Drainage

SECTION I - PURPOSE AND SCOPE

The purpose set forth herein is to ensure adequate stormwater drainage and flood control within the City of Princeton, and to protect public health and safety, to minimize property damage due to flooding, to limit runoff rates to equitably distribute the cost of necessary drainage improvements, and to minimize the maintenance cost of drainage facilities constructed. Any development or improvement of property affecting storm drainage and flood control in the City of Princeton is subject to the provisions of this Ordinance. It also applies to the individual building structures, subdivisions, excavation and fill operations.

SECTION II - STANDARD PROVISIONS

All construction for storm drainage in the development or improvement of property within the City of Princeton shall conform to the following Standards and Requirements:

A. Storm sewer inlets shall be provided along paved streets as such intervals as are necessary to limit the depth of flow as follows:

1. RESIDENTIAL STREETS - Based on parkway slopes of 1/4 inch per foot behind the curb, the 100 year Design Frequency flows shall not exceed a depth of 1 1/2 inches over the top of the curb. A maximum flow of 45 cfs will be allowed in the street.

2. COLLECTOR STREETS - Based on parkway slopes of 1/4 inch per foot behind the curb, in INDUSTRIAL AND COMMERCIAL areas, the 100 year Design Frequency flows shall not exceed a depth of 1/2 inch over the top of curb. A maximum flow of 45 cfs will be allowed on the street.

3. MAJOR THOROUGHFARES - Based on a transverse slope of 1/4 inch per foot on the pavement, the 100 year Design Frequency flow shall not exceed the elevation of the lowest top of curb. A maximum of 45 cfs will be allowed in the street.

4. ALLEYS - The 100 year Design Frequency flows shall not exceed the capacity of the alley sections. A maximum of 45 cfs. will be allowed for an alley with curbs, and a 25 cfs for alleys without curbs.

5. 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 is exceeded, the excess flow can be conveyed over land along a paved course. Normally, this would mean along a street or alley, but can require the dedications of special drainage easement on private property.

B. A closed storm sewer system shall be required to accommodate a run-off exceeding the street capacity, as provided above, up to and including the design capacity of a

seventy-two (72") inch concrete pipe. The following a recommended maximum design velocities:

Culverts	15 fps
Inlet Laterals	10 fps
Storm Sewers	12.5 fps

Discharge velocities cannot exceed the permitted velocity of the channel or conduit at the outfall.

C. An open channel may be permitted to accommodate run-off exceeding the design capacity of a seventy-two inch pipe, as provided below:

1. Channels draining in an area with a "CA" factor (coefficient to runoff and drainage area, as used in the hereinafter described "rational formula") of less than 600 shall be concrete lined to the design depth, plus six inch freeboard except that a closed system as provided above may be used. A twenty foot wide access easement shall be provided along at least one side parallel to channel. The top width of the channel at the design depth must not exceed 50' unless specifically approved by the City Engineer.

2. Channels draining an area with a "CA" factor between 600 and 1,000 shall be improved to a capacity of the 100 year design discharge by excavation, straightening and realignment. The construction of a concrete lined channel shall have a width of not less than the bottom width with concrete lined to a depth of at least three feet on the banks. Earthen side slopes shall be no steeper than 4:1, horizontal to vertical, and shall have approved ground cover to prevent erosion.

   Where drainage conditions or velocities of water will exceed that condition which would create erosion, provisions shall be made for the placement of riprap, gabion, etc., along the stream, and channel banks by the developer.

3. Channels draining an area with a "CA" factor over 1,000 shall be designed to carry the capacity of a 100 year flood frequency storm. The specific design and type of construction improvements for this drainage facility shall have specific approval by the City Engineer after review of the maintenance, erosion, and site conditions.

4. All areas of an earth Channel Section shall be improved by the Developer with a low maintenance vegetation as approved by the City Engineer, 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.

5. The setback for the building line shall be as follows:

    a. A maintenance strip shall be provided with a twenty (20) foot width along each side of the top of the channel unless approved otherwise by the city Engineer and shown on the file plat.
    b. A drainage flume section which provides for limited flow of storm water shall be located within a drainage easement of sufficient width which permits future maintenance accessibility.

D. A drainage feature which is to remain in its natural state of native growth may be accepted by the City to remain as an unimproved facility so long as the water conveyance capacity of the area is adequate to handle the future drainage requirements.

E. In lieu of the improvements of a channel draining an area with a "CA" factor in excess of 600, the City Council may elect to accept the dedication of all land within the 100 year floodway of the existing drainage channel as a permanent drainage right-of-way.

F. The criteria for drainage improvements as herein-above set forth in Paragraphs A through D of this section shall be applicable to publicly owned lands solely at the discretion of the City of Princeton.

G. Excavation, fill and grading operations within the City Limits shall be undertaken only after a proper permit has been obtained from the City Engineer. Failure to obtain the proper permit shall result in the requirement for the Developer to replace the soils, as required by Chapter 70 of the Appendix of the 1982 edition of the Uniform Building Code.

H. Easements - Drainage and floodway easements shall be provided for all open channels. Easements shall encompass all areas beneath a ground elevation defined as being the highest elevation of the following:

    1. One (1) foot above a design storm having a recurrence interval of 100 years, calculated by the City's criteria.

    2. The top of the high bank.

    3. Maintenance access.

I. Ground Cover - Any ground cover or vegetation which is planted and is a part of the improvement project will not be accepted by the City until the growth has been established and maintained by the Developer for a one (1) year time period.

SECTION III - RESPONSIBILITY OF OWNER OR DEVELOPER FOR STORM DRAINAGE

A. The owner or developer of property to be developed shall be responsible for all storm drainage flowing through or abutting such property. This responsibility includes the drainage directed to that property by ultimate development as well as the drainage naturally flowing through the property by reason of topography. It is the intent of this Ordinance that provision be made for storm drainage in accordance with Section III above, as such time as property affected is proposed for development, use, or modification.

B. Where the improvement or construction of a storm drainage facility is required along a property line common to two or more owners, the owner hereafter proposing development of his property shall be responsible for the required improvements at the time of development, including the dedication of all necessary right-of-way or easements to accommodate the improvements.

C. Where a property owner proposed development or use of only a portion of his property, provision for storm drainage in accordance with Section II above shall only be required in that portion of the property proposed for immediate development, except as construction or improvements of a drainage facility outside that designated portion of the property is deemed essential to the development of that designated portion.

D. When a property owner proposes a development, provisions shall be made in the development plan for control of excess siltation and downstream erosion.

E. The owner or owners shall dedicate to the City, the required drainage easements. Determination of minimum easement required shall be made by the City Engineer, or as outlined in Section II.

F. In the event that a property owner or developer desires to modify an existing pond or lake or desires to impound storm water by excavation, filling or construction of a dam within a property, for retention or detention, thereby creating a lake, pond, or lagoon or basin as a part of the planned development of that property, the standard provisions for storm drainage as established in Section II of this Ordinance shall be applicable, and shall also provide:

1. That an engineering plan for such construction, accompanied by complete drainage design information, prepared by a registered professional engineer, shall have been approved by the City or Princeton;

2. That the owner or developer shall have agreed to retain under private ownership the lake, pond, or lagoon or basin constructed, and assume full responsibility for the protection of the general public from any health or safety hazards related to the lake, pond, or lagoon constructed;

3. That the owner or developer shall have agreed to assume full responsibility for the maintenance of the lake, pond, or lagoon or basin constructed;

4. That the obligation herein shall run with the land and shall be a continuing obligation of the Owner or Owners of such land.

5. That all Federal, State, and County laws pertaining to impoundment of surface water are complied with, including the design construction and safety of the impounding structure. Any Existing Structure which is included in a project development area shall be improved to comply with the applicable Federal, State and county and City safety requirements for structures. The design flows shall be based upon the urbanized drainage flows which can result from a 100 year flood. All improvements shall be made to the dam structure at the expense of the developer, prior to acceptance of the adjacent street, utilities and drainage improvements as provided for under the Subdivision Ordinance.

6. On any existing structure, the Owner will furnish a study by a professional Engineer to the City for approval prior to any proposed alteration. Compensatory storage shall be provided in some manner such that equal or comparable flood retention capacity is maintained.

G. The maintenance of Private Drainage Facilities shall be provided for by the property owner or assigned agent. The City shall be kept advised of the responsible agent.

H. All existing water seepage springs, or flowing water shall be connected into an underground storm sewer system, or they shall be discharged into an appropriate facility which is intended to carry storm water runoff. Such flow will not be permitted to discharge directly into the street gutter line.

I. Fences (Private and Public Screening) shall be constructed such that blockage of surface water flow does not occur. This includes the requirement that erosive conditions shall not be created around, under or near a fence structure.

J. The developer shall provide detailed offsite drainage plans for the proper transition to natural ground or stream elevations. Criteria for onsite development shall apply to offsite improvements as required by the City Engineer.

SECTION IV - ENGINEERING DESIGN

A. Each storm drainage facility, including street capacities, shall be designed to convey the runoff which results from a certain prescribed design storm.

Drainage design requirements for open and closed systems shall provide protection for property during a storm having a 100-year recurrence interval with this projected flow carried in the streets and closed drainage systems in accordance with the following:

Drainage Facility	Design Recurrence Interval
Closed Storm Sewer Systems	10 yr. with emergency 100 yr. overflow
Closed Storm Sewer Systems at Street Low Point or Sag	25 yr. with emergency 100 yr. overflow
Culverts and Bridges	100 yr. (unless otherwise directed)
Concrete Lined Channels	50 yr. with emergency 100 yr. overflow
Earthen Channels	100 yr.

B. Computation of Storm Water Run-off for drainage areas less than 200 acres shall be by the "Rational Method", which is based on the principle that a maximum rate of run-off 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 run-off by the "Rational Method" is:

Q = CIA, where
Q = the maximum rate of discharge expressed in cubic feet per second
C = a run-off coefficient which varies with the topography, soil, soil cover, land use and moisture content of the soil at the time the run-off producing rainfall occurs. This run-off coefficient shall be based on the ultimate use of the land as recommended by the Land Use Plan for the City of Princeton, and shall be selected from Table I herein on the basis of the use shown on land use and zoning map of the Comprehensive Zoning Ordinance for the City of Princeton. If an area has had a change of Zoning to give the area land use for which the "C" in Table I is higher than use shown on land and zoning maps, the higher "C" factor shall be used.

I = Rainfall intensity in inches per hour from the applicable curves of Figure 1. Time of Concentration or Duration of Rainfall for use in Figure 1 shall be calculated by velocity data shown in Table II.

A = The drainage area, expressed in acres, contributing to the run-off at the point in question. Calculation of the drainage area shall be made from an accurate topographic map, a copy of which shall be submitted with the engineering plans for approval.

For drainage areas in excess of 200 acres, where the use of "Rational Method" does not provide reliable data, the use of unit Hydrograph Flow Determination shall be made. The use of a unit Hydrograph calculation will be based upon standard and accepted Engineering Principles normally used in the Professional subject to the approval of the City Engineer. The Soil Conservation Service Technical Release Number 55 is an acceptable method.

Computation of run-off shall be based on a fully developed drainage area, or watershed, in accordance with the land use projected in the then current comprehensive land use plan for the City of Princeton. The developer or builder shall develop their site development

plans so that the rate of runoff created by the development of their property does not exceed the rate of runoff resulting from that which presently exists. The runoff rate which will exit the project shall not be greater than that volume or velocity determined through the defined design criteria, as outlined in this Ordinance. When development can, or does provide direct drainage outlet works into Lake Ray Hubbard, consideration will be given to allow the design of storm runoff without detention, or retention within the project limits.

C. The two basic methods suggested for predicting the volume of runoff with time and the peak flow rate are the Rational Method and the Unit Hydrograph Method. The Rational Method may be used for drainage areas less than or equal to 200 acres. Drainage basins that exceed 200 acres must use the Unit Hydrograph Method. The Soil Conservation Service Technical Release Number 55 is an acceptable Unit Hydrograph Method.

When the Rational Method is used and detention is required, the volume of water supplied by the design storm may be calculated by converting the runoff rate, during a specific duration, to volume. The inflow volume should be determined for a period of at least twice the time of concentration for the site.

Retention and detention are two generalized types of storm runoff storage used to control the rate of runoff. All detention ponds should be designed to empty within a 24 hour period.

VALUES OF "C" FOR USE IN "RATIONAL METHOD" FORMULA Q = CIA

TABLE 1

Slope	Land Use from Land Use Plan	Value of "C" (Run-off Coefficient)
Flat Terrain	Park Areas – No Developable Land	0.20
0% to 1%	Park and School Land Tract	0.30
	Single Family Residential	0.45
	Duplex	0.50
	Multiple Family	0.55
	Local Business	0.65
	Central Business	0.80
	Commercial	0.80
	Industrial	0.75
Moderate Terrain	Park Areas – No Developable Land	0.30
1% to 3½%	Park and School Land Tract	0.40
	Single Family Residential	0.50
	Duplex	0.55
	Multiple Family	0.60
	Local Business	0.70
	Central Business	0.85
	Commercial	0.85
	Industrial	0.80
Steep Terrain	Park Areas – No Developable Land	0.35
3.5% and Over	Park and School Land Tract	0.45
	Single Family Residential	0.65
	Duplex	0.70
	Multiple	0.75
	Local Business	0.80
	Central Business	0.85
	Commercial	0.85
	Industrial	0.85

AVERAGE VELOCITY FOR USE IN DETERMINING TIME OF CONCENTRATION

TABLE II

Description of Water Course	0% to 3% V. in f.p.s.	4% to 7% V. in f.p.s.	8% to 11% V. in f.p.s.	Over 12% V. in f.p.s.
Surface Drainage Channels	5	9	13	15
Storm Sewers	Determine V. by Mannings Formula			
	Determine V. by Mannings Formula			

The data shown in Table II are average velocity of the run-off for calculating time of concentration or duration of rainfall for use in Figure 1. These average velocities in this table shall be used unless the designer shows calculation of velocities by streets and/or storm sewers, or overland flows.

Using the average velocities from this table, the designer shall calculate the time of concentration by the following formula unless more data is shown on the plans for calculating time of concentration.

"Inlet Time" = 5 minutes for property zoned for multiple family, local business, central business, commercial or industrial; 10 minutes for property zoned for parks, schools, single family residential and duplex.

$$T = \text{"Inlet Time"} + \frac{D}{V \times 60}$$ Where:

T = Time of concentration in minutes for use in Figure 1.

D = Distance in feet from point of concentration to upper end of drainage area under consideration.

V = Velocity in feet per second from this table or velocity calculated by designer by streets and/or storm sewers.

The existing soils are such that erosive conditions are created at certain velocities. The following velocities are considered to be maximum acceptable design conditions:

Earth (with no concrete protection)	0 to 5 feet per second
Shale	5 to 6 feet per second
Rock	6 to 10 feet per second

D. The minimum curb inlet size shall be eight (8) feet in length with a capacity of 8 cfs.

E. The construction of all improvements shall be in accordance with the standards set forth in the current Design Standards of the City of Princeton. The frequency chart in years (Figure 1), the Inlet Capacity for low point inlets (Figure 2), the drainage capacity road sections (Figure 3), and the City Criteria are hereby adopted as a part of this Ordinance.

F. Complete engineering plans for storm drainage facilities shall be prepared by a professional engineer registered in the State of Texas and experienced in civil engineering work. The total cost for such engineering plans and specifications shall be borne by the Owner or the Developer and shall be furnished to the City Engineer for his review and approval.

G. In any development, alteration, or improvement of property, the Owner may be required to provide, at his expense, a preliminary drainage study for the total area to be ultimately developed. This study shall be submitted to the City Engineer as a part of the submitted date for consideration of preliminary plat, or site plan approval.

SECTION V - CONSTRUCTION IN AREAS SUBJECT TO FLOODING

A. In all areas subject to flooding, the finished floor elevation shall be a minimum of two feet above the high water elevation calculated for the run-off from a rainfall having a recurrence interval of 100 years, in a completely developed watershed. The owner/developer shall furnish, at his expense to the City Engineer, sufficient engineering information to confirm that the minimum floor elevations proposed are as required by this paragraph. Residential construction permits will not be issued until lots and/or sites are elevated from the flood plain in accordance with F.I.M.A. approved revision.

B. No building or structure, excavation, filling, or construction of embankment or landscaping shall be permitted within a flood plain or channel which will increase water surface elevations or obstruct natural flow of water within that flood plain or channel, unless sufficient engineering design information is furnished to the City Engineer in order that he may determine that same will not adversely affect flow characteristics within that flood plain or channel, resulting in damage to that or any other property nearby.

C. The provisions of the City's current Flood Hazard Prevention Ordinance (F.I.M.A. criteria) shall be observed in preparing land development plans.

D. New construction and substantial improvement of any commercial, industrial or other non-residential structure shall have the lowest floor, including basement, elevated to the level of the base flood elevation, plus two (2.0) feet.

SECTION VI – BUILDING OR STRUCTURE SET-BACK REQUIREMENT

No building or structure, including fences, shall hereafter be constructed, reconstructed, or relocated within twenty (20) feet of any open drainage channel. It is the intent of this section to insure that an unobstructed width of at least twenty (20) feet is maintained between the top of the high bank of any such drainage channel and any building or structure. (See also Section III).

SECTION VII – MINIMUM LOT AND FLOOR ELEVATIONS

Minimum lot and floor elevations shall be established as follows:

1. Lots abutting a natural or excavated channel shall have a minimum elevation for the buildable area of the lot at least equal to the highest elevation of the drainage floodway easement, and a finished floor elevation at least two (2) feet above the 100-year design storm or F.I.M.A. floodway elevation, whichever is greater. The minimum finished floor elevation shall be set at an elevation of two (2) feet above the top of curb elevation, except when the terrain feature slopes, such that drainage is not a critical element to the project.

2. Where lots do not abut a natural or excavated channel, minimum floor elevations shall be a minimum of one (1) foot above the street curb or edge of alley, whichever is lower, unless otherwise approved by the City Engineer. Where a lot is adjacent to a drainage flume or channel, the finished floor shall be a minimum of two (2) feet above the high water elevation. Where the structure is below a street or alley, the builder shall grade and construct facilities such that a positive drainage system of swales are capable of discharging the resultant flows which may flow across the yard area into the structure.

3. The minimum finished floor elevation shall be shown on the final file plat for record purposes. Prior to final acceptance of utilities and street construction by the City, a certified statement shall be prepared by a Registered Public Surveyor showing all lot elevations, as developed within the subject project, meet or exceed the required minimum finished floor elevations. This certification shall be filed with the City Engineer.

4. Existing platted property which is subject to flooding or carries a specified or recorded minimum finished floor elevation shall be surveyed by a Registered Public Surveyor prior to obtaining a building permit. The certified survey data shall be furnished to the City Engineer for approval. Certificate of Compliance with the provisions of this ordinance pertaining to specified finished floor levels shall be required.

SECTON VIII – BUILDING PERMITS, PLAT & SITE PLAN APPROVAL TO BE WITHHELD

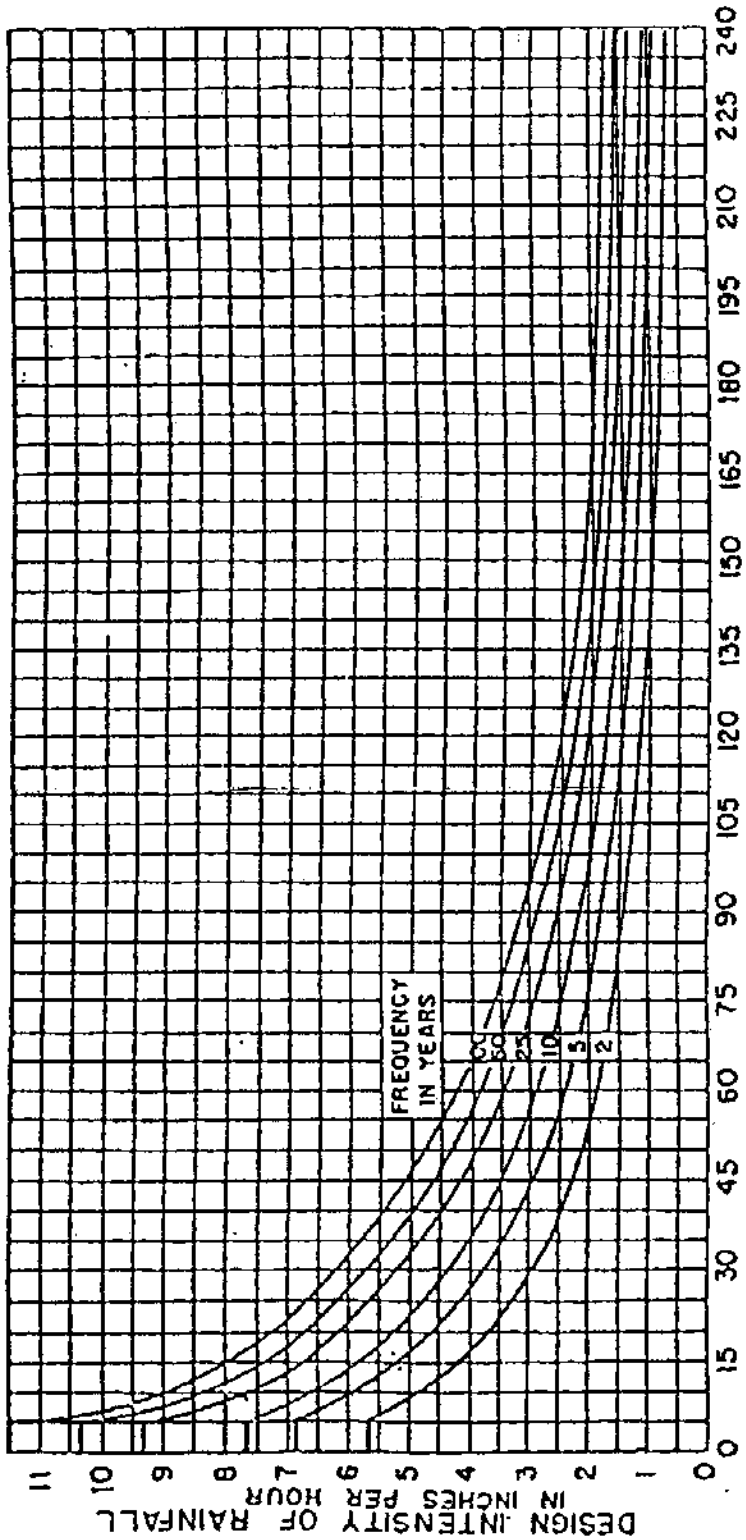
No Building Permit shall be issued, nor plat or site plan approval, nor Certificate of Occupancy approved for any construction, reconstruction, or development is not in conformity with the requirements and intent of this Ordinance. Anyone who violates any of the terms and provisions of this Ordinance shall be denied a Building Permit until the violation is corrected. Residential construction permits will not issued until lots and/or sites are elevated from the flood plain by F.I.M.A. approved revisions.

SECTION IX - MAINTENANCE GUARANTEE

The Contractor shall guarantee the work which he does against defective workmanship and materials for a period of one (1) year from the date of final acceptance by the City.

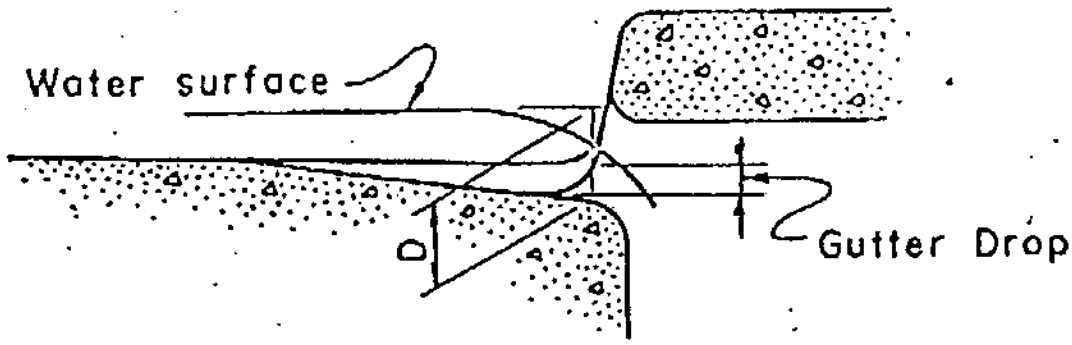
Where defective workmanship and/or materials are discovered requiring repairs to be made this guarantee, all such repair work shall be done by the Contractor at his own expense within five (5) days after written notice of such defect has been given to him by the City. Should the Contractor fail to make repair or correct such defective workmanship and/or materials within five (5) days after being notified, the City may make the necessary repairs and charge the Contractor with the actual cost of all labor and materials required.

