches (18") in diameter. Other pipe material may be used with the approval from the Director of Public Works and the City Engineer.

Subsection 5.06. Inlet Placement and Capacity

5.06.01. Inlet Design

Storm sewer inlets shall be built along paved streets at such intervals that the depth of flow, based upon the 50-year storm, does not exceed the top of curb. Inlets shall be located as necessary to remove the flow based on a 10-year storm. If in the opinion of the City Engineer the flow in the gutters would be excessive using the above design criteria, the storm sewers or inlet locations could be altered to relieve adverse conditions.

5.06.02. Inlet Placement

Inlets shall be placed upstream from an intersection whenever possible. At any intersection, only one street shall be crossed with surface drainage and this street shall be the lower classified street. When an alley intersects a street, inlets shall be placed in the alley whenever flow down that alley would cause the capacity of the intersecting street to be exceeded.

5.06.03. Inlet Standards

The minimum inlet size shall be five feet. No more than 20 feet of inlet shall be placed along one gutter at any given location. Minimum sizes of laterals shall be 18 inches for use with 5 foot inlets, and 21 inch laterals with 10 foot to 20 foot drop inlets, and 24 inch laterals for 20 foot inlets. Where laterals tie into storm sewer lines, the laterals shall be connected so that the longitudinal centers intersect.

Subsection 5.07. Pipe (Closed Conduit) Design Standards

5.07.01. Sized to Flow Full

Storm sewer conduit shall be sized to flow full. Manning's equation shall be used to determine the conduit size. If flow is less than full flow, then all calculations shall be based on partial flow characteristics.

5.07.02. Minimum and Maximum Velocities in Pipes

A. Minimum Velocities

The minimum velocities in conduit shall be 3.0 feet per second.

B. Maximum

1. The maximum discharge velocities in the pipe shall not exceed the permitted velocity of the receiving channel, or conduit, at the outfall to prevent erosive conditions.
2. The maximum outfall velocity of a conduit in partial flow shall be computed for partial depth and shall not exceed the maximum permissible velocity of the receiving channel unless controlled by appropriate energy dissipater (e.g., stilling basins, impact basins, or riprap protection).

C. Concrete Pipe Conduit

1. In general, stormwater shall be carried in concrete pipe conduit, but other types of conduit may be used to carry stormwater provided that prior permission to use other conduit materials is obtained from the City Engineer prior to plan approval.
2. Any conduits located under or crossing existing, proposed or future pavement shall be concrete pipe appropriate for those installations.

D. Standards

1. Conduits must be sized, and slopes must be set, such that runoff flows smoothly down the drainage system.
2. The hydraulic grade line shall be plotted on the profiles for all storm sewer systems (including pipes, laterals and channels).
3. The hydraulic grade line shall be a minimum of 1.5' below the adjacent street gutter elevation.

E. Analyses

1. When performing hydraulic analyses for (storm sewers) channel, or drainage way design, the starting water surface shall be based on the calculated water surface in the receiving channel (50 or 100 year).
2. The developer shall provide documentation and/or calculations verifying the water surface elevation in the receiving channel.

Subsection 5.08. Culvert Design

Culverts shall be designed to the 100-year frequency. Culverts shall be designed in accordance with the Texas Department of Transportation Hydraulic Manual, Chapter 4 - Culverts. The calculation of hydraulic grade lines will consider both inlet and outlet control for the culvert.

Subsection 5.09. Open Channels

5.09.01. Engineering Design

Open channels may be used instead of enclosed systems when the drainage area contributing flow to the channel is greater than 100 acres. Open channels shall not be permitted when the drainage area is less than 100 acres. All channels shall be designed for the 50-year frequency plus 1-foot of freeboard, or for the 100-year frequency. Both the 50-year and 100-year frequency water surface elevations shall be plotted on the channel construction drawings.

5.09.02. Excess Storm Water Runoff

Storm water runoff in excess of that allowed to collect in the streets in developed areas and runoff in undeveloped areas may be carried in open channels (not in the street right-of-way). Open channel capacity shall be calculated by Manning's formula, and roughness coefficients shall be as follows:

Table 8: Open Channel Capacity

Type of Lining	Roughness Coefficient "n"	Maximum Permissible Mean Velocity
Earth (Bermuda Grass)	0.035	8 ft. per sec.
Earth (Non-Vegetated)	0.030	5 ft. per sec.
Concrete-Lined	0.015	15 ft. per sec.
Weathered Rock	0.030	15 ft. per sec.

5.09.03. For Channels with a Contributing Drainage Area of 100 Acres or Greater

A. Channel Standards

1. Channels may be left in their natural state provided that the channel velocities are 6.0 feet per second or less.
2. If the natural channel is to be replaced by an improved channel, the flow from the 50-year design flood must be contained within the improved channel while allowing for one foot of freeboard, or the flow from the 100-year design flood must be completely contained in the channel.
3. Improved channels shall include a lined section if the design velocity is greater than eight (8) feet per second. Lining types such as concrete, riprap, rock walls and gabions, may be used upon prior approval of the City Engineer. Lined channels shall be designed to prevent erosion and to reduce the velocity to less than 8 fps before being released into unlined or natural drainage facilities.
4. Concrete lining in channels shall have a minimum thickness of six (6) inches and shall be reinforced with #3 rebar with a nominal diameter of 0.225 inches and a nominal weight of 0.136 lbs./L.F.
5. Concrete-lined channels shall have a reinforced concrete toe wall constructed along the base and side slopes of the lined channel and shall have a minimum vertical depth of two (2) feet. A horizontal concrete section, one (1) foot in width, shall be constructed between the top of the channel lining and the toe wall.
6. For lined channels, all of the channel bottom and at least the first three feet (vertical height) of the side slopes up from the channel bottom shall be lined, unless otherwise approved by the City Engineer.
7. Earthen sides above the lined section or totally earthen channels shall be on at least a four horizontal to one vertical slope (4:1) and shall have approved ground cover established to prevent erosion.
8. Unless shown to be feasible in a soils report prepared by a Licensed Professional Engineer in the State of Texas, and approved by the City Engineer, improved channels shall have side slopes no steeper than below:

a. 3 feet horizontal to 1 foot vertical for earthen, grassed-lined side slopes.

b. 1.5 feet horizontal to 1 foot vertical for concrete-lined side slopes or side slopes in rock.

9. The developer or owner shall use low maintenance vegetation for vegetative cover, as approved by the City prior to planting. The selection of materials shall comply with the current ground cover listing for North Central Texas furnished through the Texas Agricultural Extension Service.

10. The developer shall dedicate a easement on all earthen and concrete-lined channels of sufficient width to provide for excavation of the open channel to proper width, plus two feet (2') on one side and fifteen feet (15') on the opposite side to permit ingress and egress for maintenance. No channel may exist between opposite flowing lanes of traffic (in medians).

11. Culvert Discharge - Velocity Limitations

Table 9: Culvert Discharge - Velocity Limitations	
Culvert Discharging Onto	Maximum Allowable Velocity (f.p.s.)
Earth	6
Sod Earth	8
Paved or Riprap Apron	15
Shale	10
Rock	10
In no case shall the velocity at culvert discharge or in earthen channel exceed 6 fps.	
Generally, all culverts shall be designed with a free outfall, and in accordance with the State Department of Transportation, Bridge Division, Hydraulic Manual.	

Subsection 5.10. Erosion Prevention

All channel designs must consider and account for channel stabilization. This requirement pertains to all sections whether they are left in their natural conditions or are modified in any manner. Three sets of requirements are provided, depending upon the relationship of the existing channel to the limits of the developer's property. The City Engineer shall have the discretion to require the implementation of the portion of these requirements as deemed necessary, depending on the specifics of the property being developed or improved.

5.10.01. Improved Stabilized Channel Cross-Section

Provide for an improved stabilized channel cross-section which reduces all velocities to 6.0 fps or below for vegetated channels. The channel improvements must meet all City requirements.

