



# Appendix F

## Revised Stormwater Standards

F.1 - Draft Design Standards  
F.2 - Catch Basin Recommendations



# Appendix F.1

## Draft Design Standards

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CITY OF STAYTON

DEPARTMENT OF PUBLIC WORKS

DRAFT STORM DRAINAGE

DESIGN STANDARDS

2007



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**Appendices**

- A. Storm Drainage Report and Construction Plan Requirements
- B. Hydrology Calculation Requirements
- C. Water Quality and Quantity Facility Design
- D. Water Quality and Quantity Facility Operations and Maintenance Guidelines
- E. City of Stayton Standard Details (To be reviewed and provide by the City of Stayton)

## 1.0 PURPOSE

The purpose of these Storm Drainage Design Standards is to provide a consistent policy under which certain physical aspects of stormwater management will be implemented. Most of the elements contained in this document are Public Works oriented and most are related to the development or platting process; however, it is intended that they apply to both public and private work designated herein.

These Standards cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals. It is expected that engineers will bring to each project the best skills from their respective disciplines.

The Standards are also not intended to limit unreasonably any innovative or creative effort which could result in better quality, cost savings, or both. Any proposed departure from the Standards will be judged, however, on the likelihood that such variance will produce a compensating or comparable result, in every way adequate for the user and City resident.

Following from the above purpose, the standards have the objective of developing a stormwater management system which will:

- a. be consistent with the Stayton Code and adopted Sector Plans;
- b. be of adequate design to safely manage all volumes of water generated upstream and on the site to an approved point of discharge;
- c. provide points of discharge for stormwater generated by future development upstream;
- d. prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property;
- e. prevent the capacity of downstream channels and storm drainage facilities from being exceeded;
- f. have sufficient structural strength to resist erosion and all external loads which may be imposed;
- g. maintain the runoff characteristics of the original undeveloped drainage basin;
- h. protect Stayton's natural drainage system of streams and wetlands;
- i. maintain Stayton's existing high level of overall water quality;
- j. be designed in a manner to allow economical future maintenance; and
- k. be designed using materials to insure a minimum practical design life as specified herein.

### 1.1 SHORTENED DESIGNATION

These City of Stayton's Storm Drainage Design Standards shall be cited routinely in the text as the "Standards."

### 1.2 APPLICABILITY

These Standards shall govern all construction and upgrading of all public and private drainage facilities in the City of Stayton and applicable work within its service areas.

## 1.3 REFERENCES

The Standards are intended to be consistent with the most currently adopted provisions of:

- a. Stayton Code.
- b. Stayton Area Comprehensive Plan.
- c. City of Stayton Urban Growth Management Plan.
- d. Stayton Area Stormwater Management Plan.
- e. Stayton Area Water Quality Plan
- f. Oregon Statewide Planning Goals and Guidelines
- g. Oregon Department of Environmental Quality's Erosion and Sediment Control Manual

## 1.4 STANDARD SPECIFICATIONS

Except where the standards provide otherwise, design detail, workmanship and materials shall be in accordance with the City of Stayton's current edition of the "Standard Construction Specifications."

## 1.5 DEFINITIONS AND TERMS

**Building Storm Drain**—A building storm drain is that part of the piping of a stormwater drainage system which begins at the connection to the building drain at a point five (5) feet outside the established line of the building or structure and conveys stormwater to the approved point of discharge.

**City Engineer** — the Engineer employed or designated by the City as responsible for technical review of plans, drawings, specifications and making any engineering decisions directly or indirectly related to storm drainage issues.

**Creek**—Any and all surface water routes generally consisting of a channel having a bed, banks, and/or sides in which surface waters flow in draining from higher to lower land, both perennial and intermittent; the channel, banks, and intervening artificial components, excluding flows which do not persist for more than 24 hours after cessation of one-half (1/2) inch of rainfall in a 24-hour period from October through March.

**Cut Sheets**—means sheets of tabulated data, indicating stationings, structures, fittings, angle points, beginning of curve, points on curve, end of curves, storm drain slope, staking offset, various elevations, offset cuts, and storm drain depths.

**Definition of Words**—Wherever in these standards the words directed, required, permitted, ordered, designated, or words of like importance are used, they shall be understood to mean the direction, requirement, permission, or order of designation of the Director. Similarly, the words approved, acceptable, satisfactory, shall mean approved by, acceptable to, or satisfactory to the Director.

**Design Engineer**—The developer's design or consulting engineer, licensed by the State of Oregon as a Civil Engineer under whose direction plans, profiles, and details for the work are prepared and submitted to the City for review and approval.

**Detention**—The holding of runoff for a short period of time and then releasing it to the natural water course where it returns to the hydrologic cycle.



**Developer** — Anyone planning or implementing improvements to any property within the jurisdiction of the City of Stayton that meets one of the type descriptions included in Section 1.8.

**Director**—The person employed or designated by the City as responsible for implementing policy and administrative issues related to stormwater issues. The Public Works Director will coordinate with and rely upon the City Engineer with regard to issues involving technical and engineering aspects or decisions.

**Drainage Facilities**—Pipes, ditches, detention basins, creeks, culvert bridges, etc., used singularly or in combination with each other for the purpose of conveying, storing, or providing water quality treatment of runoff.

**Drainage Master Plan**—A document prepared by Keller & Associates that describes Stayton’s existing planned trunk drainage system.

**Easement**—Easements are areas along the line of all public storm drains which are outside of dedicated storm drain or road easements or rights-of-way, and shall be prepared on City forms granting rights along the line of the storm drain to the City.

**French Drain or Leach Line**—means a covered underground excavated trench filled with washed gravel that surrounds a perforated delivery pipe used to receive stormwater, wherein ‘the sides and bottom of the trench are porous, permitting the stormwater to seep into the ground.

**Impervious Areas—Impervious Surfaces.** Those hard surface areas located upon real property which either prevent or retard saturation of water into the land surface, as existed under natural conditions pre-existent to development, and cause water to run off the land surface in greater quantities or at an increased rate of flow from that present under natural conditions pre-existent to development. Common impervious surfaces include, but are not limited to rooftops, concrete or asphalt sidewalks, walkways, patio areas, driveways, parking lots or storage areas and graveled, oiled, macadam or other surfaces which similarly impact the natural saturation or runoff patterns which existed prior to development.

**Natural Location**—The location of those channels, swales, and other nonman-made conveyance systems as defined by the first documented topographic contours existing for the subject property either from maps or photographs.

**On-Site Detention**—The storage of excess runoff on the development site prior to its entry into a public storm drain system and gradual release of the stored runoff after the peak of the runoff has passed.

**Owner**—Any individual, partnership, firm, or corporation by whom the project engineer has been retained or who, as a property owner, is making arrangements with the City.

**Peak Discharge**—The maximum water runoff rate (cfs) determined for the design storm.

**Plans**—Construction plans, including system site plans, storm drain plans and profiles, cross sections, detailed drawings, etc., or reproductions thereof, approved or to be approved by the City Engineer, which show the location, character, dimensions, and details for the work to be done, in which constitute a supplement to these standards.

**Pre-Development**—a site with natural vegetation on native soils.

Private Storm Drain—means a storm drain located on private property serving more than one structure on the same premises or parking lot catchbasins.

Project Engineer—see “Design Engineer”.

Public Storm Drain—means any storm drain in public right-of-way or easement operated and maintained by the City.

Receiving Bodies of Water—Creeks, streams, lakes, and other bodies of water into which waters are artificially or naturally directed.

Release Rate—The controlled rate of release of drainage, storm, and runoff water from property, storage pond, runoff detention pond, or other facility during and following a storm event.

Right-of-Way—All land or interest therein which by deed, conveyance, agreement, easement, dedication, usage, or process of law is reserved for or dedicated to the use of the general public, within which the City shall have the right to install and maintain storm drains.

Retention Facilities—Facilities designed to or which do hold water for a considerable length of time and then consume it by evaporation, plant transpiration, or infiltration into the soil. Any point discharge to a drainage channel or receiving body of water must be addressed in the Storm Drainage Report.

Sedimentation—Disposition of erosional debris-soil sediment displaced by erosion and transported by water from a high elevation to an area of lower gradient where sediments are deposited as a result of slack water.

Silt—Fine textured soil particles including clay and sand as differentiated from coarse particles of sand and gravel.

Siltation—Deposition of (silt) waterborne sediments—fine textured sedimentation—terms used to describe the smoothing or cementing effect of a blanket of silt deposited over sand and gravel areas used by migratory fish for spawning (including colloidal material when the transporting water evaporates).

Standard Plans—The drawings of structures or devices commonly used on City work and referred to on the plans (see standard construction specifications).

Storm Drainage Report—An Engineering Report, prepared by the Developer or a designated agent, that is required by the City of Stayton. The report must provide a hydrologic evaluation of the pre-development and developed site conditions associated with the proposed improvements. The report must demonstrate how the proposed stormwater management and water quality facilities will comply with these standards. The report must be signed and stamped by a professional engineer registered in Oregon.

Streets or Roads—Any public highway, road, street, avenue, alley, way, easement, or right-of-way used or to be used for vehicle movement.

Structures—Those structures designated on the standard plans as catchbasins, manholes, etc. Detailed drawings of structures or devices commonly used in ‘ City work and mentioned in these Standards are included in the standard construction specifications.

Subdivision—means to divide an area or tract of land into four or more lots within a calendar year when such area or tract of land existed as a unit or contiguous units of land under a single ownership at the beginning of such year.

Terrace—A relatively level step constructed in the face of a grade surface for drainage, erosion control, and maintenance purposes.

Trunk Drainage System—The trunk drainage system is that portion of the drainage system of the City which receives waters from an adjacent land area in excess of 20 acres. The trunk drainage system may consist of watercourses or man-made facilities such as pipes, ditches, and culverts.

Wetlands—Those lands adjacent to watercourses or isolated therefrom which may normally or periodically be inundated by the waters from the watercourse or the drainage waters from the drainage basin in which it is located. These include swamps, bogs, sinks, marshes, and lakes, all of which are considered to be part of the watercourse and drainage system of the City and shall include the headwater areas where the watercourse first surfaces. They may be, but are not necessarily, characterized by special soils such as peat, muck, and mud.

