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# ENGINEERING AND DESIGN STANDARDS

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APPROVED 09/11/2023

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## **1 GENERAL REQUIREMENTS**

### **1.1 Introduction**

The Design Guidelines and Engineering Standards are generated to implement the provisions of the City of Mount Vernon Subdivision Ordinance and to provide for the orderly, safe, healthy, and uniform development of the area within the corporate city limits and within the surrounding City extraterritorial jurisdiction (ETJ). These design documents are to be reviewed annually and can be amended by the City with the approval of the City Council. The adherence to the requirements of these documents and/or the approval by the City of Mount Vernon and its agents in no way relieves the developer or their engineer of the responsibility for adequacy of design, which may require more stringent standards than these, the completeness of plans and specifications or the suitability of the completed facilities. In unusual circumstances, the City of Mount Vernon may determine that designs other than those of the Standards are necessary and will inform the developer of such requirements before final engineering review. The developer and/or their representative shall obtain authorization from the City of Mount Vernon, in writing, for any deviations from the requirements set forth in the Engineering Standards, Standard Specifications for Construction or Standard Details.

### **1.2 Standards of Design**

These Design Guidelines and Engineering Standards, as adopted by the City of Mount Vernon, are set forth herein and are to be considered as standards of design. These standards shall be considered as the minimum requirements, and it shall be the responsibility of the developer to determine if more stringent requirements are necessary for a particular development. It is not intended that the Standards of Design cover all aspects of a development. For those elements omitted, the developer will be expected to provide designs and facilities in accordance with good engineering practice and to cause the facilities to be constructed utilizing first class workmanship and materials. The City reserves the right to request additional information not covered within these Standards of Design to be included in the design plans by the developer/design engineer in order to validate the intent, safety, constructability, readability, and competency of the design plans. Developer/Engineer must ensure that all design and construction is in accordance with all Federal, State, and local regulations and must provide certification on final plans.

#### **1.2.1 City Ordinances**

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

#### **1.2.2 Council of Governments**

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

### 1.3 Easements

- A. General - Easements shall be provided for public facilities including water, wastewater, drainage features, and traffic signal or lighting equipment that are located outside the public right of way. Storm drains lines are also considered public if they cross property lines and collect runoff from adjacent properties. For single-family residential developments, water, wastewater, and storm drain lines shall not cross residential lots unless specifically approved by the City or appropriate designee. Additional easement width may be required to accommodate future maintenance of the facilities.
- B. Requirements for On-Site Easements and Right-of-Way Dedication to the City:
  - 1. All easements and right-of-way shall be dedicated on a plat. No separate instruments will be allowed.
  - 2. No structures (buildings, walls, fences, decks, swimming pools, signage/monuments, etc.) are allowed in or over any easements or rights-of-way. No trees shall be planted within 10' of any public water or sewer line 10" in diameter or larger. No trees shall be planted within 5' of any public water and sewer line less than 10" in diameter. No trees shall be planted within 5' of any public storm system.
  - 3. All drainage and detention easements shall be maintained, repaired, and replaced by the property owner. This statement is to be noted on the plat.
- C. Requirements for Off-Site Easements Dedicated to the City:
  - 1. Owner/Developer shall furnish the City a current title report and, metes and bounds description, and exhibit that is signed and sealed by a Texas Registered Professional Land Surveyor that shows the easements or right-of-way, location, and current ownership information.
  - 2. All easements shall be reviewed and approved by the City prior to releasing the documents for signatures by the property owners.
  - 3. The individual or entity requesting the easement shall pay all filing fees required by the County.
  - 4. The individual or entity shall return, to the City, all originally signed documents and a check for filing fees made out to Franklin County for filing.
  - 5. All filing information for all easements must be shown on all plats.
  - 6. After recordation, a copy of the filed document will be forwarded to the property owner.

### 1.4 Inspection

Inspection of construction and verification of compliance to the plans and specifications shall be conducted by the City of Mount Vernon staff under the direction of the City designee. The facilities included in this inspection requirement are streets, sidewalks, parking lots, alleys, storm drainage facilities, water distribution systems, wastewater collection system, etc. The developer shall advise all of his construction contractors of this requirement. **No development will be accepted by the City until all construction has been approved by the City of Mount Vernon.** The developer shall be responsible for any additional expense to the City at a rate established by the City at that time when inspection is done after normal business hours of the City. The date of acceptance will be when the City has accepted all items. Twenty-four (24) months from the date of acceptance the City will determine any failures or defects and repairs will be made by the contractor. **The accepted method of inspection for underground gravity-flow utilities shall be videoed (CCTV) by the developer. The City will require a copy of such inspection. The developer or contractor shall be responsible for the cost of the videoed inspection.**



### **1.5 Enforcement**

The City's Design Guidelines and Engineering Standards are issued by the Building and Code and the Public Works Departments, and who are hereby authorized to enforce the provisions of these Engineering Standards. The standards and any updates will be available on the City's website. These Engineering Standards shall be in full force and effect immediately upon adoption by the City Council. Projects will be required to comply with all requirements. The standards include the various design criteria, technical specifications, and standard construction details which are considered minimum requirements for the design and construction of adequate public facilities within the City. The Engineer of record shall bear the sole responsibility for meeting the Engineering standard of care for all aspects of the design and providing a design that is required by the site-specific conditions and intended use of the facilities, while at a minimum meeting the City's design and construction requirements.

### **1.6 Variance Request**

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

### **1.7 Fees**

All fees will be collected at the time of development. Fees will be charged according to the City of Mount Vernon current fee ordinance.

### **1.8 Final Acceptance**

Final acceptance of the project shall occur when all the items on the Checklist for Final Acceptance have been completed and signed-off on by the City. An example of the checklist for final acceptance has been included in the Appendix. Items on the checklist may vary depending on the project and other items may be required by the City. After all improvements have been completed, the developer shall be responsible for providing to the City "As Built" or "Record Drawings" in digital format on a CD-ROM or flash drive. A Final Plat, which has been fully executed, shall also be provided to the City.

## **2 STREETS**

### **2.1 General**

- A. Roadways and streets within the City of Mount Vernon shall be designed and constructed with generally accepted engineering practices and in compliance with the current Comprehensive Plan, latest Thoroughfare Plan, Zoning Ordinances, and the Subdivision Regulations.
- B. Geometrics of city roadways and streets may be defined as the geometry of the curbs or pavement areas that governs the movement of traffic within the confines of an established right-of-way. Included in the geometrics are the pavement widths, degree of curvature, width of traffic lanes, parking lanes, or turning lanes, median width separating opposing traffic lanes, median nose radii, curb radii at intersections, crown height, cross slopes, and other features.
- C. The American Association of State Highways and Transportation Officials (AASHTO) publication “A Policy on Geometric Design of Highways and Streets” shall govern design except as modified by these standards.

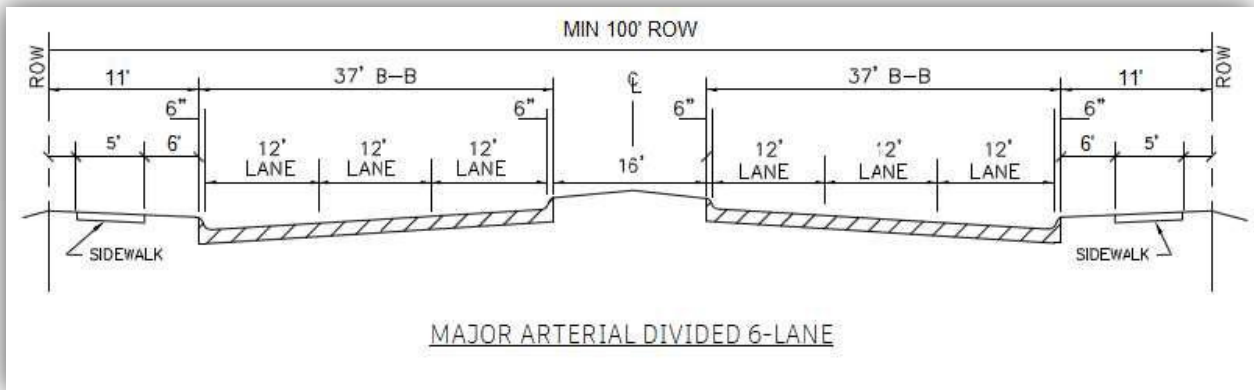
### **2.2 Design Vehicles**

Criteria for the geometric design of intersections must be based on certain vehicle operating characteristics and vehicle dimensions. The AASHTO publication “A Policy on Geometric Design of Highways and Streets” has standardized vehicle criteria, which have been adopted for use by the City. The design vehicle for all thoroughfares and city streets will be the Tractor Semi-Trailer Combination (WB-50) and will require a minimum of a 30 foot radius. Alleys and private drives shall be designed to a Single Unit Truck (SU) with a minimum radius of 20 feet.

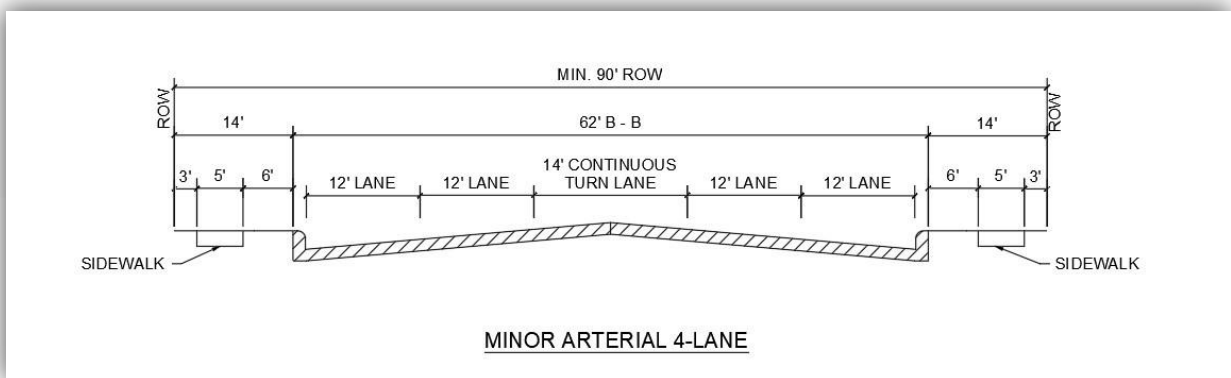
### **2.3 Functional Classifications**

- A. Thoroughfare Definitions – The City recognizes eight basic classifications of public roadways that include interstates, frontage roads, highways (freeway/toll-ways), downtown thoroughfares, major and minor arterials and major and minor collectors as identified in the Thoroughfare Chapter of the City of Mount Vernon Comprehensive Plan 2009. Each class provides a certain degree of continuity, capacity, and accessibility to adjacent land uses. While differentiated by function, there is also a variance in geometric design. The typical cross sections for each classification are depicted in below:
  - 1. Interstate
    - a. Four-lane divided roadway defined herein. Interstates are typically initially constructed as four-lane divided roadways with a wider median and then widened to six lanes at a later date.
    - b. I-30 is the only occurrence and is a major regional collector that is maintained by TxDOT.
  - 2. Frontage Roads
    - b. Designates existing frontage roads along Interstate 30 and also future frontage road connections. Typical two-lane roadway that is maintained by TxDOT. Connections to frontage roads require thorough coordination and permitting with TxDOT.
  - 3. Principal Arterial
    - a. Divided six-lane.

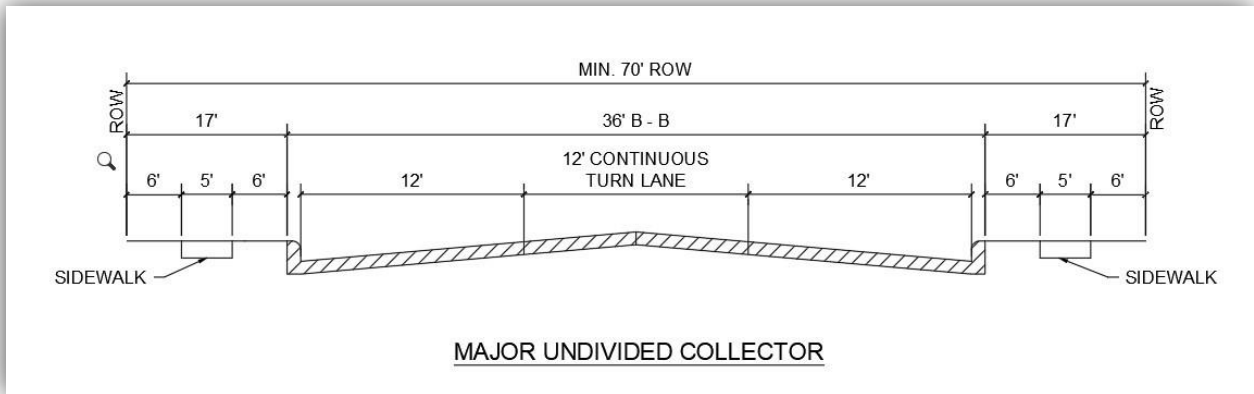
- b. 12- foot travel lanes and 16- foot median
- 4. Major Arterial
  - a. Recommend six-lane divided roadways defined herein.
  - b. Intersections of all six lane arterial streets shall be designed with recommended ROW dedication to accommodate future design.
  - c. 12-foot lanes and 16-foot median for turning lanes at intersections
  - d. 6-foot buffer and 5-foot sidewalk



- 5. Minor Arterial
  - a. Recommend five-lane undivided roadways defined herein
  - b. Intersections of all five lane arterial streets shall be designed with recommended ROW dedication to accommodate future design
  - c. 12-foot-wide lanes and 14-foot two-way left turn lane in center
  - d. 6-foot buffer and 5-foot sidewalk

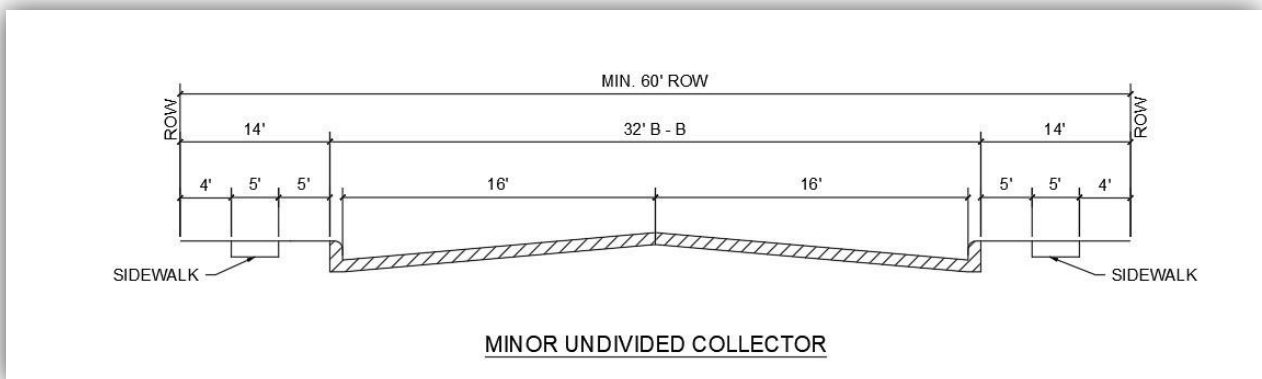


- 6. Major Collector
  - a. Three-lane design used primarily to connect neighborhoods; two travel lanes that are 12-foot wide and one turn lane in the center that is also 12-feet wide
  - b. Recommended 300 feet intersection spacing
  - c. Varying 17-27 feet parkway width along with 6-foot buffer from the back of curb and 5-foot sidewalk



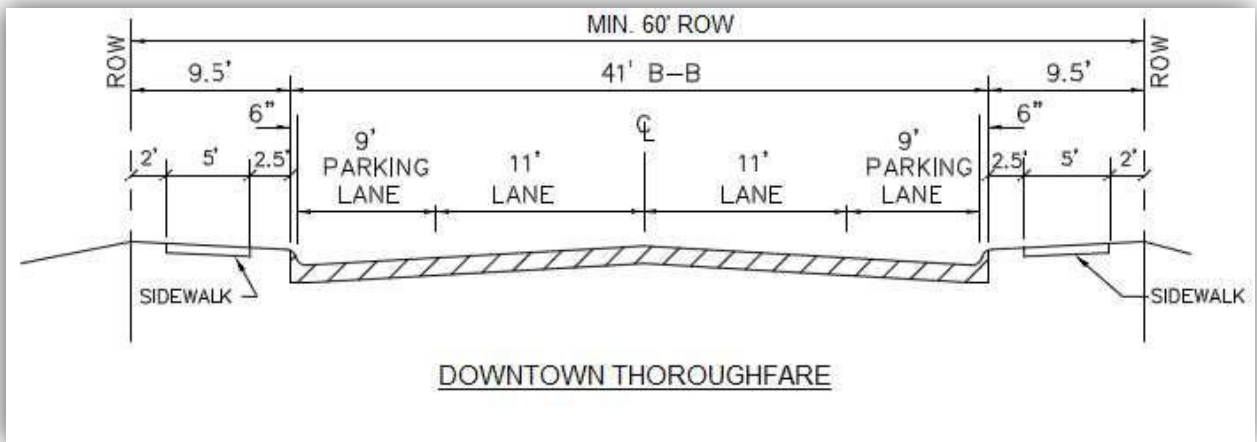
7. Minor Collector

- a. Two 16-foot lanes designed to provide the highest access with lowest mobility
- b. Recommended 300 feet intersection spacing
- c. Recommended 14-foot parkway width along with 5-foot buffer from the back of curb and 5-foot sidewalk

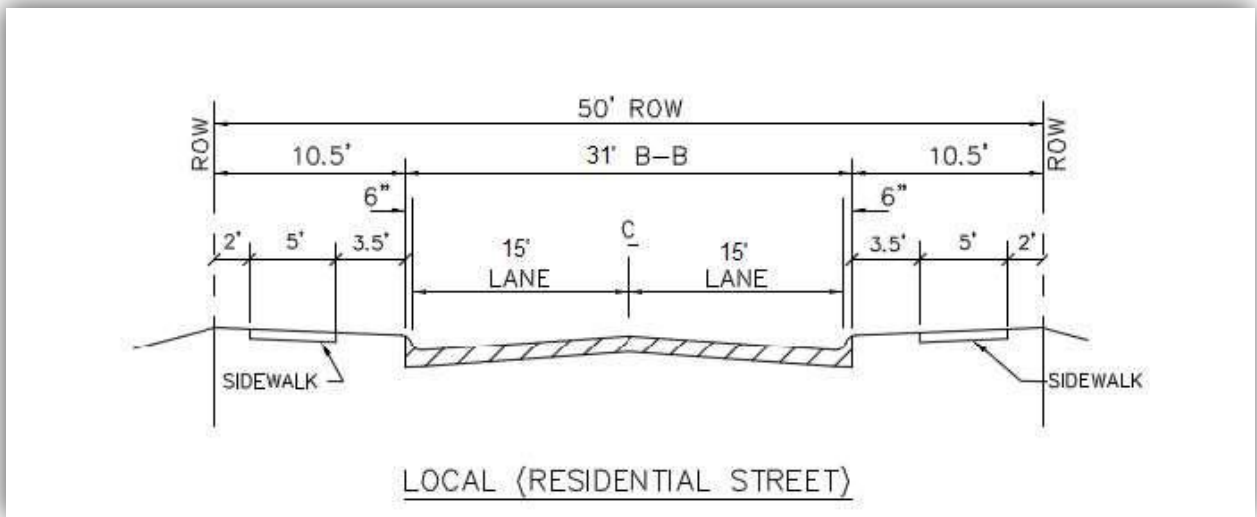


8. Downtown Thoroughfares

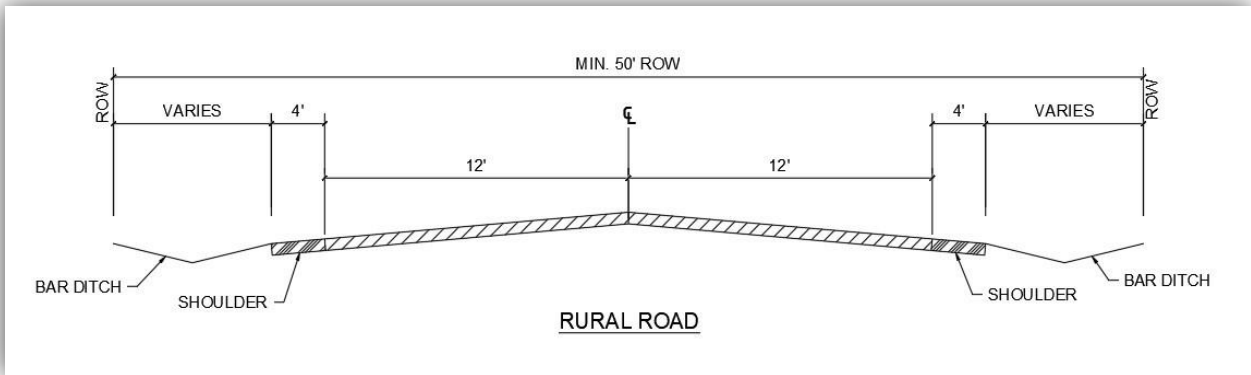
- a. Flexible geometric design characteristics that provide for unique context and downtown needs
- b. Provides for On-street parking, either angled or parallel design
- c. Incorporate buffer zone for landscaping and wide sidewalks for encouraged walkability



9. Local or Residential Streets
  - a. Applies to all other roads in the city.
  - b. Recommended two 15-foot lanes with 3.5-foot of buffer and 5-foot sidewalks



10. Rural Roads
  - a. Two 12-foot lanes with 4-foot paved shoulder
  - b. Incorporate variable sized bar ditches
  - c. Located in rural areas at City's discretion



**11. Alternate Cross Sections**

- a. If an alternate roadway cross section is proposed, it must provide the capacity, maneuverability, parking, and emergency access necessary to serve the adjacent land uses and is subject to approval by the City and the Fire Department. The right-of-way dedicated for such a roadway shall include a minimum of twelve feet (12') of right-of-way beyond the outermost face of curb on each side of the roadway.

**2.4 Geometric Design Standards**

Geometrics of City streets shall be defined as the geometry of the pavement and curb areas that govern the movement of traffic within the confines of the right-of-way (ROW). Included in the geometrics are pavement width, horizontal curvature, width of traffic lanes, median nose radii, curb radii at street intersections, pavement cross-slope, crown height, pavement thickness, and geometric shapes of islands separating traffic movements and other features.

- A. Design Speed – Design speed is a primary factor in the horizontal and vertical alignment of roadways. Design features such as curvature, super-elevation, turning movement radii, and sight distance affects roadway lane width, pavement width, pavement cross-slope, pavement crown, and clearances. Refer to Table 2.1.
- B. Grades – Roadway grades shall be a minimum of five-tenths percent (0.5%) in order to ensure proper flow of surface drainage toward inlets and a maximum of ten percent (10%). Steeper grades may be permitted on local residential streets and where required by topographical and/or natural features, as approved by the City or designee. Refer to Table 2.1.
- C. Cross-Slope – Arterials shall have a two percent (2%) cross-slope. The cross-slope can vary where there is a transition into or out of a maximum two percent (2%) super elevation. Collectors may have six-inch (6") parabolic crowns for asphalt pavement sections, and downtown thoroughfares a four-inch (4") parabolic crown.
- D. Subgrades, Pavement Thickness and Reinforcement – See Section 2.6 of the Engineering Standards for subgrade and pavement design requirements
- E. Dead-End Streets/Culs-de-sac/Stub Streets
  - 1. All dead-end streets shall have a turn-around unless otherwise approved by the City.
  - 2. The maximum length of a dead-end street with a turn-around (cul-de-sac) shall be five hundred feet (500'), measured from the ROW line of the intersecting street to the center point of the cul-de-sac or T-shaped (hammer head) turn around except in conditions of unusual topography.

3. Residential cul-de-sac turn-arounds shall have a minimum ROW width (diameter) of one hundred feet (100') and a minimum pavement diameter of eighty feet (80') serving low density residential development.
4. If any residential lot fronts onto the dead-end portion of a street that will be extended in the future, a temporary turn-around that meets the standards described above shall be constructed at the end of the dead-end street within a temporary street easement. The following note shall be placed on the plat: "Cross-hatched area is temporary street easement for turn-around until street is extended (give direction) with future development of abutting property."
5. Commercial cul-de-sac turn-arounds shall have a minimum ROW of one hundred twenty feet (120') and a minimum pavement diameter of one hundred feet (100') for all other uses.
6. Temporary turnarounds shall be provided at ends of streets more than one hundred fifty feet (150') long that will be extended in the future. No buildings shall be constructed in these sections without approval from the City.
  - I. Temporary turnarounds with a width of thirty feet (30') and radii of twenty feet (20') may be substituted in place of the typical turnarounds with twenty-four feet (24') widths and thirty feet (30') radii for hammer head turnarounds.
7. A stub street is an undivided dead-end street that will be extended in the future that does not have a turn-around, which is only allowed under the following conditions:
  - I. No residential lots shall front onto a stub street. Non-residential lots adjacent to a stub street shall have access to another street. If the length of a residential stub street exceeds the depth of the adjacent residential lots, it shall be temporarily blocked at the rear edge of the lots (or alley) with barrel-mounted barricade.
  - II. If a non-residential stub street extends more than one hundred feet (100') beyond the last driveway on the street, it shall be temporarily blocked at the last driveway with barrel-mounted barricade.
8. A stub street shall have a permanent Type III barricade installed at its terminus. A residential stub street shall also have a twenty-four by thirty inches (24"x30") sign prominently posted at its terminus with black letters on a white background that state, "NOTICE – This street will be extended as part of a future development." The installation and cost of these barricades and signs shall be the responsibility of the developer.

TABLE 2.1: GENERAL ROADWAY DESIGN CRITERIA

	Classification						
	Major Arterial	Minor Arterial	Major Collector	Minor Collector	Downtown Thoroughfares	Residential	Rural
Right-of-Way (ROW) (Min)(Feet)	100'	90'	70'	60'	Varies	50'	50'
Min. Pavement Width	37'	62'	36'	32'	31'	31'	20'
Traffic Lanes	6@12'	4@12'	2@12'	2@16'	Varies	2@15'	2@12'
Middle-Turn Lane	N/A	14'	12'	N/A	N/A	N/A	N/A
Median Width	16'	N/A	N/A	N/A	Varies	N/A	N/A
Min. Parkway Width	11'	14'	17'	14'	Varies	10.5'	N/A
Design Speed, V (MPH)	40-45	35-40	30-35	30-35	Varies	25-30	25-30
Max. Grade	8%	10%	8%	10%	10%	10%	10%
Min. Grade	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Buffer Distance	6'	6'	6'	5'	Varies	3.5'	N/A
Sidewalk Distance	5'	5'	5'	5'	Varies	5'	N/A
Stopping Sight Distance	305'-360'	250'-305'	200'	200'	Varies	200'	200'
Parking	Prohibited	Prohibited	Prohibited	Prohibited	Allowed	Allowed	Prohibited

**2.4.1 Horizontal Alignment**

**A. Horizontal Curves and Superelevation**

1. The alignment of City streets and thoroughfares is usually determined by the alignment of the existing right-of-way or structures that cannot be relocated. Changes in the direction of a street or thoroughfare are minimized by constructing a simple curve having a radius that is compatible with the speed of vehicular traffic. To increase safety and reduce discomfort for drivers traversing a curved portion of a street or thoroughfare, the pavement may be superelevated.
2. Curvature in the alignment of major thoroughfares and collectors is allowed under certain conditions, but greater traffic volume and higher vehicle speeds that accompany these facilities tend to increase accidents on curving roadways. Curves in the alignment of residential streets usually provide aesthetic values to the residential neighborhoods without affecting the orderly flow of traffic or sacrificing safety.
3. A recommended minimum centerline radius for vehicle design speed and pavement cross-slopes is shown in Table 2.2. These are based on traffic consisting of typical present-day automobiles operating under optimum weather conditions. There are other important considerations in the design of curves on City streets and thoroughfares including the location of intersecting streets, drives, bridges, and topographic features. When superelevation is required on collectors and major thoroughfares, the following basic formula shall be used:

$$R = \frac{V^2}{15(e + f)}$$

Where:

e = rate of roadway superelevation, foot per foot  
 f = side friction factor (See Table 2.3)



V = vehicle design speed, mph

R = radius of curve in feet

For local residential streets, minimum centerline radius may be 150 feet when the design speed can be considered to be 30 MPH or less. This decision will be made by the City’s designated engineer by considering the type of proposed development, location of street and length of street.

**TABLE 2.2: MINIMUM CENTERLINE RADIUS FOR THOROUGHFARES**

Rate of Superelevation (In./Ft.)	Design Speed (MPH)			
	30	35	40	45
-1/2	510 ft	720 ft	945 ft	1,310 ft
-3/8	470 ft	660 ft	865 ft	1,190 ft
-1/4	435 ft	610 ft	795 ft	1,090 ft
-1/8	405 ft	565 ft	740 ft	1,005 ft
0	370 ft	530 ft	690 ft	935 ft
+1/8	355 ft	495 ft	645 ft	870 ft
+1/4	335 ft	465 ft	610 ft	815 ft
+3/8	315 ft	440 ft	575 ft	770 ft
+1/2	300 ft	415 ft	545 ft	725 ft

**TABLE 2.3: SIDE FRICTION FACTORS FOR THOROUGHFARES**

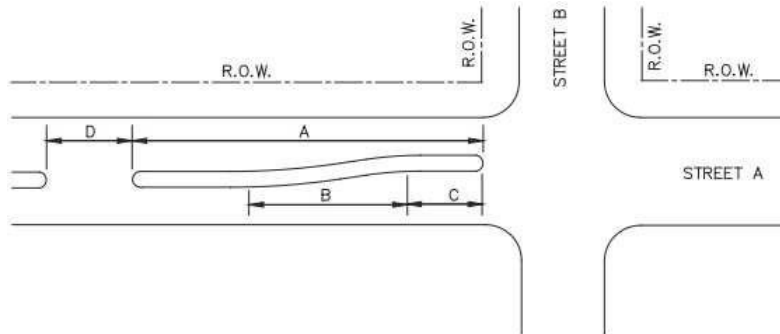
Street Classification	Side Friction Factor (f)
Arterials and Collectors	0.155
Downtown and Local	0.180

**B. Turning Lanes**

1. Turning lanes are provided at intersections to accommodate turning vehicles. The primary purpose of these turning lanes is to provide storage for the turning vehicles. The secondary purpose is to provide space to decelerate from normal speed to a stopped position in advance of the intersection or to a safe speed for the turn in case a stop is not required. Left turn lanes at intersections are usually 11 feet in width. When turning traffic is too heavy for a single lane and the cross street is wide enough to receive the traffic, two turning lanes may be provided. Availability of right-of-way may limit locations where this is feasible.
2. The location of the median nose at the end of the left turn lane should be so located that crossing left turning traffic will clear the median nose while making a normal left turn. Other considerations include adequate clearance between the median nose and through

traffic on the intersecting thoroughfare and locations of the median nose to properly clear the pedestrian crosswalks.

3. The transition curves used in left-turn lanes shall be two, 250-foot radius reverse curves with a total transition length of 100 feet. Minimum storage length requirements for left-turn lanes are as shown in Figure 2.1.



INTERSECTING STREET TYPE		MINIMUM LENGTH (FEET)			
STREET A	STREET B	A	B	C*	D**
Principal Arterial (6 Lanes)	Principal Arterial (6 Lanes)	310	100	150	60
Principal Arterial (6 Lanes)	Minor Arterial (4 Lanes)	260	100	100	60
Principal Arterial (6 Lanes)	Major Collector (4 Lanes) Minor Collector (2 Lanes)	260	100	100	60
Principal Arterial (6 Lanes)	Local/Private (2 Lanes)	220	100	60	60
Minor Arterial (4 Lanes)	Principal Arterial (6 Lanes)	310	100	150	60
Minor Arterial (4 Lanes)	Minor Arterial (4 Lanes)	260	100	100	60
Minor Arterial (4 Lanes)	Major Collector (4 Lanes) Minor Collector (2 Lanes)	260	100	100	60
Minor Arterial (4 Lanes)	Local/Private	220	100	60	60

LEFT-TURN STORAGE AREA WIDTH 11' MINIMUM

MEDIAN WIDTH (SEE GEOMETRIC DESIGN STANDARD FOR PRINCIPAL AND MINOR ARTERIAL).

\*MINIMUM LENGTH – ACTUAL LENGTH DEPENDENT UPON ANTICIPATED TURN VOLUME

\*\* OR STREET WIDTH + 8 FEET – WHICHEVER IS GREATER. A VARIANCE MAYBE GRANTED BY CITY COUNCIL ON A CASE BY CASE BASIS.

FIGURE 2.1: MEDIAN DESIGN STANDARDS

C. Street Intersections

1. All street designs and intersections shall be approved by the City in accordance with the AASHTO manual, "A Policy on Geometric Design of Highway and Streets", most current edition.
2. More than two streets intersecting at one point shall be avoided, except where it is impractical to secure a proper street system otherwise. Where several streets converge at one point, setback lines, special rounding or cut-off of corners or a traffic circle may be required to ensure safety and facility of traffic movement.
3. A standard intersection shall be at grade and at right angles if at all possible. However, site constraints may require intersections at angles less than 90 degrees. The radii required to fit the minimum paths of the design vehicles are longer than those for

standard or 90 degree intersections. Special intersections shall be designed using data for the design vehicles.

4. Visibility easements will be required for all ninety (90°) degree intersections. For all intersections that are not ninety (90°) degrees, an engineered visibility easement is required by the design engineer and the City may require non-standard ROW clips and curb return radii.
5. Curb radii at intersections shall have a minimum radius of thirty (30) feet along arterials, twenty-five (25) feet along collectors and twenty (20) feet along local and residential streets.
6. Arterial and collector street intersections shall have property line corner clips with a minimum tangent distance of thirty (30) feet. Local and residential streets shall not normally be required to have a ROW corner clip at their intersection with other streets or thoroughfares, but a 10-foot by 10-foot sidewalk corner clip will be required.
7. All proposed paving connections to existing paving require a longitudinal butt joint connection.

#### **2.4.2 Vertical Alignment**

##### **A. Street Grades**

1. The vertical alignment of City streets and thoroughfares should be designed to ensure the safe operation of vehicles and should allow easy access to adjacent property. A roadway that is safe for vehicles is dependent on criteria such as operating speeds, maximum grades, vertical curves, and sight distance. In addition to these considerations, other factors related to vertical alignment include storm drainage, crown and the grade and right-of-way elevation relationship.
2. The grade of a street, particularly at its intersection with another street, is of prime importance in providing a safe, comfortable riding surface. The intersection design of two streets shall include grades that will result in a plane surface or at least a surface that approximates a plane surface. A vehicle traveling on either thoroughfare should be able to traverse the intersection at the design speed without discomfort. To accomplish a smooth transition, crossfall toward the median of each thoroughfare may be required. In drawing the grades of intersecting thoroughfares in the profile view of plan/profile sheets, profiles of all four curbs shall be shown as a continuous line through the intersection.

##### **B. Vertical Curves**

1. When two longitudinal street grades intersect at a point of vertical intersection (PVI) and the algebraic difference in the grades is greater than one percent (1.0%), a vertical curve is required. Vertical curves are utilized in roadway design to effect a gradual change between tangent grades and should result in a design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The vertical curve shall be formed by a simple parabola.

##### **C. Crest Vertical Curves:**

1. When a vertical curve is required, it must not interfere with the ability of the driver to see the street ahead. This length of street, called the stopping sight distance, should be of sufficient length to enable a person in a vehicle having an eye height of 3.5 feet above

the pavement and traveling at design speed to stop before reaching an object in his path that is 2.0 feet high.

2. The minimum safe stopping sight distance and design speeds are shown in Table 2.4. These sight distances are based on each design speed shown and a wet pavement. The length of crest vertical curve required for the safe stopping sight distance of each street type may be calculated using the formula  $L = KA$  and the values of K for a crest vertical curve shown in Table 2.4.

**TABLE 2.4: CREST VERTICAL CURVES**

Design Speed (MPH)	Coeff. of Friction (a)	Stopping Sight Dist. (Ft.)	Stopping Sight Dist. Rounded for Design (Ft.)	K	K Rounded for Design
15	0.42	72.98	75	4.01	5
20	0.40	106.83	125	8.59	10
25	0.38	146.70	150	16.19	20
30	0.36	193.58	200	28.20	30
35	0.34	248.72	250	46.55	50
40	0.32	313.67	325	74.03	80
45	0.31	383.12	400	110.44	120

(a) AASHTO, p. 316

**ROUNDED MINIMUM LENGTH OF VERTICAL CURVE IN FEET  
For Speeds and K Values Shown Below ( $L = KA$ )**

Algebraic Grade Diff. (%) (A)	MPH	15	20	25	30	35	40	45
	K	5	10	20	30	50	80	120
1		5	10	20	30	50	80	120
2		10	20	40	60	100	160	240
3		15	30	60	90	150	240	360
4		20	40	80	120	200	320	480
5		25	50	100	150	250	400	600
6		30	60	120	180	300	480	720
7		35	70	140	210	350	560	840
8		40	80	160	240	400	640	960
9		45	90	180	270	450	720	1080
10		50	100	200	300	500	800	1200
11		55	110	220	330	550	880	1320
12		60	120	240	360	600	960	1440
13		65	130	260	390	650	1040	1560
14		70	140	280	420	700	1120	1680
15		75	150	300	450	750	1200	1800

**D. Sag Vertical Curves**

1. When a sag vertical curve is required, the vertical curve shall be of sufficient length to provide a safe stopping sight distance based on headlight sight distance. The minimum length of sag vertical curve required to provide a safe stopping sight distance may be calculated using the formula  $L = KA$  and values of K for a sag vertical curve are shown in Table 2.5.

TABLE 2.5: SAG VERTICAL CURVES

Design Speed (MPH)	Coeff. of Friction (a)	Stopping Sight Dist. (Ft.)	Stopping Sight Dist. Rounded for Design (Ft.)	K	K Rounded for Design
15	0.42	72.98	75	8.13	10
20	0.40	106.83	125	14.75	20
25	0.38	146.70	150	23.56	30
30	0.36	193.58	200	34.78	40
35	0.34	248.72	250	48.69	50
40	0.32	313.67	325	65.69	70
45	0.31	383.12	400	84.31	90

(a) AASHTO, p. 316  
 (b) AASHTO, p. 312

ROUNDED MINIMUM LENGTH OF VERTICAL CURVE IN FEET  
 For Speeds and K Values Shown Below ( $L = KA$ )

Algebraic Grade Diff. (%) (A)	MPH	15	20	25	30	35	40	45
	K	10	20	30	40	50	70	90
1		10	20	30	40	50	70	90
2		20	40	60	80	100	140	180
3		30	60	90	120	150	210	270
4		40	80	120	160	200	280	360
5		50	100	150	200	250	350	450
6		60	120	180	240	300	420	540
7		70	140	210	280	350	490	630
8		80	160	240	320	400	560	720
9		90	180	270	360	450	630	810
10		100	200	300	400	500	700	900
11		110	220	330	440	550	770	990
12		120	240	360	480	600	840	1080
13		130	260	390	520	650	910	1170
14		140	280	420	560	700	980	1260
15		150	300	450	600	750	1050	1350

**2.4.3 Sight Distances at Intersections**

An important consideration in the design of City streets is the vehicle attempting to enter the street from a side street or drive. The operator of the vehicle attempting to enter should have an unobstructed view of the whole intersection and a length of the thoroughfare to be entered sufficient to permit control of the vehicle to avoid collisions. The minimum sight distance considered safe under various assumptions of physical conditions and driver behavior is related directly to vehicle speeds and to the resultant distance traversed during perception, reaction, and braking. This sight distance, which is termed intersection sight distance, can be calculated for different street widths and for various grades. Intersection sight distance shall be as set forth in AASHTO publication "A Policy on Geometric Design of Highways and Streets."

**2.5 Driveway Standards**

**2.5.1 Maximum Number of Driveways**

The maximum number of driveways per platted lot and the minimum spacing between such driveways shall be as provided for in Table 2.6.

TABLE 2.6: MAXIMUM NUMBER OF DRIVEWAYS AND MINIMUM SPACING BETWEEN DRIVEWAYS (PER PLATTED LOT)

Land Use	Frontage (Feet)	Maximum Number of Driveways Per Property	Minimum Spacing Between Driveway Curb Returns on Same Property
Single-Family	90' or more	2	20
Single-Family	Less than 90'	1	N/A
Attached Housing	90' or more	2	20
Attached Housing	Less than 90'	1	N/A
Non-Residential*	More than 250'	2	100
Non-Residential	Less than 250'	1	N/A

\*One additional driveway may be added for each additional 500 feet of lot width in excess of 250 feet. For driveways on arterials and thoroughfares, only one driveway is allowed for each 500 feet of lot width instead of 250 feet of width.

NOTE: State standards, if more restrictive, shall apply for properties fronting state or federal roads.

**2.5.2 Minimum Corner Clearance**

The minimum corner clearance between a driveway and an intersection shall be as provided for in Table 2.7.

- A. Corner clearance shall be defined as follows:
  - 1. For streets with curbs:
    - a. The distance between the intersection of the projected curb lines of the two streets and the driveway curb return.
  - 2. For streets without curbs:
    - a. The distance between the intersection of the projected edge of pavement lines of the two streets and the intersection of the edge of driveway pavement at edge of pavement of the street.

**TABLE 2.7: MINIMUM CORNER CLEARANCE BETWEEN DRIVEWAY AND INTERSECTION**

Type of Street Driveway is On	Type of Street Intersected	MINIMUM CORNER CLEARANCE	
		Approach Side of Intersection	Departure Side of Intersection
Major / Minor Collector	Major / Minor Collector	150	100
Major / Minor Collector	Major / Minor Arterial	100	70
Major / Minor Collector	Local Residential / Rural	50	30
Major / Minor Arterial	Major / Minor Collector	100	70
Major / Minor Arterial	Major / Minor Arterial	70	50
Major / Minor Arterial	Local Residential / Rural	40	30
Local Residential / Rural	Major / Minor Collector	50	30
Local Residential / Rural	Major / Minor Arterial	40	30
Local Residential / Rural	Local Residential / Rural	30	30

**2.5.3 Driveway Design Standards**

Driveway design standards shall be as shown in Table 2.8.

**TABLE 2.8: DRIVEWAY DESIGN STANDARDS**

Land Use	Driveway Approach			
	Approach Width in Feet		Curb Radius* in Feet	
	Minimum	Maximum	Minimum	Maximum
<b>RESIDENTIAL</b>				
Single Family	20	24	5	10
Attached Housing	20	24	5	10
<b>NON-RESIDENTIAL</b>				
Office	24	30	15	30
Retail (except Service Stations)	24	30	15	30
Service Station	24	40	15	30
Industrial	24	45	25	50
<b>DIVIDED DRIVEWAYS**</b>				
Non-Residential	18	24	15	40

\* Or chamfer distances where driveway attaches to a Country Lane

\*\* Must have raised median at least 6 feet wide; approach widths are for each side.

**NOTES:**

- a. The minimum and maximum approach widths are for the point where curb radii (from the public street) end or the approach width at the right-of-way line.
- b. Where the width of an aisle changes or where the approach width is different from the width of the aisle or driveway farther into the property, the following formula shall be used to determine the minimum taper length:

$$L = 20 \times W$$

Where: L = taper length  
 W = difference in width

**2.5.4 Driveway Storage**

Driveway storage shall be defined as the distance between the street right-of-way line and the near side of the first intersecting interior aisle. The minimum length of this storage shall be as provided for in Table 2.9.

**TABLE 2.9: MINIMUM DRIVEWAY STORAGE LENGTH**

Number of Parking Spaces Per Driveway	Minimum Storage Length (Feet)
Less than 50	18
50 to 200	50
More than 200	78

**2.5.5 Driveway Grades**

On streets with curbs, driveways must be a minimum of six inches higher than the gutter elevation on the uphill side of the driveway at some point along its length (preferably at the right-of-way line). This is to prevent water from the street flowing onto private property.

Where driveway construction or reconstruction must occur off the street right-of-way, the usual maximum grade is fourteen percent (14%). The maximum change in grade without vertical curve is twelve percent (12%).

Due to state laws requiring barrier free construction of sidewalks, steps or other abrupt changes in sidewalk grades are prohibited at driveways. All sidewalks shall meet the requirements of the Texas Accessibility Standards. Developer or contractor shall provide post construction TDLR inspection reports to the City.

**2.5.6 Driveways Connecting to Rural Lanes**

Driveways connecting to rural lanes and located on public right-of-way shall be constructed according to details adopted by the City. The size of the drainage pipe or opening shall be established by a Licensed Professional Engineer. Design calculations shall be submitted to the City’s designated engineer for review before driveway construction begins.



### **2.5.7 Driveways for Residential Developments**

Concrete, asphalt residential driveways to serve single car garages shall not be less than eighteen (18) feet in width. Two car garages, carports and/or storage areas shall not be less than eighteen (18) feet and no more than twenty-four (24) feet in width at the property line. The width of the driveway for a three-car garage shall be twenty-eight (28) feet or larger on a case-by-case basis.

Residential driveways shall be separated from one another by a distance of at least ten (10) feet. The radii of all residential driveway returns shall be a minimum of five (5) feet and shall not extend past the adjoining property line. The driveway approaches devoted to one use shall not occupy more than sixty percent (60%) of the frontage abutting the roadway or alley.

Residents will be allowed to construct private driveways with gravel or asphalt millings.

### **2.5.8 Driveways for Multifamily Developments**

Concrete or asphalt driveways providing access to multi-family or nonresidential uses shall have a minimum width of twenty-four (24) feet and a maximum width of forty-five (45) feet when measured at their narrowest point near, or at, the property line. The minimum radius for these uses shall be twenty-five (25) feet. Larger radii are encouraged. Driveway radii returns shall not extend across abutting property lines. The drive aisles shall have a minimum width of twenty-four (24) feet.

### **2.5.9 TxDOT Coordination for Driveways**

Driveways on TxDOT facilities shall be placed in accordance with City Standards set forth in this section, the requirements of current TxDOT's Access Management Manual, and required TxDOT Driveway Permit approval. TxDOT Driveway Permits shall be processed through the City Building and Development Department.

TxDOT Permit Plan sets shall be 11"x17" in size and signed and sealed by a licensed professional engineer with the State of Texas. Permit plan sets shall include: typical sections, paving plan, and profile, all applicable TxDOT standard details, traffic control plans sheets, striping plans, demo plans, drainage plans (drainage area map, storm sewer plans and profiles, culvert plans and profiles), and any other items required by TxDOT or City to construct the driveway. A Traffic Impact Analysis shall be submitted to the City with all TxDOT Driveway Permits.

## **2.6 Pavement Design Requirements**

All new City Streets, alleys, and rehabilitation of existing streets shall be constructed in accordance with these design guidelines. The following specifies minimum standards required for the pavement, subgrade, and subsurface design for roadways and alleys within the City. These minimum standards are not intended to replace the professional judgment of the Geotechnical Engineer for any specific project. The standards may need to be expanded or modified on a case-by-case basis as determined necessary and appropriate by the licensed Geotechnical Engineer, and as approved by the City in writing.

### **2.6.1 Geotechnical Investigation**

A. Field Investigation elements include:

1. Borings shall be drilled on center of proposed roadway, or within proposed roadway widening, at 500-foot spacing (or less), alternating between each roadway direction to a depth of at least 10 feet below finished subgrade or until competent rock is encountered, whichever is shallower. Where existing roadways exist, borings shall be taken just outside the limits of the existing roadway. Additional borings may be requested by the City.

2. Borings shall be sampled at 3-foot intervals or less to a depth of 10 feet below finished subgrade, and at 5-foot intervals or less thereafter.
  3. Bulk samples of each soil type encountered in the upper 5 feet shall be taken for Laboratory Investigation.
- B. Laboratory Investigation elements include:
1. Moisture Content Tests (ASTM D 2216) shall be performed based on in-situ conditions. Average all swell test results to determine the mean maximum swell percentage and the standard deviation.
    - a. For samples taken during the months of June through September, use the mean swell percentage to determine the design swell percentage.
    - b. For samples taken during the months of October through May, use the mean plus one standard deviation to determine the design swell percentage.
      2. Soil types in each boring shall be classified as follows:
        - a. Atterberg limits (ASTM D 4318)
        3. Percent Passing the No. 200 sieve (ASTM D 1140)
        4. Moisture/Density
  - C. A geotechnical re-evaluation will be required if there is no appreciable progress onsite for more than 6 months; when conditions have changed significantly between moisture conditioning and liming operations; when Contractor and/or Owner have not properly maintained moisture content; when the finished grade is more than 2 feet above or below the existing grade; or as deemed necessary by the City. The re-evaluation shall include additional field and laboratory testing to confirm moisture conditioning is still acceptable, and how to rectify the substandard condition prior to liming operations, as necessary. Borings for the re-evaluation will be required on center of roadway at 1,000-foot spacing (or less) or on an 800-foot grid throughout a subdivision to a depth of at least 10 feet below finished grade or until competent rock is encountered, whichever is shallower.
  - D. Geotechnical investigation must address heavily treed areas, where such trees are to be removed. Additional borings may be required in these areas.

### **2.6.2 Subgrade Requirements**

- A. Laboratory Investigation elements include:
1. Lime stabilization series for each soil type expected to be in the upper 12-inches of the subgrade. The Eades-Grimm method of pH testing shall be used to obtain a beginning point. Additional testing shall be performed for each soil type to determine lime content. Minimum design criteria are:
    - a. pH = 12.4 (or maximum pH) after mellowing (ASTM D 2976);
    - b. Swell potential < 1.0 percent under 200 psf stress test (ASTM D 4546); and,
    - c. The minimum lime content shall be the percentage, by weight, of hydrated lime as determined by lime stabilization series plus 1.0%, and in no case be less than the City's minimum requirements as listed in Table 5.1.
  2. Test for sulfates in the upper 3-feet of the subgrade in each boring using EPA 9038 or EPA 375.4 with 10:1 dilution ratio. Provide testing to determine the levels of sulfate present in all soil types in the upper 3 -feet.
    - a. Formations having over 6,000 ppm (0.6%) sulfates shall be lime stabilized using a double application method. Refer to Technical Specifications for lime application methods.

- b. Alternative subgrade options may be proposed by the Geotechnical Engineer and may be approved by the City.
- c. Flexible base, if proposed as an alternative subgrade, shall have a minimum depth of 6 inches and shall extend a minimum of 2-feet behind the back of curb. Flexible base shall meet TxDOT Specifications, Item 247, Type A or B, Grade 1, 2 or 6.
- d. All base courses shall be constructed on subgrade course approved by the City. In areas of poor subgrade, the developer may be required to stabilize the subgrade material with lime or other approved materials to obtain an acceptable subgrade condition, as determined by the City.
- e. All subgrade improvements shall be in accordance with these Engineering Design Standards, the Technical Specifications, and the Geotechnical Report requirements unless otherwise approved by the City designee.

### **2.6.3 Pavement Design**

Asphalt concrete design: All Standards shall be followed meeting the minimum requirements in the Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets, and Bridges, most current edition. Surface shall be a minimum of 2 inches thick, meeting requirements of Items 340 - Hot Mix Asphaltic Concrete Pavement, Type D. Refer to detail sheets A-1 "Residential (Local) 6-Inch HMAC Pavement Section" and A-3 "Residential (Collector) 7-Inch HMAC Pavement Section." Design is subject to the City's approval.

Portland Cement Concrete design: Six-inch reinforced concrete pavement with integral curb and gutter. The compressive strength of the concrete shall not be less than 4,000 psi in 28 days, the cement content shall be no less than 6.5 sacks per cubic yard, and the maximum water/cement ratio shall not exceed 5.0 gallons/sack. Where the subgrade is rock, the rock shall be removed to a depth of four inches and backfilled with sand before placing the concrete. The pavement shall be reinforced with #4 bars on 18" centers or #3 bars on 10" centers. All subgrade, subbase, form lines, and grades shall be approved by the City prior to the placement of any concrete. Refer to detail sheets A-2 "Residential (Local) 6-Inch Concrete Pavement Section" and A-4 "Residential (Collector) 7-Inch Concrete Pavement Section." Design is subject to the City's approval.

### **2.7 Turn Lanes**

All left turn storage areas shall be eleven (11) feet wide with minimum storage requirements for left-turn lanes. The transition curves used in left-turn lanes shall be two (2), 250-foot radius reverse curves with a total transition length of 100 feet. Medians less than seven (7') feet wide (face to face) are required to be constructed of reinforced integral stained and stamped color concrete a minimum of six (6") inch thick median pavement. All median noses are to be constructed of City approved integral stained and stamped color concrete. The color and pattern to be approved by the City. The paver system shall be installed a distance of ten (10') feet from the end of the nose.

### **2.8 Intersections**

More than two streets intersecting at one point shall be avoided, except where it is impractical to secure a proper street system otherwise. Where several streets converge at one point, setback lines, special rounding or cut-off of corners or a traffic circle may be required to ensure safety and facility of traffic movement. The design of any such intersection shall be approved by the City. All street designs shall be

in accordance with AASHTO manual, A Policy on Geometric Design of Highway and Streets, most current edition.

No street intersection, unless approved by the City Engineer, shall be at an angle less than 60 degrees. Major street intersections shall have property line corner radii with a minimum tangent distance of 30 feet. Minor and residential streets shall have as the property line corner, the point of intersection of intersecting streets. Curb radii at intersections shall in no case be less than 11.5 feet measured from the back of the curb.

Visibility easements will be required for all ninety (90°) degree intersections. For all intersections that are not ninety (90°) degrees, an engineered visibility easement is required by the design engineer.

- A. Arterial/Collector Street intersections - thirty (30) foot by thirty (30) foot easement
- B. Residential Street intersections - twenty (20) foot by twenty (20) foot easement
- C. Alley to street intersections - ten (10) foot by ten (10) foot easement
- D. Curb radii at intersections shall have a minimum radius of thirty (30) feet along arterials, twenty-five (25) feet along collectors and twenty (20) feet along residential streets.
- E. In any case where streets intersect at an angle of other than ninety (90) degrees, the City may require non-standard right-of-way corner clips and curb return radii.
- F. All proposed paving connections to existing paving require a longitudinal butt joint connection.

## **2.9 Dead End Streets**

Where a road does not extend beyond the boundary of the subdivision and its continuation is not required by the Planning and Zoning Commission or the City Council for access to adjoining property, its terminus shall normally not be nearer to such boundary than 50 feet. However, the Planning Commission or the City Council may require the reservation of an appropriate easement to accommodate drainage facilities, pedestrian traffic, or utilities. A cul-de-sac turnaround shall be provided at the end of a permanent dead-end street in accordance with local government construction standards and specifications.

Cul-de-sacs are permitted and encouraged within residential subdivisions. Use of this design shall provide proper access to all lots and shall not exceed six hundred (600) feet in length, measured from the center of the cul-de-sac to the center of the intersecting street (not a dead-end street). Cul-de-sac shall have a minimum paving radius of thirty-five (35) feet and a minimum right-of-way radius of forty-five (45) feet. In lieu of the typical design specified above, the City may approve alternative concepts for another application.

## **2.10 Parking**

All parking areas and spaces shall be designed and constructed of steel reinforced concrete in accordance with the following minimum requirements:

- A. All parking areas and spaces shall be designed and constructed of steel reinforced concrete so as to have free ingress and egress at all times.
- B. No parking space or parking area shall be designed to require a vehicle to back into a public street or across a public sidewalk, except in the case of one- and two-family dwelling units

### **2.10.1 On Street**

Minimum Dimensions for On-Street Parking:

- A. Parallel Parking – Each parking space shall not be less than nine (9) feet in width and twenty-two (22) feet in length. Maneuvering space will not be less than twenty (20) feet.

### **2.10.2 Off Street**

Minimum Dimensions for Off-Street Parking:

- A. Ninety-degree parking – Each parking space shall be not less than nine feet wide nor less than 18 feet in length. Maneuvering space shall be in addition to parking space and shall be not less than 24 feet perpendicular to the building or parking line.
- B. Sixty-degree angle parking – Each parking space shall not be less than nine feet wide perpendicular to the parking angle nor less than 17 feet in length when measured at right angles to the building or parking line. Maneuvering space shall be in addition to parking space and shall be not less than 20 feet perpendicular to the building or parking line.
- C. Forty-five-degree angle parking – Each parking space shall be not less than nine feet wide perpendicular to the parking angle nor less than 16 feet in length when measured at right angles to the building or parking line. Maneuvering space shall be additional to parking space and shall be not less than 18 feet perpendicular to the building or parking line.
- D. When off-street parking facilities are located adjacent to a public alley, the width of the alley may be assumed to be a portion of the maneuvering space requirement. The maneuvering space requirement for parking areas shall not include any portion of an abutting public street or highway.

### **2.11 Sidewalk**

Sidewalks shall be provided for all residential streets in subdivisions and on all streets. Barrier free ramps and sidewalks along screening walls, landscaped areas, trails, parks, open space, greenbelts, and/or drainage ways, shall be installed by the Developer with street construction and the sidewalks in front of residential lots shall be installed by the home builder. The City may require sidewalks in other locations.

Sidewalks not located on the back of curb shall be a minimum of five (5) feet in width and shall have three (3) feet of green space, if no trees are present, between the Right of Way line and the outside edge of sidewalk. If trees are present, the minimum setback from the back of curb shall be a minimum of seven (7) feet.

Sidewalks that are adjacent to the back of curb must be a minimum of 5 feet and lugged into the curb. Sidewalks shall be located wholly within the street Right of Way, sidewalk corner clip easement, or road easement. If a fire hydrant is too close to the sidewalk, swerve sidewalk toward the right-of-way line to maintain five (5) feet clear path. If a sidewalk has to be built outside the right-of-way, a sidewalk easement is required. This requirement may be waived by the City Council. Sidewalks/Trails wider than 5' will be required to have engineered details.

#### **2.11.1 Texas Accessibility Standards (TAS)**

- A. All plans and specifications for the construction or alteration of public buildings and facilities, privately owned buildings and facilities leased or occupied by state agencies, places of public accommodation, pedestrian facilities within public right-of-way, and commercial facilities must be in compliance with the Texas Accessibility Standards (TAS) for individuals with disabilities and must conform to the standards required by regulations issued by the Texas Department of Licensing and Regulation (TDLR) under the Architectural Barriers Act, codified

as Article 9102. Texas Civil Statutes (see Architectural Barriers Administrative Rules – Section 68.30 for exemptions).

- B. Projects with a total estimated construction cost of \$50,000 or more are required to submit a full set of construction documents in accordance with Administrative Rule 68.20 to TDLR for registration and review. For Public Right-of-Way projects, the estimated cost for the project shall be based on pedestrian elements only in accordance with Administrative Rule 68.102. If a project's total estimated construction cost is less than \$50,000, it is not required to be submitted to TDLR for registration and review; however, the project is still required to comply with TAS.

An architect, engineer, interior designer, or landscape architect with overall responsibility for the design of a building or facility subject to subsection 5(j) of the Architectural Barriers Act, shall mail, ship, or hand deliver the project registration form, review and inspection fees, and construction documents to the TDLR, a registered accessibility specialist, or a contract provider no later than thirty (30) business days after the design professional seals and signs the construction documents. An Architectural Barriers Project Registration form must be completed for each subject building or facility.

### **2.12 Traffic Information and Control Devices**

Any work disturbing traffic on City streets shall require a signed and sealed traffic control plan by a Registered Professional Engineer in the State of Texas. All signage in City right-of-way shall conform to the Texas Manual of Uniform Traffic Control Devices.

The developer shall be responsible for and arrange for the installation of all pavement striping, regulatory, warning, guide, and school zone signs including posts, as shown on the plans or as directed by the City. Street name signs shall be installed at each intersection. Examples of regulatory, warning, information and guide signs are as follows:

- A. Regulatory signs shall include, but are not limited to, STOP, 4-WAY, YIELD, KEEP RIGHT and speed limit signs.
- B. Warning signs shall include, but are not limited to, DEAD END, NO OUTLET, DIVIDED ROAD, DIP, and PAVEMENT ENDS.
- C. Guide signals shall include, but are not limited to, street name signs, DETOUR, direction arrow and advance arrow.
- D. Traffic striping and buttons shall be provided by the developer as shown on plans or as directed by the City.

All signage within medians shall be break away pole bases.

### **2.13 Permanent Lane Markings**

The purpose of this section is to describe the typical layout of permanent lane markings used by the City of Mount Vernon. These marking standards are designated by number or letter types. Numerical designation (i.e., TYPE 1, TYPE 2, etc.) is used to denote markings separating lanes of traffic moving in the same direction and are white markings. Alphabetical designation (i.e., TYPE A, TYPE B, etc.) is used to denote markings separating lanes of traffic moving in opposing directions and are yellow. Therefore, any street section with pavement markings can be fully described by a TYPE number and/or letter combination.

Lane lines and center lines will utilize reflectorized thermoplastic hot applied coatings. The width of the marking shall be as indicated below unless otherwise stated. Lane and cross walk markings are required on all thoroughfares, arterials, collectors, residential and local streets. Stop bars are required for each lane at all traffic lights and stop signs.

The following describes the types of layouts as designated in these standards. Drawings that include specifications of each type are available from the City.