5.10.02. Grade Control Structures

For vegetated channel sections with overbank velocities ranging from 6 to 8 fps, construct grade control structures within the channel and overbank areas to prevent erosion. Grade control structures shall have a minimum effective depth of 3.0 feet below existing or proposed grades with an adequate number of structures to prevent degradation.

5.10.03. Vegetation Cover

At least seventy percent (70%) of any disturbed land area shall be cover by vegetation.

Subsection 5.11. Starting Water Surface Condition

When performing hydraulic analyses for (storm sewers) channel, or drainage way design, the starting water surface shall be based on the calculated water surface in the receiving channel (50 or 100-year). The developer shall provide documentation and/or calculations verifying the water surface elevation in the receiving channel. If the time of concentration for the storm sewer discharge is less than the time of concentration for the receiving waterway, then additional calculations shall be provided to account for the free outfall condition.

Subsection 5.12. Detention

If it is determined that development will have an adverse effect (increase runoff, raise water surface elevation or flood) on downstream property owners, developments, or other improvements (i.e., streets, etc.), then detention may be required by the City.

Subsection 5.13. Flumes

The use of flumes is not recommended for widespread use. Flumes shall not be permitted when the purpose of a permanent flume is to carry runoff down the sides of earthen channels. A flume may be used to direct overflow runoff along property lines until the runoff can be intercepted by streets or conduits. Flumes crossing sidewalks shall be covered or bridged such as to minimize danger to pedestrians.

Subsection 5.14. Residential Grading and Drainage

5.14.01. Lot to Lot Drainage Standards

For standards refer to the Unified Development Code.

5.14.02. Four General Residential Categories

Four general categories of residential lot grading and drainage plans are anticipated within the City. Specific deviations from these four plans will be considered on an individual basis.

A. Type 1: Rear Ridge

1. Lot grading resulting in a ridge along the rear property line of the residential lots with the lots flowing from back to front into the street.
2. Single swale between lots along side lot lines when lots are at the same grade.
3. Single swale along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

B. Type 2: Gentle Cross Slope

1. Lot grading resulting from a gentle cross slope between parallel streets.
2. An interceptor system may be constructed along the rear lot line within a drainage easement 20 feet in width.
    i. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.
3. Single swale between lots along side lot lines when lots are at same grade.
4. Single swale along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

C. Type 3: Steep Cross Slope

1. Lot grading resulting from a steep cross slope between parallel streets.
2. An interceptor system may be constructed along the rear lot line of the lower or downstream lot, solely upon the downstream lot, within a drainage easement a minimum of 20 feet in width.
    a. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.
    b. In cases where swales only are utilized, the minimum easement width may be reduced, with the approval of the Director of Public Works, if the depth of the swale is shallow enough to maintain a mowable slope within the swale with the reduced easement width.
3. Single swale between lots alongside lot lines when lots are at the same grade.
4. Single swale along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

D. Type 4: Rear Valley/Swale

1. Lot grading resulting from a natural or planned valley or swale along the rear property line resulting in flows from lots fronting the parallel streets collecting at the rear of the lots.
2. An interceptor system shall be constructed along the rear lot line within a drainage easement a minimum of 20 feet in width.
    a. The system shall consist of an interceptor swale, underground system with collection inlets, or a combination of both and shall collect and convey the flows from the upstream lots to a City System designed to receive the flows.
    b. In cases where swales only are utilized, the minimum easement width may be reduced, with the approval by the City, if the depth of the swale is shallow enough to maintain a mowable slope within the swale with the reduced easement width.
3. Single swale between lots alongside lot lines when lots are at same grade.
4. Single swale along the downhill side of the side lot line between two lots which have a grade difference requiring small retaining wall or exaggerated slope. (Swale shall be on the uphill side of the retaining wall.)

Subsection 5.15. Nonresidential Grading and Drainage

5.15.01. Lot to Lot Grading and Drainage Standards

For standards refer to the Unified Development Code.

5.15.02. Universal Considerations

A. Erosion Control

1. Erosion control is addressed at the time of completion of the development and prior to release for building permits.
2. Specific actions on the part of the individual home builder or building contractor shall be taken as needed to prevent damage to the swale system as well as the enclosed systems resulting from erosion and sediment build up.
3. Refer to Ordinance 10-08-05-24 for erosion control and illicit discharge regulation.

B. Inspection

Inspection of all lot grading and drainage shall take place:

1. In conjunction with the final inspection and acceptance (Letter of Final Acceptance) of the development infrastructure; and
2. At the time of final inspection of the structure under permit for Certificate of Occupancy.
3. Refer to Ordinance 10-08-05-24 for erosion control and illicit discharge regulation.

C. Enforcement

1. No approval and acceptance of the development infrastructure shall be issued by the City until the lot grading and drainage meets the plans submitted with the development's Construction Plans.
2. No Certificate of Occupancy shall be issued until lot grading and drainage meets the plans submitted with the building permit Application.

Subsection 5.16. Swimming Pool, Fence, Parking Lot, & Other Permit Applications

Unless exempted Director of Planning, building permit applications for the construction of swimming pools, fences, storage buildings, and other types of construction shall include a Grading and Drainage Plan reflecting the planned construction's impact upon the existing lot grading and drainage and any modifications to the existing lot grading and drainage that will be necessary to maintain proper drainage on the lot.

5.16.01. Development Projects in Progress

A. Buildings
Buildings under construction shall meet the intent of this policy by whatever means necessary to insure that lots drain appropriately.

B. Developments
Developments under construction shall incorporate the necessary additional drainage features and easements to meet the intent of this policy to insure that lots drain appropriately.

Section 6. Sanitary Sewer

Subsection 6.01. Basic Requirements

6.01.01. Minimum Diameter of Sewer Mains

The minimum diameter of sewer mains shall be eight inches (8").

6.01.02. Drainage Area Consideration

All sanitary sewers shall be designed with consideration for serving the full drainage area subject to collection by the sewer in question.

6.01.03. Manholes

A. General Standards

1. Manholes shall be placed at points of change in alignment, grade, or size of sewer, the intersection of sewers, and the end of all sanitary sewer mains that will be extended at a later date.
2. Manholes shall be placed on property lines in the vicinity of their designated area.
3. Manholes 10’ or deeper must be 5’ in diameter; otherwise a standard 4’ wide manhole may be used.
4. Manholes shall be placed in lieu of cleanouts at the end of the line if the sewer line is deeper than three feet.

B. Spacing

1. Maximum manhole spacing for sewers with straight alignment and uniform grades should be determined so as to assure continuous operation based on available cleaning equipment.
2. The maximum manhole spacing shall be as follows:

Table 10: Minimum Manhole Design Standards

Sewer Pipe Size	Manhole Diameters	Maximum Distance Between Manholes
8"	4'-0"	650 Feet
10"	4'-0"	800 Feet
12"	5'-0"	900 Feet
15"	5'-0"	1,000 Feet
18"	5'-0"	1,000 Feet
21"	5'-0"	1,000 Feet
24"	5'-0"	1,000 Feet
30"	6'-0"	1,000 Feet
36"	6'-0"	1,000 Feet

6.01.04. Etching

The face of the curb shall be etched with an "MH" to mark the location of all manholes. The letters shall be a minimum of 3 inches high. This is to be done by the utility contractor using a marked-up set of plans. The location of the etching shall be along line that intersects the center of the manhole cover and is perpendicular to the centerline of the street. For manholes located in intersections the curb shall be stamped at the closest location to the manhole.

6.01.05. Sanitary Sewer Layout

All sewers shall be laid in straight alignment where possible with a uniform grade between the manholes. In those cases where horizontal curvature must be utilized to serve a particular area, the minimum radius of curvature shall be two hundred feet (200'). Grades and appurtenances of sanitary sewers shall conform to the requirements of the TCEQ, and the following are the minimum slopes which should be provided for a velocity of at least 2 feet per second; however, slopes greater than these are desirable.