**1.6 ENGINEERING POLICY**

The engineering policy of the City of Stayton requires strict compliance with Oregon Revised Statute 672 for professional engineers.

All engineering plans, reports, or documents shall be prepared by a registered professional Civil Engineer, or by a subordinate employee under his/her direction, and shall be signed by the engineer and stamped with his/her seal to indicate his/her responsibility for them. It shall be the project engineer’s responsibility to review any proposed storm drain system, extension, and/or existing system change with the City, prior to engineering or proposed design work, to determine any special requirements or whether the proposal is permissible. A “Preliminary Review” and/or a “Plans Approval for Construction” stamp of the City, on the plans, and etc., for any job, does not in any way relieve the project engineer of his/her responsibility to meet all requirements of the City or obligation to protect the life, health, and property of the public. The Plan for any job shall be revised or supplemented at any time it is determined that the full requirements of the City have not been met.

**1.7 APPROVAL OF ALTERNATE MATERIALS OR METHODS**

Any alternate material or method not explicitly approved herein will be considered for approval on the basis of the objectives set forth in 1.00 PURPOSE. Persons seeking such approvals shall make application in writing. Approval of any major deviation from these Standards will (normally) be in written form. Approval of minor matters will be made in writing if requested.

Any alternate must meet or exceed the minimum requirements set in these Standards.

The written application is to include, but is not limited to, the manufacturer’s specifications and testing results, design drawings, calculations, and other pertinent information.

Any deviations or special problems shall be reviewed on a case-by-case basis and approved by the City Engineer. When requested by the City, full design calculations shall be submitted for review with the request for approval.

## 1.8 GENERAL APPLICABILITY

Permanent drainage facilities shall be provided on all property improvements within the City of Stayton per these Standards for the following types of development:

- a. All major or minor partitions and subdivisions.
- b. All commercial, industrial, single-family, and multifamily developments creating new impervious surfaces of greater than one thousand square feet in area within any twelve-month period. Individual single family residences maybe reviewed by the City Engineer on a case by case basis. These standards are intended to fulfill the requirements of Section 1406, “Special Storm Sewers,” of the Uniform Plumbing Code for private storm drains.
- c. Developments entailing construction which would change the point of discharge of surface waters, the quantity of discharge, or discharge surface waters at a higher velocity than that of the preconstruction discharge rate, or add to pollution of surface waters.
- d. Construction or reconstruction of public roadways and temporary detours.
- e. Developments entailing construction in or adjacent to any existing stream or surface watercourse including intermittent streams.
- f. Developments requiring construction in or adjacent to the 100 year floodplain of any stream.

## 2.0 GENERAL DESIGN CONSIDERATIONS

Storm drainage design within a development area must include provisions to adequately control runoff and provide water quality treatment from all public and private streets and the roof, footing, and area drains of residential, multifamily, commercial, or industrial buildings sufficient to meet the City's current TMDL requirements for compliance. The Design shall also include provisions to the drainage system in conformance with the adopted Stormwater Drainage Master Plan. These provisions are:

- a. Surface or subsurface drainage, caused or affected by the changing of the natural grade of the existing ground or removal of natural ground cover or placement of impervious surfaces, shall not be allowed to flow over adjacent public or private property in a volume or location materially different from that which existed before development occurred, but shall be collected and conveyed in an approved manner to an approved point of discharge.
- b. Surface water entering the subject property shall be received at the naturally occurring locations and surface water exiting the subject property shall be discharged at the natural locations with adequate energy dissipaters within the subject property to minimize downstream damage and with no diversion at any of these points.
- c. The approved point of discharge for all stormwater may be a storm drain, existing open channel, creek, detention, or retention pond approved by the City Engineer. Acceptance of suggested systems will depend upon the prevailing site conditions, capacity of existing downstream facilities, and feasibility of the alternate design.
- d. When private property must be crossed in order to reach an approved point of discharge, it shall be the developer's responsibility to acquire a recorded drainage easement (of dimensions in accordance with those included in Section 4.1.4 from the private property owner meeting the approval of the City Engineer. The drainage facility installed must be a closed conduit system. Temporary drainage ditch facilities, when approved, must be engineered to contain the stormwater without causing erosion or other adverse effects to the private property.
- e. The design storm peak discharge from the subject property may not be increased from conditions existing prior to the proposed development.
- f. Water Quality: All runoff from impervious areas and developed areas shall be treated for water quality and pollution reduction. The developer and project engineer are encouraged to incorporate "green" or low impact, environmentally friendly controls similar to those included in Appendix C in their designs. Water quality measures must address the Willamette Basin TMDL target pollutants of mercury, bacteria, and temperature.
- g. The developer shall include sufficient flow control facilities (i.e. detention ponds, lakes, retention areas, infiltration devices, etc.) in the project design to ensure that the releases from the developed condition does not exceed the natural occurring releases from the pre-developed condition. It will be the responsibility of the developer/project engineer to provide hydrologic and design calculations for both the pre-developed and developed conditions (in accordance with Appendix B) and to demonstrate compliance for the 2, 5, 10, 25, 50 and 100 year storm events. Flow control facilities shall be designed in accordance with Appendix C.
- h. Minimum width of an access easement from an existing public road to a drainage facility shall be fifteen (15) feet.
- i. Temporary and permanent erosion control measures shall be provided in accordance with Section 6.0 of these standards.

- g. Stormwater quality facilities shall be provided as required in Section 5.0.
- h. A Drainage Report and Drainage Plans shall be submitted in accordance with the guidelines presented in Appendix A.

## 2.1 DESIGN CRITERIA

### 2.1.1 Design Storm Recurrence

The intensity-duration design frequency is based on the type area through which the facility (pipe or ditch) passes and the size of the drainage facility. The adopted criteria are listed in Table 2-1.

<b>TABLE 2-1. DESIGN STORM RECURRENCE</b>	
Area	Conveyance: Peak Flow/Recurrence
Residential Areas	25-year storm
Commercial and High Value Districts	25-year storm
Trunk Lines (24" pipe and larger)	25-year storm
Minor Creeks and Drainage Ways (not shown as a flood plain on the Flood Insurance Rate Map (FIRM) (Culverts and Channels)	50-year storm
Major Creeks (shown as a flood plain on the FIRM) (Culverts, Bridges, etc)	100-year storm

### 2.1.2 Water Quality

All runoff from impervious areas and developed areas shall be treated for water quality and pollution reduction. Facilities shall be sized to treat flow from the Water Quality Storm, calculated from the total precipitation of 0.36 inches falling in 4 hours with a storm return period of 96 hours, as shown in Appendix B.

### 2.1.3 Flow Control Releases

Stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 50-year, 24-hour return storm. Specifically, the 2, 10, 25, and 50-year post development runoff rates will not exceed their respective 2, 10, 25 and 50-year pre-development runoff rates from each discharge location. Facilities shall be designed with an emergency spillway sized to pass 100-year storm event or an approved hydraulic equivalent.

## 2.2 SUBMITTAL REQUIREMENTS

### 2.2.1 Storm Drainage Report

A Storm Drainage Report must be submitted in accordance with Appendix A: Storm Drainage Report and Construction Plan Requirements.

## ***Calculations***

Design calculations shall be submitted for all drainage facilities and provided in a Drainage Report as outline in Appendix B.

### **2.2.2 Storm Drainage Construction Plans**

Storm Drainage Construction Plans must be submitted in accordance with Appendix A: Storm Drainage Report and Construction Plan Requirements.

### **2.2.3 Plan Submittal**

Construction plans shall be submitted in duplicate to Public Works/Engineering through the Permit Application Center (PAC) for checking to ensure compliance with these Standards, City of Stayton Ordinances, and good engineering practice. Submitted plans shall include specifications, test data, a materials list, drainage calculations, a soils report and design recommendations, easement and right-of-way descriptions, tie to City of Stayton Bench Mark and Monument System, and other material as requested by the City Engineer. A plan check fee will be levied at the time plans are submitted to PAC.

Once the plans are approved and the construction permit issued, the consulting engineer shall be responsible for providing all surveying services necessary to stake the project and prepare the as-built drawings when the project is complete.

## 3.0 COLLECTION

The following section contains the physical design requirements for the stormwater collection for public storm drains in the city. These design requirements may be used for private systems when plumbing code requirements cannot be met, provided the system is designed by a professional civil engineer.

### 3.1 SURFACE

In general, storm drains shall be designed to have access for cleaning no further than 400 feet apart with junctions made at manholes, cleanouts, or catchbasins.

#### 3.1.1 Roof Drains

Roof drains shall run through a vegetative filtration such as a planter box, rain garden, or lawn.

#### 3.1.2 Curb and Gutter

Types and Application, see Standards Plan No. 303

In general, curb and gutter shall be installed on all new street construction or reconstruction to control drainage from sheet flowing across the street, to preserve curb exposure during subsequent overlays, and to eliminate cracking new curbs during the street paving operation.

- a. Type “A” curb and gutter shall be utilized for all street with slope less than 0.5 ft. per 100 feet.  
The minimum gutter grade permitted shall be 0.25 feet per 100 feet (0.25 percent grade).
- b. Rolled Curb may be used in urban developments on private streets only.
- c. Type “C” curb may be used with slopes down to a minimum 0.50 feet per 100 feet (.50% grade).

#### 3.1.3 Catchbasin and Connector Pipes

This portion of drainage system is comprised of the curbed gutters of streets, the catchbasin inlets that collect the surface runoff, and ten-inch diameter connector and/or outlet pipes.

The inlet systems are to be designed in accordance with the following criteria:

- (a) ODOT Hydraulics Manual.
- (b) Hydraulic Engineering Circular No. 22 (FHWA-TS-84-202) Drainage of Highway Pavements.

#### ***Cleanouts and Catchbasin Design Requirements***

- a. Catchbasins and cleanouts may be used for the junction of pipes fifteen (15) inches-or less in diameter, and where the depth from rim to invert is less than four (4.0) feet. Pipe lines eighteen (18) inches in diameter may be connected to the larger dimension of the structure (catchbasin/cleanout) when the structure is formed and poured around the pipe during new construction.

Variance from the four (4) foot maximum depth will be reviewed on a case by case basis for approval on fifteen (15) and eighteen (18) inch diameter pipes.