The Contractor shall provide a performance bond for a period of one (1) year time period after the date of acceptance of the work to cover his guarantee as set forth above.



FREQUENCY CHART IN YEARS

FIGURE 1



SECTION

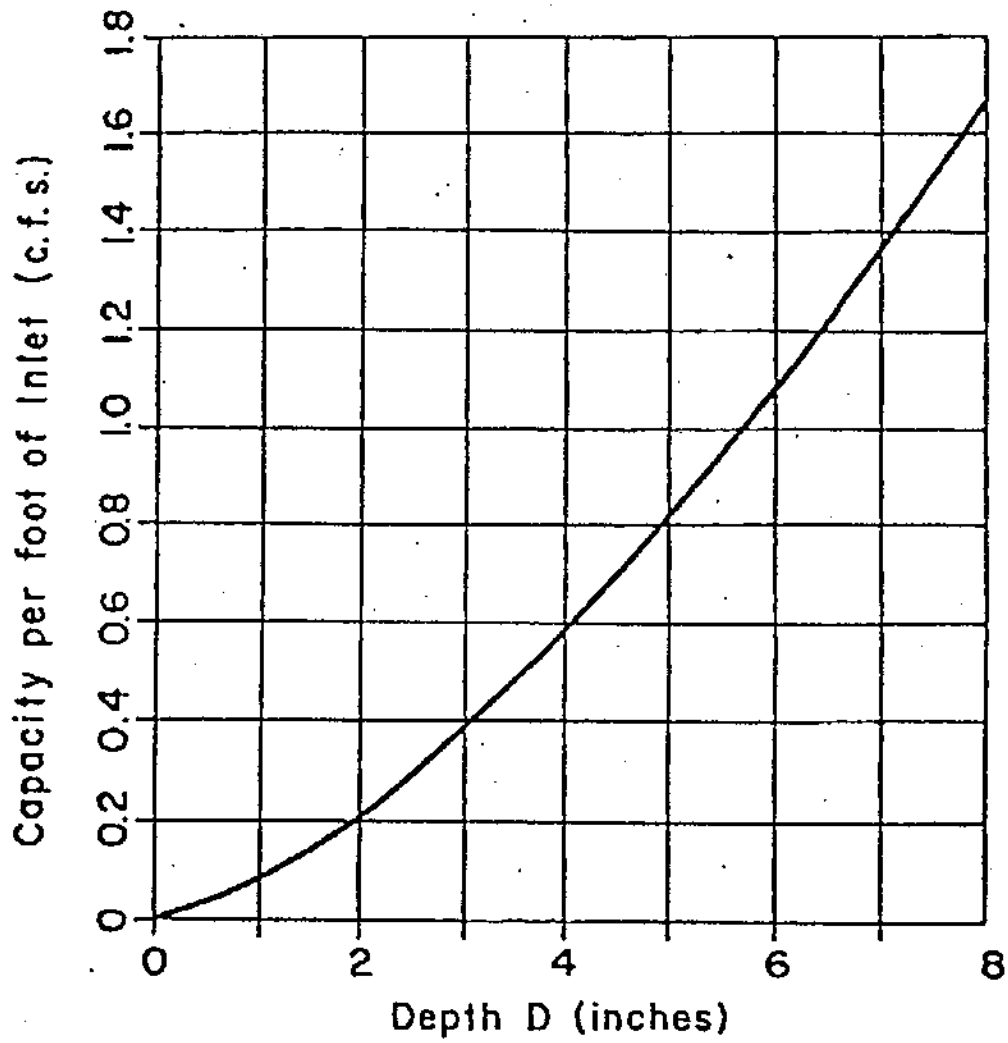


FIGURE 2

INLET CAPACITY FOR LOW POINT INLETS

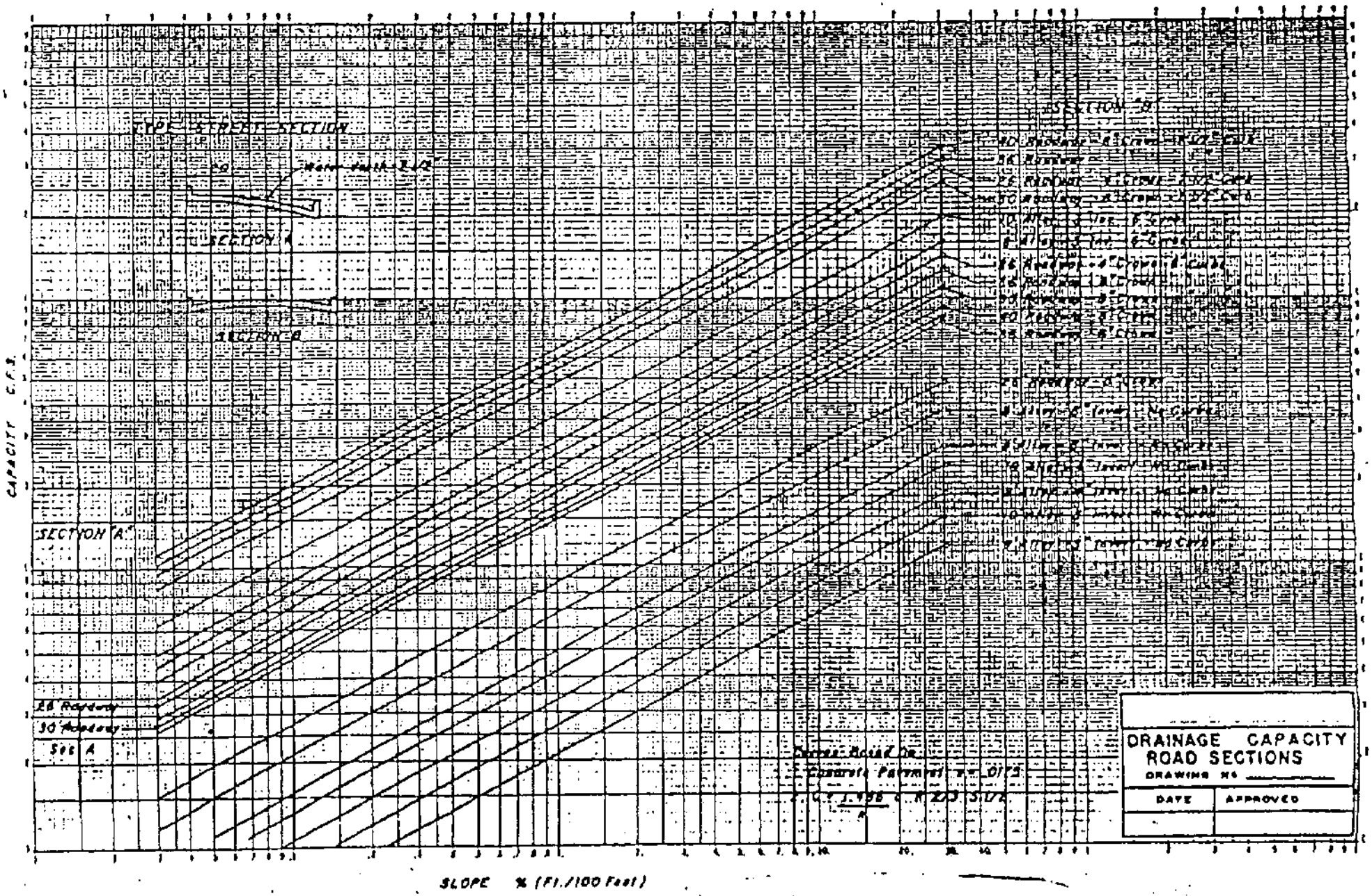

CAPACITY C.F.S.
SLOPE % (Ft./100 Feet)
SECTION A
SECTION B
SECTION C
SECTION D
TYPE STREET SECTION
DRAINAGE CAPACITY
ROAD SECTIONS
DRAWING NO.
DATE
APPROVED

FIGURE 3

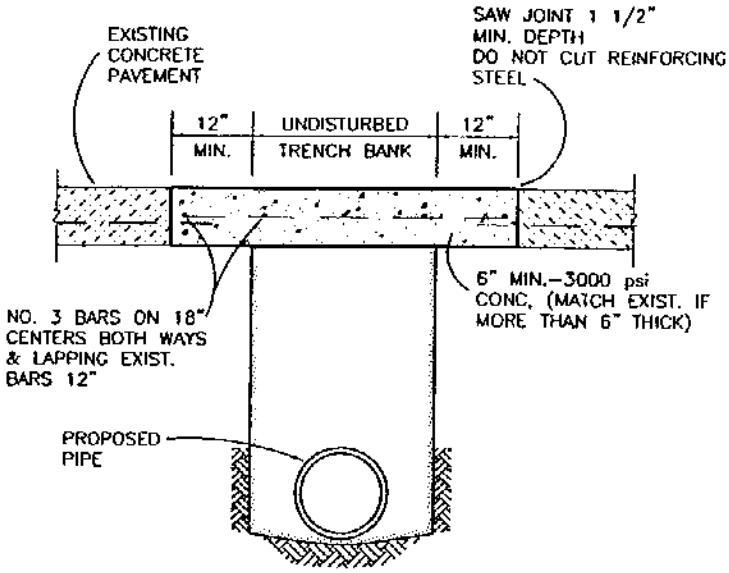
STORM DRAINAGE

INDEX

GENERAL NOTES

1. ALL MATERIALS AND PRACTICES SHALL BE AS SPECIFIED IN THE NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION (WITH MOST RECENT AMENDMENTS).
2. ALL STORM SEWER PIPE SHALL BE REINFORCED CONCRETE PIPE.
3. STORM SEWER PIPES SHALL BE MINIMUM 18" DIAMETER.
4. ALL STORM SEWER TO BE T.V. INSPECTED AFTER INSTALLATION.

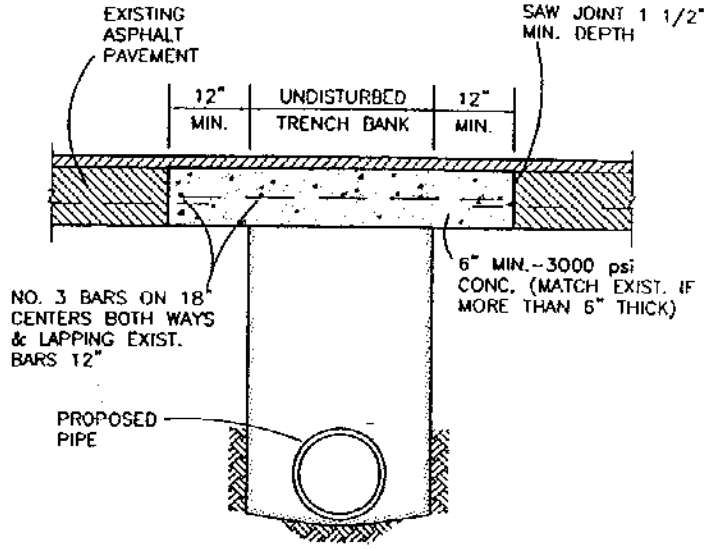
	GENERAL NOTES: STORM DRAINAGE	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D01



SEE EMBEDMENT FOR TYPE OF PIPE

CONCRETE STREET OR DRIVEWAY REPAIR

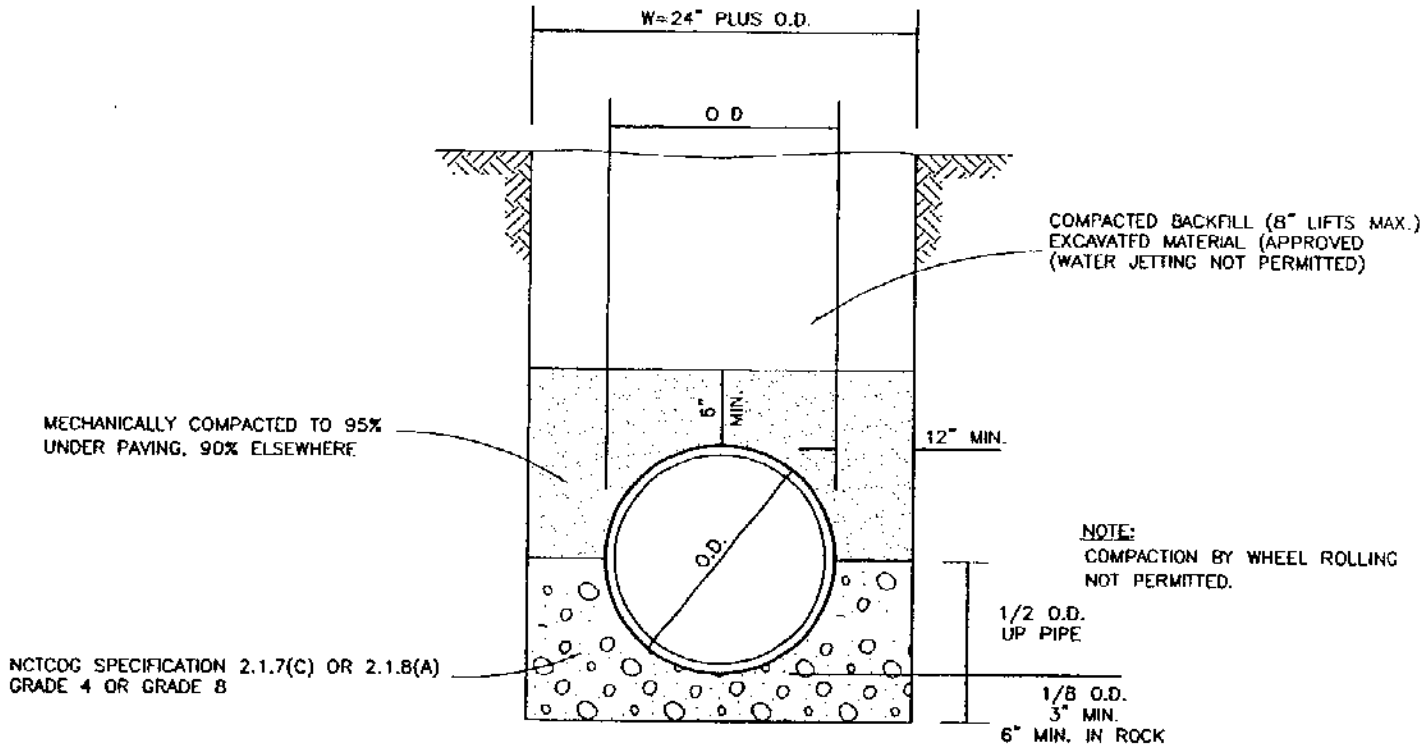
N.T.S.



SEE EMBEDMENT FOR TYPE OF PIPE

ASPHALT STREET OR DRIVEWAY REPAIR

N.T.S.

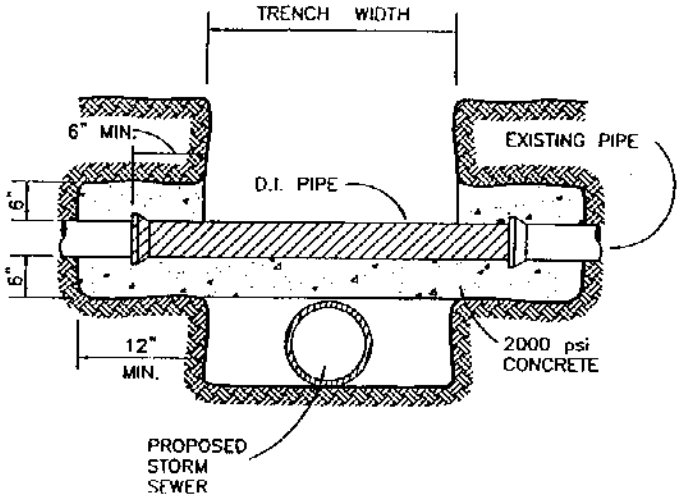


STORM SEWER PIPE BEDDING

N.T.S.

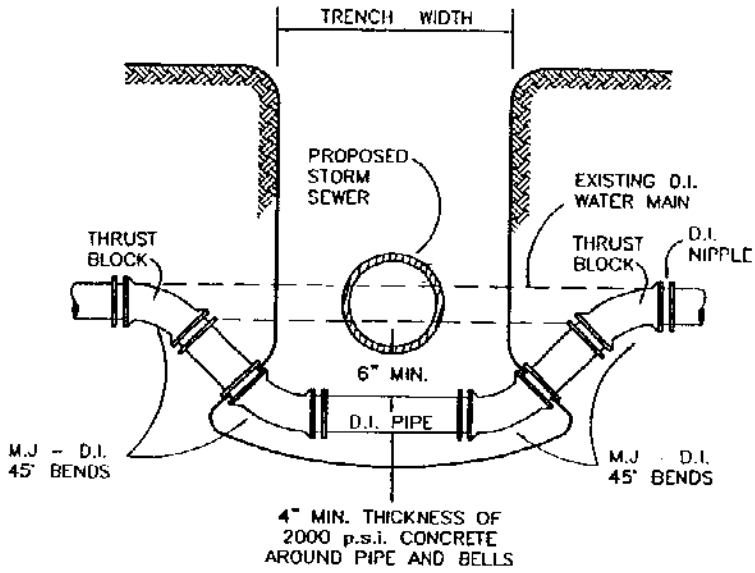
NOTE :
DEPTH OF TRENCH BELOW PIPE
3" MIN. FOR 27" PIPE & SMALLER
4" MIN. FOR 30" TO 60" PIPE
6" MIN. FOR 66" PIPE & LARGER

	CONCRETE STREET REPAIR ASPHALT STREET REPAIR PIPE BEDDING	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD-002



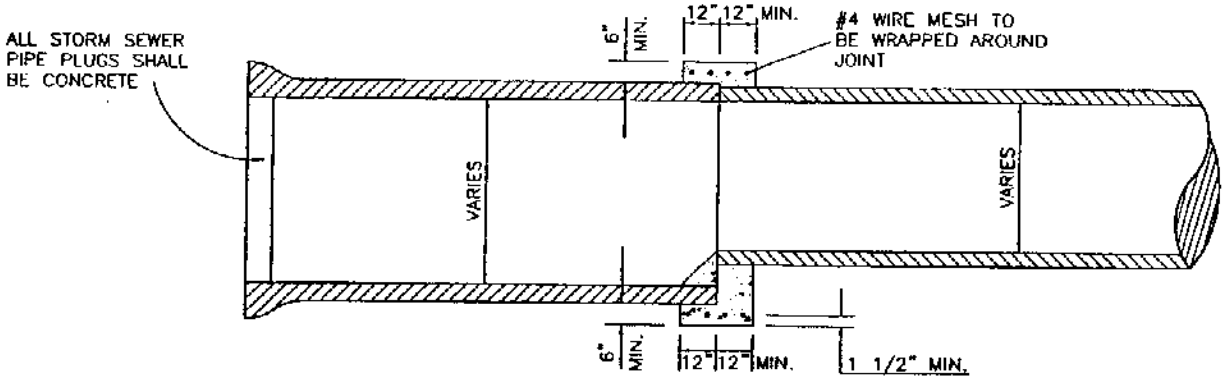
DETAIL OF UTILITY SUPPORT

N.T.S.



DETAIL FOR WATER MAIN LOWERING

N.T.S.

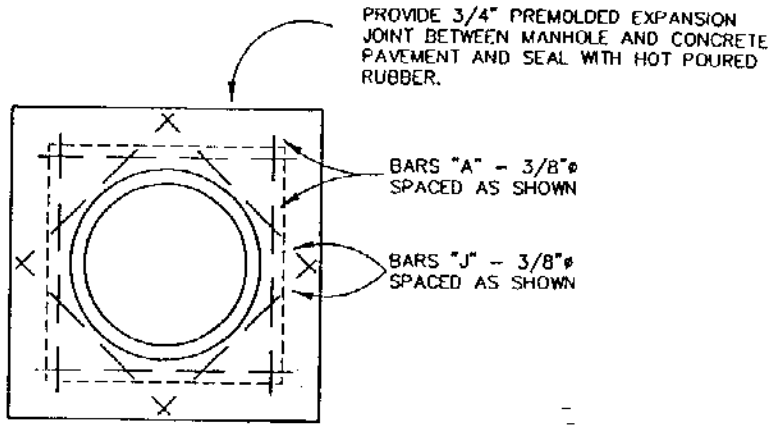


DETAIL OF CONCRETE COLLAR FOR PIPE CONNECTIONS

N.T.S.

	UTILITY SUPPORT WATER MAIN LOWERING CONCRETE COLLAR	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D03

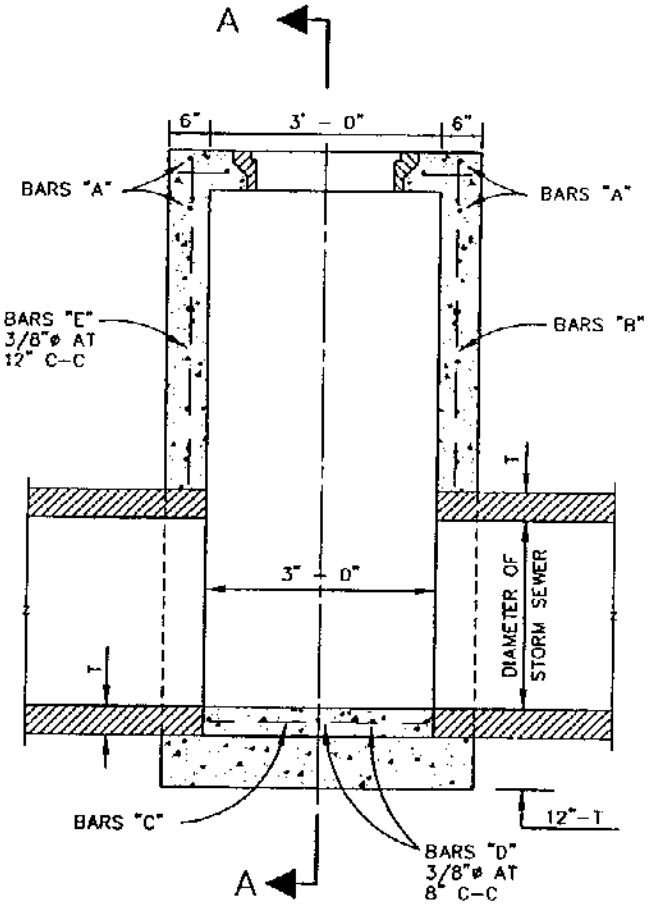
NOTE :
FRAME AND COVER SHALL BE BASS & HAYES PATTERN NO. 380–24 OR EQUAL AND SHALL BE GRAY CAST IRON CONFORMING TO ASTM SPEC. A–48 FOR CLASS 30 CAST IRON.



TOP PLAN
TYPE A & TYPE B
STORM SEWER MANHOLE

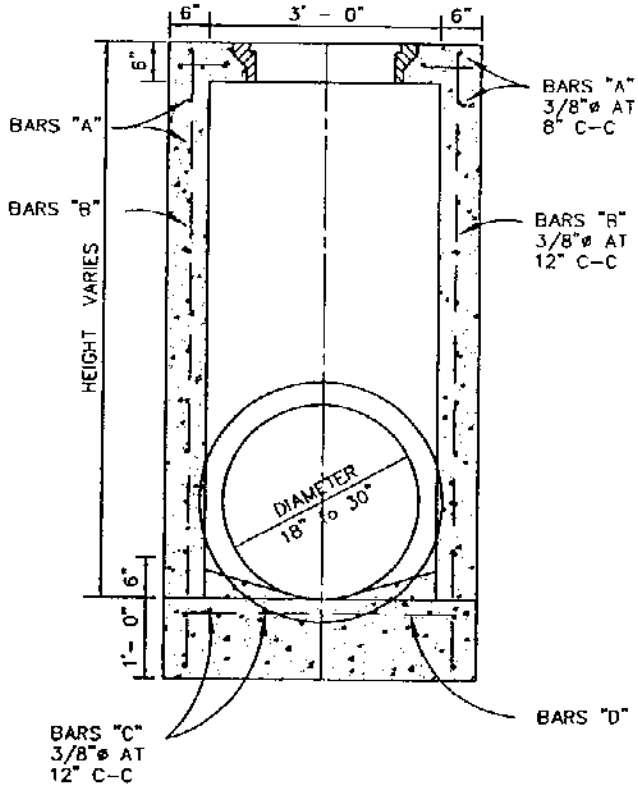
NOTE : MAXIMUM PIPE SIZE TO BE USED 78"ø

N.T.S.



