# 2M-1 General Information for Storm Sewer Design

## A. Introduction

Storm sewer facilities collect stormwater runoff and convey it away from structures and through the roadway right-of-way in a manner that adequately drains sites and roadways and minimizes the potential for flooding and erosion to properties. Storm sewer facilities consist of curbs, gutter, intakes, manholes, and storm sewers. The placement and hydraulic capacities of storm sewer facilities should be designed to take into consideration damage to adjacent property and to secure as low a degree of risk of traffic interruption by flooding as is consistent with the importance of the road, the design traffic service requirements, and available funds.

## B. Definitions

**Hydraulic grade line:** The hydraulic grade line is the locus of elevations to which the water would rise in successive piezometer tubes if the tubes were installed along a pipe run.

**Pressure head:** Pressure head is the height of a column of water that would exert a unit pressure equal to the pressure of the water.

**Velocity head:** Velocity head is a quantity proportional to the kinetic energy flowing water expressed as a height or head of water.

## C. Location of storm sewers

### 1. Storm sewers in street right-of-way

a. Storm sewers parallel to the street and in the right-of-way should be placed behind the back of curbs, as close as practical, to fit specific manhole or intake connections.

b. Storm sewers perpendicular to the street are to connect at each end by intakes or manholes.

c. Storm sewers in the street right-of-way should be concrete pipe (Class III) to prevent utility cuts through the pipe. This includes storm sewer service stubs equal to or greater than 12 inches in diameter, 10 feet outside of the right-of-way. Class V concrete pipe should be used under railroad tracks (including jack pipe).

d. If PVC or HDPE pipe is allowed by the Jurisdiction, it should be encased in flowable mortar. The reason for the encasement is to prevent utilities from unknowingly cutting or damaging the plastic pipe. If the flowable mortar encasement is not provided, the backfill envelope around the pipe can be disturbed. Since the pipe depends on the backfill envelope around the pipe for its strength, the pipe can be damaged if the backfill is disturbed. In areas where plastic pipe will not be adjacent to existing or future utilities, the encasement is not needed to maintain the pipe's integrity. An example would be an outfall sewer in a floodplain or a storm sewer outside of street right-of-way.

2. **Public storm sewers outside of street right-of-way but within public easement.** Storm sewers will be placed in a storm sewer public easement. Public storm sewer easements should have a minimum total width of 20 feet or two times the depth of the sewer, whichever is greater, with the storm sewer centered in the easement. Additional width may be required by the Jurisdictional Engineer to ensure proper access for maintenance purposes. When determining the width of the easement, consideration needs to be given to placement of excavated materials for the repair of the pipe.

   a. Storm sewer outlets (mains) should be concrete pipe, particularly under pavements or where utilities exist or are proposed. Concrete pipe under parking lots and shoulders may be Class II pipe.

   b. Upon the approval of the Jurisdictional Engineer, plastic pipe and CMP may be used outside of the street right-of-way where the granular backfill will not be disturbed by other utilities or other construction in the area.

   c. Storm sewer along a side property line should run the length of the property line and outlet past the rear property line to a receiving drainageway.

## D. Pipe materials

Pipe material and properties should conform to Table 1. Pipe loading information for storm sewer pipe was removed from this chapter and is currently being revised. It will be re-issued in the future.