- b. The maximum length of curb and gutter which may be drained by a catchbasin is five hundred (500) feet. Catchbasins shall be installed where the improvement ends on all streets terminating on a descending grade, and piped to an approved point of discharge.
- c. On new main line and lateral construction, catchbasin laterals of thirty (30) feet or less and ten (10) inches in diameter may tie into the main line with a shop fabricated 90° ‘T’, provided said connection is located not more than one hundred (100) feet from a manhole or cleanout on said main line being fifteen (15) inches or larger in diameter.
- d. The width of gutter flow on residential street shall not go past the shoulder and one travel lane or top the curb for a twenty (25) year design storm at any point along the street.
- e. Catchbasins shall be designed to completely intercept the ten (10) year design storm gutter flow.
- f. Type 1 catchbasins, Standard Drawings No. 203, shall be used at all locations where other construction (e.g., driveways, pedestrian ramps, etc.) or facilities do not prohibit. Exceptions will be considered on a case-by-case basis.
- g. Type “A” grates shall be used in street sags; Type “B” grates shall be used on construction grades.

### **3.1.4 Manholes**

- a. Manholes shall be installed at all pipe junctions where the depth from rim to invert exceeds four (4) feet or where the pipe is eighteen (18) inches in diameter or greater except as provided for in Section 3.1.3 (a). Exceptions will be reviewed on a case by case basis for approval.
- b. Manholes for pipes twenty-four (24) inches or greater in diameter shall conform to Standard Plan No. 104.
- c. Where the pipe size decreases upstream through the manhole, the upstream invert must be set above the downstream invert a distance equal to the difference in the two diameters (the crowns kept at the same elevation).

### **3.1.5 Slope Intercept Drainage**

Slope intercept drains shall be provided at the following locations and shall be designed with the requirements of Section 6.0 of these Standards with respect to erosion control:

- a. along the upper boundaries of a development where the natural ground slope exceeds ten (10) percent to intercept drainage from the tributary area above the site.
- b. along the lower boundary of a development where the natural ground slope exceeds ten (10) percent to prevent drainage onto a lower tributary area other than by means of an approved point of discharge.
- c. along the top of all cuts which exceed four (4) feet with cut slopes which exceed 2:1 where the tributary drainage area above the cut slopes towards the hinge point of the cut and has a drainage path greater than forty (40) feet measured horizontally.

## **3.2 SUBSURFACE DRAINAGE**

Subsurface drains (underdrains) shall be provided at the following locations:

- a. on all cut and fill slopes in excess of four (4) feet for stability except when a soils report submitted by a registered professional engineer experienced in soils certifies they are not required.
- b. for all existing springs or springs intercepted during construction activity for other facilities, i.e., sewer, water mains, or street excavations.
- c. where high ground water exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or underfloor flooding of buildings.

The drainage line installed shall begin at a cleanout and terminate at an approved point of discharge. Open jointed storm drain lines will not be considered as an acceptable solution.

## 4.0 CONVEYANCE

The following section contains the physical design requirements for the stormwater conveyance for public storm drains in the city. These design requirements may be used for private systems when plumbing code requirements cannot be met, provided the system is designed by a professional civil engineer.

### 4.1 PIPED SYSTEMS

#### 4.1.1 Laterals

This portion of the drainage system begins with a 12 inch or larger diameter pipe at the discharge point of the “CATCHBASIN, GUTTERS, AND CONNECTOR PIPE SYSTEM.” This portion of the system is designed to convey the twenty-five year frequency flow of the entire contributing area in its fully developed land use condition. This system terminates at the subsequent downstream point at which it is no longer capable of conveying the flow in an uncharged state in an 18 inch diameter pipe, at which point the system becomes a “TRUNKLINE.”

#### 4.1.2 Trunk Lines

This portion of the drainage system can be a pipe or an open channel. The trunk line system begins with an equivalent 21 inch diameter or larger pipe at the discharge point of the “LATERAL SYSTEM.” The trunk system is designed to convey the twenty-five year frequency storm flow of the entire contributing area in its fully developed land use condition. This assumes on site and/or regional detention is incorporated in the design. This system terminates at the subsequent downstream point at which it is no longer capable of conveying the flow in an unchanged state in a pipe diameter less than 36 inches.

#### 4.1.3 Culvert Design

Culverts provide for passage of water under or through obstructions placed across streams and drainageways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding. For pipe systems or culverts that convey flows from or through sensitive areas, a local representative of Oregon Department of Fish and Wildlife (ODFW) or other applicable state or federal agency should be contacted to determine if fish passage is required and to identify site specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.

#### 4.1.4 Design Criteria

##### ***Pipe Materials***

Pipe materials for public storm drains shall be PVC pipe, but concrete pipe should be considered for diameters greater than 18 inches.

Acceptable abbreviations for existing and proposed types of pipe are as follows:

PVC—Polyvinyl Chloride

CP—Concrete Pipe

Private storm drain pipe materials shall conform to Section 1403 of the Uniform Plumbing Code.

Pipe load analysis calculations must be submitted when requested by the City Engineer. Instances for such a request will include shallow cover (less than the minimum specified below), excessive cover and for the most economical pipe class.

Concrete pipe lines twenty-one (21) inches or greater in diameter which are laid transversed to traffic in the street section and which are subject to wheel loads shall be reinforced concrete rubber ringed Class III C-76.

Approval of alternate materials will be reviewed on a case-by-case basis for approval which shall include cast in-place pipe methods.

**Pipe Size**

Main line and lateral storm drains shall not be less than twelve (12) inches diameter and shall begin at a structure and shall terminate at an approved point of discharge.

Proposed exceptions to the above will be reviewed and considered for approval on a case-by-case basis by the City Engineer.

When two (2) parallel pipes are installed in lieu of a box culvert, the minimum separation between the pipes shall be one (1) foot or one-third the diameter, whichever is greater. This requirement may be waived if the void between the pipes below the spring line is filled by grouting or other approved method/substance.

**Minimum Grade**

All storm drains shall be laid on a grade which will produce a mean velocity (when flowing full) of at least two and one-half (2-1/2) feet per second, based upon Manning’s pipe friction formula using a roughness coefficient valued at not less than 0.013, or the pipe manufacturer’s recommendations, whichever is greater. The minimum acceptable grade for various pipe sizes with an “n” value of 0.013 are listed below:

<b>TABLE 2-5. MINIMUM PIPE GRADE</b>		
Inside Pipe Diameter (inches)	2.5 ft/sec Grade (feet per 100 feet)	2.0 ft/sec Grade (feet per 100 feet)
4	1.31	0.84
6	0.77	0.49
8	0.52	0.33
10	0.39	0.25
12	0.3	0.19
15	0.23	0.14
18	0.18	0.11
21	0.14	0.09
24	0.12	0.08
27	0.1	0.07
30 (or larger)	0.09	0.06

The minimum grade may be reduced from the above table to produce an absolute minimum velocity of 2.0 fps upon approval of the City Engineer. Cases requiring a flatter grade than permitted above shall also be reviewed on a case-by-case basis for approval by the City Engineer.

In theory, new PVC pipe has a manufacturer's "n" value of 0.009; however, sand and grit as well as slime build-up on the pipe walls render a true "n" value with time of 0.013; hence, an "n" value of less than 0.013 will not be considered for approval.

The use of corrugated aluminum pipe will require approximately one larger pipe size for any given flow, due to a Manning "n" value of 0.24 +/- depending upon corrugation patterns, use of coatings, etc. All use of corrugated aluminum pipe shall be supported by size calculations in accordance with the manufacturer's recommendations.

### ***Alignment***

Generally, storm drains shall be laid on a straight alignment between catch basins and between manholes; however, lines 12 inch diameter and smaller may be laid on horizontal curves conforming to the street curvature, but not less than a radius of 200 feet. PVC and aluminum pipe shall be laid on straight alignment only.

Variance for horizontal curves on larger size pipes shall be reviewed on a case by case basis for approval by the City Engineer.

### ***Anchor Walls***

Storm drains laid on slopes of twenty (20) percent or greater shall be secured by anchor walls in accordance with Standard Plan No. 113.

Where velocities greater than fifteen (15) per second are attained, special provision shall be made to protect structures against erosion and displacement by shock.

If either of these conditions occur the installation must be approved by the City Engineer.

### ***Cover Requirements***

All storm drains shall be laid at a depth sufficient to protect against damage by traffic and to drain building footings where practical. Sufficient depth shall mean the minimum cover from the top of the pipe to finish grade at the storm drain alignment.

Under normal conditions minimum cover shall be twenty-four (24) inches above the top of the pipe in paved areas and thirty (30) inches at all other locations. For PVC pipe, minimum cover shall be thirty-six (36) inches.

In areas of relatively flat terrain, the design engineer must show that sufficient depth is provided at the boundary of the development to properly drain the remainder of the upstream basin area tributary to the site.

### ***Location***

Where storm drains are being designed for installation parallel to other utility pipe or conduit lines, the vertical location shall be in such a manner that will permit future side connections of main or lateral storm drains and avoid conflicts with parallel utilities without abrupt changes in vertical grade of main or lateral storm drains.

**Storm Drains in Streets or Easements**

- a. Under normal conditions, storm drains shall be located in the street right-of-way within two (2) feet of the curbline and preferably on the low side of the street, except when catch basin location warrants otherwise. All exceptions shall be reviewed on a case-by-case basis for approval.
- b. When it is necessary to locate storm drains in easements, the storm drain shall be centered in the easement. Exception: When the storm drain is 12 inches in diameter and the easement is centered on a property line, the storm drain shall be offset eighteen (18) inches from property line (distances being measured property line to center line of pipe). All storm drain easements shall be exclusive and shall not be used for any purpose which would interfere with the unrestricted use of the storm drain line. Exception to this requirement will be reviewed on a case by case basis, such as a utility corridor in a new subdivision.
- c. Easements for storm drain lines fifteen (15) inches or less in diameter shall have a minimum width of ten (10) feet. Pipe line eighteen (18) to thirty-six (36) inches in diameter shall have a minimum width of fifteen (15) feet. All pipe lines greater than thirty-six (36) inches in diameter, shall have a minimum width of twenty (20) feet.
- d. Open channels shall have easements sufficient in width to convey the 100-year Floodplain Line when a 100-year design storm is required or fifteen (15) feet from the waterway centerline or ten (10) feet from the top of the recognized bank, whichever is greater. A fifteen (15) foot wide access easement shall be provided on both sides of the channel for channel widths greater than fourteen (14) feet at the top of the recognized bank.
- e. Easement locations for public storm drains serving a PUD, apartment complex, or commercial/industrial development shall be in parking lots, private drives, or similar open areas which will permit an unobstructed vehicle access for maintenance by City forces.
- f. All easements must be furnished to the City for review and approval prior to recording.

