

STORMWATER MANAGEMENT

Chapter 10

STORMWATER MANAGEMENT SYSTEM DESIGN

Sec. 1001. DESIGN STANDARDS

Stormwater management systems shall be designed and constructed consistent with the following:

- A. **Conformance with These Standards.** Design and construction of stormwater systems, including materials, shall conform to relevant sections of these standards, including the appendixes and index of drawings contained in each. For additional information and requirements, refer to Chapters 5 and 9.
- B. **Conformance with Other Standards.** In addition, all design and construction, including materials, shall conform with the relevant requirements of the publications specified in Section 105; except as otherwise provided in these Standards, or by contract with the City of Ferndale.

Sec. 1002. RUNOFF - DESIGN FLOWS

- A. **Runoff Management.** Stormwater runoff shall be controlled to be consistent with the following standards:
 - 1. **Stormwater Runoff Rates.** The following rainfall amounts shall be used in calculation of stormwater runoff, based on a 24-hour rainfall event.

<u>Recurrence</u>	<u>Rainfall</u>
2 Year	1.90"
10 Year	2.80"
25 Year	3.25"
100 Year	4.00"

2. **Post-Development Stormwater Control.** Pre-development runoff shall be calculated for existing site conditions using the 2-year, 24-hour; 10-year, 24-hour; and 100-year 24-hour design storms. The post-development peak rate of runoff from development sites shall be limited to 50 percent of the 2-year, 24-hour design storm while maintaining the existing condition peak runoff rate for the 10-year, 24-hour and 100-year, 24-hour design storms. This requirement may be modified by the City if the subject property lies within a drainage basin covered by a City approved basin plan and post-development peak runoff conforms with the requirements of the plan.

When peak discharge control is required on a subject property, detention/retention facilities, on-site filtration systems, or a combination shall be provided to handle all surface water in excess of the peak discharge. Upon sizing of a detention/retention facility meeting the above requirements, the volume may need to be increased by a correction factor of 20 to 50 percent, as determined from Figure 10-1. The volume increase shall be applied horizontally so as not to change the stage/discharge relationship.

3. **Water Quality Design Storm and Treatment Facilities.** Stormwater treatment facilities shall be sized to capture and treat the water quality design storm, defined as the 6-month, 24-hour return period storm. The 6-month, 24-hour storm is typically calculated as 64 percent of the 2-year, 24-hour storm.
4. **Existing Drainage to be Maintained.** Off-site surface water drainages entering the site shall enter and leave the site at their existing locations. Energy dissipators shall be provided, as necessary, to minimize downstream stormwater damage. There shall be no diversions at the inlet or outlet points, unless previously authorized by an approved comprehensive stormwater management plan and approved by downstream property owners.

B. **Peak Discharge Determination.** Peak Discharge rates shall be determined as follows:

1. For all computations, except for basin plans or equivalent, the minimum standard shall be the Soil Conservation Service Unit Hydrograph (SCSUH) method (1) with the level pool routing method. The Santa Barbara Urban Hydrograph (SBUH) method is also an acceptable method. Other acceptable methods, including but not limited to continuous simulation methods, are those allowed by the Department of Ecology Stormwater Management Manual for the Puget Sound Basin or approved by the City of Ferndale Public Works Director.

Sec. 1003. STORMWATER CONVEYANCE

A. General. Stormwater conveyance systems shall be designed to convey the design storm peak flows as follows:

1. New conveyance systems shall be constructed of vegetation-lined channels as opposed to pipe systems, where feasible. Vegetative channels shall generally be considered feasible if:
 - (a) the system is collecting from rural sites or areas with little impervious surface.
 - (b) the channel gradient generally does not exceed five percent, and
 - (c) no modification to currently adopted standard roadway cross-sections in these Standards are necessitated by the channel, and
 - (d) the channel will be accessible for maintenance.
2. Conveyance design shall incorporate grass swales and/or other means of biofiltration for surface water prior to off site discharge. Where existing open ditch drainage provides biofiltration, the drainage shall not be enclosed unless alternative stormwater treatment is provided.
3. Fish migration to existing fish habitat areas shall not be obstructed by the construction of new stormwater conveyance systems.