- TYPE 1: is a skipped white line normally used on streets having four or more lanes. The normal stripe/skip cycle of 15'/25' is used with a 4-inch wide stripe.
- TYPE 2: consists of a single solid white line, four inches wide, normally to designate special lane control (RIGHT LANE MUST TURN RIGHT).
- TYPE 3: consists of a single solid line white line, eight inches wide, to designate a left turn bay.
- TYPE 4: consists of a 12-inch wide solid white line used to designate each side of a crosswalk.
- TYPE 5: consists of a 24-inch wide solid white line used to designate a stop bar.
- TYPE A: is a skipped yellow centerline used on roadways of only two lanes of traffic. The normal stripe/skip cycle of 15'/25' is used with a four-inch wide stripe.
- TYPE B: is a solid yellow centerline used on undivided four lane roadways. These markings consist of two solid four-inch wide yellow stripes with a four-inch space.

## **2.14 Signs**

### **2.14.1 Street Name Signs**

- A. Street name signs shall be installed at all intersections of public streets, private streets, and public ways in accordance with the City's Standard Details, Technical Specifications and requirements.
- B. Street name blades shall be nine inch (9") tall aluminum.
- C. The street name shall be left justified, with block numbers located in the upper right-hand and upper left-hand corners. Abbreviated street designations shall be located in the lower right-hand corner. Where applicable, the abbreviation for the street direction (N, S, E and W) shall be at the upper left – hand corner.
- D. The lettering of the street name shall be Federal Highway Series B or Series C (manufacturer is to determine best series to use based on length of blade and length of name), six inches (6") tall and upper/lower case. Letters of abbreviated street designations shall be three inches (3") tall upper/lower case (i.e., Ln, Pkwy, Dr, Ct, etc.). Block numbers and abbreviation for direction shall be 3" tall.
- E. A street name shall be limited to sixteen (16) characters, not including the street designation. A street name shall either consist of one word no longer than sixteen (16) letters or two words separated by one space where the two words have no more than fifteen (15) letters combined.
- F. Sign sheeting shall be high intensity. The background shall be green and the legend shall be white.

- G. For a street with only one cul-de-sac end, a standard W 14-2a “No Outlet” shall be mounted over the street name blade. In the case of a street with two cul-de-sac ends, two standard W 14-2a “No Outlet” signs shall be mounted over the street name blade in the appropriate directions.
- H. Owners, developers, and/or contractors should contact the City of Mount Vernon at 903-537-2252 to obtain block number information. Block numbers are required on all street name blades, even if no homes or buildings front onto the street.

### **2.14.2 Regulatory Signage**

Regulatory signs should be used only where justified by engineering judgment. All signage plans shall be reviewed and approved by the City of Mount Vernon and be designed in accordance with the principles described in the current Texas Manual on Uniform Traffic Control Devices (TMUTCD).

All street and regulatory signage shall be installed, inspected, and approved prior to final acceptance of the project. This inspection typically takes place as part of the City’s final walkthrough. Any sign related issue/issues will be noted on the projects final punch list.

- A. A detailed street and regulatory signage plan are to be submitted to the City of Mount Vernon. All signs shall be shown in the engineering plans for review and approval. The signage plan shall be shown on a separate signage & pavement marking layout sheet or as a part of the plan & profile sheet. The plan shall identify the specific sign designation, size, and location for each sign. Sign standards shall also be included in the engineering plans.
- B. All signage installed shall comply with the current “Texas Manual on Uniform Traffic Control Devices” and the “Standard Highway Sign Designs for Texas.” The sign layout drawings shall show the color and dimensions of all sign face legend components including background color, legend color, borders, symbols, letter size and style.
- C. The developer shall be responsible for furnishing and installing all regulatory signage, warning signage and street name signage along with all necessary sign mounts in accordance with the approved engineering plans. A sample production sign shall be submitted to the Traffic Signs & Pavement Markings Supervisor for review and approval. The sample sign must be submitted at least 10 days prior to the scheduled installation date.

### **2.14.3 Standard Street Sign Pole and Fixtures**

- A. Standard Street Signpost – shall be 12’ long - minimum (2-3/8”) galvanized steel round post with a minimum of 60 mil wall thickness.
- B. Standard Post Installation Depth – signpost shall be installed into solid ground to a minimum depth of 24-inches and anchored with a minimum of 60lbs of concrete.
- C. Standard Post Bracket – shall be (18”) cast aluminum round post bracket street sign mount for bottom street blade.
- D. Standard Top Crossing Bracket – shall be (12”) cast aluminum top crossing street sign bracket mount for top street blade.
- E. Standard Mounting Bracket Assemblies – shall be (2-2/8”) diameter aluminum round post interlocking bracket x 2 per pole.

### **2.14.4 Decorative Sign Pole and Fixtures**

The City of Mount Vernon will allow the installation of decorative signs and posts or other non-standard items by Developers/Homeowners Associations on a case-by-case basis provided that their installation



does not result in an adverse impact to the public safety and that there is no cost to the City for installation or maintenance. Residential developer requesting such installations will be required to give the recorded documentation of an incorporated Homeowner's Association (HOA) to the City. The City of Mount Vernon maintains only standard street and regulatory signs/post installed on public streets within its designated right-of-way. The City of Mount Vernon does not maintain decorative sign poles and fixtures installed by developers or HOA.

If the developer elects to install non-standard decorative signs, sign poles and fixtures, the designated HOA must enter into a maintenance agreement with the City covering the hold harmless provisions. These provisions shall be noted on the approved final plat for the subdivision. The platted maintenance provisions will serve as the agreement and applies to all non-standard decorative signs, poles/post, hardware, or any other attachments. The City of Mount Vernon has no maintenance or other responsibility for these items. The ownership and maintenance of all such signs, poles and fixtures become the maintenance responsibility of the designated HOA.

Decorative Sign Pole/Fixture Submittals: A detail of the decorative sign poles, pole fixtures and base mounting shall be included with the submittal of the civil engineering construction plans. The submittal shall also include a street/site plan indicating the location and identification of all proposed signage and post to scale.

## **2.15 Lighting**

All developments shall provide streetlights. Streetlights shall not be greater than four hundred feet (400') apart and shall not be closer than one hundred fifty feet (150') apart except when located at two closely spaced intersections or at a roundabout. Streetlights shall be centered one and half (1 ½) feet off the back of curb.

Cul-de-sac streets over two hundred twenty-five feet (225') in length, measured from centerline of cross street to center point of cul-de-sac, shall, at a minimum, have a streetlight installed at the street intersection and on the perimeter of the cul-de-sac bulb. The developer is responsible for providing easements and shall submit proof that any necessary arrangements with the appropriate power company have been made. Electrical power lines shall be installed below grade with pad-mounted transformers.

Fire hydrants shall not be installed on the same corner of a residential intersection that contains a streetlight or a signpost. The fire hydrant shall be located away from the corner (beyond the curb return) or be located on a different corner of the intersection. The placement of streetlights shall be at the approval of the city.

### **3 DRAINAGE DESIGN REQUIREMENTS**

#### **3.1 Development Criteria**

Drainage facilities shall be designed and constructed at such locations and of such size and dimensions to adequately serve the development and the contributing drainage area upstream of the development. The developer shall provide all the necessary easements and rights-of-ways required for drainage structures including, but not limited to, storm drains and open channels, (lined or unlined), flood detention facilities, and stormwater diversion or containment facilities (such as levees, dams, berms and stream diversions). The minimum easement width for drainage facilities shall be 30 feet. For detention pond easements, water lines and wastewater lines will not be allowed in the easement.

The design flows for the drainage system shall be calculated by the Rational Method in accordance with the requirements set forth in this document unless otherwise noted within these Standards (such as where the unit hydrograph methods are required). Curbs, inlets, manholes, etc. shall be designed and constructed in accordance to the Standard Details. Materials and construction procedures shall conform to the requirements of the Standard Specifications for Construction.

The developer shall provide plans, specifications, and design calculations for all drainage structures. All open channels that are not concrete lined shall be designed to prevent erosion. The City shall specifically approve the type of methods used for prevention of erosion.

The design, size, type, and location of all storm drainage facilities shall be subject to the approval of the City. The requirements set forth herein are considered minimum requirements. The developer and their engineers shall bear the total responsibility for the adequacy of design. The approval of the facilities by the City in no way relieves the developer and their engineer of this responsibility.

The design factors, formulas, graphs, and procedures described shall serve as means to prove that adequate conveyance of storm water and adequate flood prevention within the City is being provided. Responsibility for the actual design remains with the developers and design engineer of record. Deviation from the requirements of these standards shall require the approval of the City.

The City, as a participant in the National Flood Insurance Program (NFIP), must enforce all parts of its adopted Flood Hazard Damage Prevention and Erosion Control Ordinance, as approved by the Federal Emergency Management Agency (FEMA). Therefore, the requirements of that ordinance are adopted and included as a part of the City's Standards of Design and Construction.

The developer shall be responsible for the necessary facilities to provide drainage patterns and drainage controls such that properties within the overall watershed, whether upstream or downstream of the development, are not adversely affected by storm drainage from facilities on the development.

The storm drainage plan provided as part of the final engineering drawings shall address how storm water on the proposed development and affected adjoining properties will be controlled during phased and completed development. Off-site improvements may be required to carry the additional flows caused by the proposed development. If the downstream system is insufficient to carry the proposed flow without causing potentially increased flood damages, detention will be required to release only the flow amount capable of being carried in the existing system.

Storm drainage released from the site will be discharged to a natural water course or storm sewer system of an adequate size to convey the 100-year storm runoff expected after development.

### 3.2 Hydrology

#### 3.2.1 Rational Method

Rational Method is a procedure used in hydrology to accurately calculate small runoff drainages that contain impermeable area. It is recommended that the rational method be used for computing peak flow of runoff for areas smaller than 200 acres. Examples of implementation of this method include designing parking lots, inlets, small detention facilities, etc. The rational formula is expressed by:

$$Q = C \times I \times A$$

where: Q = peak runoff rate, cubic feet per second (cfs)  
 C = runoff coefficient (no dimension)  
 I = average rainfall intensity (in/hr)  
 A = drainage area in acres (ac)

#### 3.2.2 Runoff Coefficient

Runoff Coefficient describes the percentage of precipitation that appears as runoff and shall be based on total development under existing land conditions. Table 3.1 below contains values for runoff coefficients that are associated with typical land use within the City of Mount Vernon. However, if an area of land is not described by the table, then a coefficient shall be developed by utilizing values that are comparable to the values shown. In the case of a situation where an area constitutes multiple land uses a weighted runoff coefficient may be used.

TABLE 3.1: RUNOFF COEFFICIENTS AND MAXIMUM INLET TIMES

Zoning District Name	Run-off Coefficient "C", for Sandy Soils	Run-off Coefficient "C", for Clay Soils	Max Inlet Time (minutes)
Agricultural Residential	0.30	0.40	20
Single Family Residential	0.40	0.50	15
Single Family Residential	0.50	0.60	15
Two Family Residential	0.55	0.65	15
General Residential	0.55	0.65	15
Multi-Family	0.70	0.80	10
Retail District	0.85	0.85	10
Central Area District	0.90	0.90	10
Commercial District	0.90	0.90	10
Light Industrial	0.70 - 0.90	0.70 - 0.90	10
Heavy Industrial	0.70 - 0.95	0.70 - 0.95	10
Planned Development	0.55	0.65	20
<b>Non-Zoned Land Uses:</b>			
Church	0.70	0.90	10
School	0.50	0.90	10
Park	0.30	0.70	10
Cemetery	0.30	0.50	15
Street and Highway ROW	0.95	0.95	10

**3.2.3 Time of Concentration**

The time it takes water to flow from the furthest point in a watershed to a designated point of measurement is the time of concentration. The furthest point to an outlet in a watershed is not necessarily the longest flow distance to the outlet but represents the longest travel time. There are multiple methods used to determine time of concentration, however, to avoid an iterative process the SCS TR55 method should be used. This method takes the sum of travel times for sheet flow, shallow concentrated flow, and open channel flow.

- A. Sheet flow: The maximum allowable length for sheet flow is 200 feet (200') for undeveloped drainage areas and 100 feet (100') for developed areas. Table 3-2 below contains typical 'n' values for sheet flow and sheet flow can be determined by the following equation:

$$T_t = \frac{.007(nL)^8}{(P_2)^5(S)^4(60)}$$

- where:
- T<sub>t</sub> = travel time (minutes)
  - n = Manning's roughness coefficient (Table 3.2)
  - L = Flow length (ft.)
  - P<sub>2</sub> = 2-year, 24-hour rainfall
  - S = land slope of hydraulic grade line (ft/ft)

TABLE 3.2: TYPICAL SHEET FLOW 'n' VALUES

Surface Description	n
Smooth surfaces (i.e., concrete, asphalt, gravel, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover less than 20%	0.06
Residue cover greater than 20%	0.17
Grass:	
Short Prairie Grass	0.15
Bermuda Grass	0.41
Dense Grasses	0.24
Range (natural)	0.13
Woods:	
Light underbrush	0.40
Dense underbrush	0.80

- B. Shallow Concentrated Flow: This flow begins where the sheet flow left off. This type of flow can be calculated by:

$$T_{sc} = \frac{L_{sc}}{3600V(60)}$$

- where:
- T<sub>sc</sub> = travel time (minutes)
  - L<sub>sc</sub> = Flow length (ft.)
  - V = Velocity (ft./s)
  - Unpaved Slope = 16.135 \* (S)<sup>5</sup>

$$\text{Paved Slope} = 20.328 * (S)^5$$

- C. Channel Flow: The travel time of channel flow begins where shallow concentrated flow ends. It is found by utilizing Manning’s equation to find the average velocity and then using this velocity in the shallow concentrated flow equation. Manning’s equation is as follows:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

- where: n = Manning’s roughness coefficient (See section 3.3)  
 R = hydraulic radius (cross sectional area / wetted perimeter) (ft)  
 S = hydraulic grade line slope (ft/ft)

**3.2.4 Rainfall Intensity**

Rainfall intensity is a measure of the amount of rain that accumulates at a location over a specified period of time and is based on design rainfall duration as well as design frequency of occurrence. The design storm frequency for drainage design in Mount Vernon will be 100 years in every case. That is, drainage structures must accommodate for the storm runoff event in which has a one percent chance of being equaled or exceeded in a given year.

The values for rainfall coefficients (b, d, e) below were found for the respective intensity level through the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 11, or can be found through the NOAA’s Precipitation Frequency Data Server. These coefficients were determined based on the county of the data in question, in this case Franklin County. When calculating the peak storm runoff, rainfall intensity shall be determined from the following formulas:

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

$$I_s = \frac{63.5}{(t_c + 10.88)^{.7868}}$$

$$I_{10} = \frac{73.27}{(t_c + 10.84)^{.779.4}}$$

$$I_{25} = \frac{83.81}{(t_c + 10.61)^{.77.47}}$$

$$I_{50} = \frac{94.34}{(t_c + 10.43)^{.7709}}$$

$$I_{100} = \frac{104.98}{(t_c + 10.21)^{.7683}}$$

c

- Where: I = Rainfall Intensity (in/hr)  
 t<sub>c</sub> = Time of Concentration (min)  
 e, b, d = coefficients based on rainfall IDF data  
 These equations can be observed graphically in Figure 3.1

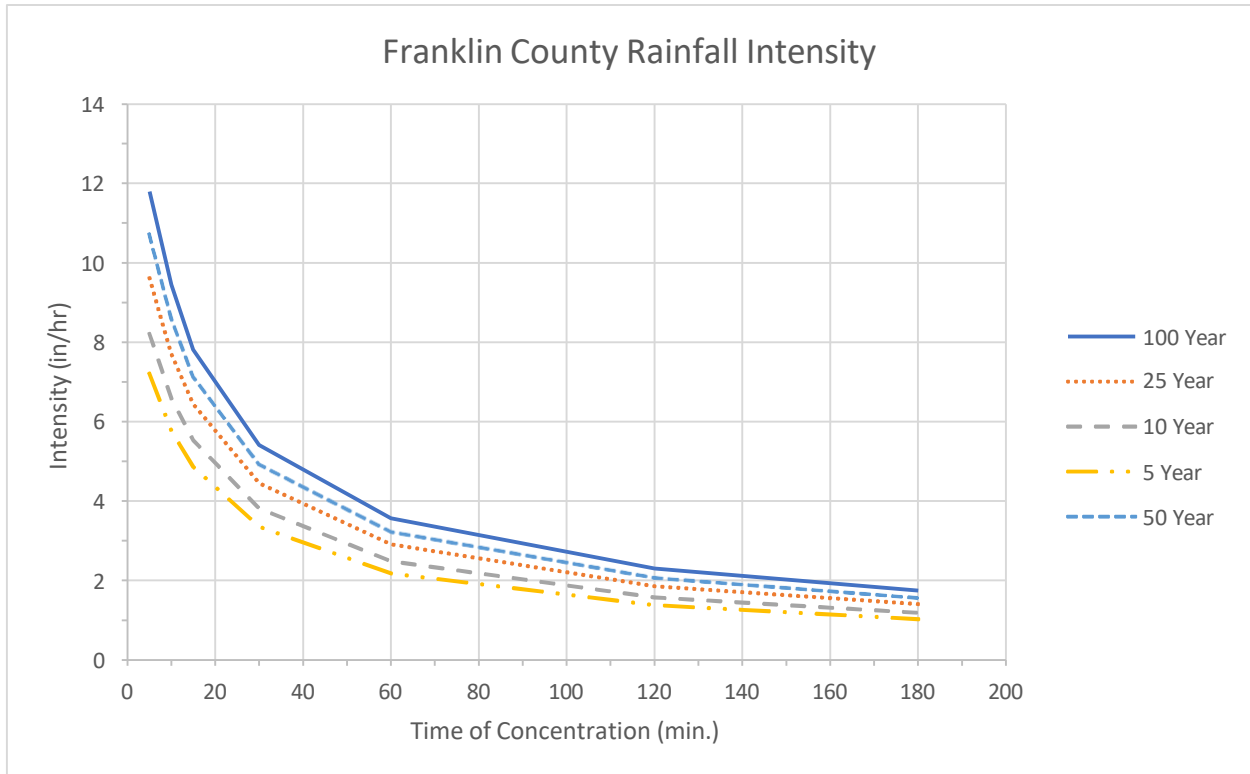


FIGURE 3.1: RAINFALL INTENSITY FOR MOUNT VERNON

### 3.2.5 Drainage Area

A drainage area will be defined as an area characterized by all runoff conveyed to the same outlet. The size and shape of the drainage area must be determined. The area may be calculated by means of utilizing topographic surveys and a drainage area map must be provided along with the project. It is important that drainage subarea contributing to each inlet point be identified and all flow rate calculation points be delineated.

### 3.2.6 Unit Hydrograph Method

A unit hydrograph method (such as the SCS/NRCS curve number method) may be used to calculate runoff from drainage areas up to 200 acres and shall be used for calculating runoff from drainage areas greater than or equal to 200 acres. Data is presented below for use in unit hydrograph calculations.

#### A. Precipitation

Depth/Duration/Frequency data for Mount Vernon (developed from NOAA Technical Memorandum NWS HYDRO-35 "Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States" and Weather Bureau Technical Paper No. 40 "Rainfall Frequency Atlas of the U.S.") is presented in Table 3.3.

TABLE 3.3: PRECIPITATION DEPTH IN INCHES

Rainfall Frequency					
Duration	2-yr	5-yr	10-yr	25-yr	100-yr
5 min	0.501	0.601	0.684	0.801	0.982
10 min	0.801	0.962	1.100	1.280	1.580
15 min	1.010	1.220	1.380	1.610	1.950
30 min	1.400	1.680	1.910	2.220	2.700
60 min	1.820	2.180	2.490	2.910	3.570
2 hours	2.270	2.750	3.145	3.710	4.600
3 hours	2.550	3.100	3.570	4.230	5.270
6 hours	3.050	3.750	4.340	5.160	6.480
12 hours	3.610	4.450	5.160	6.160	7.750
24 hours	4.220	5.230	6.070	7.260	9.130

B. Curve Numbers

Curve numbers for use in the SCS curve number runoff method is presented in Tables 3.4 and 3.5. Hydrologic soil groups shall be determined from the SCS soil surveys of Franklin County.

TABLE 3.4: RUNOFF CURVE NUMBERS FOR URBAN AREAS  
*Compiled from NRCS T.R. 55 "Urban Hydrology for Small Watersheds", Rev. 1986*

Cover Description		Curve No. for Hydrologic Soil Group			
		A	B	C	D
Cover Type and Hydrologic Condition	Avg. Percent Impervious				
<i>Open Space (lawns, parks, golf courses, cemeteries)</i>					
	Poor condition (grass cover <50%)	68	79	86	89
	Fair conditions (grass cover 50% to 75%)	49	69	79	84
	Good condition (grass cover >75%)	39	61	74	80
<b>Impervious Areas</b>					
	Paved parking lots, roofs, driveways (excl. ROW)	98	98	98	98
	Streets and roads				
	Paved; curbs and storm drains (excl. ROW)	98	98	98	98
	Paved; open ditches (incl. ROW)	83	89	92	93
	Gravel (incl. ROW)	76	85	89	91
	Dirt (incl. ROW)	63	77	85	88
<b>Urban Districts</b>					
	Commercial and business	85	89	92	94
	Industrial	72	81	88	91
<b>Residential Districts By Average Lot Size</b>					
	1/8 acre or less (town houses)	65	77	85	90
	1/4 acre	38	61	75	83
	1/3 acre	30	57	72	81
	1/2 acre	25	54	70	80
	1 acre	20	51	68	79
	2 acres	12	46	65	77

TABLE 3.5: RUNOFF CURVE NUMBERS FOR AGRICULTURAL LANDS

Compiled from NRCS T.R. 55 "Urban Hydrology for Small Watersheds", Rev. 1986

Cover Description		Curve No. for Hydrologic Soil Group			
		A	B	C	D
Cover Type	Hydrologic Condition				
Pasture, grassland or range – continuous forage for grazing <sup>(1)</sup>	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay		30	58	71	78
Brush – brush-weed-grass mixture with brush the major element <sup>(2)</sup>	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods-grass combination (orchard or tree farm) <sup>(3)</sup>	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods <sup>(4)</sup>	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads – buildings, lanes, driveways and surrounding lots		59	74	82	86

<sup>(1)</sup> Poor: <50% cover (heavily grazed), Fair: 50% to 75% cover (moderately grazed), Good: >75% cover (lightly grazed)

<sup>(2)</sup> Poor: <50% cover, Fair: 50% to 75% cover, Good: >75% cover

<sup>(3)</sup> CN is for 50% woods and 50% grass, others may be computed from the CN's for woods and pasture

<sup>(4)</sup> Poor: Forest litter, small trees and brush are destroyed by heavy grazing or regular burning  
Fair: Woods are grazed but not burned, some forest litter covers the soil

Good: Woods are protected from grazing, litter and brush adequately cover the soil

**C. Lag Time**

Lag time shall be calculated as 60% of the time of concentration. Time of concentration shall be computed in accordance with subchapter 3.2.3.

**3.3 Hydraulics**

**3.3.1 Open Channel Flow**

Open channel flow pertains to liquid flow within a channel or conduit that is characterized by a flowing free surface. The analysis of open channel flow in engineering is pertinent to design and aids in determining of features such as flood elevations, time of concentration, and other flow related concerns. For design purposes all flow can be assumed as steady and uniform.

**3.3.2 Channel Design**

**A. General**

1. Any channel modification must meet the applicable requirements of all Local, State and Federal Regulatory Agencies.
2. Channels shall be improved to a capacity of the 100-year design discharge by excavation, straightening and realignment, as required.
3. All open channels require a minimum freeboard of one foot (1') above the 100-year water surface elevation.



4. In lieu of the improvements of a channel draining an area, the City Council may elect to accept the dedication of all land within the natural 100-year floodplain of the existing drainage channel as a permanent right-of-way.
  5. Channel armoring for erosion control shall be provided where deemed necessary by the City designee. Armoring options should encourage vegetative growth.
  6. Unlined, un-vegetated excavated channels are not allowed. Construction of excavated channels will not be considered complete until the channel banks are stabilized.
- B. Landscape plans must be submitted and approved by the City prior to any channelization being allowed. The goal of an open channel is to create a natural vegetated channel.
1. Supercritical flow shall not be allowed in channels except at drop structures and other energy dissipaters.
- C. Maintenance
1. Excavated open channels are subject to facility maintenance agreements.
  2. If the channel cannot be maintained from the top of the bank, a maintenance access ramp shall be provided and included within the drainage easement.
- D. Geometry
1. Earthen side slopes shall be no steeper than four-to-one (4:1), horizontal to vertical, and shall be sodded to prevent erosion.
  2. Minimum channel bottom widths are recommended to be equal to twice the depth of the channel. Any permanent open channel shall have a minimum bottom width of five feet (5').
  3. The minimum slope for an excavated improved channel is 1% unless a pilot channel is constructed, or otherwise approved by the City.

### **3.3.3 Design Frequency**

Open channels in the City of Mount Vernon shall be designed to contain the runoff from the 100-year frequency storm within the right-of-way while providing a minimum of one foot of freeboard. In those cases where channel modifications are necessary to control increased flows from proposed development, proposed water surface profiles are restricted such that the proposed 100-year flood shall not exceed the existing 100-year flood profile. Additionally, the channel must be designed to have sufficient freeboard to provide adequate drainage of lateral storm sewers, during the 25-year storm.

### **3.3.4 Velocity**

- A. Velocities
1. A downstream assessment shall be performed to determine maximum discharge velocities.
  2. Table 3-3 provides allowable ranges for roughness coefficients of open channels, as well as maximum allowable velocities for various types of excavated channel cover. These maximum velocities do not apply for drainage facilities discharging off-site.
  3. At transitions in channel characteristics, velocities must be reduced to the maximum velocity per the downstream assessment. Velocities must be reduced before the flow reaches the natural channel using either energy dissipaters and/or wider and less steep channel.

### **3.3.5 Flow Depth**

Channels should maintain a depth as shallow as possible for a successful design. Maintenance of deeper channels becomes more problematic.

**3.3.6 Freeboard**

There are currently no widely adopted standards pertaining to the design levels of freeboard in open channels. However, it shall be adopted that a minimum value of 1 foot of freeboard be administered between the 100-year frequency water elevation in all facets. Although it is not required, additional freeboard should be considered by the designing engineer for deserving situations that may cause damage or threaten civilian safety. Design aspects that may yield such disposition may include flow profile stability, overflowing channel banks, and design discharge estimates.

**3.3.7 Manning’s Roughness Coefficient**

Manning’s Roughness Coefficient will be utilized in the design of open channel flow properties. Table 3.6 provides the reader with typical roughness coefficients as well as maximum allowable velocities for certain open channel covers. It is important to note that not all situations apply to the table therefore the designing engineer reserves the responsibility of maintaining an ethical design.

TABLE 3.6: CHANNEL ROUGHNESS COEFFICIENTS AND VELOCITIES

Channel Description	Roughness Coefficient	Max Channel Velocity (fps)
concrete-lined	0.013	15
brick-lined	0.015	15
gabions	0.04	10
Riprap	0.035	10
maintained grass	0.035	8
non-maintained grass	0.04	8
dense overgrowth	0.06	8

**3.4 Storm Sewer Design**

The use of computer programs for design of large storm drain systems is encouraged. Any programs should match the design methods described in this manual as closely as possible. Input and output files shall be submitted for review in printed form along with the construction plans. However, for small systems, hand calculations are acceptable provided they follow these guidelines.

**3.4.1 Flow in Gutters and Inlet Locations**

Storm drain conduits shall begin at the point where the depth of flow based in the gutter in the 10-year storm reaches the gutter capacity. For pavement sections that do not have curbs, including alleys, the 25-year storm shall be contained within the right-of-way. Inlets are then located as necessary to remove the flow based on a 10-year storm frequency. If, in the judgment of the City’s designated engineer, the flow in the gutter would be excessive under either of these conditions, then consideration should be given to extending the storm drain to a point where the gutter flow can be intercepted by more reasonable inlet locations. Multiple inlets at a single location are permitted in extenuating circumstances. For Class 1 streets, inlets shall be placed upstream from an intersection to prevent water running through intersections. For Class 2 streets, inlets should be placed upstream from an intersection where feasible to prevent water running through intersections. Inlets should also be located on the approach street to an intersection and in alleys where necessary to prevent water from entering these intersections in amounts that would cause the allowed street capacity to be exceeded.

The use of the street for carrying storm water shall be limited to the following:

**Spread of Water – 10 Year Storm Frequency**

- A. Arterials and Collectors - one 10’ wide traffic lane on each side shall remain clear. The area in a continuous left turn lane may be used to satisfy this requirement if there are no impediments to traffic such as raised medians.
- B. Downtown and Residential/Local Streets – Water shall not be deeper than the crown or curb height of the street (whichever is less).
- C. Alley - Contained within the paved surface.

**Spread of Water – 25 Year Storm Frequency**

- A. In addition to the requirements above, for subdivisions with curbed streets, all storm water in the 25-year storm shall be contained within the street or alley pavement. The water depth shall not be greater than curb height.

**3.4.2 Capacity of Streets and Alleys**

The following equation for flow in triangular channels may be used for computing the capacity of streets and alleys having a straight cross slope.

$$d = 1.24 \left( \frac{QnS_x}{S^{1/2}} \right)^{3/8}$$

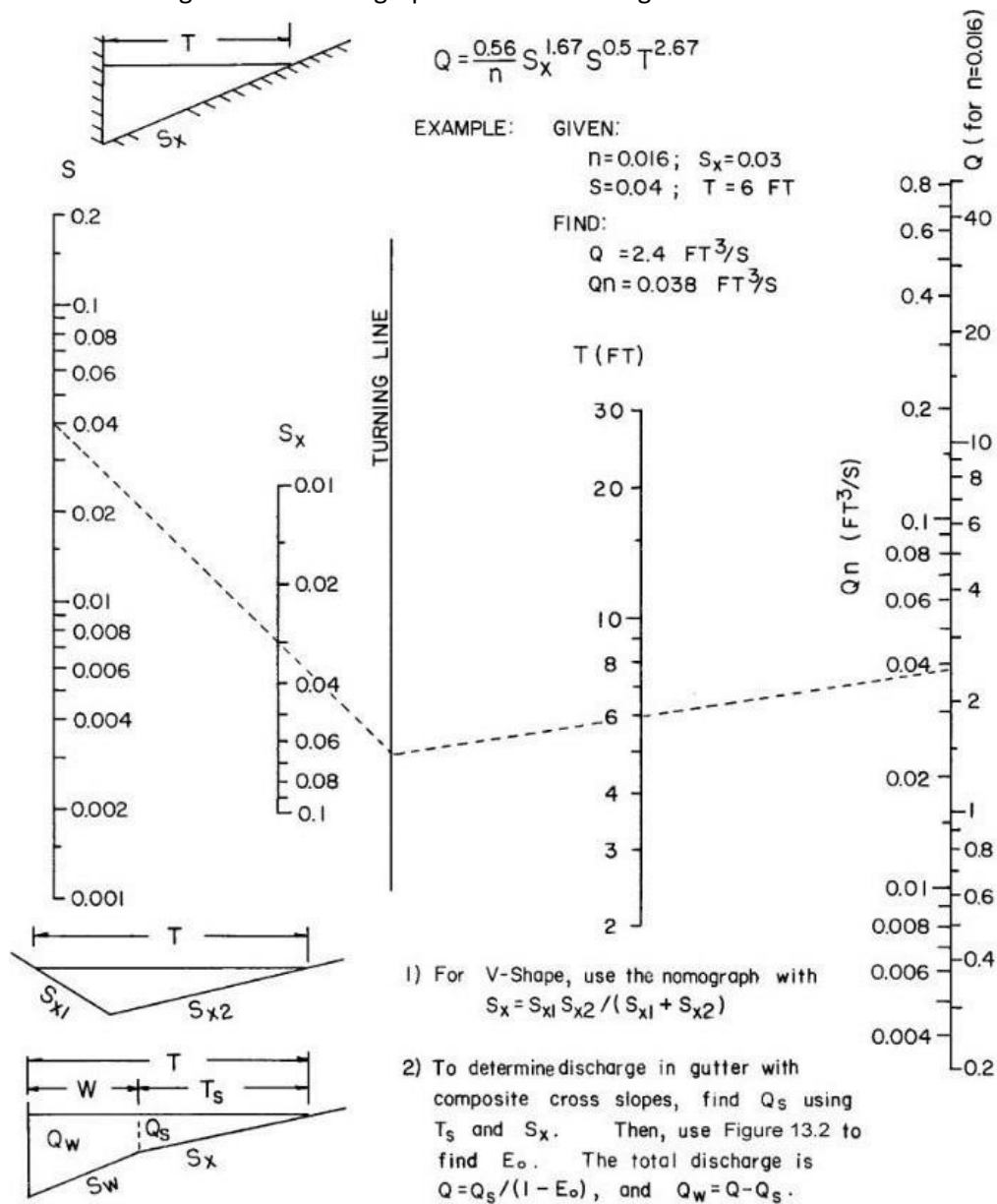
The following nomograph (Figure 3.2) can also be used to calculate the capacity of streets and alleys having a straight cross slope. The ponded width can be calculated using the following equation.

$$T = \frac{d}{S_x}$$

- where:
- d = depth of water in the curb and gutter cross section (ft.)
  - Q = gutter flow rate (cfs)
  - n = Manning’s roughness coefficient
  - S<sub>x</sub> = pavement cross slope (ft./ft.)
  - S = longitudinal slope (ft./ft.)

All street and alley capacities shall be calculated using a roughness coefficient of n = 0.0175.

Figure 3.2 – Nomograph for Flow in Triangular Channels



### 3.4.3 Valley Gutters

The use of valley gutters to convey storm water across a street intersection is subject to the following criteria:

- A. Arterial and Collector Streets shall not be crossed with a valley gutter.
- B. At any intersection, valley gutters should cross only the lower classified street.

### 3.4.4 Sizing and Location of Inlets

For determining the size and locations of inlets, the following shall be used as a minimum:

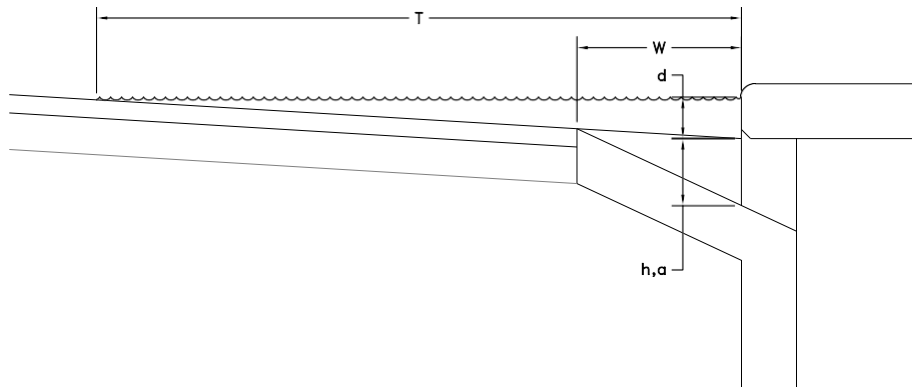
TABLE 3.7 – INLET OPENING REQUIREMENTS

Street Grade	Length of Inlet Opening for Each C.F.S. of Gutter Flow
Sags	0.6 Feet
Less than 2%	1.0 Feet
2.0 to 3.5%	1.5 Feet
Greater than 3.5%	2.0 Feet

The maximum length of any inlet shall be 20 feet. An inlet shall be constructed at every low point in a street.

**3.4.5 Inlet Capacity**

Curb inlets on grade shall be designed to capture all gutter flow with the exception of an allowable carryover flow of up to 0.5 cfs. Curb inlets in sags shall be designed to capture all gutter flow. Dimensions used in calculating the capacity of curb inlets are shown in the following figure:



**3.4.6 Curb Inlets on Grade**

For curb inlets on grade, capacity calculations can be found in HEC-12 Drainage of Highway Pavements. The length of depressed curb inlet required for total interception can be found using this equation or the nomograph in Figure 3.3.

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

Where: LR = curb opening length required for total flow interception (ft)  
 Q = total flow reaching inlet (cfs)

- S = longitudinal slope (ft/ft)
- N = Manning's roughness coefficient
- Se = equivalent cross slope (ft/ft)

The equivalent cross slope can be defined as:

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

- Where:
- Se = equivalent cross slope (ft/ft)
  - Sx = cross slope of the road (ft/ft)
  - a = gutter depression depth (ft)
  - W = gutter depression width (ft)
  - E<sub>0</sub> = ratio of depression flow to total flow

The ratio of depression flow to total flow can be found using this equation.

$$E_0 = 1 - \left(1 - \frac{W}{T}\right)^{2.67}$$

- Where:
- E<sub>0</sub> = ratio of depression flow to total flow
  - W = width of depressed gutter (ft)
  - T = total spread of water in the gutter (ft)

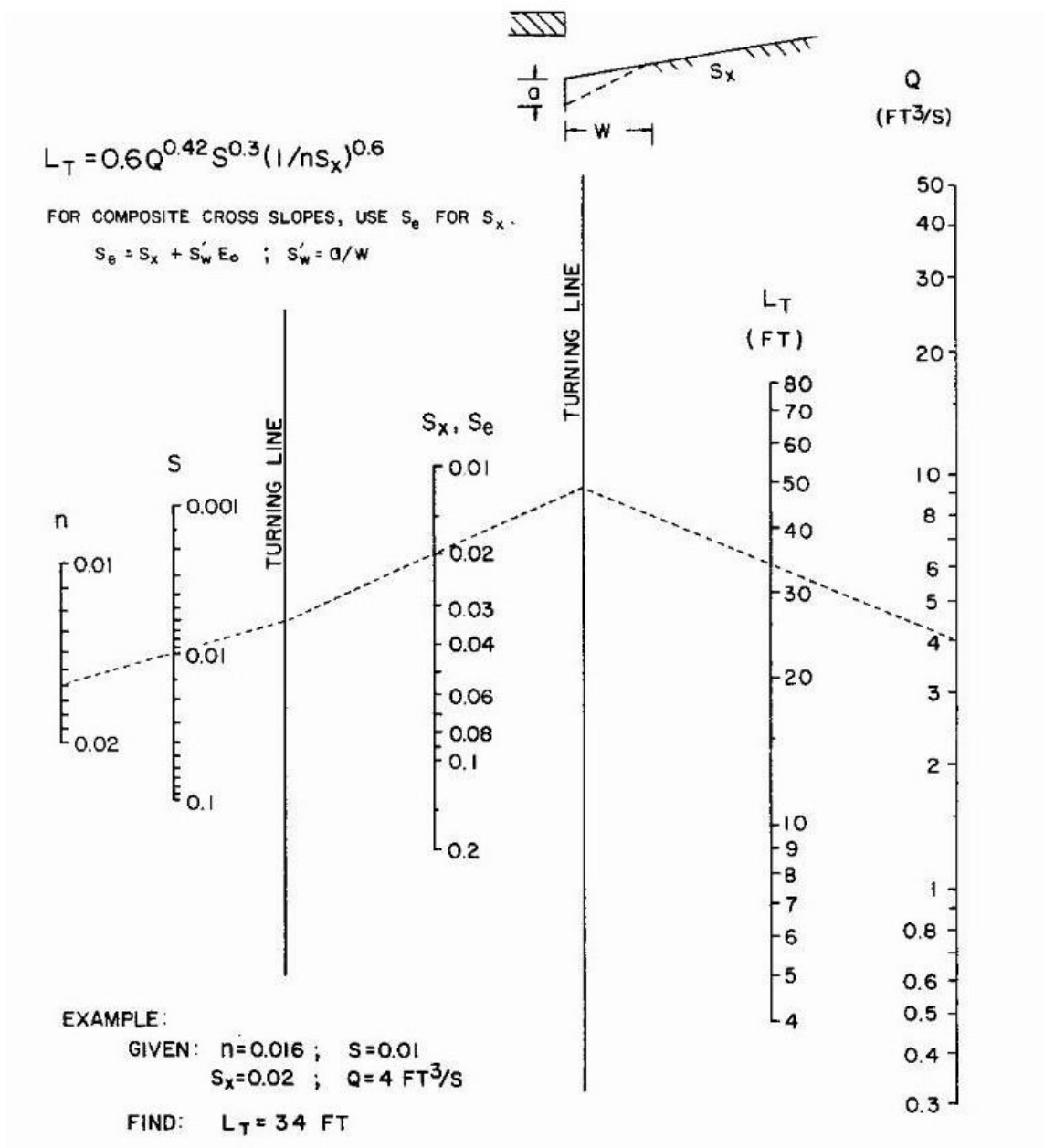


FIGURE 3.3 – NOMOGRAPH FOR CURB OPENING INLET LENGTH

### 3.4.7 Curb Inlets in a Sag

Capacity calculations for curb inlets in a sag can also be found in HEC-12 Drainage of Highway Pavements. Curb inlets in a sag function as a weir or as an orifice depending on the ratio of the depth of flow to the opening height. With depths of flow up to the opening height, the inlet functions as a weir. With depths of flow greater than 1.4 times the opening height, the inlet functions as an orifice. For depths of flow between 1.0 and 1.4 times the opening height, the capacity should be based on the lesser of the computed weir and orifice capacities.

The inlet length required when an inlet functions as a weir can be found by using the following equation:

$$L = \frac{Q}{C_w d^{1.5}}$$

Where:

- L = required length of curb opening (ft)
- Q = total flow reaching inlet (cfs)
- C<sub>w</sub> = weir coefficient (suggested value = 2.3)
- d = depth of gutter flow (ft)

If the depth of flow is greater than 1.4 times the opening height, the inlet will function as an orifice. The required length of inlet operating as an orifice is given by the following equation:

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

Where:

- L = required length of curb opening (ft)
- Q = total flow reaching inlet (cfs)
- C<sub>o</sub> = orifice coefficient (suggested value = 0.67)
- H = depth of opening (ft)
- G = acceleration due to gravity (32.2. ft/s<sup>2</sup>)
- D<sub>e</sub> = effective head at the centroid of the orifice (ft)  
= d + h/2 (where d = depth of gutter flow)

For inlets where the depth of gutter flow is between 1.0 and 1.4 times the opening height, the required inlet length shall be calculated for weir flow and orifice flow and the larger required length shall be used.

### **3.5 Closed Conduits**

#### **3.5.1 Hydraulic Grade Line**

The crown of the pipe should be near the elevation of the hydraulic grade line, in most cases, to eliminate excessive excavation. The hydraulic grade line in the inlet shall not be higher than 18 inches below the top of curb elevation at the inlet in the design storm.

After the computation of the quantity of storm runoff entering each inlet, the size and slope of pipe required to carry the design storm are to be determined. All hydraulic gradient calculations shall begin at the outfall of the system. The following are the criteria for the starting elevation of the hydraulic gradient:

- A. The 100-year water surface elevation in a creek, stream or other open channel is to be calculated for the time of peak pipe discharge in the same storm and that elevation used for beginning the hydraulic gradient.
- B. When a proposed storm drain is to be connected to an existing storm drain system that has a design flow less than the proposed, the hydraulic gradient for the proposed storm drain should start at the elevation of the existing storm drains hydraulic gradient based on the proposed design storm of the upstream system.



**3.5.2 Design**

In hand calculations, all closed conduits shall be hydraulically designed as shown in Chapter 6, STORM DRAINS, of the Texas Department of Transportation, "Hydraulic Manual." The required capacity of the storm drain lines shall be based on drainage area size and not on inlet capacity.

**3.5.3 Velocity**

Pipe grade shall be set to produce a velocity of not less than 3 feet per second (fps) when flowing fully. Grades producing velocities of less than 3 fps will not be allowed. All storm drainpipe and driveway culverts shall be a minimum of 18 inches in diameter. Discharge velocity shall be calculated with a tailwater depth not greater than the lesser of the top of the pipe at the pipe outlet or the actual 100-year water surface elevation in the channel.

Table 3.8 shows the maximum allowable velocities in closed conduits:

TABLE 3.8: MAXIMUM ALLOWABLE VELOCITY

Type of Conduit	Maximum Velocity
Culverts	15.0 fps
Inlet Laterals	15.0 fps
Storm Drains	15.0 fps

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

**3.5.4 Roughness Coefficients**

The recommended value for the roughness coefficient "n" for concrete conduits with smooth joints and good alignment is 0.013. Where engineering judgment indicates a value other than 0.013 should be used, the appropriate adjustments should be made in the calculations and the variance noted.

**3.5.5 Head Losses**

Head losses for wyes and pipe size changes will be calculated by the formulas:

For  $V_1 < V_2$

$$H_L = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

For  $V_1 > V_2$

$$H_L = \frac{V_2^2}{4g} - \frac{V_1^2}{4g}$$

Where:

$H_L$  = the head loss in feet measured at the point of wye or pipe size change.

$V_1$  = upstream velocity

$V_2$  = downstream velocity

$G$  = acceleration due to gravity (32.2 ft/s<sup>2</sup>)

Head losses for manholes and junction boxes shall be calculated by the formula:

$$H_L = \frac{V_2^2 - KV_1^2}{2g}$$

Where:

$H_L$  = the head loss in feet measured from the downstream water surface elevation.

$V_2$  = the downstream velocity

$K = 0.75$  for straight run

= 0.50 for run with 45° branch

= 0.25 for run with 90° branch

= 0.00 for 90° bend

$V_1$  = upstream velocity or velocity in the lateral

$G$  = acceleration due to gravity (32.2 ft/s<sup>2</sup>)

\*Note that the head loss shall be computed independently for the main and each branch conduit.

Head losses for pipe bends will be calculated by the formula:

$$H_L = \frac{KV^2}{2g}$$

Where:

$H_L$  = head loss in feet measured at the upstream end of the bend

$K = 0.50$  for 90° Bend

= 0.43 for 60° Bend

= 0.35 for 45° Bend

= 0.20 for 22.5° Bend

$V$  = pipe velocity (ft/s)

$g$  = acceleration due to gravity (32.2 ft/s<sup>2</sup>)

The use of pipe bends is discouraged and will be allowed only in special situations with the permission of the City.

In the case where an inlet is at the upstream end of a line, the equation becomes the following without any velocity of approach:

$$H_L = \frac{KV^2}{2g}$$

Where:

$H_L$  = head loss in feet measured at the upstream end of the bend

$K = 1.25$

$V$  = pipe velocity (ft/s)

$g$  = acceleration due to gravity (32.2 ft/s<sup>2</sup>)

If the head loss calculated under any of the above is less than 0.1 feet, the minimum head loss to be used at wyes, junctions, manholes, and pipe size changes for design of storm drainage system is 0.10 foot.

### **3.6 Culverts**

- A. In the design of culverts, the Engineer shall keep head losses and velocities within reasonable limits while selecting the most economical structure. This normally requires selecting a structure that creates a head water condition and has a velocity of flow safely below the allowed maximum.
- B. The vertical distance between the upstream design water surface and the roadway or bridge elevation is termed "freeboard." The dimension is included as a safety factor to protect against unusual clogging of the culvert and to provide a margin for future modifications in surrounding physical conditions. Normally, a minimum of 2 feet shall be considered a reasonable freeboard when the structure is designed to pass a design storm frequency of 25 years. Unusual surrounding physical conditions may be cause for a change in this requirement. Hydraulic design of culverts shall be in accordance with Chapter 8, CULVERTS, of the Texas Department of Transportation Hydraulic Design Manual.

### **3.7 Headwalls**

Headwalls are to be used to protect the embankment from erosion and the culvert from displacement. Sloped headwalls conforming to the minimum slope specified in this Design Manual shall be constructed at the end of all circular pipe drainage facilities and vertical headwalls with wingwalls and aprons shall be constructed for all rectangular shaped hydraulic structures.

Special headwalls and wingwalls may be required at the entrances and exit of all hydraulic structures where velocities are in excess of 8 feet per second. Culvert headwalls shall be designed such that the flow line of the culvert coincides with the flow line of the stream or channel.

The maximum exit velocity from the culvert is limited to the maximum velocity allowed in the stream or channel receiving the flow. Concrete riprap is used to protect the stream bed from scour and erosion. The riprap shall be reinforced and have toe walls to prevent undermining.

### 3.8 Detention

It is the City's intent to utilize detention (or detention/retention) of storm water runoff as a solution towards control of potential hazards created by storm water runoff including reduction in the impact on downstream storm water drainage facilities; prevention of erosive conditions in water drainage ways; protection against downstream and adjacent property damage; and preservation of existing floodplains along major creeks. Detention basins may also improve water quality by allowing some sediment to settle out.

#### 3.8.1 Level of Development Equivalent

- A. Detention ponds shall have a side slope 4:1 or flatter. No retaining walls are allowed in detention ponds.
- B. The detention pond bottom grade shall be at a minimum of 1% slope. A 4-inch-thick concrete low flow flume shall be installed from the pond's inlet structure/structures to the outfall structure.
- C. Detention structures shall have a minimum of one foot (1') of freeboard above the 100- year water surface elevation.
- D. The State of Texas has jurisdiction of all dams, regardless of dam height or impoundment storage size, if they are classified by State regulations and guidelines with hazard classifications as "high – or significant-hazard". [Reference: Texas Administrative Code, Title 30, Part 1, Chapter 299, Subchapter A, (a)(3)]. Dams with maximum height of over 5 feet must be approved by the State, unless the dam maximum height is less than 15 feet and a registered professional engineer licensed in Texas adequately shows, with an engineering study using the State of Texas Dam Safety guidelines and regulations, that a sudden breach of the dam during and a major flood event, as specified and determined by the State's procedures, would not cause any significant increase in flooding or significant increase in flood damages as compared to a non-breach of the dam during a non-breach flood event. For dams permanently impounding water, the study should also determine the extent of additional flooding that would be caused by a sudden breach of the dam during non-flooding events. If the breach of the dam can be proven to not cause any significant flood damages (other than to the dam embankment), then it can be proven to be classified as a "low-hazard" dam by State definition, and the dam may be exempt, at the City's discretion, from requiring State review and approval. However, regardless of whether the dam design is reviewed by the State, all dams, regardless of size, must have an emergency spillway and be designed, constructed, maintained, and operated per State Dam Safety Guidelines, including emergency action management. The maximum height of the dam, hazard classifications, and "significant" increased flooding (as related to embankment breach analyses) are determined based on the State's definitions and regulations.
- E. No detention is allowed in the FEMA 100-yr and local 100-yr fully developed floodplain.
- F. No detention pond is allowed with outlet elevation below a receiving stream's or channel's 100-yr fully developed flood elevation.
- G. No franchise utilities (Gas, Electric, Cable, Telephone, Communications, etc.), water lines and wastewater lines (except storm systems) are allowed in detention ponds, and detention easements.
- H. Underground detention systems must be a fully enclosed pipe system.

- I. The detention pond shall have an emergency overflow in case the main outfall structure gets clogged. The emergency overflow shall be sized to pass the fully developed 100-year flood at a minimum, or greater based on State Dam Safety requirements. City-approved erosion protection shall be placed along the length of the emergency overflow to the flowline of the receiving structure, creek or channel, and extended as necessary to prevent erosion of the dam structure.
- J. The detention systems are to be installed and verified for design compliance along with the associated storm sewer and outfall structures and drainage channels, prior to any paving operations. All constructed detention ponds, drainage ways, and open channels shall have the sides and bottom stabilized with sod or anchored seeded matting prior to any paving construction (including building slab). The matting or sod shall be anchored at high velocity locations if deemed necessary. Erosion protection is to be placed at the pond's outflow structure along with any associated erosion BMPs noted on the erosion control plan.
- K. Sometimes a detention facility will be utilized by several developments, and then a pro-rata agreement/detention masterplan may be entered into with the development constructing the facility and the other developments utilizing the facility. Without a pro-rata agreement/detention master plan of all parties in advance of construction of all combined developments, no new proposed development will be allowed to take credit for any "over detention" of a previous development or the reduction of discharges from a previous development within the watershed in the determination of detention requirements.
- L. Detention pond outfall structures shall be fitted with a trash rack.

### **3.8.2 Detention Requirements**

- A. All non-residential development (or other redevelopment areas that will not impact the storm water flow) shall construct detention facilities.
- B. Residential developments shall construct detention facilities if it is determined that the downstream system does not have adequate hydraulic capacity for the developed flow and the capacity of the downstream system cannot be increased to allow the conveyance of the developed flows.

### **3.8.3 Design Methodology**

Detention facilities that have a drainage area of less than 20 acres shall be sized using the Modified Rational Method. If the drainage area is equal to or greater than 20 acres, then the Unit Hydrograph Method shall be used. The Modified Rational method may be used for drainage areas more than 20 acres, but the Unit Hydrograph Method must be performed as a comparison. The more conservative of the two methods shall be used to design the pond (and technical documentation of both methods should be provided to the City for review and verification of the most conservative method selected).

The following conditions shall be used when implementing the Modified Rational Method.

- A. The proposed development will construct detention facilities to detain the increase in runoff between the existing 100-year flows ( $C_{undeveloped}$ , TC = 20 minute) and the fully developed flows ( $C$  – depends on zoning, TC = 10 minute). The "C" value is based on zoning, not pervious/impervious areas. Large area of dedicated open space dedicated to City can be considered by City in this value.
- B. Storm rainfall intensity (in/hr) for different storm years shall be as follows:

	100 year	50 year	25 year	10 year	5 year	2 year
10 min.	9.8	9	8.3	7.1	6.1	5.3
15 min.	9	8.1	7.5	6.5	5.5	4.5
20 min.	8.3	7.5	6.6	5.9	4.9	3.9
30 min.	6.9	6.1	5.5	4.8	4.1	3.3
40 min.	5.8	5.2	4.6	4	3.4	2.6
50 min.	5	4.5	4	3.5	2.8	2.3
60 min.	4.5	3.9	3.5	3	2.6	1.9
70 min.	4	3.7	3.3	2.8	2.4	1.8
80 min.	3.7	3.5	3.1	2.6	2.3	1.7
90 min.	3.5	3.3	2.9	2.5	2.1	1.6
100 min.	3.4	3	2.7	2.4	1.9	1.5
110 min.	3.2	2.9	2.5	2.3	1.8	1.4

## 4 WATER SYSTEM REQUIREMENTS

### 4.1 General

All water improvements must be designed and constructed in accordance with 30 TAC 290 "Public Drinking Water." Water mains shall be looped as directed by the City unless granted written permission otherwise. Refer to the Utility Assignments detail sheets that accompany this manual for location of water and sewer lines.

- A. All water mains shall be a minimum size of 6-inch diameter pipe. All water lines shall be looped unless agreed upon in writing by the City prior to construction. Dead end mains shall be at a maximum of 600' and provide a minimum 2" flush valve when allowed.
- B. In commercial and industrial districts, water mains must be of adequate size to provide for the building total fire flow. Fire flow shall be Needed Fire Flow (NFF) as determined from the "Fire Suppression Rating Schedule" as published by the Insurance Services Office. Fire flow requirements shall be met at peak day demand.
- C. Peak day domestic demand shall be as defined in 30 TAC 290.45.

TABLE 4.1: WATER CONSUMPTION RATES

Density (Dwelling Units/Acre)	Peak Day Water Consumption (gallons per acre per day)
1.0 D.U./Acre	2,600
2.0 D.U./Acre	3,500
3.0 D.U./Acre	4,700
3.8 D.U./Acre	5,000

The density shall be determined by dividing the total number of dwelling units by the total platted area. The domestic water demand shall be calculated by multiplying the water consumption values in the above table by the total acreage in the platted area.

For densities other than those listed above, water consumption rates may be interpolated or extrapolated from the values given in the table.

Peak hourly rates may be considered to be two times the peak day consumption. Water lines shall be sized to meet the peak hourly domestic demand as well as the fire flow requirements as described previously.

Profiles with elevations shall be provided for mains 8-inches in diameter and larger.

All utility easements shall be a minimum of twenty five (25) feet wide and dedicated to the City of Mount Vernon.

## **4.2 Water Valves**

Valves 12-inches and smaller shall be placed on or near street property lines and shall be spaced at a maximum of 800 feet apart in residential, duplex and apartment districts and not over 500 feet apart in all other districts. They shall be placed 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 a manner that a shutdown can be made for a 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 City.

## **4.3 Fire Hydrants**

### **4.3.1 Number and Locations**

A sufficient number of fire hydrants shall be installed to provide hose stream protection for every point on the exterior wall of the building. There shall be sufficient hydrants to concentrate the required fire flow, as recommended by the publication "Fire Suppression Rating Schedule" published by the Insurance Services Office, around any building 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 General Residential:  
As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersection 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. Attached Housing:  
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 center line of the roadway, and the front of any structure at grade and shall be no further than 400 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 center line of the roadway, and the front of any structure at grade shall be no further than 400 feet from a minimum of two fire hydrants as measured along the route that a 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 Fire Department approval.

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

- A. Attached Housing
  - a. Within 150 feet of the main entrance.



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

Fire lanes shall be a minimum of 24-feet wide. All fire lanes shall have a minimum centerline radius of 40'.

No fire hydrant shall be located closer than fifty (50') feet to a non-residential building or structure unless approved by the City.

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

#### **4.3.2 Restrictions**

- A. All required fire hydrants shall be placed on water mains of no less than six (6") inches in size.
- B. Valves shall be placed on all fire hydrant leads.
- C. Required fire hydrants shall be installed so the breakaway point will be no less than three (3") inches, and no greater than five (5") inches above the grade surface.
- D. Fire hydrants shall be located as shown in the utility assignments detail sheets. The fire hydrant shall not be in the sidewalk.
- E. In non-residential developments a 6-inch lead will be required on all fire hydrants that are located more than 50 feet from the looped main.
- F. All required fire hydrants placed on private property shall be adequately protected by either curb stops, bollards or other methods as approved by the City's designee and shall be in easements. Such stops or bollards shall be the responsibility of the landowner on which the fire hydrant is placed.
- G. All required fire hydrants shall be installed so that the pumper nozzle connection will face the fire lane or street, or as directed by the City.
- H. Fire hydrants, when placed at intersections or access drives to parking lots, 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.
- I. Fire hydrants located on private property shall be accessible to the Fire Department at all times.
- J. Fire hydrants shall be located at street or fire lane intersections when feasible.
- K. Fire Hydrant manufacturer shall be approved by the city.

#### **4.3.3 Main Size for Fire Hydrant Supply**

No more than two hydrants will be allowed on a 6-inch main between intersecting lines. The maximum length of a six-inch fire hydrant lead is 150'.

#### **4.3.4 Fire Lines**

The City of Mount Vernon will own, operate and maintain all fire lines serving fire hydrants. Such fire lines shall be designed and constructed in accordance with the City's standards and shall be placed in an easement dedicated to the City for this purpose. Sprinkler service lines, fire line connections and other fire lines that are not maintained by the City shall be equipped with a detector check valve having a

capacity equal to the required fire flow. Detector check valves shall be constructed in accordance with City standards.

#### **4.3.5 Minimum Cover**

The minimum cover to the top of the pipe must vary with the valve stem. In general, the minimum cover below the street grade or furnished grade (whenever is lower) should be as follows: 8-inch and smaller, 4.0 feet; 10 to 14-inch, 4.5 feet to 5 feet; 16-inch, 5.0 feet to 5.5 feet. Lines larger than 16-inch shall have a minimum of 6 feet of cover (sufficient to allow other utilities to go over the large main). For water lines to be constructed along county type roads which are commonly built with a crown above the surrounding property, increase the cover as required to allow for future paving grade changes.

#### **4.3.6 Meter Box and Service**

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 as shown on the Utility Assignments detail sheets and as shown on the Construction Details. Minimum requirements for water service sizes are:

- A. One-inch water services are required to serve all single and two-family residential lots. Separate meter connections shall be provided for each of the family units.
- B. The size of apartment, condominium, multi-family services or commercial will depend on the number of units served with one meter per individual residential unit.

#### **4.3.7 Service Connections - Hydrants**

A service connection shall not be allowed on fire hydrant leads except as authorized by the City.

### **4.4 Fire Protection**

The City of Mount Vernon has adopted the 2018 edition of the International Fire Code including all Appendix Chapters, as published by the International Code Council.

### **4.5 Testing**

- A. Water Quality and Testing:
  - 1. Water mains shall be designed to provide adequate circulation by looping water mains to prevent odor, taste and color problems associated with stagnant water. Disinfection must be performed in accordance with American Water Works Association (AWWA) requirements. Water samples shall be collected and submitted to a City approved laboratory by the Contractor. The water main will remain out of service until the water mains have been tested and approved for public consumption. In general, bacteriological tests are performed with passing results after the lines have been pressure tested. One water sample per street name or as approved by the City.
- B. The contractor shall be responsible for the following:
  - 1. Cleaning pipes by purging using the flushing method or the poly-pig method to enter and exit at approved strategic locations and to include all equipment, materials, fittings and labor.
  - 2. Disinfection in accordance with the latest version of AWWA C651 and AWWA C652. Provide disinfection report stating the type of form of disinfection used, date and time of disinfection start and completion, test locations, initial and 24 hour residuals in ppm for each outlet test, date and time of flushing, and disinfectant residual after flushing in ppm for each outlet tested.

3. Bacteriological report with testing laboratory name, address and phone number, time date and location of sample collection, name of person collecting samples, initial and 24 hour disinfectant residuals in ppm for each outlet tested, coliform bacteria test results and a certification that water conforms, or fails to conform, to bacterial standards of the Texas Department of Health.
4. Hydrostatic testing:
  - a. Perform testing in accordance with AWWA C600/AWWA C605
  - b. Test pressure shall be 150 psi (1.5 times the working pressure of 100 psi).
  - c. Pipeline fill rate shall not exceed 1,000 gpm.
  - d. Hydrostatic test shall be at least 2 hours in duration. During tests, test pressures shall not vary by more than +/- 5 psi (145 to 155 psi).
  - e. Test pressure shall be maintained within the tolerance by adding makeup water into the pipeline. The amount of makeup water added shall be accurately measured and shall not exceed the testing allowance. No pipe installation will be accepted if the quantity of makeup water is greater than that determined by the testing allowance.
  - f. Testing allowance:

$$L = \frac{S * D * \sqrt{P}}{148,000}$$

Where:

L = testing allowance (makeup water), in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during hydrostatic test, in psi

- C. All temporary test points are to have corporation stops at the main.
- D. All temporary testing and chlorination points shall be removed from the corporation prior to final acceptance.
- E. The contractor shall provide backfill, density and concrete testing for all projects unless specified otherwise. All reports shall be turned in to the City within five (5) working days.