**Relation to Creeks and Drainage Channels**

Storm drain lines shall enter a creek or drainage channel at 90° or less to the direction of flow. The outlet shall have a head wall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of pipe or channel being entered will govern which protective measures are required. All protective measures must conform to the requirements of Section 6.0 of these Standards with respect to erosion control.

**4.2 SURFACE DRAINAGE**

**4.2.1 Channel Protection**

Open channels shall be designed to prevent scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6” thick gravel base. The following provides additional design guidance in assisting the design Engineer, however, the design Engineer shall be responsible for the final design.

<b>PROTECTION FOR NEW CHANNEL CONSTRUCTION</b>
Velocity at Design Flow (fps)

Greater than	Less than or equal to	Required Protection	Thickness	Minimum Height above Design Water Surface
0	3	Vegetation Lining	N/A	0.5 ft
3	5	Vegetation Lining and Check Dams	N/A	0.5 ft
5	8	Bioengineered lining* or ODOT Class 50** Riprap	N/A	1 ft
8	12	ODOT Class 200** Riprap	1.5 ft	2 ft
12	20	Slope Mattress, etc.***	2.5 ft	2 ft
<p>* Bioengineered lining allowed for greater than 5 fps.</p> <p>** ODOT Riprap Class in English Units</p> <p>*** For high velocity channels, engineering calculations are to be submitted to the City for review</p>				

### 4.2.2 Outfall Protection

Outfalls will be designed to prevent scouring at the outfall discharge and provide velocity reduction prior to discharge to the receiving channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6" thick gravel base. The following provides additional design guidance in assisting the design Engineer, however, the design Engineer shall be responsible for the final design.

ROCK PROTECTION AT OUTFALLS					
Required Protection Minimum Dimensions					
Velocity at Design Flow (fps)	Type	Thickness	Width	Length	Height
0 to 5	ODOT Class 50** Riprap	1.5 ft	Dia. + 6 ft	8 ft or 4x dia, whichever is great	crown + 1 ft
5 to 10	ODOT Class 200** Riprap	2.5 ft	Dia. + 6 ft or 3 x dia, whichever is greater	12 ft or 4x dia, whichever is great	crown + 1 ft
10 to 20	Designed System*	As required	As required	As required	crown + 1 ft
Greater than 20	Energy Dissipater Required				
* For high velocity outfalls, engineering calculation are to be submitted to the City for review.					
** ODOT Riprap Class in English Units					
*** For high velocity channels, engineering calculations are to be submitted to the City for review					

**4.2.3 Creeks or Drainage Ways Not Shown with a Floodplain on the Federal Insurance Rate Maps (FIRM) as Published by the Federal Emergency Management Agency (FEMA)**

This portion of the drainage system can be a covered facility (pipe, etc.) or an open channel. This portion of the drainage system begins with an equivalent 36 inch diameter or larger pipe at the discharge point of the “trunk system.” This system is designed to convey the 25 year frequency storm flow of the entire contributing area in its fully developed state. This system terminates at the subsequent downstream point of discharge at which the system is clearly a creek whose floodplain is first designated on the FIRM or is determined to be an interim flood hazard area by the City Engineer.

**4.2.4 Waterways with Floodplains Shown on the FIRM**

These reaches of the drainage system are located on the FIRM, or as otherwise located by the City Engineer, and are always designed for the 100 year frequency storm flow of the entire contributing area in its fully developed land use condition.

**4.2.5 Artificial Water Source Requirements**

- a. Artificial watercourses shall be designed with a “natural” curved alignment with a variable side slope not to exceed four to one, except that in tight spots created by existing natural features (e.g., boulders, large trees, etc.) where the slope can be three to one until the natural feature is bypassed or where steeper slopes are needed and do not impair the hydraulic efficiency of the waterway. The watercourse shall include a low flow channel as described in “e.” below and will be reviewed on a case-by-case basis for approval.

The bank shall be designed with one (1) foot of free board above the design storm with a minimum top of bank width of six (6) feet. A larger width shall be provided when required by



the City Engineer for maintenance purposes. The backslope of the bank shall not exceed two (2) horizontal to one (1) vertical. The existing ground adjacent to the toe of the bank backslope shall be graded to slope away at 2 percent to prevent water ponding at the backslope toe.

- b. Design shall be curvilinear with a 100 foot minimum radius. Tighter curves may be used if the City Engineer determines that sufficient erosion control has been incorporated into the design to maintain stable conditions following development.
- c. A low flow channel shall be designed to carry a two year design storm or the normal low water flow of a year-round creek, whichever is greater. Low flow channel slopes shall not exceed two to one and shall be stabilized to the satisfaction of the City Engineer. In general, bank stabilization will be required in any channel with a design flow velocity in excess of three feet per second. The invert shall be paved with concrete if the velocity is less than three (3) feet per second and to prevent local ponding for mosquito abatement purposes.
- d. New roadside ditch construction adjacent to public streets by new developments will not be permitted. Exception to this requirement will be reviewed on a case-by-case basis.
- e. Capacity of channels shall be determined by the Manning Formula. The value for “n” shall be 0.033 for maintained grass-lined “swales. The value for “n” shall be 0.35 for channels with rock-lined bottoms.
- f. Existing ditches approved for the point of discharge for storm drains and culverts shall be provided with rock-lined bottoms and side slopes at the discharge point of storm drain or culvert as specified in Section 4.2.2. These requirements are in addition to those required by Section 4.1.4 “Relation to Creeks and Drainage Channels.”
- g. All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following construction. Bank stabilization measures shall be consistent with the erosion control requirements in Section 6.0 of these Standards unless the City Engineer determines other proposed methods provide equal or greater erosion control.
- h. Points of discharge from culverts and storm drains into ditches and swales 15 percent or greater in grade shall be rock-lined with boulders with one face a minimum of 24” in dimension. Said rock lining shall extend for a distance of ten feet minimum from the point of culvert or storm drain discharge and shall have a width three feet in excess of the diameter of the culvert or storm drain. Special energy dissipaters may be substituted for boulders at the discretion of the City Engineer.

#### **4.2.6 Natural Creeks**

a. Creek Classification—Creeks in Stayton shall be classified as salmon-producing creeks or other creeks. No in-stream work will be allowed in salmon producing creeks during the months of September or October. The intent is to minimize sediment production in these creeks during critical salmon spawning season. The following creeks shall be included in the salmon-producing classification:

- Mill Creek
- Salem Ditch

A permit must be obtained from the Division of State Lands and the Department of Fish and Wildlife for all work between the creek banks.

## 4.2.7 Salmon-Producing Creek Requirements

The following requirements must be met in salmon-producing creeks. These are not in replacement of the requirements in 2.24 for natural creeks, but in addition to them.

- a. Creek bed alterations shall provide diversified habitats for a variety of creek organisms and a pleasing appearance. Creek bed alternations may be approved by the City Engineer on a case-by-case basis with approval to consider provision of:
  - 1) Sufficient water depth to support fish and other aquatic life during low flows.
  - 2) Diversity of water velocities through the use of pools and riffles.
  - 3) A meandering channel to facilitate a. and b. above.
  - 4) Sufficient creek bed gradient to provide adequate flow velocities.
- b. Creek bed gravel shall be well rounded rock in the following gradations (with larger rock in sufficient quantity to provide adequate riffling) or as approved by the City Engineer:

Mill Creek Approx. 15% 6”-3”

- c. Creek banks and sides shall be designed and constructed so as to provide stability, adequate shading, and cover for fish and other aquatic life, to the approval of the City Engineer. Shading shall be provided by plantings of appropriate types and sufficient quantities per Section 6.0 of these Standards. Creek bank designs and vegetation restoration plans may be approved by the City Engineer on a case-by-case basis.

Vertical creek banks (walls) should be avoided whenever possible as such a creek channel configuration decreases the creek carrying capacity and increases in-creek velocities during high flows.

- d. All creek work and channel design shall include a construction sequence list designed primarily to control erosion (per Section 6.0 of these Standards) and also to facilitate the planned construction. The construction sequence may be modified by the City Engineer during the construction as field conditions warrant. Such modifications may include more or less erosion control and construction shut down.
- e. Vegetation disturbance shall be minimized, creek banks shall be revegetated with appropriate native vegetation to provide shading for the creek.

## 4.2.8 Other Natural Creek Requirements

- a. Natural creeks shall be preserved and all work in and adjacent to creeks shall incorporate both temporary and permanent erosion control measures in accordance with Section 6.0 of these Standards. No alteration will be permitted that reduces the overall creek capacity.
- c. Creek construction, relocation, and/or reconstruction may be approved if the City Engineer determines that such a proposal will result in an overall benefit to or maintenance of a surface water system of equal quality in terms of water quantity and quality control.
- d. Any and all stream work shall be consistent with the floodplain management policies and regulations.
- e. Any and all stream work shall be consistent with the City’s Stormwater Management Plan.

## 5.0 STORMWATER QUALITY AND QUANTITY FACILITIES

City of Stayton requires stormwater facilities for development creating new impervious surfaces of greater than one thousand square feet in area within any twelve-month period. These stormwater facility standards are intended to provide guidance toward flow control and reduction in stormwater pollutants. The guidelines are not intended to be a comprehensive list of all stormwater facilities, but provides a general overview of those commonly used.

Stormwater facilities are installed to reduce flow and pollutants from a site prior to entering the cities storm drainage system or natural drainage course. Stormwater plans submitted to the city must address water quality measures taken to meet the Willamette Basin TMDL targets for mercury, bacteria, and temperature.

In selecting the appropriate stormwater facility for a site the designer must consider the site characteristics, anticipated land uses, runoff characteristics, and treatment objectives.