ELEVATION

N.T.S.

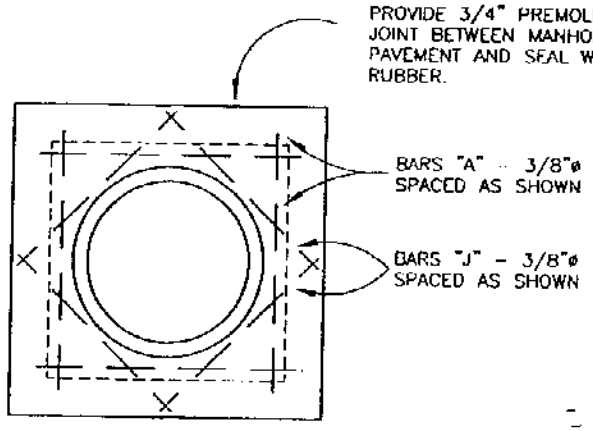


SECTION A–A

N.T.S.

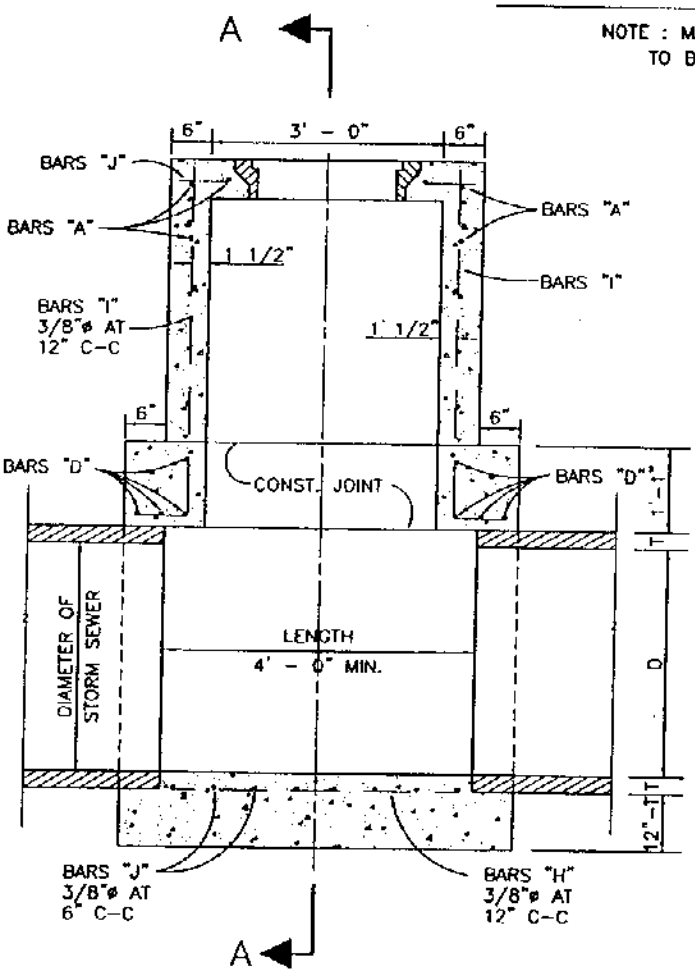
	TYPE A STORM SEWER MANHOLE	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD–D04

NOTE :
FRAME AND COVER SHALL BE BASS & HAYES PATTERN NO. 380-24 OR EQUAL AND SHALL BE GRAY CAST IRON CONFORMING TO ASTM SPEC. A-48 FOR CLASS 30 CAST IRON.



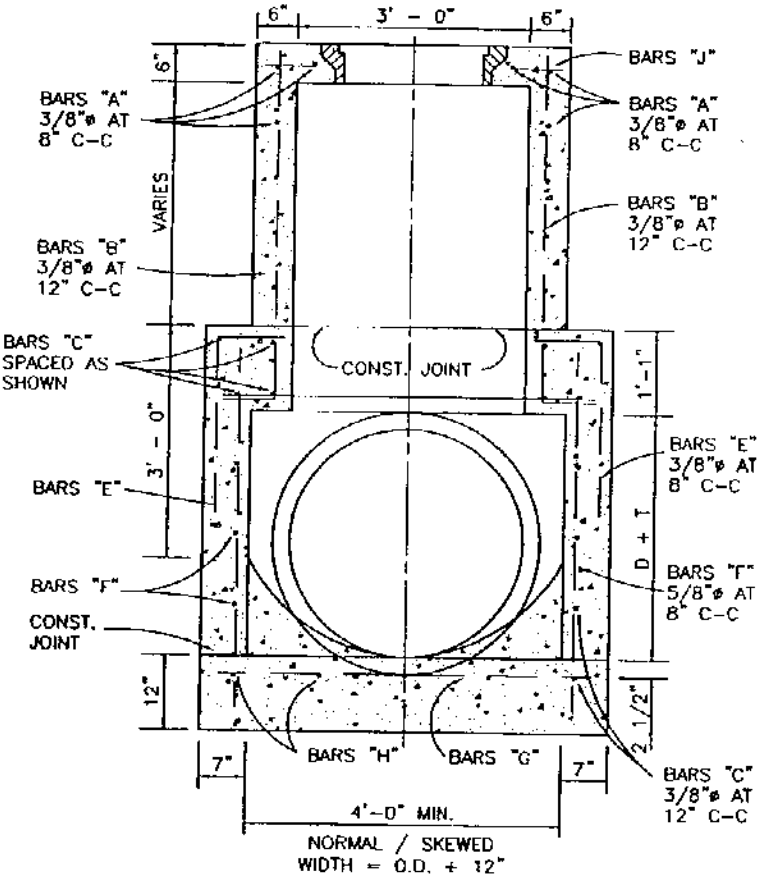
TOP PLAN
TYPE A & TYPE B
STORM SEWER MANHOLE

NOTE : MAXIMUM PIPE SIZE TO BE USED 78"ø
N.T.S.



ELEVATION

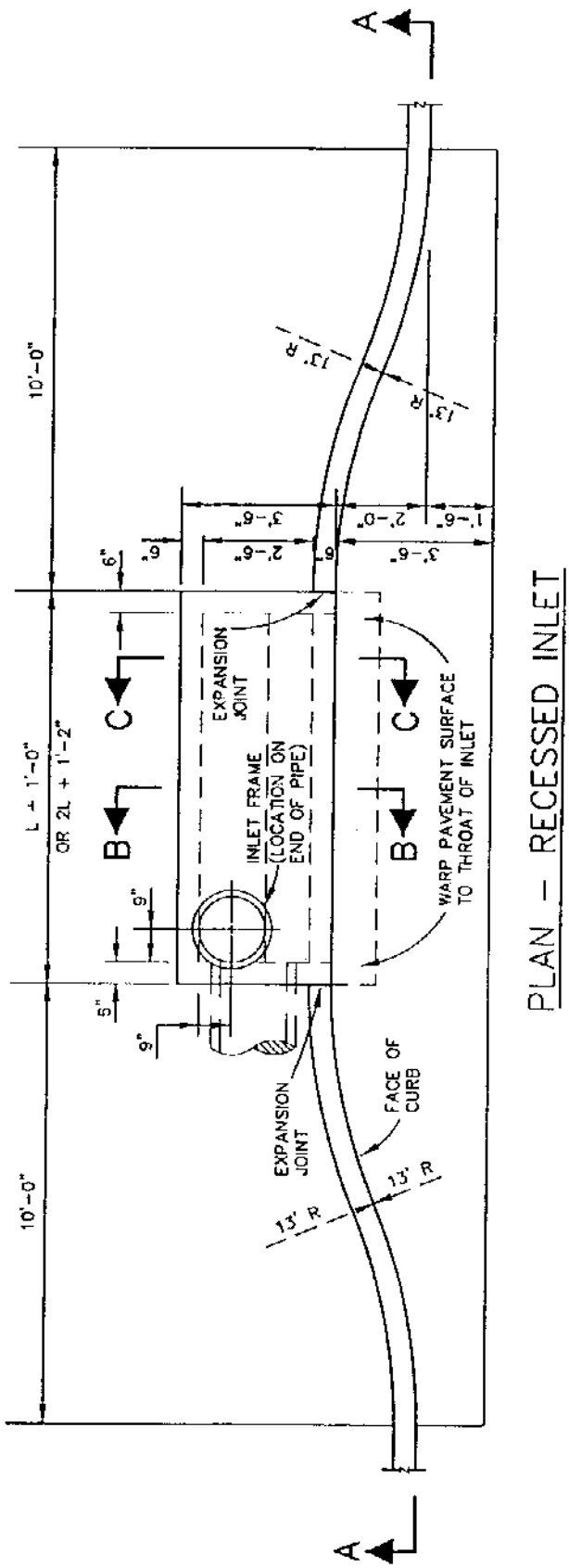
N.T.S.



SECTION A-A

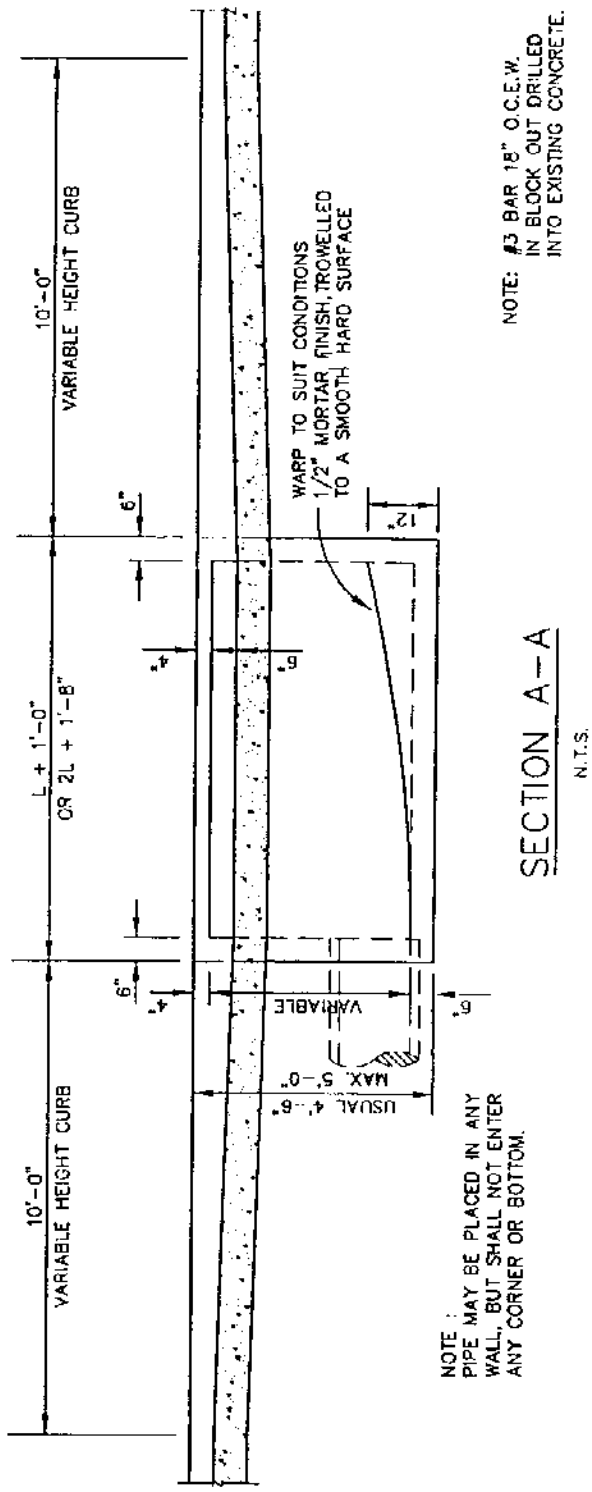
N.T.S.

	TYPE B STORM SEWER MANHOLE	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-005



PLAN – RECESSED INLET

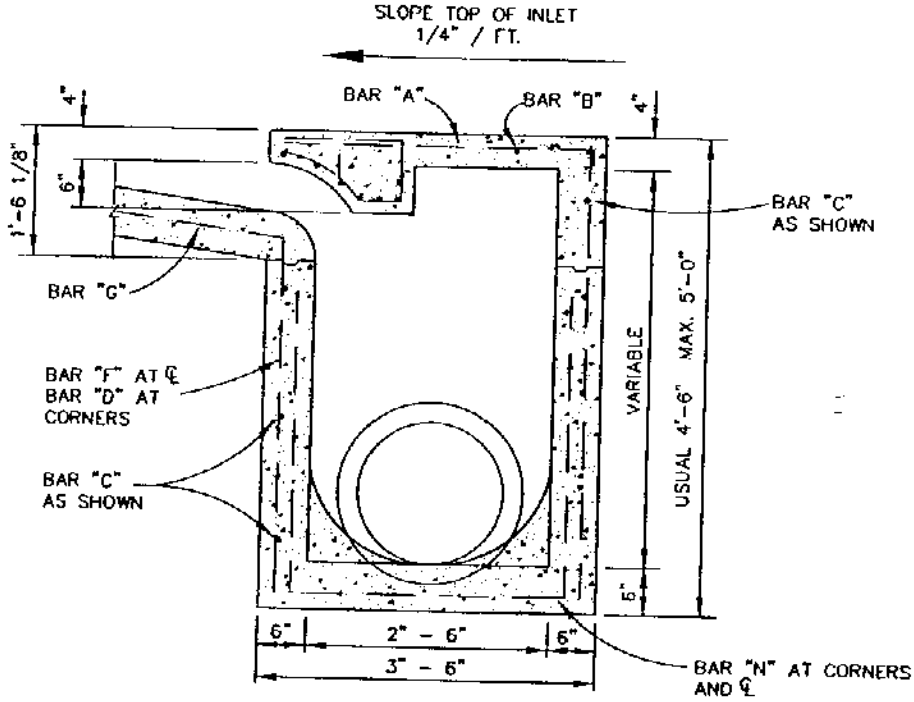
N.T.S.



SECTION A–A

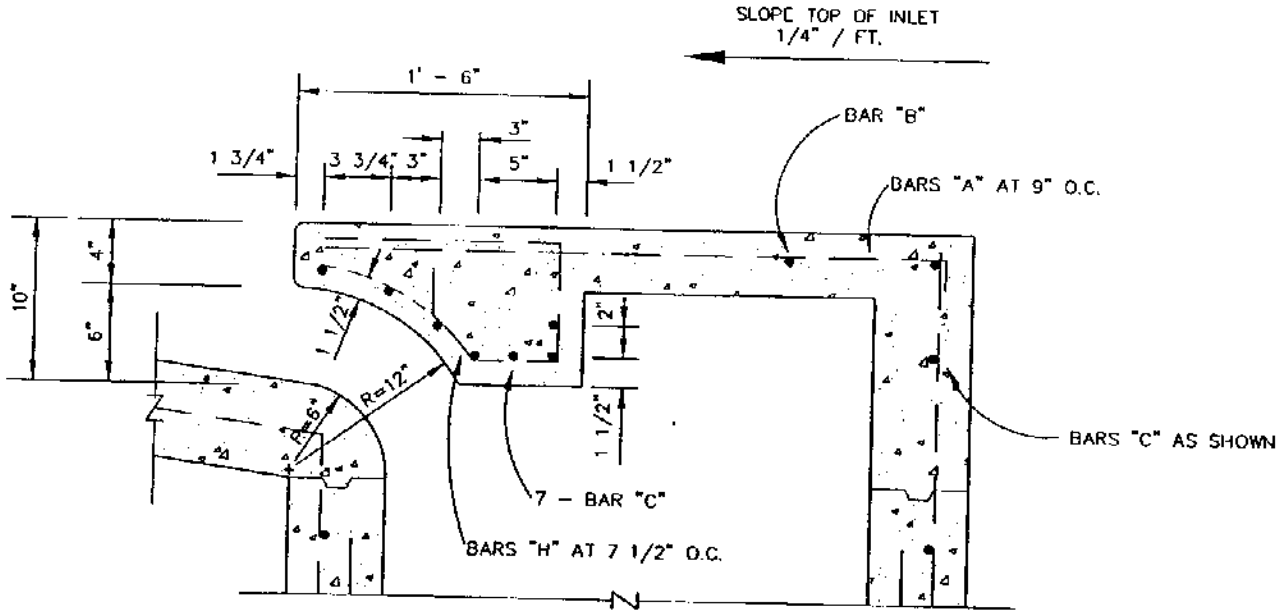
N.T.S.

	RECESSED CURB INLET 4,6,8 and 10 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD–D06



SECTION B–B

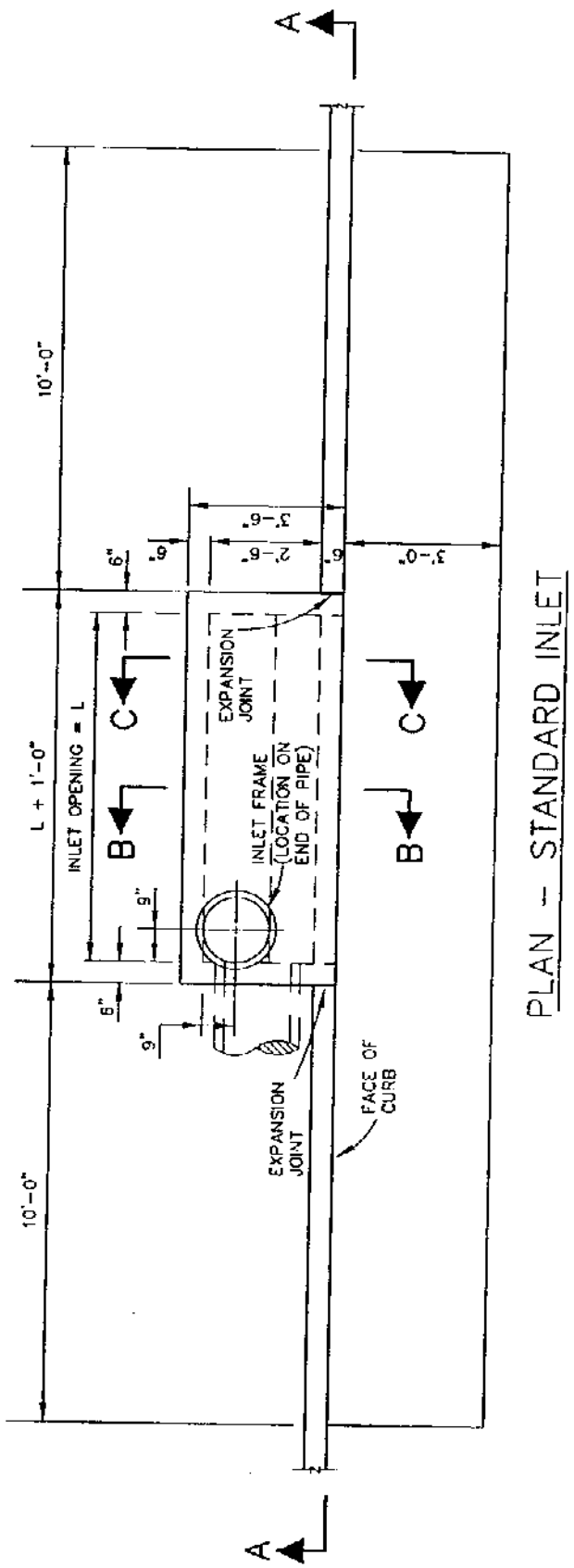
N.T.S.



SECTION C–C

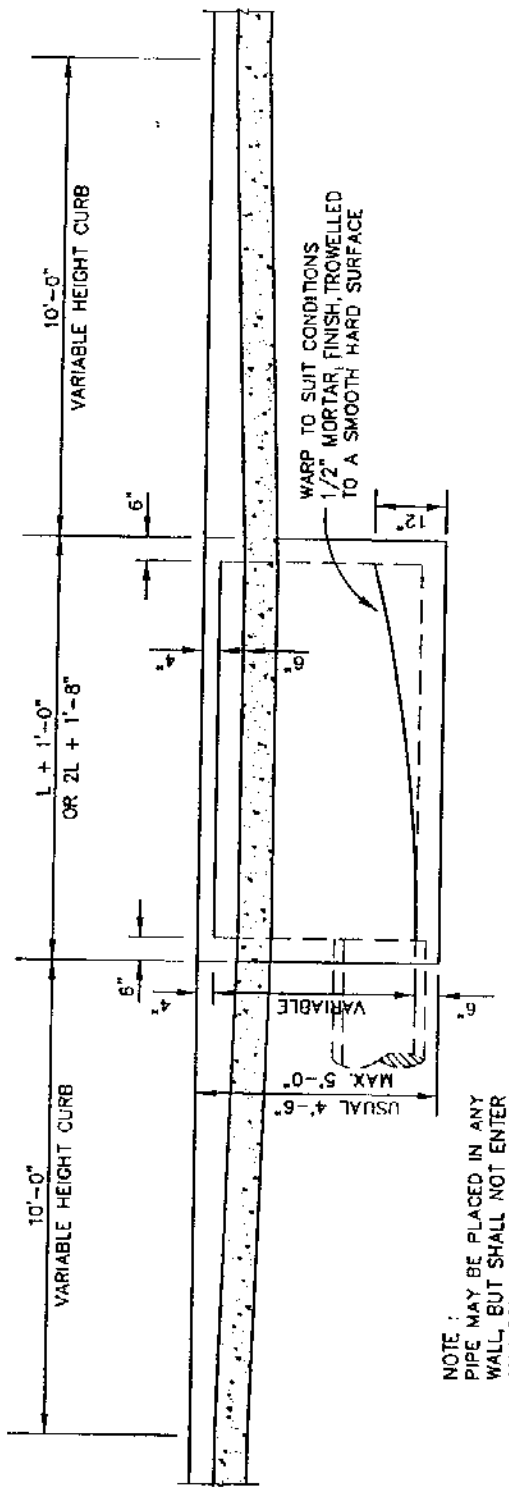
N.T.S.

	RECESSED CURB INLET 4,6,8 & 10 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D07



PLAN - STANDARD INLET

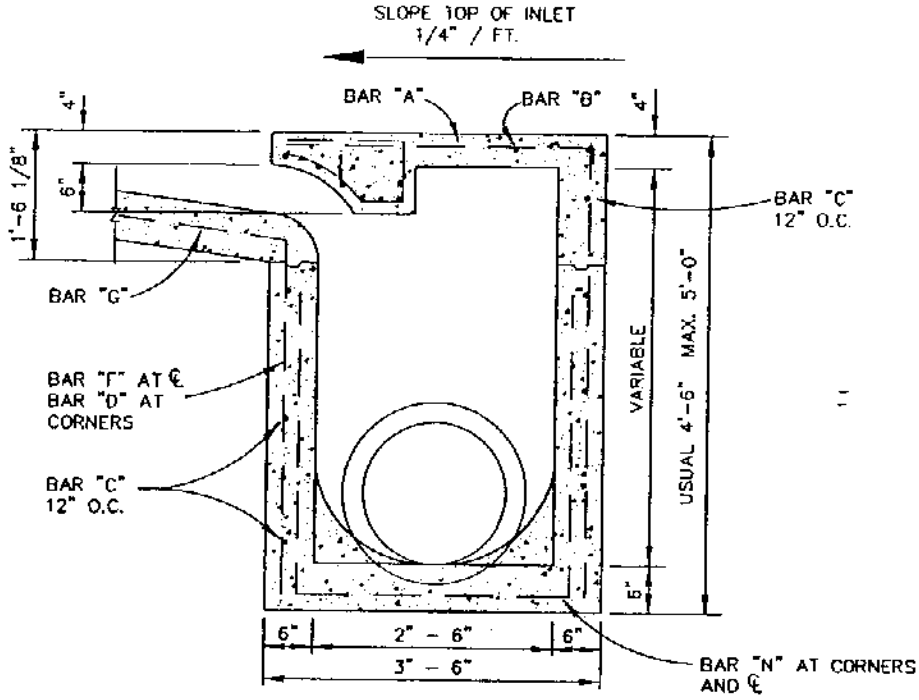
N.T.S.