**Table 1:** Typical Stormwater Piping[1]

| Typical Application | Pipe Material | Standard | Thickness Class (min.) | Pipe Stiffness (min.) | Size Range | Interior | Joints | Max. Depth of Bury[2] |
|---|---|---|---|---|---|---|---|---|
| **Storm sewer** | RCP | ASTM C 76 | Class III Wall B | N/A | 15"-120" | Smooth | Tongue & Groove | 7' to 40' |
| | RCAP | ASTM C 506 | Class A III | N/A | Equiv. 15"-120" | Smooth | Tongue & Groove | 6' to 14' |
| | RCEP | ASTM C 507 | Class HE III Class VE III | N/A | Equiv. 15"-120" | Smooth | Tongue & Groove | N/A |
| | RCPP | ASTM C 361 | Class C 25 | N/A | 15"-120" | Smooth | Tongue & Groove | N/A |
| **Culverts** | CMP | AASHTO M 36 | Iowa DOT RF-32 | N/A | 18"-120" | Corrugated | Coupling Bands | N/A |
| | CMAP | AASHTO M 36 | Iowa DOT RF-33 | N/A | Equiv. 18"-120" | Corrugated | Coupling Bands | N/A |
| | RCP | ASTM C 76 | Class III Wall B | N/A | 18"-120" | Smooth | Tongue & Groove | 7' to 40' |
| | Spiral Rib Metal Pipe | ASTM A 760 | 0.064" | N/A | 18"-120" | Corrugated | Coupling Bands | N/A |
| | Spiral Rib Arch Pipe | ASTM A 760 | 0.064" | N/A | 18"-120" | Corrugated | Coupling Bands | N/A |
| | Structural Plate | AASHTO M 167 | Iowa DOT RF-33 | N/A | 60" + | Corrugated | Bolted | N/A |
| | Coated CMP | AASHTO M 274 | Iowa DOT RF-32 | N/A | 18"-120" | Corrugated | Coupling Bands | N/A |
| | Aluminum Structural Plate | AASHTO M 219 | 0.100" (min) | N/A | 60" + | Corrugated | Bolted | N/A |
| **Subdrains or storm sewers** | PVC-solid wall | ASTM D 3034, F 679 | SDR 35 | 46 psi | 6"-42" | Smooth | Bell & Spigot | 24' to 30' |
| | Corrugated PVC | ASTM F 679 | N/A | 46 psi | 6"-36" | Smooth | Bell & Spigot | 24' |
| | Closed Profile PVC | ASTM F 1803 | N/A | 46 psi | 21" -60" | Smooth | Bell & Spigot | 24' |
| | Composite PVC | ASTM D 2680 | N/A | 46 psi | 8" -15" | Smooth | Bell & Spigot | 32' |
| | Corrugated HDPE | AASHTO M 294 | N/A | Varies by diameter[3] | 12"-60" | Smooth or Corrugated | Bell & Spigot | 8' to 9' |
| | Corrugated HDPE Tubing | AASHTO M 252 | N/A | 35 psi | 6"-10" | Smooth or Corrugated | Soil Tight | 8' |
| | CMP | AASHTO M 36 | Type I | N/A | 6"-15" | Corrugated | Coupling Bands | N/A |
| | RCP | ASTM 36 | Class III | N/A | 12"-120" | Smooth | Tongue & Groove | 7' to 40' |
| **Footing drain sewer collectors** | PVC | ASTM D 3034 | SDR 35 | 46 psi | 8"-15" | Smooth | Bell & Spigot | 24' |
| | Corrugated PVC | ASTM F 949 | N/A | 46 psi | 8"-36" | Smooth | Bell & Spigot | 24' |
| | Corrugated HDPE[3] | AASHTO M 252 | N/A | 35 psi | 8"-10" | Smooth or Corrugated | Soil Tight | 9' |
| | Corrugated HDPE[3] | AASHTO M 294 | N/A | Varies by diameter | 12"-24" | Smooth or Corrugated | Bell & Spigot | 8' to 9' |

[1] Site conditions may dictate something other than the typical piping.

[2] See Part 9B - Trench Design. Installations may be designed to exceed indicated maximum depth by modification of assumed conditions.

[3] If less than 46 psi, must pass 5% deflection test after installation.

## E. Physical requirements

1. **Minimum cover over storm sewer pipes.** The recommended minimum cover over storm sewer pipes should be 1 foot below the pavement slab, except for HDPE pipe, which should have a minimum cover of 2 feet; or as specified by the type of pipe as described in Chapter 9, whichever is greater. Where the clearance is less than 1 foot below the pavement, the Project Engineer will provide a design method to maintain the integrity of the pipe and pavement. For storm sewer pipe outside of the pavement, the minimum cover should be 1 foot 6 inches or as specified by the type of pipe (described in Chapter 9, Utilities), whichever is greater.

2. **Minimum flow line depth for footing drain sewers:** 3 feet 6 inches.

3. **Minimum pipe size**

    a. **Storm sewers:** 15 inches in diameter.

    b. **Subdrains:** 6 inches in diameter.

    c. **Footing drain collector sewers in public right-of-way:** 8 inches in diameter.

    d. **Building storm sewer stubs:** 4 inches in diameter

4. **Velocity within storm sewer pipe**

    a. Minimum flow (1/2 full pipe) = 3 fps cleaning velocity

    b. Maximum flow (1/2 full pipe) = 15 fps

5. **Velocity at outlet of pipe.** Energy dissipation is required when discharge velocities exceed those allowed for downstream channel. (See Tables 2 and 3).

    a. With flared end section, maximum of 5 fps, and according to Tables 2 and 3, without any energy dissipation.

    b. Maximum with flared end section, footing, and rip-rap = 10 fps

    c. Maximum with energy dissipation device = 15 fps

6. **Partially full pipe flow.** For convenience, charts for various pipe shapes have been developed for calculating the hydraulic properties (Figures 1, 2, and 3). The data presented assumes that the friction coefficient, Manning's "n" value, does not vary throughout the depth.

7. **Minimum storm sewer and footing drain grades**

    a. Velocity sets minimum grade for storm sewers and footing drain sewers, 2 fps for low-flow and 3 fps for design storm.

    b. Cross runs - grades 1% minimum. Desired minimum velocity of 3 fps for design storm.

    c. All other sewers - see Figure 1, Discharge of Circular Pipe-CFS

    d. Building storm sewer stubs - 1% minimum

e. Subdrains – 0.5% minimum

8. **Intakes:** See Section 2M-3.

9. **Manholes:** See Section 2M-3.

## F. Horizontal alignment

Sewer will be laid with a straight alignment between structures with the following one exception: in subdivisions where street layouts are such that a straight alignment is difficult and the storm sewers are 54 inches in diameter or greater the sewers may be curved. The curvature will be factory fabricated pipe bends and should be concentric with the curvature of the street. The radius of curvature must not be less than 200 feet. The pipe manufacturer's recommended maximum deflection angle may not be exceeded.