Stormwater facilities shall also be construction in accordance with the following requirement and Appendix C: Water Quality and Quantity Facility Design. Numerous resources are available which provide additional detail and design requirement for stormwater facilities, including City of Portland Stormwater Management Manual, Clean Water Services Design and Construction Standards for Sanitary Sewer and Surface Water Management, the King County Surface Water Design Manual, and the Washington Department of Ecology's (DOE) Stormwater Management Manual for Western Washington.

### 5.1 WATER QUALITY FACILITIES

Owners of new development and other activities which create new impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site are required to construct or fund permanent water quality facilities to reduce contaminants entering the storm and surface water system.

#### 5.1.1 Criteria for Requiring Construction of a Water Quality Facility

- a. A water quality facility shall be constructed on-site unless, in the judgment of the City, any of the following conditions exist:
  - 1) The site topography or soils makes it impractical, or ineffective to construct an on-site facility;
  - 2) The site is small, and the loss of area for the on-site facility would preclude the effective development.
  - 3) There is a more efficient and effective regional site within the subbasin that was designed to incorporate the development or is in the near vicinity with the capacity to treat the site.
  - 4) The development is for the construction of one or two family (duplex) dwellings on an existing lot of record.
- b. If construction of an on-site facility is not required, the owner of the development shall pay a System Development Charge in accordance with City Rules and Regulations. The System Development Charge shall be calculated on an equivalent basis of constructing the minimum Standard Water Quality Swale.

### **5.1.2 Water Quality Facility Design Standards**

- a. The stormwater quality facilities shall be designed to remove 80 percent of the total suspended solids from the runoff from 100 percent of the newly constructed impervious surfaces.
- b. The total suspended solids removal efficiency specifies only the design requirements and is not intended as a basis for performance evaluation or compliance determination of the stormwater quality control facility installed or constructed pursuant to this document.
- c. If an onsite water quality facility cannot be constructed to treat the runoff from the development's impervious surface, then with City approval, an on- or off-site water quality facility may be designed to treat runoff from an equivalent area of adjacent untreated impervious surfaces.
- d. Facilities shall be designed such that flow from the development is treated off-line from the storm conveyance system and reconnected to upstream flows following treatment. If an off-line facility is not feasible, additional capacity may be required for upstream flow.
- e. Discharges to sensitive areas shall maintain the hydroperiod and flows of pre-development site conditions to the extent necessary to protect the characteristic functions of the sensitive area.
- f. The stormwater quality facilities shall be designed for a dry weather storm event totaling 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours.
- g. Water quality facilities shall be constructed as part of the subdivision public improvements.
- h. Other design options for meeting this section may be considered by the City for approval.
- i. All water quality facilities shall be designed in accordance with Appendix C: Water Quality and Quantity Facility Design.
- j. Water quality facilities shall be designed to address the Willamette Basin TMDL pollutants of mercury, temperature, and bacteria.

### **5.1.3 Impervious Area Used In Design**

- a. For single family and duplex residential subdivisions, stormwater quality facilities shall be sized for all impervious area created by the subdivision and for all existing impervious area proposed to remain on site.
- b. For all developments other than single family and duplex, including rowhouses and condominiums, the sizing of stormwater quality facilities shall be based on the impervious area created by the development and for all existing impervious area proposed to remain on site, including structures and all roads and impervious areas. Impervious surfaces shall be determined based upon building permits, construction plans, or other appropriate methods of measurement deemed reliable by City.
- c. The City encourages design initiatives that reduce effective impervious area. In developments other than single family and duplex, a decrease in the size of the water quality facility may be possible.

## **5.2 WATER QUANTITY/FLOW CONTROL FACILITIES**

Each new development including, but not limited to new subdivisions, all commercial and industrial development and all parking lots with a total developed area of 1000 square feet or more and all other developments where the City engineer determines control is needed to prevent flooding or damage

downstream. must incorporate techniques for mitigating its impacts on the public stormwater system. The City shall determine which of the following techniques may be used to satisfy this mitigation requirement.

- a. Construction of permanent on-site stormwater quantity detention facilities designed in accordance with Appendix C: Water Quality & Quantity Facility Design; or
- b. Enlargement or improvement of the downstream conveyance system in accordance with Appendix C: Water Quality & Quantity Facility Design; or
- c. Payment of a Storm and Surface Water Management System Development Charge (SWM SDC) which includes a water quantity component to meet these requirements.

### **5.2.1 Criteria for Requiring On-Site Detention**

- a. If the on-site facility is required to be constructed, the development shall be eligible for a credit against SWM SDC fees. On-site facilities shall be constructed when any of the following conditions exist:
  - 1) There is an identified downstream deficiency, and detention rather than conveyance system enlargement is determined to be the more effective solution.
  - 2) There is an identified regional detention site within the boundary of the development.
  - 3) There is a site within the boundary of the development, which would qualify as a regional detention site under criteria or capital plan adopted by the City.
  - 4) Water quantity facilities as required by City adopted watershed management plans or adopted subbasin master plans.

### **5.2.2 Water Quantity Facility Design Criteria**

- a. All water quantity facilities shall be designed in accordance with City guidance documents and be consistent with Appendix C: Water Quality and Quantity Facility Design.
- b. When required, stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 25-year, 24-hour return storm. Specifically, the 2, 10, and 25-year post development runoff rates will not exceed their respective 2, 10, and 25-year pre-development runoff rates; unless other criteria are identified in an adopted watershed management plan or subbasin master plan.
- c. When required because of an identified downstream deficiency, stormwater quantity on-site detention facilities shall be designed such that the peak runoff rates will not exceed pre-development rates for the specific range of storms which cause the downstream deficiency.
- d. Construction of on-site detention shall not be allowed as an option if such a detention facility would have an adverse effect upon receiving waters in the basin or subbasin in the event of flooding, or would increase the likelihood or severity of flooding problems downstream of the site.
- e. Channel Protection shall be provide as required in Section 4.2.1.
- f. A downstream analysis shall be preformed as described in Section 5.2.4.

### **5.2.3 Water Quantity Facility Design Standards**

All water quantity facilities shall be designed in accordance with Appendix C: Water Quality and Quantity Facility Design.

#### **5.2.4 Downstream System Analysis**

- a. The design engineer for each development constructing new impervious surface of more than 1,000 square feet shall submit documentation, for review by the City, of the downstream capacity of any existing storm facilities impacted by the proposed development. The design engineer must perform an analysis of the drainage system downstream of the development to a point in the drainage system where the proposed development site constitutes ten percent or less of the total tributary drainage volume, but in no event less than 1/4 mile.
- b. If the capacity of any downstream public storm conveyance system or culvert is surpassed, due directly to the development, the developer shall correct (mitigate) the capacity problem or construct an on-site detention facility unless approved otherwise by the City.
- c. If the projected increase in surface water runoff which will leave a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition prior to development, or the developer must construct an on-site detention facility.
- d. Any increase in downstream flow shall be reviewed for erosion potential, defined as downstream channels, ravines, or slopes with evidence of erosion/incision sufficient to pose a sedimentation hazard to downstream conveyance systems or pose a landslide hazard by undercutting adjacent steep slopes.

## 6.0 EROSION AND SEDIMENT CONTROL

The applicability of this section shall be for all construction projects and earth disturbance projects with ground disturbance greater than one thousand (1000) square feet in area within any twelve-month period.

Prior to approval of construction an Erosion/Sedimentation Control Plan shall be developed in accordance with the following criteria and the Oregon DEQ guidelines set forth in the *Erosion and Sediment Control Manual*

- a. Proposed measures for controlling runoff during all three phases of construction:
  - 1) Prior to excavation or construction.
  - 2) During excavation and construction.
  - 3) After construction until the site is stabilized.
- b. For subdivision plats this shall include temporary erosion control measures to be utilized by the applicant during installation of plant improvement and by subsequent builders during construction of dwellings and other lot improvements.
- c. Prior to the initial clearing and grading of any land development, provisions shall be made for the interception of all potential silt-laden runoff that could result from said clearing and grading. Said interception shall preclude any silt-laden runoff from discharging from the proposed land development to downstream properties unless previously approved by the City Engineer. Said interception shall cause all silt-laden runoff to be conveyed by open ditch or other means to whatever temporary facility is necessary to remove silt prior to discharge to downstream properties.
- d. Prior to initial clearing and grading of construction site, an evaluation of the following factors must be performed:
  - 1) Soil Erodibility—Soil erodibility should be identified using Soil Conservation Service erodibility ratings. Erosion control techniques shall be designed accordingly.
  - 2) Slope and Runoff—All cleared areas will require protection from erosion.
  - 3) Cover—Erosion protection will be required for all disturbed areas.
- e. Temporary/permanent hydroseeding or acceptable seeding and mulching must be provided whenever perennial cover cannot be established on sites which will be exposed for 180 days or more.
- f. Construction projects and earth disturbance projects with ground disturbance greater than one acre shall obtain a National Pollutant Discharge Elimination System Stormwater Construction General Permit No. 1200-C as required by the Oregon DEQ.

APPENDIX A  
STORM DRAINAGE REPORT AND  
CONSTRUCTION PLAN REQUIREMENTS



## **STORM DRAINAGE REPORT**

a. The Drainage Report shall be on 8-1/2" x 11" paper and maps shall be folded to 8-1/2" x 11" size unless another format is approved prior to submittal.

b. The Drainage Report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:

- 1) Cover Sheet, including the project name, land use authority case file number, proponent's name, address and telephone number, Design Engineer, and date of submittal.
- 2) Table of Contents, with the page numbers for each section of the report, including exhibits, appendices, and attachments.
- 3) Vicinity Map.
- 4) Project Description: Describe the type of permit(s) for which the proponent is applying, the size and location of the project site, address or parcel number and legal description of the property, property zoning. Also describe other permits required (e.g. Corps of Engineers 404 Fill Permit, DEQ Erosion Control Permits, etc). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.
- 5) Existing Conditions:
  - a) Describe existing site conditions and relevant hydrological conditions including but not limited to:
    - Project site topography;
    - Land cover and land use;
    - Abutting property land cover and land use;
    - Offsite drainage to the property;
    - Natural and constructed channels;
    - Sensitive areas, wetlands, creeks, ravines, gullies, steep slopes, springs and other environmentally sensitive areas on or adjacent to the project site.
    - Seasonal groundwater levels for subsurface system components (i.e., lines, detention ponds, underground storage, etc.)
  - b) General soils conditions present within the project site, using SCS soil designations.
  - c) Points of discharge for existing drainage from the project site.
  - d) Include references to relevant reports such as basin plans, flood studies, groundwater studies, wetland designation, watershed plans, subbasin master plans, sensitive area designation, environmental impact statements, water quality reports, or other relevant documents. Where such reports impose additional conditions on the Proponent, those conditions shall be included in the report.
  - e) Soils Report(s), where applicable.