Table 11: Sanitary Sewer Minimum Slopes

Sewer - Diameter	Minimum Slope in Feet Per 100 Feet
4-inch in the right-of-way (service only)	1.000
6-inch (service only)	0.500
8-inch	0.330
10-inch	0.250
12-inch	0.200
15-inch	0.150
18-inch	0.110
21-inch	0.090
24-inch	0.080
27-inch	0.060
30-inch	0.055
36-inch	0.045

6.01.06. Flow Line

The flow line into a manhole must **not** be greater than 6 inches above the flow line out, or the flow line in must be greater than 2 foot above the flow line out. Manholes where the flow line in is greater than 2 feet above the flow line out shall be drop manholes.

6.01.07. Sewers

Sewers shall be located in the right-of-way as per standard detail and shall be a minimum of five feet (5') deep to the top of pipe.

6.01.08. Cleanouts

Standard cleanouts shall be constructed at the ends of all sanitary sewers where a manhole is not provided. A 2'-0" x 2'-0" x 4" reinforced concrete pad (#3 rebar) shall be placed around all cleanouts. The curb location shall be stamped with “CO” in letters a minimum of three (3) inches high.

6.01.09. Specifications

All pipe manholes, cleanouts, embedments materials, testing procedures, and other improvements, associated with the installation of the sanitary sewerage system improvements shall be furnished and constructed in conformance with the applicable specifications of A.S.T.M., A.N.S.I., W.E.F. and N.S.F., latest editions.

6.01.10. Final Grade

Manholes and cleanouts shall be adjusted to final grade prior to placement of permanent paving.

6.01.11. Rainstopper

All manholes shall be equipped with a non-collapsible rainstopper installed between the lid and ring. Rainstopper manufacturers shall be approved by the City.

6.01.12. Extend to the Borders of the Subdivision

All sewer mains installed within a subdivision must extend to the borders of the subdivision as required for future extensions of the collection system, regardless of whether such extensions are required for service within the subdivision.

6.01.13. Service Laterals

All service laterals below proposed areas to be paved shall be installed and properly backfilled prior to the subgrade preparation and pavement construction.

6.01.14. Lateral Locations Stamped

All lateral locations shall be stamped into the curb by the utility contractor with an "S" at the point the lateral crosses the curb. Lettering shall be at least three inches (3") high.

6.01.15. Service Lateral used for the Discharge of Industrial Waste

Any service lateral used for the discharge of industrial waste into the City's sanitary sewer collection system shall have a control manhole constructed and maintained by the discharger of the industrial waste. The control manhole shall be constructed downstream from any storage tanks or pretreatment works and shall be used by the City for sampling and monitoring the industrial waste. The control manhole shall be constructed in a location where City personnel are not restricted from access. The control manhole shall be located within the Right-of-way or the industry must provide an easement.

6.01.16. All Residential Sewer Services

All residential sewer services shall be 4 inch SDR-35 pipe located on the lot, ten feet down stream from the center of the lot with a plug and green sewer tape at the end of the line.

6.01.17. Depth

Sewer services shall be no deeper than 6 to 7 feet unless otherwise specified. Services that cross roads must be compacted and densities taken.

6.01.18. 150 psi Rated Sewer Line

When a 150 psi rated sewer line is required due to its proximity to a water line (less than 9’ horizontally), the 150 psi rated pipe shall terminate at a manhole on each end. All changes in pipe inside diameter shall require a manhole at the junction.

6.01.19. Sanitary Sewers Specifications

A. Standards

Sanitary sewer mains shall be constructed of polyvinyl chloride (PVC) pipe and shall conform to the specifications of ASTM D 3034, SDR 35, or equal. Joints for the PVC pipe and fittings shall be compression rubber gasket joints. The bell shall consist of an integral wall section with factory installed ring securely locked in bell groove to provide positive seal under all installation conditions. Fittings and accessories shall be manufactured and furnished by the pipe supplier, or approved equal, and shall have bell and/or spigot configuration identical to that of the pipe. If the sanitary sewer main is greater than fourteen feet (14’) deep, SDR-26 or equal shall be used.

B. Connections

Connections shall be made with fabricated fittings. Field-glued connections are not allowed. When PVC pipe passes through a manhole wall, a positive water-tight connection shall be made.

C. Design

The PVC pipe shall be placed on a six-inch (6") layer of crushed rock, rounded gravel bedding material. The trench shall be backfilled with a minimum of six inches (6") of gravel/rock on the sides and six inches (6") gravel/rock over the top of the pipe and consolidated to a minimum of 95 percent standard proctor density. This is basic Class "B" embedment as defined by ASCE Manual No. 37 and AWWA C900-75 and ASTM C2321, with five percent (5%) maximum Mandrell Test to be performed. The embedent material is further defined as follows:

1. 95% of Material Passing 3/4" Screen
2. 95% of Material Retained on No. 4 Screen

D. Standard Details and Specifications

The encasement, embedment, and backfill requirements for PVC pipe, and ductile iron pipe shall conform to the standard details and specifications of the City.

6.01.20. Tests

A. Testing

Prior to acceptance, the sanitary sewers shall be subject to T.V. camera, air (in accordance with American Water Works Association [AWWA]), and Mandrell tests. Force mains shall be tested at 150 psi for four (4) hours. Testing time shall be determined by the City Inspector.

B. Payment of all Expenses

Any developer or contractor causing infiltration or in-flow into the City's sanitary sewer system, either knowingly or unknowingly, shall be required to pay all expenses incurred by the City due to said infiltration or in-flow as determined by the City.

6.01.21. Lift Stations

A. Design

All lift stations shall be designed and constructed with two or more sewage pumps, and the stations shall be capable of pumping the design maximum flow with the largest pump out of service. Detailed design data, plans, and specifications of the pumps shall be submitted to the City Engineer prior to the installation of the lift station.

B. Additional Design

The lift station site design shall also include the following:

1. Auto dialer with active telephone service,
2. SCADA system and all required antennas and electronics to connect to city systems,
3. A metering system,
4. A fence of 6’ chain link with 3’ of barbed wire or 8’ chain link,
5. Gates approved by the City, and
6. Paved access.

6.01.22. Force Mains

A. Materials

All force mains shall be polyvinyl chloride or ductile iron water pipe. Ductile iron pipe shall be minimum class 50, with rubber gasket joint, and shall have a cement mortar lining, with a seal-coat of bituminous material or may have a polyethylene lining.

B. Design

At design for average flows, a cleansing velocity of at least two (2) feet per second shall be maintained. Automatic air relief valves shall be placed at high points in the force main.

Section 7. Water

Subsection 7.01. Basic Requirements

7.01.01. Water Mains Standards

All water mains in residential areas shall be a minimum of six inches (6") in size and looped with six inch (6") minimum diameter mains at intervals not to exceed one thousand feet (1000'). Where intervals between connecting mains must exceed one thousand feet (1000'), or where dead ends must exist, eight inch (8") diameter or larger mains shall be installed.

Water mains in industrial and commercial areas shall be AWWA C900 Class 151 (DR18) PVC pipe, a minimum eight inches (8") in size and be connected to an eight inch (8") or larger main that connects to pump stations or elevated storage reservoirs every six hundred feet (600'). Where dead-ends must exist, eight inch (8") or larger mains shall be installed with a flush valve or fire hydrant installed. The minimum limits set forth in the above shall not be exceeded except upon the specific approval by the City Engineer, Public Works Director, and the Fire Chief, but in no event shall these requirements be less than the minimum required by the State Board of Insurance or the Fire Prevention and Engineering Bureau of Texas.

7.01.02. Fire Hydrant Flush Values

Install flush valve where necessary.

7.01.03. Water Main Testing

The water mains shall be tested at 150 psi for 4 hours in accordance with AWWA testing standards.