SECTION A-A

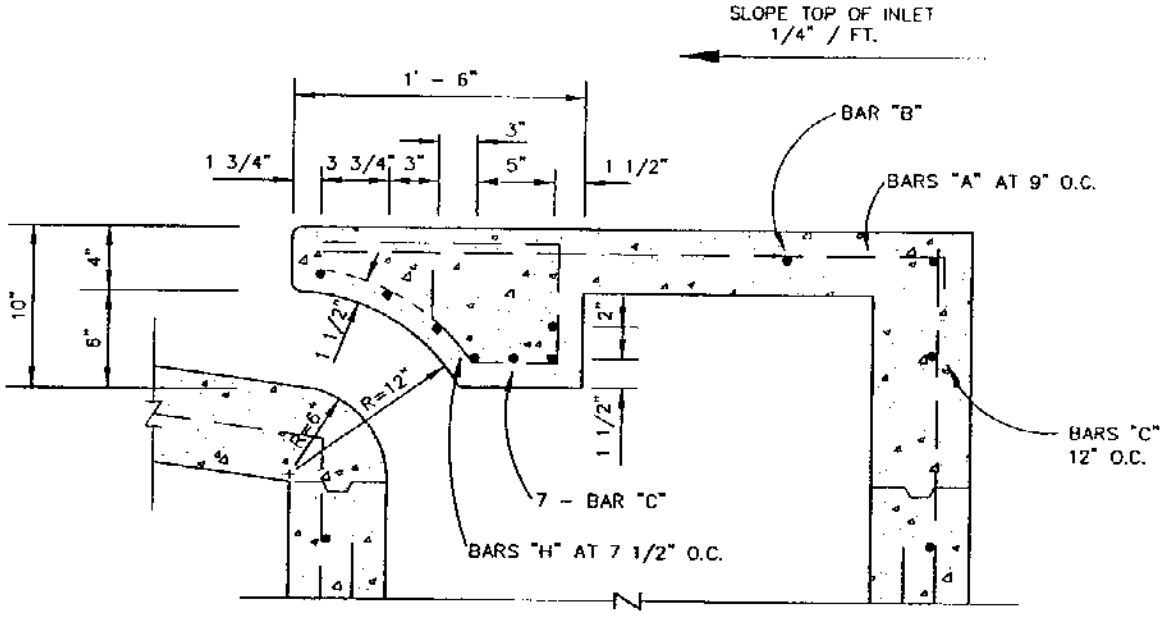
N.T.S.

	STANDARD CURB INLET 4,6,8 and 10 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-008



SECTION B-B

N.T.S.



SECTION C-C

N.T.S.

	STANDARD CURB INLET 4,6,8 & 10 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D09

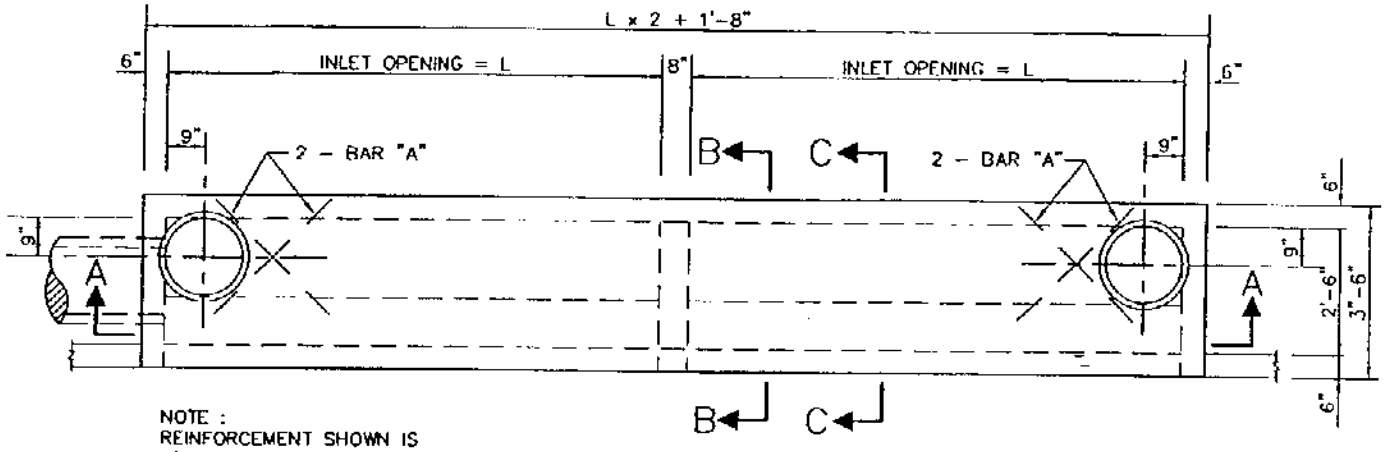
REINFORCING STEEL SCHEDULE

DIMENSIONS SHOWN ARE FOR MAXIMUM SIZE INLET

INLET LENGTH	BAR TYPE	BAR DIA. (1/8")	NO. REQ'D.	BAR DIMENSIONS		
				A	B	C
4'	A	3	6	3'-2"	0'-3"	–
	B	3	1	2'-10"	–	–
	C	4	15	4'-8"	0'-6"	–
	D	4	5	4'-8"	–	–
	F	4	1	3'-2"	–	–
	G	3	5	2'-0"	1'-3"	–
	H	3	3	*	*	*
	N	3	3	3'-2"	3'-2"	3'-2"
6'	A	3	9	3'-2"	0'-3"	–
	B	3	1	4'-10"	–	–
	C	4	15	6'-8"	0'-6"	–
	D	4	5	4'-8"	–	–
	F	4	1	3'-2"	–	–
	G	3	5	2'-0"	1'-3"	–
	H	3	3	*	*	*
	N	3	3	3'-2"	3'-2"	3'-2"
8'	A	3	12	3'-2"	0'-3"	–
	B	3	1	6'-10"	–	–
	C	4	15	8'-8"	0'-6"	–
	D	4	5	4'-8"	–	–
	F	4	1	3'-2"	–	–
	G	3	5	2'-0"	1'-3"	–
	H	3	4	*	*	*
	N	3	3	3'-2"	3'-2"	3'-2"
8'	A	3	10	3'-2"	0'-3"	–
	B	3	2	8'-10"	–	–
	C	4	16	10'-8"	0'-6"	–
	D	4	4	4'-8"	–	–
	E	5	6	10'-8"	–	–
	G	3	5	2'-0"	1'-3"	–
	H	3	15	*	*	*
	I	4	8	4'-8"	3'-2"	3'-2"
	L	4	5	4'-3"	–	–

* SEE DIAGRAM FOR DIMENSIONS

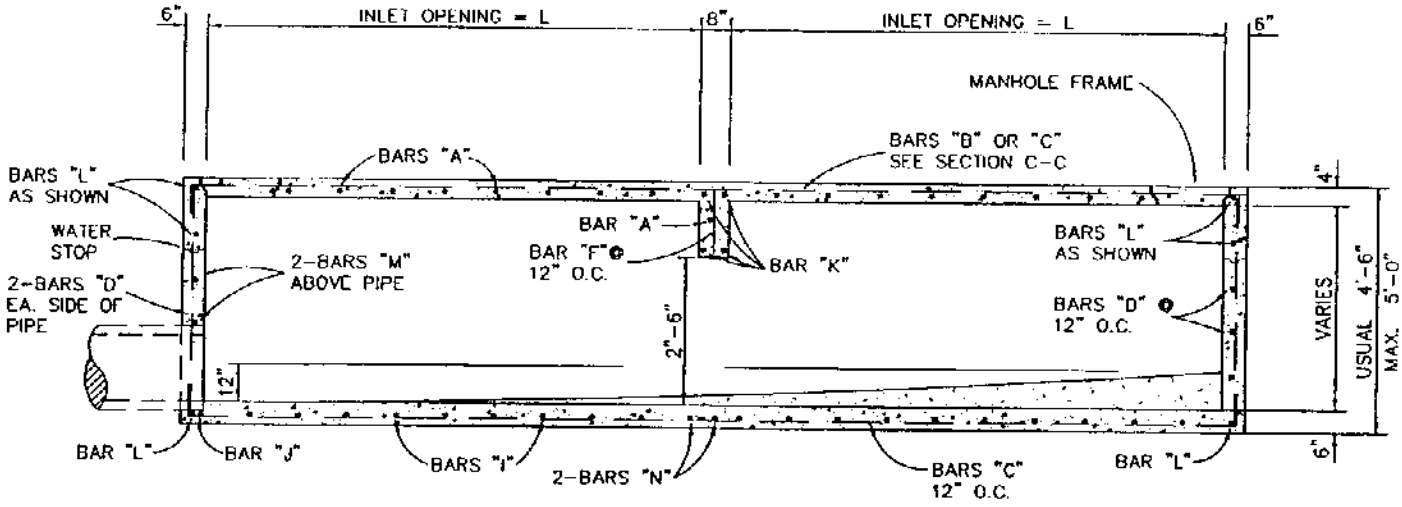
REINFORCING STEEL SCHEDULE 4, 6, 8, & 10 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
	DATE: 1999	SHEET: SD-D10



NOTE :
REINFORCEMENT SHOWN IS ADDITIONAL FOR SPECIAL CONDITION. FOR REMAINDER OF REINFORCEMENT SEE SECTIONS.

PLAN

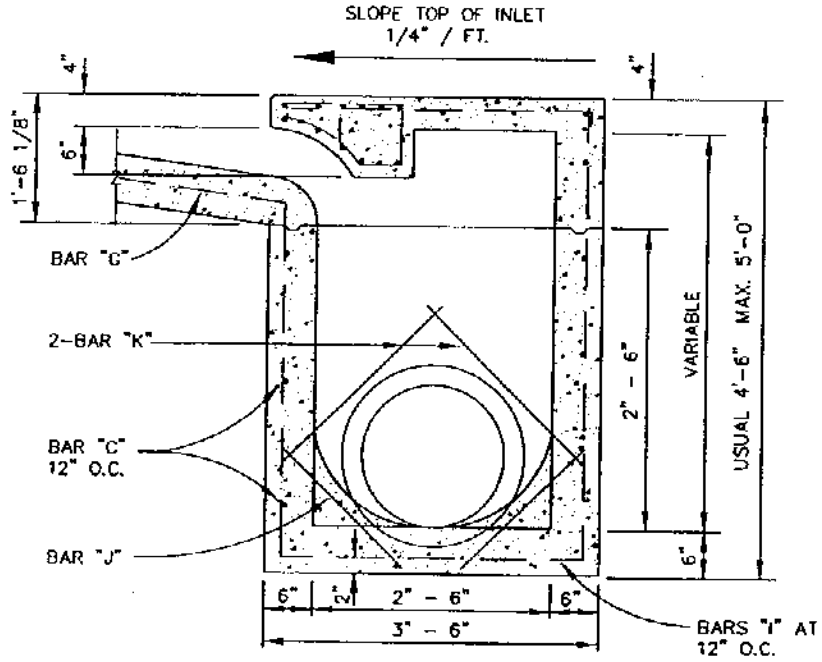
N.T.S.



SECTION A-A

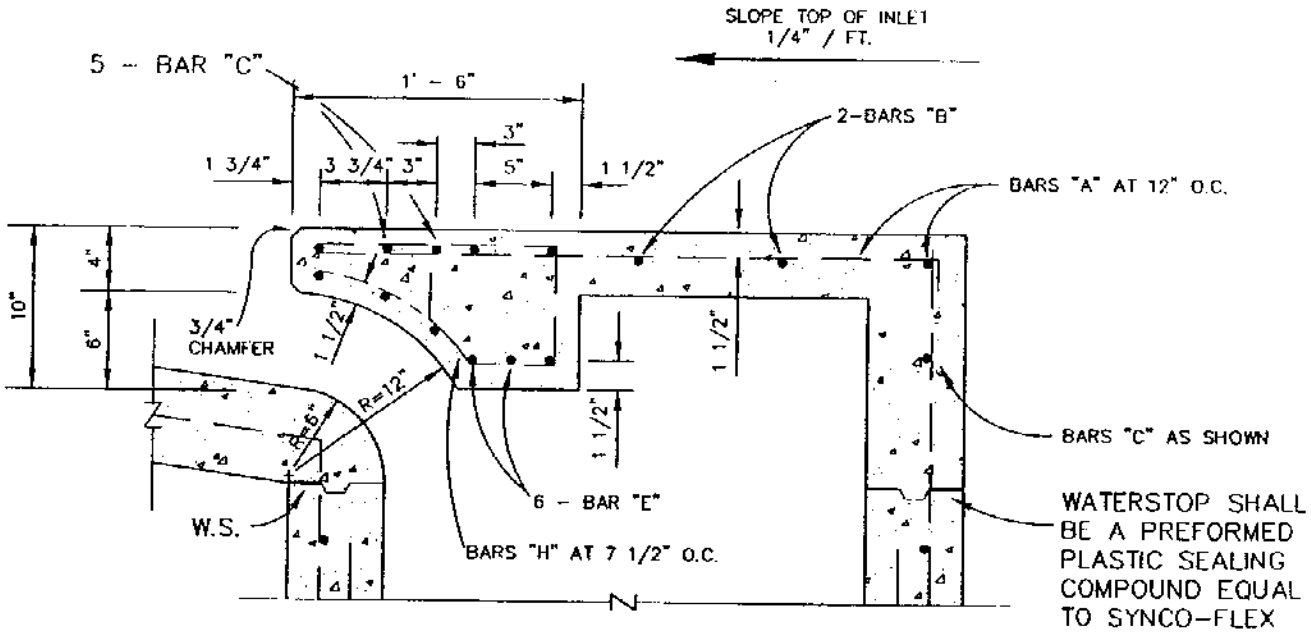
N.T.S.

	12, 14, 16 AND 20 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D11



SECTION B-B

N.T.S.



SECTION C-C

N.T.S.

	CURB INLETS 12, 14, 16, AND 20 FOOT INLETS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D12

REINFORCING STEEL SCHEDULE

DIMENSIONS ARE FOR MAXIMUM SIZE INLETS

INLET LENGTH	BAR TYPE	BAR DIA. (1/8")	NO. REQ'D.	BAR DIMENSIONS			INLET LENGTH	BAR TYPE	BAR DIA. (1/8")	NO. REQ'D.	BAR DIMENSIONS		
				A	B	C					A	B	C
6'	A	3	15	3'-2"	0'-6"	–	8'	A	3	19	3'-2"	0'-6"	–
	B	3	2	11'-6"	–	–		B	3	2	15'-6"	–	–
	C	4	16	13'-4"	0'-6"	–		C	4	16	17'-4"	0'-6"	–
	D	4	9	4'-8"	–	–		D	4	9	4'-8"	–	–
	E	5	6	13'-4"	–	–		E	5	6	17'-4"	–	–
	F	4	5	1'-2"	–	–		F	4	5	1'-2"	–	–
	G	3	12	2'-0"	1'-3"	–		G	3	12	2'-0"	1'-3"	–
	H	3	26	*	*	*		H	3	26	*	*	*
	I	4	12	4'-8"	3'-2"	3'-2"		I	4	16	4'-8"	3'-2"	3'-2"
	J	5	1	*	*	*		J	5	1	*	*	*
	K	5	6	3'-2"	0'-6"	–		K	5	6	3'-2"	0'-6"	–
	L	4	11	3'-2"	0'-6"	–		L	4	11	3'-2"	0'-6"	–
	M	4	2	3'-0"**	–	–		M	4	2	3'-0"**	–	–
	N	4	2	4'-8"	3'-2"	4'-8"		N	4	2	4'-8"	3'-2"	4'-8"
7'	A	3	17	3'-2"	0'-6"	–	10'	A	3	23	3'-2"	0'-6"	–
	B	3	2	13'-6"	–	–		B	3	2	19'-6"	–	–
	C	4	16	15'-4"	0'-6"	–		C	4	15	21'-4"	0'-6"	–
	D	4	9	4'-8"	–	–		D	4	9	4'-8"	–	–
	E	5	6	15'-4"	–	–		E	5	6	21'-4"	–	–
	F	4	5	1'-2"	–	–		F	4	5	1'-2"	–	–
	G	3	15	2'-0"	1'-3"	–		G	3	15	2'-0"	1'-3"	–
	H	3	32	*	*	*		H	3	32	*	*	*
	I	4	14	4'-8"	3'-2"	3'-2"		I	4	20	4'-8"	3'-2"	3'-2"
	J	5	1	*	*	*		J	5	1	*	*	*
	K	5	6	3'-2"	0'-6"	–		K	5	6	3'-2"	0'-6"	–
	L	4	11	3'-2"	0'-6"	–		L	4	11	3'-2"	0'-6"	–
	M	4	2	3'-0"**	–	–		M	4	2	3'-0"**	–	–
	N	4	2	4'-8"	3'-2"	4'-8"		N	4	2	4'-8"	3'-2"	4'-8"

* SEE DIAGRAM FOR DIMENSION

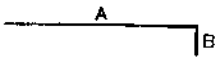
** FIELS CUT AS REQUIRED TO ACCOMMODATE DRAIN PIPE

REINFORCING STEEL SCHEDULE
12, 14, 16, & 20 FOOT INLETS

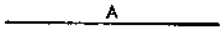
STANDARD CONSTRUCTION DETAILS
STORM DRAINAGE

DATE: 1999

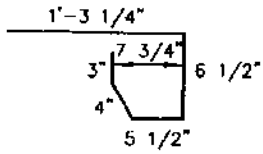
SHEET: SD-013



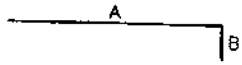
BAR A



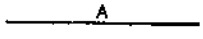
BAR E



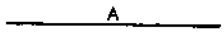
BAR H



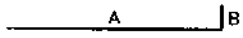
BAR J



BAR B

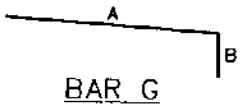


BAR F

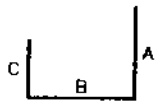


BAR K

BAR C & L



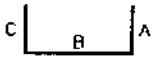
BAR G



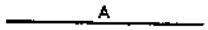
BAR I & N

BAR D

BAR L



BAR N

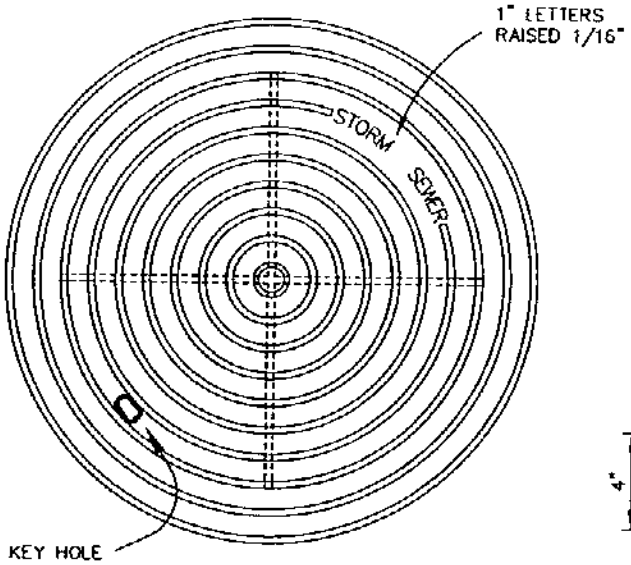


BAR M

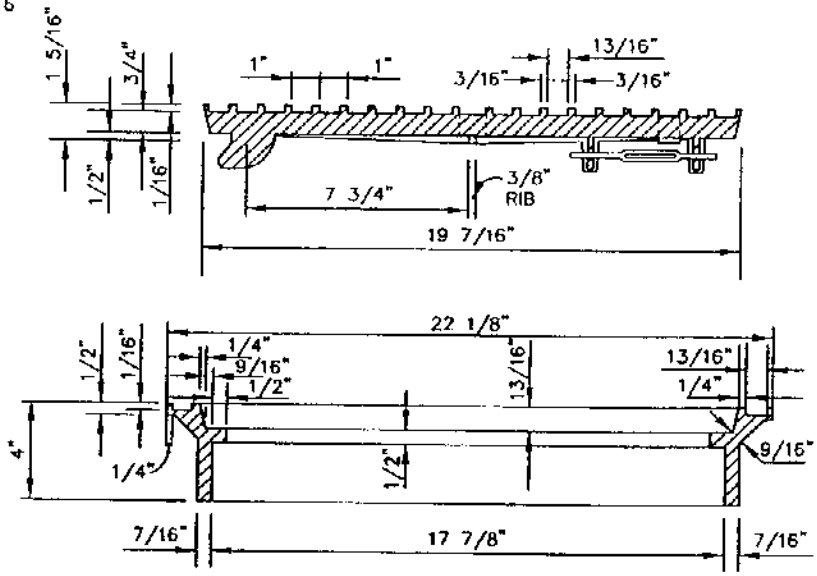
BAR J

BAR DIAGRAMS

N.T.S.



PLAN OF FRAME

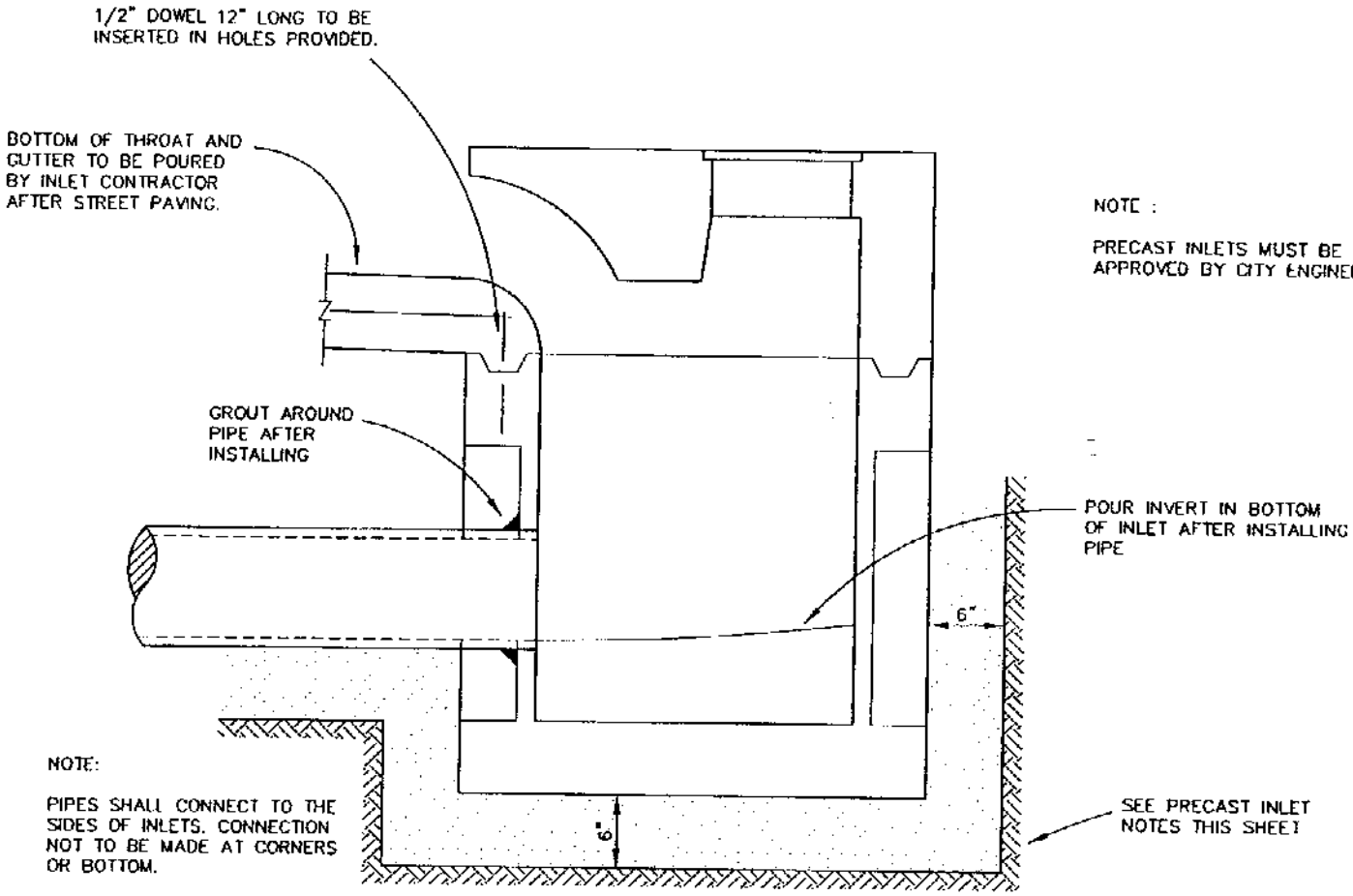


SECTION OF FRAME AND COVER

INLET FRAME AND COVER

N.T.S.

