TABLE OF DETAILS

STORM DRAINAGE DESIGN REQUIREMENTS

In order that the Engineering Department may adequately review preliminary plats, construction plans, and stormwater management plans, the following items should be indicated or accounted for on all plans submitted for approval:

D-1 All storm drainage facilities shall comply with the requirements as stated in the Stormwater Management Program for the City of Greenville and the North Carolina Division of Water Quality Stormwater Best Management Practices Manual.

D-2 Storm drainage pipes to be designed for a 10-year storm (post development), catch basins to be designed for a 2-year storm (post development). Use NOAA ATLAS 14 Precipitation Data and assume time of concentration equals duration.

D-3 Minimum storm drainage pipe size is 15 inches.

D-4 Double Basins are permitted.

D-5 Minimum allowable velocity is 2.5 feet per second. Maximum velocity is 10 feet per second within a system. Exiting velocities shall be in conformance with the Sedimentation and Erosion Control Ordinance of the City of Greenville or the latest version thereof.

D-6 Drainage pipes which are located parallel or near parallel to public streets shall be contained within street rights-of-way. If this is not possible, dedicated storm drainage easements shall be required as defined on Std. detail 681.01.

D-7 In cases where two ditches intersect at perpendicular or obtuse angles, erosion control measures must be indicated.

D-8 Headwalls or flared end sections will be required at the influent and effluent of all pipe systems. Headwalls shall be constructed in accordance with the NCDOT Standard Roadway Drawings (latest edition).

D-9 Indicate all ditch sections with centerline elevations at least every 50' and cross sections if there is a significant change in the profile.

D-10 Indicate topography, ditches, pipes, swales, and drainage easements which are adjacent to the proposed project.

D-11 Catch basins shall be placed such that the maximum depth of flow in the curb and gutter for all streets shall not exceed 6" for standard curb and gutter and 4" for roll type curb and gutter.

D-12 With all storm drainage designs, the following design data must be submitted for each run of pipe.

a. Area drained (incremental and total)
b. Design storm intensity adjusted for duration
c. Design flow
d. Coefficient of runoff
e. Grade of pipe
f. Type of pipe and N value
g. Size of pipe
h. Velocity of flow
i. Maximum capacity
j. Hydraulic grade line

D-13 Not more than one acre may drain in the street at a single concentrated point unless calculations are submitted and approved by the City Engineer which verify that the maximum depth of flow in the curb and gutter is not exceeded.

D-14 The minimum grade for any storm drainage pipe shall be 0.3%. In the event that this requirement cannot be met, the City Engineer may approve an alternate provided the minimum velocity of 2.5 ft/sec is met.

D-15 Any storm drainage system to be city-maintained shall be CCTV inspected per the "Process for Camera Inspection before paving."

D-16 Any storm drainage system to be city-maintained shall have “Record Drawings” submitted and approved prior to scheduling a pre-final street acceptance inspection. All “Record Drawings' for storm drainage infrastructure shall include, but is not necessarily limited to, the information as identified in the *Street and Storm Drainage “Record Drawings” Submittal Requirements.*

D-17 Maximum distance between manholes/boxes shall be 300'.

D-18 If the tailwater elevation is unknown use the pipe invert elevation plus 80% of the pipe diameter. If routing of stormwater management facilities shows that the tailwater elevation is less than the invert plus 80% of the pipe diameter for the ten year storm then use elevation of the ten year storm from routing calculations.

REQUIREMENTS FOR INSTALLATION OF REINFORCED CONCRETE PIPE

1. Reinforced Concrete pipe shall meet the requirements of AASHTO M 170 (latest revision). All pipe installed within the street right-of-way shall be Class III or higher. Minimum and maximum fill heights for pipes within the right of way shall be in accordance with the NCDOT Roadway Standard Drawings (Sheet 300.01). Minimum cover for pipes outside the right of way shall be 0.5 feet or as recommended by the manufacturer, whichever is more restrictive.
2. A flexible plastic joint material shall be applied on the spigot end of the pipe. Joints shall be pushed together until the pipe is completely homed. Joints shall be wrapped with a non-woven geotextile fabric (silt fence is acceptable), extending a minimum of 12” beyond either side of the connection.
3. A manning's roughness coefficient of 0.013 (“n” factor) shall be used in the design of reinforced concrete drainage systems.
4. Backfill shall be a NCDOT Class II or better.
5. In areas where high groundwater exists, joints shall meet ASTM C443.
6. All pipes shall be designed to meet a minimum H-20 load condition.
7. Minimum of 4" of stone bedding (#57) required for pipes larger than 48" diameter.