- f) Hydrologic Analysis
- g) Basin Map(s), showing boundaries of project, any offsite contributing drainage basins, onsite drainage basins, approximate locations of all major drainage structures within the basins, and depicting the course of stormwater originating from the subject property and extending all the way to the closest receiving body of water. Reference the source of the topographic base map (e.g. USGS), the scale of the map, and include a north arrow.
- h) Drainage Basin Description: Describe the drainage basin(s) to which the project site contributes runoff, and identify the receiving waters for each of these drainage basins.
- i) Developed Site Drainage Conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposal for the collection and conveyance of site runoff from the project site, for the control of any increase in stormwater quantity resulting from the project, and for the control of stormwater quality.
- j) Description of upstream basins, identifying any sources of runoff to the project site. This should be based on field investigation. Any existing drainage or erosion issues upstream that may have an impact on the proposed development should be noted.
- k) Downstream analysis, include a summary table comparing the pre-developed and developed hydraulic analysis for all discharge points.
- l) Hydraulic Design Computations, supporting the design of all proposed stormwater conveyance, quantity and quality control facilities, and verifying the capacity of existing and proposed drainage facilities. These computations may include capacity and backwater analysis required either as part of the proposed drainage design or as part of the downstream drainage investigation, and flood routing computations required for the design of detention/retention storage facilities, for wetland impact analysis, or for floodplain analysis. A description on how the stormwater system will function during the water quality storm, 2-year storm, 25-year storm and the 100-year storm shall also be included.
- m) Maintenance and Operation Manual: Required for privately owned and maintained stormwater quantity and quality control facilities. This manual will be an attachment to the maintenance covenant.
- n) Appendices: Shall include technical information as necessary.

# STORM DRAINAGE CONSTRUCTION PLANS

## General

Complete plans and specifications for all proposed drainage improvements including any necessary dedications and easements shall be submitted for approval and must receive the required approval prior to construction permit issuance and beginning of construction.

## Plan Preparation

Construction plans and specifications shall be prepared by a professional civil engineer licensed in the State of Oregon. It is the responsibility of the Design Engineer to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of the design guidelines contained in this document.

a. Dimensions—Construction plans shall be clearly and legibly drawn on paper 22 by 34 inches with a 1-1/2 inch clear margin on the left edge and one inch margins on all other edges.

Plans from consultants for construction permit projects shall be blue-line or photocopied drawings meeting the above size (24 by 36 inch blue-line prints are acceptable.)

b. Scale—Horizontal scale shall be 1" = 50'; vertical scale shall be 1" = 5' or as approved by the City Engineer.

c. Form—Title Sheet, Plan and Profiles, Storm Drain Appurtenances, and Site Drainage Plan.

The Drainage Plan shall contain the following:

### ***Title Sheet***

a. Plan view (Site Plan) of the entire project, showing street right-of-way and/or subdivision layout to a scale of 1" = 100'. A smaller scale may be used on large projects upon approval of the City Engineer. A project is too large when a minimum dimension of two (2) inches cannot be maintained between the title, system site plan, and vicinity map. A scale of 1" = 200' may be used in this case. The site plan shall be a composite plan showing all complete properties to be served by the storm drain improvements and properties adjacent to and within 250 feet of those served, existing and proposed natural or artificial streams, swales, and storm drains, line sizes, designations, structures and their numbers, tract names and numbers, lot numbers or property owners' names, street names, and total acreage including streets directly served.

b. Index of Sheets.

c. Complete legend of symbols used.

d. Vicinity Map to a scale of not less than 1" = 800' showing the project location and drainage basin used to size the system.

e. Title Block—located in lower right hand corner or right edge of paper with scale, north point, date, drawing number, the Design Engineer's name, address and official stamp, and where applicable, the owner/developer's name and address.

f. Temporary and permanent bench marks including their descriptions.

g. General and special notes relating to construction methods. Note: For projects showing five (5) lots or less, the title sheet and plan and profile sheet may be one and the same if approved by the City Engineer.

### ***Project Site***

At least one sheet will contain a plan view of the entire project site. In the event the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet containing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.

### ***Existing Conditions***

A topographical contour map clearly defining existing conditions:

- a. Existing contours of the land at two (2) foot intervals or as approved by the City Engineer with the location of existing buildings, structures on the property. Location of any existing building or structure on adjacent property which is within fifteen (15) feet of a proposed public drainage facility;
- b. Adjacent streets, including street names.
- c. Existing public and private utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert or flowline elevations.
- d. All areas, within 250 feet of the site, improved or unimproved, lying upstream and draining to or through the proposed development;
- e. Location of existing drainage facilities which transport surface water onto, across, or from the site, including natural watercourses, artificial channels, drain pipes, or culverts.
- f. Locations of springs or other subsurface water outlets;
- g. Existing environmentally sensitive areas (e.g. ravines, swales, steep slopes, springs, wetlands, creeks, lakes, etc.). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year flood plain boundary (if applicable).
- h. Arrows indicating drainage direction in all public and private property and for all hydraulic conveyance systems.

### ***Proposed Drainage Improvements Plan***

A topographic contour plan clearly defining proposed conditions:

- a. Proposed contours of the land after completion of the project at two (2) foot intervals or as approved by the City Engineer. This shall include elevations, dimensions and location, extent, and slopes of all grading work proposed to be done.
- b. Identify cut and fill areas, desilting facilities, interceptor ditches (channels), velocity check dams, soils, topography, vegetation, and areas of proposed reseeding.
- c. Proposed structures including roads and road improvements, parking surfaces, building footprints, walkways, landscape areas, etc.

- d. Proposed utilities, showing exact line and grade of all proposed utilities at crossings with the proposed drainage system.
- e. Setbacks from environmentally sensitive areas.
- f. Proposed drainage structures, including pipes, open channels, culverts, ponds, vaults, biofiltration swales, infiltration facilities, outfalls, riprap treatment, energy dissipaters, etc.
- g. Plan and profile of drainage conveyance facilities will include the following information: pipe sizes, pipe types and materials, lengths, slopes, type of structure (e.g. Type 2 CB), location of structures, invert elevations in/out of structures, and top elevations of structures. Notes shall be included referencing details, cross-sections, profiles, etc.
- h. Indicate any proposed phasing of construction.
- i. Boundaries of all areas that will be paved or otherwise altered in a manner that will increase surface water runoff and boundaries of all areas to remain in an existing or natural condition.

### ***Stormwater Quality and Quantity Facility Plan(s)***

A detailed grading plan will be provided for all open stormwater quantity control and/or quality control facilities. This plan shall include the following:

- a. Existing ground contours (screened) and proposed ground contours at a minimum of a 2-foot contour interval. Slopes steeper than 6 horizontal to 1 vertical shall be identified.
- b. Location of top and toe of slope.
- c. Limits of embankment designed to impound water.
- d. Location of all drainage structures as well as any other piped utilities in vicinity.
- e. Flow route of the secondary/emergency overflow system.
- f. Maintenance access, as applicable.

### ***Landscape Plan***

A detailed landscape plan will be provided for open stormwater quantity control and/or quality control facilities. This plan shall include the following:

- a. Final ground contours at a minimum of a 2-foot contour interval.
- b. Location of top and toe of slope.
- c. Maximum water surface elevation.
- d. Location of all drainage structures as well as any other piped utilities in vicinity (screened).
- e. Limits of areas to receive amended topsoil.

### ***Cross Sections***

Cross sections shall be provided for at least the following:

- a. Detention/retention ponds (including parking lot ponds and other multi-use facilities), wet ponds and sediment ponds. This cross section(s) shall graphically illustrate:

- (1) The design maximum water surface for the 2-year and 25-year design storms.
  - (2) The proposed dead storage water surface (as applicable).
  - (3) Pavement section or amended soil section as applicable.
- b. Proposed ditches and swales, including vegetated swales.

### ***Storm Drain System Plan and Profiles***

#### ***Plan***

Plan view of storm drain lines shall be to a scale of 1" = 50' and shall contain the following information in addition to the above:

- a. Adjacent street curbs and property lines, right-of-way and utility easements referenced to property corners, street intersections, or section lines. Adequate two (2) foot contour lines or property corner and curb elevations to help determine the points of disposal for building storm drains.
- b. The location of each manhole and catchbasin shall be numbered and stationed to facilitate checking the plans with the profiles. The stationing shall be tied to existing property corners and/or street monuments with the relationship of each manhole and catch basin shown to the property corners (minimum two directions). Each line with a separate designation shall be stationed continuously up grade from Station 0+00 at its point of connection to another line.
- c. Location of water courses, railroad crossings, culverts, and sanitary sewers that cross the alignment within 250 feet of the proposed extension. All water course channels must show the 100 year flood plain and floodway channel for the design storm as specified by Sections 2.01 and 2.29 of these Standards.
- d. Location of water mains, valves, pump stations, blow-offs, services, gas mains, underground power, and other utilities that either cross the alignment within 250 feet of the terminus of the proposed extension or are adjacent to the proposed extension within the public right-of-way or within ten (10) feet of the easement line. The intent is to prevent grade conflicts of all future extensions.
- e. The location and elevation of the bench mark used as the basis of vertical control in the design shall be shown on the plans and referenced to property corners and/or street monuments.

#### ***Profiles***

Profiles for the individual storm drain lines and open channels shall be to the same horizontal scale on the same sheet and drawn immediately below the corresponding plan view to a vertical scale of 1" = 5' reading from 0+00 left to right (where conditions warrant, right to left may be approved as well as a smaller vertical scale), and shall contain at least the following information in addition to the above:

- a. Location of catchbasins, manholes, and other appurtenances with each manhole and catchbasin numbered and stationed as in item 2 of Plan above.
- b. Profile of the existing and proposed ground/or pavement surface, storm drain invert, and backwater curve for the design storm.