#### **4.6 Horizontal and Vertical Clearances**

- A. A clearance of eighteen inches (18") shall be maintained when crossing storm drain systems. Where minimum clearance cannot be achieved, water mains shall be encased in six inches (6") of concrete in accordance with the standard detail.
- B. Water mains shall be designed as straight as possible following the existing or proposed grade at the minimum depth of cover. Bends shall be provided where vertical slope changes exceed eighty percent (80%) of the manufacturer's recommended joint deflection.
- C. Excessive high points that trap air and restrict water flow should be avoided.

##### **4.6.1 Location Adjacent to Streets**

- A. Water mains shall be installed a minimum of one foot (1') from the back of the curb, as measured to the centerline of pipe.

- B. The water main locations can be adjusted based on existing field conditions with approval from the City (reference Utilities layout details).
- C. Water mains shall be designed to minimize bends and fittings and follow right-of-way or centerline alignment curves at a uniform distance from the right-of-way or centerline.
- D. Dead end water mains shall extend a minimum of five feet (5') beyond the edge of the pavement. If adjacent to a fitting, extend a minimum of twenty feet (20') or one pipe joint beyond fitting.

#### **4.6.2 Highway Crossings**

A steel encasement pipe shall be used to encase the carrier pipe at all TxDOT highway crossings. The crossing shall be at 90 degrees (perpendicular) to the highway. All boring of water and wastewater lines shall be by dry bore methods. No wet bore will be allowed unless approved in writing by the TxDOT District Office.

#### **4.6.3 Creek Crossings**

Water and wastewater lines at creek crossing shall be designed to go under the flowline of the crossing. The lines shall be in steel encasement pipe with a minimum vertical clearance of four (4) feet from the encasement pipe and the flowline of the creek to protect from future creek undercutting. The encasement pipe shall be extended to the creek's erosion hazard set back line for future maintenance of the carrier pipe. Where an erosion hazard set back does not exist due to a shallow creek the encasement pipe shall extend 15 feet on either side of the main channel of the creek. All creek crossings shall be profiled and shall show the erosion hazard set back line along with the projected 4(H):1(V) sloping line and 15-foot buffer from the intersecting point of the ground. Aerial crossing of water lines is not allowed.

Aerial crossings for wastewater lines may be used only when all other alternatives have been evaluated and determined not to be feasible.

Aerial crossings of wastewater lines require approval by the City. If an aerial crossing is to be installed, reference additional requirements in the Wastewater System Section.

#### **4.6.4 Separation Between Water and Sanitary Sewer**

- A. The separation distance between water mains and wastewater mains, manholes or other appurtenances is governed by Title 30 of the Texas Administrative Code, Part 1, Chapter 290, Subchapter D, Rule 290.44(e) and Chapter 217, Subchapter C, Rule 217.53(d).
- B. Water mains shall have a minimum separation distance of nine feet (9') in all directions from wastewater collection facilities. Separation distances shall be measured from the outside surface of each of the respective facilities.
- C. If the minimum separation distances cannot be achieved for parallel water and wastewater mains, the separation distances may be reduced if the material of the wastewater main has a minimum pressure rating of 150 psi. In these cases, the water main shall be placed above the wastewater main with minimum separation distances of four feet (4') horizontally and two feet (2') vertically.
- D. If the minimum separation distances cannot be achieved for crossing water and wastewater mains, the separation distances may be reduced under two scenarios: 1. The wastewater main has a minimum pressure rating of 150 psi. 2. The water or wastewater main is cased for a minimum of eighteen feet (18') with a casing pipe having a minimum pressure rating of 150

psi. Under each scenario, the water main shall be centered on the wastewater main crossing with a minimum separation distance of twelve inches (12").

- E. When water mains are designed to be closer than nine feet (9') to wastewater manholes the water main shall be cased as described in section 2.1.3D above
- F. Residential water and sewer service lines shall be ten feet (10') apart.

#### **4.6.5 Thrust Restraint**

- A. All pressurized water and wastewater mains shall be restrained against thrust forces due to changes in pipeline diameter or alignment in order to prevent joint separation or movement.
- B. Thrust restraint shall be accomplished by concrete thrust blocks and restrained joints.
- C. All valves, fittings and changes in elevation shall have concrete thrust blocks and restrained joints installed.
- D. Thrust blocking shall be Class "B" concrete and sulfate resistant. It shall be able to withstand a minimum 200 psi test pressure with a minimum safety factor of 1.5 without exceeding the soil bearing capacity.
- E. Restrained joints lengths shall be calculated to withstand a minimum 200 psi test pressure with a minimum factor of safety of 2.0.
- F. All calculations are based on internal pressure of 200 psi for ductile iron and P.V.C
- G. Volumes of thrust blocks are net volumes of concrete to be furnished. The corresponding weight of the concrete is equal to or greater than the vertical components of the thrust on the vertical bend.
- H. Pour concrete for block against undisturbed earth
- I. Dimensions may be varied as required by field conditions where and as directed by the City.
- J. The soil bearing pressure is based on 1000 lbs/sf in soil and 2000 lbs/sf in rock.
- K. Use polyethylene wrap or equal between concrete and bend, tee or plug to prevent the concrete from sticking to it.
- L. For standard fittings, concrete shall not extend beyond joints.
- M. The following technical references are available for calculating thrust restraint systems:
  - 1. AWWA Manual M9: Concrete Pressure Pipe by AWWA, Latest Edition.
  - 2. AWWA Manual M11: Steel Pipe – A Guide for Design and Installation by AWWA, Latest Edition.
  - 3. AWWA Manual M23: PVC Pipe – Design and Installation by AWWA, Latest Edition.
  - 4. Thrust Restraint for Ductile Iron Pipe by Ductile Iron Pipe Research Association (DIPRA), 2006, or Latest Edition.
  - 5. Thrust Blocking, National Fire Protection Association Standard 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2007 Edition

## **5 SANITARY SEWER REQUIREMENTS**

### **5.1 General**

All platted lots must be served by an approved means of wastewater collection and treatment. In most cases, lots will be served by a municipal sewer system. All sanitary sewer improvements must be designed and constructed in accordance with 30 TAC 317 “Design Criteria for Sewerage Systems.” Where, in the opinion of the City’s designee, connection to the municipal system is not economically feasible, on site treatment of wastewater may be allowed.

### **5.2 Locations for Sewer Lines**

Sizes for sanitary sewers shall be as required by the City. Sewers shall be constructed with extensions to the development boundary to allow for direct connection by future developments. If feasible, sewers shall be placed as shown in the Utility Assignments Detail Sheets. Where easements are used, they shall be not less than fifteen feet wide.

### **5.3 Minimum Cover**

Minimum cover shall be 3.5 feet. Any exceptions must be authorized by the City’s designee and shall have concrete protection. For sanitary sewers in streets, the minimum cover shall be 5.0 feet. In general, the minimum depth required for the sewer to serve given property with a 4-inch lateral shall be 3 feet (4.5 feet if the water line is on the same side of the street as the lateral in question) 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 = 2.7 plus 3.0 = 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. A minimum of 3 feet of cover on sewer services is required at all points in street R.O.W. where swales are constructed. On lines deeper than 12 feet, a parallel sewer line will be required when laterals are to be attached if required by the City’s designee. The maximum depth on the parallel line shall be no more than nine feet.

### **5.4 Sewage Flows, Size and Grades**

Sewage flow shall be computed in accordance with the following formula:

$$Q = \frac{C^{.89}}{295}$$

Where:

- Q = Peak wastewater flow (million gallons per day)
- C = Equivalent single family connections

Equivalent single family connections are based on a density of 2.7 persons per dwelling unit. Densities for other residential uses shall be approved by the City. Sewage flow for non-residential uses shall be determined by a licensed engineer and approved by the City.

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. See table C.2., from Texas Commission on Environmental Quality (TCEQ), for allowable minimum and maximum slope given diameter of pipe to be used.

**TABLE C.2: MINIMUM AND MAXIMUM PIPE SLOPES**

Diameter of Pipe (inches)	Minimum Slope (%)	Maximum Slope (%)
6	0.50	12.35
8	0.34	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.12	2.83
21	0.10	2.30
24	0.08	1.93
27	0.07	1.65
30	0.06	1.43
33	0.06	1.26
36	0.05	1.12
39	0.04	1.01
>39	*	*

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

All grades shall be shown to the nearest 0.01 percent. If practical, grades should be even, such as: 0.20%, 0.40%, 0.60% and 1.00%, etc., in order to facilitate field computations. When the slope of a sewer main changes, a manhole will be required.

**5.5 Manholes, Wyes, Bends, Taps, and Cleanouts**

The sizes and locations of manholes, connections, cleanouts, etc., shall be approved by the City's designee. In general, manholes shall be placed at all bends, intersections, and changes in nominal diameter of sewer main. When the manhole's rim elevation is below the 100 year water surface elevation, bolted and gasketed manholes shall be used. Clean-outs shall be placed on the ends of all lines. Drop manholes shall be required when the inflow elevation exceeds the outflow elevation by more than 24 inches.

In order to provide access to sewer lines for cleaning, manholes shall be located a maximum of 500 feet apart. The spacing between a manhole and an upstream cleanout shall be limited to 400 feet. Cleanouts may be located at the end of the line only.

**5.6 Laterals**

The sizes and locations of laterals shall be as approved by the City. 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. 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.

### **5.7 Railroad, Highway and Creek Crossings**

Railroad, State Highway and creek crossings shall be encased and approved by the City and owner of the facility being crossed.

### **5.8 Sewer Main Sizing**

- A. Although the Wastewater Master Plan may be used as a guide for sizing wastewater mains, sizing should be based on an engineering analysis of initial and future flow of the total drainage area to be served.
- B. Wastewater mains shall be sized to carry the ultimate peak flow at 100% of the full flow capacity of the pipe. Pipe capacity shall be calculated using Manning's equation. A roughness coefficient of 0.013 shall be used.

#### **5.8.1 Force Mains**

- A. Force main capacity shall be sized to meet the pump capacity. The force main shall be sized to handle the ultimate basin capacity. The force main may be designed to handle a portion of the basin with the ability to expand for the ultimate basin capacity if approved by the City. The minimum force main size shall be 4 inch diameter except for grinder pump lift stations. The minimum recommended velocity is 3 feet per second, and the velocity shall not be less than 2.5 feet per second when only the smallest pump is in operation.
- B. Force main sewer pipe shall be designed to meet the working pressure requirements of the particular application. Design calculations and pipe selection shall be submitted to the City in report format.
- C. A force main must be designed to abate any anticipated odor.
- D. Force main pipe materials shall AWWA C900-16 PVC Pipe (green in color) for all sizes, DR 14 (PC 305) for pipeline sizes 12-inch and smaller, and DR 18 (PC 235) for 14-inch and larger wastewater pipelines.
- E. For trench depths greater than 12 feet or other dead and/or live loading considerations, the engineer shall provide a pipe with the appropriate DR rating which shall exceed the minimum requirements.
- F. All fittings shall be wrapped ductile iron in accordance with AWWA C110 or AWWA C153. Fittings shall have a prime coat on the outside surface and shall have an interior lining of 40-mils nominal dry film thickness of Protecto 401 Ceramic Epoxy Lining or approved equal, applied in accordance to the manufacturer's recommendations.
- G. All valves and fittings shall be restrained with Mega-lug or approved equal. Joint material for PVC shall conform to ASTM F471. H.
- H. Plans shall include plan and profile for the force main.
- I. Force main shall have a minimum of 4 feet of cover and be laid to standard specifications for potable waterline.
- J. Force main separation and design criteria from water mains and all other utility lines shall meet the minimum requirements from TCEQ.
- K. All force mains shall have magnetic marker tape installed above pipe.



## 5.9 Sewer Services and Cleanouts

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

- A. Wastewater service laterals for single-family residential shall be a minimum of four inches (4") in diameter. Laterals shall be installed ten feet (10') downstream from the center of the lot and have a minimum distance of ten feet (10') separation from the water service.
- B. Wastewater service laterals for multiple units, apartments, local retail and commercial developments shall be a minimum of six inches (6") in diameter.
- C. Wastewater service laterals for manufacturing and industrial shall be a minimum of eight inches (8").
- D. Manholes are required on six inch (6") and larger wastewater service laterals where they connect to the main line.
- E. Wastewater service laterals shall not be attached to wastewater mains that are deeper than twelve feet (12'). Deep cut or drop connections are not to be permitted.
- F. Wastewater service laterals shall not be attached to existing sewer cleanouts.
- G. Each building shall have only one wastewater service lateral with a clean-out on the owner's side except duplexes which shall have two wastewater service laterals independently attached to the main.
- H. All mains installed for future developments shall include wastewater service laterals.
- I. All wastewater service laterals crossing water mains shall conform to the requirements of the TCEQ Chapter 217, Subchapter C, Rule 217.53(d), latest revision, or Section 2.2.3 of this standard.

Sanitary sewer clean-out requirements are as follows:

- A. For new development extend PVC clean-out thirty-six inches (36") above finished grade with plug.
- B. At the time-of-service connection the clean-out extension shall be adjusted, and the lateral clean-out cover installed at the finished ground elevation.
- C. All fittings shall be solvent weld.
- D. All fittings shall be PVC SDR 35 or schedule 40.
- E. Center line of clean-outs to be placed 6 inches inside city right-of-way line unless specified otherwise.
- F. All new service laterals shall have clean-outs as per standard wastewater service connection.
- G. Cleanouts for new construction shall be furnished and placed in areas with no vehicular traffic
- H. Slope of lateral to be two percent (2%) minimum.
- I. The wastewater lateral shall be connected to building lateral and constructed in such a way as to clear existing and proposed utilities.
- J. The mainline lateral connection to the private building lateral shall be as close to the property line as possible.
- K. Install four inches (4") stopper or cap at property line if building lateral does not exist.

## 5.10 Manholes

### 5.10.1 Sizing

Manholes shall be sized as follows:

- A. Four feet (4') feet in diameter for six, eight, ten and twelve inches (6", 8", 10", and 12") diameter pipes.

- B. Five feet (5') in diameter for fifteen, eighteen, twenty-one, twenty-four and twenty-seven inches (15", 18", 21", 24" and 27") pipes.
- C. Six feet (6') in diameter for thirty and thirty-six inches (30" and 36") pipes.
- D. Five feet (5') in diameter minimum for manholes deeper than twelve feet (12').

**5.10.2 Spacing**

- A. Manholes shall be installed at all changes in grade and direction and have a maximum spacing per TCEQ.

**5.10.3 Manhole Abandonment**

- A. Remove frame, lid and cone barrel section unless approved otherwise by the City or designee.
- B. Cut and plug all abandoned sewer mains at manhole.
- C. Fill bottom (twelve inches (12")) of manhole with 2000 psi concrete.
- D. Backfill and compact the hole with sand and/or gravel.
- E. Repair surface to match existing as per city standards.

**5.11 Lift Stations****5.11.1 Wet Well Design**

Wet well shall be cast in place or pre-cast watertight and gas tight walls with watertight joint meeting ASTM C478-90 with antimicrobial additive. Steel, fiberglass, HDPE and RCP are not acceptable materials. The tops may be pre-cast with the hatches built in. All wall penetrations through the wet well wall shall be gas tight. The wet well shall be hydrostatically tested to the top of the wet well for 48 hours prior to putting the lift station into service. Only losses due to evaporation will be tolerated. Additional design requirements are as follows:

- A. Orientation
  - 1. Orientation shall consider the routing of incoming sewer and force main for ease of maintenance and to minimize effluent turbulence. Orientation shall allow a 5 ton vehicle to pull in forwards or backwards directly to the wet well or the dry well. All influent gravity lines discharging into the wet well shall be located so that the invert/flow line is above the "on" setting liquid level of the pumps. Lift stations with two or more wet wells shall include a sluice gate between each wet well.
- B. Level Sensors
  - 1. Liquid level sensors shall be level regulators switch. Sensors shall be provided for "All Pumps Off," "Lead Pump On", "Lag Pump On" and "High Level Alarm" levels as well as additional "Lag-Lag Pump On" for lift stations with more than two pumps. Level Sensors shall be placed in a stilling well.
- C. Wet Well and Valve Vault Separation
  - 1. Wet wells and valve vaults shall be separated by at least one foot (1') and have separate entrances.
- D. Liner and Coatings
  - 1. Wet wells shall have a minimum of 10% sloped bottoms to the pump intakes and shall have a smooth finish to avoid excess sludge deposits. Wet well interiors shall be coated with 2 coats of epoxoline. Application shall be per manufacturer recommendation. Wet well exteriors shall be coated with tar and its application shall also be by manufacturer's recommendation.
- E. Hatches

1. The wet well shall have a lockable odor suppressing aluminum door with an aluminum frame and safety grate. The minimum opening size shall be 4 feet x 6 feet with 2 doors large enough to adequately maintain the wet well.
- F. Ventilation
1. The design of a wet well must reduce odor potential in a populated area or as directed by the City. Passive ventilation structures shall be provided and must include screening to prevent the entry of birds and insects to the wet well. An air vent pipe shall have a minimum diameter of four inches (4") with outlet located one foot (1') above wet well top. Continuous mechanical ventilation structures shall be provided with ventilation equipment providing a minimum capacity of 12 air exchanges per hour and be constructed of corrosion resistant material.
- G. Wet Well Volume
1. Wet well volume for a submersible pump station is the volume contained above the top of the motor, or as specified by the pump manufacturer. High level alarm elevation shall be a minimum of sixty inches (60") below the top of the wet well or forty-eight inches (48") below the flow line elevation of the lowest service tap, whichever elevation is lower. Wet well volume shall be calculated by the following method:

$$V = \frac{Q_p t}{4}$$

where:            V = required capacity (gal)  
                       t = minimum time of one pumping cycle or time between successive starts (min.)  
                       Q<sub>p</sub> = pump capacity (gpm)

Pump cycle time, based on Peak flow, must equal or exceed the following:

<u>Pump Horsepower</u>	<u>Minimum Cycle Times (minutes)</u>
less than 50	6
50 – 100	10
Over 100	15

The operation cycle "t" shall not be less than 10 minutes minimum for Average flow and not more than 60 minutes for minimum flow conditions. The operation cycle time must exceed the manufacturer's requirements.

- H. Valve Vault
1. Valve vaults shall have sloped bottoms towards a floor drain to remove liquid build up. The floor drain line from the valve vault connecting to the wet well must prevent gas and liquids from entering valve vault. The valve vault shall have a lockable aluminum door with an aluminum frame. The minimum opening size shall be 2 feet x 3 feet or large enough to adequately maintain the valve vault.
- I. Lighting

1. Lighting shall be provided at each lift station to allow for visibility for night work.
2. All lighting shall be LED and be fully shielded from adjacent property.

#### **5.11.2 Pumps**

- A. Stations shall contain a minimum of two pumps and shall be capable of handling peak flows with one pump out of service.
- B. All pumps shall be explosion proof, non-clog, submersible type capable of passing a 2-1/2 inch diameter sphere or greater. Vortex impellers shall be used to prevent clogging.
- C. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point will be 60 percent. The minimum required horsepower for the motor must be capable of handling the entire range as shown in the pump curve. Where necessary, a higher horsepower pump will be required to prevent any damage to the motor as a result of loss of hydraulic head situation.
- D. The pump rail system shall be MTM Sch 40 stainless steel with supports on 8 feet maximum spacing.

#### **5.12 Inverted Siphon**

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

- A. Two or more barrels (pipes).
- B. A minimum pipe diameter of six inches (6").
- C. The necessary appurtenances for convenient flushing and maintenance.
- D. One upstream and one downstream manhole for cleaning equipment, inspection, and flushing.
- E. The siphon must be sized with sufficient head to achieve velocity of at least three feet per second (3fps) at initial and design flows.
- F. The inlet and outlet shall divert the normal flow to one barrel.
- G. The system shall be designed to allow any barrel to be taken out of service for cleaning.
- H. The system shall be designed to minimize nuisance odors.

## **6 LANDSCAPE REQUIREMENTS**

### **6.1 General Requirements**

- A. The purpose of this section is to provide additional requirements and standards to address landscaping requirements in the City of Mount Vernon. Refer to the following ordinances and documents for a full list of regulations: Code of Ordinance, Section 20-52 - Landscape Requirements
- B. Landscape construction plans are recommended to be prepared and sealed by a Landscape Architect licensed to practice Landscape Architecture within the State of Texas.
- C. Landscaping areas requirements shall be twenty (20) percent of the total square footage of the building site with the exception of any areas exempted by phased development or classification as floodway or undisturbed area.

### **6.2 Approved Plant Materials**

This section outlines criteria of plant materials that are justifiable in landscape design. Approved plant materials include:

- A. Plant materials shall be either acceptable native plants to the city area, or plants that are known to be acclimated to the North East Texas region.
- B. The selection of individual plant materials shall require that the species chosen be adaptable to the specific environment and conditions in which it will be planted, i.e., soils, water availability, height limitations and shade.
- C. Trees shall be selected to avoid those species known to cause damage to public improvements.
- D. Artificial plants are not acceptable in satisfying this section.

### **6.3 Irrigation**

Minimum design requirements for landscape irrigation include:

- A. Every development shall be required to have either an irrigation system or a hose connection. The hose connection shall be within 150 feet of all landscaping. A 10% reduction in the required landscape area shall be made when an irrigation system is provided for the entire landscaped area.
- B. Irrigation systems shall be designed and installed to minimize runoff onto paved surfaces. Overspray on streets and walks are prohibited.
- C. Private irrigation system mainlines, valves, or control wires located within the City's right-of-way shall be maintained by the adjacent property owner.
- D. The bore depth under streets, drive aisles, and fire lanes shall allow two feet (2') minimum from the bottom of paving to the top of the sleeve, or greater if required to clear other utilities
- E. All irrigation piping and boxes shall be purple in color.
- F. A separate water meter is required for irrigation.
- G. ET controllers shall be installed on AC power.
- H. A ball valve is required on the upstream side of control valve and shall be located in a jumbo box.
- I. Backflow prevention devices are required for all irrigation systems.
- J. Provide a section valve to regulate pressure in the irrigation system.
- K. Check valves are required where elevation differences will cause low-head drainage.
- L. Minimum main line pipe size shall be 1-1/4".

- M. Minimum lateral line pipe size shall be 3/4".
- N. System shall deliver a minimum residual pressure of 30 psi at the spray head and 50 psi for rotors.
- O. Where drip systems are used, they shall be designed to provide water uniformly from subgrade PVC piping.
- P. Feeder laterals and mainlines shall be located as close to the center of median as feasible.

## 7 STORM WATER POLLUTION PREVENTION

### 7.1 Design and Implementation

Where an NPDES (National Pollutant Discharge Elimination System) Construction General Permit is required for construction of a project (under regulations contained in 30 TAC, under the authority of the Clean Water Act), a Storm Water Pollution Prevention Plan (SWPPP) meeting the permit requirements must be prepared, included with the plans and specifications, and posted onsite during construction. SWPPP must be prepared and implemented on the site before any construction activities begin, including grading, and must be continuously updated.

### 7.2 BMP Guide

The best management practice (BMP) for storm water pollution prevention is dependent on the type of construction that will take place on site. However, the following includes typical practices that will improve the quality of storm water at any facility.

- A. Housekeeping – The best stormwater management practice that can be implemented. Operating a clean site, free of debris, sediments, and trash can greatly reduce the chances of stormwater pollution.
- B. Soil erosion and sediment control – Sedimentary particles are quite common and can be produced from the ground or material stockpiles. This can be avoided by planting ground cover such as grass, basic landscaping, or stone use. Stone filters are a simple tool that greatly reduces the appearance of sediment in runoff.
- C. Spill and prevention control – Spills of pollutants such as oil can cause devastating effects to the environment can be easily avoided with proper planning. Outlining measures to stop, contain, and clean spills of contaminated materials will help control these situations.
- D. Inspections – Regular, documented inspections of construction sites with an emphasis on environmental quality can prove effective in control of unwanted discharges
- E. Training – Educating personnel on stormwater pollution, where pollution comes from, and how to prevent these situations that will make a difference in polluted or clean runoff.

## 8 MATERIAL SPECIFICATIONS

### 8.1 Paving Materials

- A. Concrete – Shall be constructed and tested in accordance with Item 360 of Txdot’s Standard Specifications for Construction and Maintenance of Highway, Streets, and Bridges (latest edition)
- B. HMAC – Shall be constructed and tested in accordance with Item 340 of Txdot’s Standard Specifications for Construction and Maintenance of Highway, Streets, and Bridges (latest edition)
- C. Soil Stabilization
  - 1. Lime Stabilization – Shall be constructed and tested in accordance with Item 260 of Txdot’s Standard Specifications for Construction and Maintenance of Highway, Streets, and Bridges (latest edition)
  - 2. Cement Stabilization – Shall be constructed and tested in accordance with Item 275 of Txdot’s Standard Specifications for Construction and Maintenance of Highway, Streets, and Bridges (latest edition)
- D. Joint Sealant - Cold Applied one part silicone material (DOW Corning 890-SL or approved equal)

### 8.2 Drainage Materials

- A. Pipe – For use in city right-of-way and under pavement (whether or not in city right-of-way)
  - 1. Reinforced Concrete Pipe – In accordance with ASTM C-76
- B. Pipe – For use outside city right-of-way and not under pavement (whether or not in city right-of-way)
  - 1. Reinforced Concrete – In accordance with ASTM C-76
  - 2. Corrugated HDPE – Soil-tight with smooth interior wall and annular exterior corrugations in accordance with ASTM F2306 and embedment of Aggregate Type A2 – Type 1 Pipe Embedment
- C. Pipe – For driveway culverts only
  - 1. Reinforced Concrete – In accordance with ASTM C-76
  - 2. Corrugated HDPE – Soil-tight with smooth interior wall and annular exterior corrugations in accordance with ASTM F2306 and embedment of Aggregate Type A2 – Type 1 Pipe Embedment
  - 3. Corrugated Metal Pipe – Aluminized Type 2 Steel in accordance with ASTM A929 with helical corrugations and embedment of Aggregate Type A2 – Type 1 Pipe Embedment
- D. Box Culvert – ASTM C1433

### 8.3 Water Materials

- A. Water Main Material
  - 1. All water mains shall be AWWA C900 or C905 PVC DR 18, with bell and spigot joints. AWWA C909 Class 150 PVC pipe may also be used with the approval of the City. Double bell couplings may not be used for joining pipes except in horizontal directional drilling. Compact mechanical joint ductile iron fittings with thrust restraining follower glands and concrete thrust blocks shall be used.



2. For water mains 24-inches in diameter and larger, reinforced concrete, pre-tensioned reinforced (steel cylinder type), and ductile iron pipe complying with AWWA C303, Class 150 may be considered on a case-by-case basis.
3. All water mains outside utility easements that supply fire sprinkler systems shall be minimum 200 PSI working pressure and U.L. listed.
- B. Valves 18 inches and under shall be non-rising stem resilient seat gate valves in accordance with AWWA C515 and placed in the vertical position. Valves larger than 18-inches shall be butterfly valves.
- C. Water Services
  1. Meter box – Plastic with cast iron lid and cast-iron reader covers (19"x14"x12")
  2. Curb stop – Ford B41-444W with lock wing
  3. Copper tubing – Type K with compression connections
  4. HDPE tubing – SDR 9 (200 psi) CTS with stainless steel inserts
  5. Corporation stop – Ford F1100-4
  6. Service saddle – Ford 202B double strap bronze saddle

**8.4 Sewer Materials**

- A. Sewer pipe shall be SDR 26 PVC in accordance with ASTM D 3034.
- B. Sewer pipe joint materials shall have resilient properties conforming to ASTM F 477.

**8.5 Aggregate Materials**

- A. Aggregate Type A1 - Drain Rock
  1. Drain rock shall be clean, washed, sound, durable, well-graded crushed rock, crushed gravel, or natural stone gravel.
  2. Drain rock shall conform to ASTM C33 Size No. 3 coarse aggregate as shown in the following table:

Sieve Size	Percent Passing (By Weight)
2 ½ in.	100
2 in.	90-100
1 ½ in.	35-70
1 in.	0-15
½ in.	0-5

- B. Aggregate Type A2 – Type 1 Pipe Embedment
  - 1. Type 1 pipe embedment shall be clean, washed, sound, durable, well-graded crushed rock, crushed gravel, or natural stone gravel.
  - 2. Type 1 pipe embedment shall conform to ASTM C33 Size No. 57 coarse aggregate as shown in the following table:

Sieve Size	Percent Passing (By Weight)
1 ½ in.	100
1 in.	95-100
½ in.	25-60
No. 4	0-10
No. 8	0-5

- C. Aggregate Type A3 – Type 2 Pipe Embedment
  - 1. Type 2 pipe embedment shall consist of a well-graded, angular, crushed rock with a maximum particle size of ¾ inch. No more than 10% of the material shall pass the No. 200 sieve.
- D. Aggregate Type A4 - Pea Gravel
 

Pea gravel shall be natural gravel that is washed and free of clay, shale, and organic matter. It shall be graded in accordance with ASTM C136 to the following limits:

  - 1. Minimum Size: 1/4 inch
  - 2. Maximum Size: 5/8 inch
- E. Aggregate Type A5 – Flexible Base
  - 1. Flexible base material shall be crushed stone produced from oversize quarried aggregate, sized by crushing, and produced from a naturally occurring single source. Crushed gravel or uncrushed gravel shall not be acceptable. No blending of sources or additive materials will be allowed in flexible base.
  - 2. Flexible base material shall conform to TxDOT Item No. 247 Type A Grade 2.
- F. Aggregate Type A6 - Sand
  - 1. Sand shall be natural river or bank sand that is free of silt, clay, loam, friable or soluble materials, and organic matter.
  - 2. Sand shall conform to the gradation shown in the following table:

Sieve Size	Percent Passing (By Weight)
No. 4	100
No. 16	80-100
No. 50	20-60
No. 100	10-40
No. 200	0-10

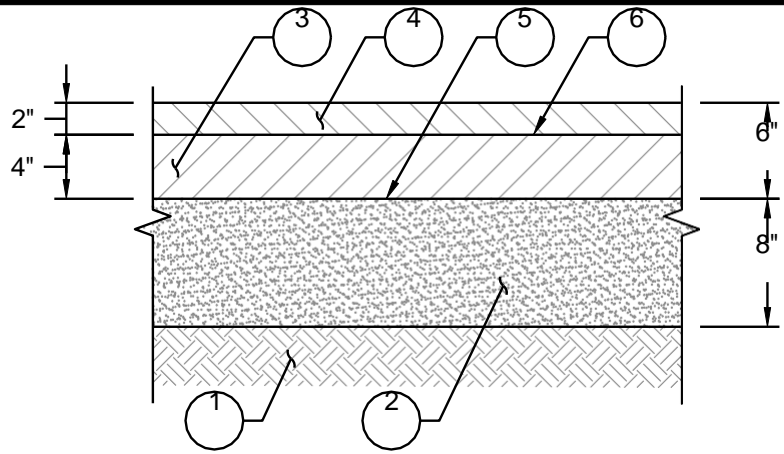
**8.6 Soil Materials**

- A. Soil Type S1 – Subgrade
  - 1. Subgrade material is material remaining in place after excavation.
  - 2. Subgrade material shall be suitable for pipe subgrade. It shall be undisturbed.

3. Where subgrade soils are soft, loose, or otherwise unsatisfactory, the soil shall be removed and replaced as determined by the City's designee.
- B. Soil Type S2 – Type 1 Common Fill
1. Type 1 common fill shall be excavated and re-used material or borrow material approved by the City.
  2. Type 1 common fill shall be graded free of lumps larger than three inches, rocks larger than two inches, excessive silts, and debris.
  3. Do not use soil containing brush, roots, or similar organic matter.
  4. Type 1 common fill shall conform to ASTM D2487 Class II or Class III soils with a liquid limit less than 40 and a plasticity index less than 20 but greater than four.
- C. Soil Type S3 – Type 2 Common Fill
1. Type 2 common fill shall be the same as Type 1 common fill except that it shall have no lumps or rocks greater than  $\frac{3}{4}$  of an inch.
- D. Soil Type S4 – Select Fill
1. Select fill shall be imported borrow material from a borrow area approved by the City's designee.
  2. Select fill shall be clayey sand soils free from organic matter with no lumps larger than one inch, no rocks larger than  $\frac{1}{2}$  inch, and no excessive silts.
  3. Do not use soils containing brush, roots, sod, or other organic materials.
  4. Select fill shall conform to ASTM D2487 Class II or Class III and shall have a liquid limit less than 45 with a plasticity index less than 15.
- E. Soil Type S5 – Topsoil
1. Topsoil shall be soil suitable for growth of surface cover. Material shall be stripped and stockpiled from the site or borrowed from off-site.
  2. Topsoil shall be free from roots, brush, rocks, and other extraneous matter exceeding one inch in any direction. Topsoil shall be free from weeds.
  3. Topsoil shall be minimum 60% sand, maximum 30% silts, maximum 10% clay, and no less than 6% and no more than 20% organic matter.
  4. If requested by the City, submit test data showing compliance with this specification. Include percent weight of constituent material, material particle size, and pH.

**NOTES:**

1. PAVEMENT SECTION SHOWN IS MINIMUM SECTION ALLOWED FOR RESIDENTIAL STREET. DESIGN CONDITIONS VARY. PAVEMENT SECTION SHALL BE INCREASED AS DIRECTED BY THE CITY OF MOUNT VERNON AS CONDITIONS REQUIRE.
2. ALL RESIDENTIAL STREETS SHALL HAVE CURB AND GUTTER UNLESS OTHERWISE APPROVED BY THE CITY OF MOUNT VERNON.
3. TREATED SUBGRADE SHALL EXTEND 2' BEYOND THE PROPOSED BACK OF CURB FOR CURBED PAVEMENT AND 2' BEYOND THE EDGE OF PAVEMENT FOR NON-CURBED PAVEMENT.



**MARK DESCRIPTION**

- 1 REMOVE ALL VEGETATION AND DEBRIS PRIOR TO BEGINNING EMBANKMENT. SCARIFY GROUND SURFACE TO 8" AND RECOMPACT TO 95% OF STANDARD PROCTOR (ASTM D-698). PROOF ROLL, TxDOT ITEM 216. ALL AREAS PRIOR TO PLACEMENT OF EMBANKMENT TO DETECT ANY AREAS OF WEAKNESS AND REPLACE WITH FOUNDATION MATERIAL AT CITY OF MOUNT VERNON'S DIRECTION. AT TIME OF COMPACTION, THE MOISTURE CONTENT OF THE SOIL SHALL BE AS FOLLOWS:

SOIL DESCRIPTION	PLASTICITY INDEX (PI)	MOISTURE CONTENT AT TIME OF COMPACTION
NON-PLASTIC SILTY SAND SOILS	PI<15	+/- 3%
SANDY CLAY SOILS	15<PI<25	-1% TO +3%
CLAY SOILS	PI>25	-1% TO +3%

INSTALL FILL FOR EMBANKMENT IN 8" LIFTS, COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698). MOISTURE CONTENT SHALL BE AS DESCRIBED ABOVE AT THE TIME OF COMPACTION. SELECT FILL SHALL BE ON-SITE CLAYEY SOILS OR OFF-SITE MATERIAL. OFF-SITE MATERIAL SHALL BE FREE OF ORGANIC MATTER, OR ROCK FRAGMENTS LARGER THAN 2" IN ANY DIRECTION AND POSSES A PLASTICITY INDEX BETWEEN 10 AND 45, WITH A LIQUID LIMIT OF 70 OR LESS. THE FIRST LIFT OF FILL SHALL BE PLACED WITHIN 48 HOURS OF SATISFACTORY COMPACTION OF THE UNDERLYING SUBGRADE SOILS.

BLEND THE SUBGRADE SOILS TO A DEPTH OF 12" OVER THE PHASE TO OBTAIN A UNIFORMLY CONSISTENT PLASTICITY INDEX PRIOR TO LIME STABILIZATION.

- 2 8" OF SUBGRADE SHALL BE STABILIZED WITH LIME OR CEMENT DEPENDING UPON THE PREDOMINANT SUBGRADE SOILS PLASTICITY INDEX AS INDICATED BELOW:

LIME TREATMENT OF CLAY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 260. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. LIME SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. A MINIMUM OF SIX PERCENT (6%) HYDRATED LIME SHOULD BE USED TO TREAT SANDY CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) BETWEEN 16 AND 25. A MINIMUM OF EIGHT PERCENT (8%) HYDRATED LIME SHOULD BE USED TO TREAT CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 26 OR GREATER. LIME STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ ±3% OF OPTIMUM MOISTURE. THE REQUIRED APPLICATION RATES ARE OUTLINED BELOW:

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	LIME REQUIRED (LBS/SY)
16 TO 25	6	8	42
≥26	8	8	54

CEMENT TREATMENT OF SANDY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 275. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. CEMENT SHOULD BE ADDED ONLY TO THAT AREA WHERE THE MIXING, COMPACTION AND FINE GRADING CAN BE COMPLETED IN DAYLIGHT WITHIN TWO (2) HOURS OF APPLICATION, AND IN ONE CONTINUOUS OPERATION. A MINIMUM OF FOUR PERCENT (4%) TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE USED TO TREAT SANDY AND/OR SILTY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 15 OR LESS. THE REQUIRED APPLICATION RATE FOR A FOUR PERCENT (4%) TREATMENT DEPTH OF EIGHT (8) INCHES IS OUTLINED BELOW BASED ON THE PLASTICITY INDEX (PI) OF THE PREDOMINANT SUBGRADE SOILS. CEMENT STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ -4% TO +1% OF OPTIMUM MOISTURE

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	CEMENT REQUIRED (LBS/SY)
≤15	4	8	30

- 3 4" OF HMAC INSTALLED IN TWO 2" LIFTS, TxDOT ITEM 340, TYPE A OR B COMPACTED USING AIR VOID CONTROL METHOD.

- 4 2" OF HMAC, TxDOT ITEM 340, TYPE D, COMPACTED USING AIR VOID CONTROL METHOD.

- 5 MC-30 PRIME COAT APPLIED AT A MAXIMUM RATE OF 0.25 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF, AND THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS.

- 6 CRS-2H TACK COAT MECHANICALLY APPLIED AT A MAXIMUM RATE OF 0.10 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF, AND THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS. TACK COAT SHALL BE APPLIED BETWEEN ALL LAYERS OF HMAC.



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:  
9/6/2023

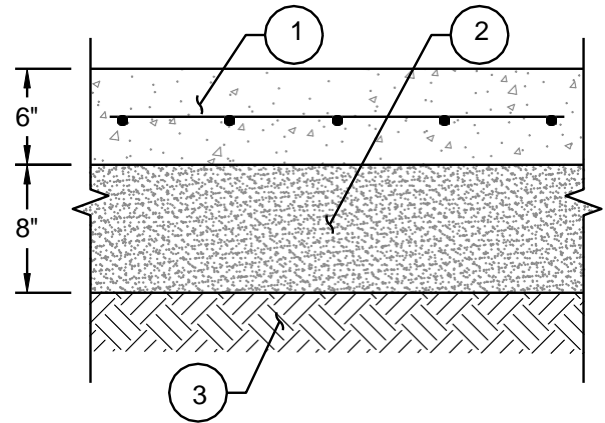
ENGINEERING DESIGN  
MANUAL

RESIDENTIAL (LOCAL)  
6 - INCH HMAC  
PAVEMENT SECTION

A-1

**NOTES:**

1. PAVEMENT DESIGN SHALL BE CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (CRCP), JOINTED CONCRETE PAVEMENT. ALTERNATE PAVEMENT DESIGN MUST BE SUBMITTED AND APPROVED BY THE CITY OF MOUNT VERNON.
2. PAVEMENT SECTION SHOWN IS THE MINIMUM SECTION ALLOWED FOR RESIDENTIAL STREETS. DESIGN CONDITIONS VARY. PAVEMENT SECTION SHALL BE INCREASED AS DIRECTED BY THE CITY OF MOUNT VERNON AS CONDITIONS REQUIRE.
3. ALL CONCRETE PAVEMENT SHALL HAVE MONOLITHIC CURB UNLESS OTHERWISE APPROVED BY THE CITY OF MOUNT VERNON.
4. TREATED SUBGRADE SHALL EXTEND 2' BEYOND THE PROPOSED BACK OF CURB FOR CURBED PAVEMENT SECTION AND 2' BEYOND THE EDGE OF PAVEMENT FOR NON-CURBED PAVEMENT.



**MARK DESCRIPTION**

① 6" PORTLAND CEMENT CONCRETE PAVEMENT. PAVEMENT SHALL BE TxDOT CLASS P HAVING A MINIMUM 4400 PSI COMPRESSIVE STRENGTH AT 28 DAYS (MINIMUM 6 SACKS PER CUBIC YARD), WITH #4 BARS AT 18" ON CENTER EACH WAY OR #3 BARS 10" ON CENTER EACH WAY. TRAVERSE AND LONGITUDINAL JOINTS SHALL HAVE A MAXIMUM SPACING OF 15' ON CENTER. TRAVERSE EXPANSION JOINTS SHALL BE PLACED AT CURB RETURNS AT INTERSECTIONS, PAVEMENT WITH TRANSITIONS, AND AT 500' MARK SPACING.

② 8" OF SUBGRADE SHALL BE STABILIZED WITH LIME OR CEMENT DEPENDING UPON THE PREDOMINANT SUBGRADE SOILS PLASTICITY INDEX AS INDICATED BELOW:  
 LIME TREATMENT OF CLAY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 260. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. LIME SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. A MINIMUM OF SIX PERCENT (6%) HYDRATED LIME SHOULD BE USED TO TREAT SANDY CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) BETWEEN 16 AND 25. A MINIMUM OF EIGHT PERCENT (8%) HYDRATED LIME SHOULD BE USED TO TREAT CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 26 OR GREATER. LIME STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ ±3% OF OPTIMUM MOISTURE. THE REQUIRED APPLICATION RATES ARE OUTLINED BELOW:

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	LIME REQUIRED (LBS/SY)
16 TO 25	6	8	42
≥26	8	8	54

CEMENT TREATMENT OF SANDY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 275. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. CEMENT SHOULD BE ADDED ONLY TO THAT AREA WHERE THE MIXING, COMPACTION AND FINE GRADING CAN BE COMPLETED IN DAYLIGHT WITHIN TWO (2) HOURS OF APPLICATION, AND IN ONE CONTINUOUS OPERATION. A MINIMUM OF FOUR PERCENT (4%) TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE USED TO TREAT SANDY AND/OR SILTY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 15 OR LESS. THE REQUIRED APPLICATION RATE FOR A FOUR PERCENT (4%) TREATMENT DEPTH OF EIGHT (8) INCHES IS OUTLINED BELOW BASED ON THE PLASTICITY INDEX (PI) OF THE PREDOMINANT SUBGRADE SOILS. CEMENT STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ -4% TO +1% OF OPTIMUM MOISTURE.

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	CEMENT REQUIRED (LBS/SY)
≤15	4	8	30

③ REMOVE ALL VEGETATION AND DEBRIS PRIOR TO BEGINNING EMBANKMENT. SCARIFY GROUND SURFACE TO 8" AND COMPACT TO 95% OF MAXIMUM DENSITY PER ASTM D-698 STANDARD PROCTOR. PROOF ROLL COMPACTED SUBGRADE PER TxDOT ITEM 216 PRIOR TO PLACEMENT OF EMBANKMENT TO DETECT ANY AREAS OF WEAKNESS AND REPLACE WITH FOUNDATION MATERIAL AS DIRECTED BY THE CITY OF MOUNT VERNON. DURING COMPACTION, THE MOISTURE CONTENT OF THE SOIL SHALL BE AS FOLLOWS:

SOIL DESCRIPTION	PLASTICITY INDEX (PI)	MOISTURE CONTENT AT TIME OF COMPACTION
NON-PLASTIC SILTY SAND SOILS	PI<15	+/- 3%
SANDY CLAY SOILS	15<PI<25	-1% TO +3%
CLAY SOILS	PI>25	-1% TO +3%

INSTALL FILL FOR EMBANKMENT IN 8" LIFTS, COMPACTED IN HORIZONTAL LIFTS TO A MINIMUM OF 95% OF MAXIMUM DENSITY PER ASTM D-698 STANDARD PROCTOR. MOISTURE CONTENT SHALL BE AS DESCRIBED ABOVE DURING COMPACTION. SELECT FILL SHALL BE ON-SITE CLAYEY SANDY SOILS OR OFF-SITE MATERIAL. MATERIAL SHALL BE FREE OF ORGANIC MATTER OR ROCK FRAGMENTS LARGER THAN 2" IN ANY DIRECTION AND POSSES A PLASTICITY INDEX BETWEEN 10 AND 45, WITH A LIQUID LIMIT OF 70 OR LESS. THE FIRST LIFT OF FILL SHALL BE PLACED WITHIN 48 HOURS OF SATISFACTORY COMPACTION OF THE UNDERLYING SUBGRADE SOILS.

IF DIRECTED BY THE CITY OF MOUNT VERNON, BLEND THE SUBGRADE SOILS TO A DEPTH OF 12" OVER THE PROJECT AREA TO OBTAIN A UNIFORMLY CONSISTENT PLASTICITY INDEX PRIOR TO LIME OR CEMENT STABILIZATION.



STREETS

LATEST REVISION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

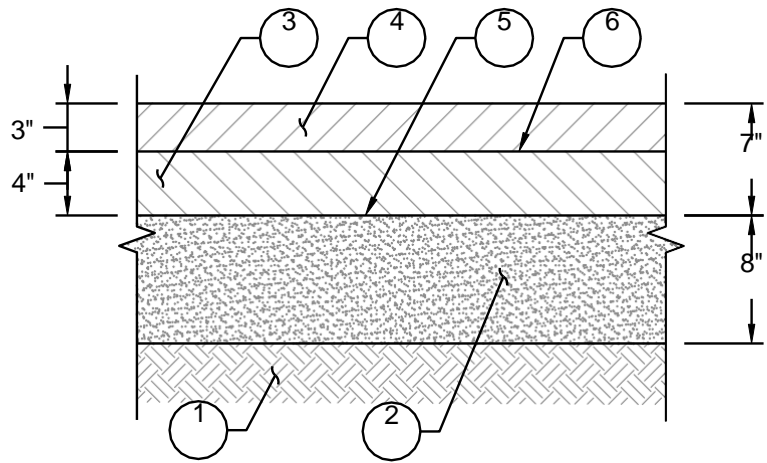
RESIDENTIAL (LOCAL)  
6 - INCH CONCRETE  
PAVEMENT SECTION

A-2

SHEET No.

**NOTES:**

1. PAVEMENT SECTION SHOWN IS MINIMUM SECTION ALLOWED FOR RESIDENTIAL STREET. DESIGN CONDITIONS VARY. PAVEMENT SECTION SHALL BE INCREASED AS DIRECTED BY THE CITY OF MOUNT VERNON AS CONDITIONS REQUIRE.
2. ALL RESIDENTIAL STREETS SHALL HAVE CURB AND GUTTER UNLESS OTHERWISE APPROVED BY THE CITY OF MOUNT VERNON.
3. TREATED SUBGRADE SHALL EXTEND 2' BEYOND THE PROPOSED BACK OF CURB FOR CURBED PAVEMENT AND 2' BEYOND THE EDGE OF PAVEMENT FOR NON-CURBED PAVEMENT.



**MARK DESCRIPTION**

- 1 REMOVE ALL VEGETATION AND DEBRIS PRIOR TO BEGINNING EMBANKMENT. SCARIFY GROUND SURFACE TO 8" AND RECOMPACT TO 95% OF STANDARD PROCTOR (ASTM D-698). PROOF ROLL, TxDOT ITEM 216, ALL AREAS PRIOR TO PLACEMENT OF EMBANKMENT TO DETECT ANY AREAS OF WEAKNESS AND REPLACE WITH FOUNDATION MATERIAL AT CITY OF MOUNT VERNON'S DIRECTION. AT TIME OF COMPACTION, THE MOISTURE CONTENT OF THE SOIL SHALL BE AS FOLLOWS:

SOIL DESCRIPTION	PLASTICITY INDEX (PI)	MOISTURE CONTENT AT TIME OF COMPACTION
NON-PLASTIC SILTY SAND SOILS	PI<15	+/- 3%
SANDY CLAY SOILS	15<PI<25	-1% TO +3%
CLAY SOILS	PI>25	-1% TO +3%

INSTALL FILL FOR EMBANKMENT IN 8" LIFTS, COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698). MOISTURE CONTENT SHALL BE AS DESCRIBED ABOVE AT THE TIME OF COMPACTION. SELECT FILL SHALL BE ON-SITE CLAYEY SOILS OR OFF-SITE MATERIAL. OFF-SITE MATERIAL SHALL BE FREE OF ORGANIC MATTER, OR ROCK FRAGMENTS LARGER THAN 2" IN ANY DIRECTION AND POSSES A PLASTICITY INDEX BETWEEN 10 AND 45, WITH A LIQUID LIMIT OF 70 OR LESS. THE FIRST LIFT OF FILL SHALL BE PLACED WITHIN 48 HOURS OF SATISFACTORY COMPACTION OF THE UNDERLYING SUBGRADE SOILS.

BLEND THE SUBGRADE SOILS TO A DEPTH OF 12" OVER THE PHASE TO OBTAIN A UNIFORMLY CONSISTENT PLASTICITY INDEX PRIOR TO LIME STABILIZATION.

- 2 8" OF SUBGRADE SHALL BE STABILIZED WITH LIME OR CEMENT DEPENDING UPON THE PREDOMINANT SUBGRADE SOILS PLASTICITY INDEX AS INDICATED BELOW:


LIME TREATMENT OF CLAY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 260. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. LIME SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. A MINIMUM OF SIX PERCENT (6%) HYDRATED LIME SHOULD BE USED TO TREAT SANDY CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) BETWEEN 16 AND 25. A MINIMUM OF EIGHT PERCENT (8%) HYDRATED LIME SHOULD BE USED TO TREAT CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 26 OR GREATER. LIME STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ ±3% OF OPTIMUM MOISTURE. THE REQUIRED APPLICATION RATES ARE OUTLINED BELOW:

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	LIME REQUIRED (LBS/SY)
16 TO 25	6	8	42
≥26	8	8	54

CEMENT TREATMENT OF SANDY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 275. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. CEMENT SHOULD BE ADDED ONLY TO THAT AREA WHERE THE MIXING, COMPACTION AND FINE GRADING CAN BE COMPLETED IN DAYLIGHT WITHIN TWO (2) HOURS OF APPLICATION, AND IN ONE CONTINUOUS OPERATION. A MINIMUM OF FOUR PERCENT (4%) TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE USED TO TREAT SANDY AND/OR SILTY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 15 OR LESS. THE REQUIRED APPLICATION RATE FOR A FOUR PERCENT (4%) TREATMENT DEPTH OF EIGHT (8) INCHES IS OUTLINED BELOW BASED ON THE PLASTICITY INDEX (PI) OF THE PREDOMINANT SUBGRADE SOILS. CEMENT STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ -4% TO +1% OF OPTIMUM MOISTURE

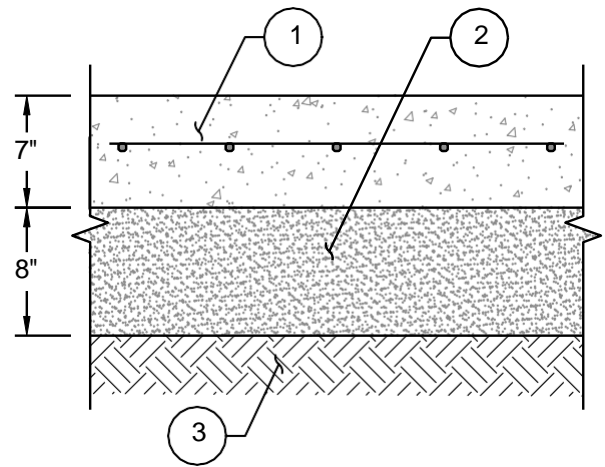
PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	CEMENT REQUIRED (LBS/SY)
≤15	4	8	30

- 3 4" OF HMAC INSTALLED IN TWO 2" LIFTS, TxDOT ITEM 340, TYPE A OR B COMPACTED USING AIR VOID CONTROL METHOD.
- 4 3" OF HMAC, TxDOT ITEM 340, TYPE D, COMPACTED USING AIR VOID CONTROL METHOD.
- 5 MC-30 PRIME COAT APPLIED AT A MAXIMUM RATE OF 0.25 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF, AND THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS.
- 6 CRS-2H TACK COAT MECHANICALLY APPLIED AT A MAXIMUM RATE OF 0.10 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF, AND THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS. TACK COAT SHALL BE APPLIED BETWEEN ALL LAYERS OF HMAC.

	STREETS	ENGINEERING DESIGN MANUAL	RESIDENTIAL (COLLECTOR) 7 - INCH HMAC PAVEMENT SECTION	A-3
	LATEST REVISION: 9/6/2023			

**NOTES:**

1. PAVEMENT DESIGN SHALL BE CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (CRCP), JOINTED CONCRETE PAVEMENT. ALTERNATE PAVEMENT DESIGN MUST BE SUBMITTED AND APPROVED BY THE CITY OF MOUNT VERNON.
2. PAVEMENT SECTION SHOWN IS THE MINIMUM SECTION ALLOWED FOR RESIDENTIAL STREETS. DESIGN CONDITIONS VARY. PAVEMENT SECTION SHALL BE INCREASED AS DIRECTED BY THE CITY OF MOUNT VERNON AS CONDITIONS REQUIRE.
3. ALL CONCRETE PAVEMENT SHALL HAVE MONOLITHIC CURB UNLESS OTHERWISE APPROVED BY THE CITY OF MOUNT VERNON.
4. TREATED SUBGRADE SHALL EXTEND 2' BEYOND THE PROPOSED BACK OF CURB FOR CURBED PAVEMENT SECTION AND 2' BEYOND THE EDGE OF PAVEMENT FOR NON-CURBED PAVEMENT.



**MARK DESCRIPTION**

① 7" PORTLAND CEMENT CONCRETE PAVEMENT. PAVEMENT SHALL BE TxDOT CLASS P HAVING A MINIMUM 4400 PSI COMPRESSIVE STRENGTH AT 28 DAYS (MINIMUM 6 SACKS PER CUBIC YARD), WITH #4 BARS AT 18" ON CENTER EACH WAY OR #3 BARS 10" ON CENTER EACH WAY. TRAVERSE AND LONGITUDINAL JOINTS SHALL HAVE A MAXIMUM SPACING OF 15' ON CENTER. TRAVERSE EXPANSION JOINTS SHALL BE PLACED AT CURB RETURNS AT INTERSECTIONS, PAVEMENT WITH TRANSITIONS, AND AT 500' MARK SPACING.

② 8" OF SUBGRADE SHALL BE STABILIZED WITH LIME OR CEMENT DEPENDING UPON THE PREDOMINANT SUBGRADE SOILS PLASTICITY INDEX AS INDICATED BELOW:  
 LIME TREATMENT OF CLAY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 260. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. LIME SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. A MINIMUM OF SIX PERCENT (6%) HYDRATED LIME SHOULD BE USED TO TREAT SANDY CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) BETWEEN 16 AND 25. A MINIMUM OF EIGHT PERCENT (8%) HYDRATED LIME SHOULD BE USED TO TREAT CLAY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 26 OR GREATER. LIME STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ ±3% OF OPTIMUM MOISTURE. THE REQUIRED APPLICATION RATES ARE OUTLINED BELOW:

PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	LIME REQUIRED (LBS/SY)
16 TO 25	6	8	42
≥26	8	8	54

CEMENT TREATMENT OF SANDY SUBGRADE SOILS SHOULD BE ACCOMPLISHED IN ACCORDANCE WITH TxDOT ITEM 275. THE COMPACTION REQUIREMENTS INDICATED BELOW SHOULD BE SPECIFIED IN LIEU OF THE REQUIREMENTS RECOMMENDED BY TxDOT. TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL SURFACE VEGETATION AND DEBRIS. CEMENT SHOULD BE ADDED ONLY TO THAT AREA WHERE THE MIXING, COMPACTION AND FINE GRADING CAN BE COMPLETED IN DAYLIGHT WITHIN TWO (2) HOURS OF APPLICATION, AND IN ONE CONTINUOUS OPERATION. A MINIMUM OF FOUR PERCENT (4%) TYPE I, TYPE II, OR TYPE I/II PORTLAND CEMENT SHOULD BE USED TO TREAT SANDY AND/OR SILTY SUBGRADE SOILS HAVING A PLASTICITY INDEX (PI) OF 15 OR LESS. THE REQUIRED APPLICATION RATE FOR A FOUR PERCENT (4%) TREATMENT DEPTH OF EIGHT (8) INCHES IS OUTLINED BELOW BASED ON THE PLASTICITY INDEX (PI) OF THE PREDOMINANT SUBGRADE SOILS. CEMENT STABILIZED SUBGRADE SHALL BE COMPACTED TO A MINIMUM OF 95% OF STANDARD PROCTOR (ASTM D-698) @ -4% TO +1% OF OPTIMUM MOISTURE.

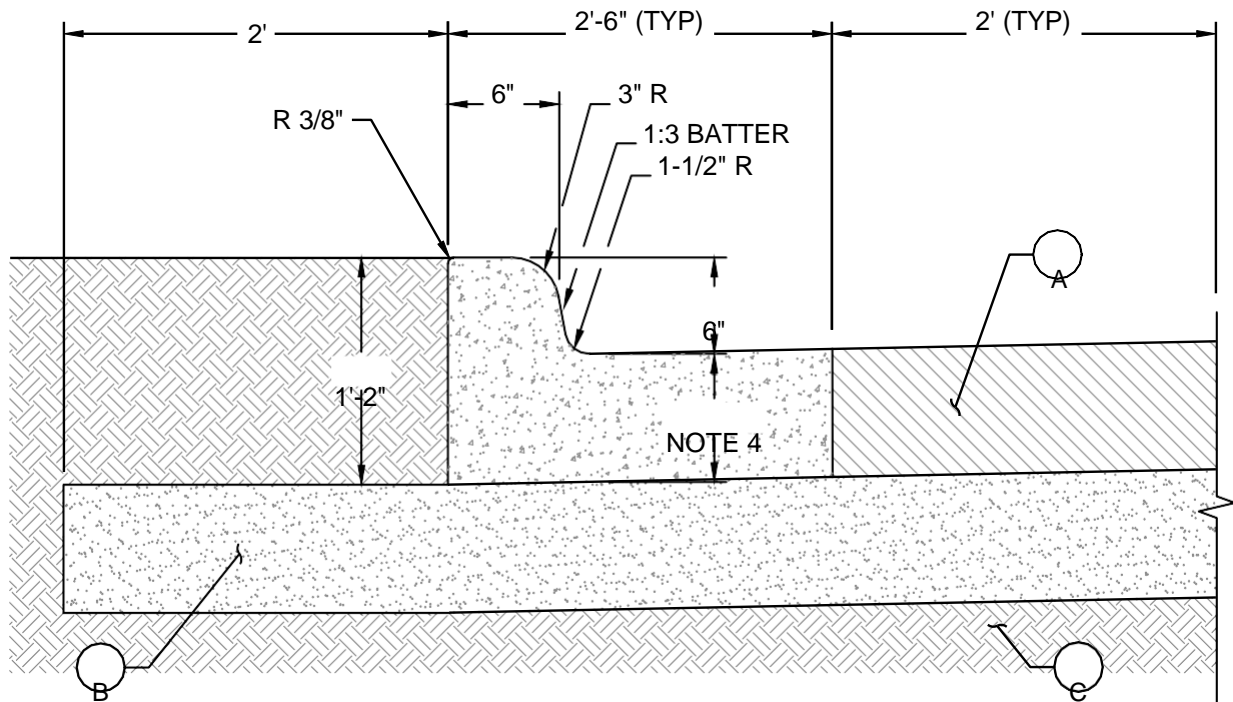
PLASTICITY INDEX (PI)	APPLICATION (%)	DEPTH OF TREATMENT (INCHES)	CEMENT REQUIRED (LBS/SY)
≤15	4	8	30

③ REMOVE ALL VEGETATION AND DEBRIS PRIOR TO BEGINNING EMBANKMENT. SCARIFY GROUND SURFACE TO 8" AND COMPACT TO 95% OF MAXIMUM DENSITY PER ASTM D-698 STANDARD PROCTOR. PROOF ROLL COMPACTED SUBGRADE PER TxDOT ITEM 216 PRIOR TO PLACEMENT OF EMBANKMENT TO DETECT ANY AREAS OF WEAKNESS AND REPLACE WITH FOUNDATION MATERIAL AS DIRECTED BY THE CITY OF MOUNT VERNON. DURING COMPACTION, THE MOISTURE CONTENT OF THE SOIL SHALL BE AS FOLLOWS:

SOIL DESCRIPTION	PLASTICITY INDEX (PI)	MOISTURE CONTENT AT TIME OF COMPACTION
NON-PLASTIC SILTY SAND SOILS	PI<15	+/- 3%
SANDY CLAY SOILS	15<PI<25	-1% TO +3%
CLAY SOILS	PI>25	-1% TO +3%

INSTALL FILL FOR EMBANKMENT IN 8" LIFTS, COMPACTED IN HORIZONTAL LIFTS TO A MINIMUM OF 95% OF MAXIMUM DENSITY PER ASTM D-698 STANDARD PROCTOR. MOISTURE CONTENT SHALL BE AS DESCRIBED ABOVE DURING COMPACTION. SELECT FILL SHALL BE ON-SITE CLAYEY SANDY SOILS OR OFF-SITE MATERIAL. MATERIAL SHALL BE FREE OF ORGANIC MATTER OR ROCK FRAGMENTS LARGER THAN 2" IN ANY DIRECTION AND POSSES A PLASTICITY INDEX BETWEEN 10 AND 45, WITH A LIQUID LIMIT OF 70 OR LESS. THE FIRST LIFT OF FILL SHALL BE PLACED WITHIN 48 HOURS OF SATISFACTORY COMPACTION OF THE UNDERLYING SUBGRADE SOILS.