7.01.04. Fire Hydrant

Fire hydrants shall conform strictly to the latest edition AWWA C502 *Standard Specifications for Ordinary Water Works Service* dry-barrel fire hydrants with all bronze to bronze moving parts, except for changes or additions specifically outlined as follows:

A. Details

All fire hydrants shall have one 4 1/2” steamer nozzle and two 3 1/2” NST hose connections with the City's standard threads. The main barrel valve opening shall not be less than five inches (5"), and shall be placed on connecting mains of not less than eight inches (8") in diameter. Six inch (6") gate valves shall be placed on all fire hydrants leads.

B. Valves

Valves for fire hydrants shall be flanged directly to the tees installed on the main.

C. Paint

All fire hydrant bonnets and caps shall be painted by the developer in accordance with the size of the water main in which the fire hydrant lead is attached. The remainder of the hydrant above ground shall be painted aluminum.

1. 8-inch Main - Safety Blue
2. 10-inch main and larger - Standard Yellow

D. Operating Nut

The operating nut shall be a 1 1/2 inch pentagon nut, designed to prevent seepage of rain or sleet and the accumulation of dust around the revolving nut. The operating nut shall conform to the standards now in use by the City. The hydrant valve shall open by turning to the LEFT.

E. Operating Mechanism

The hydrant top or bonnet shall be free draining of a type that will maintain the operating mechanism in readiness to use under freezing conditions. It shall be so designed as to make tampering difficult and shall be provided with convenient means to afford lubrication to insure ease of operation and the prevention of wear and corrosion.

F. Breakable Flange or Breakable Cast-Iron Flange Bolts

The body of the hydrant shall be equipped with a breakable flange, or breakable cast-iron flange bolts, just above the grade-line.

G. Extension Design

All hydrants shall be of such design as will permit their extension without excavating in case of future grade changes.

H. Accident Design

The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision, it may be replaced without excavating or breaking the pavement. The barrel and operating mechanism shall be so designed that in case of accident, damage or breaking of the hydrant above or near the grade level, the main valve will remain reasonably tight against leakage or flooding.

I. Waterway

Changes in shape or size of the waterway shall be accomplished by means of easy curves. The junctions of hose or pumper nozzles with the barrel shall be rounded to ample radii. Exclusive of the main valve opening, the net area of the waterway of the barrel and foot piece of the smallest part shall be not less than 150 percent of that of the net opening of the main valve.

J. Drain or Drip Valve

Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs or gravity is not acceptable.

K. Operating Stems

Operating stems whose threads are not located in the barrel or waterway shall be made of genuine wrought iron or steel and shall be bronze bushed where passing through the stuffing box. Operating threads must be sealed against contact with the water at all times regardless of open or closed position of main valve. All operating stems shall be coupled opposite the break flange with a breakable coupling or coupled in such a way as to part without breaking.

L. "O" ring seals

Unless otherwise specified by the City, hydrants shall be furnished with "O" ring seals.

M. Hydrant Adjustment

The hydrant head shall be constructed so that it may be rotated to face the nozzles in any desired direction. Fire hydrants shall be adjusted to proper grade after placement of permanent paving and the steamer nozzle shall be placed facing the street frontage.

N. Bronze Cap Nut

Hydrants closing with the pressure must have a bronze cap nut to seal the bottom end of steam threads against contact with water.

O. Placement

Fire hydrants shall be installed within the area between the back of curb and front of sidewalk with the use of grade lock devices or retainer glands. Thrust blocks shall be placed behind the hydrant so as not to

block the weep holes. **"DO NOT"** use plastic around bottoms of hydrants not allowing the weep holes to drain.

P. Reflector and Stamp

A blue Stimsanite Fire Lite reflector or approved equal shall be placed in the center of the street opposite the fire hydrants. "FH" shall be stamped on the curb at the location of the fire hydrant in letters a minimum of 3 inches high.

Q. Flush Values

Flush valves shall be installed in cul-de-sacs where a fire hydrant is placed more than 100 feet from the end of the cul-de-sac. Flush valves shall consist of 2" copper tapped to the main and run into a jumbo meter box with a female curb stop, pointed up.

R. Drawings

If required by the City, the developer shall furnish drawings with complete detailed dimensions of the hydrant proposed for the subdivision.

S. Fire Hydrant Locations and Standards

1. Fire hydrants shall be placed at all locations shown in the plans. Each hydrant shall be set upon a slab of stone or concrete not less than four inches (4") thick and not less than one (1) square foot of surface area. Where solid rock exists in the bottom of the trench and same is excavated to the proper depth to form a foundation for the hydrant, the slab of stone or concrete above specified may be omitted.
2. The hydrant shall be set perpendicular, and to the proper depth, and shall be carefully and substantially blocked against firm trench walls using Class 2,000 concrete as herein specified.
3. There shall be placed around the base of the hydrant not less than seven (7) cubic feet of sound broken stone or clean gravel, or other suitable material to provide sufficient reservoir capacity so that the hydrant will completely drain when closed.

T. Fire Hydrant Installation Required before Erection of any Building

Fire hydrants shall be installed and operable prior to a building permit being issued.

U. Easements

The owner of any commercial or industrial tract property contemplated for development on which fire hydrants and water mains are to be installed shall provide easements to the City whereby the Fire, Police and Water Utilities Departments of the City shall have ready ingress and egress to, from, and across such property to any location on such property when necessary to extinguish a fire or to prevent the occurrence of a fire or to maintain, service and inspect such fire hydrants and water mains that may be installed or when such access to and from said property is essential to the preservation of life or property.

7.01.05. Gate Valves

Gate valves shall conform to American Water Works Association Specification C 509, or latest edition. Valves shall be designed for a minimum water working pressure 150 pounds per square inch. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning to the left. Each valve shall have the maker's initials, pressure rating, and year in which manufactured cast in the body. Valves installed for future service shall be in the closed position on stubouts. At least twenty feet (20') of pipe shall be installed beyond the valve and plugged.

All valves buried in the ground shall be provided with cast-iron valve boxes of proper dimensions to fit over the valve bonnets and to extend to such elevation at or slightly above the finished street grade or ground line. Tops shall be complete with adjustable covers. Valve boxes shall be set vertical and concentric with the valve stem and adjusted to proper line and grade after placement of permanent paving. Any valve box which has so moved from its original position as to prevent the application of the valve key shall be satisfactorily reset by the developer at his

own expense. A reinforced concrete pad of the dimensions 2'-0" x 2'-0" x 4" with #3 rebar shall be placed around all valve boxes.

7.01.06. Depth of Cover

The depth of cover shall be a minimum of 60 inches from finished grade to top of pipe.

7.01.07. Pipeline Markers

Pipeline Markers will be used to locate road crossings and cross country lines in rural areas.

7.01.08. Valve Markers

Valve markers shall be provided in rural areas.

7.01.09. Adequate Air Relief, Drain, and Flush Valves

Adequate air relief, drain, and flush valves must be provided for flushing, disinfection, daily operation requirements, and repairs.

7.01.10. Conformance of Water System Improvements

All pipe, fittings, valves, services, embedment materials, testing procedures, and other facilities related to the water system improvements shall be furnished and installed in conformance with the applicable specifications. A.S.T.M, A.W.W.A., A.N.S.I., latest editions.

7.01.11. Minimum Fireflow

The minimum fireflow shall be as recommended by the State Board of Insurance.

7.01.12. Stamping “W”

All service locations shall be marked by stamping a "W" into the face of the curb where the service intersects the curb. All lettering shall be a minimum of 3 inches high.

7.01.13. Stamping “V”

All valve locations shall be stamped into the face of the curb with the letter "V". All lettering shall be a minimum of 3 inches high. The stamp shall be located on a line that intersects the curb and valve box cover perpendicular to the center line of the street.

7.01.14. Water Mains Twelve-Inch (12") in Diameter and Smaller

All water mains twelve inches (12") in diameter and smaller may be either ductile iron pipe, thickness Class 50 minimum, or polyvinyl chloride pipe as specified below, unless otherwise specified. Water mains larger than twelve inches (12") may be constructed with either, PVC, ductile iron pipe, or other materials approved by the City Engineer.