	BAR DIAGRAMS INLET FRAME & COVER	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D14



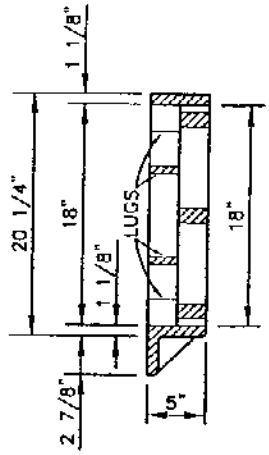
INSTALLATION DRAWING FOR PRECAST 5' AND 10' CURB INLETS

N.T.S.

NOTES FOR PRECAST INLET :

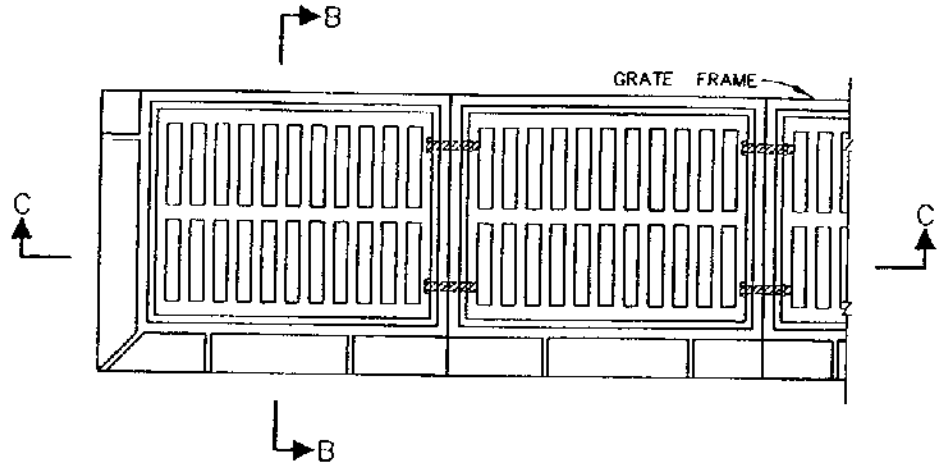
1. THE FLOOR OF THE EXCAVATION MUST PROVIDE A FIRM, LEVEL BED FOR THE BASE SECTION TO REST UPON.
2. A MINIMUM OF 6" OF 1"DIAMETER (MAX.) ROCK OR GRAVEL SHALL BE USED TO PREPARE THE BEDDING TO FINAL GRADE OR IN LIEU OF THIS, THAT AT LEAST 6" OF 2 SACK CEMENT STABILIZED SAND BE USED TO PREPARE THE BEDDING TO GRADE. CEMENT STABILIZED SAND TO BE ALLOWED TO SET BY KEEPING HOLE PUMPED DRY.
3. AFTER CASTING HAS BEEN INSTALLED ON THE PROPER BEDDING, THE BACKFILL MATERIAL, WHICH IS FREE FLOWING AND CLEAR OF ROCKS IN EXCESS OF 4" DIAMETER AND OTHER LUMPS WHICH WOULD PROHIBIT PROPER COMPACTION, SHALL BE COMMENCED IN LIFTS OF NO MORE THAN 18". THE MATERIAL USED FOR BACKFILL SHOULD BE OF A TYPE SUITABLE TO OBTAIN THE DENSITY REQUIREMENTS FOR THE SPECIFIC JOB.

	PRECAST CURB INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD--015



SECTION B–B

N.T.S.

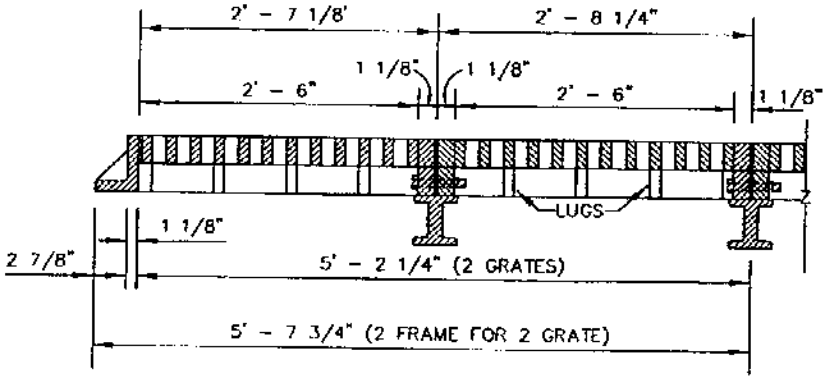


PLAN VIEW – GRATE

N.T.S.

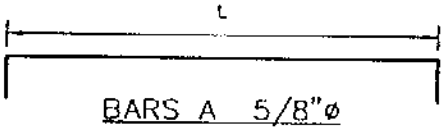
NOTES :

1. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
2. TACK WELD GRATES IN PLACE.
3. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.



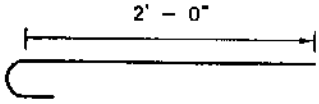
SECTION C–C

N.T.S.

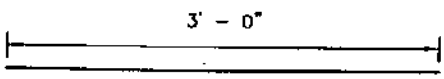


BARS A 5/8"ø

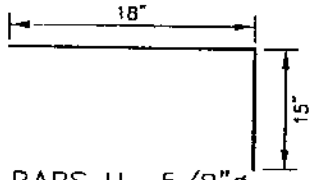
TWO GRATE INLET , L=5'–10 1/4"
THREE GRATE INLET , L=8'–6 1/2"
FOUR GRATE INLET , L=11'–2 3/4"



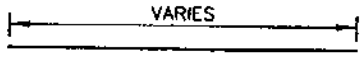
BARS B 5/8"ø



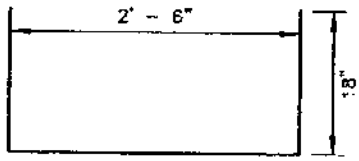
BARS C 3/8"ø



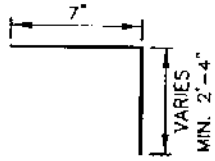
BARS H 5/8"ø



BARS I 4/8"ø



BARS J 4/8"ø

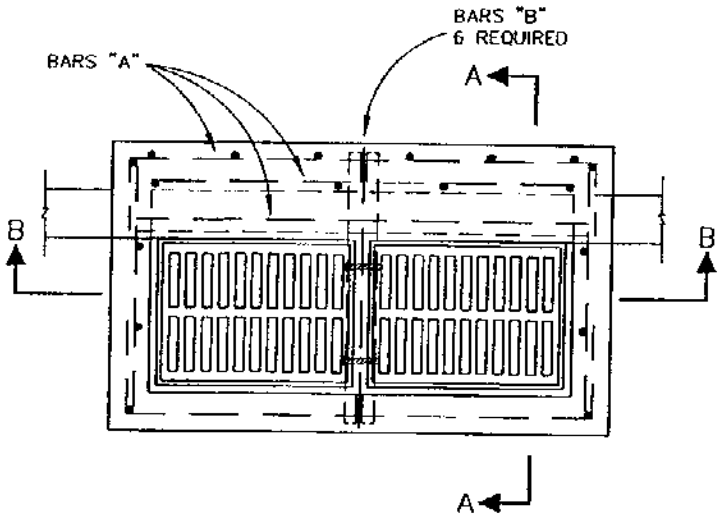


BARS K 4/8"ø

NOTE :

GRATE AND FRAME SHALL BE PATTERN NO. 814 AS MANUFACTURED BY BASS & HAYES FOUNDRY, INC. OR APPROVED EQUAL.

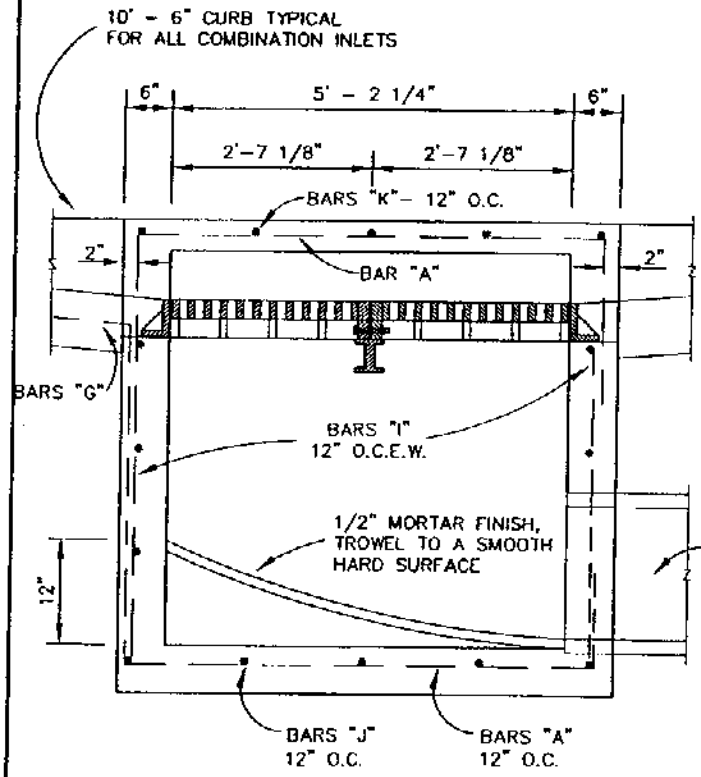
	COMBINATION INLETS GRATE DETAILS BAR DIAGRAMS	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD–016



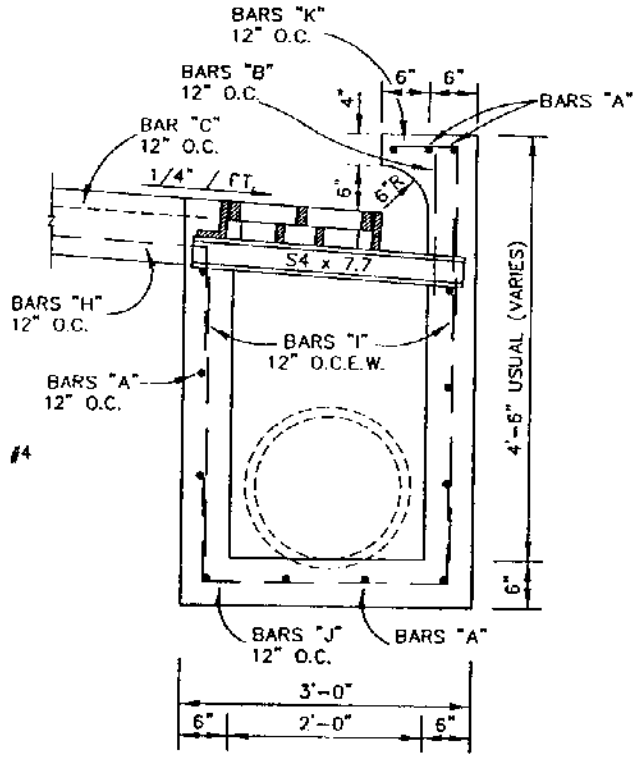
NOTES :

1. COMBINATION INLETS TO BE USED IN ALL ALLEYS WHERE INLETS ARE REQUIRED.
2. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
3. TACK WELD GRATES IN PLACE.
4. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

TWO GRATE INLET
PLAN VIEW
N.T.S.

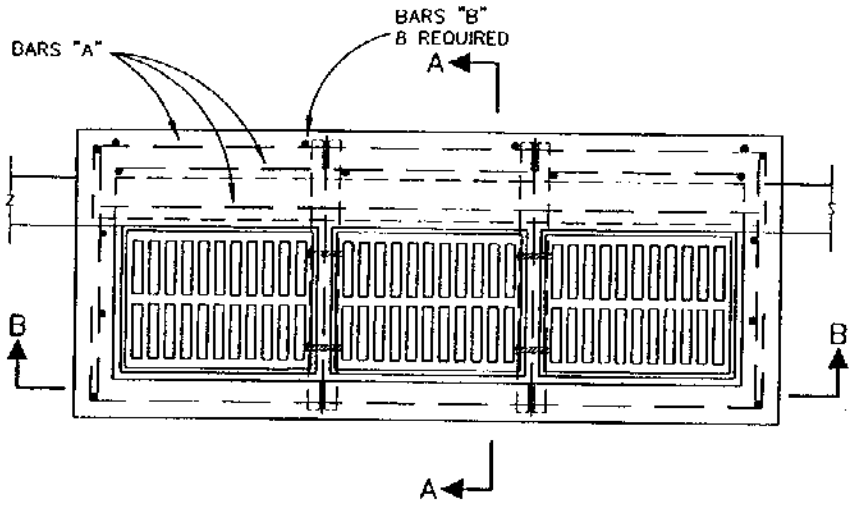


SECTION B-B
N.T.S.

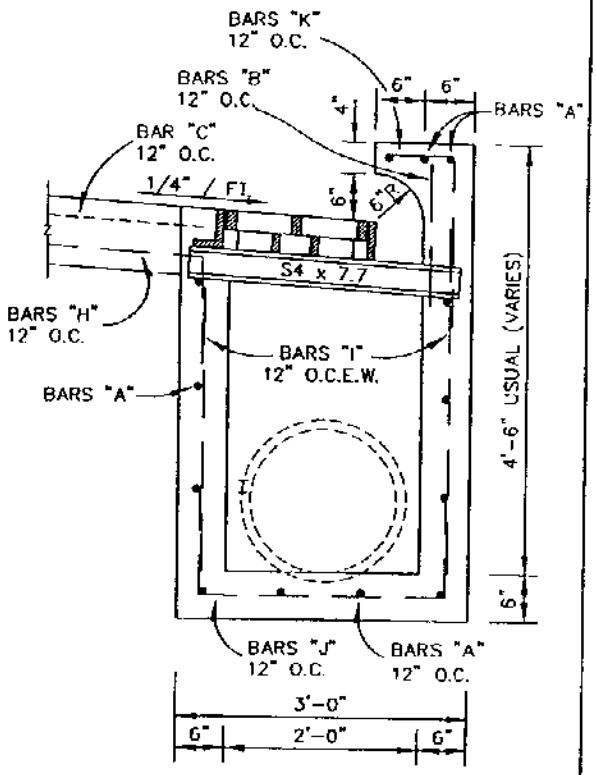


SECTION A-A
N.T.S.

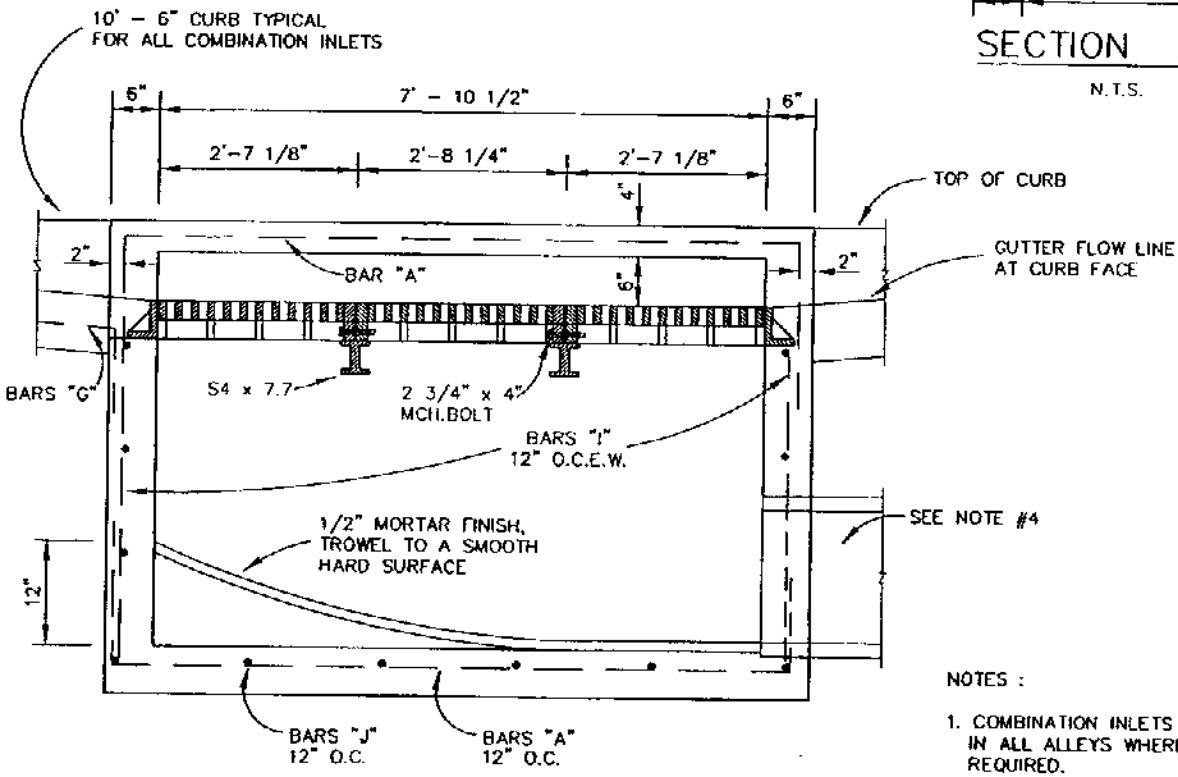
	COMBINATION INLET TWO GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D17



THREE GRATE INLET
PLAN VIEW
N.T.S.



SECTION A-A
N.T.S.

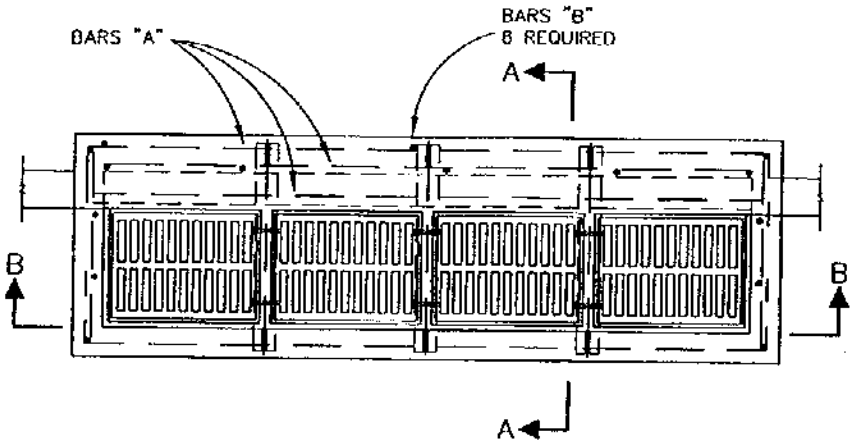


SECTION B-B
N.T.S.

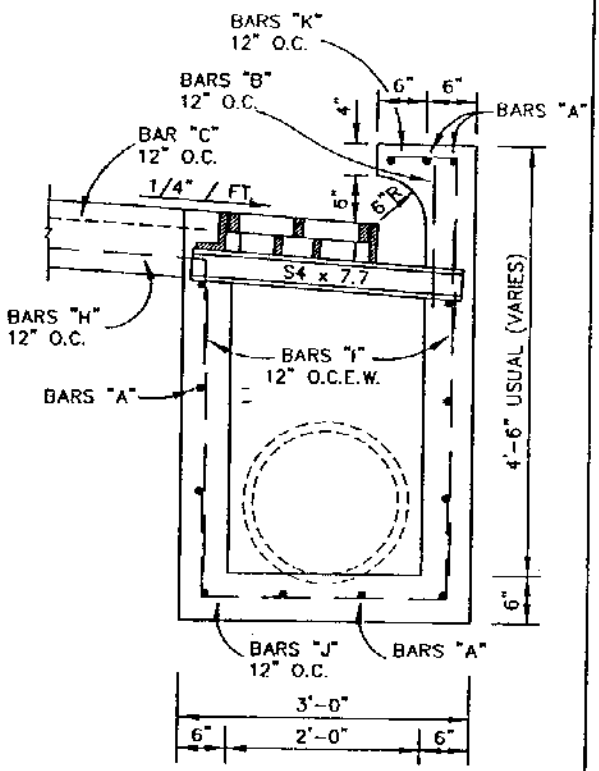
NOTES :

1. COMBINATION INLETS TO BE USED IN ALL ALLEYS WHERE INLETS ARE REQUIRED.
2. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
3. TACK WELD GRATES IN PLACE.
4. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

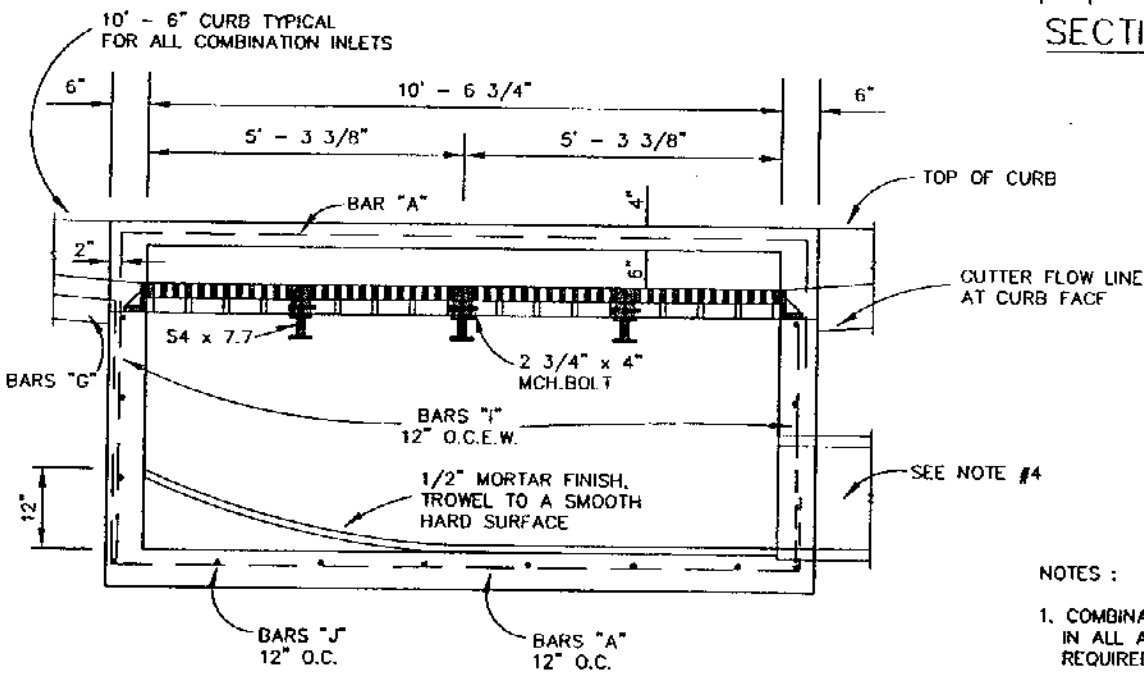
	COMBINATION INLET THREE GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD-D18



FOUR GRATE INLET
PLAN VIEW
N.T.S.



SECTION A–A
N.T.S.