IF DIRECTED BY THE CITY OF MOUNT VERNON, BLEND THE SUBGRADE SOILS TO A DEPTH OF 12" OVER THE PROJECT AREA TO OBTAIN A UNIFORMLY CONSISTENT PLASTICITY INDEX PRIOR TO LIME OR CEMENT STABILIZATION.



MARK	DESCRIPTION
A	PAVEMENT PER CITY OF MOUNT VERNON STANDARDS.
B	LIME OR CEMENT STABILIZED SUBGRADE PER CITY OF MOUNT VERNON STANDARDS. EXTEND COMPACTED STABILIZED SUBGRADE TO A MINIMUM OF 2 FEET BEYOND THE BACK OF CURB.
C	SCARIFY AND COMPACTED SUBGRADE PER CITY OF MOUNT VERNON STANDARDS. EXTEND A MINIMUM OF 2 FEET BEYOND THE BACK OF CURB.

NOTES:

1. PORTLAND CEMENT CONCRETE SHALL BE TxDOT CLASS P HAVING A MINIMUM COMPRESSIVE STRENGTH OF 4400 PSI AT 28 DAYS (MINIMUM 6 SACKS PER CUBIC YARD).
2. CURB AND GUTTER SHALL HAVE BROOM FINISH.
3. CROSS SLOPE OF GUTTER SHALL MATCH THE CROSS SLOPE OF THE PAVEMENT SECTION UNLESS OTHERWISE DIRECTED BY THE CITY OF MOUNT VERNON.
4. GUTTER THICKNESS SHALL MATCH THE THE PAVEMENT THICKNESS (6" MINIMUM).
5. FOR AREAS WITH SIDEWALK ADJACENT TO THE CURB AND GUTTER, THE LOCATIONS OF JOINTS IN THE SIDEWALK AND CURB AND GUTTER SHALL MATCH. INSTALL 1/2" EXPANSION JOINT AT BACK OF CURB BETWEEN CURB AND SIDEWALK.



STREETS

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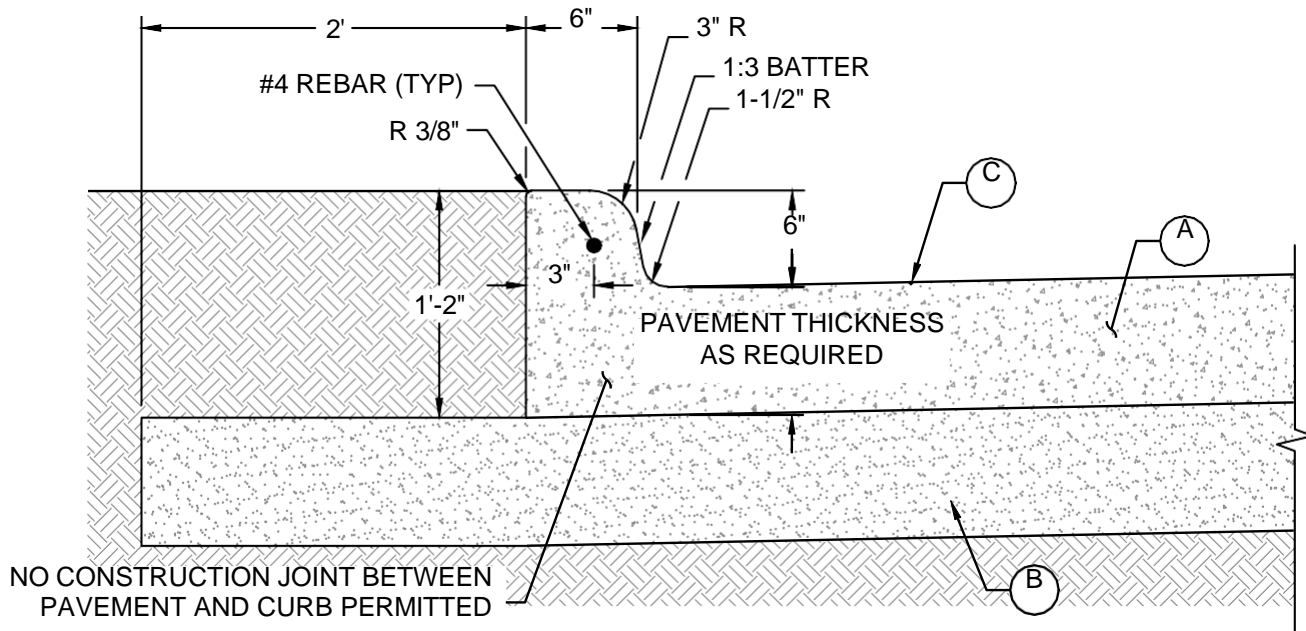
9/6/2023

ENGINEERING DESIGN  
MANUAL

STANDARD CURB  
AND GUTTER

A-5





**NOTES:**

1. PORTLAND CEMENT PAVEMENT SHALL BE TxDOT CLASS P HAVING A MINIMUM 4400 PSI COMPRESSIVE STRENGTH AT 28 DAYS (MINIMUM 6 SACKS PER CUBIC YARD).
2. INSTALL TWO #4 DIA x 18" SMOOTH DOWEL BARS CENTERED IN GUTTER AT CONSTRUCTION JOINTS AND TRANSITIONS.
3. INSTALL TRANSVERSE JOINTS IN CURB AND GUTTER MATCHING PAVEMENT TRANSVERSE JOINT LOCATIONS AND TYPES.
4. CROSS SLOPE OF GUTTER SHALL MATCH CROSS SLOPE OF PAVEMENT.
5. CONSTRUCTION JOINT AND/OR COLD JOINT BETWEEN THE CURB AND PAVEMENT IS NOT PERMITTED.

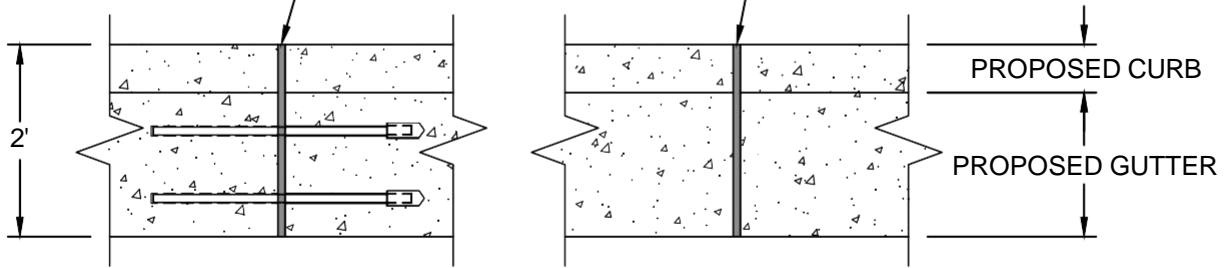
**MARK**

**DESCRIPTION**

- (A) CONCRETE PAVEMENT PER CITY OF MOUNT VERNON STANDARD (MINIMUM 6" THICK FOR RESIDENTIAL LOCAL AND MINIMUM 7" THICK FOR RESIDENTIAL COLLECTOR).
- (B) LINE OR CEMENT STABILIZED SUBGRADE PER CITY OF MOUNT VERNON STANDARD. EXTEND STABILIZATION A MINIMUM OF 30" BEYOND THE BACK OF CURB.
- (C) PROVIDE SCORE OR OTHER APPROVED DELINEATION LINE 30" FROM AND PARALLEL TO BACK OF CURB TO CREATE STANDARD 30" CURB AND GUTTER APPEARANCE. FINISH CURB AND GUTTER WITH BROOM FINISH MATCHING STANDARD 30" CURB AND GUTTER TO SET APART FROM PAVEMENT FINISH.

CONCRETE PAVEMENT - CURB AND GUTTER SHALL BE MONOLITHICALLY PLACED WITH CONCRETE PAVEMENT. JOINTS IN CURB AND GUTTER SHALL MATCH PAVEMENT JOINT LOCATIONS AND TYPES. INSTALL TWO No. 4 x 18" SMOOTH DOWEL BARS CENTER IN PAVEMENT AND EVENLY SPACED IN GUTTER.

ASPHALT PAVEMENTS  
DUMMY JOINTS 1/4" WIDE x 3/4" DEEP, 1/4" RADIUS TOOLED OR SAW - CUT JOINT



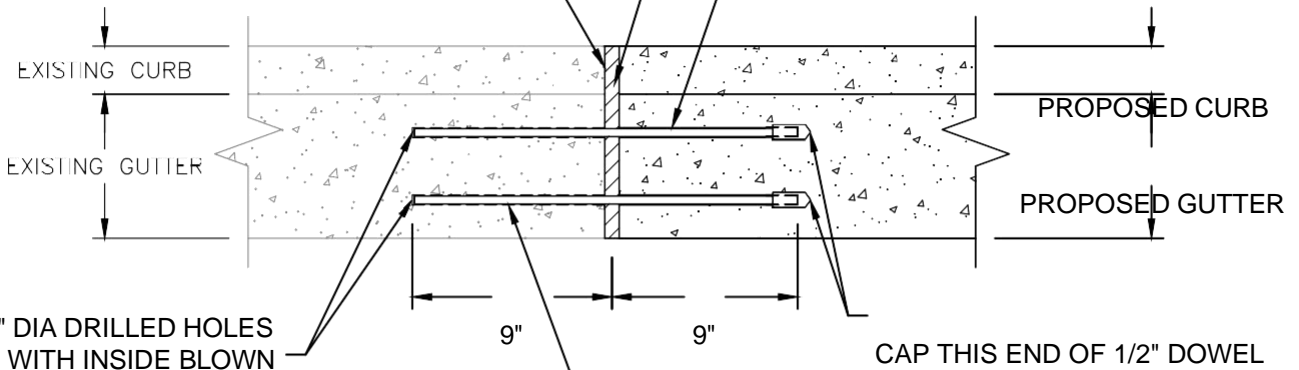
**CURB AND GUTTER JOINT DETAIL (PLAN VIEW)**

NTS

TIE - IN AT EXISTING JOINT OR SAW-CUT EXISTING CURB AND GUTTER FULL WIDTH AT TIE - IN POINT

INSTALL 1/2" PREMOLDED EXPANSION JOINT MATERIAL AT TIE - IN POINT

PAINT AND GREASE ENDS PRIOR TO NEW CURB AND GUTTER PLACEMENT



CLEAN AND COATED WITH APPROVED EPOXY RESIN  
2 BARS PER TIE - IN

1/2" DIA SMOOTH DOWELS x 18'  
COAT ONE HALF WITH APPROVED EPOXY RESIN BEFORE INSERTION INTO THE DOWEL HOLE  
2 BARS PER TIE - IN

CAP THIS END OF 1/2" DOWEL

**EXPANSION JOINT (PLAN VIEW)**

NTS



STREETS

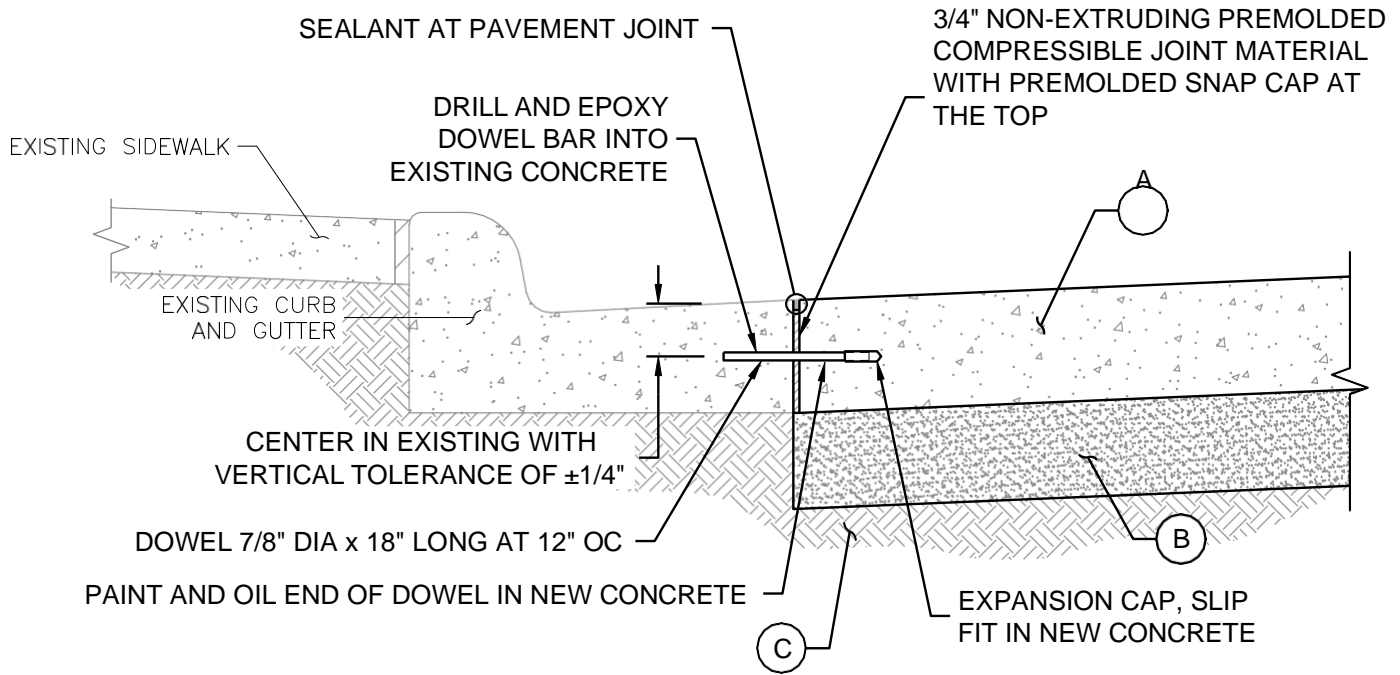
ENGINEERING DESIGN  
MANUAL

CURB AND GUTTER JOINTS

A 7

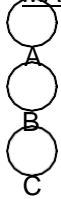
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9/6/2023

SHEET No.



MARK

DESCRIPTION



A CONCRETE PAVEMENT PER CITY OF MOUNT VERNON STANDARDS.

B LIME OR CEMENT TREATED, COMPACTED SUBGRADE PER CITY OF MOUNT VERNON STANDARDS.

C SCARIFY AND COMPACT PER CITY OF MOUNT VERNON STANDARDS.

NOTES:

1. ALL TIE - INS SHALL BE DONE WITH EXPANSION JOINTS AS DETAILED HERE UNLESS OTHERWISE APPROVED BY THE CITY OF MOUNT VERNON.
2. DETAIL IS TYPICAL FOR TIE - IN OF NEW CONCRETE PAVEMENT TO EXISTING CURB AND GUTTER.
3. NEW CURB AND GUTTER TIE - IN TO EXISTING PAVEMENT - SIMILAR CONSTRUCTION IS REQUIRED FOR TIE - IN OF NEW CURB AND GUTTER TO EXISTING PAVEMENT WITH DOWEL BARS FIXED IN PAVEMENT AND GREASED BAR WITH CAP IN CURB AND GUTTER.
4. EXPANSION JOINTS SHALL BE CONTINUOUS AND SHALL EXTEND ON ALL SIDES OF BLOCKOUTS AND TIE - INS.
5. PREMOLDED JOINT MATERIAL SHALL HAVE SNAP CAP AT THE TOP. CUTTING OR SHREDDING THE JOINT MATERIAL IS NOT PERMITTED. SEAL JOINTS AS REQUIRED BY THE CITY OF MOUNT VERNON.



STREETS

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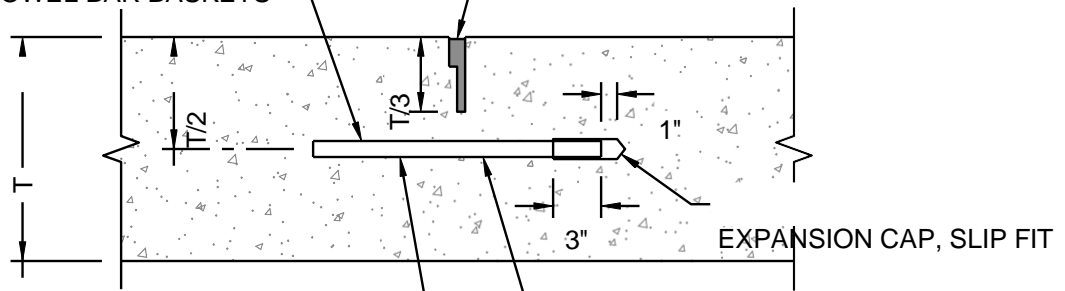
CURB AND GUTTER  
PAVEMENT TIE - IN

A-8

SHEET No.

SET IN PLACE AT CENTER OF PAVEMENT SECTION WITH DOWEL BAR BASKETS

REFER TO JOINT SEALING DETAIL



#6 SMOOTH BARS x 18" LONG AT 12" OC FOR 6" AND 7" CONCRETE PAVEMENT  
 #8 SMOOTH BARS x 18" LONG AT 12" OC FOR CONCRETE PAVEMENTS GREATER THAN 7" DEPTHS

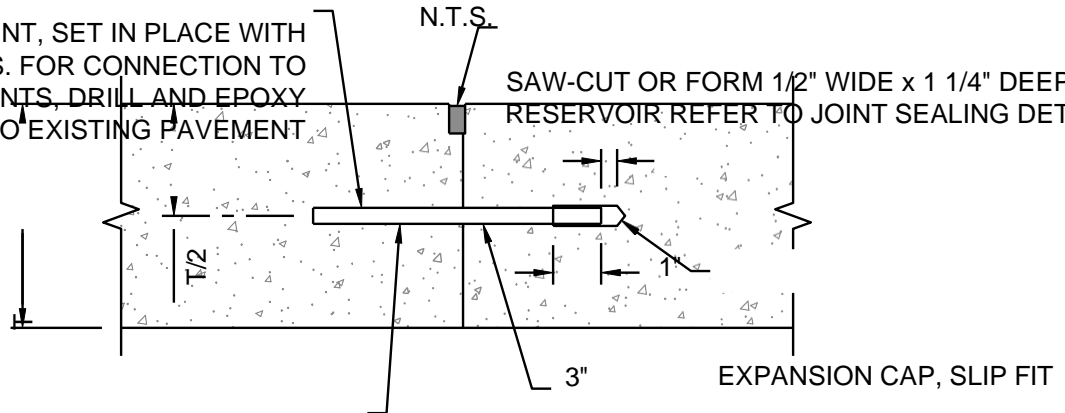
PAINT AND OIL THIS END OF DOWEL

**TRANSVERSE JOINT**

FOR NEW PAVEMENT, SET IN PLACE WITH DOWEL BAR BASKETS. FOR CONNECTION TO EXISTING PAVEMENTS, DRILL AND EPOXY DOWEL BAR INTO EXISTING PAVEMENT

N.T.S.

SAW-CUT OR FORM 1/2" WIDE x 1 1/4" DEEP RESERVOIR REFER TO JOINT SEALING DETAIL



#6 SMOOTH BARS x 18" LONG AT 12" OC FOR 6" AND 7" CONCRETE PAVEMENT  
 #8 SMOOTH BARS x 18" LONG AT 12" OC FOR CONCRETE PAVEMENTS GREATER THAN 7" DEPTHS

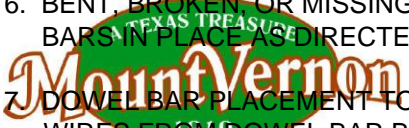
PAINT AND OIL THIS END OF DOWEL

**TRANSVERSE CONSTRUCTION JOINT**

N.T.S.

NOTES:

1. CONCRETE PAVEMENT THICKNESS SHALL BE A MINIMUM OF 6" FOR RESIDENTIAL LOCAL STREETS AND A MINIMUM OF 7" FOR RESIDENTIAL COLLECTOR STREETS.
2. TRANSVERSE JOINTS SHALL BE STRAIGHT WITH NO MORE THAN 1" VARIATION IN 20 FEET.
3. TRANSVERSE JOINTS SHALL BE SPACED NO MORE THAN 12.5 FEET OC FOR LOCAL STREETS AND 15 FEET OC FOR COLLECTOR STREETS.
4. DOWEL BARS SHALL BE SPACED AT 12" OC AND SHALL BE OFFSET 18" FROM LONGITUDINAL JOINT INTERSECTIONS.
5. JOINT SEALANT RESERVOIR SHALL BE A MINIMUM OF 1/3 THE PAVEMENT THICKNESS AND 3/4" WIDE (±1/8"). SAW-CUT JOINTS SHALL BE COMPLETED WITHIN 24 HOURS OF CONCRETE PLACEMENT.
6. BENT, BROKEN OR MISSING BARS SHALL BE REPLACED WITH NEW BARS. DRILL AND EPOXY REPLACEMENT BARS IN PLACE AS DIRECTED BY THE CITY OF MOUNT PLEASANT.
7. DOWEL BAR PLACEMENT TOLERANCE SHALL BE ±1/4" HORIZONTALLY AND VERTICALLY. REMOVE SHIPPING WIRES FROM DOWEL BAR BASKETS PRIOR TO CEMENT PLACEMENT.



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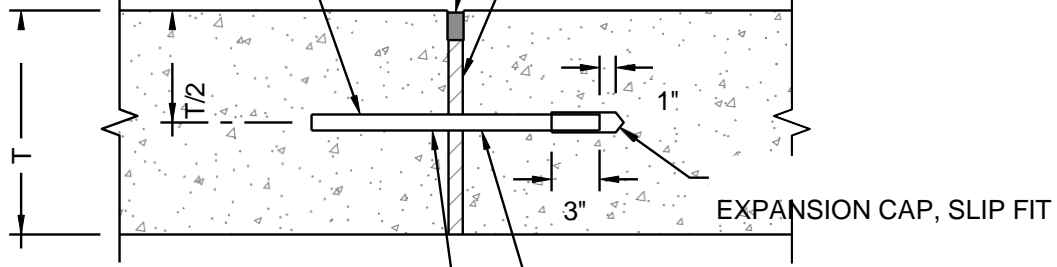
TRANSVERSE JOINTS

A-9

SHEET No.

SET IN PLACE AT CENTER OF PAVEMENT SECTION WITH DOWEL BAR BASKETS

REFER TO JOINT SEALING DETAIL  
3/4" NON-EXTRUDING PREMOLDED COMPRESSIBLE MATERIAL WITH SNAP CAP



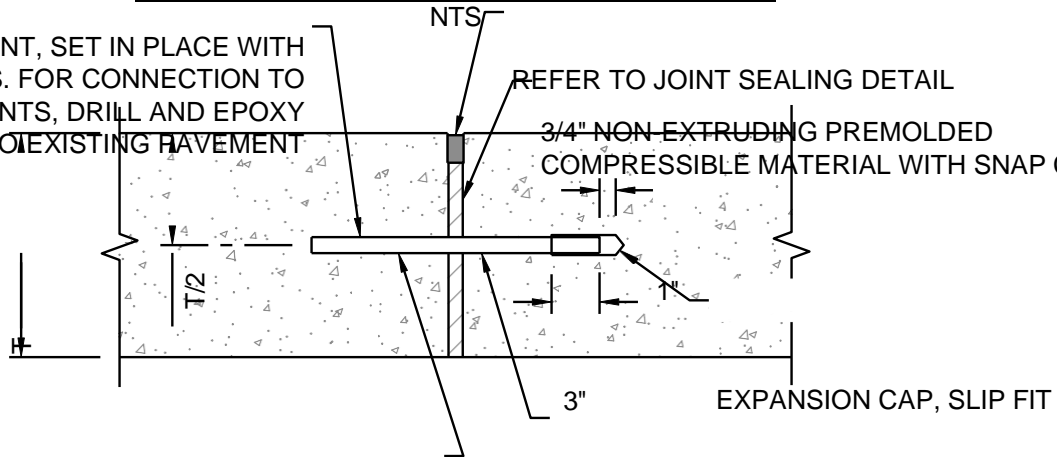
#6 SMOOTH BARS x 18" LONG AT 12" OC FOR 6" AND 7" CONCRETE PAVEMENT  
#8 SMOOTH BARS x 18" LONG AT 12" OC FOR CONCRETE PAVEMENTS GREATER THAN 7" DEPTHS

PAINT AND OIL THIS END OF DOWEL

### TRANSVERSE EXPANSION JOINT

FOR NEW PAVEMENT, SET IN PLACE WITH DOWEL BAR BASKETS. FOR CONNECTION TO EXISTING PAVEMENTS, DRILL AND EPOXY DOWEL BAR INTO EXISTING PAVEMENT

REFER TO JOINT SEALING DETAIL  
3/4" NON-EXTRUDING PREMOLDED COMPRESSIBLE MATERIAL WITH SNAP CAP



#6 SMOOTH BARS x 18" LONG AT 12" OC FOR 6" AND 7" CONCRETE PAVEMENT  
#8 SMOOTH BARS x 18" LONG AT 12" OC FOR CONCRETE PAVEMENTS GREATER THAN 7" DEPTHS

PAINT AND OIL THIS END OF DOWEL

### TRANSVERSE EXPANSION - CONSTRUCTION JOINT

NOTES:

NTS

1. PROVIDE EXPANSION JOINTS AT INTERSECTING PAVEMENTS. ADDITIONAL EXPANSION JOINTS SHALL BE LOCATED AS DIRECTED BY THE CITY OF MOUNT VERNON.
2. CONCRETE PAVEMENT THICKNESS SHALL BE A MINIMUM OF 6" FOR RESIDENTIAL LOCAL STREETS AND A MINIMUM OF 7" FOR RESIDENTIAL COLLECTOR STREETS.
3. TRANSVERSE JOINTS SHALL BE STRAIGHT WITH NO MORE THAN 1" VARIATION IN 20 FEET.
4. DOWEL BARS SHALL BE SPACED AT 12" OC AND SHALL BE OFFSET 18" FROM LONGITUDINAL JOINT INTERSECTIONS.

5. BENT, BROKEN, OR MISSING BARS SHALL BE REPLACED WITH NEW BARS. DRILL AND EPOXY BARS IN PLACE AS DIRECTED BY THE CITY OF MOUNT VERNON.

6. DOWEL PLACEMENT TOLERANCE SHALL BE  $\pm 1/4$ " HORIZONTALLY AND VERTICALLY. REMOVE SHIPPING WIRES FROM DOWEL BAR BASKETS PRIOR TO CEMENT PLACEMENT.



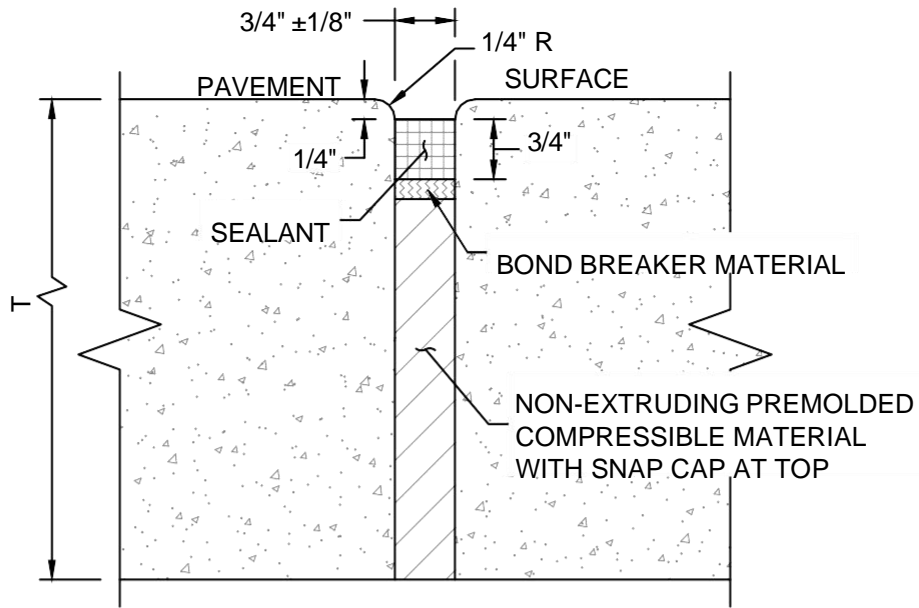
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TRANSVERSE  
EXPANSION JOINTS

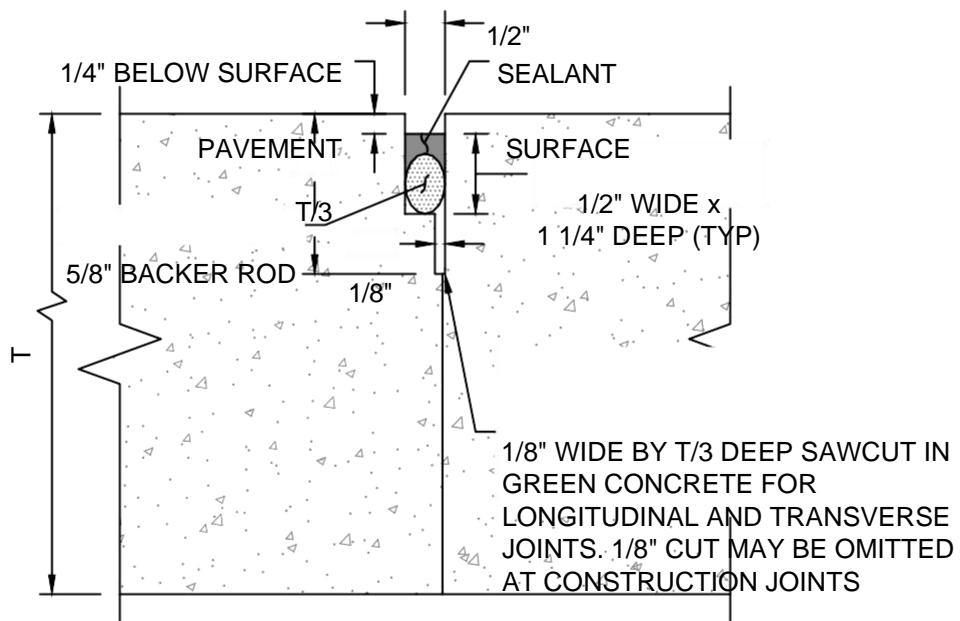
A-10

SHEET No.



**EXPANSION JOINT**

NTS



**SEALANT RESERVOIR CONTRACTION JOINT,  
TRANSVERSE JOINT, CONSTRUCTION JOINT**

NTS

**NOTE:**

LONGITUDINAL AND TRANSVERSE JOINTS SHALL BE A MINIMUM OF 1/8" WIDE FOR 1/3 OF THE PAVEMENT THICKNESS.



STREETS

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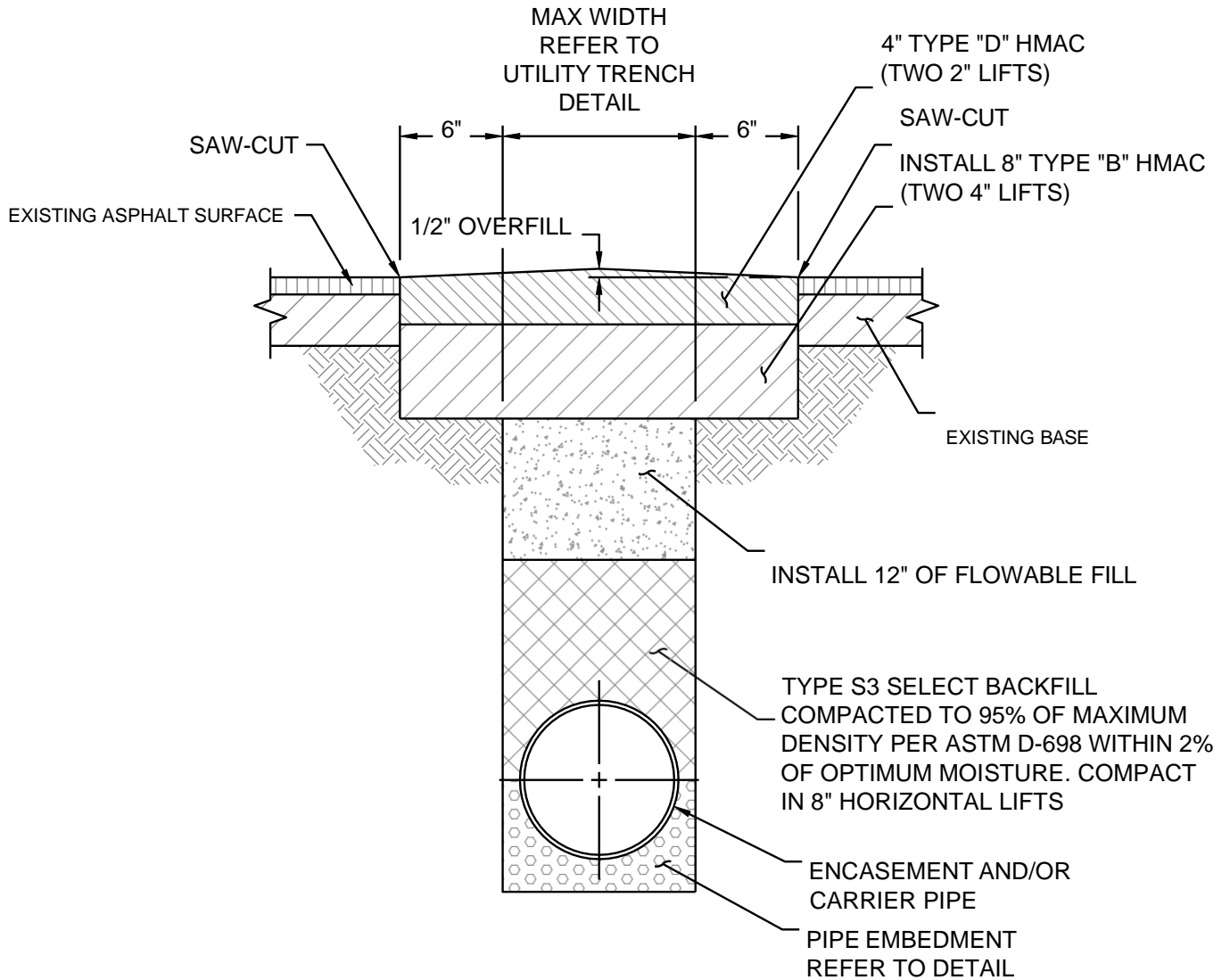


DESIGN MANUAL

JOINT SEALING

A-11

SHEET No.



**NOTE:**

PROVIDE CRS-2H TACK COAT AT A RATE OF 0.10 GALLON PER SQUARE YARD BETWEEN EACH ASPHALT LIFT.

**SAW-CUT AND REPAIR ASPHALT ROAD PAVEMENT DETAIL**

NTS



STREETS

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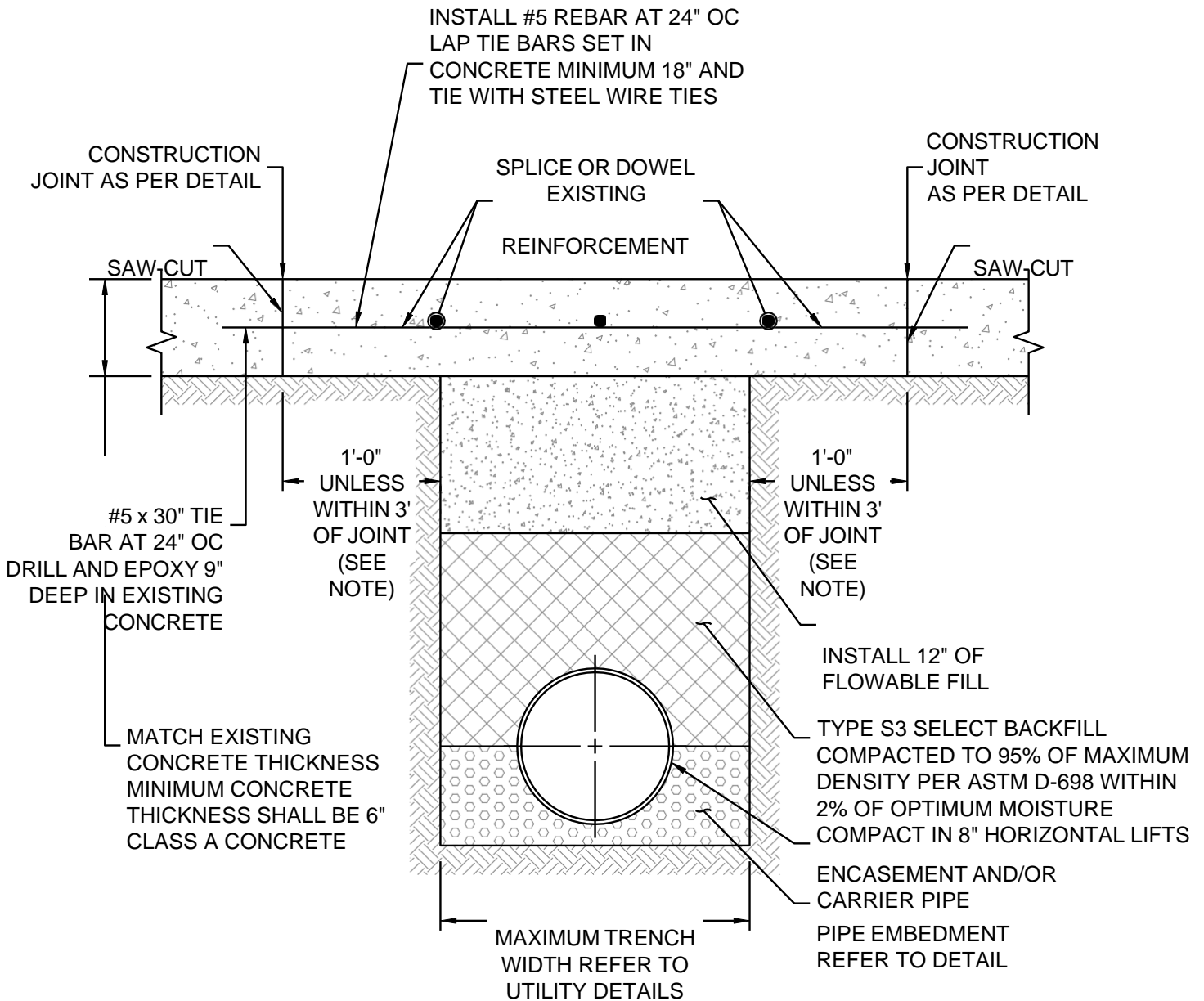
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ENGINEERING DESIGN MANUAL

SAW-CUT AND REPAIR ASPHALT ROAD PAVEMENT

A-12

SHEET No.



**NOTE:**

- CONTRACTOR SHALL MATCH EXISTING FINISH, GRADE, AND JOINTS.
- CONSTRUCTION JOINT SHALL BE TYP. 1' OUTSIDE OF TRENCH WALL. IF CONSTRUCTION JOINT IS INSIDE OF 3' FROM AN EXISTING JOINT, CONSTRUCTION JOINT SHALL BE PLACED 3' BEYOND EXISTING JOINT

**SAW-CUT AND REPAIR CONCRETE  
PAVEMENT AND DRIVEWAY DETAIL**



STREETS

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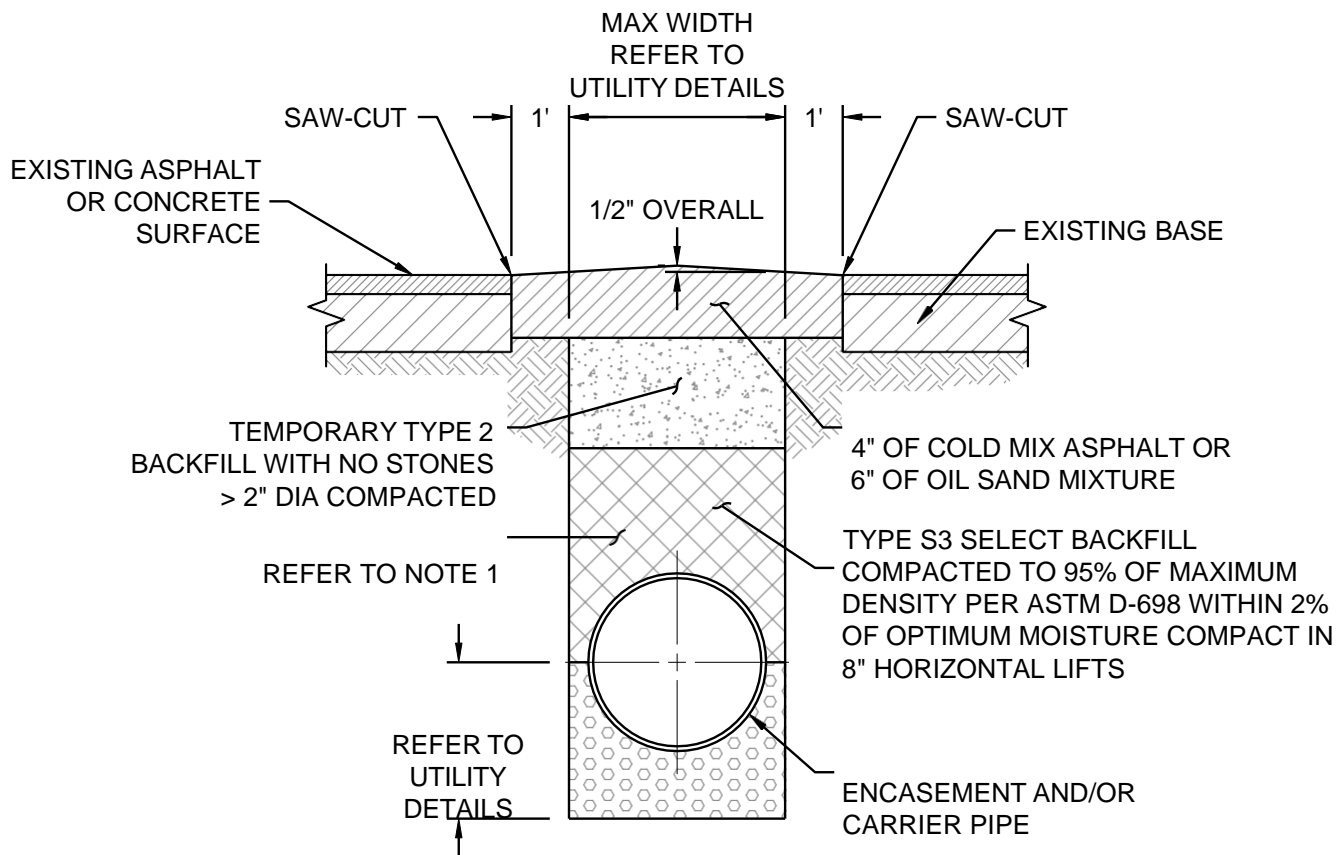
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SAW-CUT AND  
REPAIR CONCRETE  
ROAD PAVEMENT

A-13

SHEET No.



**NOTE:**

1. CONCRETE PAVEMENT: EXTEND COMPACTED S3 BACKFILL TO WITHIN 12" OF THE BASE OF THE CONCRETE PAVEMENT. ASPHALT PAVEMENT: EXTEND COMPACTED S3 BACKFILL TO WITHIN 12" OF THE TOP OF THE ASPHALT PAVEMENT.
2. TO BE USED FOR TEMPORARY STREET OR DRIVEWAY REPAIR FOR EXISTING STREETS OR DRIVEWAY WITHIN CONSTRUCTION LIMITS UNTIL FINAL ROADWAY SECTION IS COMPLETED.

**TEMPORARY PAVEMENT REPAIR DETAIL**

		NTS	
	STREETS	ENGINEERING DESIGN	TEMPORARY PAVEMENT REPAIR
LATEST REVISION: 9/6/2023		MANUAL	A-14

INSTALL MINIMUM 2' WIDE DRIVEWAY ASPHALT  
TRANSITION SECTION WHEN CONNECTING TO  
ASPHALT OR GRAVEL DRIVEWAYS ONLY

7" THICKENED EDGE  
INSTALL EXPANSION JOINT  
WHEN CONNECTING TO  
CONCRETE DRIVEWAYS ONLY

SIDEWALKS AT LOCATIONS  
REQUIRED BY THE CITY OF  
MOUNT VERNON

VARIES (12' MIN - 30' MAX)

A

CURB RETURN AS  
SHOWN IN SECTION A-A

3' (MIN)



5' MINIMUM UNLESS  
OTHERWISE APPROVED

RADIUS SEE  
NOTE 5

SLOPE  
VARIES

NOTE 1

FLOW LINE OF GUTTER

A

2-6"

SIDEWALK WIDTH  
VARIES 6' (TYP). SEE  
PAGE 31 OF DESIGN  
MANUAL

STANDARD 30" CURB AND GUTTER

ASPHALT PAVEMENT

PLAN VIEW

TAPERED CURB  
TAPERED CURB BEYOND  
ASPHALT ROAD SURFACE

ELEVATION LEVEL WITH  
TOP OF STREET CURB

3'  
ADA  
PATH

DRIVEWAY  
TRANSITION

SECTION A-A

7" THICKENED EDGE  
5" ASPHALT PAVEMENT

REFER TO CITY OF MOUNT  
VERNON STANDARD  
DETAILS FOR PAVEMENT  
THICKNESS

NOTES:

1. WHEN CONNECTING TO EXISTING CURB AND GUTTER: SAW-CUT AND REMOVE EXISTING CURB AND GUTTER TO THE LIMITS REQUIRED BY THE CITY OF MOUNT VERNON. CONSTRUCT CURB AND GUTTER EXPANSION JOINTS PER CITY OF MOUNT VERNON STANDARD AT EACH CURB AND GUTTER TIE - IN.
2. FOR NEW CURB AND GUTTER AT NEW DRIVEWAY, INSTALL EXPANSION JOINT IN CURB AND GUTTER AT 5 FEET FROM END OF EACH DRIVEWAY CURB RETURN OR AS APPROVED BY THE CITY OF MOUNT VERNON.
3. ASPHALT THICKNESS SHOWN IS FOR RESIDENTIAL DRIVEWAYS. COMMERCIAL DRIVEWAYS SHALL HAVE A MINIMUM THICKNESS OF 6".
4. ASPHALT DRIVEWAY APRONS AT CONCRETE STREETS ARE NOT ALLOWED.
5. RESIDENTIAL LOCAL - MIN RADIUS = 5', MAX = 10'. RESIDENTIAL COLLECTOR - MIN RADIUS 8', MAX RADIUS 10'; MINOR ARTERIAL-MIN RADIUS 20'; PRINCIPLE ARTERIAL- 30' MIN..
6. MAX CURB CUT: LOCAL = 40', COLLECTOR = 46'; ARTERIAL = 95'

TYPICAL ASPHALT DRIVEWAY DETAIL

NTS

STREETS

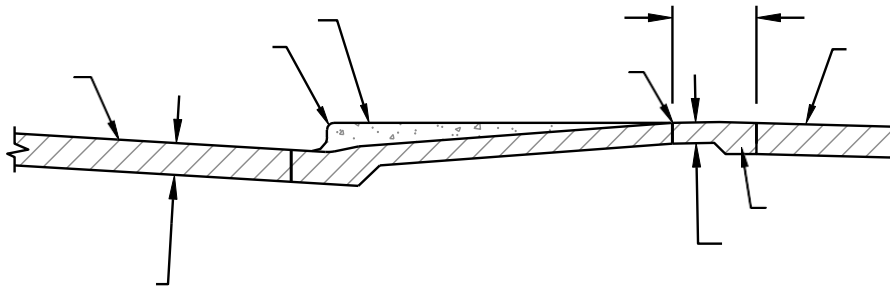
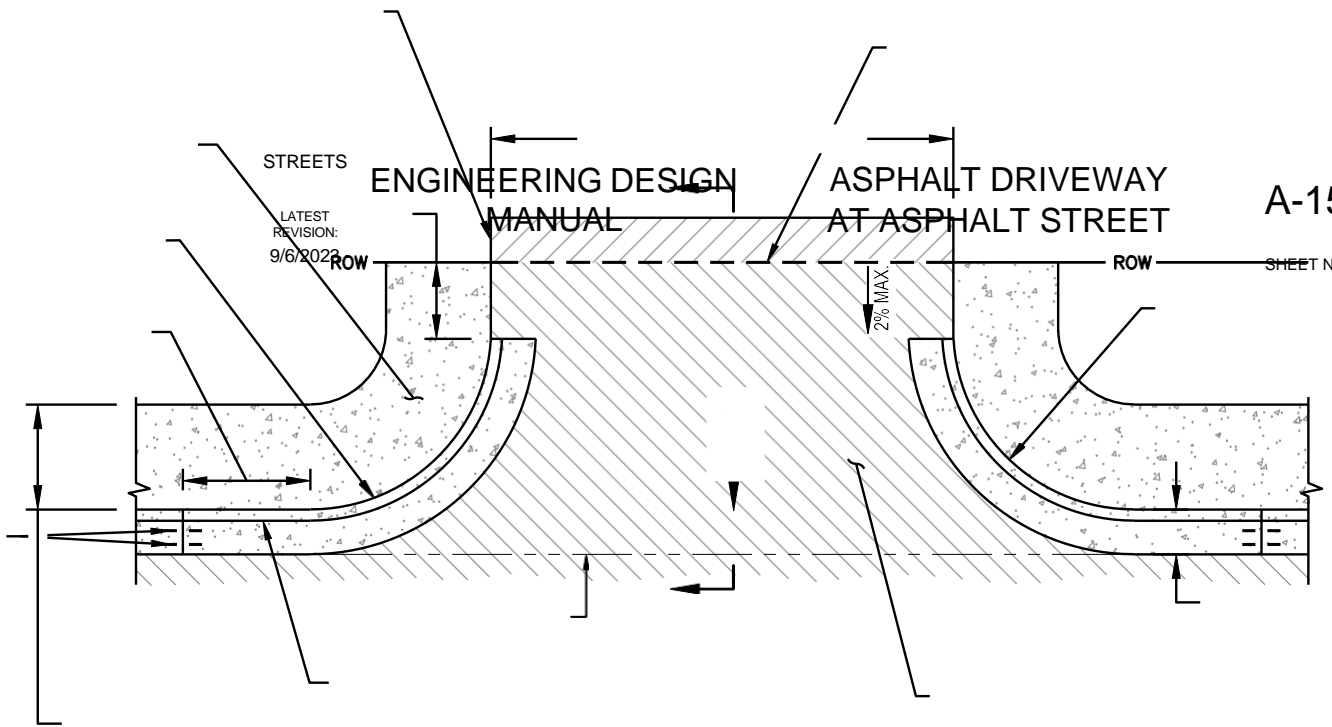
ENGINEERING DESIGN  
MANUAL

ASPHALT DRIVEWAY  
AT ASPHALT STREET

A-15

LATEST  
REVISION:  
9/6/2022

SHEET No.



CLASS P CONCRETE

VARIES (12' MIN - 30' MAX)

7" THICKENED EDGE  
INSTALL EXPANSION JOINT  
WHEN CONNECTING TO  
CONCRETE DRIVEWAYS ONLY

INSTALL MINIMUM 2' WIDE DRIVEWAY  
ASPHALT TRANSITION SECTION WHEN  
CONNECTING TO ASPHALT OR  
GRAVEL DRIVEWAYS ONLY

A

PROVIDE SAW CONTRACTION  
JOINTS AS REQUIRED 3' (MIN)  
SPACING BETWEEN  
CONTRACTION JOINTS SHALL  
NOT EXCEED 10 FEET

EXPANSION JOINT

2% MAX.

RADIUS SEE NOTE 8  
SIDEWALKS AT  
LOCATIONS REQUIRED  
BY THE CITY OF  
MOUNT VERNON

SIDEWALK WIDTH  
VARIES 6' (TYP)

SLOPE  
VARIES



MONOLITHIC CURB  
TYPICAL STANDARD 30"  
CURB AND GUTTER ONLY  
IF APPROVED BY THE

FLOW LINE OF GUTTER

A  
PLAN VIEW

#3 REBAR @  
18" OCEW

2-6"

CITY OF MOUNT VERNON

TAPERED CURB BEYOND

SAWCUT OR  
BLOCKOUT LINE  
SEE NOTES

ROAD SURFACE

ELEVATION LEVEL WITH  
TOP OF STREET CURB

3' ADA  
PATH

DRIVEWAY  
TRANSITION

REFER TO CITY OF MOUNT  
VERNON STANDARD  
DETAILS FOR PAVEMENT  
THICKNESS

TAPERED CURB

5"

SECTION A-A

7" THICKENED EDGE

#3 REBAR @ 18" OCEW

NOTES:

1. EXISTING PAVEMENT - SAW-CUT AND REMOVE EXISTING CONCRETE PAVEMENT AND CURB AND GUTTER AT BLOCKOUT LINE.
2. NEW PAVEMENT - CONSTRUCT NEW PAVEMENT TO BLOCKOUT LINE.
3. CONSTRUCTION EXPANSION JOINT AT SAWCUT/BLOCKOUT LINE AT PAVEMENT WITH 3/4" SMOOTH DOWEL BARS AT 12" OC. DRILL AND EPOXY INTO EXISTING PAVEMENT. GREASE AND INSTALL GREASE CAP IN DRIVEWAY CONCRETE.
4. CONSTRUCT CURB AND GUTTER EXPANSION JOINT WITH TWO #4 SMOOTH BARS CENTERED IN GUTTER.
5. REFER TO CITY OF MOUNT VERNON STANDARD DETAILS FOR EXPANSION JOINTS AND SEALING.
6. CONCRETE THICKNESS SHOWN IS FOR RESIDENTIAL DRIVEWAYS. COMMERCIAL DRIVEWAYS SHALL HAVE A MINIMUM THICKNESS OF 6".
7. CONCRETE DRIVEWAY APRONS ARE REQUIRED AT ALL CONCRETE STREET.
8. RESIDENTIAL LOCAL - MIN RADIUS = 5', MAX = 10'. RESIDENTIAL COLLECTOR - MIN RADIUS 8', MAX RADIUS 10'; MINOR ARTERIAL-MIN RADIUS 20'; PRINCIPLE ARTERIAL- 30' MIN.
9. MAX CURB CUT: LOCAL = 40', COLLECTOR = 46'; ARTERIAL = 95'



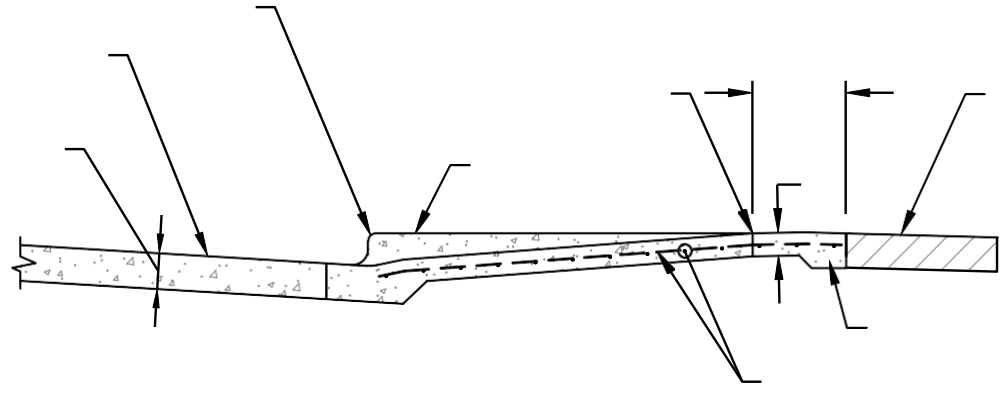
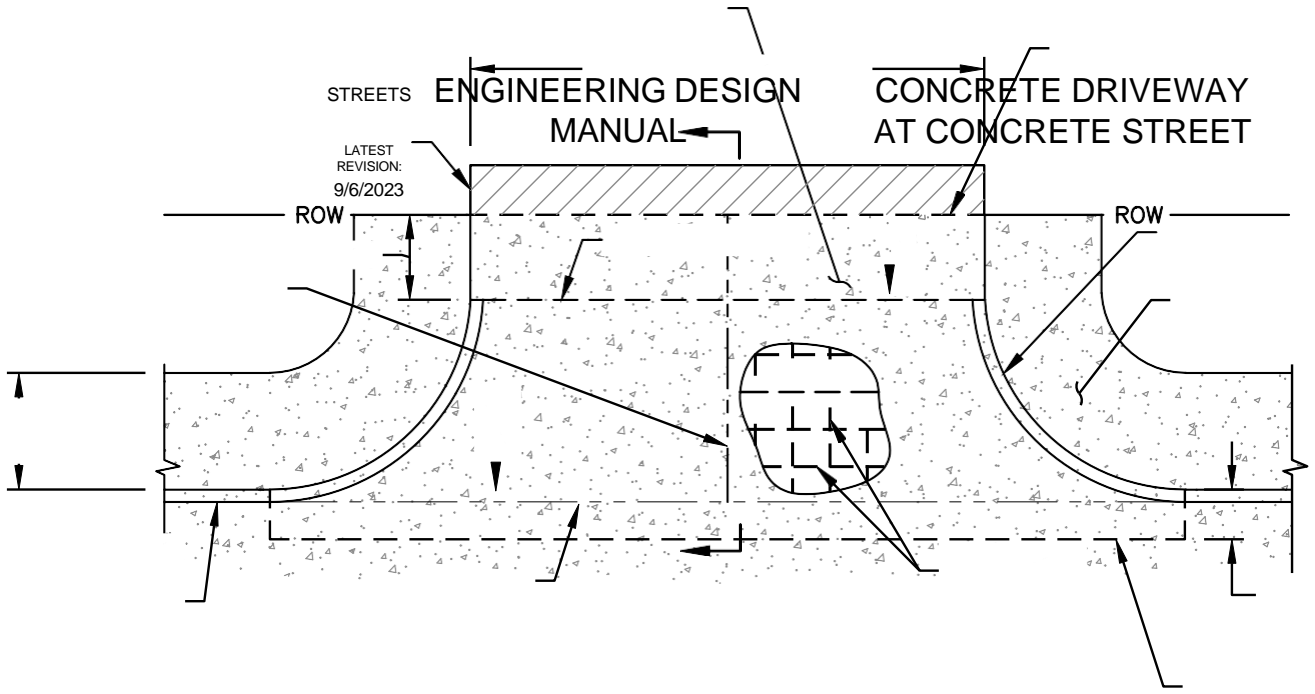
STREETS ENGINEERING DESIGN  
MANUAL

CONCRETE DRIVEWAY  
AT CONCRETE STREET

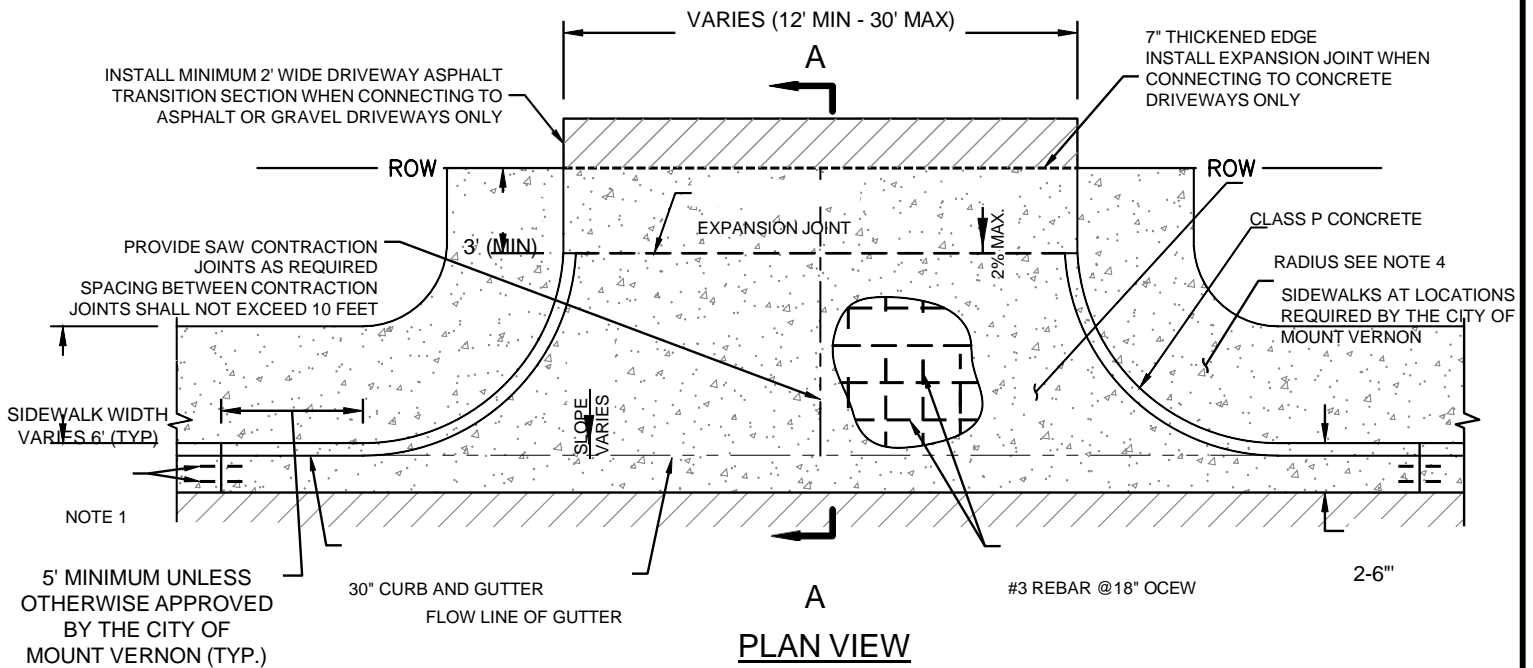
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SHEET No.