7.01.15. Ductile Iron Pipe

The ductile iron pipe shall have a single rubber gasket joint, shall have a cement mortar lining of the "Enameline" type, or approved equal, and shall have a minimum cover of sixty inches (60"). Water mains fourteen inches (14") and larger may be either ductile iron pipe, thickness Class 50 minimum, with cement mortar lining, or reinforced concrete steel cylinder pipe, Class 150 minimum. Ductile iron pipe or pvc with approved casing shall be required in all bores, in unstable solid conditions (expansive clays, unstable subsoil), in or near creeks or where lines must be installed at shallow depths (less than 36").

The ductile iron pipe shall be centrifugally cast in metal molds in accordance with the latest edition of the applicable specifications of ANSI A21.5 (AWWA C151) and Federal Specification WW-P-421c. The joint details shall

be in accordance with the applicable specifications of ANSI A21.11 (AWWA C111), latest edition. All ductile iron pipe shall be polywrapped.

7.01.16. Polyvinyl Chloride (PVC) Pipe

Polyvinyl chloride (PVC) pipe may be installed for water mains in the public water utility system.

A. PVC Pipe and Fittings

1. PVC pipe shall be new, manufactured in the United States of America, and shall conform to the current specifications of AWWA C900 Class 150 (DR18) PVC pipe with cast iron outside dimensions and with rubber ring joints. PVC water pipe shall be listed by Underwriters Laboratories and approved for use in cities and towns of Texas by the State Board of Insurance. The rigid PVC pipe shall bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

2. Provision must be made for contraction and expansion at each joint with a rubber ring and an integral thickened bell as part of each joint. Pipe and fittings must be assembled with a non-toxic lubricant. Pipe shall be made from NSF approved class 12454-A or B PVC compound conforming to a minimum ASTM resin specification D 1784. PVC pipe shall be Class 150 (DR 18) and meet the physical dimensions as shown on the following list.

Table 12: PVC Physical Dimensions

Nominal Size (Inches)	Outside Diameter (Inches)	Class 150 (DR-18) Nominal Wall Thickness (Inches)
6	6.90	0.406
8	9.05	0.533
10	11.10	0.654
12	12.20	0.777

3. PVC pipe shall be designed for a minimum 150 p.s.i. water pressure, plus 35 p.s.i. surge allowance. Service connections shall not be made by direct tapping for service lines; a brass tapping saddle shall be used to tap service lines.

B. PVC Pipe Special Embedment

1. PVC Pipe shall be placed on a six inch (6") layer of cushion sand.

2. The trench shall be backfilled with a minimum of six inches (6") of sand on the sides and twelve inches (12") of loose sand over the top of the pipe and consolidated to a minimum of 95 percent standard proctor density. This is basic - Class "B" as defined by ASCE Manual No. 37 and AWWA C900-75. Final backfill is to conform to Section W.4.16.1, or Section W.4.16.2. The Class "B" embedment material is further defined as follows:

   a. 95% of Material Passing 3/4" Screen

   b. 95% of Material Retained on No. 4 Screen

   c. Cushion sand acceptable by the City

3. Tracer tape, blue in color, similar to Terra Tape or an approved equal "D" DETECTABLE, shall be installed in the backfill material twenty four inches (24”) over the top of all water mains in accordance with the manufacturer's recommendations.

7.01.17. Fittings

Fittings shall be ductile iron with mechanical joints and shall be cement-lined and coated with a seal-coat of bituminous material, unless the pipe material is reinforced concrete steel cylinder, in which case special fitting shall be furnished. Megalug flanges (or equivalent) shall be used. All ductile iron fittings shall conform to the applicable standards and specifications of ANSI, latest edition.

7.01.18. Water Services

Water services shall be placed on property lines to serve two lots. A service consists of a bronze or brass tap saddle with 1" CC thread, 1" comp x CC thread corporation stop, 1" copper, 1" curb stop compression x female thread, and a bull-head 7-1/2" wide with male thread on all three sides and two 3/4" angle stops. The top of the angle stop shall be 7-1/2" below the top of the meter box.

7.01.19. Where Single Services Exist

Where single services exist they shall be placed on property line with a 1" line and reduced at the angle stop.

7.01.20. Where a Dual Service Intersects a Manhole or Hydrant

Where a dual service intersects a manhole or hydrant, two singles shall be brought up to both sides of the object with the same specifications as single services.

7.01.21. Thrust Blocking

Thrust blocking shall be installed behind fire hydrants, elbows, and tees without plastic wrap.

7.01.22. Water Samples

Water samples may be taken after the pressure test and chlorine has been injected and sat for a 24 hour period. Water samples can be taken by the City or by the Contractor. Test Results shall be sent to City of Corinth, 3300, Corinth Parkway, Corinth, Texas 76208 Attention: Utilities Superintendent.

Section 8. Sidewalks

Subsection 8.01. General

8.01.01. Construction

All concrete for sidewalks shall be placed on a two inch (2") sand cushion and shall be reinforced with #3 rebar.

8.01.02. Slope

Longitudinal slope of sidewalks shall be that of the curb adjacent to the sidewalk. The transverse slope of the sidewalk shall be 1/4-inch per foot sloping toward the curb. The maximum ground slope from the edge of the sidewalk on the property line side shall not exceed A 3:1 slope. If it does exceed a 3:1 slope, a retaining wall, that is acceptable to the City, shall be provided on the property line.

All sidewalks shall conform to the requirements of the Americans with Disabilities Act (ADA).

8.01.03. Construction Joint

A construction joint shall be placed where the sidewalk connects to the backs of curbs and driveways.

Subsection 8.02. Sidewalk Routing

8.02.01. Specification

A. The following specifications shall apply:

1. Ramp to be 4' in width.
2. Ramp to be constructed with Class "A" concrete.
3. Ramp concrete thickness shall be the same as the street (6" normal residential).
4. No. 3 bars shall be used for reinforcement (18" on centers).
5. Curb return shall match existing curb height of the street and taper to the connecting walk with a 1 foot radius.
6. Street shall be blocked out (max. 12") and dowels installed.
7. Saw joints shall be made 1 1/2" minimum depth and sealed with silicone joint sealant material.
8. Subgrade shall be prepared to a minimum depth of 6".
9. At no time shall the walk running parallel to the street be altered, unless approved by the City to avoid obstructions.
10. Surface of walk may be coarse and ribbed to provide extra traction.

Section 9. Retaining Wall Construction

Subsection 9.01. Design

9.01.01. Construction Standards

A retaining wall shall be designed and constructed using a cantilevered reinforced concrete structure, masonry gravity structure, or stone gravity structure, capable of supporting the live load and dead load forces. Brick may be used as a facing material on a concrete retaining wall, but shall not be used as a structural element of the wall.

9.01.02. Development Standards

If a retaining wall is to be constructed in a new subdivision, the design of the retaining wall shall accompany the site development construction plans with the submittal of the final plat. A geotechnical report, sealed and signed by a geotechnical engineer licensed in the State of Texas, shall be provided with the retaining wall design. Design of structural elements of the wall exceeding four (4) feet in height shall be sealed and signed by a structural engineer licensed in the State of Texas.