- c. Size, slope, length, and type of material of the line between consecutive catchbasins or manholes (type of pipe may be designated by abbreviations listed under Section 2.13), type of pipe bedding and backfill material.
- d. Elevation of original ground, finished grade, proposed rim elevation, and storm drain inverts at each catchbasin or manhole (Mean Sea Level Datum, U.S.G.S.).
- e. Railroad crossings, ditch, or creek channels with elevations of the ditch or creek bed and the 100-year flood elevation profile. See Section 2.20 for additional plan requirements.
- f. Utility crossings that conflict with the proposed storm drain installation.
- g. All existing facilities upon which work is to be performed, i.e., installation, repair, or removal.

SPECIAL NOTE: The Design Engineer shall field locate and verify the alignment, depth, and inverts of all existing facilities shown on the plans that will be crossed by proposed facilities and shall certify them with a note on the plans. City as-builts are only to be used as an aid to the Design Engineer when field verifying the existing facilities.

### ***Storm Drain Appurtenances***

Detailed drawings shall be included for all storm drain appurtenances including manholes, catchbasins, culverts, head walls, orifice controls, detention diversion structures, etc. Appropriate references to City of Stayton Standard Drawings may be used in lieu of details actually shown on the plans.

### ***Surface Drainage***

- a. Plan requirements for surface drainage courses shall include the requirements previously specified above and the following supporting data:
  - 1. Plan drawn to a scale of not less than 1" = 100' with north arrow and vicinity map. Topography with two (2) foot contours. If in a floodplain shown on the F.I.R.M. show the 100-year floodway contour.
  - 2. Profile of the channel showing the existing flowline and top of bank, proposed flowline and top of bank and design stormwater surface profile (backwater curve).
  - 3. A minimum of three (3) cross sections of the existing channel adjoining or crossing the property taken at the upstream, midsection, and downstream boundaries of the property. More section may be required depending on the length of the reach and existing channel alignment.

APPENDIX B  
HYDROLOGY CALCULATION REQUIREMENTS



# 1.0 HYDROLOGIC ANALYSIS

This section presents acceptable methodology for estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods should be used to analyze existing and design proposed drainage systems and related facilities.

## 1.1 Rational Method

The rational method for analyzing small drainage basins is allowed with the following limitations:

- a. Only for use in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.
- b. Drainage subbasin area cannot exceed 25 acres for a single calculation without approval from the City.
- c. The time of concentration shall be five minutes when computed to be less than five minutes.
- d. Rainfall intensities shall be from the rainfall intensity-duration curve for City of Stayton as shown on Figure 1.

### **Runoff Coefficients**

The recommended coefficients of runoff (C) are listed in Table 1.

<b>TABLE 1. RUNOFF COEFFICIENTS, C</b>				
Soil Cover	Flat s<2%	Terrain	Rolling Terrain 2%<s<40%	Steep Terrain s>10%
Relatively high permeability (lawns, pasture, woods)	0.20		0.25	0.3
Moderate impermeability				
1) Single-family residential in urban areas, except corner lots with duplex potential	0.40		0.45	0.50
2) Gravel parking lots	0.50		0.55	0.60
3) Mobile home parks	0.60		0.65	—
4) Multi-family residential, zero-lot-line single-family residential and potential duplex lots in single-Family residential	0.70		0.75	0.80
High impermeability (roofs and paved areas)	0.90		0.90	0.90

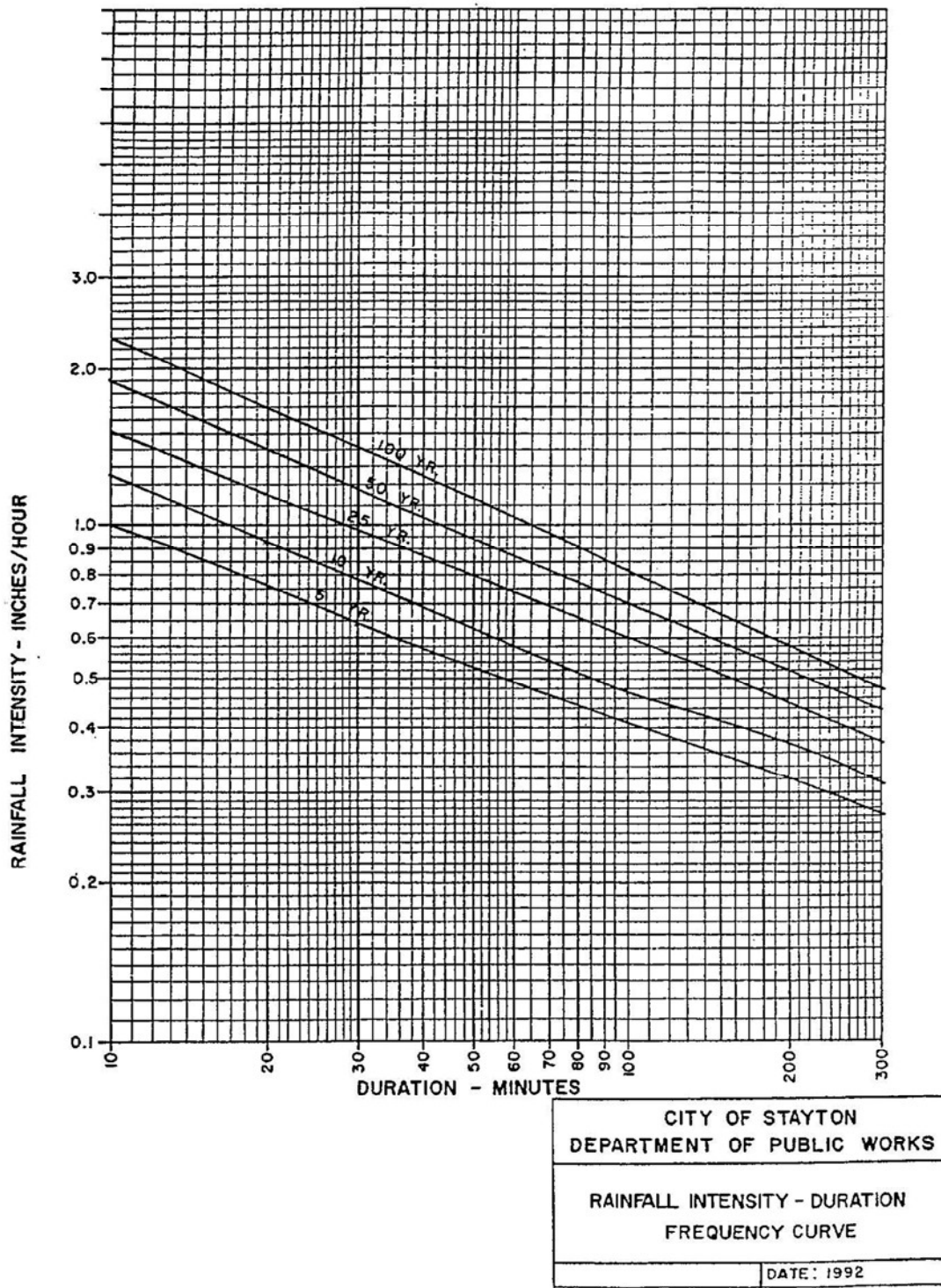


Figure 1. City of Stayton Rainfall Intensity-Duration Frequency Curve

## 1.2 Unit Hydrograph Methods

a. To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the City. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.

b. The Design Storm

1. Return frequency and duration specify the design storm event. The design storms shall be based on two parameters:
  - Total rainfall (depth in inches).
  - Rainfall distribution (dimensionless).

c. Design Storm Distribution

1. The rainfall distribution to be used within the City is the design storm of 24-hour duration based on the standard NRCS Type 1A rainfall distribution using the chart on the following page. The total depth of rainfall for storms of 24-hour duration and 2, 5, 10, 25, 50 and 100 year recurrence are 2.7, 3.2, 3.5, 4.0, 4.4, 4.7 inches respectively. As reported in the City of Salem, Stormwater Master Plan, September 2000.
2. The Table 2 contains the NRCS Type 1A precipitation distribution.

**TABLE 2.  
TYPE IA DESIGN STORM DISTRIBUTION CHART**

Hour	Percent Rainfall		Rainfall Depth (inches)					
	Incremental	Cumulative	2yr	5 yr	10 yr	25 yr	50 yr	100 yr
			2.7	3.2	3.5	4.0	4.4	4.7
1	2.40	2.40	0.06	0.08	0.08	0.10	0.11	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.09	0.10	0.11	0.13	0.14	0.15
4	3.80	12.00	0.10	0.12	0.13	0.15	0.17	0.18
5	4.44	16.44	0.12	0.14	0.16	0.18	0.20	0.21
6	5.18	21.62	0.14	0.17	0.18	0.21	0.23	0.24
7	6.48	28.10	0.17	0.21	0.23	0.26	0.29	0.30
8	16.44	44.54	0.44	0.53	0.58	0.66	0.72	0.77
9	7.58	52.12	0.20	0.24	0.27	0.30	0.33	0.36
10	5.28	57.40	0.14	0.17	0.18	0.21	0.23	0.25
11	4.96	62.36	0.13	0.16	0.17	0.20	0.22	0.23
12	4.32	66.68	0.12	0.14	0.15	0.17	0.19	0.20
13	4.02	70.70	0.11	0.13	0.14	0.16	0.18	0.19
14	3.42	74.12	0.09	0.11	0.12	0.14	0.15	0.16
15	3.28	77.40	0.09	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.10	0.11	0.12	0.13	0.14
17	2.80	83.20	0.08	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.08	0.08	0.10	0.11	0.11
19	2.40	88.00	0.06	0.08	0.08	0.10	0.11	0.11
20	2.40	90.40	0.06	0.08	0.08	0.10	0.11	0.11
21	2.40	92.80	0.06	0.08	0.08	0.10	0.11	0.11
22	2.40	95.20	0.06	0.08	0.08	0.10	0.11	0.11
23	2.40	97.60	0.06	0.08	0.08	0.10	0.11	0.11
24	2.40	100.00	0.06	0.08	0.08	0.10	0.11	0.11

d. Runoff Parameters

The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.

- 1) Area
- 2) Curve Number
- 3) Time of Concentration
  - a) Selection of Area:

To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use within a given basin must be addressed by dividing the basin area into subbasin areas of similar land use and/or runoff characteristics. Hydrographs should be computed for each subbasin area and superimposed to form the total runoff hydrograph for the basin.