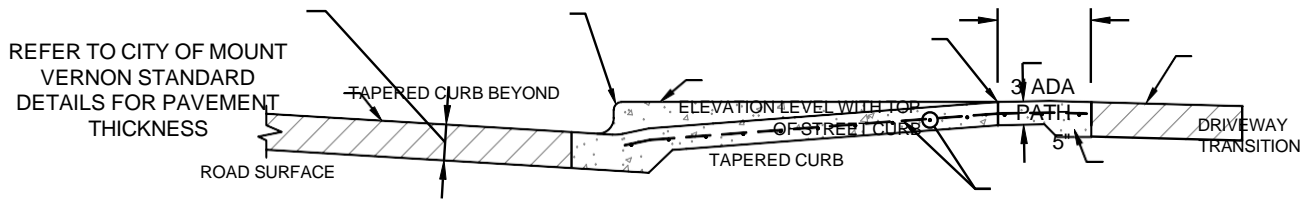
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REVISION:  
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**PLAN VIEW**



**SECTION A-A**

7" THICKENED EDGE  
#3 REBAR @ 18" OCEW

**NOTES:**

1. WHEN CONNECTING TO EXISTING CURB AND GUTTER: SAWCUT AND REMOVE EXISTING CURB AND GUTTER TO THE LIMITS REQUIRED BY THE CITY OF MOUNT VERNON. CONSTRUCT CURB AND GUTTER EXPANSION JOINTS PER CITY OF MOUNT VERNON STANDARD AT EACH CURB AND GUTTER TIE - IN.
2. FOR NEW CURB AND GUTTER AT NEW DRIVEWAY, INSTALL EXPANSION JOINT IN CURB AND GUTTER AT 5 FEET FROM END OF EACH DRIVEWAY CURB RETURN OR AS APPROVED BY THE CITY OF MOUNT VERNON.
3. CONCRETE THICKNESS SHOWN IS FOR RESIDENTIAL DRIVEWAYS. COMMERCIAL DRIVEWAYS SHALL HAVE A MINIMUM THICKNESS OF 5.5".
4. RESIDENTIAL LOCAL - MIN RADIUS = 5', MAX = 10'. RESIDENTIAL COLLECTOR - MIN RADIUS 8', MAX RADIUS 10'; MINOR ARTERIAL-MIN RADIUS 20'; PRINCIPLE ARTERIAL- 30' MIN.
5. MAX CURB CUT. LOCAL = 40', COLLECTOR = 46' . ARTERIAL = 95'



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ENGINEERING DESIGN  
MANUAL

CONCRETE DRIVEWAY  
AT ASPHALT STREET

A-17

SHEET No.

PROVIDE SAW CONTRACTION JOINTS AS REQUIRED  
SPACING BETWEEN CONTRACTION JOINTS

VARIES (12' MIN - 30' MAX)

7" THICKENED EDGE  
INSTALL EXPANSION JOINT WHEN  
CONNECTING TO CONCRETE  
DRIVEWAYS ONLY

SHALL NOT EXCEED 10 FEET

EXPANSION JOINT

CLASS P CONCRETE

A

INSTALL MINIMUM 2' WIDE DRIVEWAY ASPHALT  
TRANSITION SECTION WHEN CONNECTING TO  
ASPHALT OR GRAVEL DRIVEWAYS ONLY

6' (TYP)

SIDEWALK  
WIDTH  
VARIES

SIDEWALK AT  
LOCATIONS  
REQUIRED BY  
THE CITY OF  
MOUNT VERNON

SLOPE 8.33% MAX

3' (2% OR LESS  
CROSS SLOPE)

SLOPE 8.33% MAX

A

CURB AND GUTTER

FLOW LINE OF GUTTER

#3 REBAR @  
18" OCEW

EXPANSION JOINT WITH TWO #4  
SMOOTH DOWEL BARS AT  
GUTTER TIE IN FOR ALL  
PAVEMENT TYPES (TYP)

END OF DRIVEWAY  
APRON OR DUMMY JOINT  
IN SIDEWALK (TYP)

PLAN VIEW

EXPANSION JOINT WITH 3/4"  
SMOOTH DOWEL BARS @ 12" OC AT  
CONCRETE PAVEMENT

ELEVATION LEVEL WITH TOP  
OF STREET CURB  
TOP OF SIDEWALK

DRIVEWAY  
TRANSITION

TAPERED CURB BEYOND  
ROAD SURFACE

REFER TO CITY OF MOUNT VERNON STANDARD  
DETAILS FOR PAVEMENT THICKNESS

ASPHALT STREET PAVEMENT - END OF DRIVEWAY  
CONCRETE STREET PAVEMENT - EXPANSION JOINT WITH  
DOWEL BARS PER STANDARD DETAILS

3' (2% OR LESS  
CROSS SLOPE)

SLOPE AND  
LENGTH VARIES  
TO MATCH  
EXISTING GRADE  
(1/12 MAX)

7" THICKENED EDGE  
#3 REBAR @ 18" OCEW

SECTION A-A

NOTES:

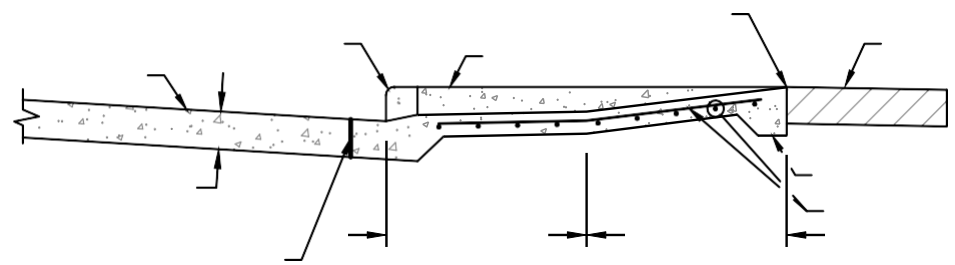
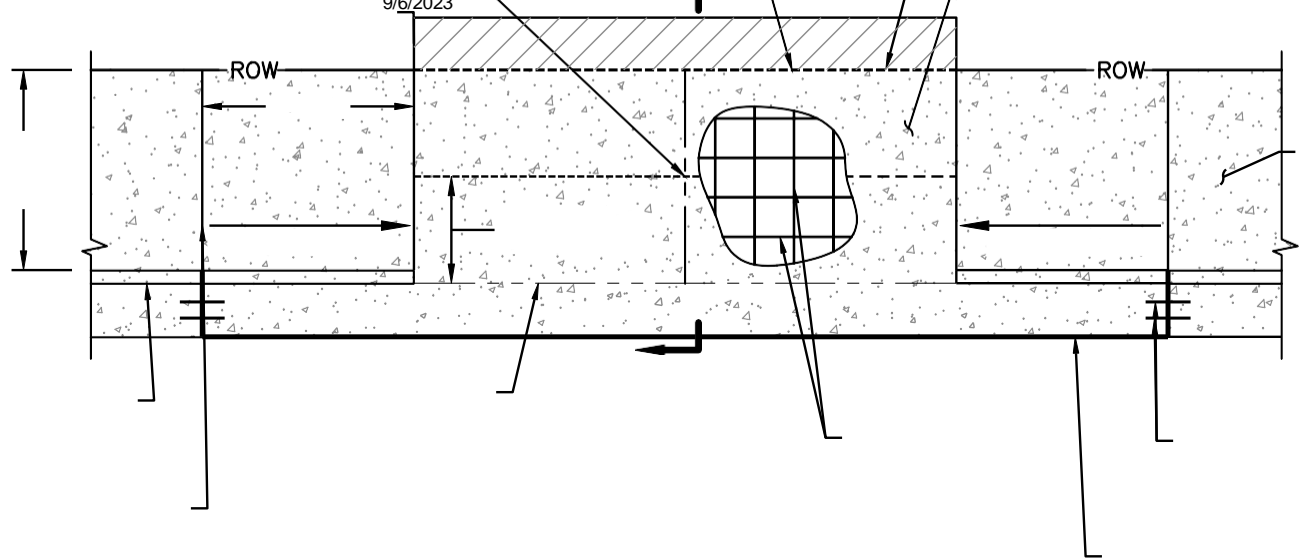
1. WHEN CONNECTING TO EXISTING CURB AND GUTTER: SAW-CUT AND REMOVE EXISTING CURB AND GUTTER TO THE LIMITS REQUIRED BY THE CITY OF MOUNT VERNON. CONSTRUCT CURB AND GUTTER EXPANSION JOINTS PER CITY OF MOUNT VERNON STANDARD AT EACH CURB AND GUTTER TIE - IN.
2. FOR NEW CURB AND GUTTER AT NEW DRIVEWAY, INSTALL EXPANSION JOINT IN CURB AND GUTTER AT END OF EACH DRIVEWAY FLARE OR AS APPROVED BY THE CITY OF MOUNT VERNON.
3. CONCRETE THICKNESS SHOWN IS FOR RESIDENTIAL DRIVEWAYS. COMMERCIAL DRIVEWAYS SHALL HAVE A MINIMUM THICKNESS OF 6".

STREETS  
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# ENGINEERING DESIGN MANUAL

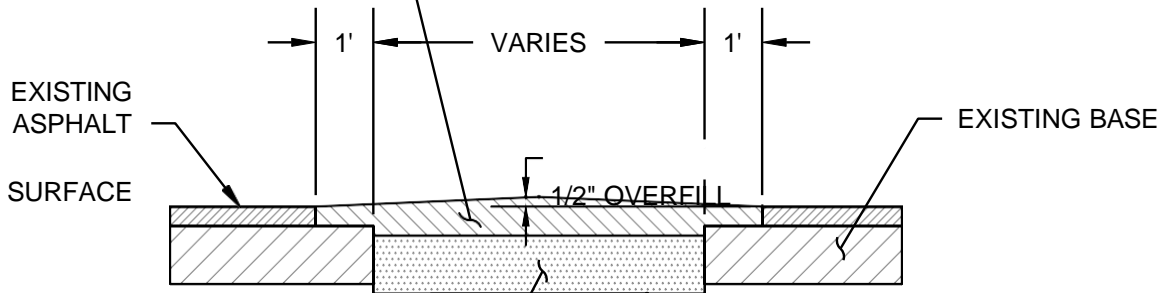
## CONCRETE DRIVEWAY

A-18  
SHEET No.



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2" TYPE "D" HMAC PROVIDE  
PRIME COAT ON FLEX BASE



8" TxDOT FLEXIBLE BASE ITEM 247,  
TYPE A, GRADE 2 COMPACTED IN  
TWO (2) 4" LIFTS TO 95% OF  
STANDARD PROCTOR (ASTM D-698  
AT ±2% OF OPTIMUM MOISTURE)  
(PAY LIMIT FOR OPEN-CUT REPAIR)

## ASPHALT REPAIR DETAIL



STREETS

ENGINEERING DESIGN

ASPHALT PAVEMENT

A-19

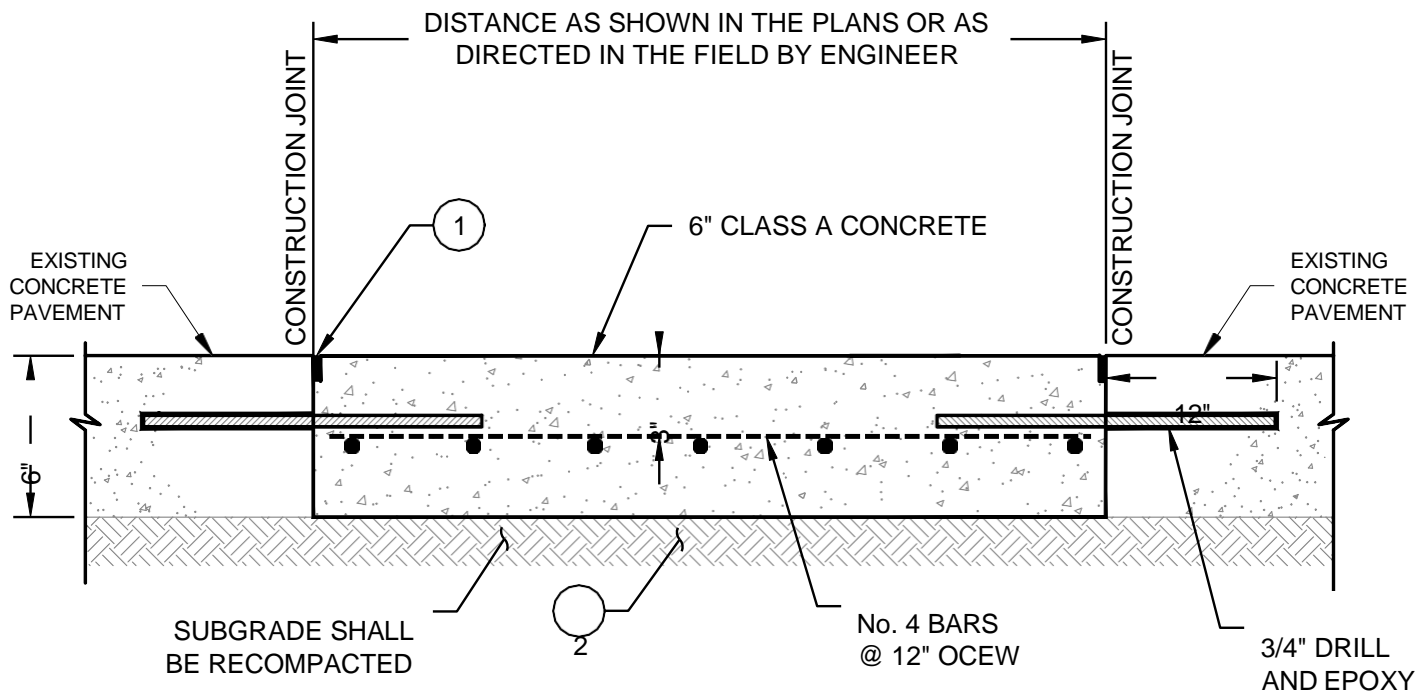
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MANUAL

REPAIR

NTS

SHEET No.



**NOTES:**

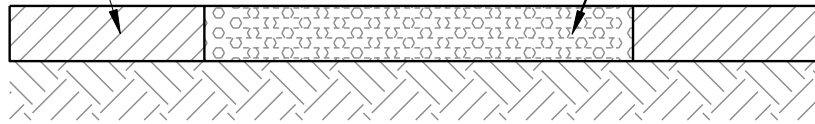
1. SAW-CUT EXISTING CONCRETE PAVEMENT A MINIMUM OF 3" DEEP AROUND PERIMETER OF PAVEMENT REPAIR. INSTALL No. 4 REBAR DOWEL (24") AT 12" CENTERS AROUND PERIMETER OF REPAIR.
2. WHILE THE PAVEMENT IS REMOVED, THE CONTRACTOR SHALL PROTECT OR MAINTAIN THE AREA SO THAT A FIRM DRY SUBGRADE IS ENSURED. EACH WORK AREA SHALL BE SHAPED TO ALLOW DRAINAGE OR BE PUMPED AFTER EACH RAIN.
3. ALL DAMAGE TO EXISTING CONCRETE SLABS CAUSED BY THE INSERTION OF DOWELS OR THE REMOVAL OF THE EXISTING CONCRETE SHALL BE REPAIRED. SPALLS AND CRACKS SHALL BE REPAIRED BY SAW-CUTTING THE DAMAGED AREA WITH SQUARE CORNERS, REMOVING THE FULL DEPTH OF CONCRETE, COMPACTING THE SUBGRADE, AND INSTALLING CONCRETE WHICH IS THE THICKNESS OF THE EXISTING CONCRETE.
4. EXISTING EXPANSION, CONSTRUCTION AND SAWED DUMMY JOINTS SHALL BE REPLACED TO SAME LOCATION WITHIN PAVEMENT REPAIR AREA.

## CONCRETE PAVEMENT REPAIR

	STREETS	ENGINEERING DESIGN	CONCRETE PAVEMENT	A-20
	LATEST REVISION: 9/6/2023	MANUAL	REPAIR	



EXISTING GRAVEL



8" TxDOT FLEXIBLE BASE  
ITEM 247, TYPE A, GRADE 2  
COMPACTED IN TWO (2) 6"  
LIFTS TO 95% OF STANDARD  
PROCTOR (ASTM D-698 AT  
 $\pm 2\%$  OF OPTIMUM MOISTURE)

## GRAVEL DRIVE REPAIR



STREETS

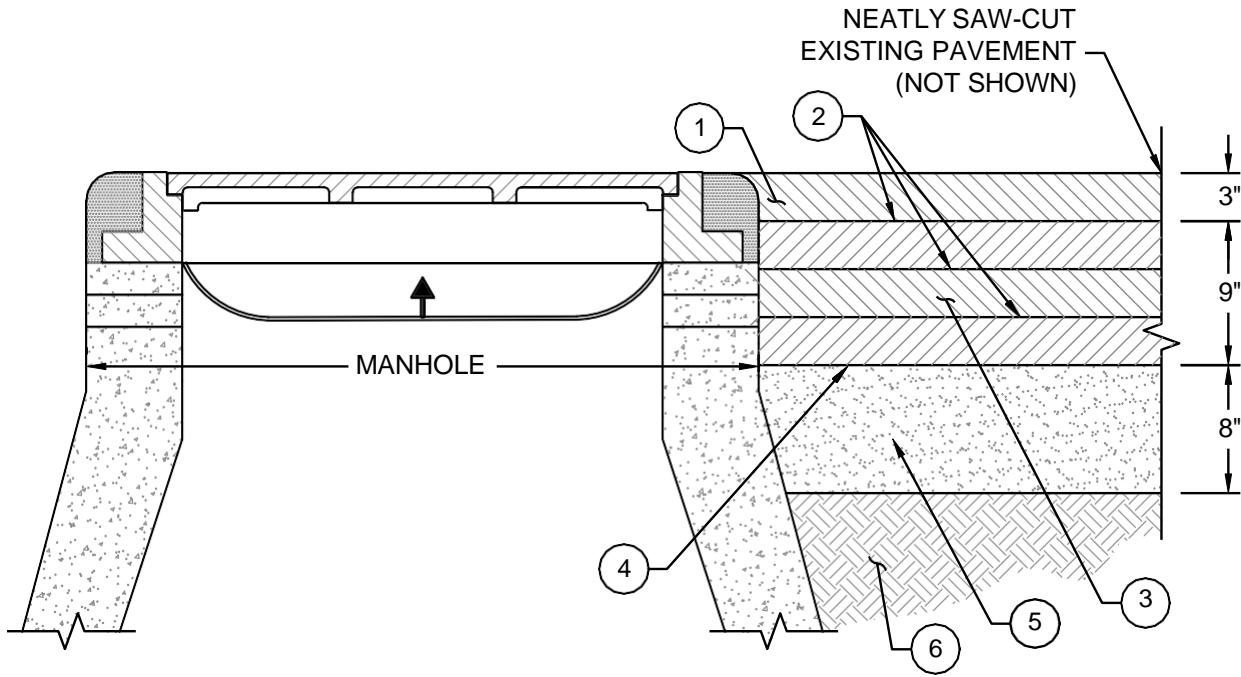
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REVISION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

GRAVEL DRIVE REPAIR

A-21

SHEET No.



<u>MARK</u>	<u>DESCRIPTION</u>
①	3" OF HMAC, TXDOT ITEM 340, TYPE C, COMPACTED USING AIR VOID CONTROL METHOD.
②	AR-4000 TACK COAT MECHANICALLY APPLIED AT A MAXIMUM RATE OF 0.25 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF. THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS. TACK COAT SHALL BE APPLIED BETWEEN ALL LAYERS OF HMAC.
③	9" OF HMAC, TXDOT ITEM 340, TYPE B, INSTALLED IN THREE 3" LIFTS AND COMPACTED USING AIR VOID CONTROL METHOD. A TACK COAT SHALL BE APPLIED BETWEEN THE THREE LIFTS.
④	MC-30 PRIME COAT APPLIED AT A MAXIMUM RATE OF 0.25 GALLONS PER SQUARE YARD. RATE OF APPLICATION SHALL BE ADJUSTED IN THE FIELD TO PROVIDE UNIFORM COVERAGE WITHOUT RUNOFF. THE RATE SHALL BE APPROVED BY THE CITY OF MOUNT VERNON, BASED UPON FIELD TESTS.
⑤	8" CEMENT TREATED SUBGRADE INSTALLED IN ACCORDANCE WITH TXDOT ITEM 275. TYPE I, TYPE II, OR TYPE I/III PORTLAND CEMENT SHALL BE ADDED TO THE SUBGRADE AFTER REMOVAL OF ALL DEBRIS. THE CEMENT APPLICATION RATE SHALL BE 4% (30 LBS PER SQUARE YARD). THE PULVERIZATION REQUIREMENT SHALL BE 60% PASSING THE No. 4 SIEVE. THE FINAL COMPACTION SHALL BE A MINIMUM OF 95%± OF STANDARD PROCTOR (ASTM D-698) AT A MOISTURE CONTENT OF -4% TO +1% OF OPTIMUM MOISTURE.
⑥	BACKFILL EXCAVATION WITH SELECT FILL (TYP S3). COMPACT IN 8" HORIZONTAL LIFTS TO 95% OF MAXIMUM DENSITY WITHIN 2% OF OPTIMUM MOISTURE (ASTM D-698)

**NOTE:**

CONCRETE STREETS -TOP 12" SHALL BE TXDOT CLASS P CONCRETE WITH A MINIMUM COMPRESSIVE OF 4,400 PSI AT 28 DAYS. INSTALL EXPANSION JOINTS ON ALL SIDES OF CONCRETE PAVEMENT REPAIR WITH #8 x 18" SMOOTH DOWELS DRILL AND EPOXY AT 12" OC AT CENTER OF PAVEMENT. GREASE AND GREASE CAPS ON DOWELS INSIDE CONCRETE PAVEMENT REPAIR.



STREETS  
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ENGINEERING DESIGN  
MANUAL

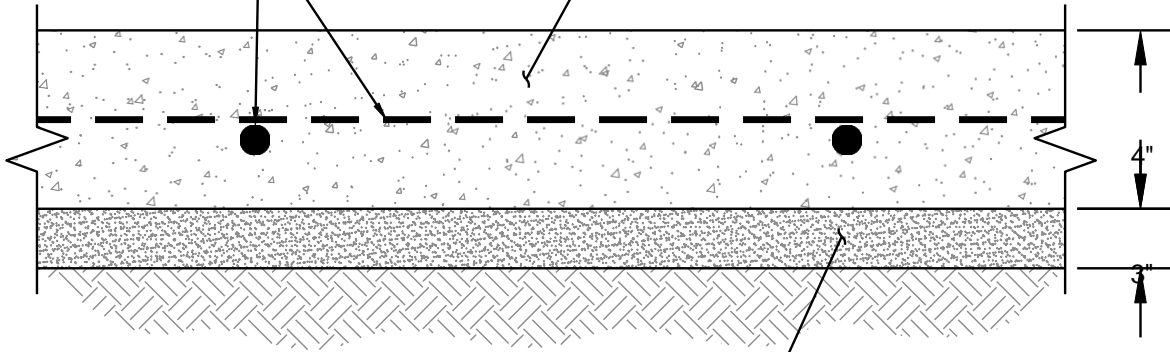
PAVEMENT REPAIR  
AT MANHOLE

A-22

SHEET No.

No. 3 REBAR @ 24" OCEW

CONCRETE SIDEWALK CLASS  
A, 3000 PSI @ 28 DAYS



2" COMPACT SAND ON COMPACT SUB-BASE  
(REFERENCE TXDOT SPECIAL  
SPECIFICATION 3147 FOR DETAILS)

### CONCRETE SIDEWALK DETAIL



STREETS

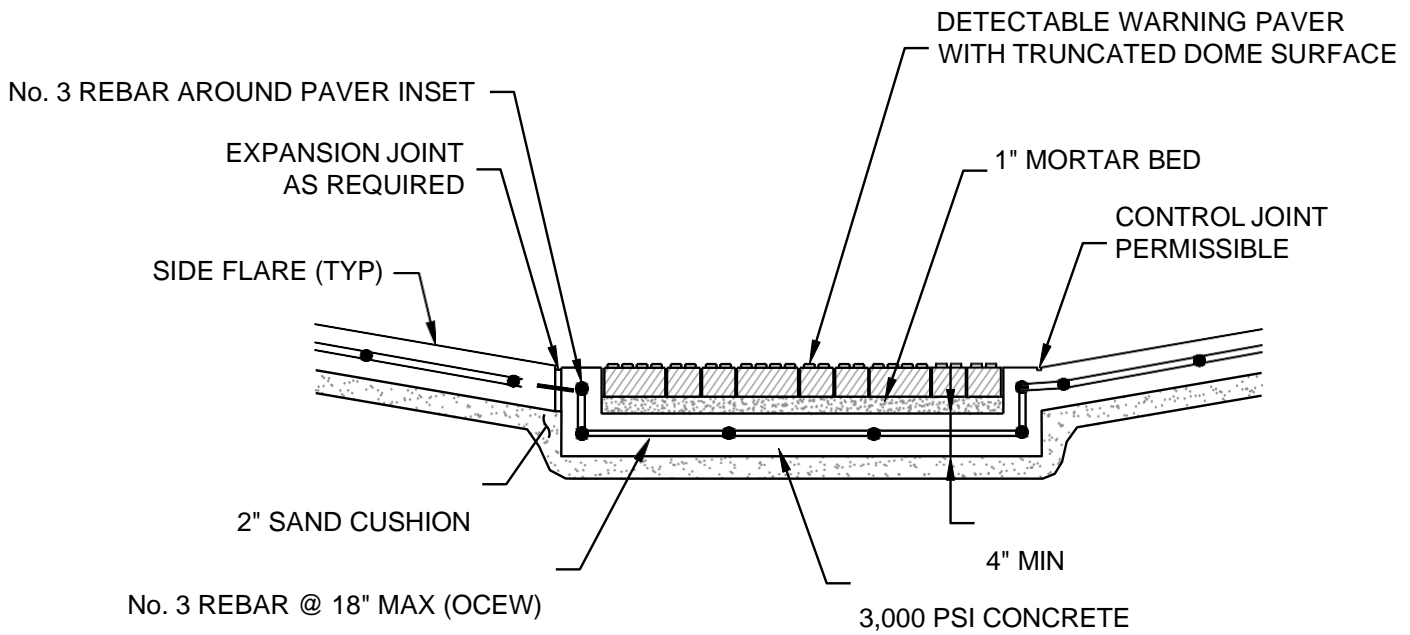
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SIDEWALK

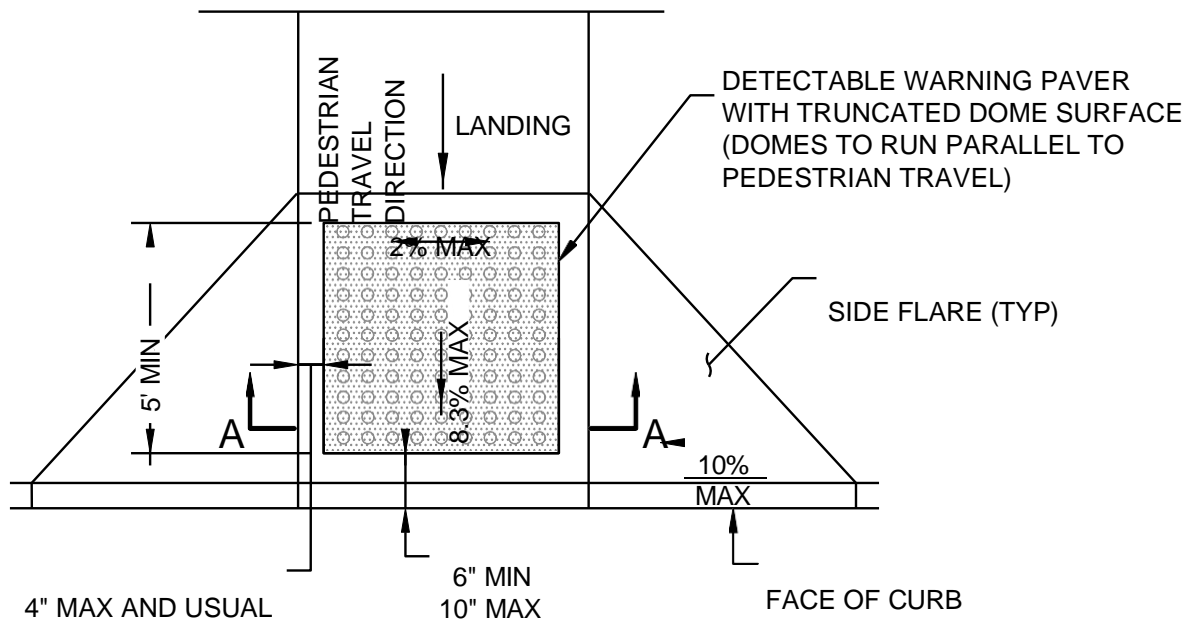
A-23

LATEST  
REVISION:  
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SHEET No.



**SECTION A-A**



**FLARED CURB RAMP**



STREETS

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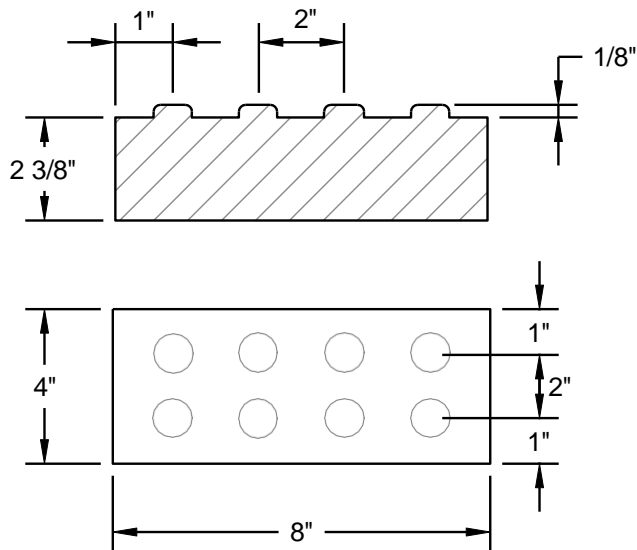
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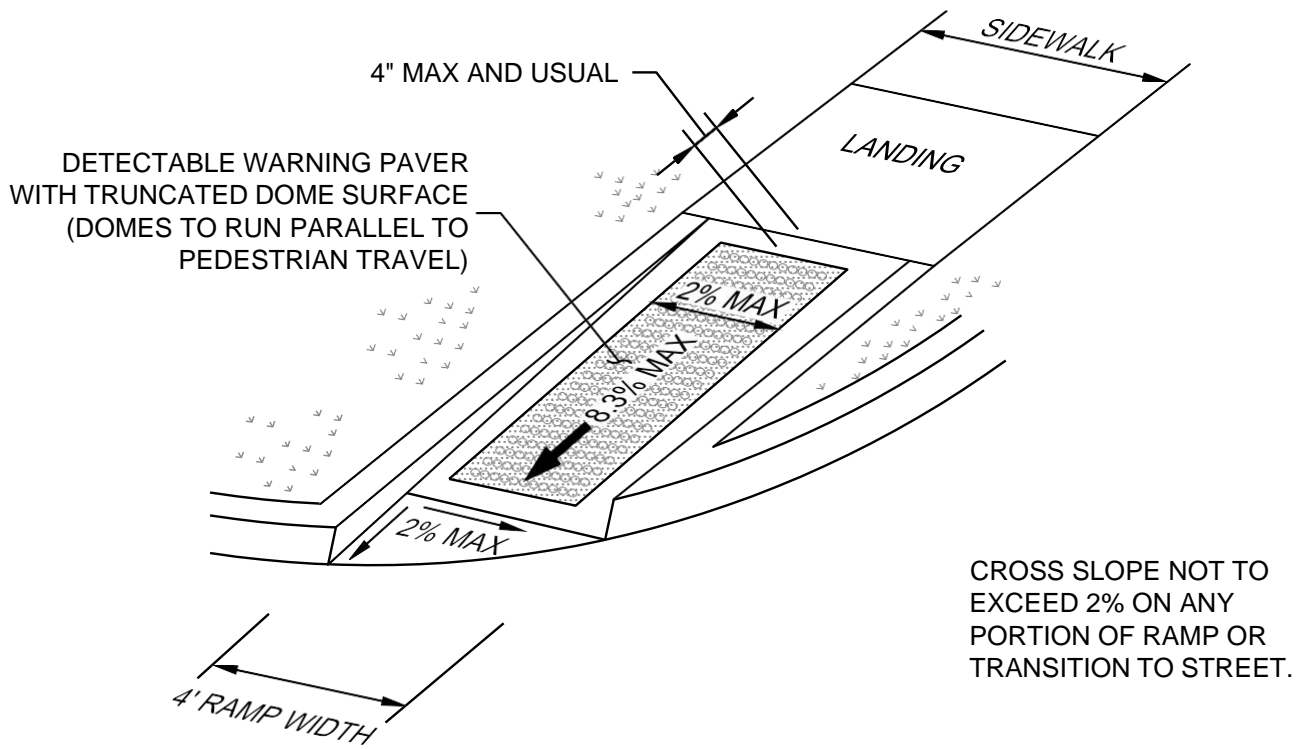
CURB RAMP  
SHEET 1

A-24

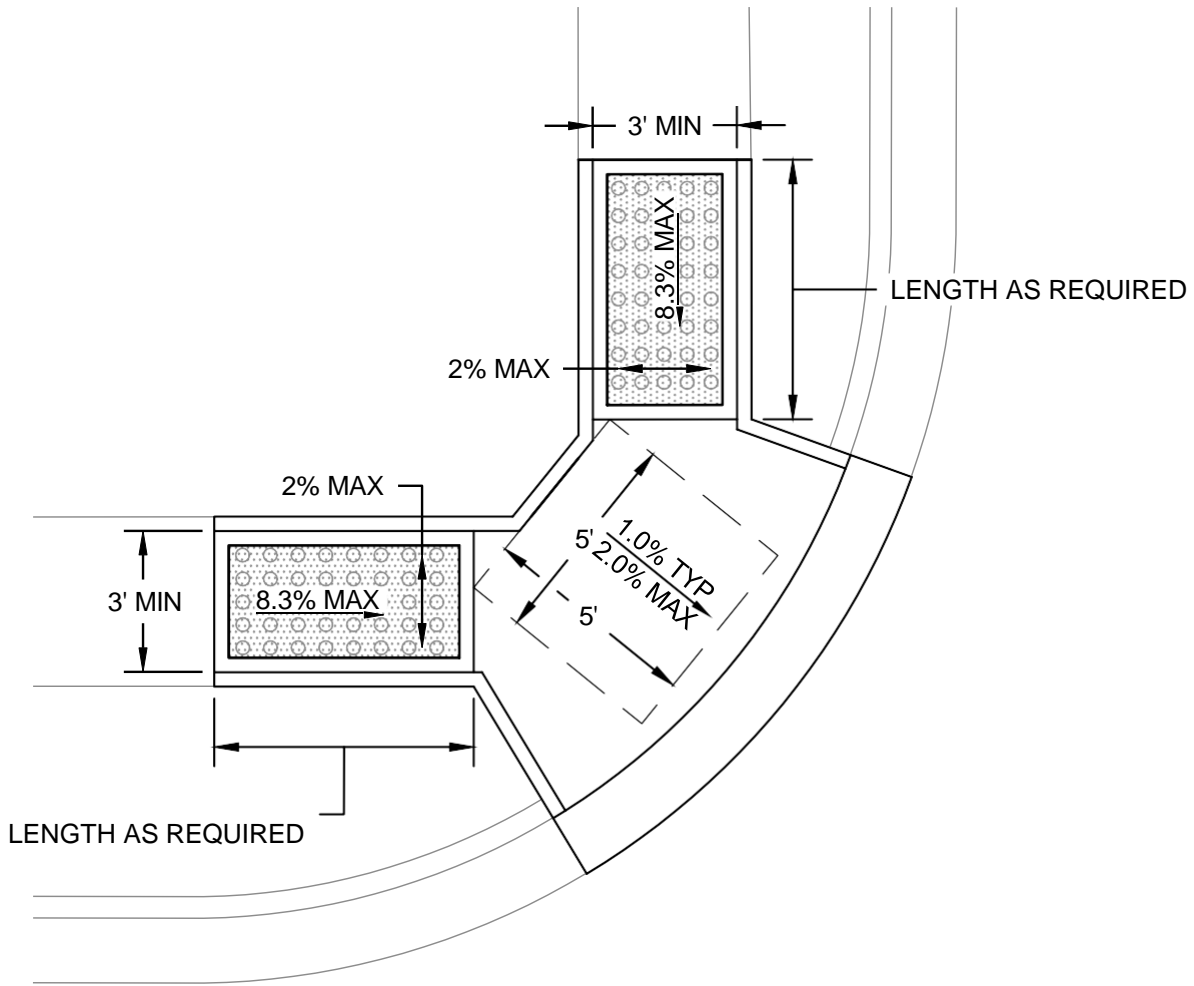
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## DETECTABLE WARNING PAVER



## DIRECT CURB RAMP



## DIRECT CURB RAMPS WITH LANDING

NTS



STREETS

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3/6/2020

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MANUAL

CURB RAMP SHEET 3

A-26

SHEET No.

GENERAL NOTES FOR DETECTABLE WARNINGS:

1. CURB RAMPS MUST CONTAIN A DETECTABLE WARNING SURFACE THAT CONSISTS OF RAISED TRUNCATED DOMES COMPLYING WITH SECTION 4.29 OF THE TEXAS ACCESSIBILITY STANDARDS (TAS). THE SURFACE MUST CONTRAST VISUALLY WITH ADJOINING SURFACES, INCLUDING SIDE FLARES. FURNISH DARK BROWN OR DARK RED DETECTABLE WARNING SURFACE ADJACENT TO UNCOLORED CONCRETE, UNLESS SPECIFIED ELSEWHERE IN THE PLANS.
2. DETECTABLE WARNING SURFACES MUST BE SLIP RESISTANT AND NOT ALLOW WATER TO ACCUMULATE.
3. ALIGN TRUNCATED DOMES IN THE DIRECTION OF PEDESTRIAN TRAVEL WHEN ENTERING THE STREET.
4. DETECTABLE WARNING SURFACES SHALL BE A MINIMUM OF 24" IN DEPTH IN THE DIRECTION OF PEDESTRIAN TRAVEL, AND EXTEND THE FULL WIDTH OF THE CURB RAMP OR LANDING WHERE THE PEDESTRIAN ACCESS ROUTE ENTERS THE STREET.
5. DETECTABLE WARNING SURFACES SHALL BE LOCATED SO THAT THE EDGE NEAREST THE CURB LINE IS A MINIMUM OF 6" AND A MAXIMUM OF 10" FROM THE EXTENSION OF THE FACE OF CURB. DETECTABLE WARNING SURFACES MAY BE CURVED ALONG THE CORNER RADIUS.

GENERAL NOTES FOR PEDESTRIAN FACILITIES:

1. ALL SLOPES ARE MAXIMUM ALLOWABLE. THE LEAST POSSIBLE SLOPE THAT WILL STILL DRAIN PROPERLY SHOULD BE USED. ADJUST CURB RAMP LENGTH OR GRADE OF APPROACH SIDEWALKS AS DIRECTED.
2. LANDINGS SHALL BE 5' x 5' MINIMUM WITH A MAXIMUM 2% SLOPE IN ANY DIRECTION.
3. MANEUVERING SPACE AT THE BOTTOM OF CURB RAMPS SHALL BE A MINIMUM OF 4' x 4' WHOLLY CONTAINED WITHIN THE CROSSWALK AND WHOLLY OUTSIDE THE PARALLEL VEHICULAR TRAVEL PATH.
4. MAXIMUM ALLOWABLE CROSS SLOPE ON SIDEWALK AND CURB RAMP SURFACES IS 2%.
5. CURB RAMPS WITH RETURNED CURBS MAY BE USED ONLY WHERE PEDESTRIANS WOULD NOT NORMALLY WALK ACROSS THE RAMP, EITHER BECAUSE THE ADJACENT SURFACE IS PLANTING OR OTHER NON-WALKING SURFACE OR BECAUSE THE SIDE APPROACH IS SUBSTANTIALLY OBSTRUCTED. OTHERWISE, PROVIDE FLARED SIDES.
6. ADDITIONAL INFORMATION ON CURB RAMP LOCATION, DESIGN, LIGHT REFLECTIVE VALUE AND TEXTURE MAY BE FOUND IN THE CURRENT EDITION OF THE TEXAS ACCESSIBILITY STANDARDS (TAS) AND 16 TAC 68.102.
7. HANDRAILS ARE NOT REQUIRED ON CURB RAMPS. PROVIDE CURB RAMPS WHEREVER ON ACCESSIBLE ROUTE CROSSES (PENETRATES) A CURB.
8. PROVIDE A SMOOTH TRANSITION WHERE THE CURB RAMPS CONNECT TO THE STREET.
9. FLARE SLOPE SHALL NOT EXCEED 10% MEASURED ALONG CURB LINE.

GENERAL NOTES FOR PAVERS:

1. FURNISH DETECTABLE WARNING PAVER UNITS MEETING ALL REQUIREMENTS OF ASTM C-936, C-33. LAY IN A TWO BY TWO UNIT BASKET WEAVE PATTERN OR AS DIRECTED.
2. LAY FULL-SIZE UNITS FIRST FOLLOWED BY CLOSURE UNITS CONSISTING OF AT LEAST 25 PERCENT OF A FULL UNIT. CUT DETECTABLE WARNING PAVER UNITS USING A POWER SAW.



STREETS

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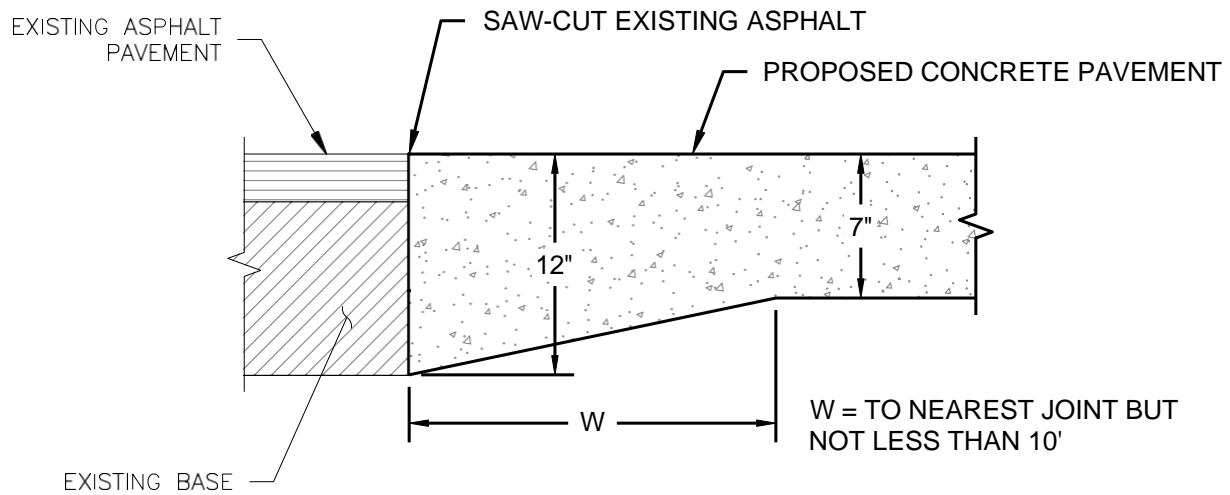
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CURB RAMP SHEET 4

A-27

SHEET No.





**NOTE:**

CONTRACTOR SHALL REPAIR DAMAGE TO EXISTING ASPHALT PAVEMENT WITH FULL DEPTH HMAC REPAIR TO BOTTOM OF EXISTING BASE.

**THICKENED EDGE JOINT**  
 PROPOSED CONCRETE PAVEMENT  
 ABUTTING EXISTING ASPHALT PAVEMENT



STREETS

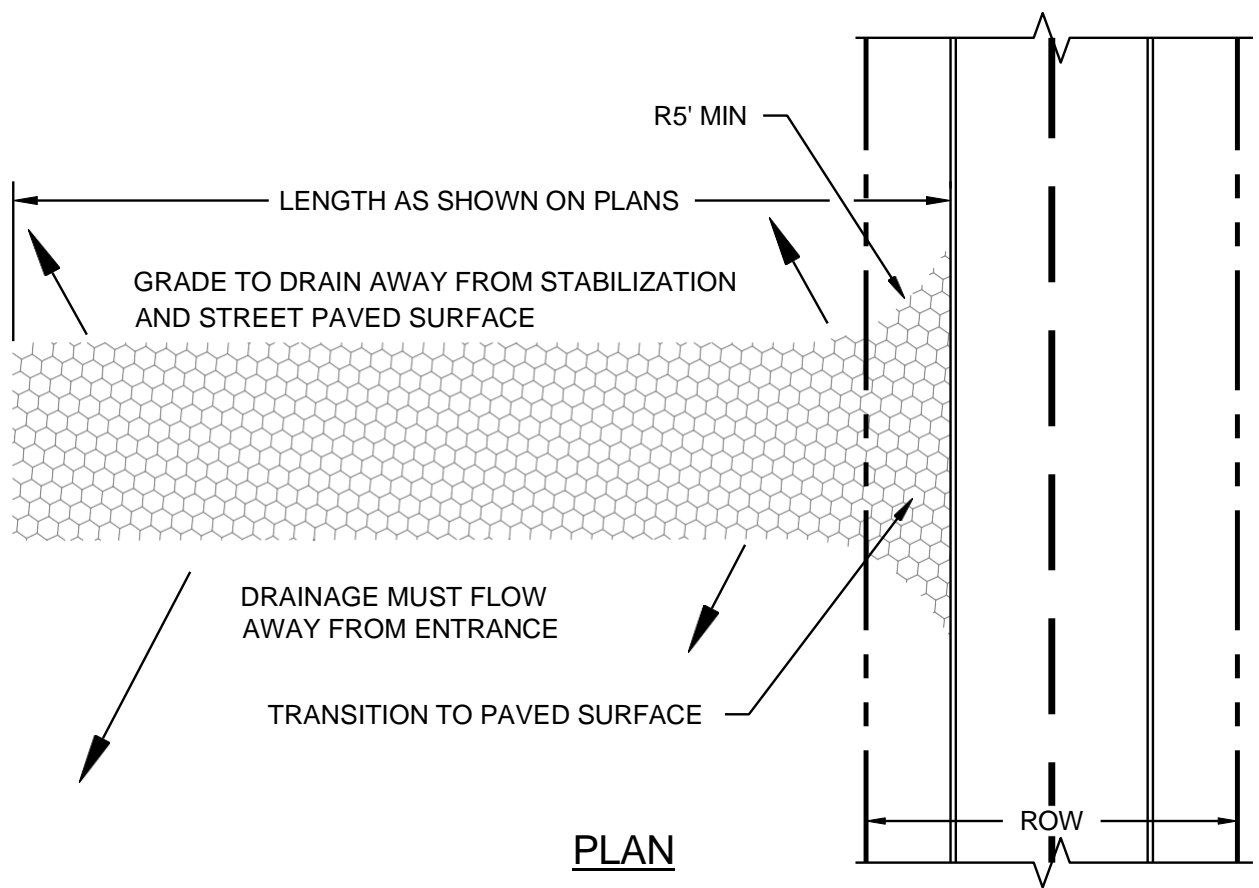
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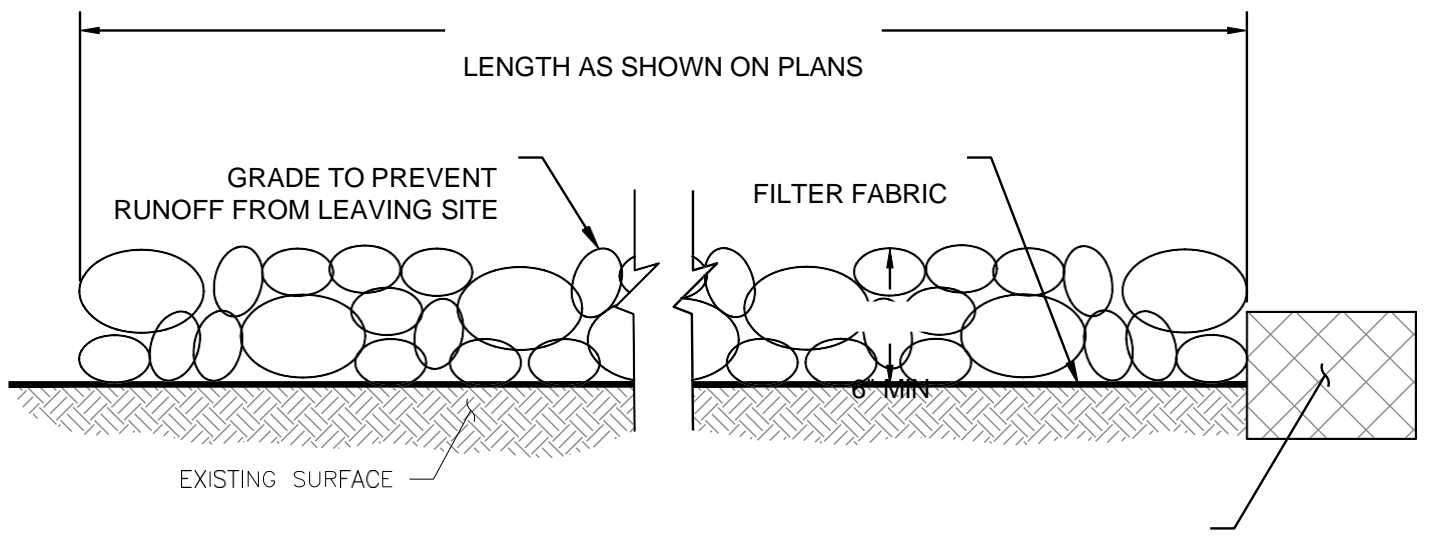
THICKENED EDGE JOINT

A-28

SHEET No.



PLAN



SECTION

PAVED SURFACE

**STABILIZED CONSTRUCTION ENTRANCE**



EROSION  
CONTROL  
LATEST

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ENGINEERING DESIGN  
MANUAL

STABILIZED  
CONSTRUCTION  
ENTRANCE  
SHEET 1

A-29

SHEET No.

STABILIZED CONSTRUCTION ENTRANCE GENERAL NOTES:

1. A STABILIZED CONSTRUCTION ENTRANCE SHALL BE REQUIRED FOR ANY CONSTRUCTION PROJECT WITH A DISTURBED AREA EXCEEDING 1/2 ACRE.
2. STONE SHALL BE 3 TO 5 INCH DIAMETER CRUSHED ROCK OR ACCEPTABLE CRUSHED PORTLAND CEMENT CONCRETE.
3. LENGTH SHALL BE SHOWN ON PLANS, WITH A MINIMUM LENGTH OF 40 FEET.
4. THE THICKNESS SHALL NOT BE LESS THAN 6 INCHES.
5. THE WIDTH SHALL BE NO LESS THAN THE FULL WIDTH OF ALL POINTS OF INGRESS OR EGRESS.
6. WHEN NECESSARY, VEHICLES SHALL BE CLEANED TO REMOVE SEDIMENT PRIOR TO ENTRANCE ONTO A PUBLIC ROADWAY. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE WITH DRAINAGE FLOWING AWAY FROM BOTH THE STREET AND THE STABILIZED ENTRANCE. ALL SEDIMENT SHALL BE PREVENTED FROM ENTERING ANY STORM DRAIN, DITCH OR WATERCOURSE USING APPROVED METHODS.
7. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PAVED SURFACES. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO PAVED SURFACES MUST BE REMOVED IMMEDIATELY.
8. THE ENTRANCE MUST BE PROPERLY GRADED OR INCORPORATE A DRAINAGE SWALE TO PREVENT RUNOFF FROM LEAVING THE CONSTRUCTION SITE.



EROSION  
CONTROL

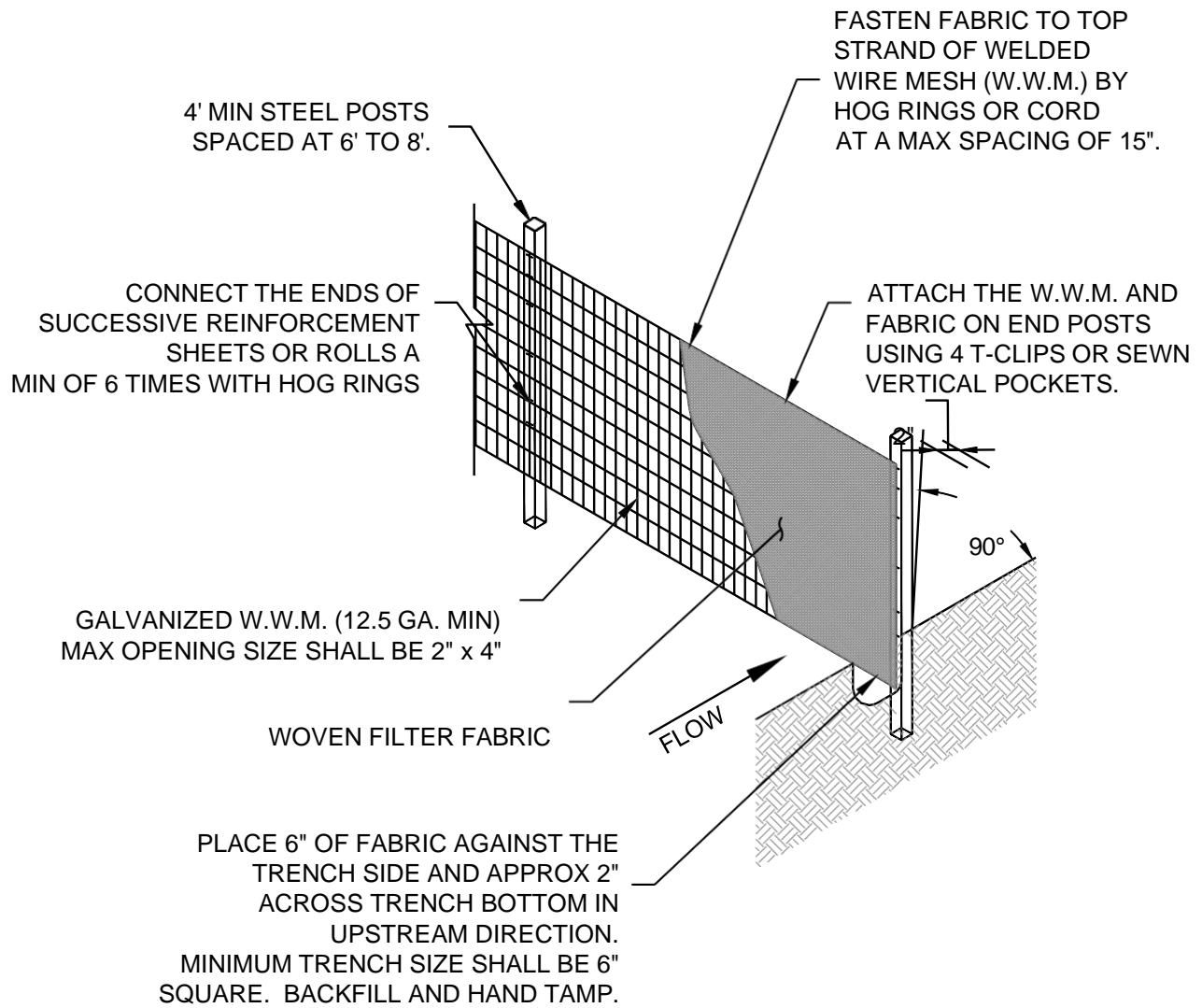
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REVISION:  
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ENGINEERING DESIGN  
MANUAL

STABILIZED CONSTRUCTION  
ENTRANCE SHEET 2

A-30

SHEET No.



## SILT FENCE

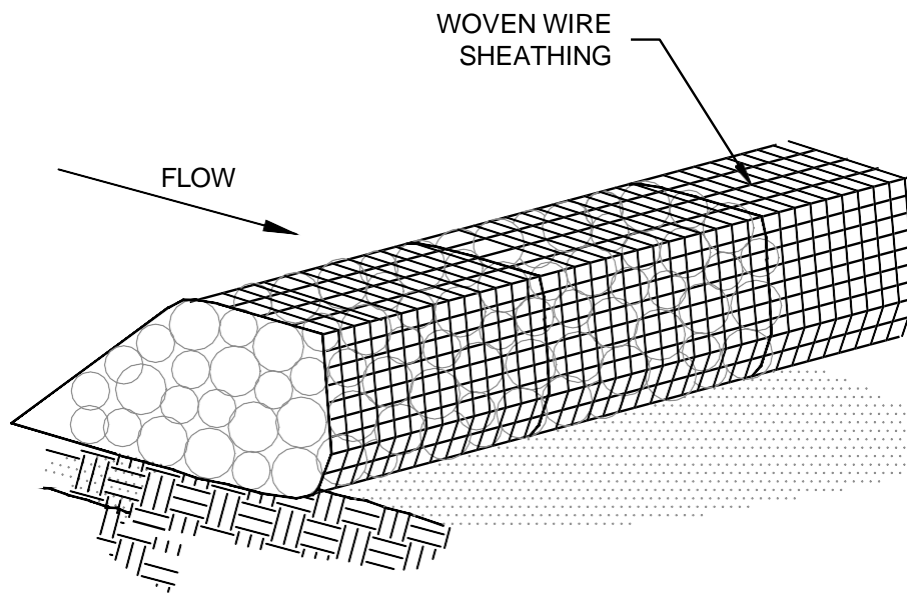


EROSION CONTROL  
LATEST REVISION:  
9/6/2023

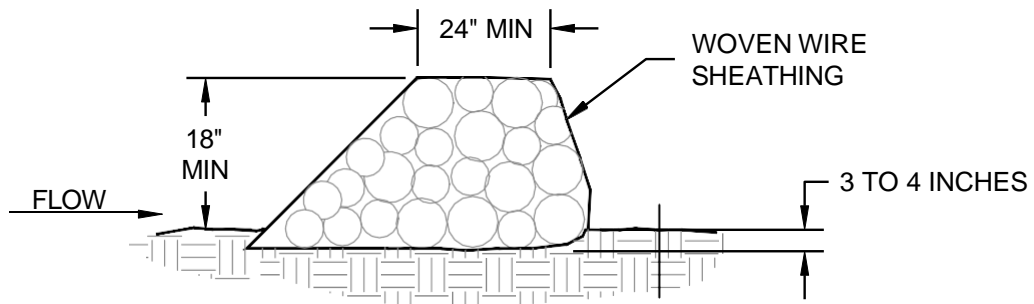
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SILT FENCE

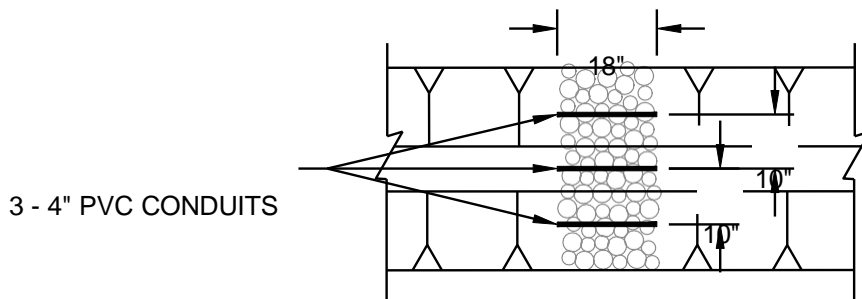
A-31



ISOMETRIC VIEW



CROSS SECTION



ROCK BERM

ENGINEERING DESIGN  
MANUAL

ROCK BERM  
SHEET 1

A-32

SHEET No.

GENERAL NOTES - ROCK BERM

1. USE ONLY OPEN-GRADED ROCK 4-8 INCHES IN DIAMETER FOR STREAM FLOW CONDITION. USE OPEN GRADED ROCK 3-5 INCHES IN DIAMETER FOR OTHER CONDITIONS.
2. THE ROCK BERM SHALL BE SECURED WITH A WOVEN WIRE SHEATHING HAVING A MAXIMUM OPENING OF 1 INCH AND A MINIMUM WIRE SIZE OF 20 GAUGE AND SHALL BE BURIED IN A TRENCH APPROXIMATELY 3 TO 4 INCHES DEEP.
3. THE ROCK BERM SHALL BE INSPECTED EVERY TWO WEEKS OR AFTER EACH 1/2" RAIN EVENT AND SHALL BE REPLACED WHEN THE STRUCTURE CEASES TO FUNCTION AS INTENDED DUE TO SILT ACCUMULATION AMONG THE ROCKS, WASHOUT, CONSTRUCTION TRAFFIC DAMAGE, ETC.
4. WHEN SILT REACHES A DEPTH EQUAL TO ONE-THIRD OF THE HEIGHT OF THE BERM OR ONE FOOT, WHICHEVER IS LESS, THE SILT SHALL BE REMOVED AND DISPOSED OF PROPERLY.
5. WHEN THE SITE IS COMPLETELY STABILIZED, THE BERM AND ACCUMULATED SILT SHALL BE REMOVED AND DISPOSED OF IN AN APPROVED MANNER.
6. ROCK BERMS SHOULD BE USED AS CHECK DAMS FOR CONCENTRATED FLOW AND ARE NOT INTENDED FOR USE IN PERIMETER PROTECTION.