REQUIREMENTS FOR INSTALLATION OF CORRUGATED ALUMINUM PIPE

1. Corrugated Aluminum pipe shall meet the requirements of AASHTO M196 (latest revision) Coupling bands shall be used at all joints and shall be of a size specified by the manufacturer in accordance with the pipe design. Bands shall conform to AASHTO Designation M196. Bands to be of Hugger-Type or approved equal.
2. Pipe installation shall be per NCDOT recommended practices.
3. A manning's roughness coefficient of 0.024 (“n” factor) shall be used in the design of corrugated metal pipe drainage systems.
4. In areas where high groundwater exists, joints shall meet performance expectations found in ASTM C443.
5. All pipes shall be designed to meet a minimum H-20 load condition.
6. Corrugated aluminum pipe shall only be approved for use on a case by case basis by the City Engineer.

REQUIREMENTS FOR INSTALLATION OF CORRUGATED HIGH DENSITY POLYETHYLENE PIPE

1. Corrugated High Density Polyethylene pipe shall meet the requirements of AASHTO M294.
2. Joints shall be bell and spigot with a rubber gasket meeting ASTM F477.
3. A manning's roughness coefficient of 0.012 (“n” factor) shall be used in the design of corrugated High Density Polyethylene pipe.
4. Pipe installation shall be per NCDOT recommended practices. Minimum and maximum fill heights for pipes within the right of way shall be in accordance with the NCDOT Roadway Standard Drawings (Sheet 300.01). Minimum cover for pipes outside the right of way shall be 12" or as recommended by the manufacturer, whichever is more restrictive.
5. Pipe backfill shall be NCDOT Class II or better.
6. In areas where high groundwater exists, joints shall meet or exceed leakage rate found in ASTM C443.
7. All pipes shall be designed to meet a minimum H-20 load condition.
8. Maximum allowable pipe deflection is 5%. Contractor shall verify deflection is within tolerance by pulling a mandrel as requested by City Engineer.
9. High Density Polyethylene pipe is not allowed within the right of way.

REQUIREMENTS FOR INSTALLATION OF POLYPROPYLENE PIPE

1. Polypropylene pipe shall meet the requirements of ASTM F2736 OR ASTM F2764.
2. Joints shall be bell and spigot with a gasket meeting the requirements of ASTM F477.
3. A manning's roughness coefficient of 0.012 (“n”) shall be used in the design of Polypropylene pipe.
4. Pipe installation shall be per NCDOT recommended practices. Minimum and maximum fill heights for pipes within the right of way shall be in accordance with the NCDOT Roadway Standard Drawings (Sheet 300.01). Minimum cover for pipes outside the right of way shall be 12" or as recommended by the manufacturer, whichever is more restrictive.
5. Pipe backfill shall be NCDOT Class II or better.
6. In areas where high ground water exists, joints shall meet or exceed leakage rate found in ASTM C443.
7. All pipes shall be designed to meet a minimum H-20 load condition.
8. Maximum allowable pipe deflection is 5%. Contractor shall verify deflection is within tolerance by pulling a mandrel as requested by City Engineer.

COMPACTION AND BACKFILL

Backfill type and compaction for reinforced concrete, corrugated high density polyethylene, and corrugated high density polypropylene pipe shall be in accordance with NCDOT Standard Specifications for Roads and Structures and manufacturers recommendations.

STORM WATER DESIGN CALCULATIONS

RUNOFF DETERMINATION

There are two acceptable methods: (1) Rational Method (good for areas less than 20 acres and minor design systems) and (2) Soil Conservation Service Method using Curve Numbers.