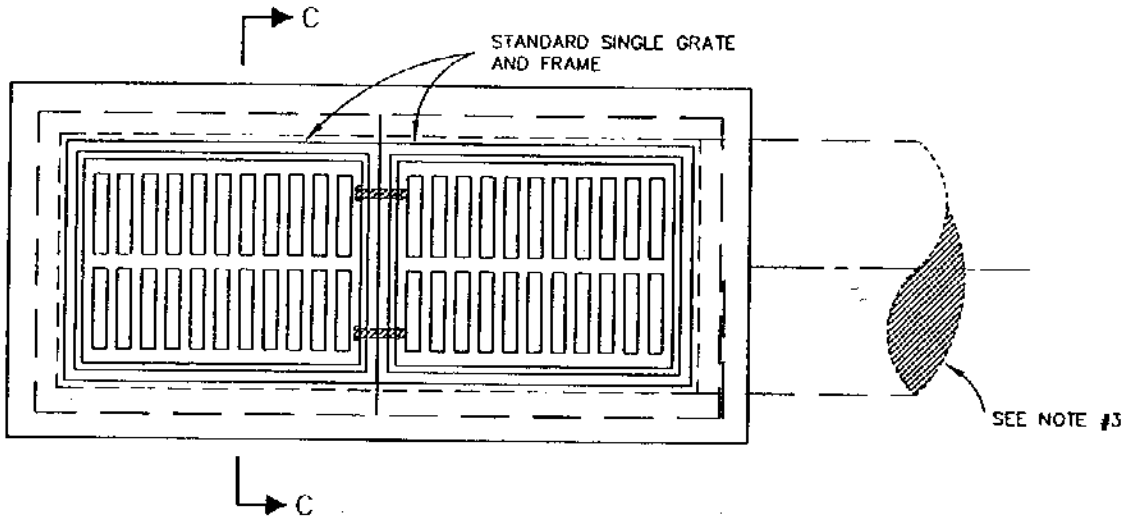


SECTION B–B
N.T.S.

NOTES :

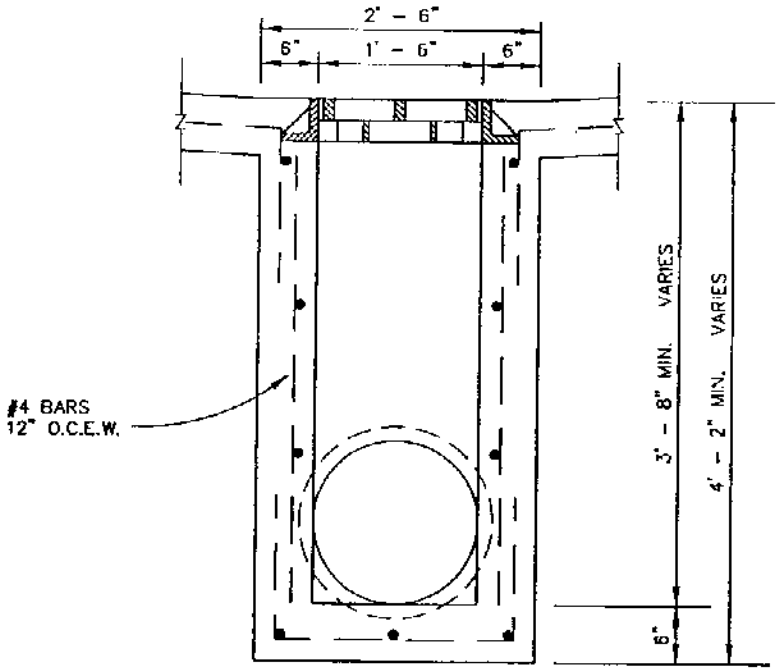
1. COMBINATION INLETS TO BE USED IN ALL ALLEYS WHERE INLETS ARE REQUIRED.
2. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
3. TACK WELD GRATES IN PLACE.
4. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

	COMBINATION INLET FOUR GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD-D19



TWO GRATE INLET

N.T.S.



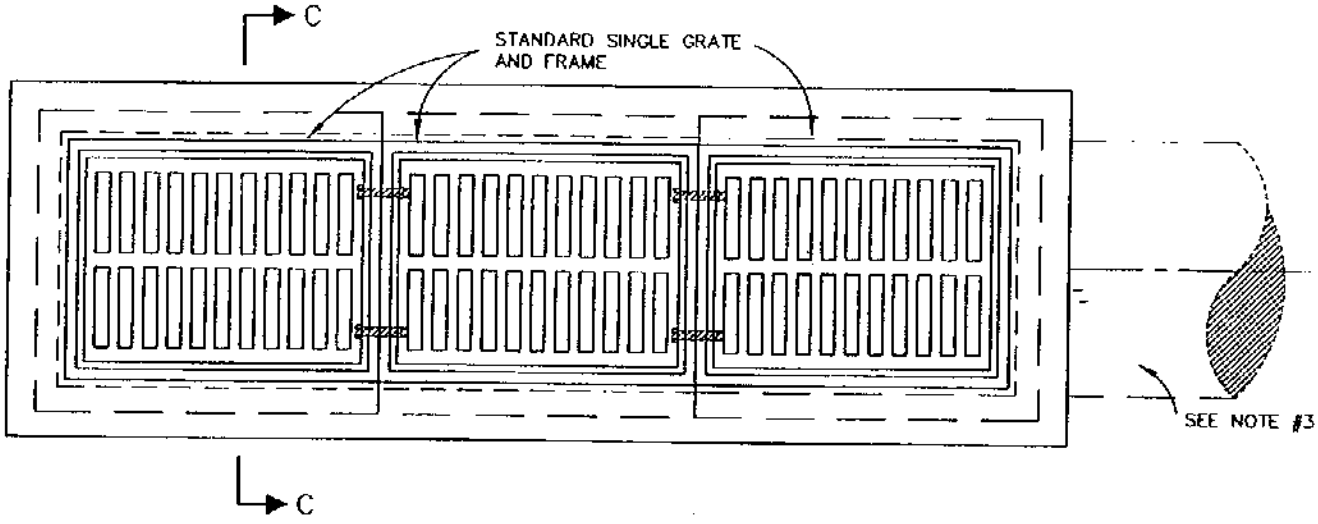
SECTION C-C

N.T.S.

NOTES :

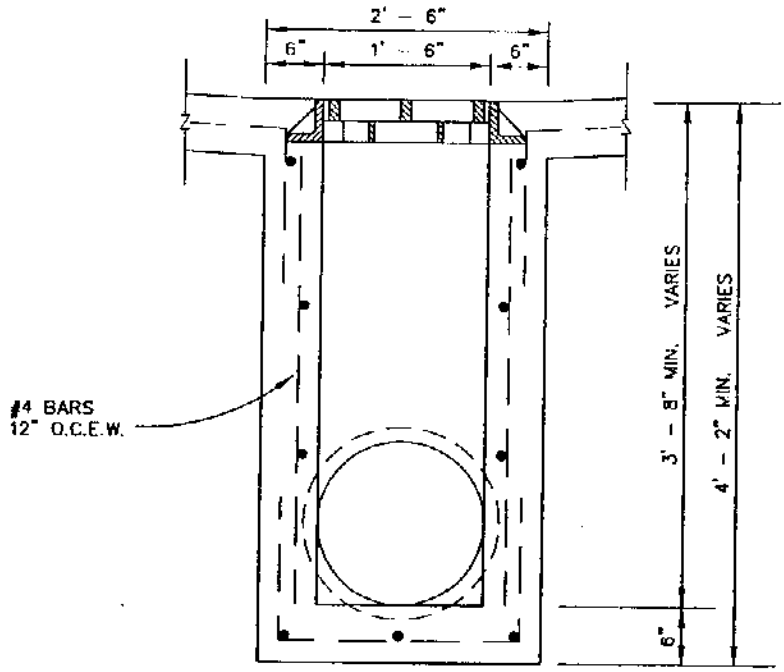
1. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
2. TACK WELD GRATES IN PLACE.
3. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

	TWO GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D20



THREE GRATE INLET

N.T.S.



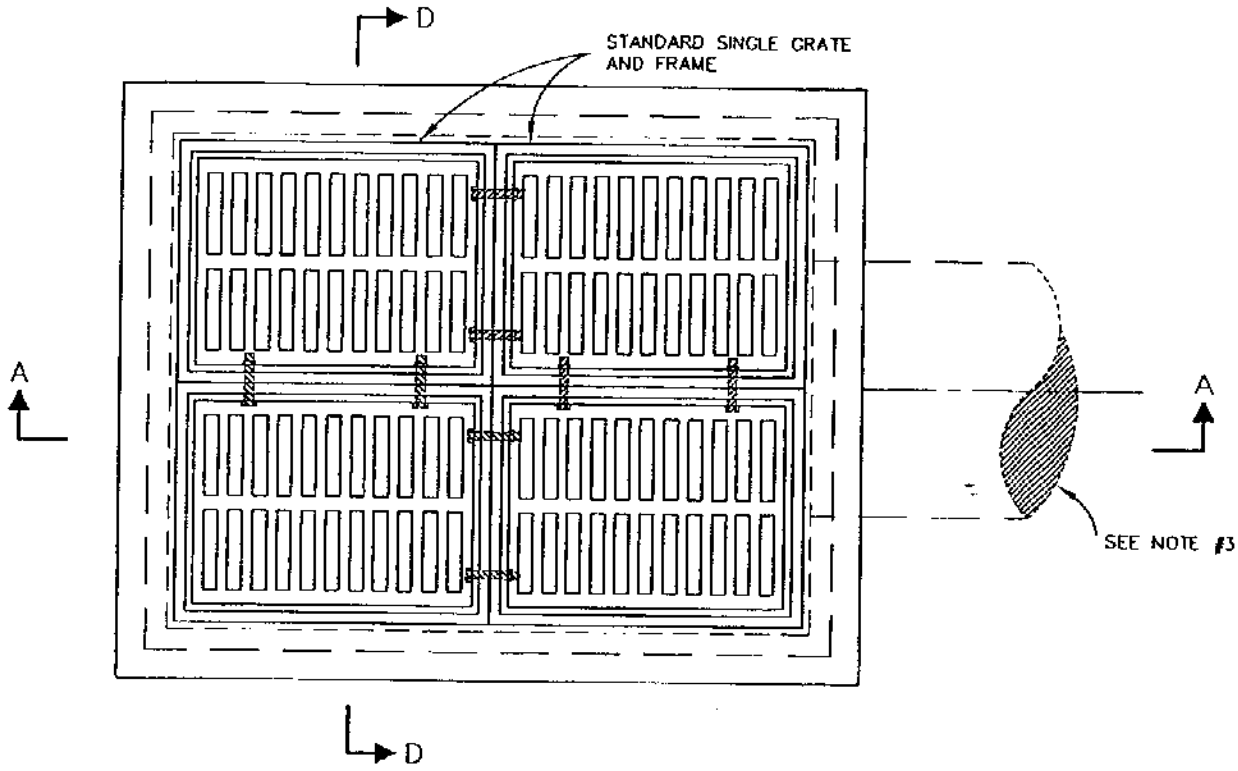
SECTION C-C

N.T.S.

NOTES :

1. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
2. TACK WELD GRATES IN PLACE.
3. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

	THREE GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE
		DATE: 1999 / SHEET: SD-021

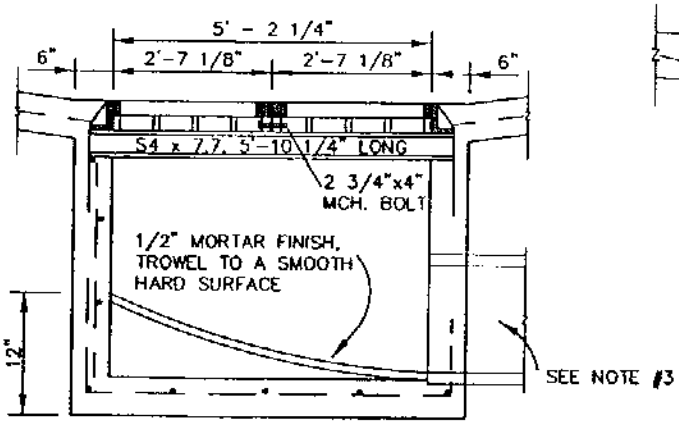


NOTES :

1. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
2. TACK WELD GRATES IN PLACE.
3. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.

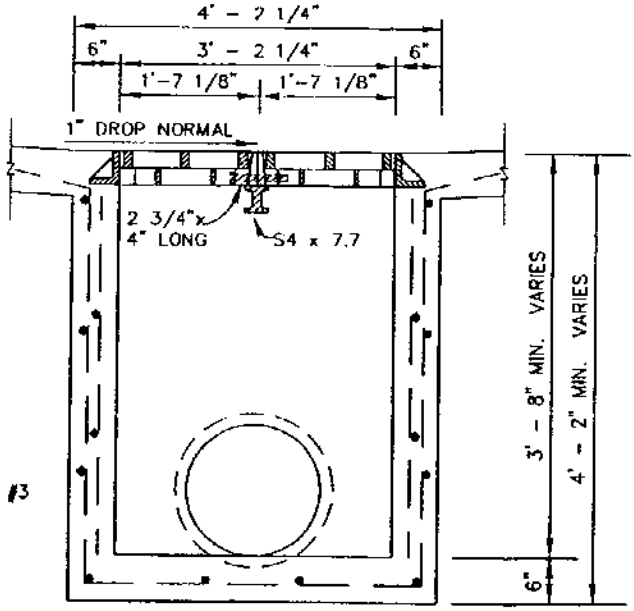
FOUR GRATE INLET

N.T.S.



SECTION A-A

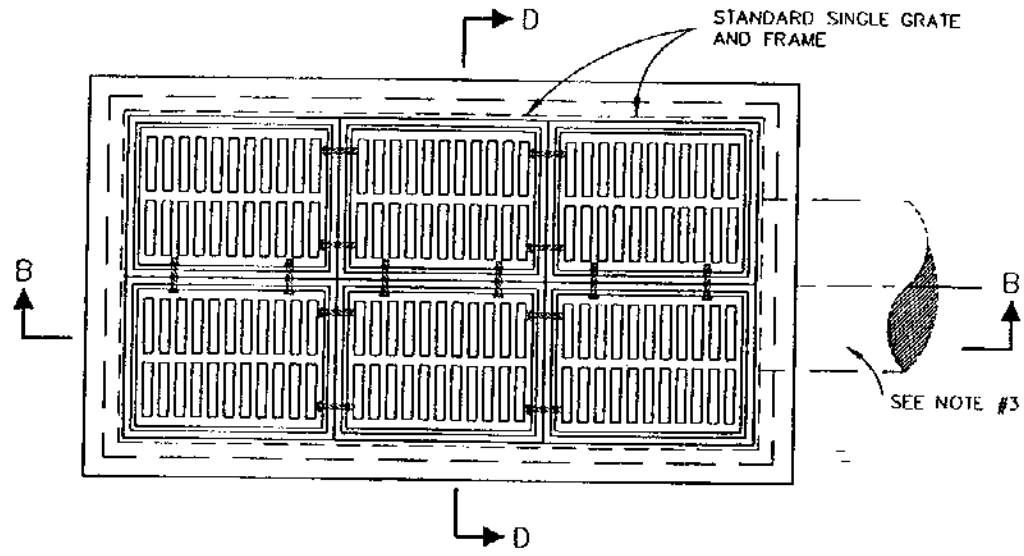
N.T.S.



SECTION D-D

N.T.S.

	FOUR GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-022

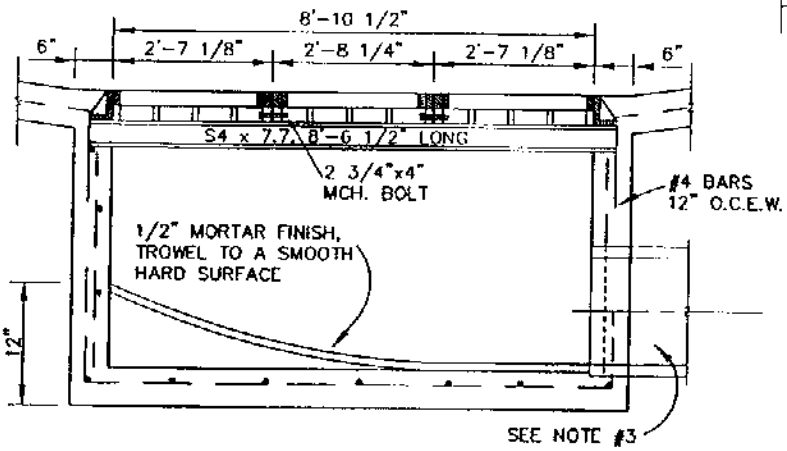


SIX GRATE INLET

N.T.S.

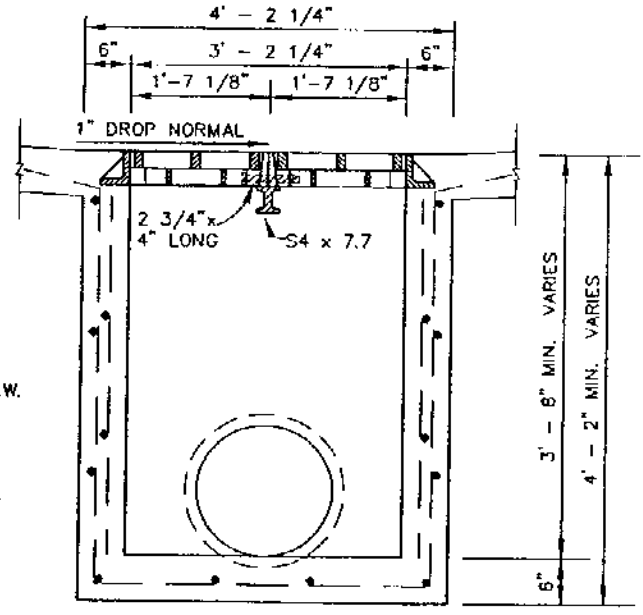
NOTES :

1. ALL LAPS AND EXTENSIONS OF REINFORCING BARS SHALL BE 36 BAR DIAMETERS UNLESS NOTED OTHERWISE.
2. TACK WELD GRATES IN PLACE.
3. PIPE MAY BE PLACED IN ANY WALL, BUT SHALL NOT ENTER ANY CORNER OR BOTTOM.



SECTION A-A

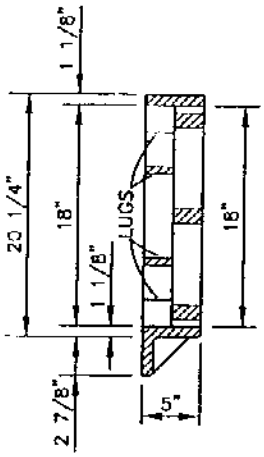
N.T.S.



SECTION D-D

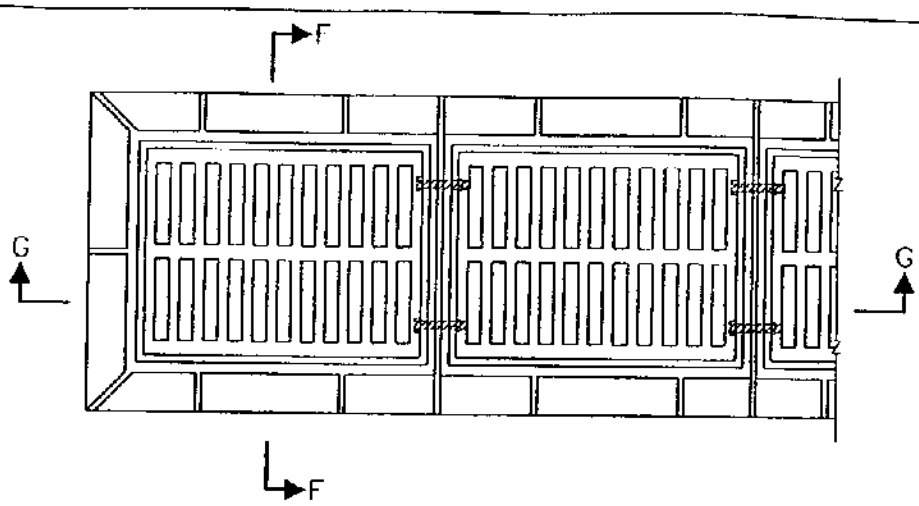
N.T.S.

	SIX GRATE INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D23



SECTION F–F

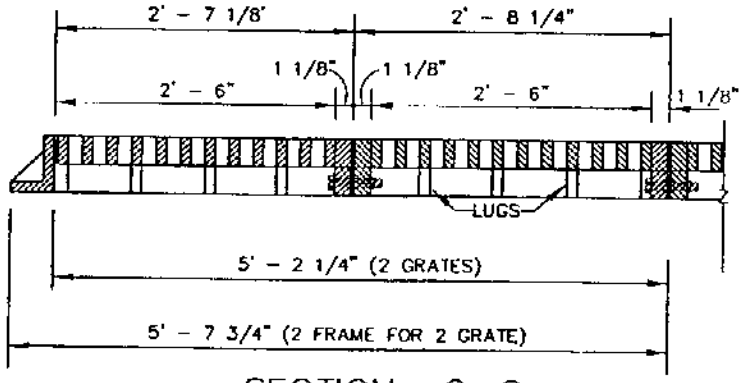
N.T.S.



PLAN VIEW – GRATE

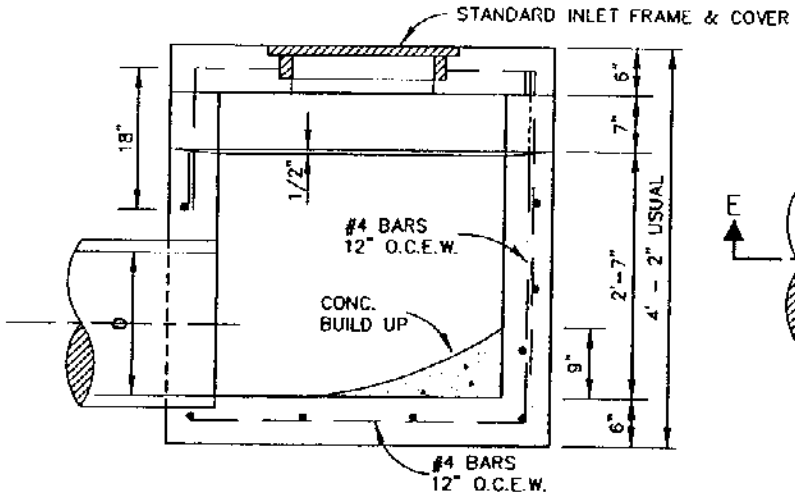
N.T.S.

NOTE :
GRATE AND FRAME SHALL BE PATTERN NO. 814 AS MANUFACTURED BY BASS AND HAYES FOUNDRY, OR APPROVED EQUAL.



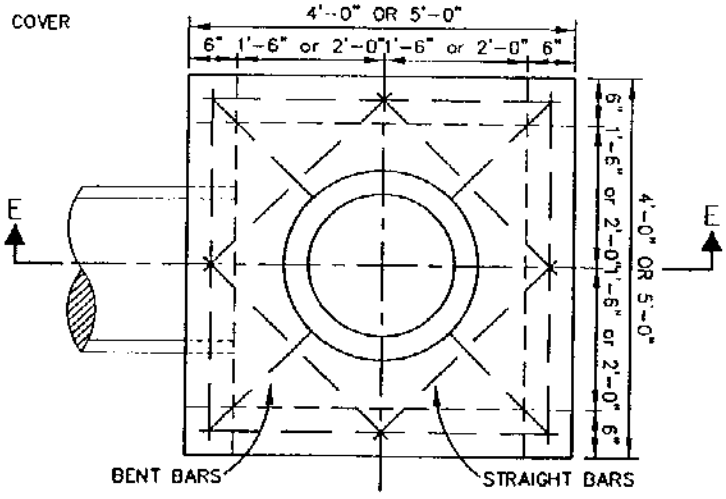
SECTION G–G

N.T.S.



SECTION E–E

N.T.S.