Subsection 9.02. Prohibited Material

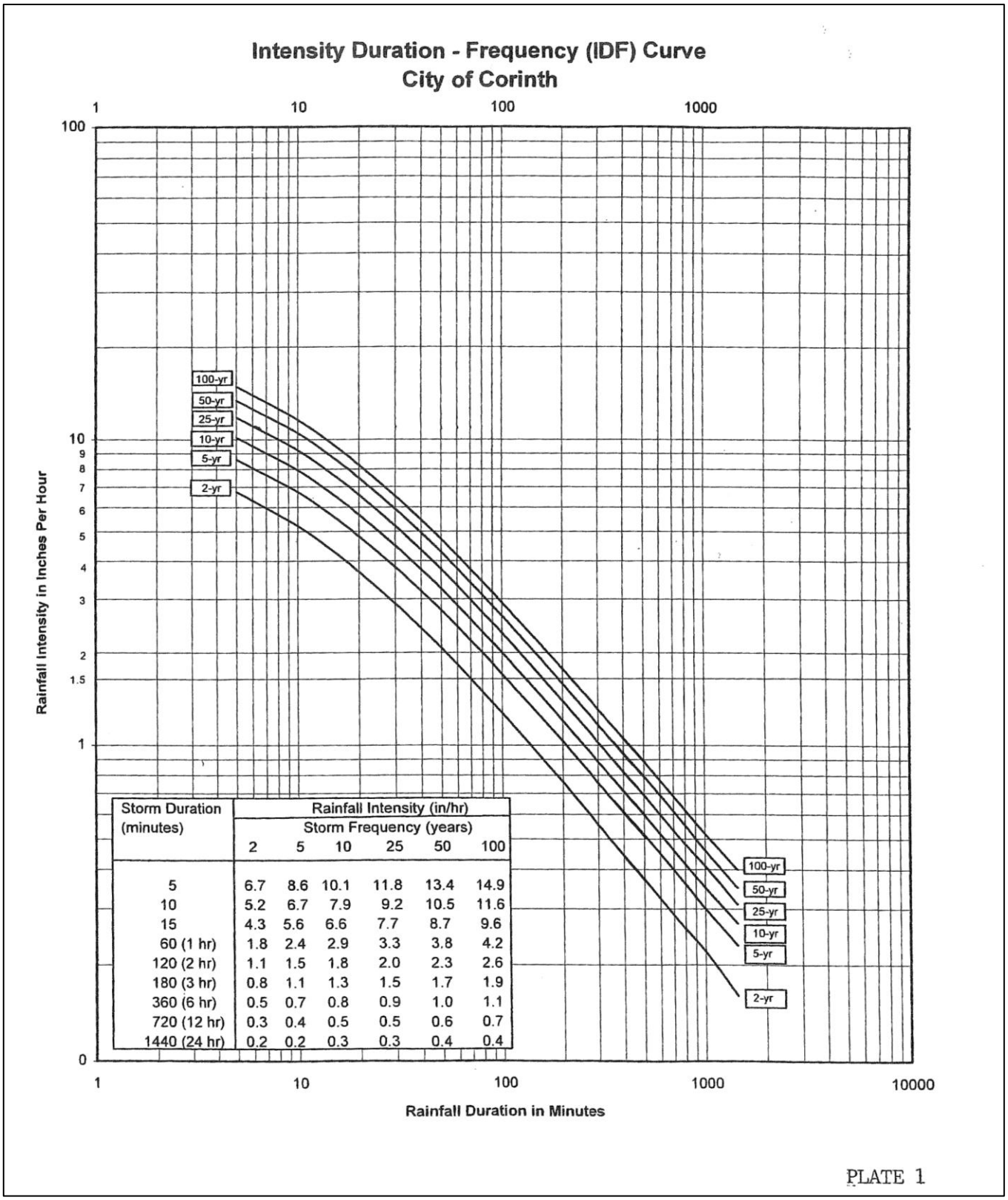
Timber material is prohibited for use as any part of a retaining wall

Section 10. Miscellaneous

Subsection 10.01. Trench Safety

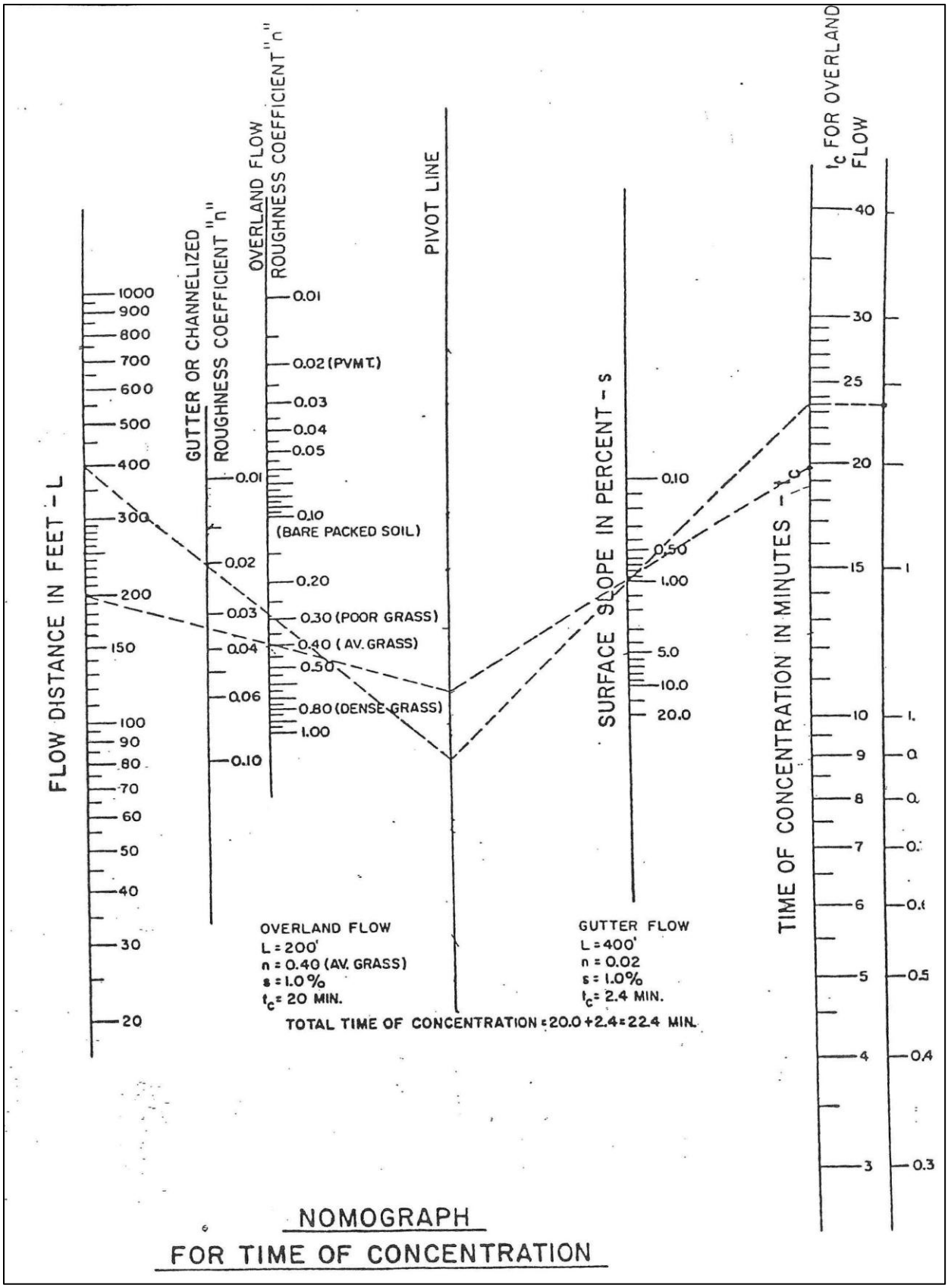
In conformance with House Bills 662 and 665 as passed by the Seventieth Legislature Regular Session of the State of Texas, all construction projects within the City of Corinth or its extraterritorial jurisdiction as provided by the Municipal Annexation Act (Article 970a, Vernon's Texas Civil Statutes) shall contain provisions for trench safety. On construction projects in which trench excavation will exceed a depth of five (5) feet, the uniform set of general conditions must require that the bid documents and the contract include detailed plans and specifications for adequate safety systems that meet Occupational Safety and Health Administration standards and that these plans and specifications include a pay item for these same safety systems.