CULVERT DESIGN

DESIGN PROCEDURE:

Culvert design shall be in accordance with the NCDOT Guidelines for Drainage Studies and Hydraulic Design, latest edition. All streets shall be designed to accommodate the design storm in the table below with a minimum freeboard of 12" to the lowest portion of the street or a maximum headwater depth of 1.2 times the open height of the culvert, whichever is lower.

DESIGN STORM	
STREET CLASSIFICATION	**DESIGN STORM FREQUENCY**
RESIDENTIAL	10 YEARS
COLLECTOR	10 YEARS
PLANNED INDUSTRIAL	25 YEARS
MINOR THOROUGHFARE	25 YEARS
MAJOR THOROUGHFARE	50 YEARS

CATCH BASIN DESIGN DATA

With all catch basin layout designs, the following design data must be submitted for each basin at a minimum. Computer software for catch basin spacing design is acceptable.

a. Inlet #

b. Drainage area

c. Surface Q (Sub area and total including bypass flow)

d. Longitudinal and transverse street grade

e. K value

f. Inlet capacity

g. Flow depth

h. Bypass flow

PIPE SYSTEM DESIGN

Pipes within the system shall be designed to carry a 10-year storm (post development). The sizing of these pipes shall be based on the Manning Equation. It should be noted that the velocities for the pipes shall be maintained between 2.5 feet per second and 10 feet per second. In addition, points of discharge should be treated in such a manner to conform with the State and local ordinances on velocity controls. This design is based on the sum of the individual areas served by the catch basins and not the sum of the capacities of each basin. A Storm Drainage Design Data Sheet with the information listed on Note D-12 in the Storm Drainage Design Requirements should be completed and submitted with each plan.

Hydraulic grade line calculations shall also be completed for all proposed public pipe systems. The hydraulic grade line shall not exceed the top of grate elevation on any catch basin (6" below top of curb) or other inlet including yard inlets on residential lots.

GENERAL NOTES:

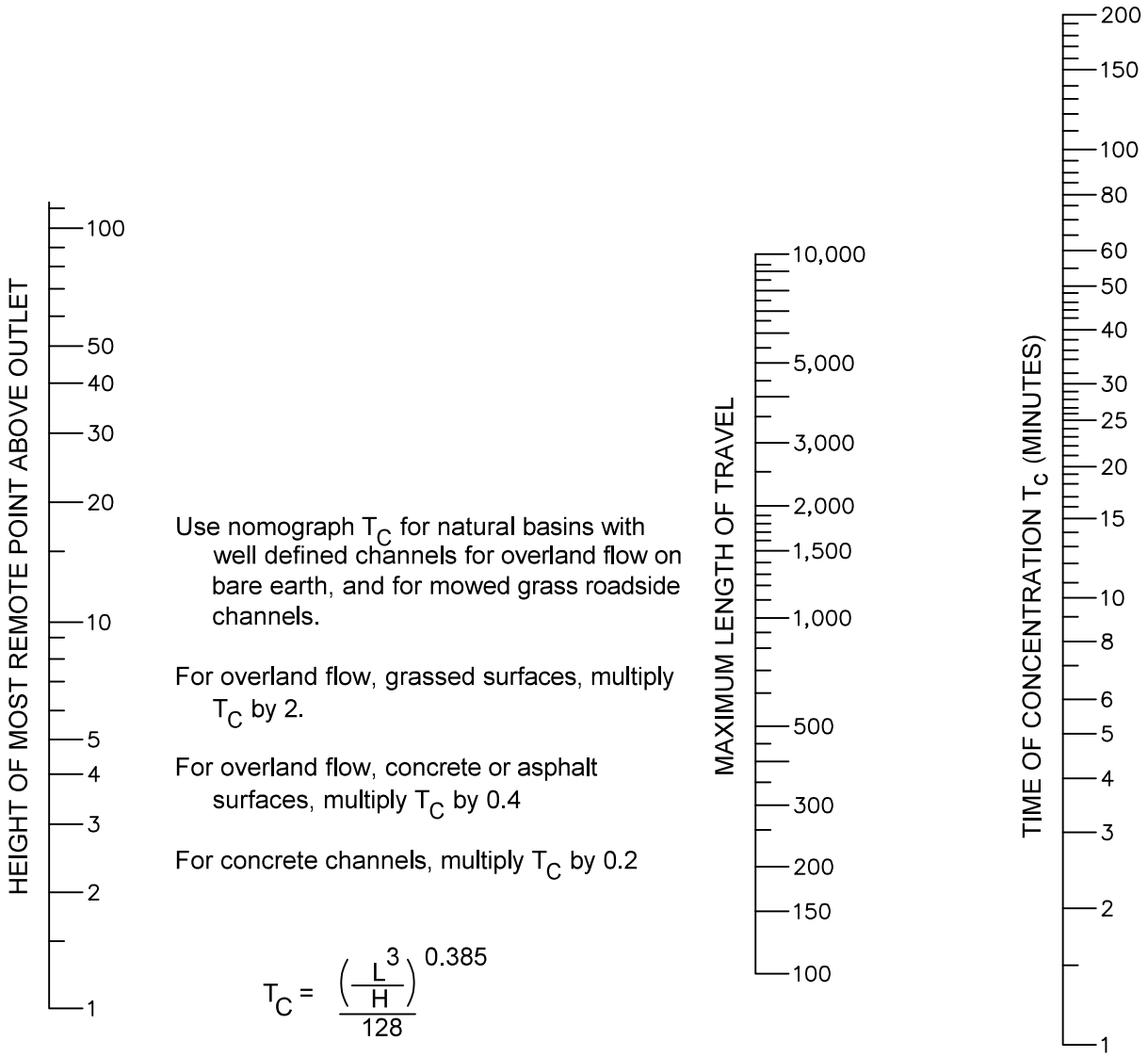
1. FOR OPEN CHANNELS THE MINIMUM EASEMENT MUST CONTAIN THE WIDTH OF THE CHANNEL FROM TOP OF BANK TO TOP BANK PLUS (+) 15' ON EACH SIDE OF CHANNEL.
2. WIDER EASEMENT WIDTHS REQUIRED FOR PIPE DEPTHS GREATER THAN SIX FEET. SEE TABLE BELOW. DEPTH MEASURED TO INVERT OF PIPE.
3. PIPE SYSTEMS AND OPEN CHANNELS ON PRIVATE PROPERTY CONVEYING STORMWATER FROM MULTIPLE PROPERTIES SHALL BE PLACED IN A STORM DRAINAGE EASEMENT.

Minimum Easement Requirements for Storm Drain Pipe

Pipe Size	Easement Requirement
15"	20'
18"	20'
24"	20'
30"	20'
36"	20'
42"	25'
48"	25'
54"+	30' MIN. (VARIES)

Additional Easement Width Requirements by Depth of Pipe

Depth	Add'l Easement Required
0'-6'	0'
6'-8'	5'
8'-10'	10'
Over 10'	15'



Use nomograph T_C for natural basins with well defined channels for overland flow on bare earth, and for mowed grass roadside channels.

For overland flow, grassed surfaces, multiply T_C by 2.

For overland flow, concrete or asphalt surfaces, multiply T_C by 0.4

For concrete channels, multiply T_C by 0.2

$$T_C = \frac{\left(\frac{L^3}{H}\right)^{0.385}}{128}$$

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TIME OF CONCENTRATION

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RUNOFF COEFFICIENTS

LAWNS:	(1) SANDY SOILS	FLAT	<2%	0.10
		AVERAGE	2% - 7%	0.15
		STEEP	>7%	0.20
	(2) HEAVY SOILS	FLAT	<2%	0.15
		AVERAGE	2% - 7%	0.20
		STEEP	>7%	0.30