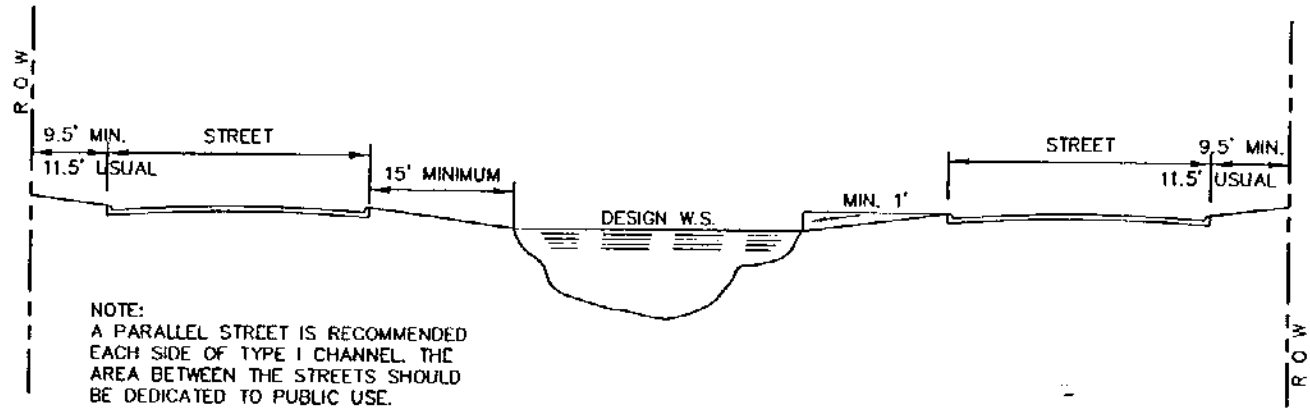


PLAN VIEW

STANDARD DROP INLET

N.T.S.

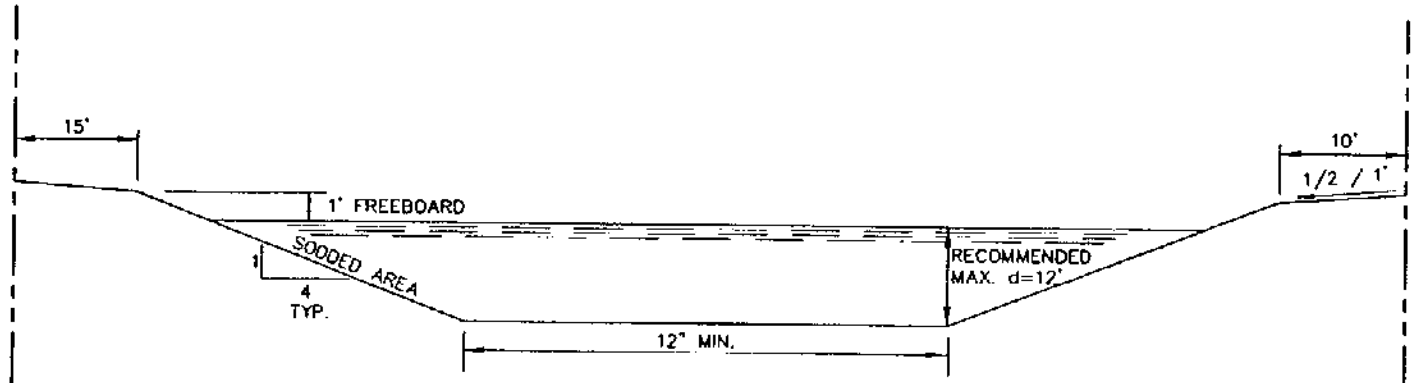
	GRATE DETAILS STANDARD DROP INLET	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-024



NOTE:
A PARALLEL STREET IS RECOMMENDED EACH SIDE OF TYPE I CHANNEL. THE AREA BETWEEN THE STREETS SHOULD BE DEDICATED TO PUBLIC USE.

NATURAL CHANNEL

N.T.S.



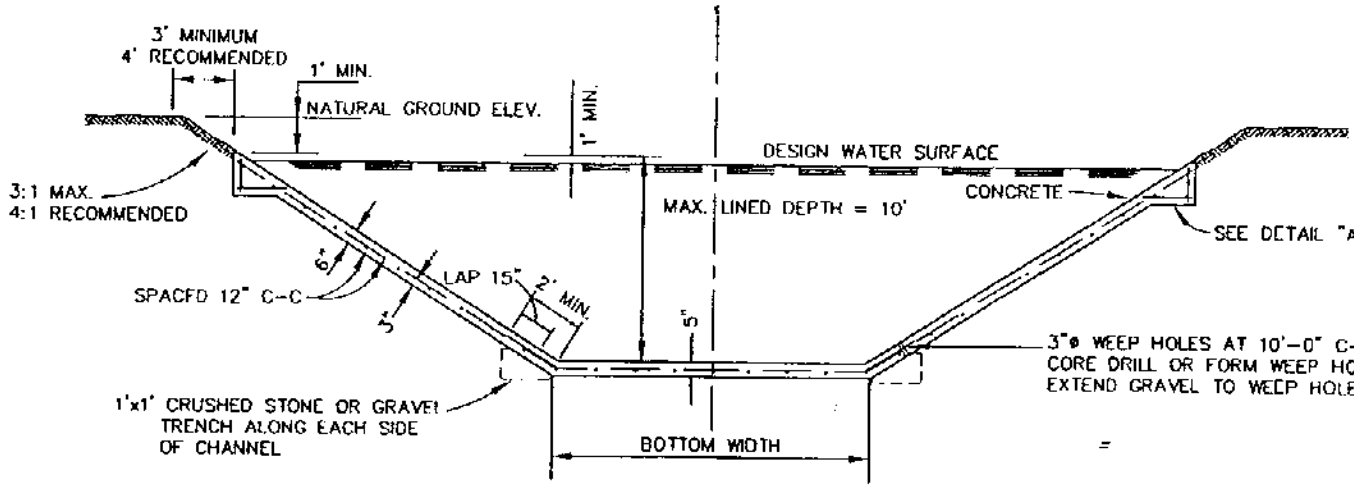
IMPROVED EARTHEN CHANNEL

N.T.S.

GENERAL NOTES FOR OPEN CHANNELS

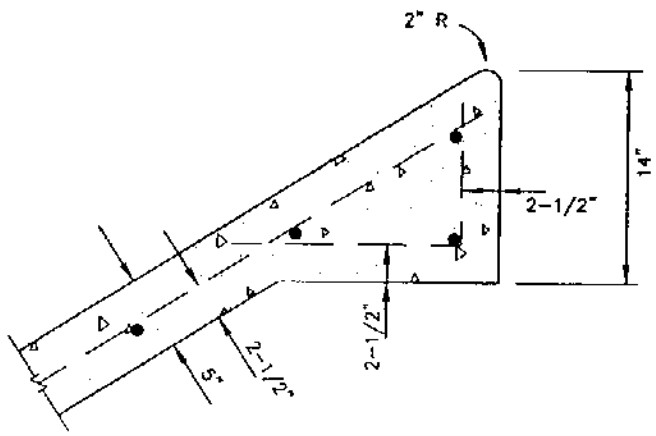
1. NATURAL CHANNEL IS SHOWN FOR LOCATION OF ADJACENT STREETS.
2. GRASS COVER REQUIRED FOR ALL SLOPES

	CHANNEL SECTIONS TYPE III CHANNEL	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-025



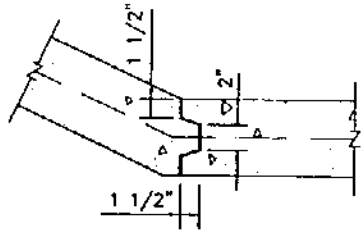
LINED CHANNEL SECTION

N.T.S.



SLAB EDGE – DETAIL "A"

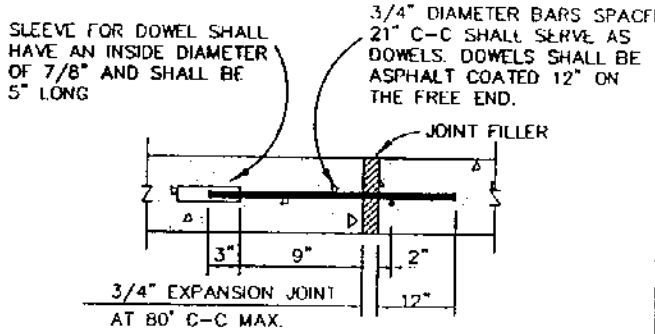
N.T.S.



CONSTRUCTION JOINT

OPTIONAL

N.T.S.

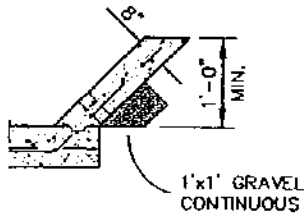


TRANSVERSE EXPANSION JOINT

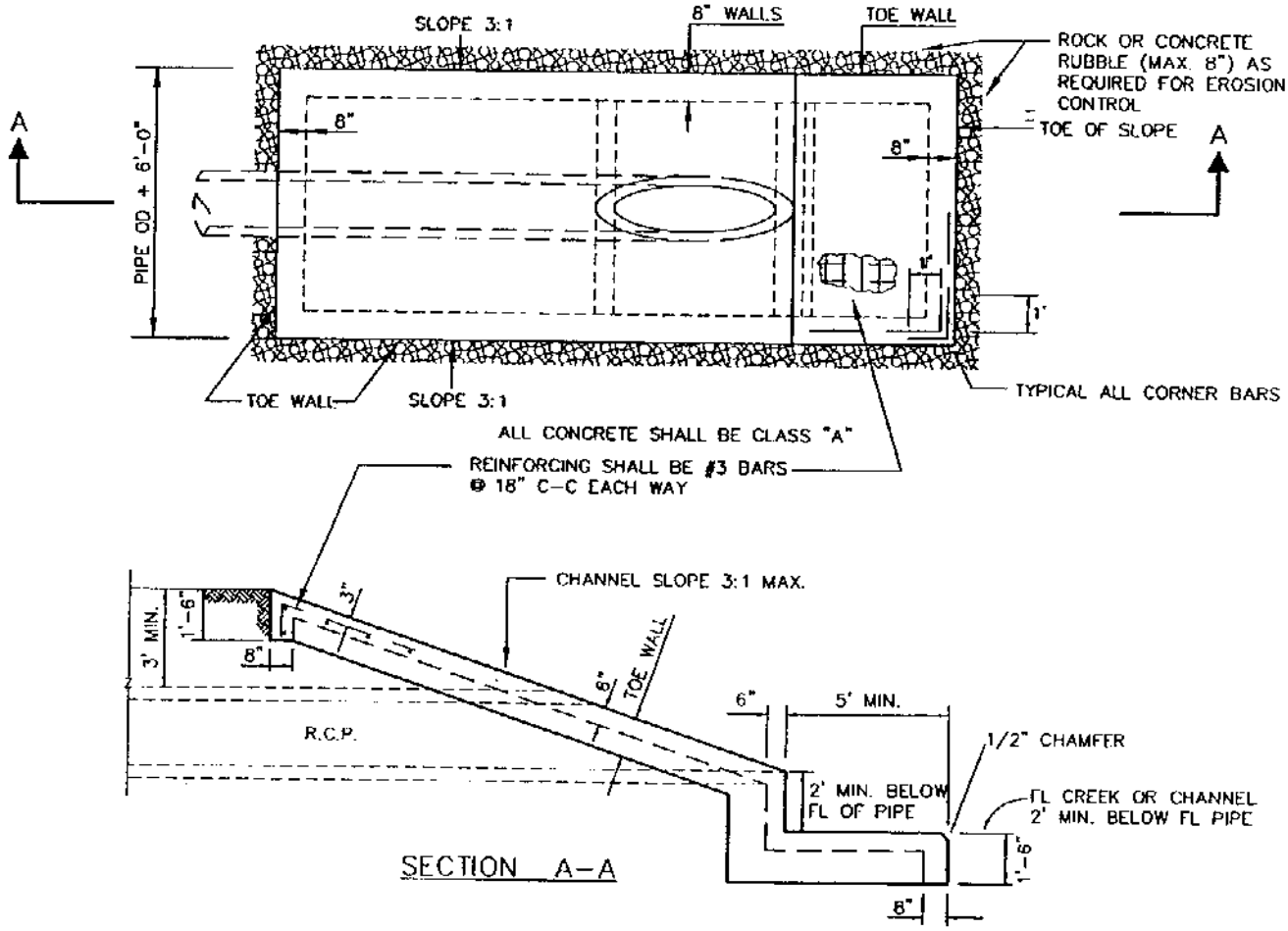
N.T.S.

GENERAL NOTES FOR LINED CHANNELS

1. CONSTRUCTION JOINT SHOWN FOR CONVENIENCE ONLY. MONOLITHIC CONSTRUCTION MAY BE USED.
2. ALL VISIBLE SURFACES SHALL BE A TROWEL FINISH.
3. ALL REINFORCING STEEL SHALL BE 3/8" DIAMETER AND SPACED 12" C to C BOTH WAYS UNLESS OTHERWISE SPECIFIED.
4. IF WOOD FORMS ARE USED WITH CONSTRUCTION JOINT, THEY SHALL BE TWO, 2"x4", AND SHALL NOT BE REMOVED UNTIL CONCRETE ON SLOPES IS READY TO BE PLACED.
5. ALL CONCRETE IN LINED CHANNEL SHALL BE CLASS "A".
6. 3/4" CHAMFER ON ALL CONCRETE CORNERS.



	TYPE C HEADWALL	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D26

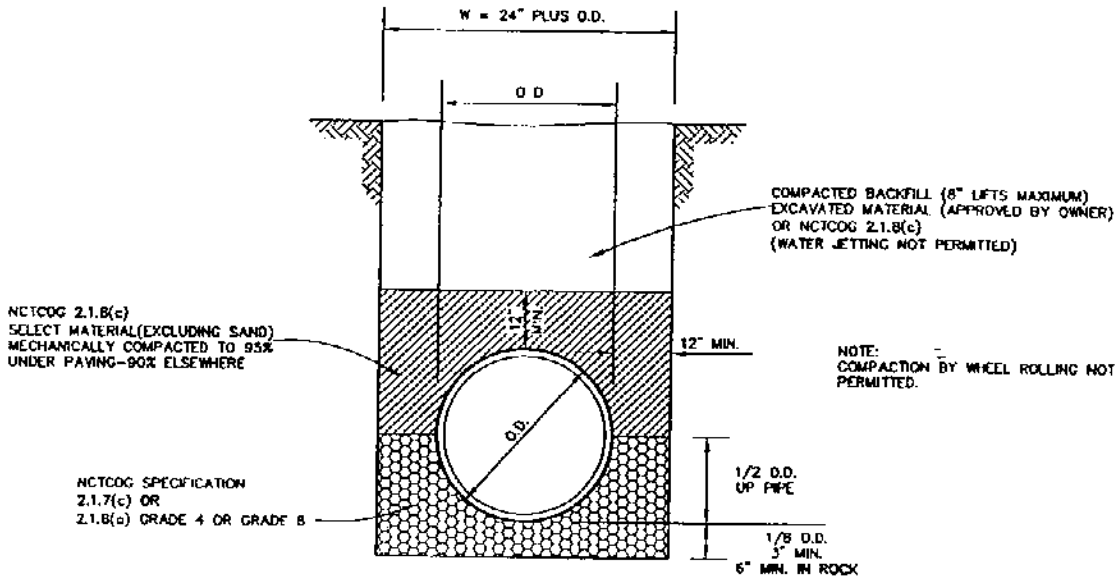


SECTION A-A

TYPE C HEADWALL

N.T.S.

	TYPE C HEADWALL	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D27



STORM SEWER PIPE BEDDING & BACKFILL

N.T.S.

NOTE :
DEPTH OF TRENCH BELOW PIPE
3" MIN. FOR 27" PIPE & SMALLER
4" MIN. FOR 30" TO 54" PIPE
6" MIN. FOR 60" PIPE & LARGER

	STORM SEWER PIPE BEDDING & BACKFILL	STANDARD CONSTRUCTION DETAILS STORM DRAINAGE	
		DATE: 1999	SHEET: SD-D28

Water & Sewer

SECTION "A" - WATER MAINS

In general, water mains are placed on the north and west side of a street, at a distance of five feet behind the curb of the street, or otherwise, as directed by the City Engineer. Where applicable, line sizes will comply with the Water System Master Plan with latest revisions.

1. In residential developments, minimum 8-inch mains will be required. For mains over 600 feet in length in commercial and manufacturing districts, 12-inch pipe may be required.

2. Dead end mains shall be 8-inch minimum and shall not exceed 600 feet in length, and a water meter service in a double lock meter box will be required, at the end of the main.

3. In non-residential developments, minimum 8-inch mains will be required. Water mains must be of adequate size to provide for the building total fire flow.

4. No water main shall be located nearer than five feet from any tree or structure.

5. Water Main Material:
   A. All water mains 12-inch in diameter and under shall be AWWA C110 or C111 ductile iron or AWWA C900 PVC, mechanical joint, or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Joint material for PVC shall conform to ASTM F477.
   B. All water mains 14-inch in diameter and larger shall be AWWA C110 or C111 ductile iron or AWWA C905 PVC, mechanical joint, or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Profile elevations shall be provided for mains 14-inch in diameter and larger.
   C. All mains supplying fire sprinkler systems outside of utility easements shall be minimum 200 PSI working pressure and U.L. listed.
   D. Ductile iron pipe shall be required for unstable soil conditions for bores without encasement pipe, in or near creeks, or for covers less then recommended.
   E. Each pipe material shall be constructed with the proper backfill material as shown on the Standard Construction Details.

6. Valves 12 inches and under shall be placed on or near street property lines not over 800 feet apart in residential, duplex, or apartment districts and not over 500 feet apart in all other districts; and in such a manner as to require preferably two, but not more than three valves to shut down each City block, or as may be required to prevent shutting off more than one fire hydrant. On cross-feed mains without services, a maximum of four valves shall be used to shut down each block. Also, valves shall be placed at or near the ends of mains in such manner that a shut down can be made for future main extension without causing loss of service on the existing main. The location of valves larger than 12 inches will be as approved by the Engineering Department. Valves 12 inches and under will be Resilient Seat Gate Valves (RSGV). Valves over 12 inches will be Butterfly Valves.

7. Fire Hydrants

Section 1 - Number and Locations

The sufficient number of fire hydrants shall be installed to provide hose stream protection for every point on the exterior wall of the building with the lengths of hose normally attached to the hydrants. There shall be sufficient hydrants to concentrate the required fire flow, as recommended by the publication "GUIDE FOR DETERMINATION OF REQUIRED FIRE FLOW" published by the Insurance Service Office, around any building with no hose line exceeding the distances hereinafter established and with an adequate flow available from the water system to meet this required flow. In addition, the following guidelines shall be met or exceeded:

A. SINGLE FAMILY AND DUPLEX RESIDENTIAL - As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 500 feet between fire hydrants as measured along the route that fire hose is laid by a fire vehicle.

B. MULTI-FAMILY RESIDENTIAL - As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 400 feet as measured along the length of the centerline of the roadway, and the front of any structure at grade shall be no further than 500 feet from a minimum of two fire hydrants as measured along the route that a fire hose is laid by a fire vehicle.

C. OTHER DISTRICTS - As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of 300 feet as measured along the length of the centerline of the roadway, and the front of any building at grade shall be no farther than 300 feet from a minimum of two fire hydrants as measured along the route that the fire hose is laid by a fire vehicle.

D. PROTECTED PROPERTIES - Fire hydrants required to provide a supplemental water supply for automatic fire protection systems shall be within 100 feet of the Fire Department connection for such system.

E. BUILDINGS FIRE SPRINKLED - An 8-inch fire line stub-out with valve shall be provided for all buildings to be sprinkled. A smaller stub-out can only be used with Engineering and Fire Department approvals.

F. Fire hydrants shall be installed along all fire lane areas as follows:

(1) Non-Residential Property or Use

(a) Within 150 feet of the main entrance.

(b) Within 100 feet of any **Fire Department** connection.

(c) At a maximum intermediate spacing of 300 feet as measured along the length of the fire lane.

(2) Apartment, Townhouse, or Cluster Residential Property or Use

(a) Within 100 feet of any Fire Department connection.

(b) At maximum intermediate spacing of 400 feet as measured along the length of the fire lane.

G. Generally, no fire hydrant shall be located closer than fifty (50) feet to a non-residential building or structure unless approved by the Engineering and **Fire Departments.**

H. In instances where access between the fire hydrant and the building which it is intended to serve may be blocked, extra fire hydrants shall be provided to improve the fire protection. Railroads, divided thoroughfares, expressways, blocks which are subject to buildings restricting movement, and other man-made or natural obstacles are considered as barriers.

Section 2 - Restrictions

A. All required fire hydrants shall be of the national standard three (3) way break-away type no less than five and one-fourth (5-1/4) inches in size and shall conform to the provisions of the latest A.W.W.A. specifications C-502 and shall be placed upon water mains of no less than six (6) inches in size. Fire hydrants shall be as specified in the Specifications and/or Special Provisions. Fire hydrants shall have a bury depth of five feet.

B. Valves shall be placed on all fire hydrants leads.

C. Required fire hydrants shall be installed so the break away point will be no less than two (2) inches, and no greater than six (6) inches above the grade surface.

D. Fire hydrants shall be located a minimum of two (2) feet and a maximum of six (6) feet behind the curb line, based on the location of the sidewalk. The fire hydrant shall not be in the sidewalk.

E. All required fire hydrants placed on private property shall be adequately protected by either curb stops or concrete posts or other methods as approved by the Engineering and **Fire Departments** and shall be in easements. Such stops or posts to be the responsibility of the landowner on which the said fire hydrant is placed.

F. All required fire hydrants shall be installed so that the steamer connection will face the fire lane or street, or as directed by the **Fire Department**.

G. Fire hydrants, when placed at intersections or access drives to parking lots, when practical, shall be placed so that no part of the fire truck will block the intersection or parking lot access when connections to the fire hydrant are made.

H. Fire hydrants, required by this article, and located on private property, shall be accessible to the **Fire Department** at all times.

I. Fire hydrants shall be located at street or fire lane intersections, when feasible.

J. A Blue Stimsonite, Fire-Lite reflector (or approved equal) shall be placed in the center of the street opposite fire hydrants.

K. In non-residential developments an 8-inch lead will be required on all fire hydrants that are located more than 50 feet from the looped main.

L. Fire hydrant bonnet shall be painted according to the main size to which it is attached. See chart below. The remainder of the hydrant above ground shall be painted aluminum.

Water Main Size	Color
4"	White
6"	Red
8"	Blue
10"	Green
12" & Larger	Yellow

8. Four-inch mains used for hydrant supply shall be replaced and dead-ends eliminated where practical. Six-inch lines shall be connected so that not more than one hydrant will be between intersecting lines and not more than two hydrants on an eight-inch main between intersecting lines.

9. The minimum cover to the top of the pipe must vary with the valve stem. In general, the minimum cover below the top of the street subgrade shall be as follows: 6-inch and smaller, 3.5 feet; 8-inch, 4.0 feet; 10-inch, 4.5 feet; 12-inch, 5 feet; lines between 14 and 16 inches, 5.5 feet to 6.0 feet. Lines larger than 16-inch shall have a minimum of 6.5 feet of cover which is sufficient to allow water and sewer and other utilities to go over the large main. For water lines to be constructed along county-type roads commonly built with a high crown above the surrounding property, increase the cover as required to allow for future paving grade changes.

10. A service with a meter box is constructed from the main to a point just behind the curb line, usually in advance of paving. The location of the meter box is at or near the center of the front of the lot to be served. On multiple apartments and business properties, the desired size and location is usually specified by the owners or architect. Minimum requirements for water service sizes are:

    A. One-inch copper services are required to serve all residential lots under 1-1/2 acres, including townhouse lots and patio homes. One-inch copper services are required to serve lots zoned Duplex. Separate services shall be provided for each of the family units.

    B. The size of apartment, condominium, or multi-family services will depend on the number of units served with a minimum of one meter per building.

    C. All services on existing water mains that are 2" or smaller should be made by Utility Operations.

    D. Bullheads may be used for retrofit only, where the water main is under the pavement.

11. A domestic service connection shall not be allowed on fire hydrant leads except as authorized by the Engineering Department.