B. Enclosed Systems. Enclosed or piped drainage systems shall be designed and installed in conformance with the following:

1. **System Sizing.** Piped or enclosed drainage systems shall be sized to convey the 100-year pre-development flow unless approved overflow facilities are provided. Design velocities shall be shown in the computations for all stormwater culverts.
2. **Energy Loss Allowance.** Allowance for energy loss due to turns, structures, pipe size change, etc., shall be included in the design of the storm drainage facilities.
3. **Gradients.** Storm drain gradients shall be designed to assure a minimum flow velocity of three feet per second when the pipe is flowing full, except when otherwise approved by the Public Works Director.

4. **Storm Drainage Easements.** Storm sewers crossing private property shall have a minimum 15 foot wide easement. Wider easements may be required by the City of Ferndale for deep storm sewers, large pipe, or unstable soil situations, or other circumstances. Drainage easements shall be located within a single lot or tract, except where the linear extent of the drain line may involve additional properties or unless otherwise approved by the Public Works Director.
5. **Underground Drain Lines - Location.** Enclosed (underground) drain lines shall not be located with their centerline closer than Ten (10) feet to any building footing.
6. **Erosion Control.** Means of preventing erosion along new channels, ditches, and at pipe outfalls, is required and shall be shown on the plans. (See Section 802.B.)

C. **Open Channel Drainage Systems.** Open channel drainage systems shall be designed and installed in compliance with the following:

1. **System Sizing.** Open channel drainage, including culverts, shall be sized for the design storm in accordance with Section 1002, by determining the maximum allowable headwater or flow elevation to which water may rise without damage to private property or the public roads. Sizing information shall be shown on the drainage plans as follows:
 - (a) The water surface and headwater elevations of the flow for the design storm shall be indicated on the plan and profile drawings, and the computations. The configuration of the finished grades constituting the banks of open channel will also be shown on the drawings.
 - (b) One (1) foot minimum freeboard shall be provided between the design flow elevation and the top of banks.
2. **Side Slopes.** Channel and ditch side slopes, as shown in the drainage plans, shall be stable. Side slopes shall be 3:1 (desired for maintenance) and may be a maximum of 1.5:1 upon approval of the Public Works Director. Side slopes steeper than 2:1 shall be paved, lined, or stabilized in another manner as approved by the Public Works Director.

3. **Maximum Channel Velocity.** The maximum allowed stream velocity shall be eight feet per second (fps). Bank stabilization is required when the design flow velocities of constructed channels exceeds five fps.
4. **Minimum Velocity.** Minimum allowed design velocity shall be 0.5 fps, unless otherwise approved by the Public Works Director.
5. **Channel Improvements - Erosional Areas.** Where erosion is a potential problem due to stormwater discharge from a culvert, a rock lining or other energy dissipator shall be provided as approved by the Public Works Director.
6. **Piped Drainage Required - Areas of High Erosion Potential.** Where erosion potential is higher or where slopes exceed 10 percent a closed drainage system with pipe is required, unless an alternative is approved by the Public Works Director.
7. **Certain Existing Stream and Ditches to Remain Open.** All existing streams and ditches and other open channels requiring a pipe size greater than 36 inch diameter pipe, shall remain open channel except at road crossings.
8. **Ditch Locations.** Where possible, ditches shall be located along or adjacent to lot lines.
9. **Open Channel Easements.** Channels crossing private property shall have a minimum easement width of the channel cross-section plus 15 feet on one side, if maintenance is required.
10. **Erosion Control.** The channels at points of discharge from culverts and storm sewers with slopes 15 percent or greater shall be rock-lined with boulders with one face a minimum of 24 inches in dimension. The rock lining shall extend for a minimum distance of 10 feet from the point of culvert or storm sewer discharge and shall have a width of three feet in excess of the diameter of the culvert or storm sewer. In addition, a special outlet structure serving as an energy dissipator may be required.