WOODS, CEMETERIES, PARKS:	0.20
UNIMPROVED AREAS (PASTURE, CROP, ETC.):	0.25
PLAYGROUNDS:	0.30

RESIDENTIAL:	(1) APARTMENTS AND TOWNHOUSES	0.70
	(2) LOT SIZE <1/4 ACRE (R-6, R-9)	0.60
	(3) LOT SIZE <1/3 ACRE (R-15)	0.55
	(4) LOT SIZE <1/2 ACRE (R-20)	0.50
	(5) LOT SIZE <1.0 ACRE	0.40
	(6) LOT SIZE >1.0 ACRE	0.35
INDUSTRIAL:	(1) LIGHT	0.70
	(2) HEAVY	0.80
COMMERCIAL:	(1) DOWNTOWN, STRIP, MALL, PAVEMENT AREAS	0.95
	(2) CENTER	0.90
	(3) NEIGHBORHOOD	0.85
ROOF:		0.95
PAVEMENT:	(1) ASPHALT OR CONCRETE	0.90
	(2) BRICK	0.80
GRAVEL:		0.40

CAPACITY OF BASIN =

$$Q = K D^{5/3}$$

WHERE:

Q= C.F.S.

D= DEPTH OF GUTTER FLOW IN FEET

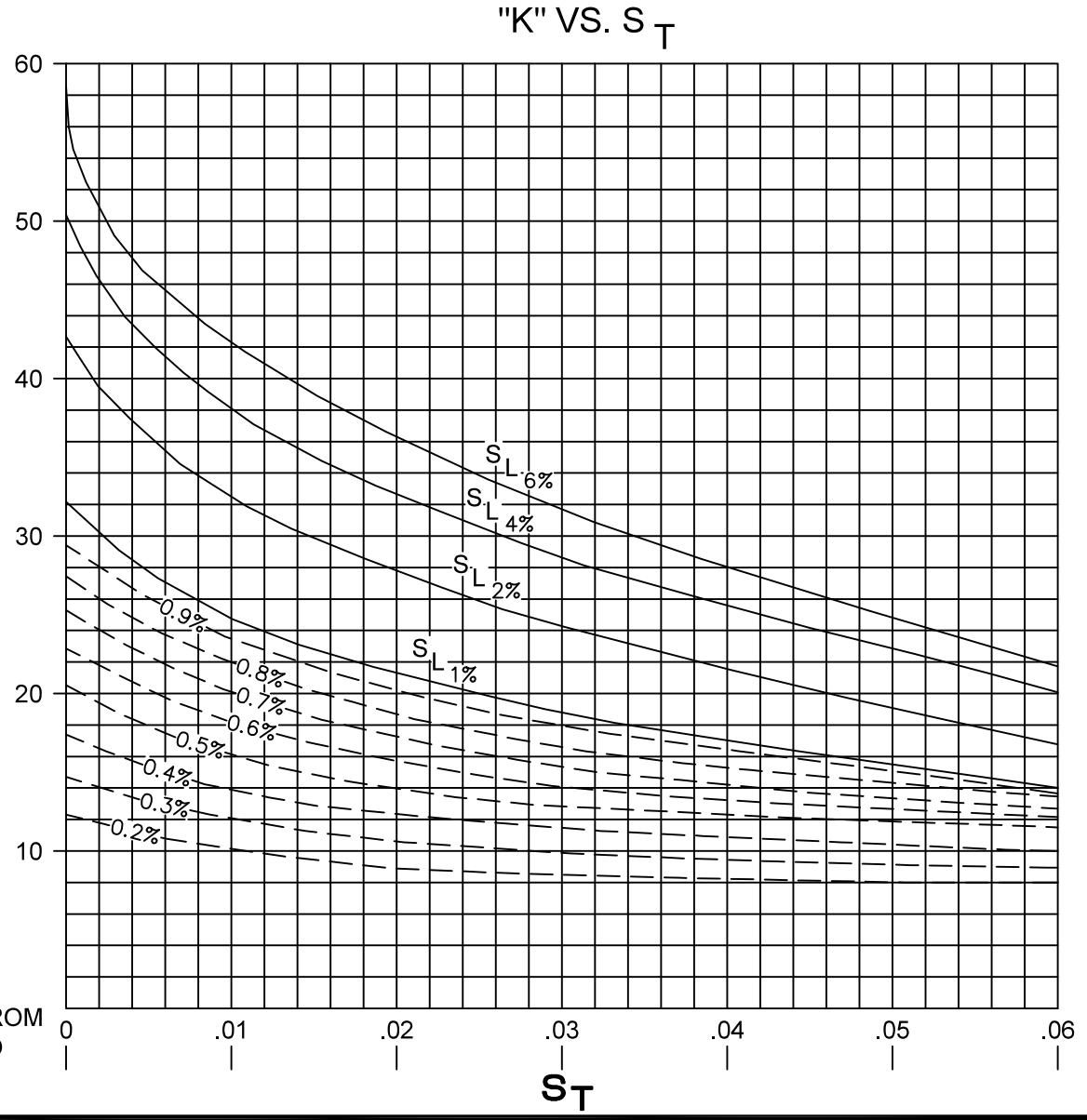
S_L = LONGITUDINAL GUTTER SLOPE

S_T = TRANSVERSE STREET SLOPE

K = GRATE INLET COEFFICIENT

— — — INDICATES INTERPOLATED VALUES

S_T = VERTICAL DISTANCE FROM CROWN TO GUTTER LINE DIVIDED BY DISTANCE FROM CREST OF ROADWAY (USUALLY C/L) TO GUTTER LINE.



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STANDARD CATCH BASIN INLET CAPACITY

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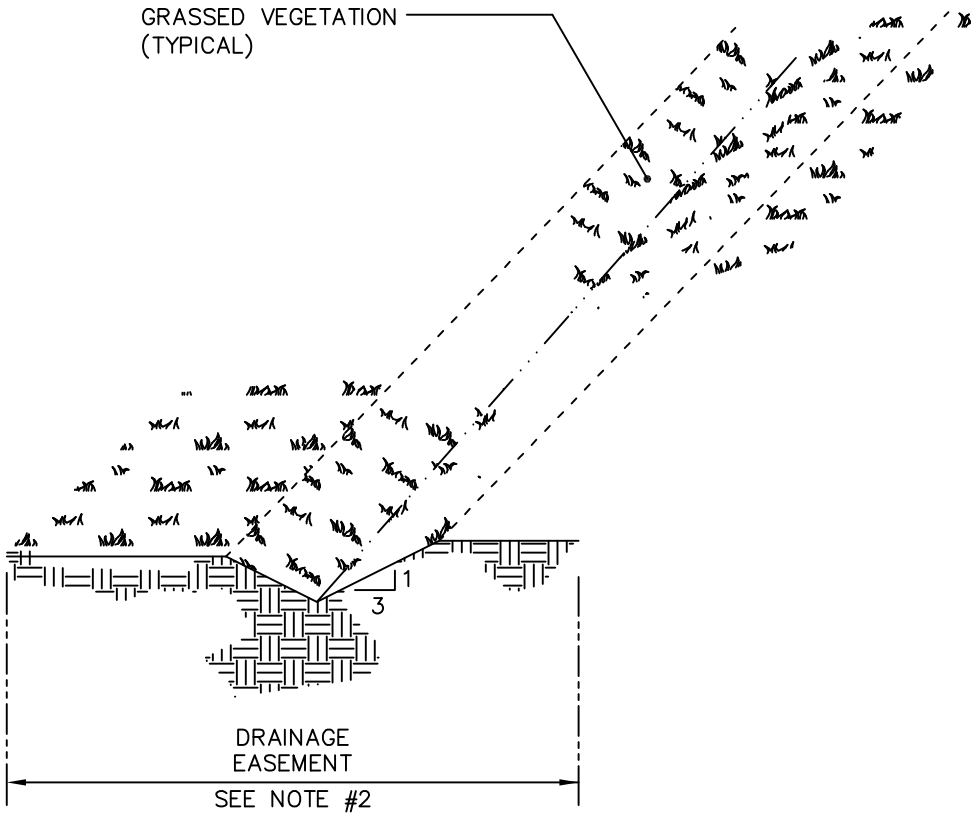
COEFFICIENT OF ENTRANCE LOSS, "ke"