EROSION  
CONTROL

LATEST  
REVISION:  
9/6/2023

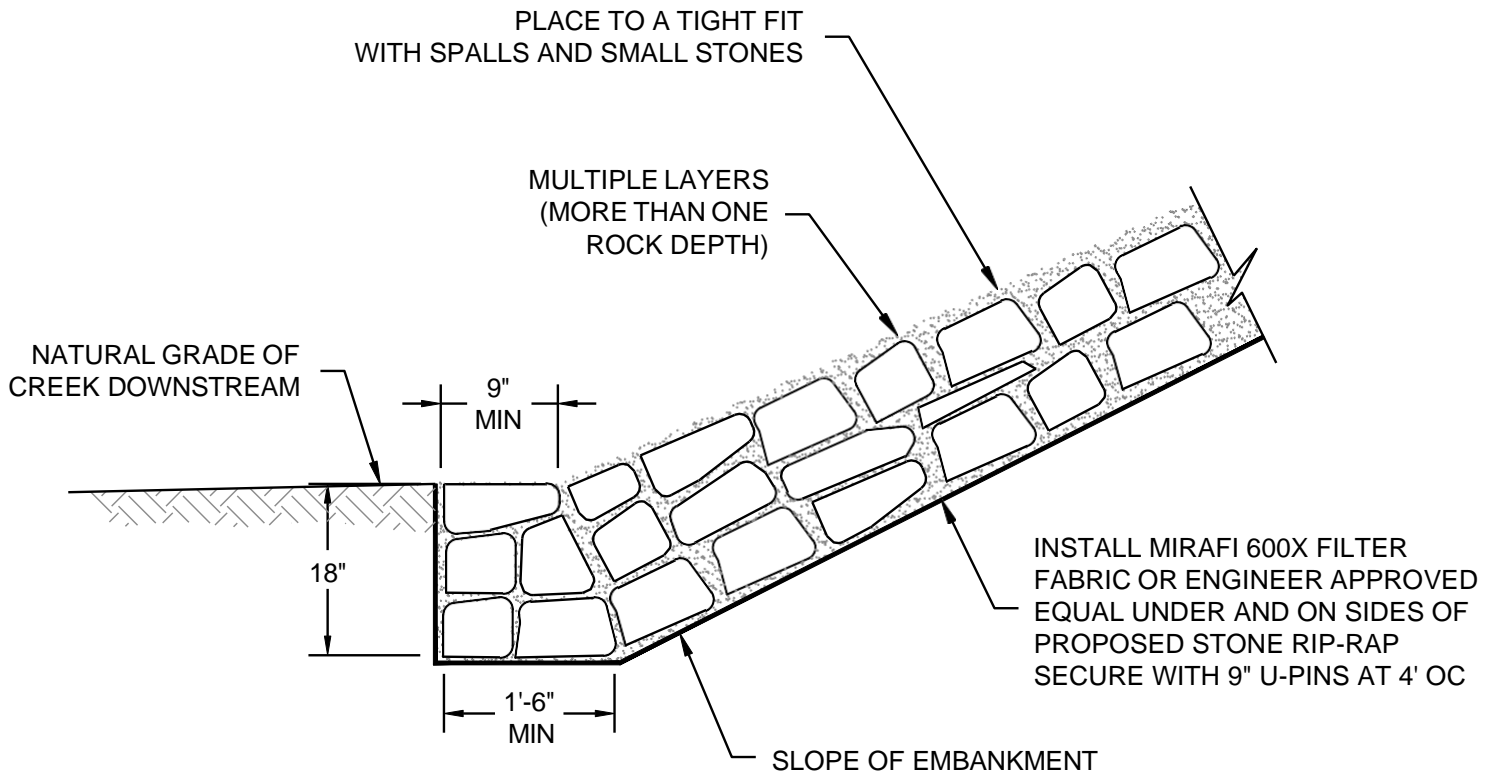
ENGINEERING DESIGN  
MANUAL

ROCK BERM SHEET 2

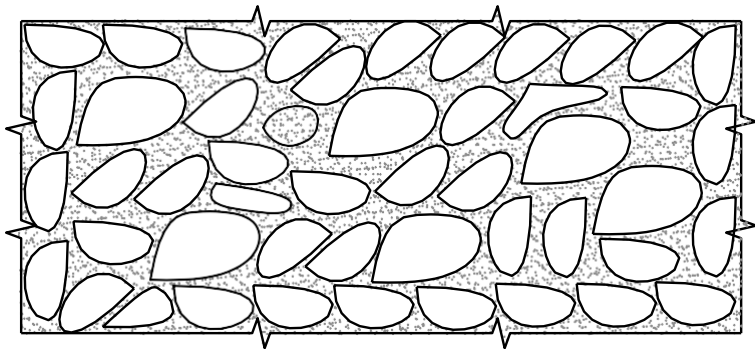
A-33

SHEET No.





ELEVATION



**NOTE:**  
 STONES FOR ROCK RIP-RAP SHALL WEIGH BETWEEN 50 AND 150 LBS. EACH, AND AT LEAST 50 PERCENT OF THE STONES SHALL WEIGH MORE THAN 100 LBS.

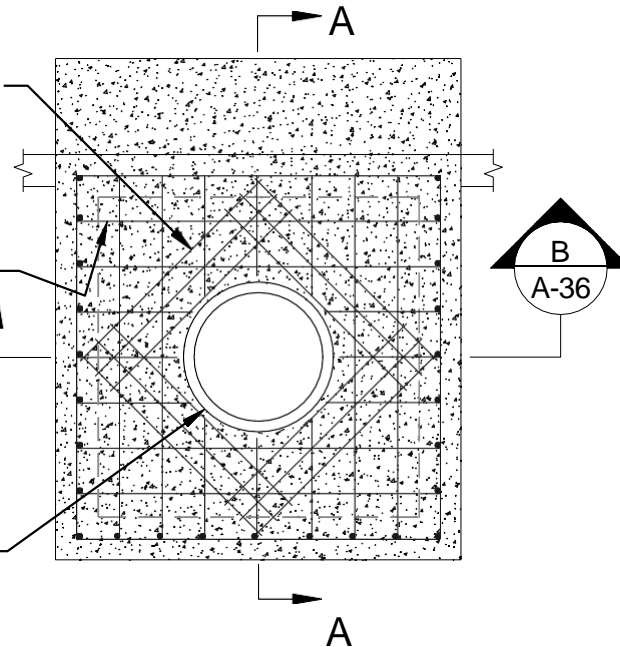
PLAN

ROCK RIP-RAP

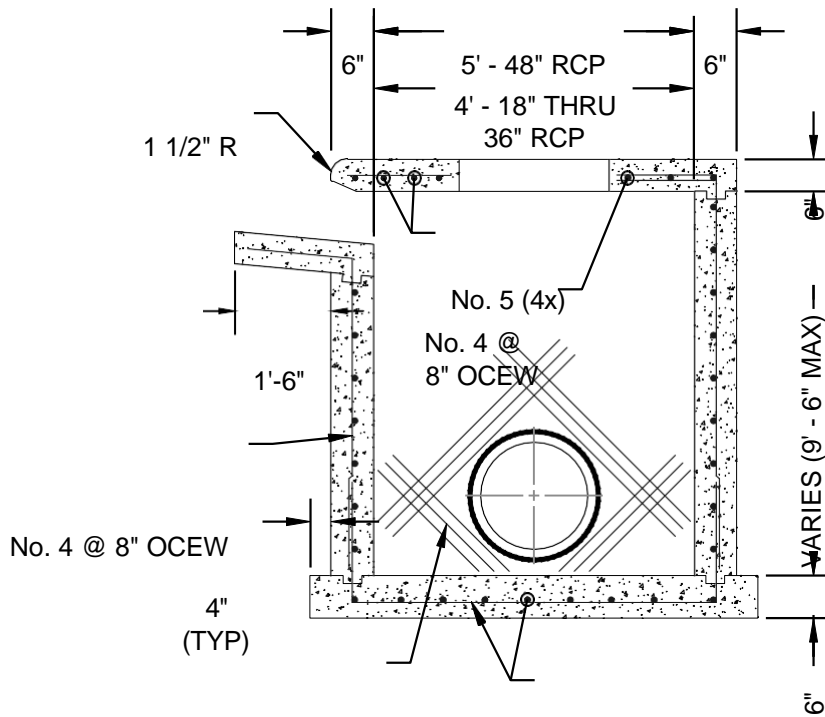
3 - No. 4 @ 4" C/C @ 45°  
(4' LG) TYP EA CORNER

No. 4 @  
8" OCEW

CAST IRON MANHOLE  
RING AND COVER



**SINGLE INLET**



No. 4" C/C @ 45° (4' LG)  
TYP EA CORNER (3x)

No. 5 @ 8" OCEW

**SECTION "A-A"**

CURB INLET AND JUNCTION BOX NOTES:

1. ALL CONCRETE SHALL BE 5 1/2 SACK MIN, 3000 PSI AT 28 DAY COMPRESSIVE STRENGTH.
2. ALL REINFORCING STEEL SHALL BE NEW, GRADE 60.

3. ALL MANHOLE RINGS AND COVERS SHALL BE AS DESCRIBED IN THE SPECIFICATIONS.

4. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 3/4".



INLETS  
OUTLETS  
AND PIPING

A  
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E

S  
T  
R  
E  
V

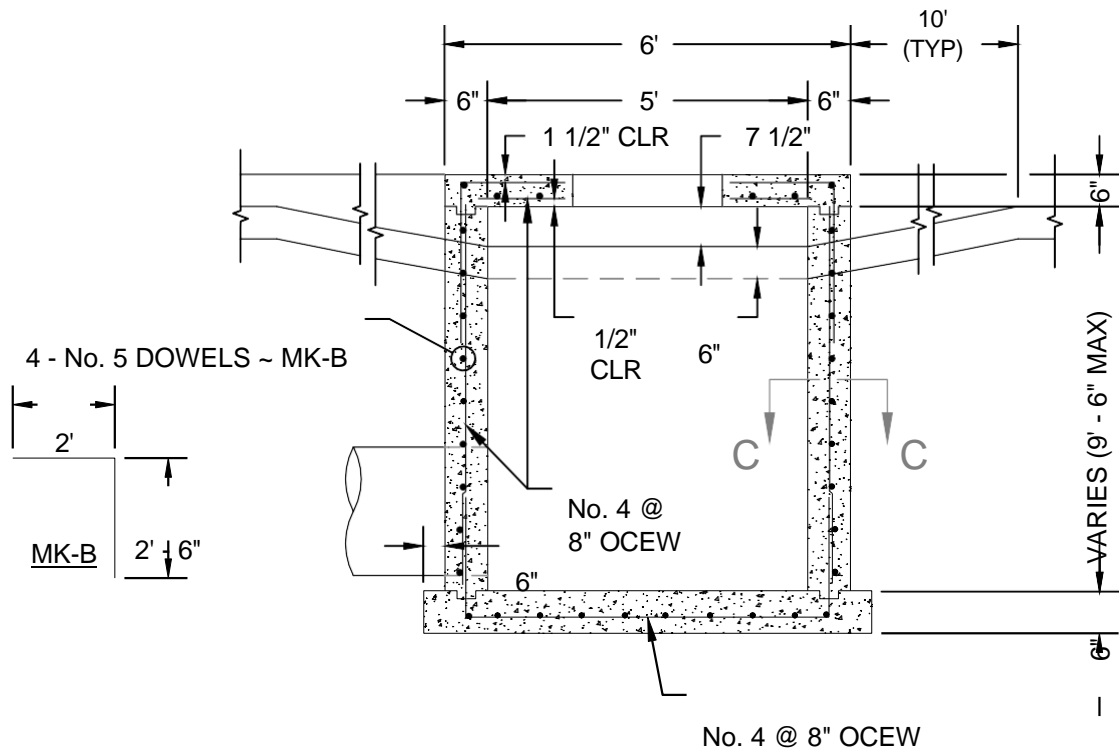
9/6/2023

ENGINEERING DESIGN  
MANUAL

SINGLE CURB INLET AND  
JUNCTION BOX SHEET 1

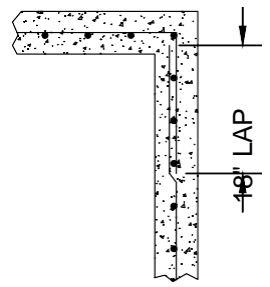
A-35

SHEET No.



SECTION B

A-35



SECTION "C-C"



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION

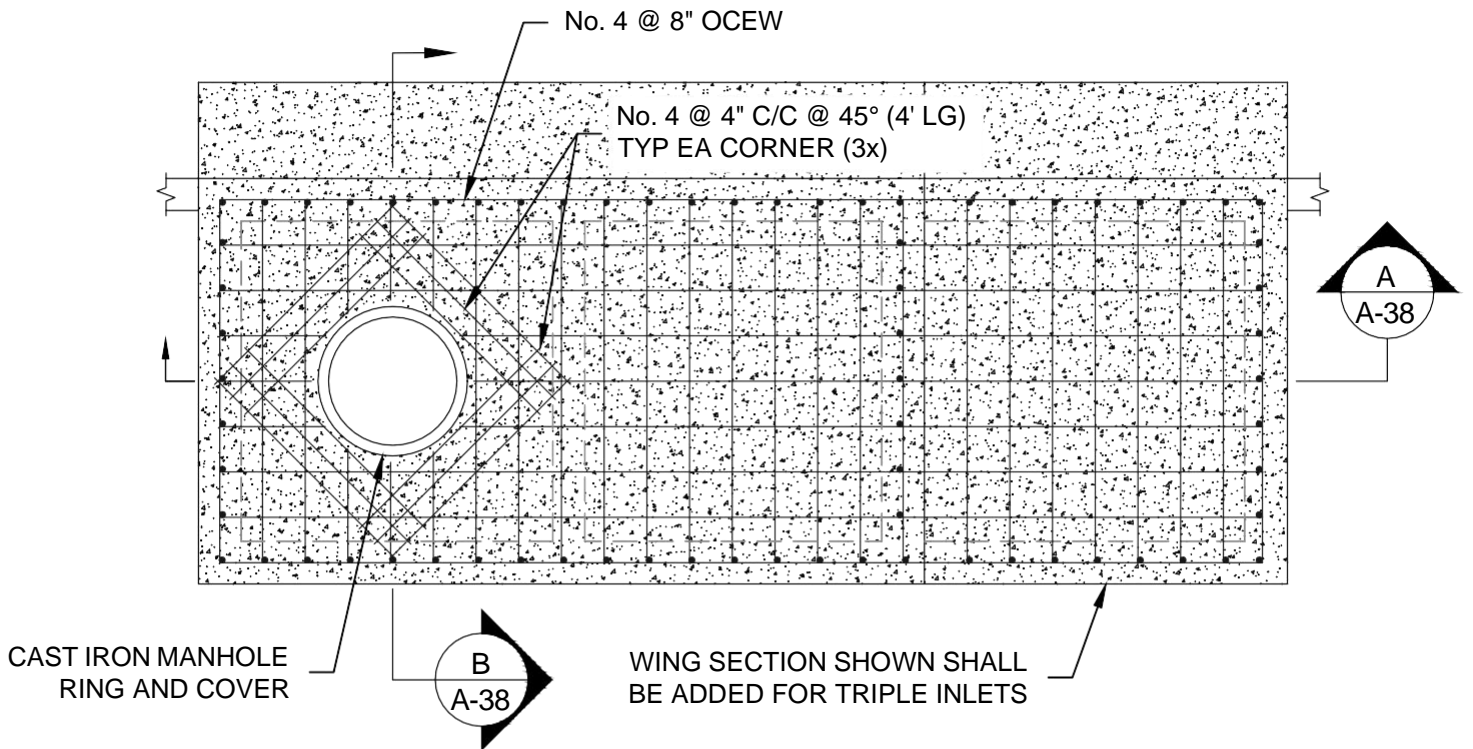
ENGINEERING DESIGN  
MANUAL

SINGLE CURB INLET AND  
JUNCTION BOX SHEET 2

A-36

9/6/2023

SHEET No.



**CURB INLET AND JUNCTION BOX NOTES:**

1. ALL CONCRETE SHALL BE 5 1/2 SACK MIN., 3000 PSI AT 28 DAY COMPRESSIVE STRENGTH.
2. ALL REINFORCING STEEL SHALL BE NEW, GRADE 60.
3. ALL MANHOLE RINGS AND COVERS SHALL BE AS DESCRIBED IN THE SPECIFICATIONS.
4. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 3/4".

**DOUBLE INLET**



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:

ENGINEERING DESIGN  
MANUAL

DOUBLE CURB INLET AND  
JUNCTION BOX SHEET 1

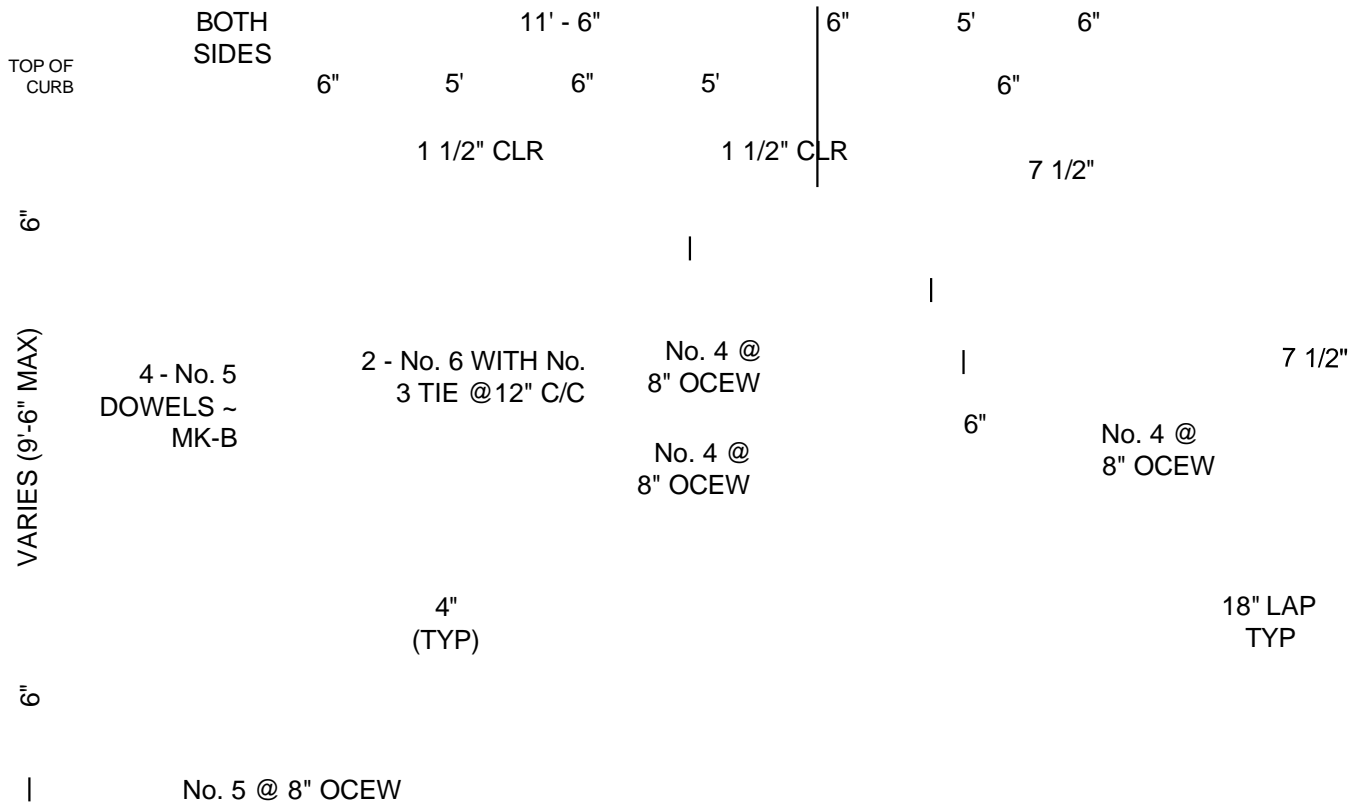
A-37

9/6/2023

SHEET No.

WING SECTION SHOWN SHALL  
BE ADDED FOR TRIPLE INLETS  
(WHERE SHOWN ON PLANS)

10" TYP



SECTION A  
A-37

2'-0"  
2'-6"

6" 5' - 48" RCP  
4' - 18" THRU  
36" RCP 6"

MK-B

1 1/2" R

No. 5 (4x)  
No. 4 @  
8" OCEW

VARIES (9' - 6" MAX)

18" LAP

1' - 6"

C C

No. 4 @  
8" OCEW

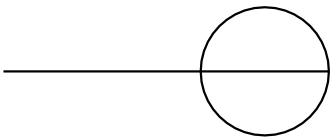
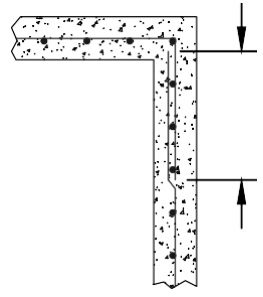
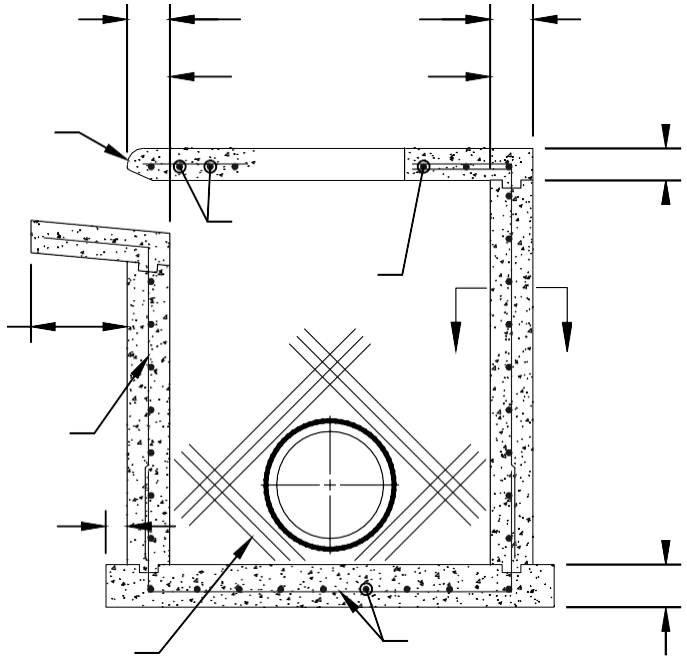
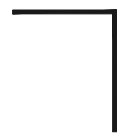
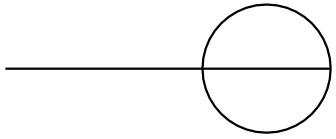
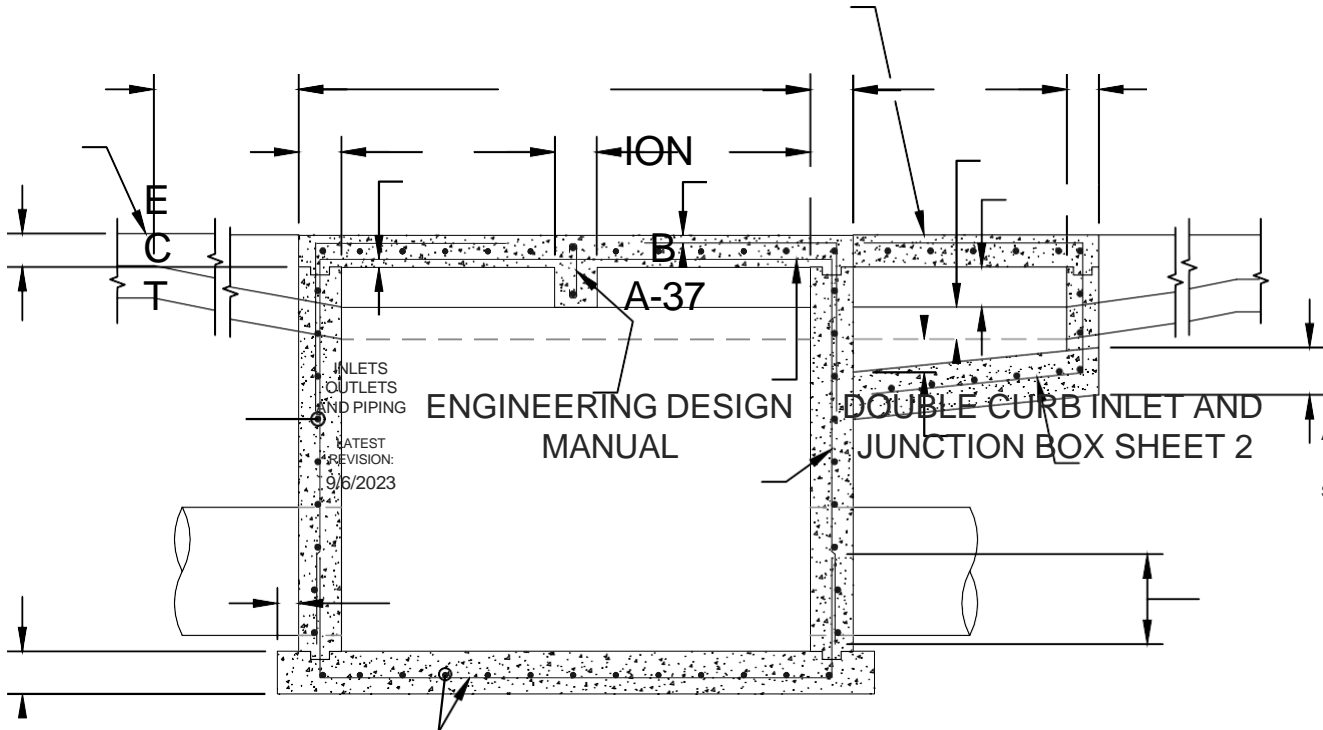
SECTION "C-C"

4" (TYP)

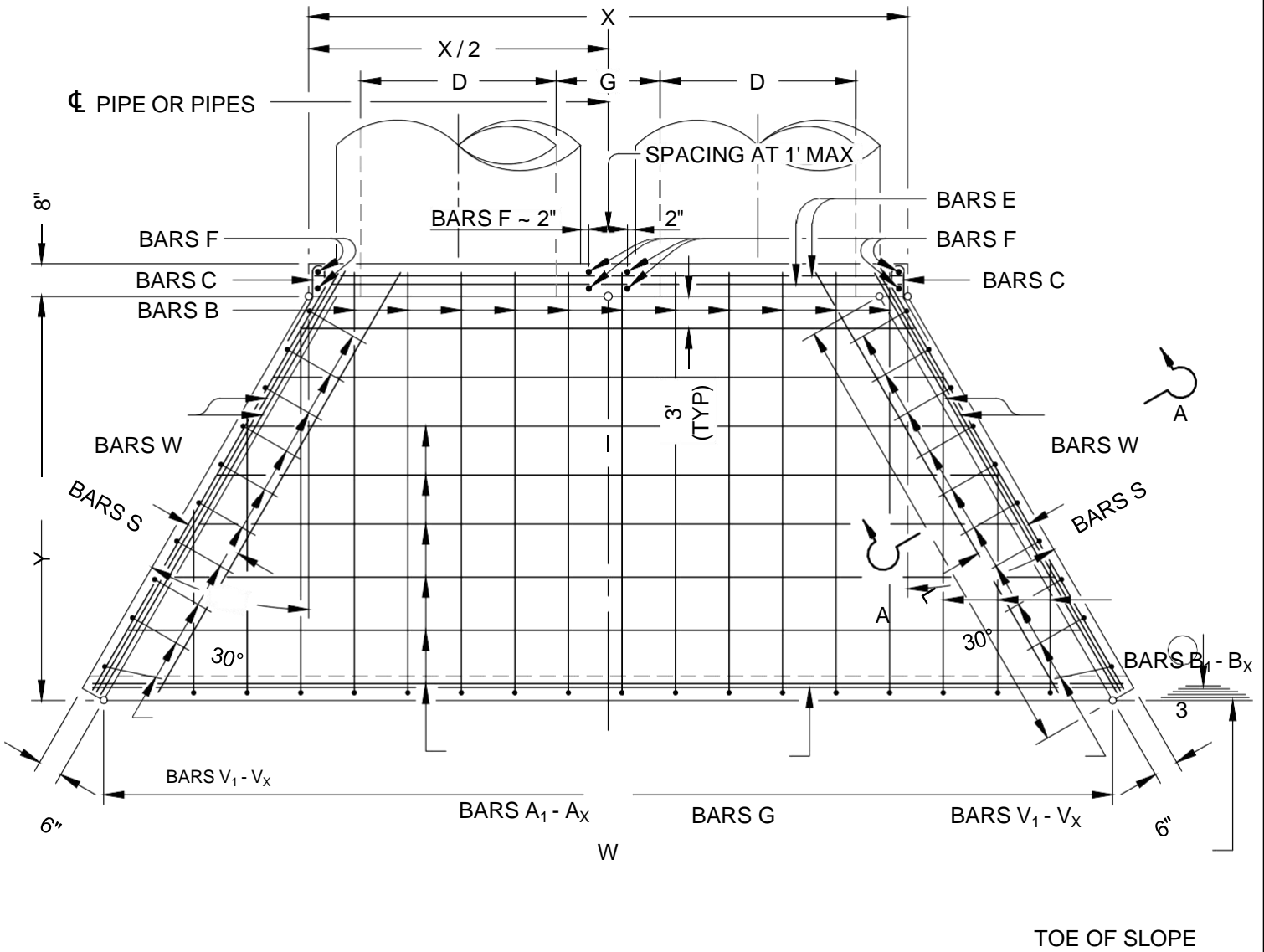
No. 4" C/C @ 45° (4' LG)  
TYP EA CORNER (3x)

No. 5 @ 8" OCEW

S



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**PLAN**

REFER TO SINGLE CURB INLET AND JUNCTION BOX  
SHEET 1 FOR SECTION A-A



INLETS  
OUTLETS  
AND PIPING

L  
A  
T

E  
S  
T  
R



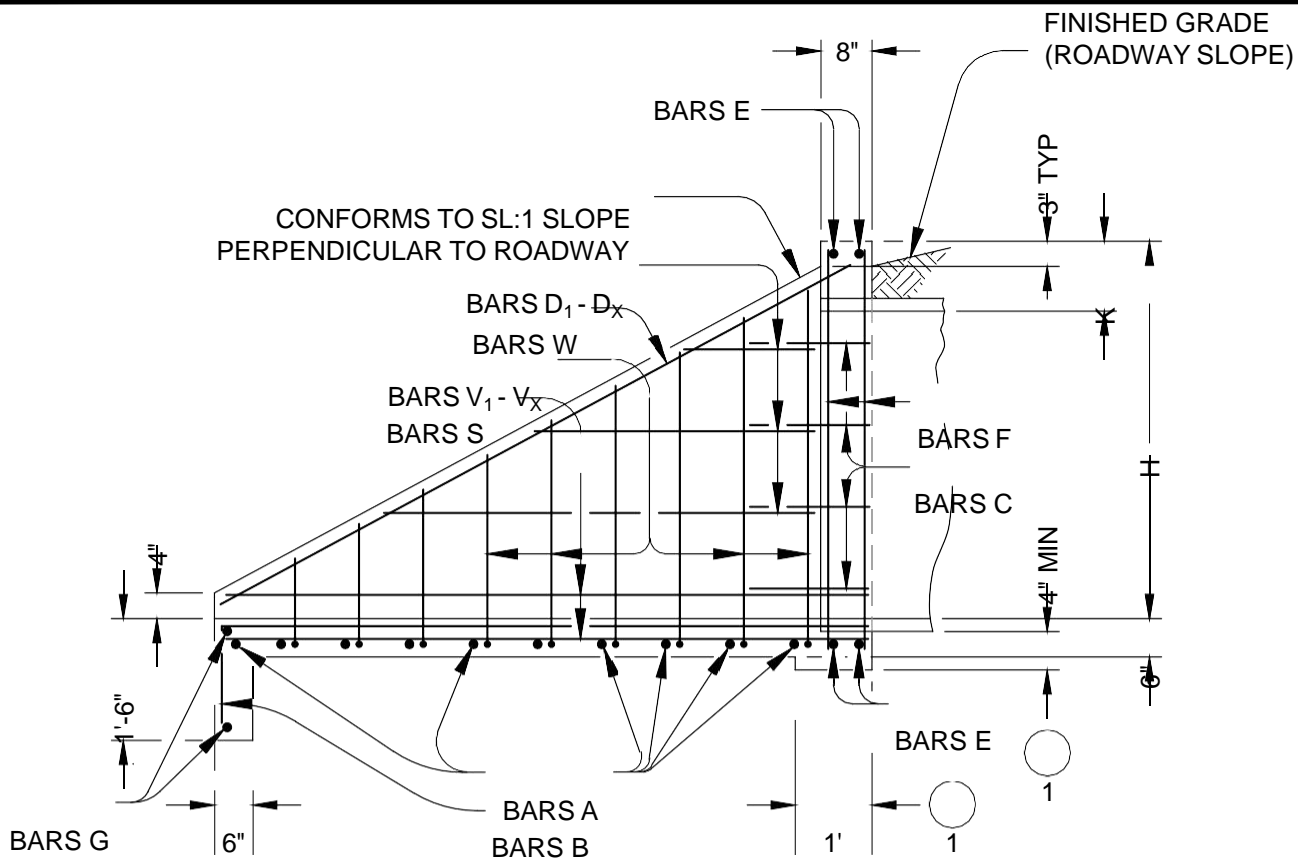
ION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

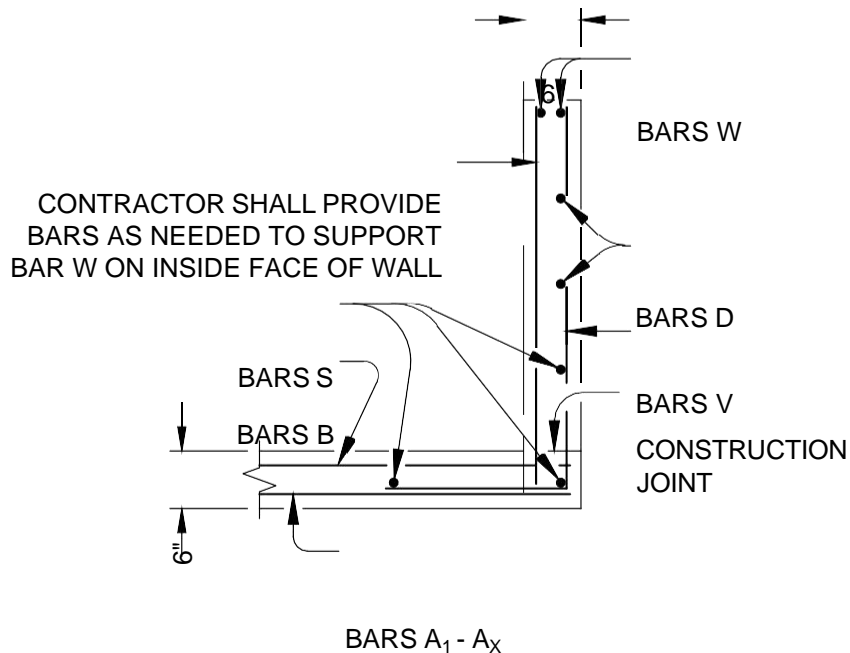
CONCRETE HEADWALL  
SHEET 1

A-39

SHEET No.



**TYPICAL WING ELEVATION**



**SECTION A-A**

REFER TO DOUBLE CURB INLET AND JUNCTION BOX SHEET 1



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:

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3

ENGINEER

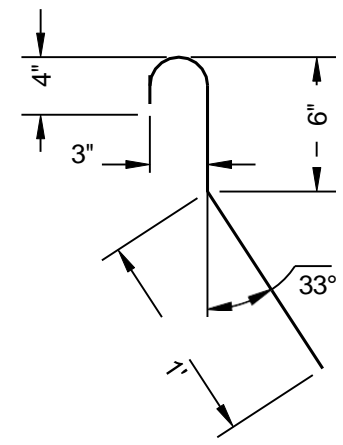
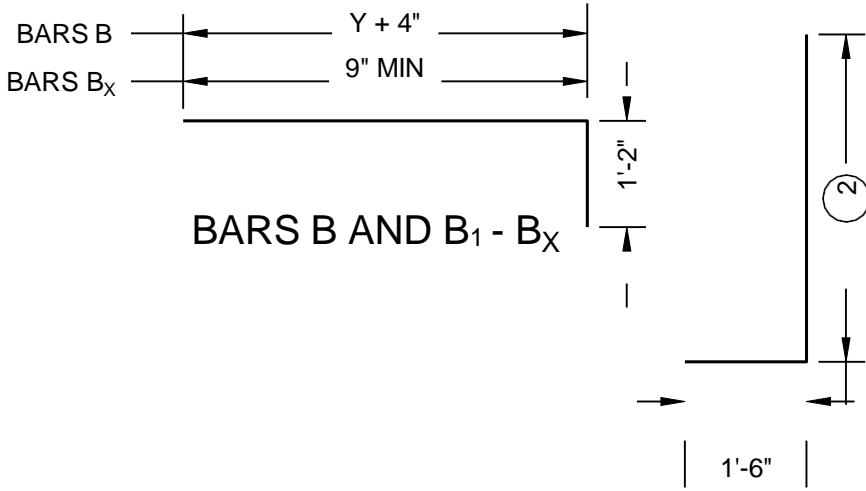
RI

NG DESIGN MANUAL

CONCRETE  
HEADWALL  
SHEET 2

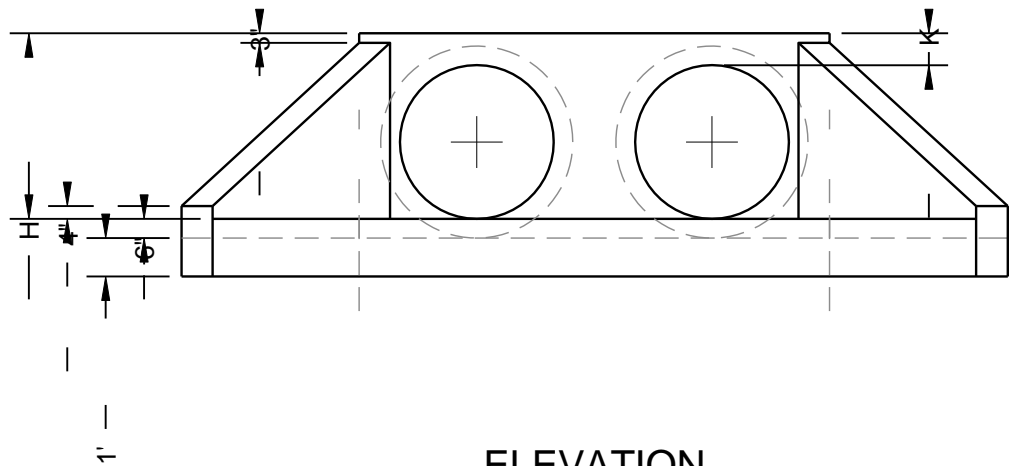
A-40

SHEET No.



BARS V

BARS C  
(2' LONG)



**ELEVATION**  
SHOWING DIMENSIONS

GENERAL NOTES:

1. DESIGNED ACCORDING TO CURRENT AASHTO STANDARD AND INTERIM SPECIFICATIONS.
2. REINFORCING STEEL SHALL BE PLACED WITH THE CENTER OF THE OUTSIDE LAYER OF BARS 2" FROM THE SURFACE OF THE CONCRETE.
3. ALL REINFORCING STEEL SHALL BE GRADE 60.
4. ALL CONCRETE SHALL BE CLASS "C" AND SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3,600 PSI.
5. NO BRIDGE RAILS OF ANY TYPE MAY BE MOUNTED DIRECTLY TO THESE CULVERT HEADWALLS.



INLETS OUTLETS AND PIPING		R E V I S I	O N : 9 /
LATEST			



- ① PROVIDE A 1' FOOTING AS SHOWN WHERE REQUIRED TO MAINTAIN 4" MINIMUM COVER FOR PIPES

$$\text{MIN LENGTH} = 6" + 3" \times \left( \frac{12 \times H - 7}{12 \times L} \right)$$

②

$$\text{MAX LENGTH} = 12" \times H - 3" \times \left( \frac{12 \times H - 7}{12 \times L} \right) - 1"$$

○

- 3 LENGTH OF WINGS BASED ON SL:1 SLOPE ALONG THIS LINE

TABLE OF REINFORCING STEEL

BAR	SIZE	SPA	No.
A	#4	1'	~
B	#3	1' - 6"	~
C	#4	1'	~
D	#3	1'	~
E	#5	~	4
F	#5	~	~
G	#3	~	2
S	#4	~	6
V	#4	1'	
W	#5	~	4

TABLE OF CONSTANT DIMENSIONS

DIA OF PIPE, D	G	K	H
12"	9"	1'	2'
15"	11"	1'	2' - 3"
18"	1' - 2"	1'	2' - 6"
21"	1' - 4"	1'	2' - 9"
24"	1' - 7"	1'	3'
27"	1' - 8"	1'	3' - 3"
30"	1' - 10"	1'	3' - 6"
33"	1" - 11"	1'	3' - 9"
36"	2' - 1"	1'	4'
42"	2' - 4"	1'	4' - 6"
48"	2' - 7"	1' - 3"	5' - 3"
54"	3'	1' - 3"	5' - 9"
60"	3' - 3"	1' - 3"	6' - 3"
66"	3' - 3"	1' - 3"	6' - 9"
72"	3' - 4"	1' - 3"	7' - 3"



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:

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ENGINEER

RT

NG DESIGN MANUAL

CONCRETE  
HEADWALL  
SHEET 4

A-42

SHEET No.

## TABLE OF VARIABLE DIMENSIONS AND QUANTITIES FOR ONE HEADWALL

SLOPE	DIA OF PIPE, D	VALUES FOR ONE PIPE				VALUES TO BE ADDED FOR EACH ADDITIONAL PIPE
		W	X	Y	L	X AND W
2:1	12"	9"	1'	2'	3' - 3 1/4"	1' - 9"
	15"	11"	1'	2' - 3"	3' - 10 1/4"	2' - 2"
	18"	1' - 2"	1'	2' - 6"	4' - 5"	2' - 8"
	21"	1' - 4"	1'	2' - 9"	5'	3' - 1"
	24"	1' - 7"	1'	3'	5' - 7"	3' - 7"
	27"	1' - 8"	1'	3' - 3"	6' - 2"	3' - 11"
	30"	1' - 10"	1'	3' - 6"	6' - 8 3/4"	4' - 4"
	33"	1" - 11"	1'	3' - 9"	7' - 3 3/4"	4' - 8"
	36"	2' - 1"	1'	4'	7' - 10 3/4"	5' - 1"
	42"	2' - 4"	1'	4' - 6"	9' - 0 1/2"	5' - 10"
	48"	2' - 7"	1' - 3"	5' - 3"	10' - 9 1/4"	6' - 7"
	54"	3'	1' - 3"	5' - 9"	11' - 11 1/4"	7' - 6"
	60"	3' - 3"	1' - 3"	6' - 3"	13' - 1"	8' - 3"
	66"	3' - 3"	1' - 3"	6' - 9"	14' - 3"	8' - 9"
	72"	3' - 4"	1' - 3"	7' - 3"	15' - 4 3/4"	9' - 4"
3:1	12"	6' - 3"	2' - 6"	4' - 3"	4' - 11"	1' - 9"
	15"	7' - 5"	2' - 9 1/2"	5'	5' - 9 1/4"	2' - 2"
	18"	8' - 6 3/4"	3' - 1"	5' - 9"	6' - 7 3/4"	2' - 8"
	21"	9' - 8 3/4"	3' - 4 1/2"	6' - 6"	7' - 6"	3' - 1"
	24"	11'	3' - 9 1/2"	7' - 3"	8' - 4 1/2"	3' - 7"
	27"	12' - 2"	4' - 1"	8'	9' - 2 3/4"	3' - 11'
	30"	13' - 4"	4' - 4 1/2"	8' - 9"	10' - 1 1/4"	4' - 4"
	33"	14' - 5 3/4"	4' - 8"	9' - 6"	10' - 11 3/4"	4' - 8"
	36"	15' - 7 3/4"	4' - 11 1/2"	10' - 3"	11' - 10"	5' - 1"
	42"	17' - 11 1/2"	5' - 6 1/2"	11' - 9"	13' - 6 3/4"	5' - 10"
	48"	21' - 1 3/4"	6' - 1 1/2"	14'	16' - 2"	6' - 7"
	54"	23' - 5 1/2"	6' - 8 1/2"	15' - 6"	17' - 10 3/4"	7' - 6"
	60"	25' - 9 1/4"	7' - 3 1/2"	17'	19' - 7 1/2"	8' - 3"
	66"	28' - 1"	7' - 10 1/2"	18' - 6"	21' - 4 1/4"	8' - 9"
	72"	30' - 4 3/4"	8' - 5 1/2"	20'	23' - 1 1/4"	9' - 4"



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

CONCRETE HEADWALL  
SHEET 5

A-43

SHEET No.



## TABLE OF VARIABLE DIMENSIONS AND QUANTITIES FOR ONE HEADWALL

SLOPE	DIA OF PIPE, D	VALUES FOR ONE PIPE				VALUES TO BE ADDED FOR EACH ADDITIONAL PIPE
		W	X	Y	L	X AND W
4:1	12"	7' - 10 3/4"	2' - 6"	5' - 8"	6' - 6 1/2"	1' - 9"
	15"	9' - 4"	2' - 9 1/2"	6' - 8"	7' - 8 1/2"	2' - 2"
	18"	10' - 9 1/2"	3' - 1"	7' - 8"	8' - 10 1/4"	2' - 8"
	21"	12' - 2 3/4"	3' - 4 1/2"	8' - 8"	10'	3' - 1"
	24"	13' - 9 1/2"	3' - 9 1/2"	9' - 8"	11' - 2"	3' - 7"
	27"	15' - 3"	4' - 1"	10' - 8"	12' - 3 3/4"	3' - 11"
	30"	16' - 8 1/4"	4' - 4 1/2"	11' - 8"	13' - 5 3/4"	4' - 4"
	33"	18' - 1 3/4"	4' - 8"	12' - 8"	14' - 7 1/2"	4' - 8"
	36"	19' - 7"	4' - 11 1/2"	13' - 8"	15' - 9 1/4"	5' - 1"
	42"	22' - 5 3/4"	5' - 6 1/2"	15' - 8"	18' - 1"	5' - 10"
	48"	26' - 6 1/4"	6' - 1 1/2"	18' - 8"	21' - 6 3/4"	6' - 7"
	54"	29' - 5"	6' - 8 1/2"	20' - 8"	23' - 10 1/4"	7' - 6"
	60"	32' - 3 3/4"	7' - 3 1/2"	22' - 8"	26' - 2"	8' - 3"
	66"	35' - 2 1/2"	7' - 10 1/2"	24' - 8"	28' - 5 3/4"	8' - 9"
72"	38' - 1 1/4"	8' - 5 1/2"	26' - 8"	30' - 9 1/2"	9' - 4"	
6:1	12"	11' - 2"	2' - 6"	8' - 6"	9' - 9 3/4"	1' - 9"
	15"	13' - 2 1/4"	2' - 9 1/2"	10'	11' - 6 1/2"	2' - 2"
	18"	15' - 2 1/2"	3' - 1"	11' - 6"	13' - 3 1/4"	2' - 8"
	21"	17' - 2 3/4"	3' - 4 1/2"	13'	15' - 0 1/4"	3' - 1"
	24"	19' - 4 1/2"	3' - 9 1/2"	14' - 6"	16' - 9"	3' - 7"
	27"	21' - 4 3/4"	4' - 1"	16'	18' - 5 3/4"	3' - 11'
	30"	23' - 5 1/4"	4' - 4 1/2"	17' - 6"	20' - 2 1/2"	4' - 4"
	33"	25' - 5 1/2"	4' - 8"	19'	21' - 11 1/4"	4' - 8"
	36"	27' - 5 3/4"	4' - 11 1/2"	20' - 6"	23' - 8"	5' - 1"
	42"	31' - 6 1/4"	5' - 6 1/2"	23' - 6"	27' - 1 1/2"	5' - 10"
	48"	37' - 3 1/2"	6' - 1 1/2"	28'	32' - 4"	6' - 7"
	54"	41' - 4 1/4"	6' - 8 1/2"	31'	35' - 9 1/2"	7' - 6"
60"	45' - 4 3/4"	7' - 3 1/2"	34'	39' - 3"	8' - 3"	



INLETS  
OUTLETS  
AND PIPING

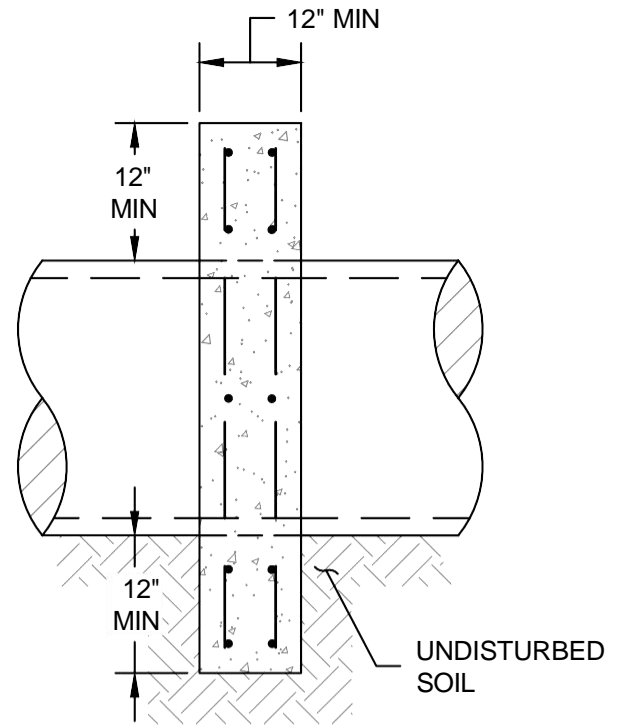
LATEST  
REVISION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

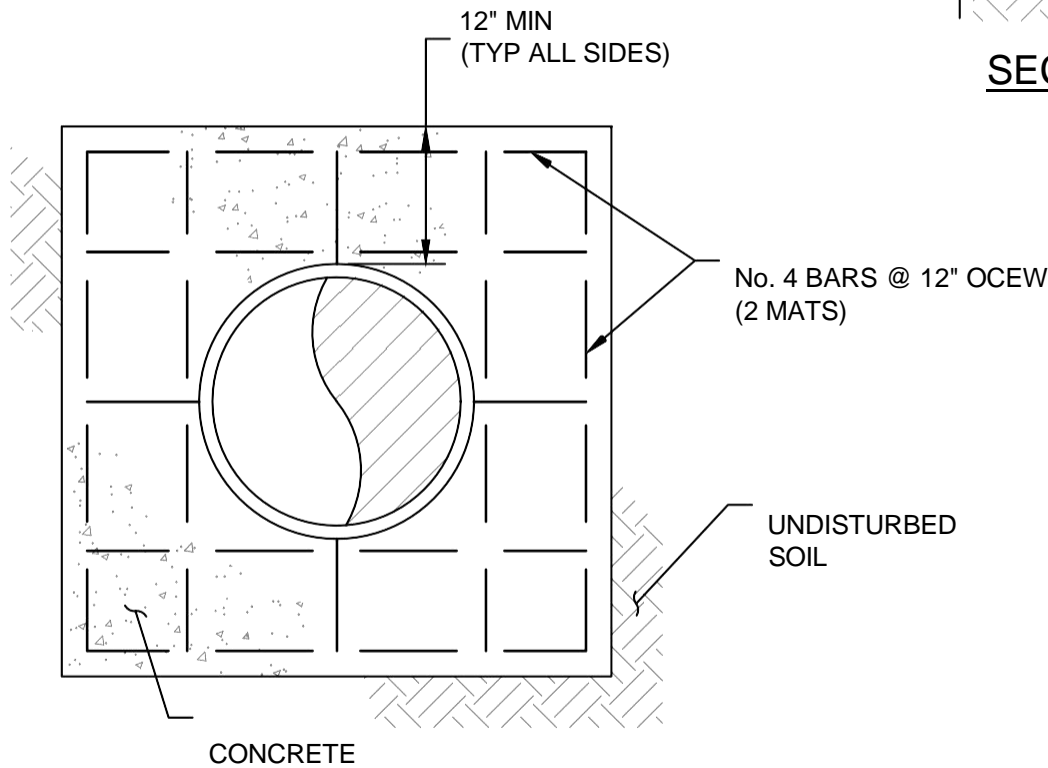
CONCRETE HEADWALL  
SHEET 6

A-44

SHEET No.



**SECTION**



**ELEVATION**

**CONCRETE COLLAR DETAIL**

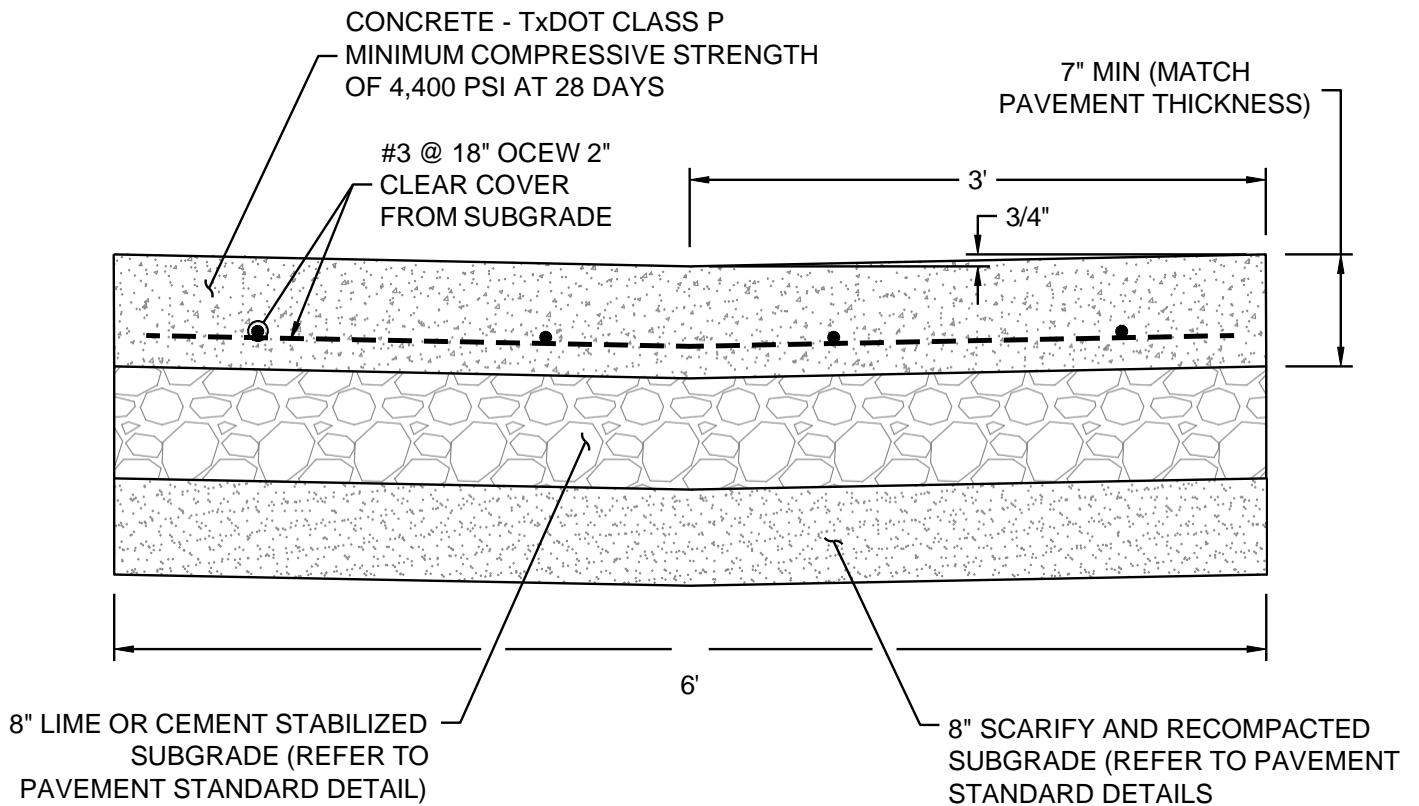


INLETS  
OUTLETS  
AND PIPING  
  
LATEST  
REVISION:  
9/6/2023

NTS  
  
ENGINEERING DESIGN  
MANUAL

CONCRETE COLLAR

A-45



**NOTES:**

1. REINFORCEMENT SHALL BE CONTINUOUS WITH MINIMUM 30" LAP AT BARS.
2. CONCRETE PAVEMENT:
  - a. MATCH JOINT LOCATIONS AND TYPES FOR CONCRETE PAVEMENTS.
  - b. AT CONCRETE PAVEMENT TRANSITIONS AND INTERSECTIONS, INSTALL EXPANSION JOINTS WITH #8 x 18" SMOOTH DOWEL BARS @ 12" OC. CENTERED IN PAVEMENT. REFER TO PAVEMENT STANDARD DETAILS.
3. FOR ASPHALT PAVEMENT:
  - a. INSTALL CONTRACTION JOINT AT CENTERLINE AND OFFSET NO MORE THAN 15 FEET OCEW.



INLETS  
OUTLETS  
AND PIPING

ENGINEERING DESIGN

CONCRETE VALLEY

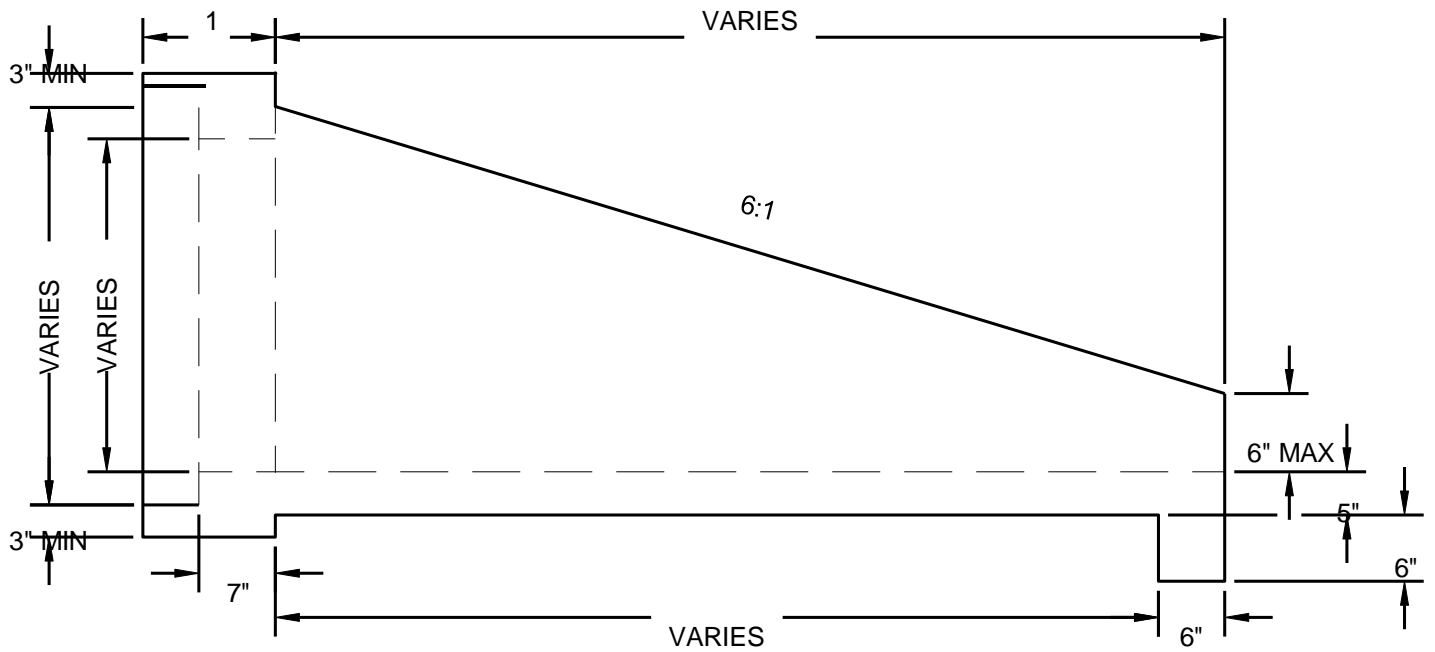
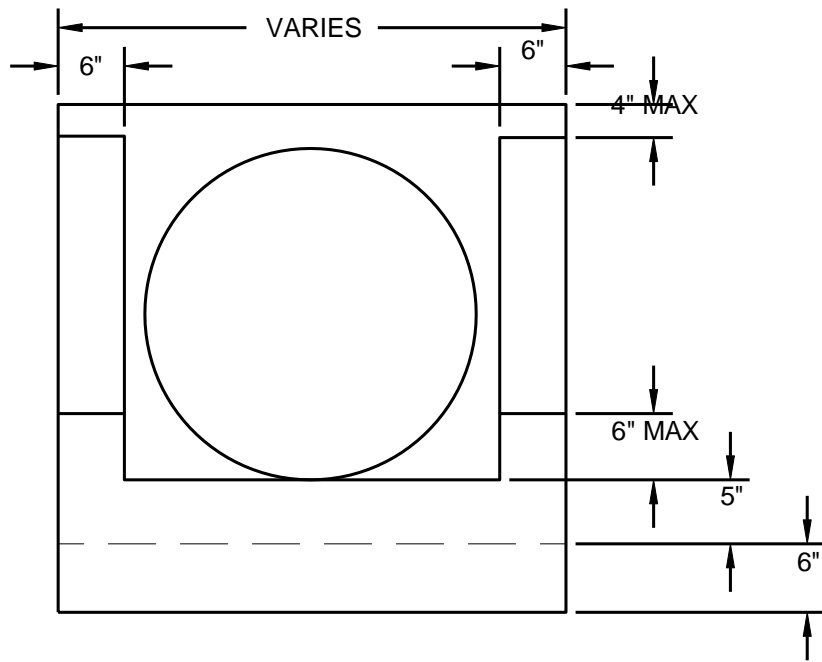
A-46

LATEST  
REVISION:  
9/11/2023

MANUAL

GUTTER DETAIL

SHEET No.