Section 11. Appendix A: Drainage Formulas and Curves



Storm Duration (minutes)	Rainfall Intensity (in/hr) Storm Frequency (years)					
	2	5	10	25	50	100
5	6.7	8.6	10.1	11.8	13.4	14.9
10	5.2	6.7	7.9	9.2	10.5	11.6
15	4.3	5.6	6.6	7.7	8.7	9.6
60 (1 hr)	1.8	2.4	2.9	3.3	3.8	4.2
120 (2 hr)	1.1	1.5	1.8	2.0	2.3	2.6
180 (3 hr)	0.8	1.1	1.3	1.5	1.7	1.9
360 (6 hr)	0.5	0.7	0.8	0.9	1.0	1.1
720 (12 hr)	0.3	0.4	0.5	0.5	0.6	0.7
1440 (24 hr)	0.2	0.2	0.3	0.3	0.4	0.4

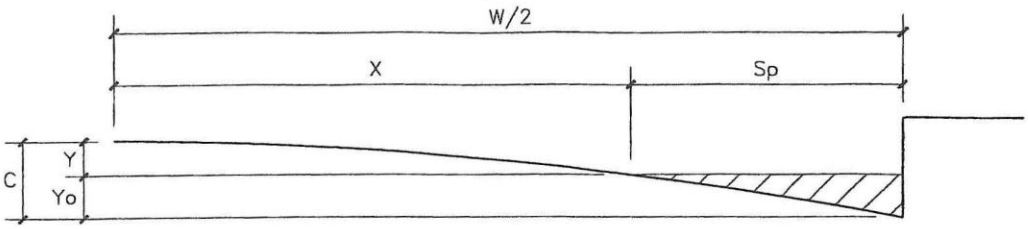
Plate 1



NOMOGRAPH
FOR TIME OF CONCENTRATION

Plate 2

FLOW IN PARABOLIC STREETS



Qo = gutter discharge in c.f.s.
C = street crown in feet
W = street width from face of curb in feet
Yo = depth of gutter flow in feet
Y = C − Yo (crown − depth)
n = roughness coefficient
So = street or gutter slope in ft. per ft.
Sp = spread of water in feet

Equation of Parabolic Street Section:

$$X = [\ ((0.5W)^2/A) * Y\ ]^{1/2}$$

Cross-Sectional Flow Area:

$$\text{Area} = \frac{CW}{6} + \frac{2XY}{3} - \frac{WY}{2}$$

Wetted Perimeter:

$$\text{Perimeter} = \frac{W}{2} + \frac{16C^2}{3W} - X - \frac{8Y^2}{3X} + C$$

Flow:

$$Qo = \frac{1.486\ C\ (\text{Area}/\text{Perimeter})^{2/3}\ (\text{Slope})^{1/2}}{n}$$

Plate 3

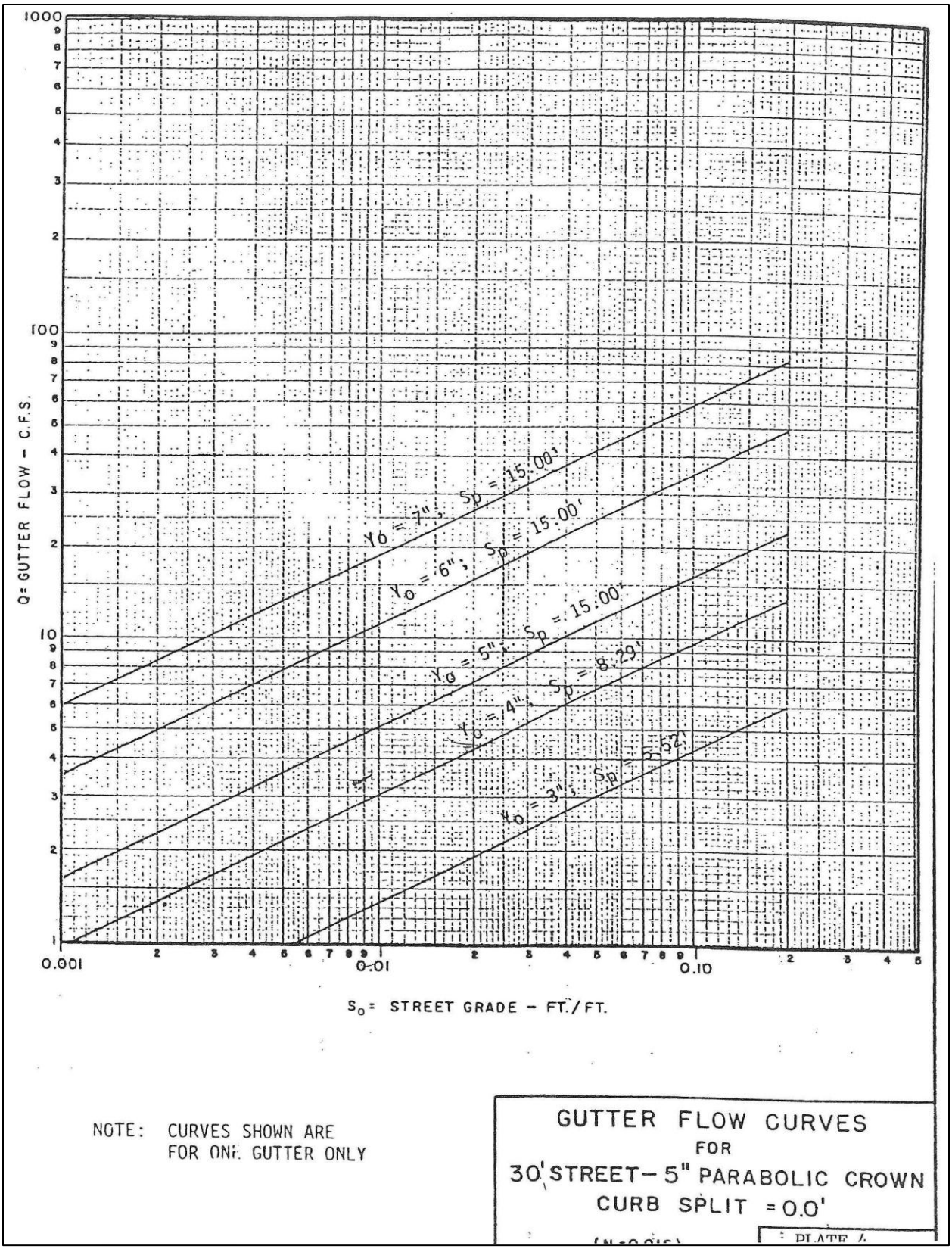

Q= GUTTER FLOW - C.F.S.
1000
100
10
1
0.001
0.01
0.10
S_o = STREET GRADE - FT./FT.
Y_o = 7"; S_p = 15.00'
Y_o = 6"; S_p = 15.00'
Y_o = 5"; S_p = 15.00'
Y_o = 4"; S_p = 8.29'
Y_o = 3"; S_p = 5.52'
NOTE: CURVES SHOWN ARE FOR ONE GUTTER ONLY
GUTTER FLOW CURVES
FOR
30' STREET - 5" PARABOLIC CROWN
CURB SPLIT = 0.0'
PLATE A

