

7. DRAINAGE DESIGN

Practices and Procedures

7-1 HYDROLOGY

For hydrology information contact the Hydrology Section in the Environmental Office.

7-2 OPEN CHANNELS AND DITCHES

7-2.01 Types

The Department uses the following types of open channels and ditches for drainage:

1. Roadside Ditches: These are used adjacent to and parallel with the highway. They remove the storm runoff from the highway section and drain the subbase material.
2. Median Ditches: These are relatively shallow, depressed areas in medians of multilane, divided highways.
3. Berm Ditches: These are provided longitudinally at the top of a cut to intercept runoff from the hillside.
4. Swale Ditches: These are provided to remove runoff from the highway.
5. Channels: In general, these refer to naturally occurring pathways for water (e.g., stream channels). Hydraulic design of channels will likely require environmental permitting. Therefore, work in natural channels should always be coordinated with the Environmental Office. The Hydrology and Water Resources Units should be consulted early in the project, before design work begins. Channel design should be executed by a Professional Engineer and/or qualified geomorphologist. Any channel relocation requires an analysis

7-2.02 Design Criteria

Cross Section

See [Design Guidance – Sideslopes and Backslopes](#)

Ditches shall be a minimum of 1 foot below subgrade. If the 1 foot dimension is not possible, closed drainage shall be used with a shallow or swale ditch.

Minimum Gradients

The desirable minimum gradient is 1.0%. The grade should not be less than 0.5%.

Channel/Ditch Lining

See Channel Linings in the [MaineDOT Best Management Practices for Erosion and Sediment Control](#).

Stone ditch protection shall be 12 inches in depth, and shall be placed from the subgrade-sideslope intercept to a point on the backslope that is at the same elevation. The minimum width should be one-third of the width at the top of the channel/ditch.

7-3 CULVERTS

7-3.01 Physical Characteristics

Culvert Materials

For culvert pipes, there are three options:

1. Option I: Any one of the following may be used:
 - a. corrugated steel, metallic (zinc or aluminum) coated pipe
 - b. reinforced concrete pipe
 - c. any metal pipe allowed under Option III

2. Option III: Any one of the following may be used:
corrugated aluminum alloy pipe
 - a. polyvinylchloride (PVC) pipe (12 in (300 mm) and 15 in (375 mm) diameters only)
 - b. polymer-precoated galvanized corrugated steel pipe
 - c. polypropylene pipe
 - d. reinforced concrete pipe

3. Reinforced Concrete Pipe (RCP)

The types of culvert material recommended for various site locations are:

1. Reinforced Concrete Pipe (RCP): See [Design Guidance – Reinforced Concrete Pipe](#).
2. Option I: Use under driveways.
3. Option III: Use unless the criteria in Nos. 1 or 2 apply.

Culvert Shapes

Use circular pipes wherever possible. Pipe arches or elliptical pipes may be used where there are clearance problems, restrictive room for headwater, etc.

Minimum Size

The minimum sizes of culvert for maintenance purposes are as follows:

Driveways: Use minimum 15-inch diameter pipe.

Cross Culverts: Use minimum 18-inch diameter pipe.

Smaller sizes can be used but must be analyzed for capacity.

Segment Length

See the Section 603 items in [Estimating Guidance](#).

Minimum Cover (Design)

Desirably, the pipe will be placed with a cover of at least 2 feet from the subgrade. The minimum cover for any type of pipe is 1 foot below the subgrade.

Spacing Between Multiple Pipes

The minimum spacing allowed between multiple pipes is as follows:

1. Up to 36-inch pipe: minimum 18-inch spacing recommended.
2. 36-inch – 72-inch pipe: spacing will be equal to the radius of the larger pipe.
3. Larger than 72-inch pipe: 36-inch spacing is recommended.

Minimum Slope

Except where the pipe is used as an equalizer, a minimum slope of 0.5% (0.005 ft/ft) should be used for any type of culvert at any site.

7-3.02 Maximum Cover/Height of Fill

For information on the maximum cover and height of fill for culverts, contact the Bridge Program.

7-3.03 Hydraulic Design of Culverts

For information on the hydraulic design of culverts, contact the Hydrology Section in the Environmental Office.

7-4 PAVEMENT DRAINAGE

7-4.01 Drainage Structures

Catch Basins

A catch basin conveys stormwater into the subsurface storm drain system. It typically includes a grate or curb inlet at ground surface where stormwater enters the catch basin and a cylindrical subsurface structure that provides connections to the underground drain system. This structure is often called the “catch basin”, separate from the surface inlet. The lower volume of the catch basin may be below the outlet pipe invert, in which case that volume acts as a sump to capture sediment, debris and associated pollutants. Catch basins act as pretreatment for other treatment practices by capturing large sediments. The performance of catch basins at removing sediment and other pollutants depends on the design of the catch basin (e.g., the size of the sump), and routine maintenance to retain the storage available in the sump to capture sediment.

The following provides selection criteria for the types of catch basins presented in the Standard Details:

1. Type A: use with Type 1 Granite Curb
2. Type B: use with any curb type or without curb.
3. Type A or B Portland: for use in the City of Portland only
4. Type F: use on lawns or areas where a Type A or B basin is not practical

The following provides selection criteria for catch basin shapes:

- 1) Shape 1: standard basin with 2 foot cone
- 2) Shape 5: offset basin with 4 foot or 2 foot cone – must specify
- 3) Flat top: limited use for shallow drainage with input from Construction Support

Grates shall be cascade in all areas unless there is a project specific need for a different types. Solid grates can be used for catch basins that act as junctions for drainage. Beehive grates can be used in areas outside of the pavement for drainage.

Manholes

Manholes shall be used for utility purposes only. See the [Standard Details](#) for shapes and tops.

Catch Basin Inlet Location

The following guidance applies to the location of catch basins:

1. For inlet spacing guidelines, see [Design Guidance – Catch Basin Placement](#).
2. If the location, according to the hydraulic analysis, falls within an intersection, driveway entrance area, curb-cut ramp, or pedestrian crosswalk, the catch basin should be placed on the high side of the feature.
3. Catch basins should be placed to capture the side street flow before it reaches the major highway.

4. On superelevated curves, catch basins should be placed to prevent water from sheeting across the highway.
5. Where granite curb is proposed, the catch basin should be located in a full-height curb section and not within a terminal curb section.

Closed Systems

The following guidance applies to closed systems:

1. Do not use pipe sizes less than 12 inches (although 6-inch underdrain is acceptable as the first section of pipe upgradient of the first inlet)
2. Match top elevations of pipes. If pipes are same diameter there should be a minimum difference of 3 inches between invert elevations.
3. Desirably, the pipe will have a cover of at least 2 feet below the subgrade. The minimum cover for any pipe should be 1 foot below subgrade.
4. Pipes that run transversely from catch basin to catch basin will be non-perforated.
5. Pipes that run longitudinally from catch basin to catch basin may be perforated, with perforations up.
6. Wherever possible, system pipes that cross under a road shall have a minimum size of 18 inches to facilitate regular maintenance and anticipate future drainage growth.
7. Catch basins should have a sump of at least 2 feet beneath the lowest pipe invert.
8. Catch basin and manhole outlet pipes should be at least as large as the largest inlet pipe.

7-4.02 Hydraulic Analysis of Closed Systems

For the hydraulic analysis of closed systems, contact the Hydrology Section in the Environmental Office.