## PRECAST SAFETY END TREATMENT



INLETS  
OUTLETS  
AND PIPING  
  
LATEST  
REVISION:  
8/6/2020

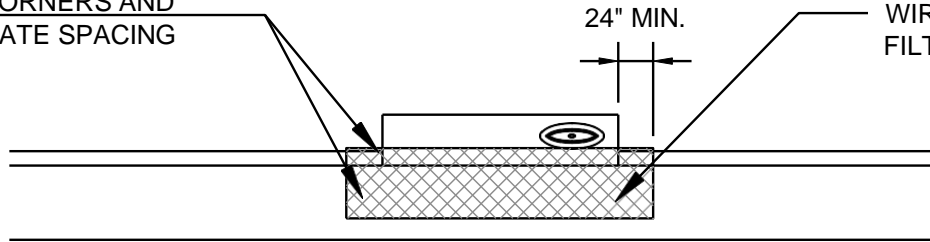
ENGINEERING DESIGN  
MANUAL

PRECAST SAFETY  
END TREATMENT

A-47

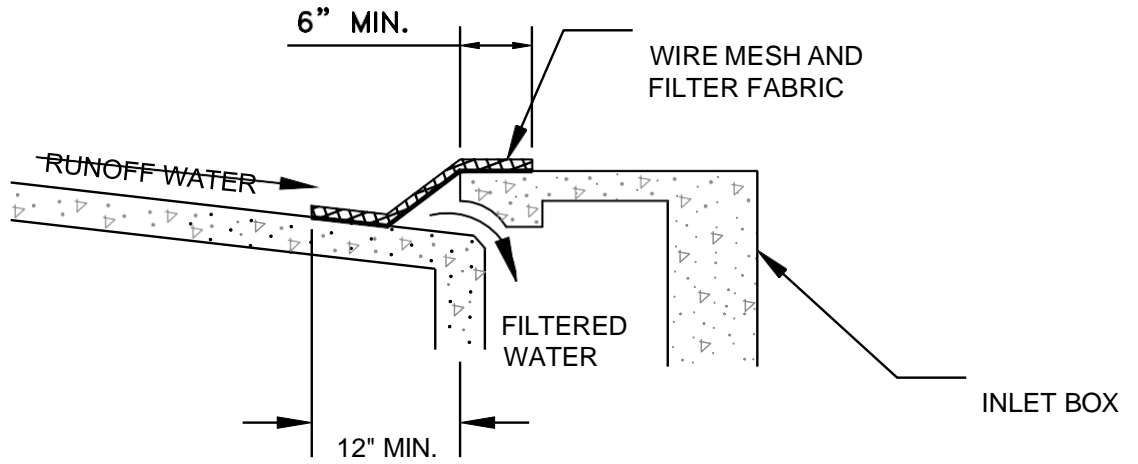
SHEET No.

SANDBAGS AT CORNERS AND APPROPRIATE SPACING



24" MIN.

WIRE MESH AND FILTER FABRIC



6" MIN.

WIRE MESH AND FILTER FABRIC

RUNOFF WATER

FILTERED WATER

INLET BOX

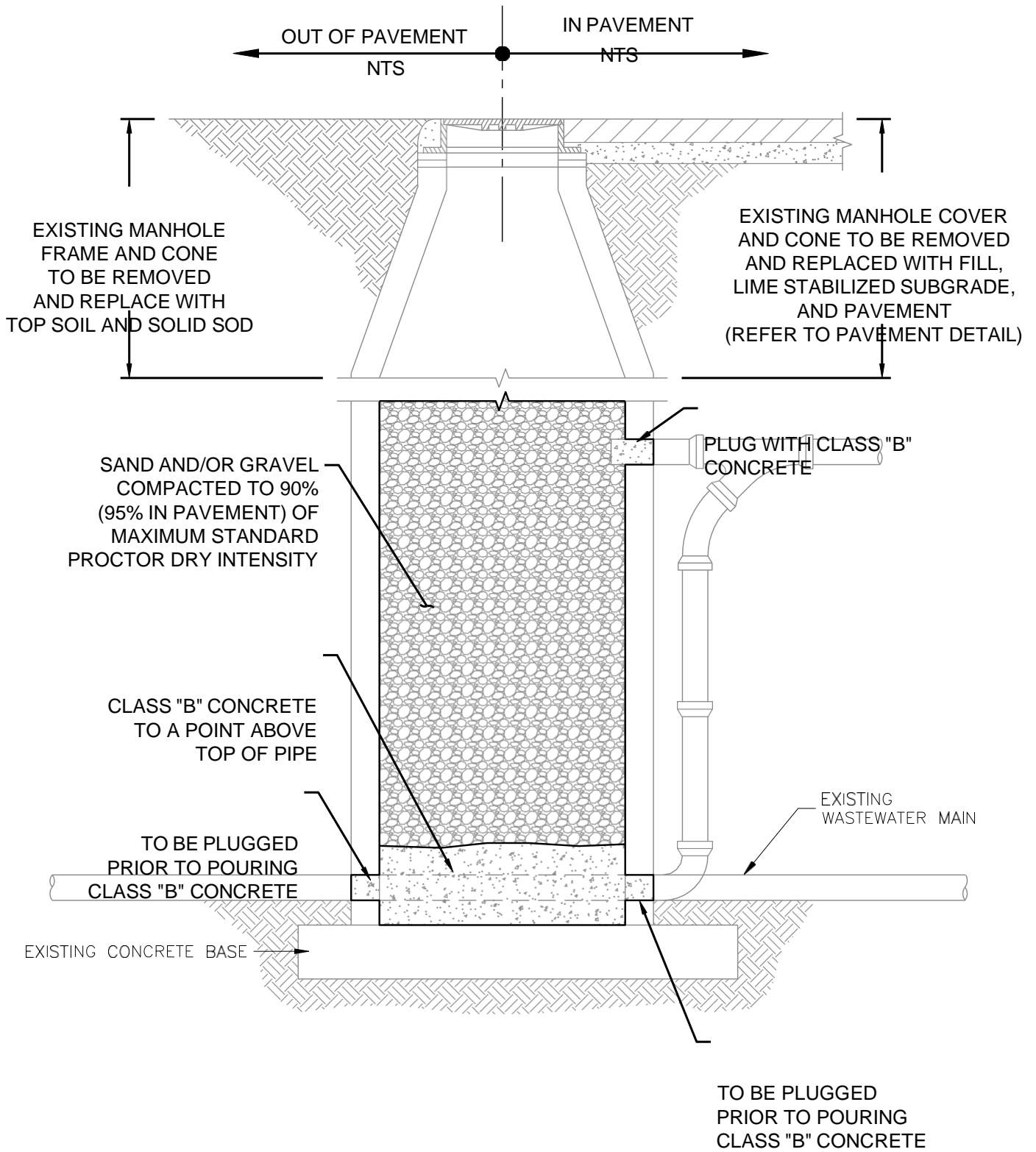
12" MIN.

CURB INLET PROTECTION

SEDIMENT BARRIER AT INLETS

N.T.S.

SHEET No.



INLETS  
OUTLETS  
AND PIPING

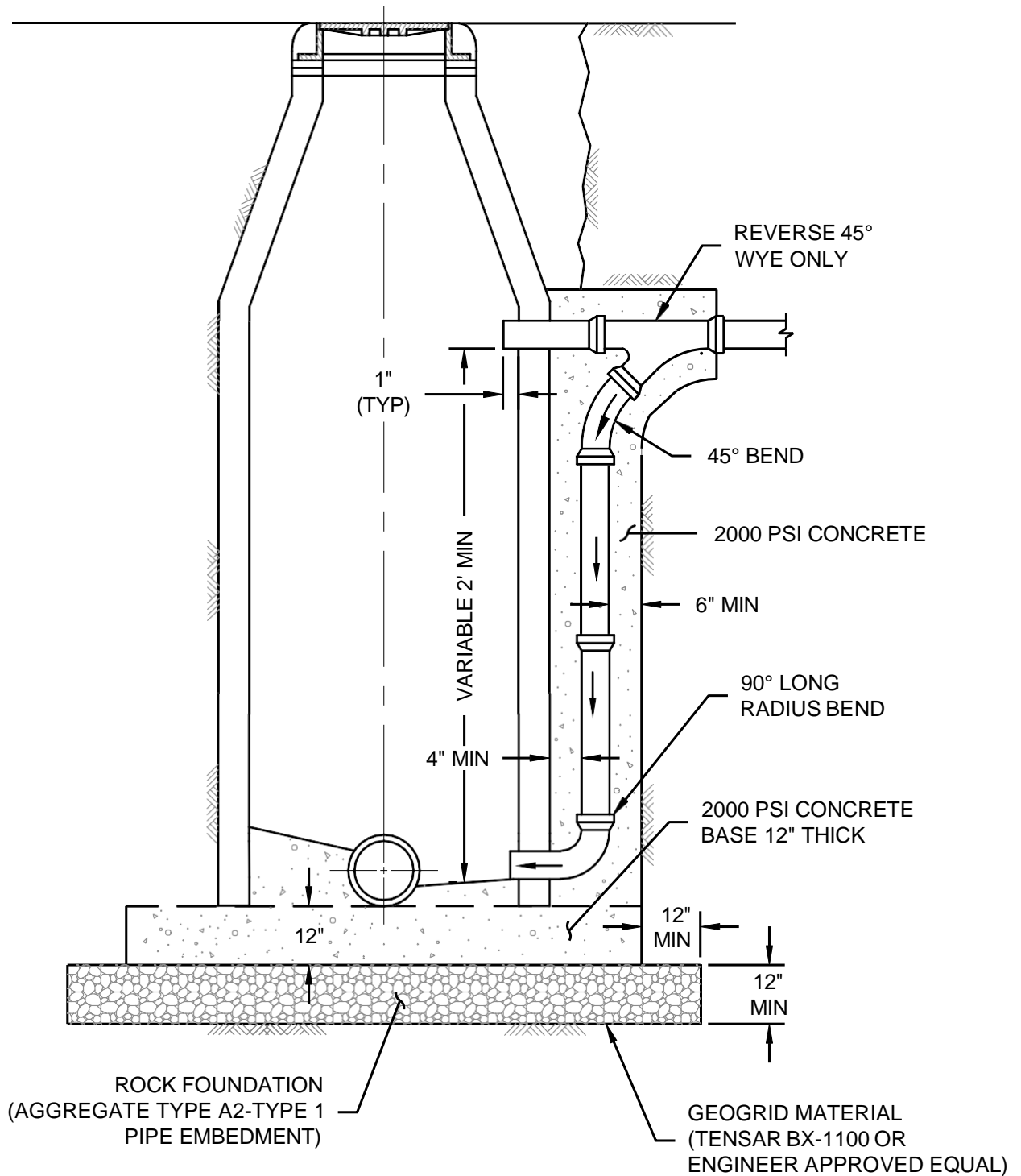
LATEST

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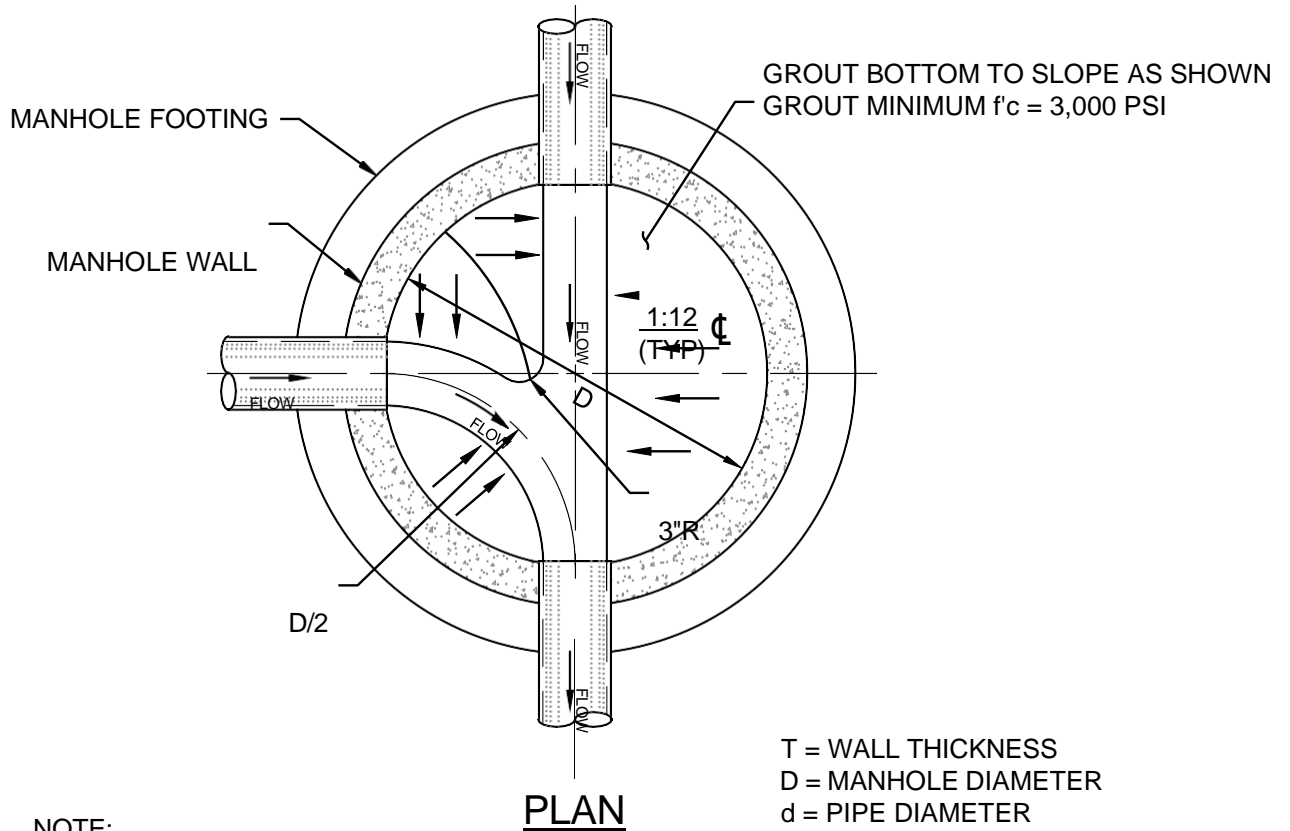
**NOTES:**

1. ALL PIPE FOR DROPS SHALL BE CLASS 350 DUCTILE IRON PIPE.
2. ALL FITTINGS SHALL BE DUCTILE IRON AND HAVE PUSH-ON TYPE JOINTS AS SHOWN.

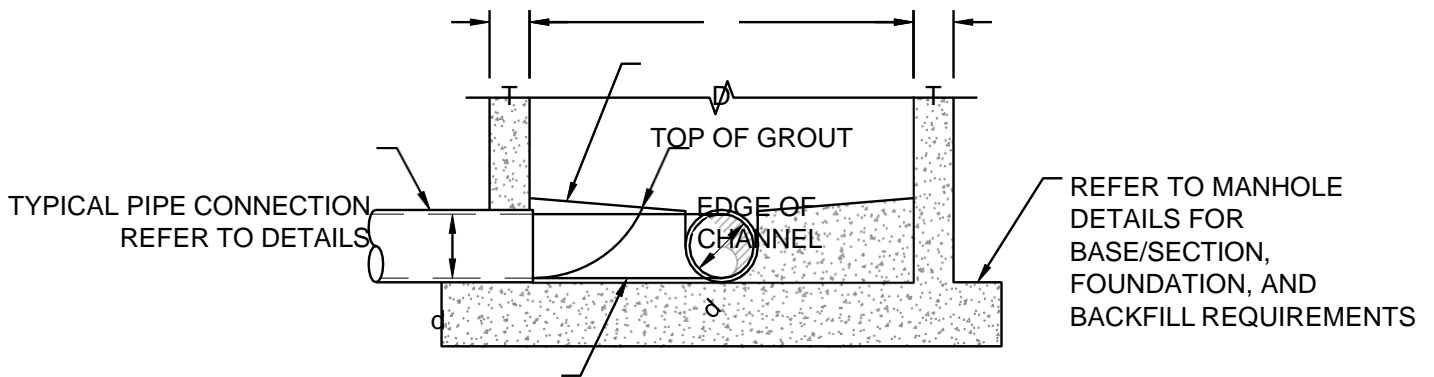
**WASTEWATER MANHOLE OUTSIDE DROP CONNECTION**



INLETS OUTLETS AND PIPING	ENGINEERING DESIGN MANUAL	WASTEWATER MANHOLE OUTSIDE DROP CONNECTION	A-50
LATEST REVISION: 9/6/2023			SHEET No.



NOTE:  
REFER TO MANHOLE  
STANDARD DRAWINGS FOR  
ADDITIONAL DETAIL OF M.H.



SECTION A-A



WASTEWATER MANHOLE LINE INTERSECTION

INLETS  
OUTLETS  
AND PIPING  
LATEST

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ENGINEERING DESIGN  
MANUAL

WASTEWATER  
MANHOLE LINE  
INTERSECTION

A-51

SHEET No.

NON SHRINK GROUT  
WHEN NOT IN PAVING

PROPOSED PAVEMENT

STANDARD CAST IRON  
MANHOLE FRAME AND  
COVER AS SPECIFIED

USE PRECAST CONCRETE  
GRADE RINGS (MAXIMUM OF 2)  
AND NON SHRINK GROUT AS  
REQUIRED TO RAISE TO GRADE

USE O-RING RUBBER  
GASKET (TYP.)

INTERMEDIATE RISER

BASE RISER WITH "BUTT  
END" INTEGRATED INTO  
CONCRETE BASE

STUB OUTS TO BE  
FITTED WITH A WATER  
TIGHT STOPPER OR CAP

STUB OUTS TO BE A MIN OF  
5' LONG WITH CONCRETE  
CRADLE (FROM SAME  
POUR AS BASE) UNDER  
THE ENTIRE LENGTH

APPROVED RESILIENT PIPE-TO-  
MANHOLE CONNECTOR OR GASKET  
REQUIRED FOR PIPE OTHER THAN  
CLAY OR CONCRETE

ROCK FOUNDATION  
(AGGREGATE TYPE  
A2-TYPE 1 PIPE EMBEDMENT)

4', 5', OR 6'  
PER CITY  
STANDARDS

SPRING LINE  
MINIMUM  
SLOPE 1:12

6" MIN

INTERMEDIATE RISER  
AVAILABLE IN 2', 4', AND  
6' LENGTHS  
(USE MIN NUMBER OF RISERS)

BASE  
RISER

1 1/2"  
CLR

12"  
MIN

12"  
MIN

#4 @ 6" OCEW  
CONCRETE (3000 PSI @ 28 DAYS)

GEOGRID MATERIAL (TENSAR BX-1100  
OR ENGINEER APPROVED EQUAL)

# WASTEWATER MANHOLE-PRECAST

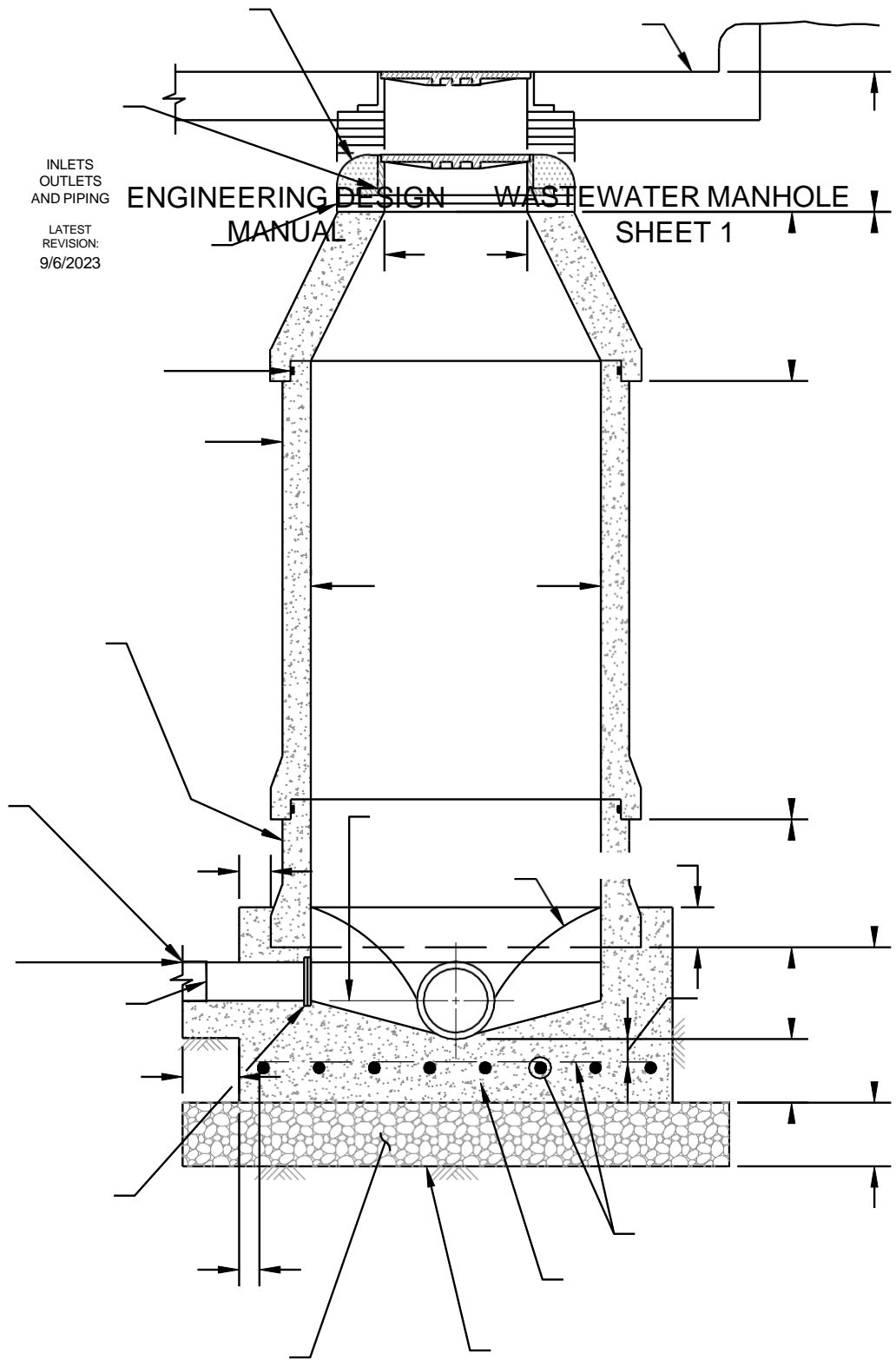
INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:  
9/6/2023

ENGINEERING DESIGN — WASTEWATER MANHOLE  
MANUAL SHEET 1

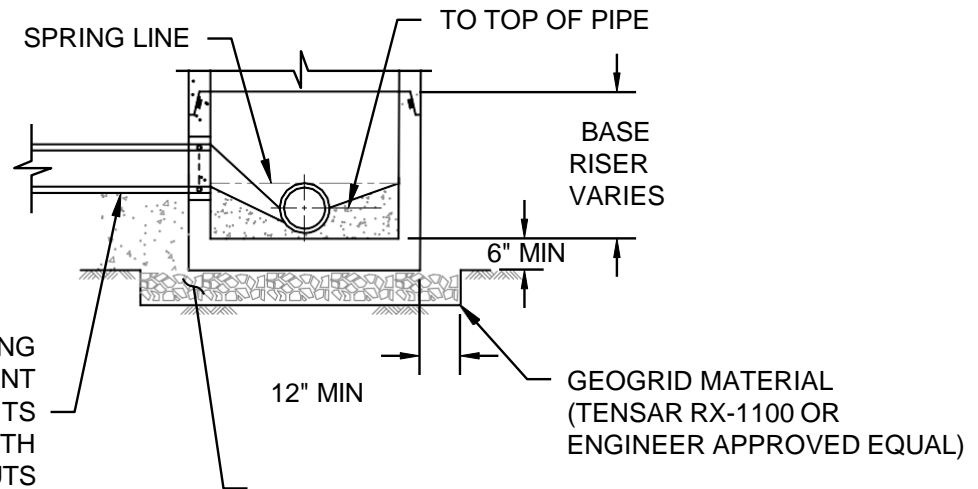
A-52

SHEET No.



**NOTES:**

1. TOP OF MANHOLE TO BE 2' - 0" ( ± 2") ABOVE ALL EXISTING GROUND IN UNDEVELOPED AREAS UNLESS OTHERWISE DIRECTED BY THE ENGINEER. MOUND DIRT AROUND MANHOLE @ 6:1 SLOPE.
2. TOP OF MANHOLE TO BE 6" ( ± 1") ABOVE EXISTING GROUND IN DEVELOPED AREAS AND ON STREET RIGHT-OF-WAYS UNLESS OTHERWISE DIRECTED BY THE ENGINEER. MOUND DIRT AROUND MANHOLE @ 6:1 SLOPE.
3. ALL MANHOLES IN PUBLIC R.O.W. SHALL HAVE PROVISIONS TO FACILITATE ANY NECESSARY ADJUSTMENT IN HEIGHT.
4. PRE CAST RISERS, CONES, FLAT TOP SLABS, REDUCING FLAT SLABS, FLOORS, GRADE RINGS & RINGS AND COVERS SHALL BE MANUFACTURED ACCORDING TO THE MOST RECENT ASTM C-478 SPECIFICATIONS.
5. MANHOLE WATERPROOFING SHALL BE ONE HEAVY EXTERIOR COAT OF TAR PAINT SUCH AS KOPPERS "BITUMASTIC SUPER- SERVICE BLACK", TNEMEC "46-449 HEAVY DUTY BLACK", VALSPAR "35-J-10", OR APPROVED EQUIVALENT.



STUB OUTS TO BE MIN 5' LONG SUPPORTED BY EMBEDMENT SPECIFIED IN PLANS. STUB OUTS TO BE GROUTED AT M.H. WITH NON SHRINK GROUT. STUB OUTS

SHALL ALSO BE FITTED WITH WATER TIGHT STOPPER OR CAP.

ROCK FOUNDATION (AGGREGATE TYPE A2-TYPE 1 PIPE EMBEDMENT)



INLETS  
OUTLETS  
AND PIPING  
LATEST

**PRECAST BASE**

REVISIONS

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: 9/6  
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ENGINEER

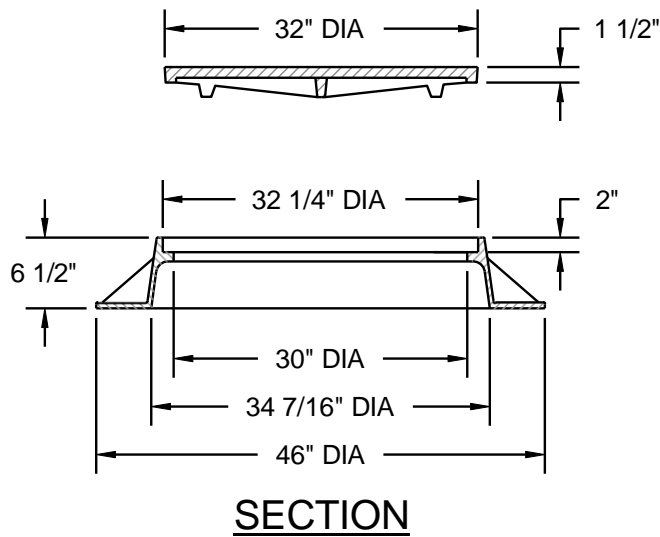
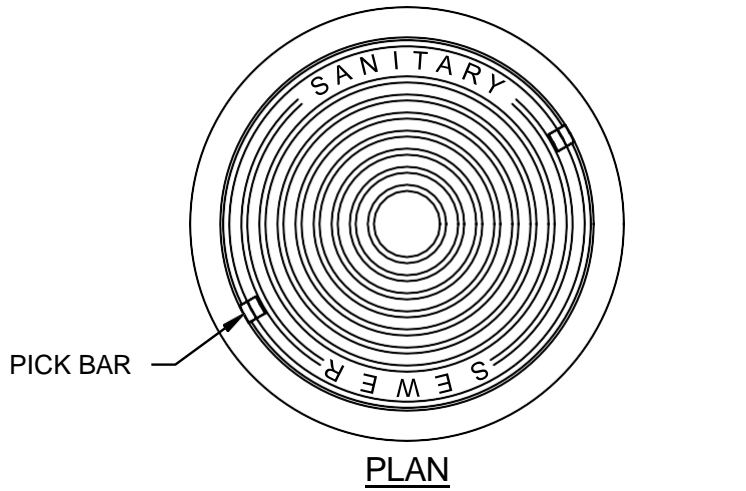
ERING DESIGN MANUAL

WASTEWATER  
MANHOLE  
SHEET 2

A-53

SHEET No.

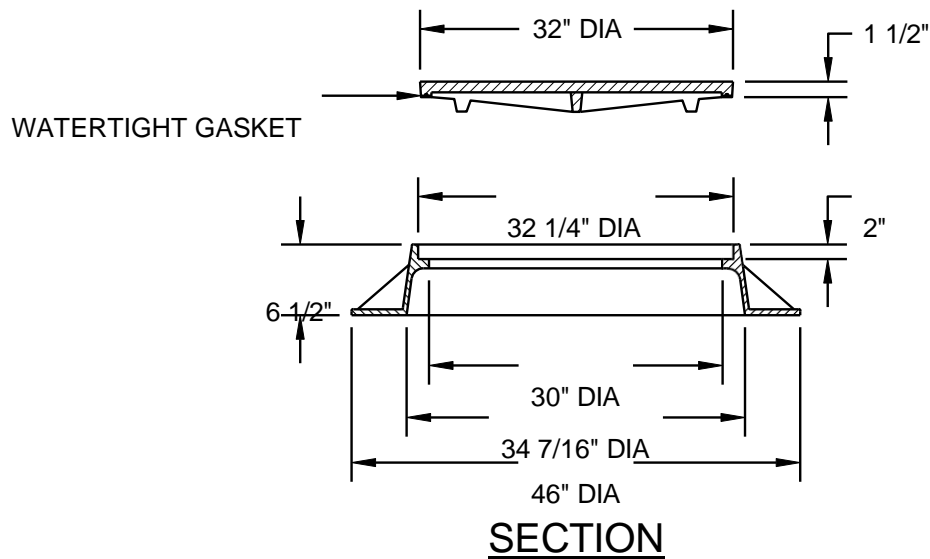
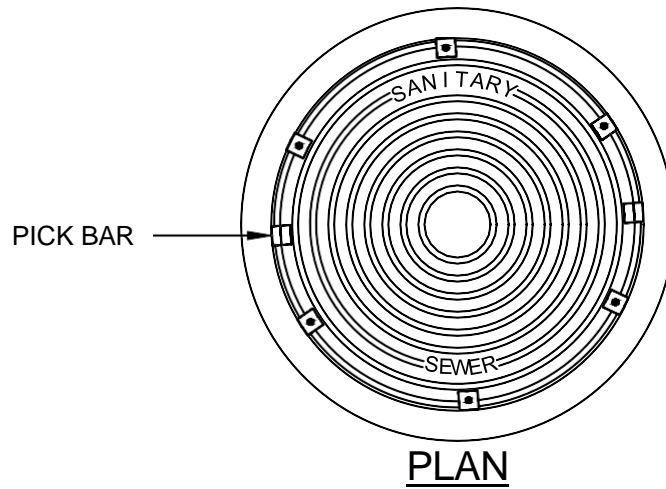




NOTES:

1. MANHOLE RINGS AND COVERS SHALL BE MACHINED SURFACE CAST IRON, NON-ROCKING TYPE.
2. MINIMUM WEIGHT FOR STANDARD RING AND COVER SHALL BE 295 LBS.
3. COVER SHALL HAVE RECESSED PICK SLOTS AND NO HOLES.

STANDARD MANHOLE RING AND COVER



**NOTES:**

1. MANHOLE RINGS AND COVERS SHALL BE MACHINED SURFACE CAST IRON, NON-ROCKING TYPE.
2. MINIMUM WEIGHT FOR BOLTED AND GASKETED RING AND COVER SHALL BE 295 LBS.
3. COVER SHALL HAVE RECESSED PICK SLOTS AND NO HOLES.
4. LID SHALL HAVE A WATERTIGHT GASKET AND A BOLTED LID. BOLTS SHALL EXTEND A MINIMUM OF 1/2" INTO THE RING.

**BOLTED AND GASKETED  
MANHOLE RING AND COVER**

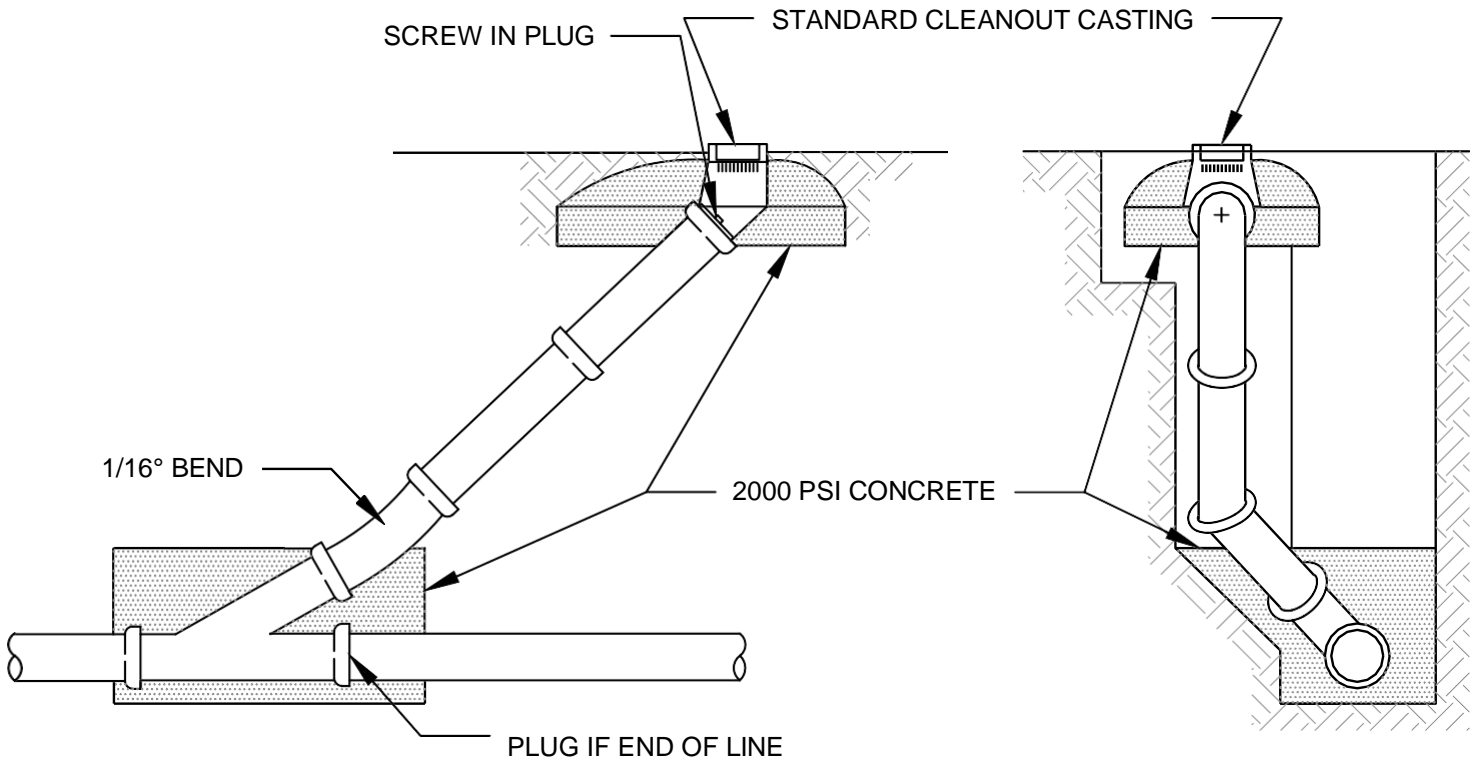


INLETS  
OUTLETS  
AND PIPING  
  
LATEST  
REVISION:  
9/6/2023

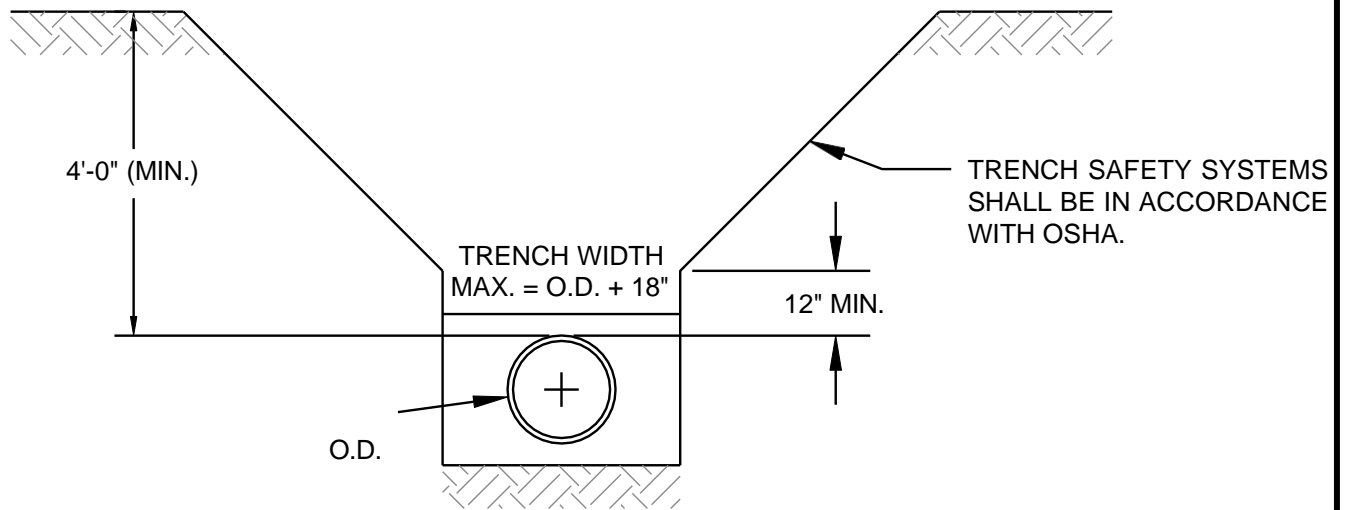
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ENGINEERING DESIGN  
MANUAL

BOLTED AND GASKETED  
MANHOLE RING AND COVER

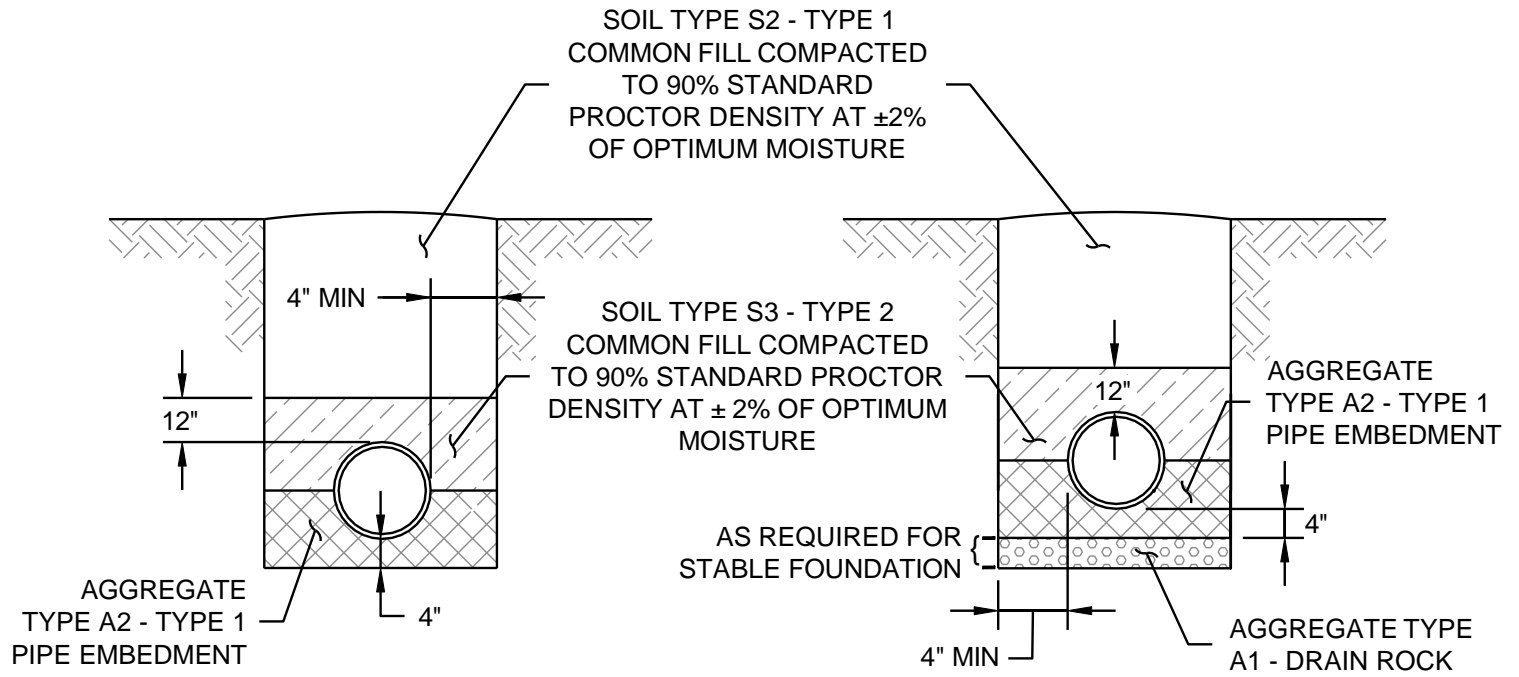
A-55



SEWER MAIN  
CLEANOUT DETAIL  
N.T.S.



TYPICAL TRENCH  
SECTION  
N.T.S.



**SEWER LINE  
CLASS B BEDDING**  
(USE UNDER NORMAL CONDITIONS)

**SEWER LINE  
CLASS B BEDDING WITH FOUNDATION**  
(USE WHEN DIRECTED BY ENGINEER)

NOTE:

REFER TO SECTION 8 OF THE DESIGN STANDARDS FOR MATERIAL SPECIFICATIONS.

**EMBEDMENT DETAILS FOR SEWER LINES**

NTS



INLETS  
OUTLETS  
AND PIPING

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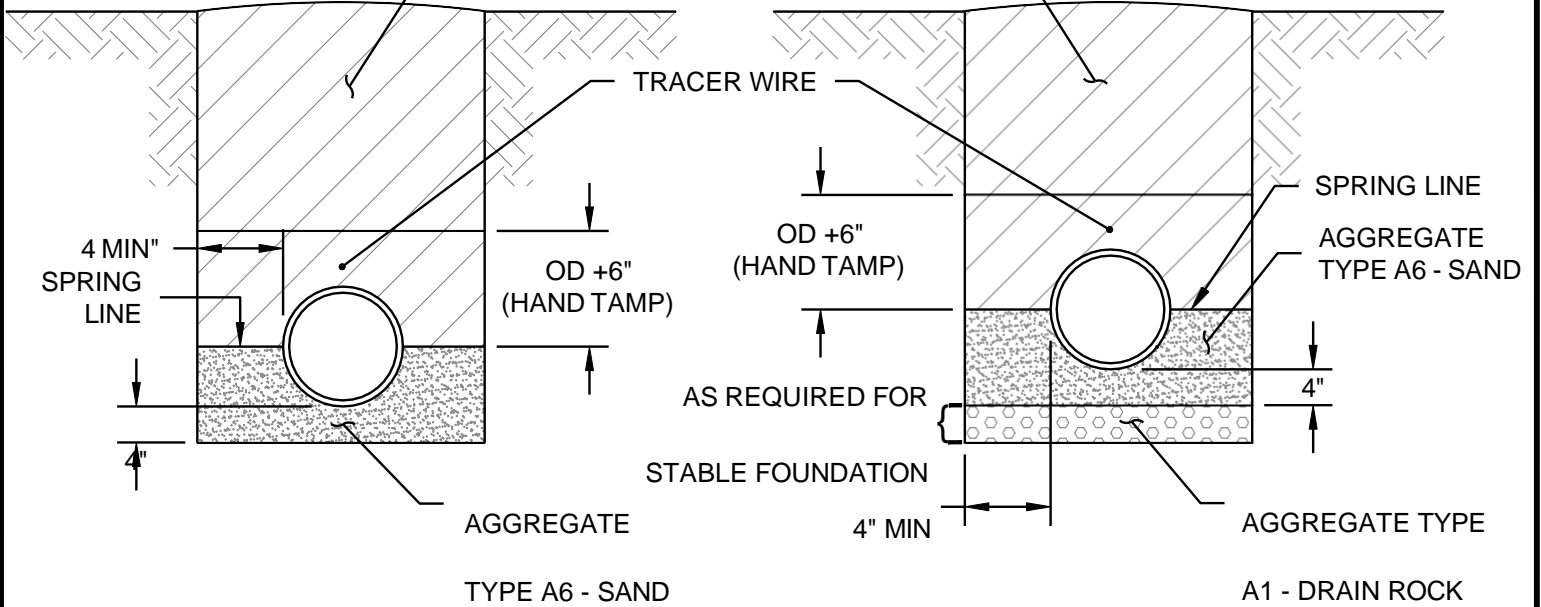
NG DESIGN MANUAL

EMBEDMENT  
DETAILS FOR  
SEWER LINES

A-58

SHEET No.

SOIL TYPE S2 - TYPE 1  
COMMON FILL COMPACTED TO  
95% STANDARD PROCTOR  
DENSITY IN 8" LOOSE LIFTS AT  
±3% OF OPTIMUM MOISTURE



**CLASS C BEDDING**

(USE UNDER NORMAL CONDITIONS)

**CLASS C BEDDING WITH FOUNDATION**

(USE WHEN DIRECTED BY ENGINEER)

NOTE:

1. PROVIDE 2"-3" GAP BETWEEN TRACER WIRE AND PIPE.
2. REFER TO SECTION 8 OF THE DESIGN STANDARDS FOR MATERIAL SPECIFICATIONS.

**EMBEDMENT DETAILS FOR WATER LINES**

NTS



INLETS  
OUTLETS  
AND PIPING

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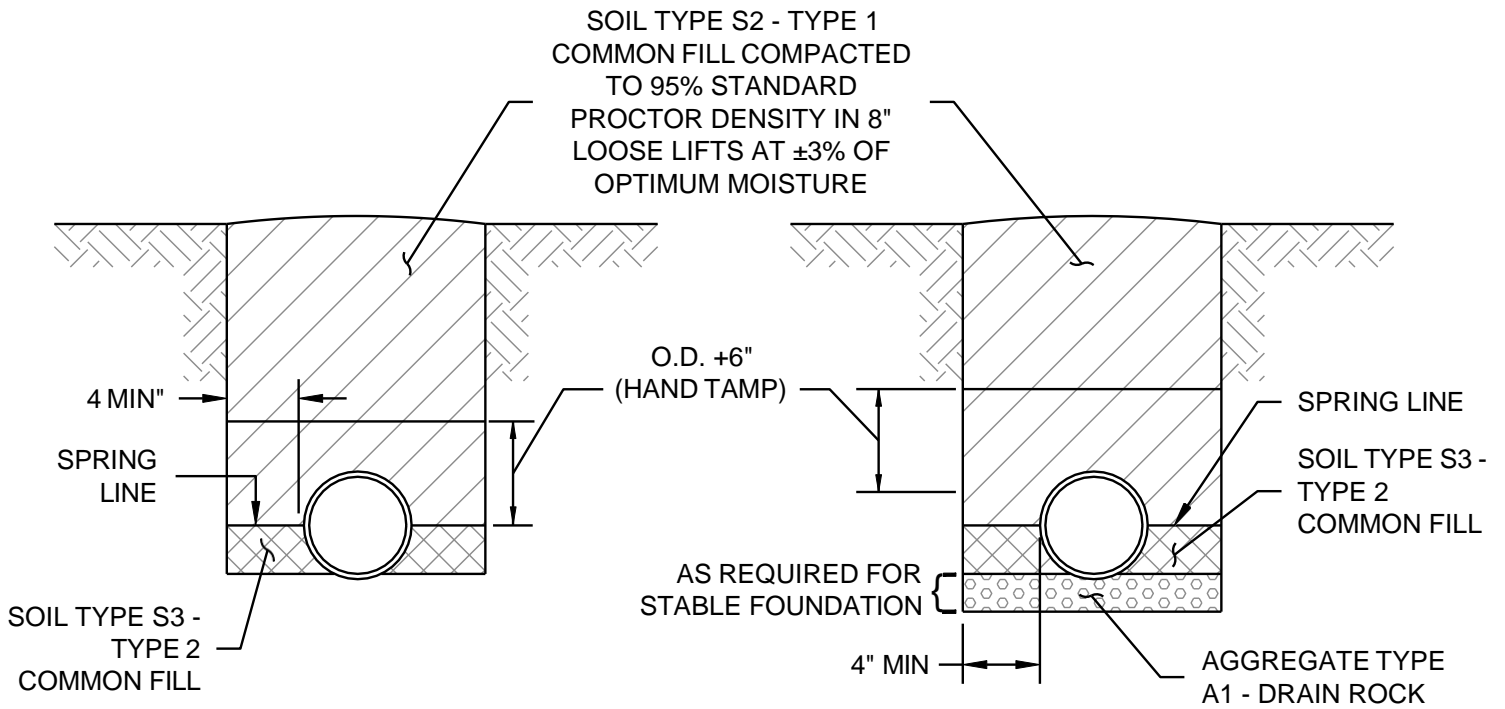
NG DESIGN MANUAL

EMBEDMENT  
DETAILS FOR  
WATER LINES

A-59

SHEET No.





**CLASS D BEDDING**  
 (USE UNDER NORMAL CONDITIONS)

**CLASS D BEDDING WITH FOUNDATION**  
 (USE WHEN DIRECTED BY ENGINEER)

**NOTE:**

REFER TO SECTION 8 OF THE DESIGN STANDARDS FOR MATERIAL SPECIFICATIONS.

**EMBEDMENT DETAILS FOR STORM DRAIN LINES**

NTS



INLETS  
 OUTLETS  
 AND PIPING

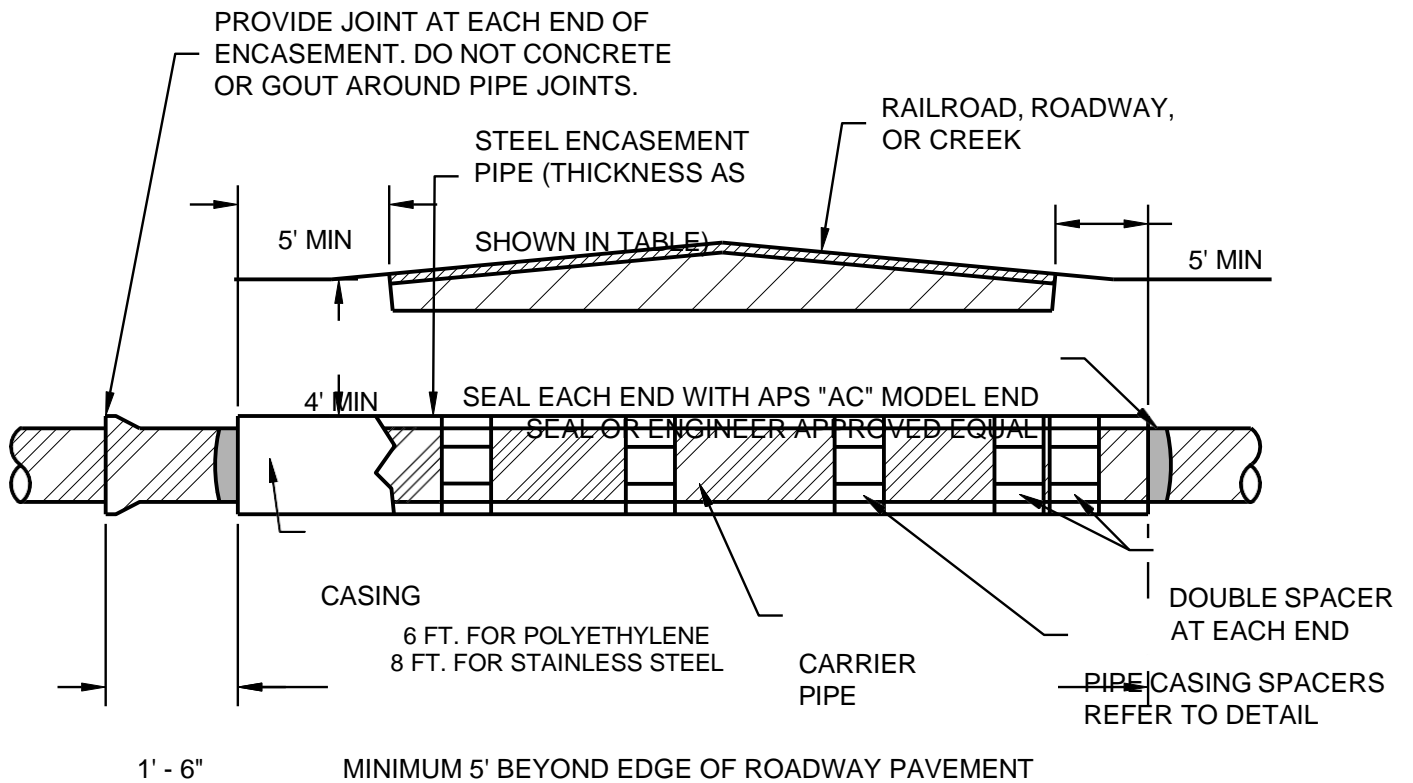
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ENGINEERING DESIGN  
 MANUAL

EMBEDMENT DETAILS  
 FOR STORM DRAIN  
 LINES

A-60

SHEET No.



CASING DIAMETER	WALL THICKNESS
<=12"	0.25"
13"-18"	0.3125"
19"-22"	0.375"
23"-28"	0.4375"
29"-34"	0.5011"
35" - 42"	0.5625"
43"-48"	0.625"

**NOTES:**

1. FOR SPLIT CASING APPLICATIONS, THE SEAM OF THE ENCASEMENT MUST BE COMPLETELY WELDED.
2. ALL CASINGS SHALL BE NEW STEEL PIPE HAVING A MINIMUM YIELD STRENGTH OF 35,000 PSI.
3. CASING SHALL MEET ASTM A36, ASTM A570, ASTM A135, ASTM A139 OR ENGINEER APPROVED EQUAL.
4. ALL CASING JOINTS SHALL BE WELDED IN ACCORDANCE WITH AWWA C206.
5. END SEALS SHALL BE ADVANCE PRODUCTS AND SYSTEMS, INC. MODEL AC OR ENGINEER APPROVED EQUAL.



**ENCASEMENT PIPE DETAIL**

INLETS  
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AND PIPING

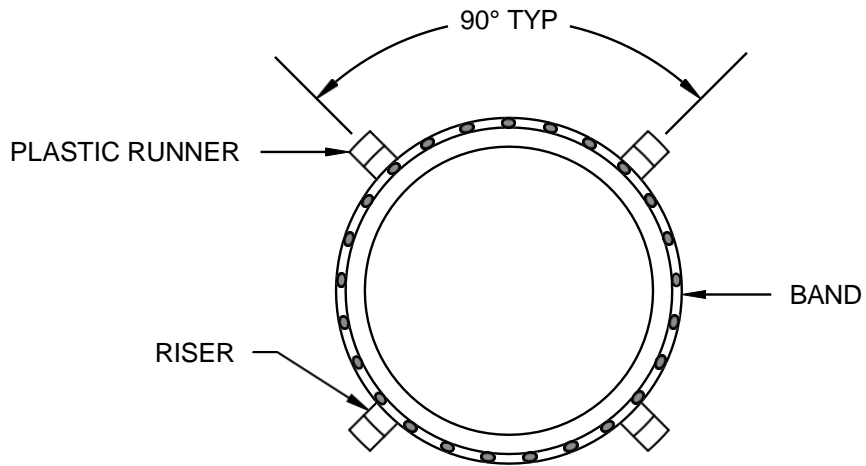
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ENGINEERING DESIGN MANUAL

ENCASEMENT  
PIPE

A-61

SHEET No.

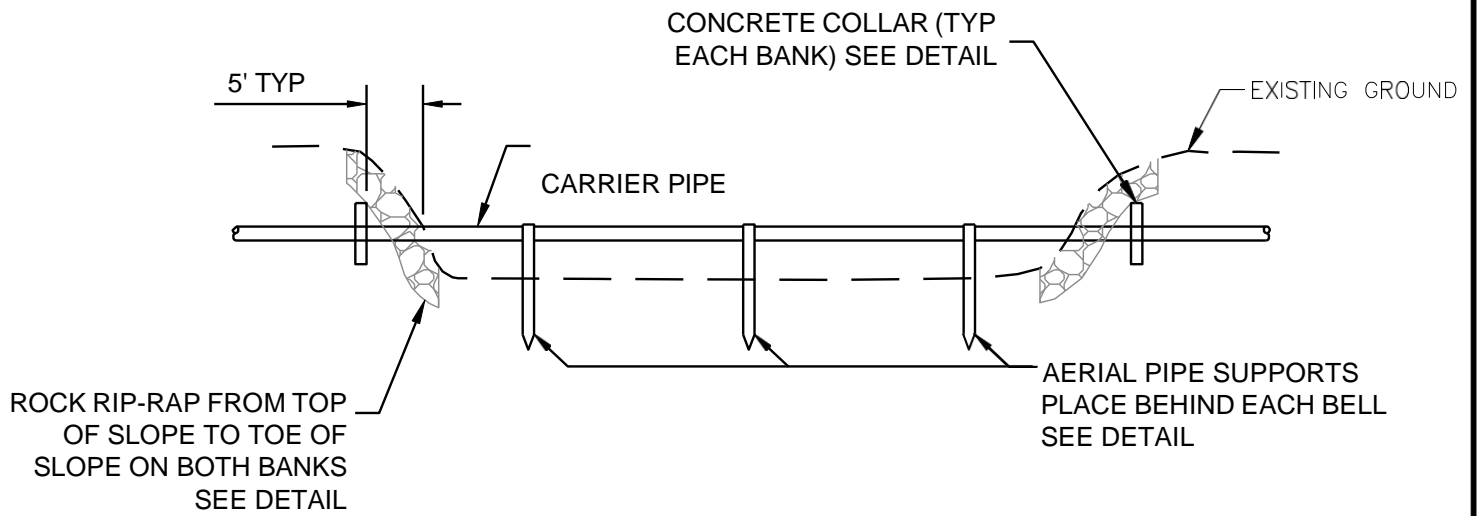


NOTE:

CASING SPACERS SHALL BE MANUFACTURED BY ADVANCE PRODUCTS AND SYSTEMS, INC. OR ENGINEER APPROVED EQUAL.