TYPE OF STRUCTURE AND DESIGN OF ENTRANCE	COEFFICIENT Ke:
PIPE, CONCRETE	
Projecting from fill	0.5
Headwall or headwall and wingwalls	0.5
Mitered to conform to fillslope	0.7
PIPE OR PIPE-ARCH, CORRUGATED METAL	
Projecting (no headwall)	0.9
Headwall or headwall and wingwalls	0.5
Mitered to conform to fillslope	0.7
BOX REINFORCED CONCRETE	
Headwall	0.5
Wingwall at 30 degrees to 75 degrees to barrel	0.4
Wingwalls at 10 degrees to 25 degrees to barrel	0.5



TYPICAL CROSS SECTION

NOTES:

1. Drainage swales shall be grassed.
2. Drainage easement shall be minimum 5' from top of bank on each side of swale.
3. Maximum depth of swale is 36".
4. Side slopes shall be no steeper than 3:1 (horizontal to vertical). The conveyance shall be designed so that it does not erode during the peak flow from the 10-year storm as demonstrated by engineering calculations.
5. Swales shall not be utilized to convey public runoff.

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SWALE (CONVEYANCE)

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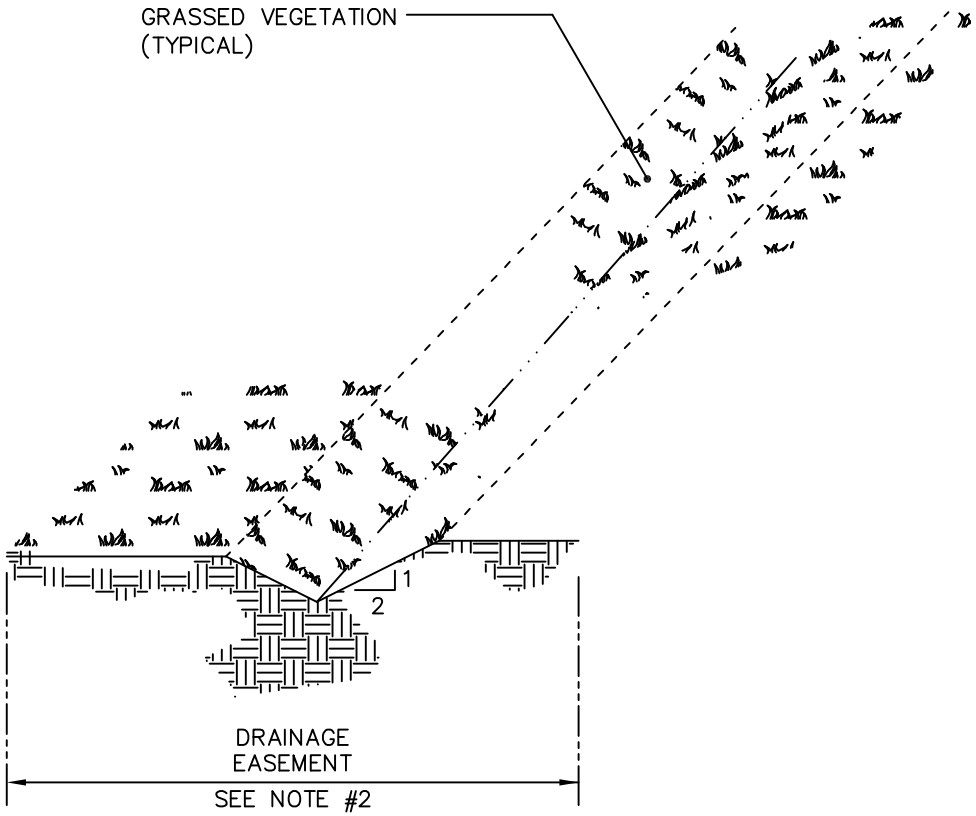

TYPICAL CROSS SECTION

NOTES:

1. Ditches shall be appropriately stabilized.
2. Drainage easement shall be minimum 15' from top of bank on each side of ditch.
3. Side slopes shall be no steeper than 2:1 (horizontal to vertical). Existing ditches with steeper side slopes may remain if it is demonstrated that the soils and vegetation will remain stable in perpetuity based on field investigation by City staff. Existing ditches to remain shall be required to provide positive flow.
4. The conveyance shall be designed so that it does not erode during the peak flow from the 10-year storm as demonstrated by engineering calculations.

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DITCH

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