SECTION "B" - SANITARY SEWERS

1. Sizes and grades for sanitary sewer shall be as required by the City Engineer, and consideration shall be given as to possible extensions for future development. If feasible, sewers shall be placed in streets. Sewers are usually located in the center of the street or alley. Each addition has its individual problems, therefore, no fixed rules will apply to all cases.

2. Minimum cover shall be 3.5 feet; exceptions unless otherwise authorized by the City Engineer Department shall be concrete encased. In general, the minimum depth for sewer to serve given property with a 4-inch lateral shall be 3-feet plus 2% times the length of the house lateral (the distance from the sewer to the center of the house). Thus, for a house 135 feet

from the sewer, the depth would be 3-feet plus 2% x 135 feet = 3.0 plus 2.7 = 5.7 feet. The depth of the flow line of the sewer should then be at least 5.7 feet below the elevation of the ground at the point where the service enters the house. On lines deeper than 12 feet, a parallel sewer line will be required when laterals are to be attached. This requirement should be discussed with the Engineer.

3. Sewage flow shall be computed in accordance with Exhibit "A", with exceptions, as required by the City Engineer. Pipes should be placed on such a grade that the velocity when flowing full is not less than two feet or more than ten feet per second. Minimum grades shall be as follows:

4" - 1.80%;	6" - 0.52%;	8" - 0.34%;	10" - 0.26%;
12" - 0.21%;	15" - 0.16%;	18" - 0.12%	

Grades may be less for very short distances if specifically approved by the Engineering Department.

4. All grades shall be shown to the nearest 0.01-foot. When the slope of a sewer changes, a manhole will be required. No vertical curves will be allowed. Horizontal curves with a minimum 200-foot radius or as indicated in Section D(1), to match change in street direction will be allowed as approved by the Engineer, but will not be allowed across residential single family and duplex lots.

5. The sizes and locations of manholes, wyes, bends, tap connections, cleanouts, etc., shall be reviewed and approved by the City Engineer. In general, manholes shall be placed at all four-way connections and three-way connections. The diameter of a manhole constructed over the center of a sewer should vary with the size of the sewer. For lines smaller than 15-inches, the manhole shall be 4.0-foot minimum diameter; for lines between 15 inches and 27 inches the manhole shall be 5.0-foot minimum diameter; for lines between 30 and 42 inches a manhole with 6-foot minimum diameter will be required. In Flood Plains and drainage courses, sealed manholes "Type S" shall be used to prevent the entrance of storm water. No more than three Type "S" manholes shall be constructed consecutively without provision for venting. Clean-outs shall be on the ends of all lines. Drop manholes shall be required when the inflow elevation is more than 18 inches above the outflow elevation. Construct manholes at each end of lines which are installed by other than open cut and at each end of aerial crossing lines. Sewer mains and water mains shall be not less than nine feet apart, edge to edge of pipe.

Manhole covers shall provide a minimum 22-3/8 inch opening for normal manholes and 24 inches for Type S.

6. Laterals: The sizes and locations of laterals shall be as designated by the Engineering Department. In general, for single family dwellings, the lateral size shall be 4-inch minimum; for multi units, apartments, local retail and commercial - 6-inch minimum; for manufacturing and industrial, the size should be 8 inches or larger as required. House laterals usually come out 10 feet downstream from the center of the lot and shall have a 10-foot lateral separation from the water service. Manholes will be required on 6-inch and larger laterals where they connect to the main line. Laterals will not be attached to sewer mains that are deeper than 12 feet. A minimum of one lateral per building shall be required. Also, a minimum of one lateral per residential lot shall be required. Duplexes shall have two laterals.

7. Railroad, State Highway and creek crossings, etc., shall be as approved by the City Engineer. All necessary permits shall be obtained by the developer prior to beginning construction.

8. Line and grade stakes for construction shall be furnished by the developer's Engineer. All property lines and corners must be properly staked to insure correct alignment. The City will not be liable for improper alignment or delay of any kind caused by improper or inadequate surveys by the developer or by interference of other utilities.

9. In order to provide access for sewer lines for cleaning, manholes and/or cleanouts shall be so located that 250 feet of sewer rod can reach any point in the line. This means that manhole spacing shall be a maximum of 500 feet; that spacing between a manhole and an upstream cleanout shall be limited to 400 feet. Cleanouts for the sewer main may be located at the end of the line only. Manhole spacing for lines over 24 inches may be increased, as determined by the Engineering Department.

10. No sewer line shall be located nearer than five feet from any tree or structure.

11. Sanitary sewer shall be located in alleys only with prior approval from the City Engineer.

12. Materials for sewer lines:

    A. All sewer pipe shall be PVC or Reinforced Concrete sewer pipe. Reinforced Concrete Pipe is allowed only on lines larger than 24 inches in diameter.

    B. Sewer pipe shall conform to the NCTCOG Specifications and/or Special Provisions, for the selected material.

C. Sewer pipe joint materials shall have resilient properties, conforming to the NCTCOG Specifications and/or Special Provisions.

SECTION "C" - FORM OF PLANS

1. If in doubt, check with the City Engineer before proceeding.

2. Plans shall be clear, legible, and neatly drawn on bordered sheets, size 24" x 36". Each sheet shall clearly display the Texas Professional Engineer's seal of the Engineer under whose direction the plans were designed. A title block in the lower right-hand corner shall be filled in to include: (1) project name; (2) Engineer's name, address, and telephone number.

3. The plan sheet should be drawn so that the north arrow points to the top or to the right side of the sheet. It is important that the plan show sufficient surrounding streets, lots, and property lines so the existing water and sewer may be adequately illustrated in order that proper consideration may be given to future extensions. Proposed water and sewer lines shall be stubbed out to the addition extremities in order that future extensions may be made with a minimum of expense and inconvenience. Unless it would make the plan very difficult to read, both water and sewer lines should be shown on the same sheet. The lines on the profile sheet shall be drawn in the same direction as on the plan. Lettering shall be oriented from left to right, or up.

4. On large additions or layouts requiring the use of more than six sheets (total of plan and profile), key sheets may be required on a scale of 1" = 400' or 1" = 1000', as designated by the Engineering Department. They shall show the overall layout with the specific project clearly indicated with reference to individual sheets.

5. The use of "off-standard" scales will not be permitted. A plan shall be drawn to scales of 1" - 100', or 1" - 40'. Plans for water and sewer that do not involve great detail should be drawn on a scale of 1" - 100'. These may be on plan-profile sheets or the "plan" may be drawn with the profiles on full ruled profile cloth or mylar. Velum will not be accepted due to deterioration. (If required for clarity, a separate sheet on 1" - 40' scale may be used to show details.) Plans in and along creeks, heavily wooded sections, streets with numerous utilities, or as may be required to produce a clean and legible drawing, shall be drawn on plan-profile sheets or separate plan and profile sheets on a scale 1" = 40'. If the plan is in an extremely congested area, a scale of 1" = 20' may be necessary and will be permitted. All profiles shall be drawn on a vertical scale as required for clarity, and the horizontal scale shall be the same as for the plan unless otherwise directed by the Engineering Department.

SECTION "D" - DATA TO BE INCLUDED

1. Sewer Data to be Included on Plan Sheet: The plan shall show the existing and proposed water and sewer lines and all appurtenances thereto. The plan should also have the storm sewer system dashed in. All lines shall be numbered, lettered or otherwise designated on both plan and profile sheets. All lines shall show sizes and direction of flow on both plan and profile sheets. Stationing shall be shown to the nearest 0.1-foot and each new line shall begin at 0+00 at the outlet and increase up the sewer. Station pluses at all junctions of sewers, horizontal P.C.'s, and P.T.'s, bends, angle points, wyes, cleanouts, manholes, the centerlines of all cross streets and railroads, and all crossing utilities, etc., shall be shown on both plan and profile. The degree of angles and horizontal curve data shall be shown on the plan only. Minimum Radius for sanitary sewer mains is 200 feet for 8-inch, 250 feet for 10-inch and 300 feet for 12-inch. Sewer laterals shall be shown at a location most convenient to serve the property. Sewer laterals will usually be near the center of the lot, either at the street or alley. If the lateral is to be adjacent to the water service, then show the lateral 10 feet downstream. The location shall be designated on the plans.

2. Sewer Data to be Included on the Profile Sheet: The data for the profile sheet shall be obtained by running a line of levels along the actual route and by taking any other necessary observations. Profiles shall show the elevations to the nearest 0.1-foot of the ground at the centerline of the sewer, and to the right and left of the centerline of the sewer at the location of the approximate center of the proposed houses or buildings to be served, and the approved street or alley grade. Profiles shall also show the sewer pipe, manholes, cleanouts, etc. The size of the sewer, the direction of the flow, and the grade to the nearest 0.01-foot shall be indicted just over the "pipe" and the total linear footage of line, size, kind of pipe, and type of embedment or encasement shown below the "pipe". All of the information pertaining to the horizontal data, station pluses, appurtenances to be built, etc., is usually shown just above the ground line, whereas, the flow line (invert) elevations are shown below the pipe. Elevations of crossing and parallel utilities shall be shown. All invert elevations shall be shown to the nearest 0.01-foot. Invert elevations shall be recorded at all junctions (all lines-in and out), at grade breaks, the ends of lines, or other points as requested by the City Engineer. Bench marks used shall also be clearly shown, giving the descriptive locations and elevations. Elevations must be established from mean sea level datum, not assumed. Bench level circuits should begin at a USGS monument and bench mark of second order accuracy established at least every one-half mile through the project. All existing water, sewer, gas, storm sewer, telephone, power, and other utilities parallel to or crossing the proposed sewer or water line shall be adequately designated as to size, type, and location. Drainage area maps and capacity calculations for sewer mains 10 inches and larger will be required.

3. Data to be Included for Water Plan and Profile: For water lines less than 12 inches in new subdivisions, the following minimum data needs to be included. Indicate the location of any existing valves required for shut-down purposes and of any tees, ends, etc., to be tied into. Indicate clearly the sizes of the lines to be installed, and all proposed valves, fire hydrants, tees, crosses, bends, reducers, plugs, sleeves, wet connections, tap connections, creek, railroad or highway crossings, tunnels, meter boxes, valve vaults, and other appurtenances at each intersection or as required. Where the pipe is to be laid around a curve, the curve data on the plat is usually sufficient unless otherwise required. The size and type of services and the material, type of joint, and class of pipe may be indicated by adequate notation in the lower left or right hand corners of the plan sheet. Water services and meter boxes shall be indicated and shall be located at or near the center of the front of each lot. If a water line is to be 12 inches or larger it will require a profile. For larger water lines follow the general procedures as outlined for sewers, except that the grades and elevations of the proposed water line usually need not be shown closer than the nearest 0.1-foot.

SECTION "E" - SYMBOLS

All plans drawn for the City by engineers shall be as nearly alike as possible; therefore, standard symbols and lines will be on all plans. (See the Attached Table)

EXHIBIT "A"
SANITARY SEWER DESIGN FLOW CALCULATIONS

SINGLE FAMILY RESIDENTIAL

1. Minimum Criteria:
   3.5 persons per unit (cpu)
   100 gallons per capita day (gpcd)
   Peak Factor per ASCE Manuals on Reports on Engineering Practice, No. 60, "Gravity Sanitary Sewer Design and Construction", Curve A, Page 39.

2. Example for (4 units per acre (upa) and 50 acre development):
   A. Population:
      (3.5 cpu) x (4 upa) x (50 acres) = 700
      Peak Factor (PF) = 5.0
   B. Flow:
      (3.5) x (4) x (50) x (100) x (5.0) = 350,000 gpd

   Note: The criteria for Multi-family Residential and apartments shall be the same as for Single Family Residential, except the number of persons per unit shall be reduced to 3.0 and the units per acre shall be adjusted according to the total units divided by total acres of the subdivision, or drainage area.

OFFICE AND LIGHT COMMERCIAL

Minimum Criteria:
1 person per parking space
25 gallons per capita day (gpcd)
Peak Factor per ASCE Curve A

HOSPITALS

Minimum Criteria:
1 person per bed
200 gallons per capita day (gpcd)
Peak Factor per ASCE Curve A

NURSING HOMES

Minimum Criteria:

1 person per bed
100 gallons per capita day (gpcd)
Peak Factor per ASCE Curve A

HIGH DENSITY OFFICE

Minimum Criteria:

1 person per parking space
20 gallons per capita day (gpcd)
Peak Factor per ASCE Curve A

es for Several Cities

Remarks (3)

itions based on a proposed density, with a d/cap average flow and peak of 400 gpd/ o often used.

on and exfiltration shall not exceed 200 gal of pipe diameter per mile of pipe per 24 od.

148

l × 3.785 = L; in. × 2.54 = cm;

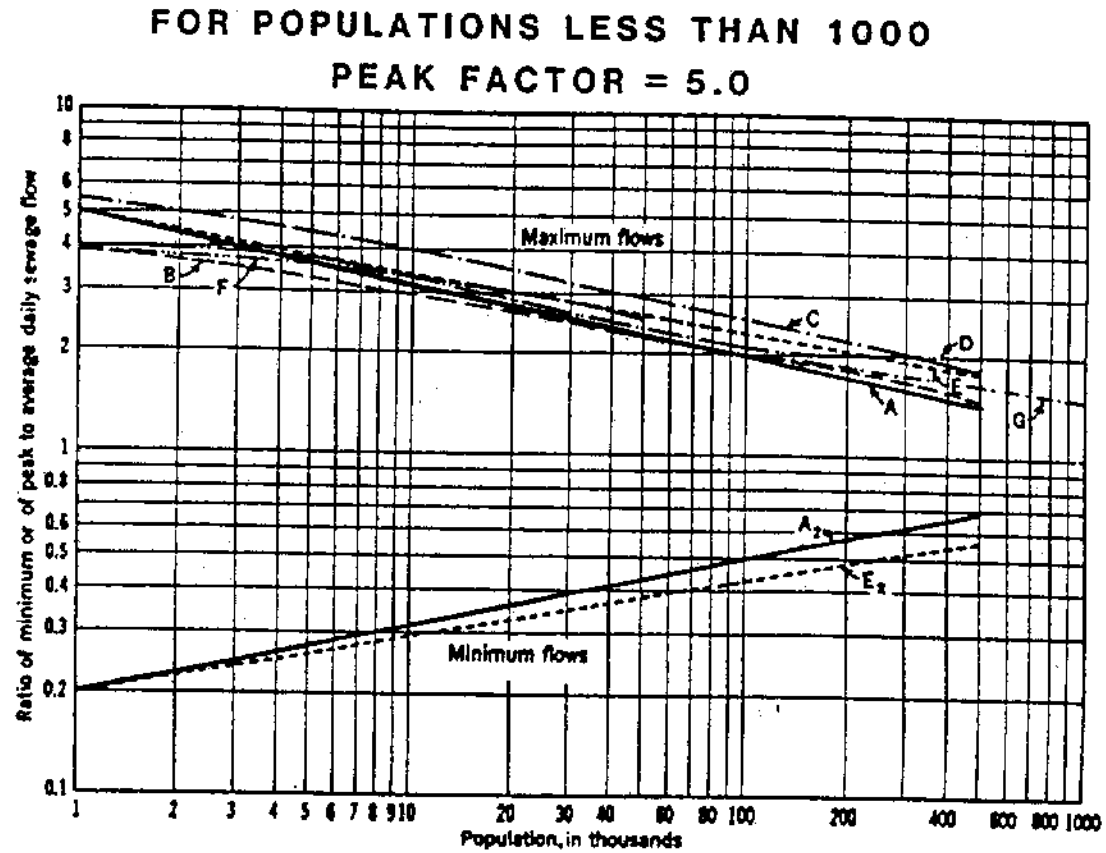
allowances for infiltration normally t allowances. Infiltration-exfiltration sewer is constructed. The design ated condition of the sanitary sewer life.

ary Wastewater

f groundwater infiltration and un- throughout any one day, with ex- een 2 and 6 a.m. and peak flows nfiltration/inflow component, on the t throughout any one day except ls of rainfall.

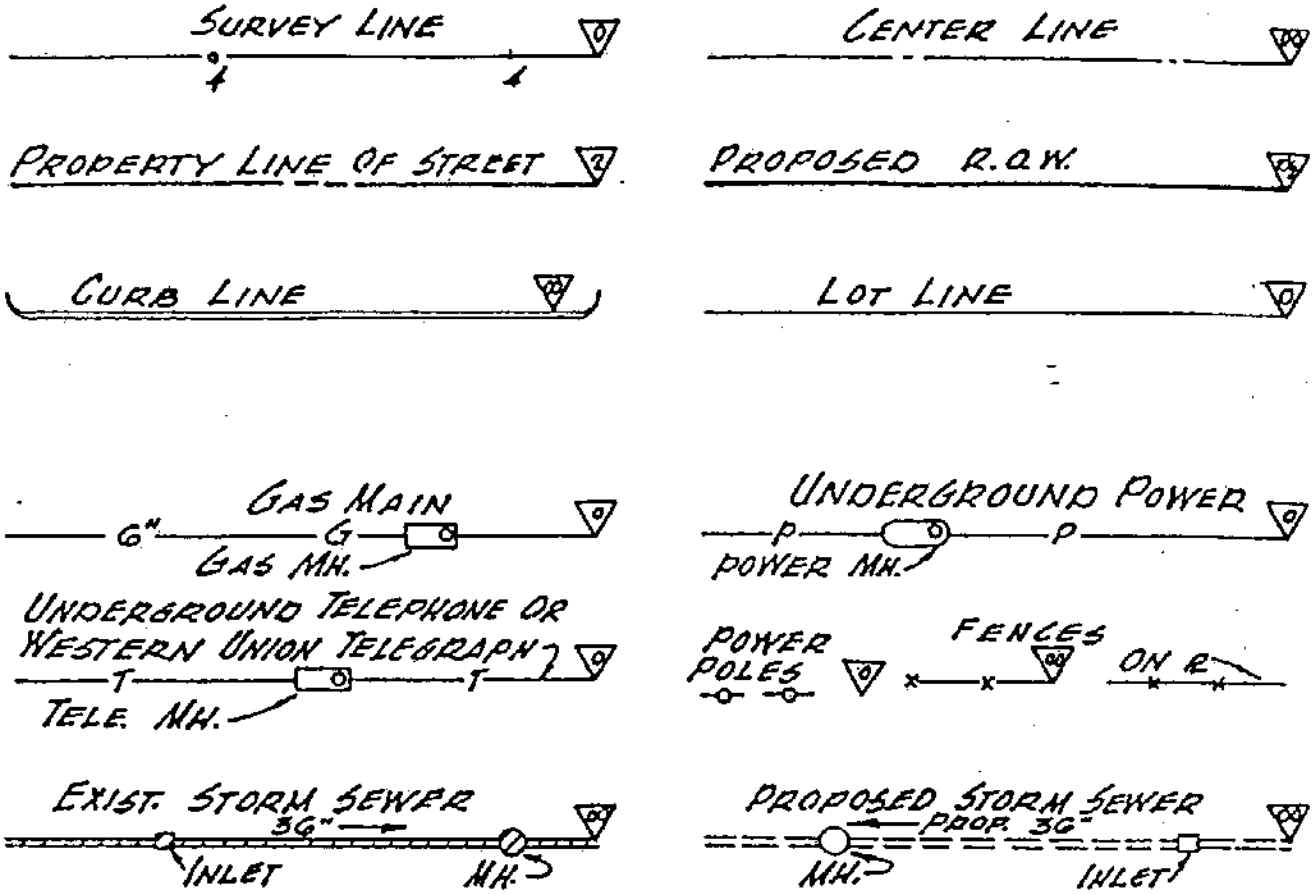
nitary component to the average for some large sanitary sewers to more

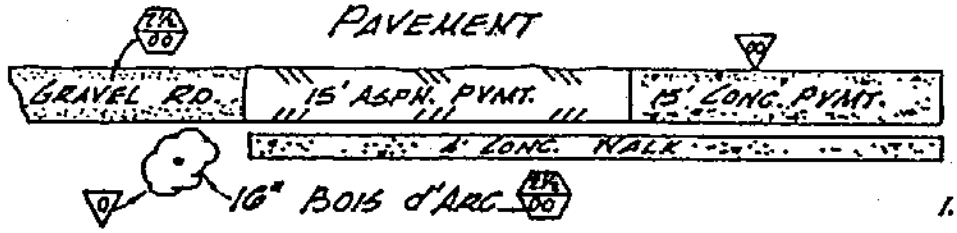
examples of the variations in peak and minimum rates of flow for situations in which dry-weather wastewater flows are expected to govern. Fig. 3-4 shows the ratios of peak and minimum flows to average daily wastewater flow recommended for use in design by various authorities. Fig. 3-5, based on dry-weather maximums, is the modification of a chart originally prepared for the design of sanitary sewers for a group of 18 cities and towns in the Merrimack River Valley, Massachusetts. The ratios given are approximately correct for a number of other municipalities in the same general area. Fig. 3-6 was developed by the Bureau of Engineering, City of Los Angeles, California, and has been in use since 1962. Fig. 3-7 shows peak residential wastewater flow for the city of Toronto, Canada.

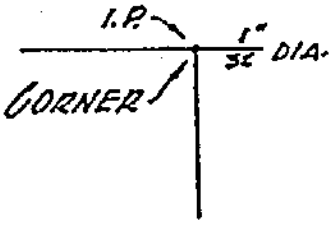


* Curve A source: Babbitt, H. E., "Sewerage and Sewage Treatment," 7th Ed., John Wiley & Sons, Inc., New York (1953).
Curve A_2 source: Babbitt, H. E., and Baumann, E. R., "Sewerage and Sewage Treatment," 8th Ed., John Wiley & Sons, Inc., New York (1956).
Curve B source: Harman, W. G., "Forecasting Sewage at Toledo under Dry-Weather Conditions," *Eng. News-Rec.* **80**, 1233 (1918).
Curve C source: Youngstown, Ohio, report.
Curve D source: Maryland State Department of Health curve prepared in 1914. In "Handbook

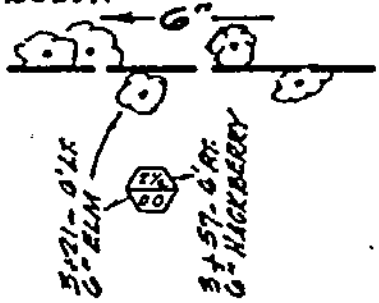
SYMBOLS FOR WATER & SANITARY SEWER PLANS



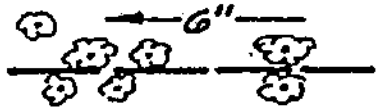




WHEN ONLY A FEW TREES EXIST AND A TREE LIST IS NOT FEASIBLE, PLOT AND DESCRIBE AS SHOWN BELOW



WHEN A TREE LIST IS USED PLOT TREES AS SHOWN BELOW & USE TREE LIST FORM.



SYMBOLS FOR WATER & SANITARY SEWER PLANS

PROPOSED WATER MAINS

8" OR LARGER

6" — 3/4" to 1" — 1/16"

4" — 1/4" to 3/8" — 1/16"

2" OR SMALLER

FUTURE WATER — 1/8" — 1/16"

FIRE HYDRANT 5/32" DIA.

EXISTING WATER MAINS

8" OR LARGER — EXIST. 8" C.I. WATER

6" — EXIST. 6" C.I. WATER

4" — EXIST. 4" C.I. WATER

2" OR SMALLER — EXIST. 2" C.I. WATER

FIRE HYDRANT 5/32" DIA.

WATER METER 5/64" DIA.

FOR PROPOSED WATER & SANI. SEW. MAINS REFERENCED ON SHEET 414-17

PROPOSED SANITARY SEWER

ALL SEWERS — 3/8" to 1/2" — 1/16"

FUTURE SEWER — 1/4" — 1/16"

MANHOLE 11/64" DIA.

CLEANOUT 3/32 DIA.

EXISTING SANITARY SEWER

ALL SEWERS — 8"

LATERAL — 3/8" — 1/16"

MANHOLE 5/32" DIA.

CLEANOUT 5/64" DIA.

RAPIDOGRAPH PEN SIZE INDICATED IN TRIANGLE