Plate 4

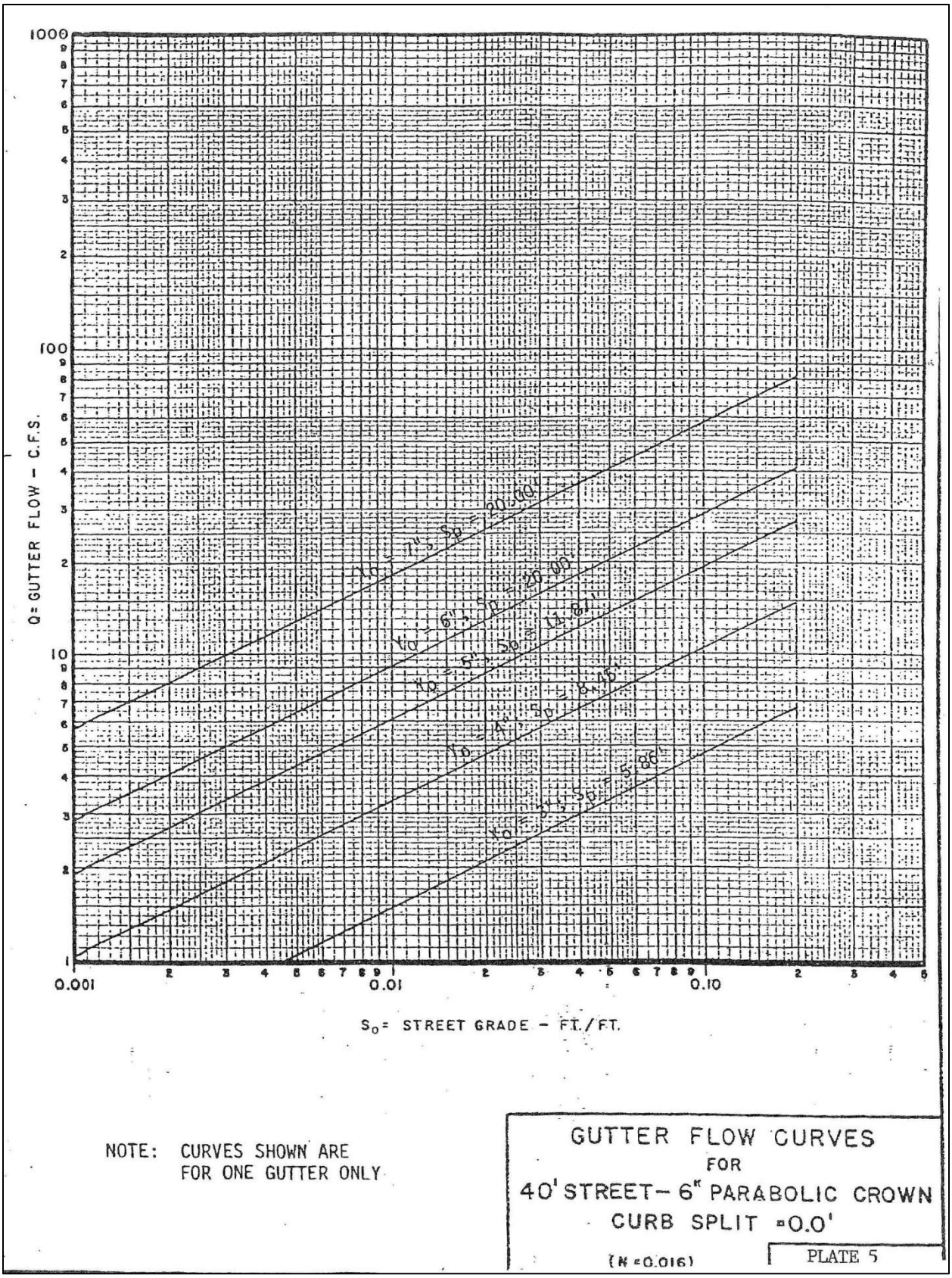

Q= GUTTER FLOW - C.F.S.
1000
100
10
1
0.001
0.01
0.10
S_o = STREET GRADE - FT./FT.
NOTE: CURVES SHOWN ARE FOR ONE GUTTER ONLY
GUTTER FLOW CURVES
FOR
40' STREET- 6" PARABOLIC CROWN
CURB SPLIT =0.0'
(N=0.016)
PLATE 5

Plate 5

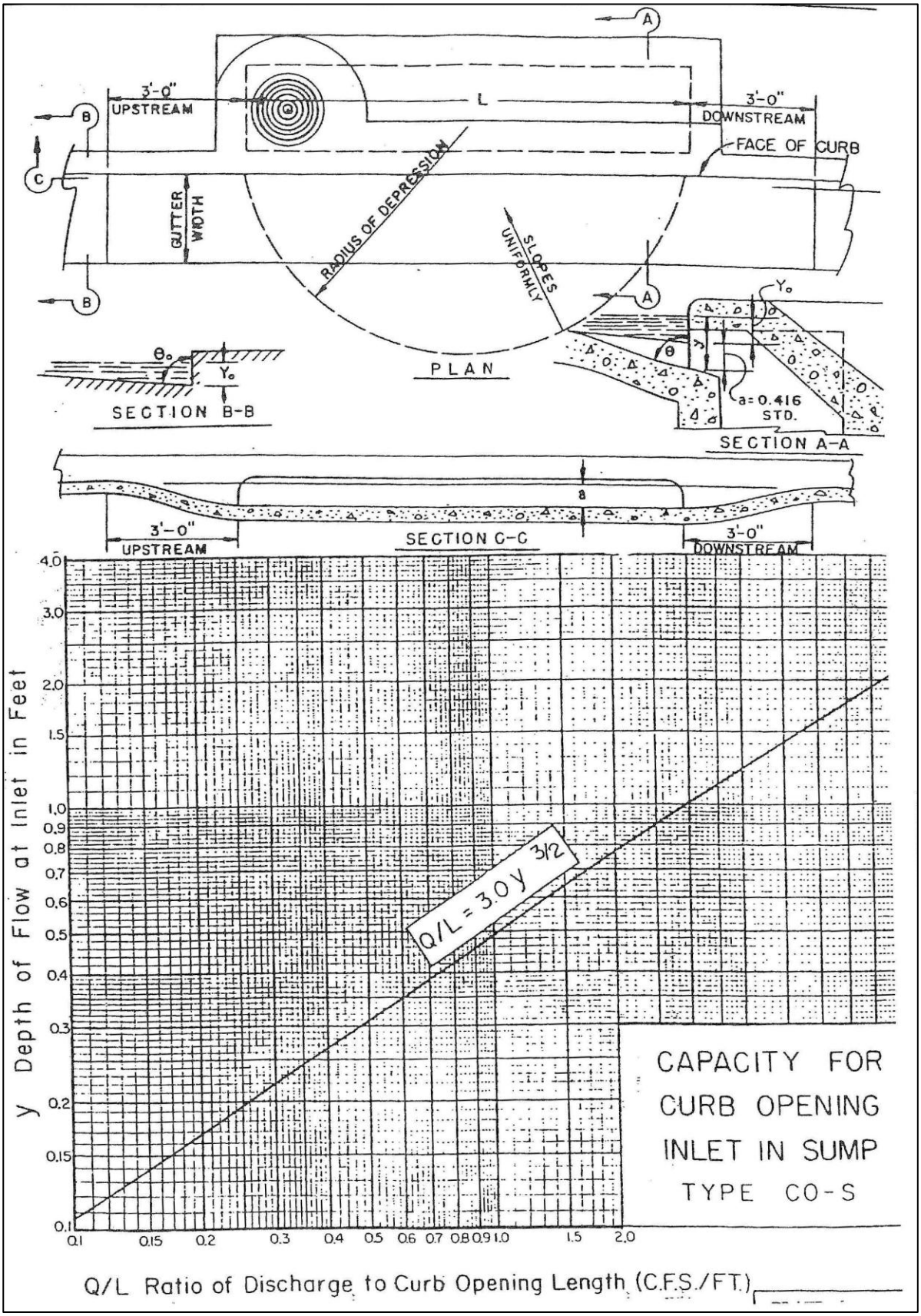

A
B
C
3'-0"
UPSTREAM
L
3'-0"
DOWNSTREAM
FACE OF CURB
GUTTER WIDTH
RADIUS OF DEPRESSION
SLOPES UNIFORMLY
PLAN
θo
Yo
SECTION B-B
θ
a= 0.416
STD.
SECTION A-A
8
SECTION C-C
y Depth of Flow at Inlet in Feet
Q/L = 3.0 y 3/2
CAPACITY FOR
CURB OPENING
INLET IN SUMP
TYPE CO-S
Q/L Ratio of Discharge to Curb Opening Length (C.F.S./FT.)

Plate 6