Sec. 1004. **STORMWATER DETENTION AND RETENTION**

A. **General Requirements.** Stormwater detention and retention facilities shall comply with the following standards.

1. **Approved Detention/Retention Facilities.** Detention/retention facilities may include open basins, ponds, roof-top storage, parking lot ponding, underground storage, gravel filled trench storage, infiltration trenches, or combinations of any of the above, or other facilities as approved by the Public Works Director. Roof-top storage may be used only when other facilities are not feasible, and shall be designed by a registered structural engineer and approved by the Public Works Director.
2. **Emergency Overflow.** All stormwater storage facilities shall make provisions for emergency overflow. The impacts of a facility failure shall be analyzed to determine on-site and off-site effects.
3. **Design for Maintenance.** Detention/retention facilities shall be designed and constructed to minimize the frequency and difficulty of future maintenance. The designer shall evaluate the range of potential problems that might occur with the system and determine the corrective action needed. The Public Works Director may require that a Maintenance and Operations Manual be prepared by the designer if the system is particularly complex or will have unusual maintenance needs. Maintenance responsibilities are detailed in Chapters 11 and 12. At a minimum, the following shall be required:
 - (a) **Accessibility of Facilities.** All detention and/or retention facilities shall be accessible for maintenance and operation. Required access roadways shall be provided in access easements and shall accommodate heavy equipment loading. Minimum access easement width shall be 20 feet. Minimum access roadway width shall be 14 feet, surfaced with at least 8 inches of gravel or equal, with grades no steeper than 15 percent.
 - (b) **Bottom Gradient.** All constructed and graded detention/retention ponds shall be sloped no flatter than 0.01 ft/ft (one percent) toward the outlet, for drainage.
4. **Facilities Not Permitted in Road Right of Ways.** Open detention/retention ponds and infiltration facilities shall not be located in dedicated public road right-of-way areas.

5. **Flood Protection from Failure.** All detention/retention facilities shall be designed and constructed in such a manner that system failure will not cause flooding in any habitable building area or on public and private roadways.
6. **Side Slopes.** Side slopes for earth-lined detention/retention ponds shall be no steeper than three horizontal to one vertical, unless access control is provided. Flatter slopes are encouraged. All detention/retention pond side slopes shall be stabilized to the satisfaction of the Public Works Director.
7. **Dammed Retention Ponds.** A detention/retention pond acting as a dam restraining 2' or more of head must be adequately designed by a Registered Professional Engineer qualified in soils and foundation engineering and dam design. The design shall be done prior to commencement of construction of the pond/dam. The engineer shall submit design data with a letter stating that the design is adequate. The plans must be stamped and signed by a registered professional engineer. Upon completion of the pond/dam, the engineer shall submit a letter stating that the pond/dam was constructed according to design and specifications. All dams falling within current Washington State Department of Ecology (DOE) Sam Safety jurisdiction shall receive DOE dam safety approval prior to construction.
8. **Freeboard.** All detention/retention ponds except parking lot ponds shall have a minimum of one foot of freeboard above the maximum design water elevation.
9. **Installation Prior to Paving and Building Construction.** All required detention/retention facilities must be constructed and in operation prior to paving and building construction unless otherwise approved by the Public Works Director.
10. **Public Safety.** The design of detention/retention facilities shall incorporate adequate measure to protect the public from the inherent hazards of such facilities including health risks associated with a failure of the system. Special protective measures, such as fencing around facilities accessible to the public, may be required by the Public Works Director as necessary to safeguard public health and safety.

- B. **Detention/Retention Basin Design.** Detention and Retention facilities shall be designed in conformance with the following:
1. **Design Methods.** The Level Pool Routing method shall be used to design detention/ retention facilities.
 2. **Outlet Control Structures.** Outlet control structures shall be provided as necessary to control stormwater discharge as necessary as determined using the criteria specified in Sec. 1002.
 - (a) **Design.** The design of the outlet control structure shall follow guidelines set forth in the Stormwater Management Manual for the Puget Sound Basin. A typical structure is shown in City of Ferndale Standard Detail ST-1 (DOT B-3, 1 of 2). Control structures can incorporate orifices, notches and/or weirs in order to meet discharge requirements. A typical shear gate for emergency flow release within an outlet control structure is shown in Standard Detail ST-2 (DOT B-3, 2 of 2).
- C. **Infiltration.** Infiltration as a means of disposing of stormwater runoff shall conform to the Best Management Practices set forth in Chapter III-3 of the Stormwater Management Manual for the Puget Sound Basin, DOE 1992.