CASING SPACER DETAIL

NTS



## AERIAL CREEK CROSSING DETAIL



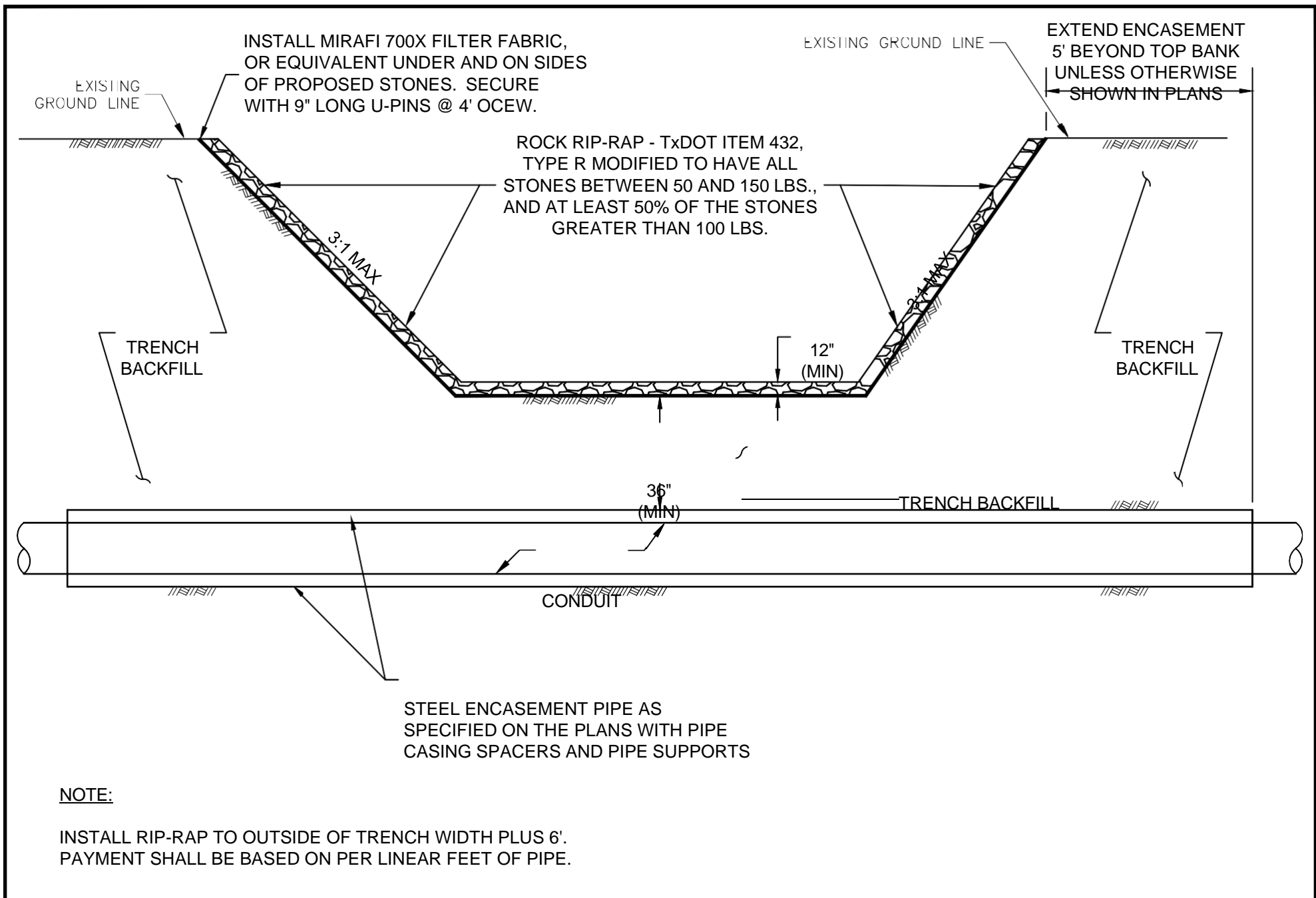
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RING DESIGN MANUAL

AERIAL CREEK  
CROSSING  
DETAIL

A-63

SHEET No.



## TYPICAL CREEK CROSSING DETAIL



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OUTLETS  
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ENGINEERING DESIGN MANUAL

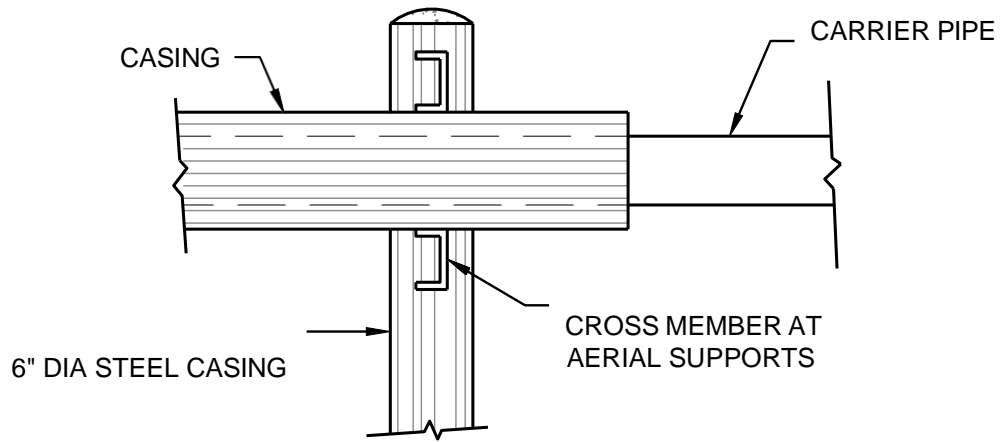
LATEST REVISION:

CREEK  
CROSSING  
DETAIL

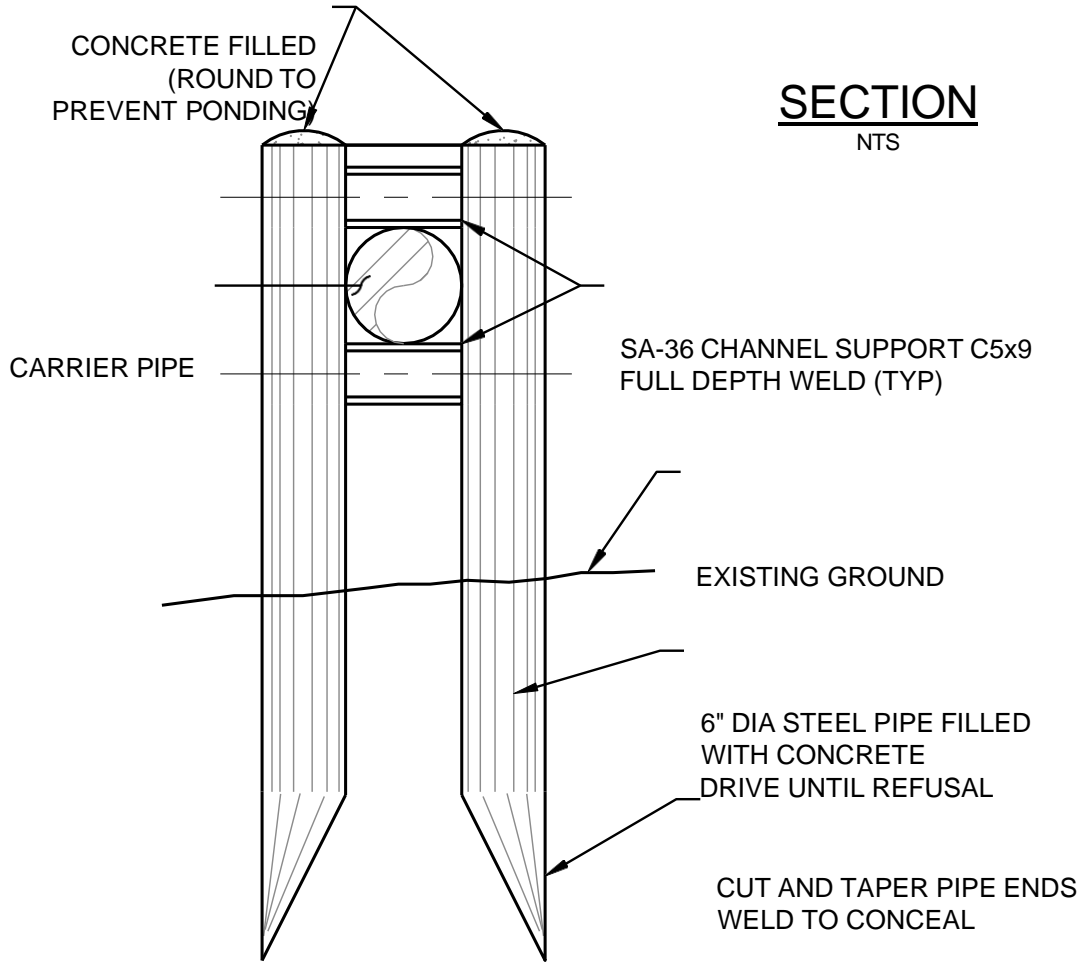
A-64

SHEET No.





**SECTION**  
NTS



**ELEVATION**  
NTS

NOTE:  
LOCATE SUPPORTS AT  
LOCATIONS SHOWN ON PLANS.



**AERIAL PIPE SUPPORT DETAILS**

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AND PIPING

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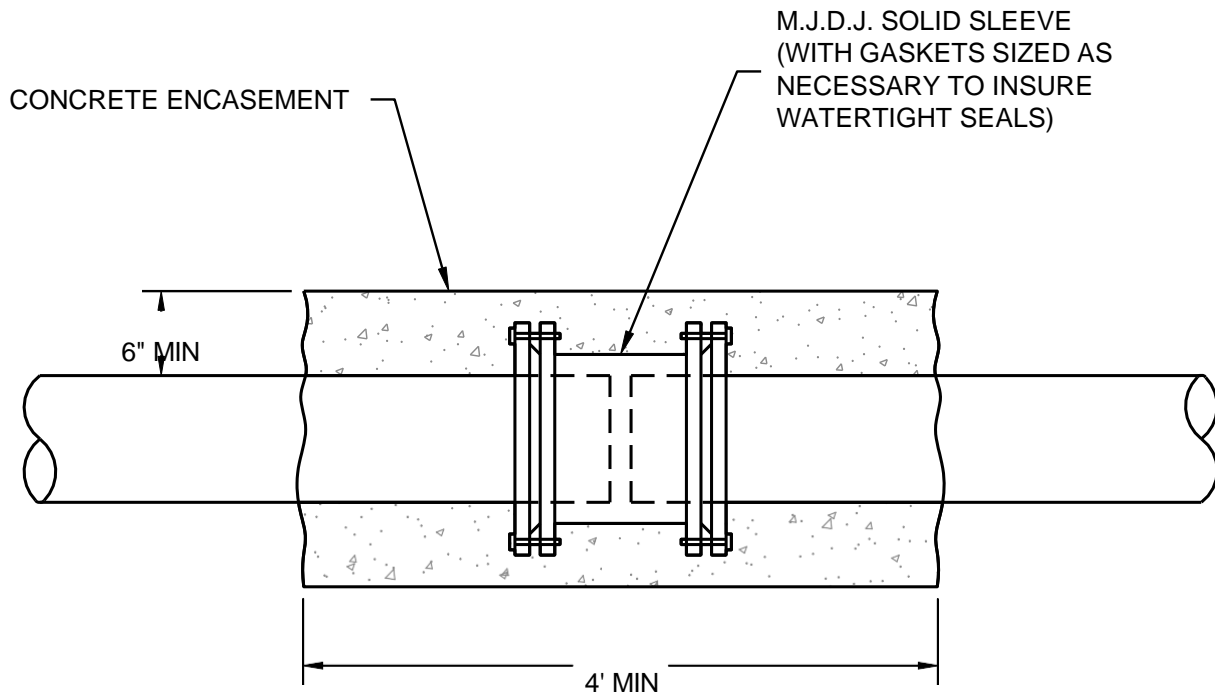
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ENGINEERING DESIGN  
MANUAL

AERIAL PIPE  
SUPPORT

A-65

SHEET No.



NOTES:

1. USE TRANSITION GASKETS BETWEEN PIPE TYPES WHEN POSSIBLE.
2. BLOCK PIPES CAREFULLY PRIOR TO CONCRETE ENCASEMENT TO INSURE ACCURATE PIPE ALIGNMENT.
3. COMPLETED JOINT MUST BE ABLE TO PASS MANDREL TESTING.

## PIPE TRANSITION COUPLING DETAIL

(USE WHERE DIFFERENT PIPE TYPES MUST BE JOINED)



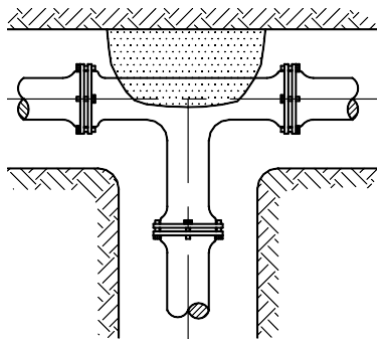
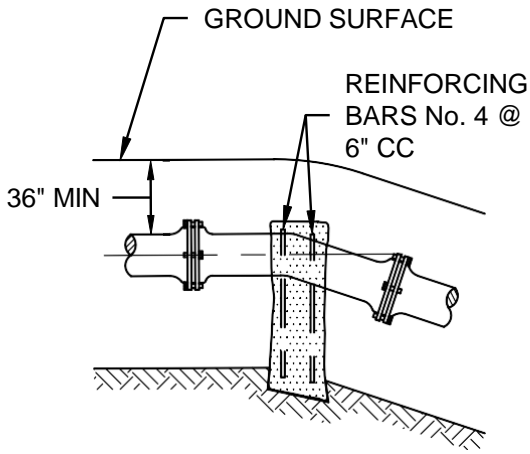
INLETS  
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ENGINEERING DESIGN  
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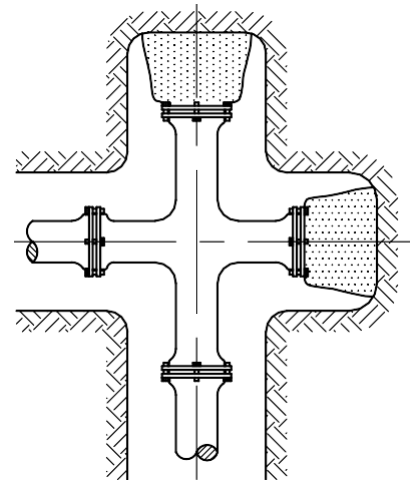
PIPE TRANSITION  
COUPLING

A-66

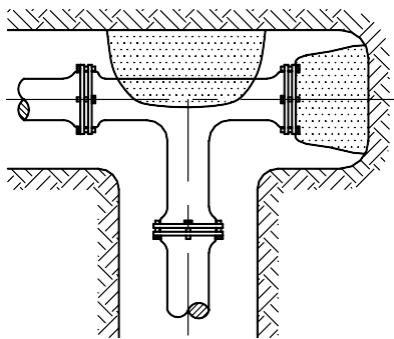
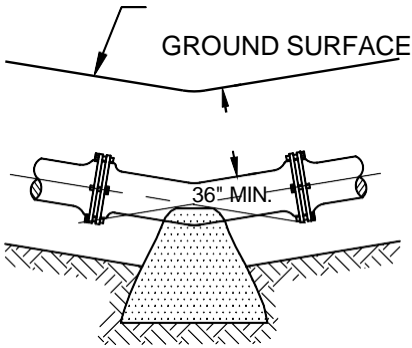
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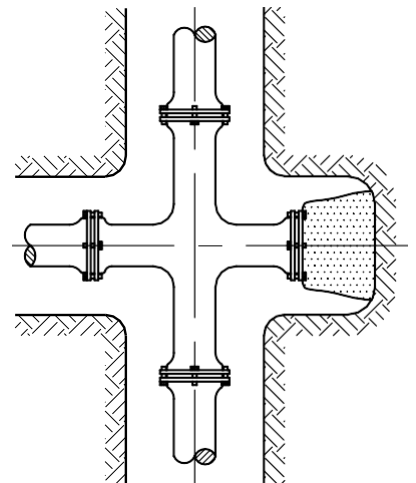
BLOCKING FOR TEE



TYPICAL SECTION OF CROSS & 2 PLUG

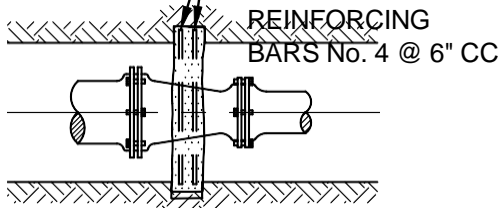
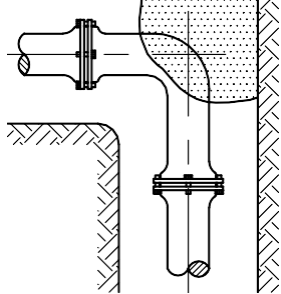


SPECIAL BLOCKING FOR TEE WITH PLUG (WHEN DIRECTED BY ENGINEER)



TYPICAL SECTION OF CROSS & BLOCKING (WHEN DIRECTED BY ENGINEER)

UNUSUAL BLOCKING FOR VERTICAL BENDS



TYPICAL BLOCKING FOR HORIZONTAL BENDS

THRUST SUPPORT FOR REDUCER CONNECTION  
(SIZE TO BE DETERMINED BY ENGINEER)



THRUST BLOCKING DETAILS

INLETS  
OUTLETS  
AND PIPING

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9/6/2023

ENGINEERING DESIGN  
MANUAL

THRUST BLOCKING  
SHEET 1

A-67

SHEET No.

PIPE SIZE	TEES & PLUGS	BENDS			REDUCERS		
	THRUST BLOCKING REQ'D. (SF)	90° THRUST BLOCKING REQ'D. (SF)	45° THRUST BLOCKING REQ'D. (SF)	22 1/2° THRUST BLOCKING REQ'D. (SF)	PIPE SIZE (IN.)	ANGLE (THETA)	THRUST BLOCKING REQ'D. (SF)
2 1/2"	0.61	0.43	0.23	0.12	4 - 3	8.2	0.05
3"	0.88	0.62	0.34	0.17	6 - 3	19.5	0.45
4"	1.57	1.11	0.60	0.31	6 - 4	12.8	0.22
6"	3.53	2.50	1.35	0.69	8 - 6	10.5	0.25
8"	6.28	4.44	2.40	1.23	10 - 8	9.6	0.30
10"	9.82	6.94	3.76	1.92	12 - 10	8.2	0.31
12"	14.14	10.00	5.41	2.76	14 - 12	7.2	0.32
14"	19.24	13.61	7.36	3.75	18 - 12	18.4	2.83
16"	25.13	17.77	9.62	4.90	20 - 14	17.5	3.04
18"	31.81	22.49	12.17	6.21	20 - 16	11.5	1.42
20"	39.27	27.77	15.03	7.66	24 - 18	14.5	3.12
24"	56.55	39.99	21.64	11.03	24 - 20	9.6	1.44
30"	88.36	62.48	33.81	17.24	30 - 20	19.5	8.30
36"	127.23	89.97	48.69	24.82	30 - 24	11.5	3.20

NOTES ON THRUST BLOCKING

ALL BLOCKING SHALL BE AGAINST UNDISTURBED HAND DUG SOIL AND SHALL BE CONCRETE HAVING:

1. A MINIMUM 28 DAY STRENGTH OF 2000 LBS. PER SQUARE INCH. THRUST CALCULATIONS TO BE BASED ON THRUST DUE TO WATER PRESSURE AT 100% OF TEST.
2. PRESSURE. THRUST = 2 AP SIN 1/2 Ø. WHERE A = AREA OF PIPE; P = WATER PRESSURE; Ø = DEFLECTION ANGLE.
3. VERTICAL UPLIFT BLOCKS SHALL BE DESIGNED ON THE BASIS OF 150 LBS. PER CU. FT. FOR CONCRETE AND SOIL AT 120 LBS. PER CU. FT. OVER THE AREA OF BLOCK.
4. VERTICAL DOWN THRUST BLOCKS SHALL BE DESIGNED ON THE BASIS OF 3500 LBS. PER SQ. FT. ALLOWABLE SOIL BEARING PRESSURE. DIMENSIONS MAY BE DECREASED WITH APPROVAL OF THE CITY ENGINEER OF MEASURED SOIL CONDITIONS PERMIT. IN POOR SOIL CONDITIONS, BLOCK DIMENSIONS SHALL BE INCREASED IN PROPORTION TO ALLOWABLE BEARING VALUE.
5. THRUST BLOCKS ON HORIZONTAL BENDS, TEES, CROSSES, AND REDUCERS SHALL BE SIZED BASED ON 2400 LBS. PER SQ. FT. OF BLOCKING SURFACE AREA IN CONTACT WITH UNDISTURBED SOIL, BLOCK DIMENSIONS MAY BE DECREASED WITH APPROVAL OF THE ENGINEER IF MEASURED SOIL CONDITIONS PERMIT. IN POOR SOIL CONDITIONS, BLOCK DIMENSIONS SHALL BE INCREASED IN PROPORTION TO THE ALLOWABLE BEARING VALUE.
6. ALL BLOCKING SHALL HAVE A MINIMUM SOIL COVER OF 1 FT.
7. ADDITIONAL REINFORCING MAY BE REQUIRED FOR HORIZONTAL BLOCKING TO HANDLE UNUSUAL SHEAR LOADING CONDITIONS.
8. ANCHOR COLLARS SHALL BE REINFORCED IN ACCORDANCE WITH REINFORCING BAR SCHEDULE FOR REDUCER BLOCKS SHOWN ABOVE. STEEL ANCHOR RING IN ACCORDANCE WITH DIMENSIONS OF ANCHOR COLLAR.
9. WRAP ALL FITTINGS AND BOLTS WITH 8 MIL POLYWRAP PRIOR TO PLACING CONCRETE BLOCKING.

THRUST BLOCKING DETAILS

N.T.S.



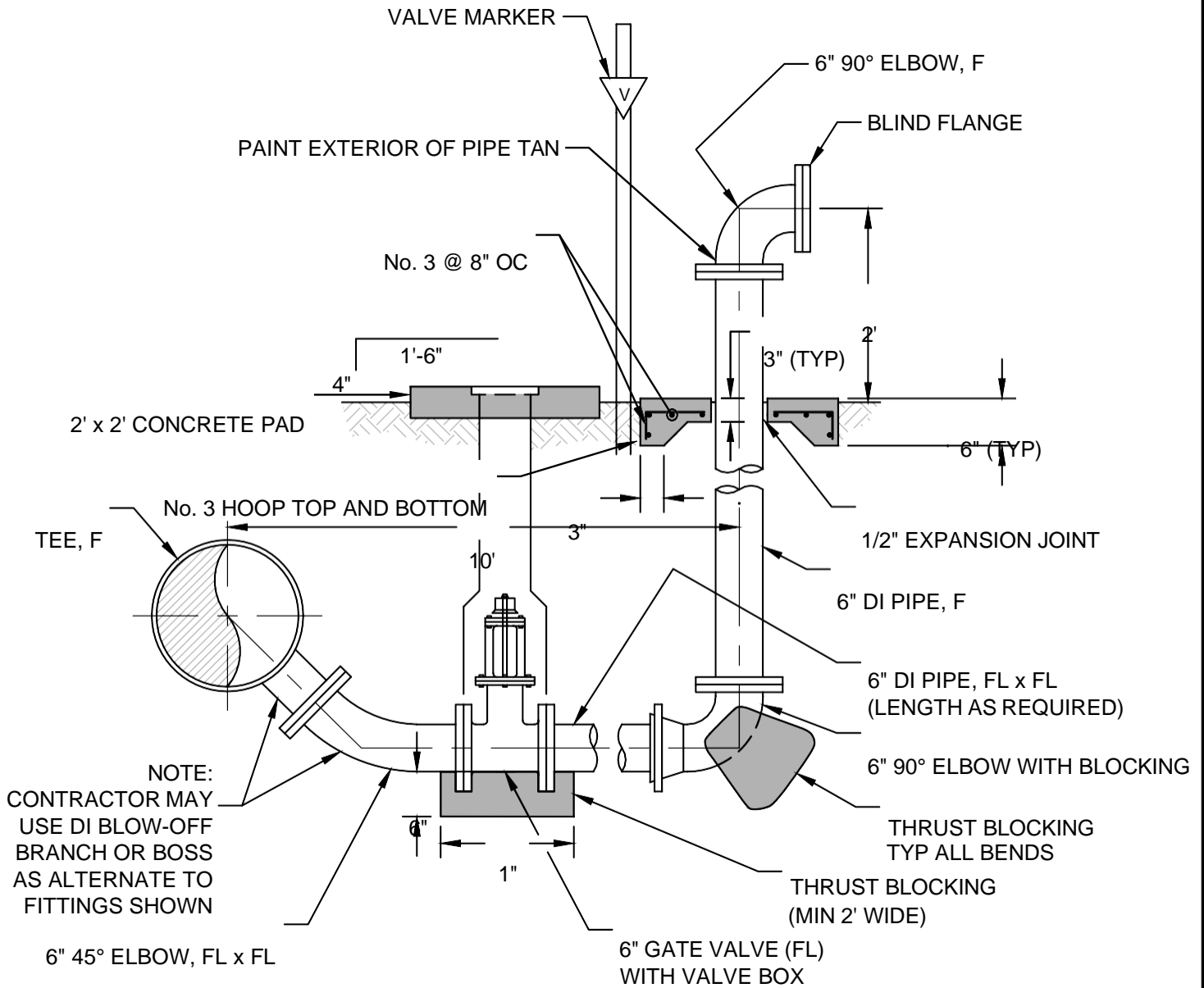
INLETS  
OUTLETS  
AND PIPING  
  
LATEST  
REVISION:  
9/6/2023

ENGINEERING DESIGN  
MANUAL

THRUST BLOCKING  
SHEET 2

A-68

SHEET No.



## 6" FLUSH VALVE DETAIL

NTS



INLETS  
OUTLETS  
AND PIPING

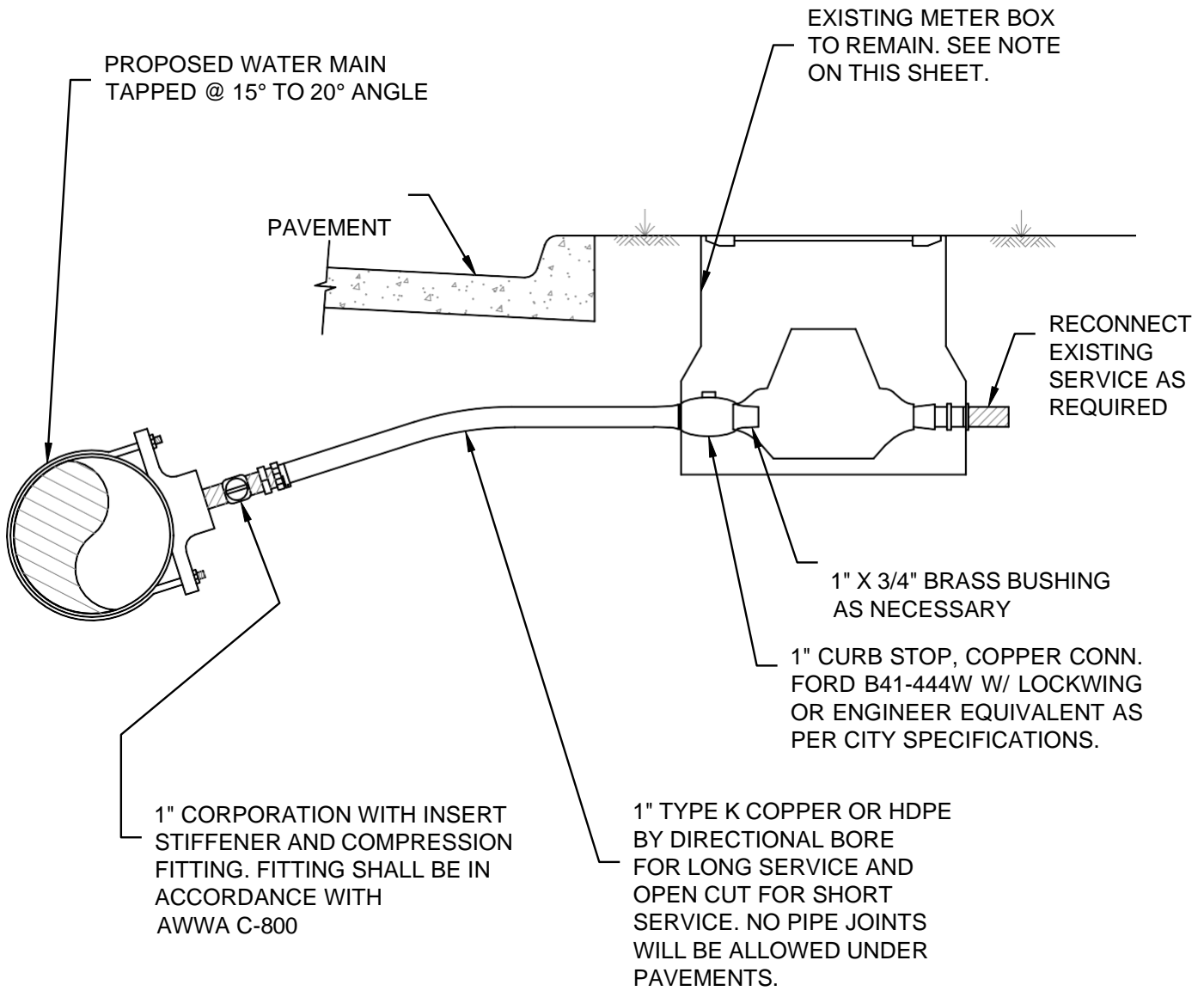
ENGINEERING DESIGN  
MANUAL

FLUSH VALVE DETAIL

A-69

LATEST  
REVISION:  
9/6/2023

SHEET No.



**WATER SERVICE - 1" LINE**

NTS



INLETS  
OUTLETS  
AND PIPING

LATEST  
REVISION:

ENGINEERING DESIGN  
MANUAL

WATER SERVICE

A-70

9/6/2023

SHEET No.



1" MIN

PC

FH

R.O.W.

1'-0"

PLAN VIEW

N.T.S.

24"  
SQUARE

FINISH GRADE AT  
HYDRANT

6" THICK SLAB FOR VALVE IN  
UNSURFACED OR ASPHALT AREAS

2" MIN  
6" MAX

MIN 7 CUBIC FEET OF  
WASHED GRAVEL OR  
CLEAN STONE FILL

6" ANCHOR COUPLING OR MJ  
RESTRAINERS (MEGALUG OR ENGINEER  
APPROVED EQUAL

6" ANCHOR COUPLING OR MJ  
RESTRAINERS (MEGALUG OR  
ENGINEER APPROVED EQUAL)

MJ x MJ TEE

MJ GATE  
VALVE

MJ HYDRANT

VARIABLE

THRUST BLOCK MUST NOT  
BLOCK WEEP HOLE

THRUST BLOCK

THRUST BLOCK

## FIRE HYDRANT INSTALLATION

INLETS  
OUTLETS  
AND PIPING

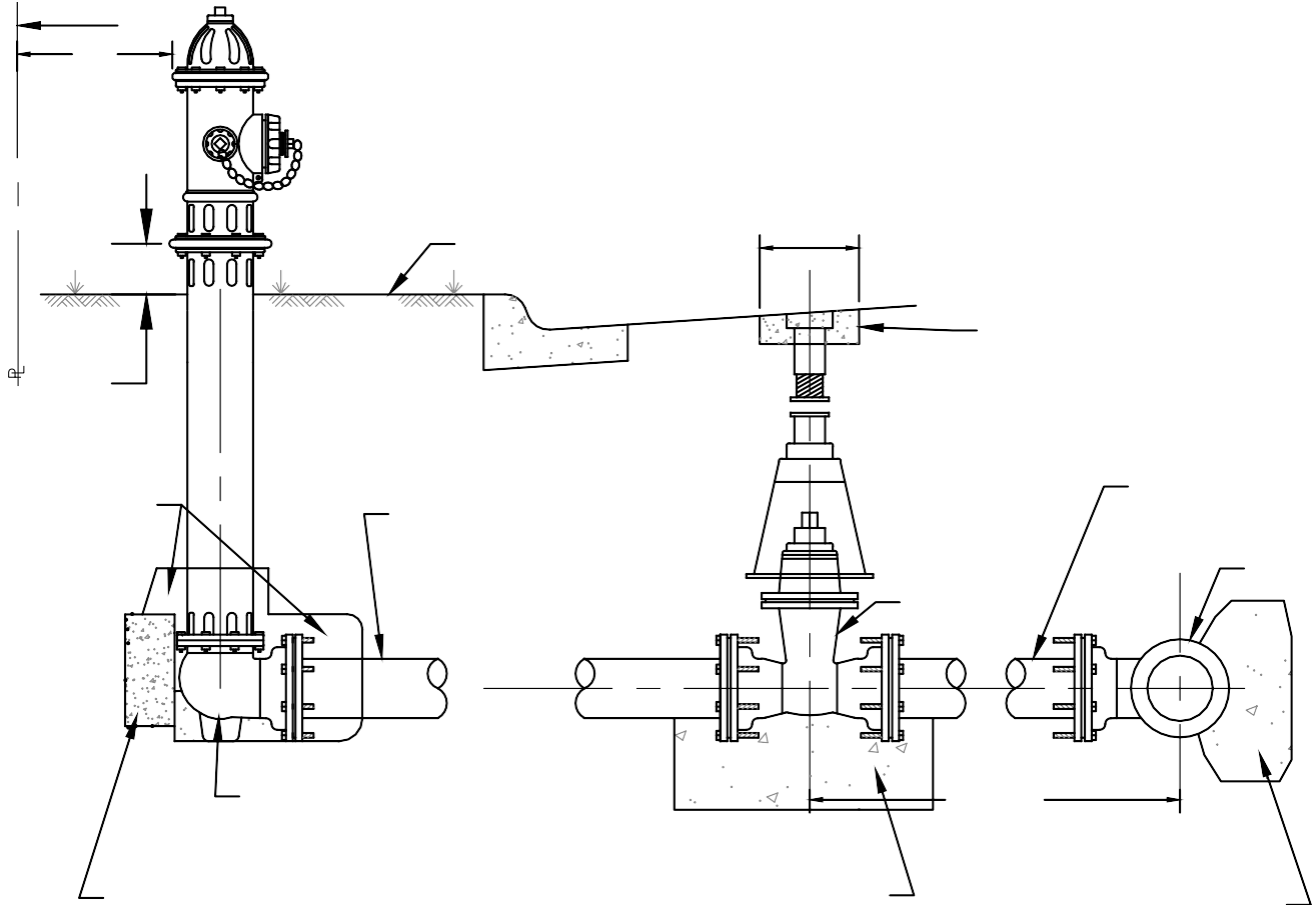
# ENGINEERING DESIGN MANUAL

LATEST  
REVISION:  
9/6/2023

## FIRE HYDRANT DETAIL

A-71

SHEET No.



NOTES:

1. IN GENERAL, ALL FIRE HYDRANTS SHALL CONFORM TO AWWA STANDARD SPECIFICATIONS FOR FIRE HYDRANT FOR ORDINARY WATER WORKS SERVICE, C-502.
2. ACTUAL VALVE LOCATION WILL DEPEND ON LOCATION OF WATER MAIN.
3. F.H. NO CLOSER THAN 18" TO EXISTING OR PROPOSED SIDEWALKS. (USUAL)
4. STANDARD BURY DEPTH 4'.
5. SET FIRE HYDRANT ON THE LOT LINE EXTENDED WHEN POSSIBLE.
6. FIRE HYDRANT SHALL BE LOCATED MINIMUM 1 FT. OUTSIDE OF THE AREA BETWEEN THE P.C.'S OF THE CORNER TURNING RADII AT INTERSECTIONS. (SEE PLAN VIEW THIS DETAIL)
7. FIRE HYDRANTS SHALL BE RED IN COLOR.
8. DRAINAGE BED SHALL CONSIST OF AGGREGATE TYPE A1 (REFER TO SECTION 8.5 OF DESIGN STANDARDS) - DRAIN ROCK WITH A MIN. VOLUME OF 7 CU. FT. DRAIN BED SHALL EXTEND A MIN. ABOVE DRAIN OUTLET.
9. USE 6" D.I. NIPPLE W/M.J. RETAINER GLANDS IF DISTANCE BETWEEN VALVE & FIRE HYDRANT MUST BE GREATER THAN 17".
10. FIRE HYDRANT TO BE BLOCKED AGAINST FIRM SOIL AS SHOWN,
11. ALL FIRE HYDRANTS SHALL BE INSTALLED PLUMB.
12. LARGE NOZZLE FACES ROAD, UNLESS OTHERWISE NOTED. ROTATE BARREL AS REQUIRED.
13. HYDRANT SHOULD NOT BE SET CLOSER THAN 4' TO OBSTRUCTIONS THAT ARE IN LINE WITH NOZZLE.
14. M.J. ANCHOR TEE FOR 16" AND SMALLER. WHEN USING REGULAR M.J. TEE USE 13" ADAPTER NIPPLE BETWEEN TEE AND VALVE.
15. HYDRANTS SHALL BE PROVIDED WITH A STANDARD 4 1/2" PUMPER NOZZLE.
16. FIRE HYDRANTS SHALL BE AS MANUFACTURED BY AMERICAN DARLING UNLESS APPROVED IN WRITING BY CITY PRIOR TO INSTALLATION.
17. INSTALL (1) 6" MJ 90° BEND IF SHOWN ON PLANS TO REDIRECT THE HYDRANT LEAD.

FIRE HYDRANT INSTALLATION NOTES



INLETS  
OUTLETS  
AND PIPING

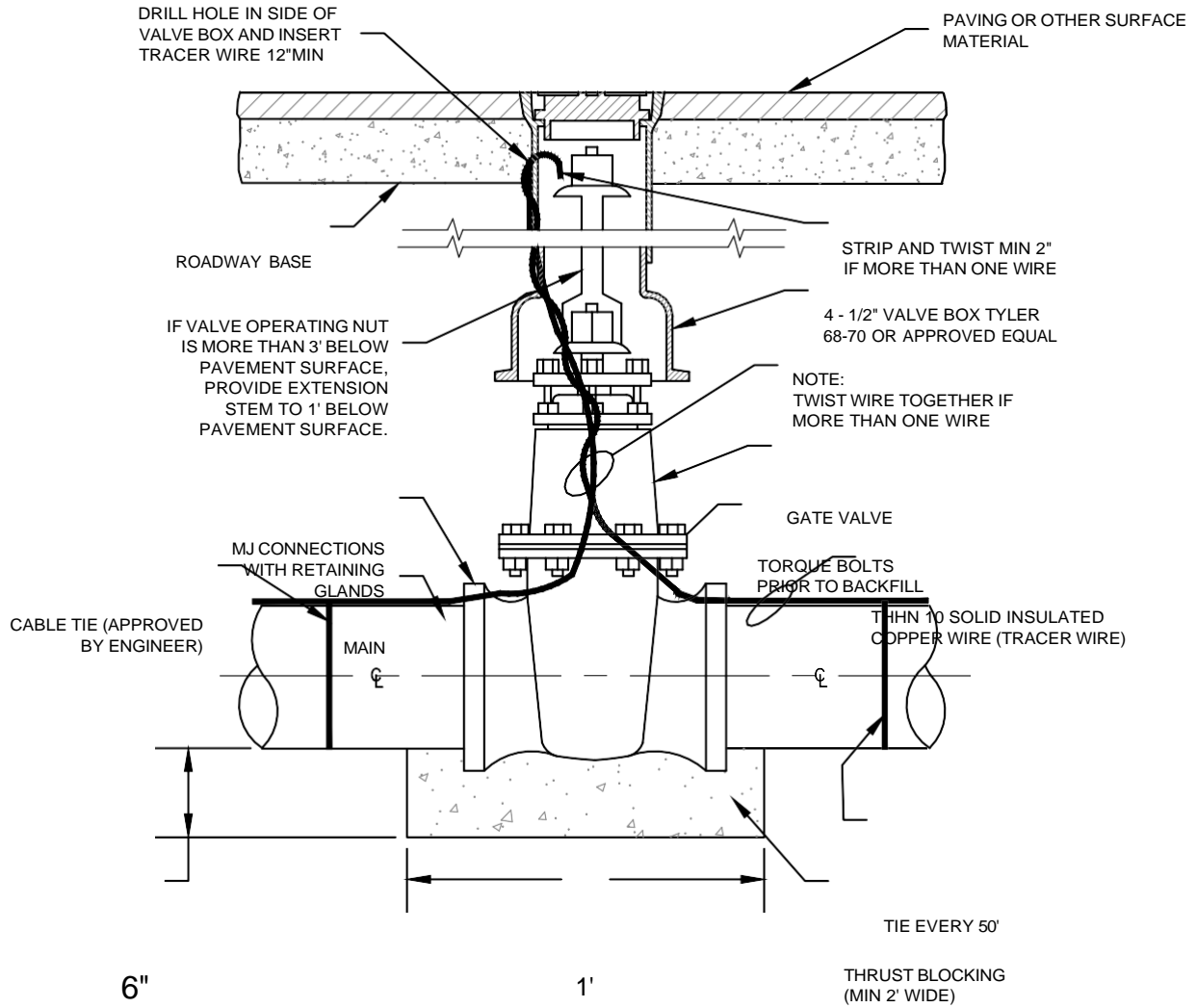
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MANUAL

FIRE HYDRANT NOTES

A-72

SHEET No.



**NOTE:**

IN UNPAVED AREAS, INSTALL 2' x 2' x 6" CONCRETE VALVE PAD FLUSH WITH THE TOP OF VALVE BOX. REINFORCE WITH No. 3 BARS 6" OC BOTH WAYS.



**GATE VALVE BOX AND EXTENSION STEM  
W/TRACER WIRE**

INLETS  
OUTLETS  
AND PIPING

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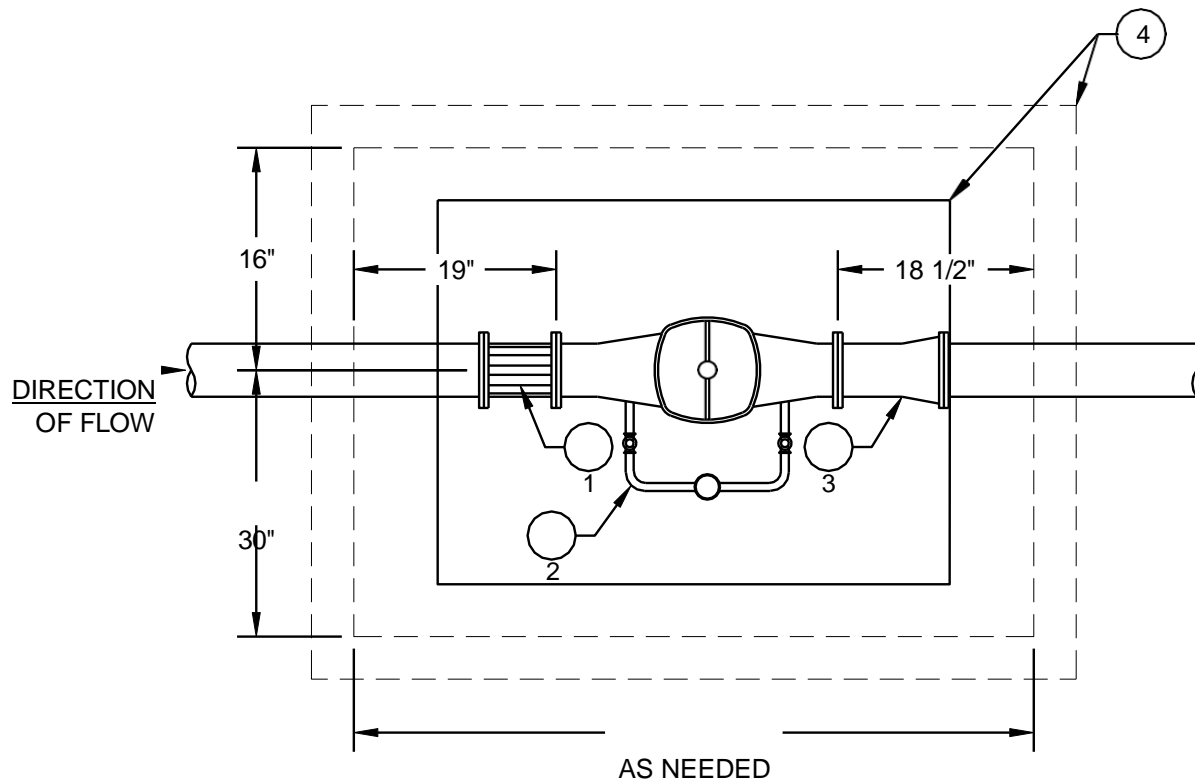
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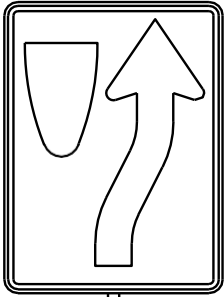
GATE VALVE BOX AND  
EXTENSION STEM WITH  
TRACER WIRE

**A-73**

SHEET No.

MATERIAL LIST		
PART No.	QUANTITY	DESCRIPTION
①	1 EA	FLANGED COUPLING METER ADAPTER
②	1 EA	DETECTOR CHECK VALVE WITH 5/8" BY-PASS METER
③	1 EA	12" LONG DUCTILE IRON NIPPLE MJ x FL
④	1 EA	PRECAST METER VAULT
	1 EA	VAULT FLOOR (NOT SHOWN)
	1 EA	36" x 48" ACCESS HATCH (SOLID LINE)





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TYPICAL EXAMPLES

DEPARTMENT MATERIAL SPECIFICATIONS

PLYWOOD SIGN BLANKS  
ALUMINUM SIGN BLANKS

DMS-7100  
DMS-7110

SQUARE FT.	MIN. THICKNESS
LESS THAN 7.5	0.080
7.5 to 15	0.100
GREATER THAN 15	0.125

FLAT SURFACE REFLECTIVE SHEETING DMS-8300  
VINYL NON-REFLECTIVE DECAL SHEETING DMS-8320

USAGE	COLOR	SIGN SHEETING
BACKGROUND	ALL	TYPE C (HIGH SPECIFIC INTENSITY)
LEGEND & BORDERS	WHITE	TYPE C (HIGH SPECIFIC INTENSITY)
LEGEND & BORDERS	BLACK	VINYL NON-REFLECTIVE DECAL SHEETING

REQUIREMENTS FOR REGULATORY SIGNS

NOTE:  
SPEED LIMIT INSIDE CITY 30 MPH UNLESS  
OTHERWISE APPROVED BY CITY.

GENERAL NOTES:

1. SIGNS TO BE FURNISHED, SHOULD BE AS DETAILED ELSEWHERE IN THE PLANS AND/OR AS SHOWN ON SIGN TABULATION SHEET. STANDARD SIGN DESIGNS AND ARROW DIMENSIONS CAN BE FOUND IN THE "STANDARD HIGHWAY SIGN DESIGNS FOR TEXAS" (SHSD).
2. REGULATORY SIGN LEGENDS SHALL USE THE FEDERAL HIGHWAY ADMINISTRATION (FHWA) STANDARD HIGHWAY ALPHABETS (B, C, D, E, EMOD OR F).
3. LATERAL SPACING BETWEEN LETTERS AND NUMERALS SHALL CONFORM WITH THE SHSD, AND ANY APPROVED CHANGES THERETO. LATERAL SPACING OF LEGENDS SHALL PROVIDE A BALANCED APPEARANCE WHEN SPACING IS NOT SHOWN.
4. REFER TO SIGN LOCATION DETAIL FOR SIGN HEIGHT REQUIREMENTS.
5. BLACK LEGEND SHALL BE APPLIED BY SCREENING PROCESS OR CUT-OUT VINYL NON-REFLECTIVE DECAL SHEETING TO WHITE BACKGROUND SHEETING, OR COMBINATION THEREOF.
6. WHITE LEGENDS SHALL BE APPLIED BY SCREENING PROCESS WITH TRANSPARENT COLORED INK, TRANSPARENT COLORED OVERLAY FILM TO WHITE BACKGROUND SHEETING OR CUT-OUT WHITE SHEETING TO COLORED BACKGROUND SHEETING, OR COMBINATION THEREOF.
7. COLORED LEGENDS SHALL BE APPLIED BY SCREENING PROCESS WITH TRANSPARENT COLORED INK, TRANSPARENT COLORED OVERLAY FILM OR COLORED SHEETING TO WHITE BACKGROUND SHEETING, OR COMBINATION THEREOF.
8. SIGN SUBSTRATE SHALL BE ANY MATERIAL THAT MEETS THE DEPARTMENT MATERIAL SPECIFICATION REQUIREMENTS FOR PERMANENT SIGN SUBSTRATES.

REQUIREMENTS FOR REGULATORY SIGNS



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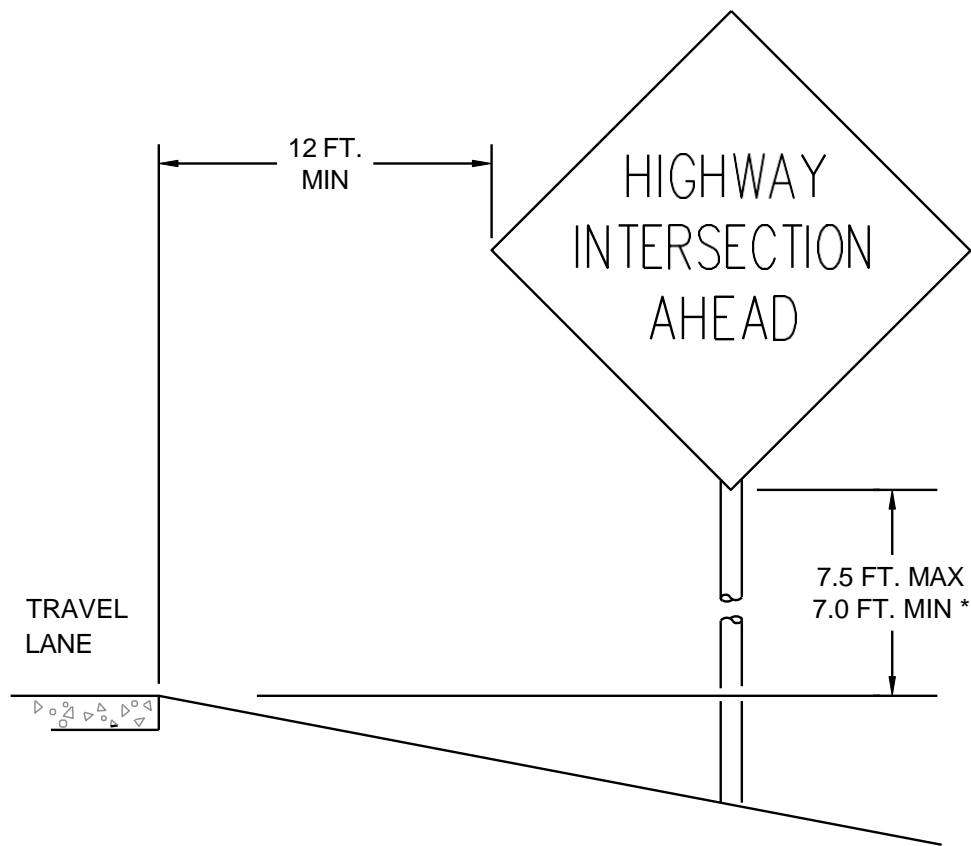
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REGULATORY SIGN  
SHEET 2

A-76

SHEET No.





## SHOULDER LESS THAN 6 FT. WIDE

WHEN THE SHOULDER IS 6 FT. OR LESS IN WIDTH,  
THE SIGN MUST BE PLACED AT LEAST 12 FT. FROM  
THE EDGE OF THE TRAVEL LANE.

\* SIGNS SHALL BE MOUNTED USING THE FOLLOWING CONDITION  
THAT RESULTS IN THE GREATEST SIGN ELEVATION:

1. A MINIMUM OF 7 TO A MAXIMUM OF 7.5 FEET ABOVE THE EDGE OF THE TRAVEL LANE OR
2. A MINIMUM OF 7 TO A MAXIMUM OF 7.5 FEET ABOVE THE GRADE AT THE BASE OF THE  
SUPPORT WHEN SIGN IS INSTALLED ON THE BACKSLOPE

## SIGN LOCATION



SIGNAGE

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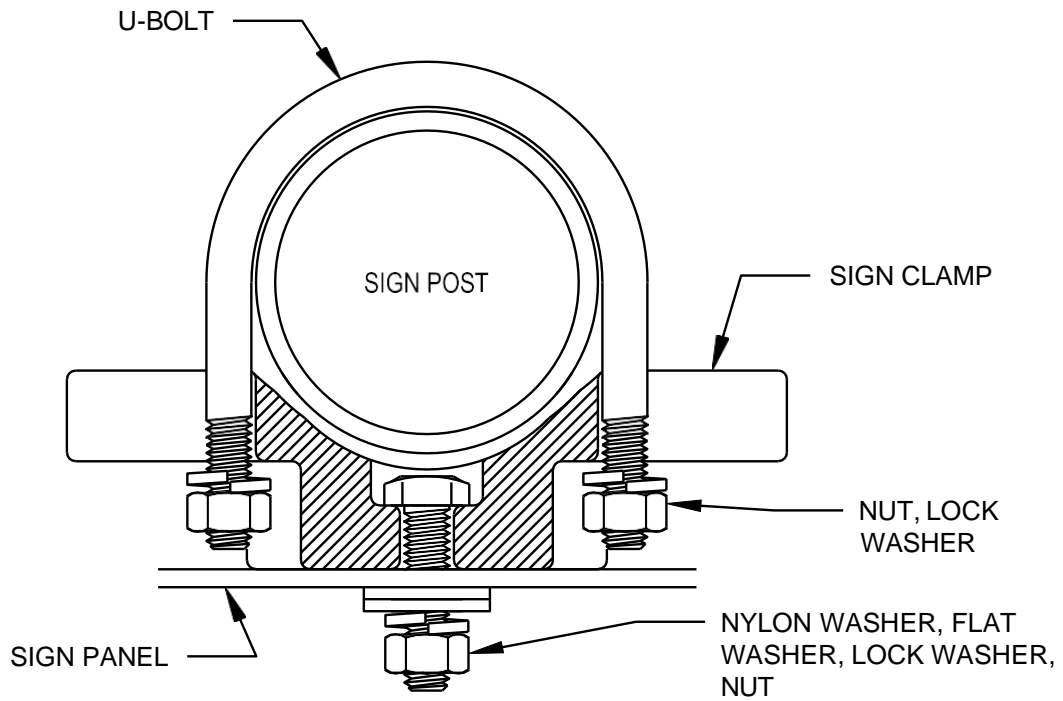
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SIGN LOCATION

A-77

SHEET No.

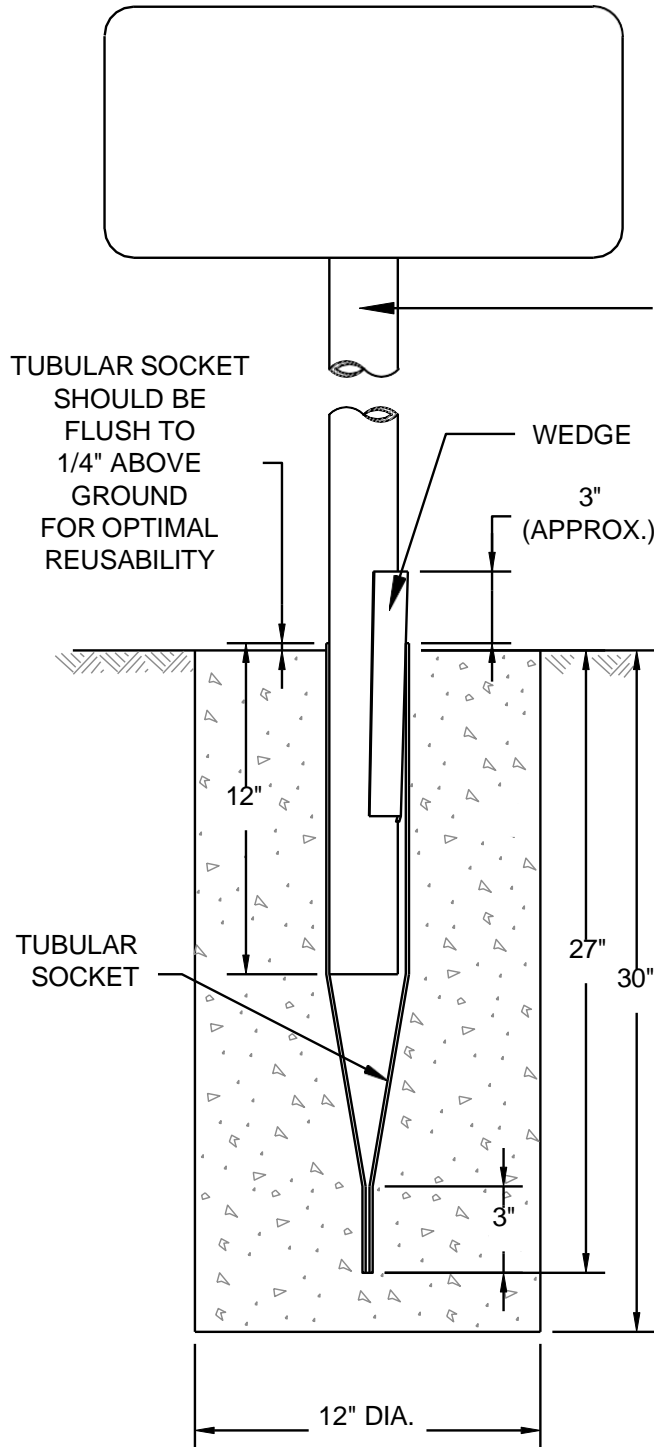


BOLTS USED TO MOUNT SIGN PANELS TO THE CLAMP ARE 5/16-18 UNC GALVANIZED SQUARE HEAD WITH NUT, NYLON WASHER, FLAT WASHER AND LOCK WASHER. THE BOLT LENGTH IS 1 INCH FOR ALUMINUM AND 1 3/4 INCH FOR PLYWOOD SIGNS.

SIGN CLAMPS MAY BE EITHER THE SPECIFIED SIZE CLAMP OR THE UNIVERSAL CLAMP.

**TYPICAL SIGN ATTACHMENT DETAIL**  
SINGLE SIGNS

PIPE DIAMETER	APPROXIMATE BOLT LENGTH	
	SPECIFIC CLAMP	UNIVERSAL CLAMP
2" NOMINAL	3"	3 OR 3 1/2"
2 1/2" NOMINAL	3 OR 3 1/2"	3 1/2" OR 4"
3" NOMINAL	3 1/2" OR 4"	4 1/2"



MATERIAL USED AS POST WITH THIS SYSTEM SHALL CONFORM TO THE FOLLOWING SPECIFICATIONS:

- 13 BWG TUBING (2.375" OUTSIDE DIAMETER)
- SEAMLESS OR ELECTRIC-RESISTANCE WELDED STEEL TUBING
- STEEL SHALL BE HSLAS GR 55 PER ASTM, A1011, OR ASTM A1008
- OTHER STEELS MAY BE USED IF THEY MEET THE FOLLOWING:
  - 55,000 PSI MINIMUM YIELD STRENGTH
  - 70,000 PSI MINIMUM TENSILE STRENGTH
- WALL THICKNESS (UNCOATED) SHALL BE WITHIN THE RANGE OF 0.083" TO 0.099"
- OUTSIDE DIAMETER (UNCOATED) SHALL BE WITHIN THE RANGE OF 2.369" TO 2.381"
- GALVANIZATION PER ASTM 123 OR ASTM A653 G210. FOR PRECOATED STEEL TUBING (ASTM A653), RECOAT TUBE OUTSIDE DIAMETER WELD SEAM BY METALLIZING WITH ZINC WIRE PER ASTM B833.

**TUBULAR SOCKET:**

- TUBULAR SOCKET PREFABRICATED FROM 12 BWG SEAMLESS OR ELECTRIC-RESISTANCE WELDED STEEL TUBING 2.875" OUTSIDE DIA. X 0.109" NOMINAL WALL THICKNESS.
- STEEL SHALL BE HSLAS GR. 55 PER ASTM A1011 OR ASTM A1008.
- OTHER STEEL MAY BE USED IF THEY MEET THE FOLLOWING:
  - 55,000 PSI MIN. YIELD STRENGTH
  - 70,000 PSI MIN. TENSILE STRENGTH
  - 20% MIN. ELONGATION IN 2"
  - WALL THICKNESS UNCOATED SHALL BE WITHIN 0.097 - 0.0113".
- GALVANIZE PER ASTM 123 AFTER FABRICATION, OR PER ASTM A653 G210.
- FOR PRECOATED STEEL (ASTM A653), RECOAT TUBE OUTSIDE DIAMETER.
- WELD SEAM BY METALIZING WITH ZINC WIRE PER ASTM B833.

SM RD SGN ASSM TY A  
**WEDGE ANCHOR SYSTEM**  
 TO BE USED FOR MOUNTING  
 NEW SIGNS AND RELOCATED SIGNS



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WEDGE ANCHOR  
 SYSTEM SHEET 1

A-79

SHEET No.

WEDGE ANCHOR SYSTEM INSTALLATION PROCEDURE:

1. DIG FOUNDATION HOLE. WHERE SOLID ROCK IS ENCOUNTERED AT GROUND LEVEL, THE FOUNDATION SHALL BE A MINIMUM DEPTH OF 18". WHEN SOLID ROCK IS ENCOUNTERED BELOW GROUND LEVEL, THE FOUNDATION SHALL EXTEND IN THE SOLID ROCK A MINIMUM DEPTH OF 18" OR PROVIDE A MINIMUM FOUNDATION DEPTH OF 30". IF SOLID ROCK IS ENCOUNTERED, THE SOCKET/STUB MAY BE REDUCED IN LENGTH AS REQUIRED TO A MINIMUM BOTTOM AND THE CLEARANCE REQUIREMENTS GIVEN MUST BE FOLLOWED. THE INNER SURFACES OF THE SOCKET/STUB MUST REMAIN FREE OF CONCRETE OR OTHER DEBRIS.
2. THOROUGHLY WET AND MIX CONCRETE IN A CONTAINER. PLACE CONCRETE INTO HOLE UNTIL IT IS APPROXIMATELY FLUSH WITH THE GROUND.
3. INSERT TUBULAR SOCKET INTO CONCRETE UNTIL TOP OF SOCKET IS APPROXIMATELY 1/4" ABOVE THE CONCRETE FOOTING.
4. PLUMB THE SOCKET AND ALLOW CONCRETE ADEQUATE TIME TO SET.
5. ATTACH THE SIGN TO THE SIGN POST.
6. INSERT THE SIGN POST INTO SOCKET AND ALIGN SIGN FACE WITH ROADWAY.
7. DRIVE THE WEDGE INTO THE SOCKET TO SECURE POST. THIS WILL LEAVE APPROXIMATELY 3 INCHES OF THE WEDGE EXPOSED.



SIGNAGE

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WEDGE ANCHOR  
SYSTEM SHEET 2

A-80

SHEET No.