Sec. 1005. WATER QUALITY

Biofiltration facilities shall be provided as required by Sec. 1109. to provide stormwater quality treatment amenities.

- A. **Design.** The design of biofiltration facilities shall follow guidelines set forth in the Stormwater Management Manual for the Puget Sound Basin. Typical facilities such as filter strips and swales are shown in Standard Detail ST-13 (DOE III-6.1).

Sec. 1006. CONSTRUCTION PLANS

- A. **General.** Construction plans and details are required for all stormwater collection systems including detention/retention facilities. Collection systems include gravity pipe systems, open channels including road ditches, and any combination thereof. A temporary erosion/sedimentation control plan shall be included for all land alteration works.

- B. **Submittal Procedure.** Drainage construction plans and supporting design calculations shall be prepared by a registered professional civil engineer. The drainage plans shall follow the same submittal procedures as set forth in Section 1014.
- C. **General Formatting.** General formatting, copying, and submittal process for drainage plans shall be in accordance with Chapter 6, Regulations for Streets and Related Work.
- D. **Contents.** Construction plans shall include a plan-profile of the drainage systems prepared in accordance with the applicable provisions in Chapter 4.

Sec. 1007. MATERIALS AND INSTALLATION STANDARDS

All materials and installations standards for storm drainage facilities shall conform to the Standard Specifications and the Technical Standards.

Sec. 1008. STREET DRAINAGE SYSTEMS GENERAL PROVISIONS

A drainage plan prepared in accordance with the provisions of Section 1014 shall be prepared and reviewed by the Public Works Director prior to the commencement of any storm drainage construction.

Sec. 1009. DITCHES - DITCH SECTION

- A. **General.** In the general, unlined ditches may be used for the drainage requirement. These ditches shall be designed and constructed in accordance with this Chapter. Driveway culverts shall also be in accordance with the these standards and shall have a minimum diameter of 12 inches and minimum length of 20 feet. Refer to detail ST-9 for culvert inlet/outlet information.
- B. **Areas of High Erosion Potential.** Where erosion is potential problem due to flow velocity or unstable soil conditions, a closed drainage system with pipe is preferred. Alternatively, the Engineer may design a paved or rock-lined ditch subject to the approval of the Public Works Director.

Sec. 1010. STORM DRAINS - CURB AND GUTTER SECTION

- A. **General.** Underground storm drainage shall be provided for curb street sections whenever the length of surface drainage exceeds 300 feet on road grades extending either direction from crest or sag on vertical curves. Refer to Section 1013 for piped drainage system requirements.
- B. **Storm Drain Pipe - Mains.** Storm drain pipe other than pipe connecting street inlets to main storm drains shall be a minimum of 12 inches in diameter and in accordance with Standard Specifications. Runoff shall be computed and, if the flow requires it, larger pipe shall be used.
- C. **Storm Drain Pipe - Connectors with Structures.** Storm drain pipe connecting street inlets to main storm drains by structure, i.e., catch basin or manhole, shall be a minimum of 8 inches in diameter with a maximum length of 48 feet.
- D. **Storm Drain Pipe - Connectors without Structures.** Connections of storm drain pipe leading from a street inlet location may be made into a main storm drain without structure, subject to the approval of the Public Works Director and subject to the following requirements:
1. The inletting structure shall be a catch basin and not a simple inlet lacking a catch or drop section.
 2. Outside diameter of inlet pipe shall not exceed one-half the inside diameter of the main storm drain, or minimum of 8", whichever is greater.
 3. Length of inlet connection shall not exceed 48 feet.
 4. Standard shop-fabricated tees, wyes, and saddles shall be used, except that connections with concrete pipe may be field-tapped.
- E. **Tight Lines.** A tight line without infiltration may be required as deemed necessary by the Public Works Director.
- F. **Storm Drains Under Roads and Driveways.** Storm drain pipe under public roads shall have a minimum of two (2) feet of cover. Culverts under driveways shall have a minimum of one (1) foot of cover.

Sec. 1011. CATCH BASINS, MANHOLES AND INLETS

- A. **Spacing.** Maximum spacing on surface drainage courses between inlets or catch basins shall be 200 feet on road grades up to 3.0 percent. When road grade is 3.0 percent or greater, maximum spacing shall be 300 feet.
- B. **Drainage Access Structures.** Drainage access structures are required at:
1. All changes in horizontal or vertical alignment.
 2. All connections to a main line pipe.
 3. All changes in pipe size.
 4. At a spacing no greater than 600 feet.
- C. **Catch Basins - Shallow Drains.** On storm drains with depths less than five feet to flow line, catch basins may be one of the following, and shall conform to the appropriate detail:
1. Catch Basin Type 1 Detail ST-4 (DOT B-1)
 2. Catch Basin Type 2 - 48" Detail ST-5 (DOT B-1e)
- D. **Catch Basins - Deep Drains.** On storm drains with depths five feet and over to flow line, joining or inletting structures shall be selected from the following, and shall conform to the appropriate detail:
1. Catch Basin Type 2 - 48" Detail ST-2 (DOT B-1e)
 2. Catch Basin Type 2 - 54" Detail ST-2 (DOT B-1e)
 3. Catch Basin Type 2 - 72" Detail ST-3 (DOT B-1f)
 4. Catch Basin Type 2 - 96" Detail ST-3 (DOT B-1f)
- E. **Manholes.** Where structure is needed for access or for juncture of storm drains, but not for catchment of silt, the structure shall be one of the following types of manhole:
1. MH Type 1 - 48" Detail SS-2
 2. MH Type 2 - 48" Detail SS-3
 3. MH Type 3 - 48"-96" Detail SS-4
- F. **Specifications - Catch Basins, Manholes and Inlet Structures.** Provisions contained in the State Standard or APWA Standard Specifications shall apply, unless otherwise specified, to catch basins and curb inlets as well as manholes. Concrete inlets shall conform to Standard Detail ST-7 (B-26). Catch basin appurtenances shall conform to Standard Detail ST-1, ST-2 or ST-3.

Subject to approval by the Public Works Director, drainage structure materials other than reinforced concrete may be used provided that required specifications are available to control quality and acceptable user experience with the product can be shown.

- G. **Curb Inlets w/o Drop Sections.** Curb inlets without drop section or catch may be used provided they are connected to a main storm drain by a catch basin.
- H. **Yards and Roof Drainage.** Adequate measures shall be taken to limit surface drainage from yards and roof drains so as to prevent water damage or nuisance within the right-of-way. Such measures may include but are not limited to the following:
 - 1. Four inch pipe laid subsurface from yard inlet to nearest catch basin or curb inlet.
 - 2. Three inch pipe laid from yard inlet under sidewalk and out through curb face. This method is not permissible when curb is on high side of super-elevation or in any situation in which street drainage cannot be confined to gutter receiving yard runoff.
 - 3. Eight inch pipe stubbed from catch basin or curb inlet structure to within one foot of the lot line and plugged, to provide future connection to one or more yard drains.
- I. **Non-main storm drainage lines.** Designated stormwater lines shall be connected to main lines through a catch basin or manhole to collect runoff from lots, yards, and isolated impervious areas such as houses. These lines shall conform to the following criteria:
 - 1. The minimum diameter shall be 8 inches.
 - 2. Tees are acceptable as connections to downspouts and other small drainage structures.

Sec. 1012 FRAMES, GRATES AND COVERS

- A. **Catch Basin Frames, Grates and Covers.** Catch basin frames, grates and covers shall conform to City of Ferndale Standard Detail ST-8 (DOT B-2a).
- B. **Flat Surface Inlet.** On drainage structures under vertical curb and gutter,

under average conditions, the frame and grate shall be as shown in the drawings or equal. When the structure does not serve as an inlet, a solid cover, or equal, shall be used. Frame and grate or lid shall be incorporated into curb and gutter sections.

- C. **Through Curb Inlets.** On drainage structures under vertical curb and gutter, a through curb inlet frame shall be used where conditions limit the effectiveness of a flat surface inlet. This will reduce problems such as clogging from leaf fall or other debris, especially in sag vertical curves.

When used with this through curb inlet frame, the standard grate shall, in all cases, be ductile iron. Installation of the through curb inlet shall be as shown in the City of Ferndale Standard Detail R-8. Through curb inlets shall be preferred over flat surface inlets.

- D. **Lock Bolts.** Locking bolts shall be provided on frames and grates or covers when:

1. Location is off the traveled portion of roadway or otherwise limits public surveillance.
2. Structure is flow restrictor/oil pollution (FROP) control device.

- E. **Specifications - Cast and Ductile Iron Components.** Unless otherwise specified, cast iron products shall conform to ASTM Designation A 48 Class 30 and ductile iron to ASTM Designation A 536 Grade 80-55-06.

Sec. 1013. MATERIALS AND INSTALLATION STANDARDS

- A. **General.** Drain Pipe materials and installation shall be in accordance with the current edition of WSDOT or APWA Standard Specifications and with the following:

1. **Bedding and Backfill.** Pipe bedding and trench backfill requirements shall be as shown in City of Ferndale Standard Detail SS-1 (DOT B-18c) and as specified in the State Standard Specifications.
2. **Cross Culvert Sizing.** Where open channels intersect public streets, the minimum diameter cross culvert shall be 18 inches, unless otherwise approved. Cross culverts shall be designed to carry the design runoff with a headwater depth not greater than two (2) times the culvert diameter for culverts 18 inches or under, or 1.5 times the culvert diameter for culverts greater than 18 inches.

3. **Pipe Anchors.** Pipe anchors may be required when pipe slopes exceed 15 percent, or when drainage structures are constructed in, or placed on unstable soils unless the stability of the soils and the placement of the pipe is certified by a licensed Geo-Technical Engineer.
4. **Catch Basins.** Type II catch basins or larger shall be required to accommodate all pipe greater than 18 inches in diameter.
5. **Design of Cross-sections.** Street ditch cross-sections may be "V" shaped or trapezoidal.
6. **Rock Channel Liners.** Rock lining shall meet the following requirements:
 - (a) Rock gradient shall be as follows, at a minimum:

Passing 8 inch square sieve	100%
Passing 2 inch square sieve	0-10%
 - (b) Rock shall be placed so as to form a firm, dense protective mat and conforming to the design surface of the ditch. Individual rocks shall not protrude more than three inches from that surface. Actual ditch dimensions shall be based on calculated stormwater flows.

Sec. 1014. PLANS AND SPECIFICATIONS

- A. **General Formatting.** General formatting, copying, and submittal process for drainage plans shall be in accordance with this Chapter.
- B. **Contents.** Construction plans shall include a plan-profile of the drainage systems prepared in accordance with the applicable provisions of Chapter 4; and shall contain, at a minimum, the following additional information:
 1. **Detailed Topography.** Detailed topography of the subject property using contours at two foot intervals, based on actual plane survey with sufficient spot elevations to delineate the perimeter and depth of specific features. On slopes greater than 10 percent, or when approved by the Public Works Director, contour intervals greater than two (2) feet may be used.

2. **Location of existing and Proposed Drainage Improvements.** Location, type, and size of existing drainage facilities and proposed improvements for handling the runoff within the site. Any proposed off-site improvements shall also be shown.
3. **Easements.** Location of existing and proposed drainage easements.
4. **Hydraulic and Other Physical Data.** Hydraulic and physical data such as grades, cross-sections, and bottom elevations of open ditches and channels, inverts of pipes, inverts and types of all structures such as manholes, catch basins, chambers, or similar structures, size, lengths, and slope of all pipes or other conveyance facilities, and invert elevations of the existing or other proposed storm drainage system that the subject drainage proposes to discharge (tie) into.
5. **Cross-sections.** Cross-sections, elevations, and details of detention/retention facilities including the design volume.
6. **Temporary Erosion-Sedimentation Control.** A temporary Erosion-Sedimentation Control Plan showing locations and proposed measures with specifications for controlling erosion and sedimentation during and after construction. Maintenance provisions shall be included during the period until on-site stabilization has occurred.
7. **Maintenance Agreements and Easements.** On-site and off-site drainage easement agreements and provisions for maintaining facilities such as detention/retention ponds.