All pervious and impervious areas within a given basin or subbasin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately the cumulative errors associated with averaging these areas are avoided and the true shape of the runoff hydrograph is better approximated.

b) Selection of Curve Number:

The Natural Resources Conservation Service (NRCS) (formerly referred to as the Soil Conservation Service (SCS)) has developed "curve number" (CN) values based on soil type and land use. The combination of these two factors is called the "soil-cover complex." The soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil Hydrologic Groups may be found in Table 4, Soil Survey of Marion County, Oregon (SCS September 1972).

The following are important criteria/considerations for selection of CN values:

- (1) Many factors may affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
- (2) CN values can be area weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas should not be combined with low CN areas (unless the low CN areas are less than 15 percent of the subbasin).
- (3) Antecedent soil moisture values should be considered. Soil should be considered to be moist prior to the start of the precipitation event.

c) SCS Curve Number Equations:

The rainfall-runoff equations of the NRCS curve number method relate a land area's runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

$$Q_d = (PR - 0.2S)^2 / (PR + 0.8S) \text{ for } PR > 0.2S; \text{ and}$$

$$Q_d = 0 \text{ for } PR < 0.2S$$

Where

$Q_d$  = runoff depth in inches over the area,

$PR$  = precipitation depth in inches over the area,

$S$  = potential maximum natural detention, in inches over the area, due to infiltration, storage, etc.

The area's potential maximum detention,  $S$ , is related to its curve number,  $CN$ :

$$S = (1000/CN) - 10$$

The computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying  $Q_d$  by the area (with necessary conversions):

$$\text{Total Runoff Volume (cubic-feet)} = Q_d (\text{in}) \times A (\text{ac}) \times 3,630 (\text{cubic-feet}/(\text{ac-in}))$$

When developing the runoff hydrograph, the above equation for  $Q_d$  is used to compute the incremental runoff depth for each time interval from the incremental precipitation depth given by the design storm hyetograph. This time distribution runoff depth is often referred to as the precipitation excess and provides the basis for synthesizing the runoff hydrograph.

d) Time of Concentration:

Time of concentration ( $T_c$ ) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time ( $T_t$ ) is the time it takes water to travel from one location to another in a watershed.  $T_t$  is a component of time of concentration ( $T_c$ ).  $T_c$  is computed by summing all the travel times for consecutive components of the drainage conveyance system.  $T_c$  influences the shape and peak of the runoff hydrograph.

(1) Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute  $T_t$ :

$$\text{Sheet Flow: } T_t = (0.93L^{0.6} \times n^{0.3}) / (10.4 \times S^{0.3})$$

Where

$T_t$  = travel time (min)

$n$  = Manning's effective roughness coefficient for sheet flow

$L$  = flow length (ft)

$I$  = rainfall intensity in inches per hour

$S$  = slope of hydraulic grade line (ft/ft)

Sheet flow shall not be used for distances exceeding 300-feet.

(2) Shallow Concentrated Flow

For slopes less than 0.005 ft/ft the following equations can be used:

a) For Unpaved Surfaces:  $V = 16.1345 (S)^{0.5}$

b) For Paved Surfaces:  $V = 20.3282 (S)^{0.5}$

Where:

$V$  = velocity in feet per second

$S$  = Slope in ft/ft

(3) Channel Flow

A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$$V = (1.486/n) \times R^{0.6} \times S^{0.5}$$

Where:

$V$  = velocity (ft/s)

n = Manning's roughness coefficient  
S = slope of flow path (ft/ft)  
R = area/perimeter

## 1.3 Water Quality Hydrology

### **Water Quality**

*The Water Quality Storm as described below has been derived from the Clean Water Services Water Quality Storm.*

The water quality storm is the storm required by regulations to be treated. The storm defines both the volume and rate of runoff.

- a. Water Quality Storm: Total precipitation of 0.36 inches falling in 4 hours with a storm return period of 96 hours.

Water quality volume (WQV) is the volume of water that is produced by the water quality storm.

- b. Water Quality Volume (WQV): 0.36-inches over 100-percent of the new impervious area.

Water Quality Volume (cf) = 0.36(in) x Area (sf) 12 (in/ft)

- c. Water Quality Flow (WQF): The average design flow anticipated from the water quality storm.

Water Quality Flow (cfs) = Water Quality Volume (cf)/14,4000 Sec

or

Water Quality Flow (cfs) = 0.36(in) x Area (sf)/12(in/ft)(4 hr)(60 min/hr)(60 sec/min)

APPENDIX C

WATER QUALITY AND QUANTITY FACILITY DESIGN





## **1.0 GENERAL REQUIREMENTS FOR WATER QUALITY AND QUANTITY FACILITIES**

- Facilities shall be designed to minimize mosquito habitat. Facilities should be designed such that water is not allowed to pond for greater than 72 hours. In facilities that are designed to hold standing water, regular monitoring is required for the presence of mosquitoes.
- An Operations and Maintenance Plan must be developed.
- A geotechnical report may be required to evaluate the suitability of the proposed facility location.

### **1.1 Erosion Protection**

a. Inlets to water quality and quantity facilities shall be protected from erosive flows through the use of an energy dissipater or rip rap stilling basin of appropriate size based on flow velocities. Flow shall be evenly distributed across the treatment area.

b. All exposed areas of water quality and quantity facilities shall be protected using coconut or jute matting. Coconut matting or high density jute matting (Geojute Plus or approved equal) shall be used in the treatment area of swales and below the WQV levels of ponds. Low density jute matting (Econo-jute or approved equal) may be used on all other zones.

### **1.2 Vegetation**

a. Vegetation shall meet requirements in either the Clean Water Service Design and Construction Standards for Sanitary Sewer and Stormwater Management or City of Portland Stormwater Management Manual.

b. No invasive species shall be planted or permitted to remain within the facility which may affect its function, including, but not limited to the following:

1. Himalayan blackberry (*Rubus discolor*)
2. Reed canarygrass (*Phalaris arundinacea*)
3. Teasel (*Dipsacus fullonum*)
4. English Ivy (*Hedera helix*)
5. Nightshade (*Solanum sp.*)
6. Clematis (*Clematis ligusticifolia* and *C. vitifolia*)
7. Cattail (*Typha latifolia*)
8. Thistle (*Cirsium arvense* and *C. vulgare*)
9. Scotch Broom (*Cytisus scoparius*)

### **1.3 Safety**

Fencing or other measures limiting access may be required on a site specific basis, as required by the City Engineer.

## **1.4 Access**

### ***General Access Requirement***

Access roads shall be provided for maintenance of all water quality and quantity facilities. The following criteria are considered to be the minimum required for facilities maintained by the City. If the Design Engineer anticipates that any of the requirements will not be met due to the configuration of the proposed development, the Design Engineer is advised to meet with City staff to gain approval for the deviation prior to submittal.

### ***Standard Road Design***

1. The road section shall be three (3) inches of class “C” asphaltic concrete; over two (2) inches of ¾”-0” compacted crushed rock; over six (6) inches of 1½”-0” compacted crushed rock; over subgrade compacted to 95-percent AASHTO T-99; or, the Design Engineer may submit an alternate design certified as capable of supporting a 30-ton maintenance vehicle in all weather conditions.
2. Strengthened sidewalk sections shall be used where maintenance vehicles will cross.
3. Maximum grade shall be 10-percent with a maximum 3-percent cross-slope.
4. Minimum width shall be 12 feet on straight runs and 15 feet on curves.
5. Curves shall have a minimum 40-foot interior radius.
6. Access shall extend to within 10-feet of the center of all structures unless otherwise approved by the City.
7. A curb or other delineator shall be provided at the edge of the road unless otherwise approved.
8. The minimum side slope for road embankments shall be 2:1.
9. A vehicle turnaround shall be provided when the access road exceed 40’ in length.

### ***Alternate Access Road***

An alternate access road design meeting the requirements of this section may be approved by the City for facilities in which access is required for general maintenance and long term care of the facility, but where there is no structure, as determined by the City, requiring regular maintenance.

1. The road section shall meet the requirements of 1.4.b.1) or an alternate section certified as capable of supporting AASHTO HS- 20 loading.
2. As an alternative to the requirements of 1.4.c.1), a concrete grid paver surface may be constructed by removing all unsuitable material, laying a geotextile fabric over the native soil, placing pavers, filling the honeycombs/grids with soil, and planting appropriate grasses.
3. Strengthened sidewalk sections shall be required.
4. Maximum grade shall be 20-percent with a maximum 3-percent cross-slope.
5. Minimum finished width shall be 12 feet.
6. A curb or other delineator shall be provided at the edge of the road unless otherwise approved.
7. The minimum side slope for road embankments shall be 2:1.

8. A vehicle turnaround shall be provided when the access road exceed 40' in length.

## **2.0 WATER QUALITY FACILITY DESIGN**

This section presents methodology for designing water quality facilities.

### **2.1 Water Quality Volumes and Flows**

Water Quality Volume and Flows shall be calculated as required in Appendix B.

## **3.0 WATER QUALITY TREATMENT FACILITIES**

The design criteria are not intended to be a comprehensive list of all stormwater facilities, but provides a general overview of those commonly used.

### **Biofiltration**

Biofiltration removes pollutants primarily by the filtering action of vegetation trapping particulates. Other pollutant removal mechanisms include sediment deposition in low-velocity areas, infiltration into the subsoil, and surface adhesion of pollutants to vegetation, biological assimilation, and soil adsorption. Biofiltration BMPs include grass swales, vegetated swales and vegetated filter strips.

Well-designed and -maintained biofilters have been known to remove the majority of suspended sediments and particulate pollutants in stormwater. Biofilters generally do not remove dissolved pollutants effectively. Swales appear to be more effective at removing metals than nutrients; however, accumulations of trace metals in biofilter sediments may occur. Resuspension or remobilization of nutrients may occur, particularly if maintenance is not performed regularly.

#### ***Vegetated Swales***

Biofiltration swales are long, gently sloped conveyance ditches with flattened sideslopes, designed to remove pollutants by filtering stormwater through vegetation. Grass is the most common vegetation, but other vegetation types, such as emergent wetland species, are often used, depending on site conditions. Swales are designed to distribute flow evenly across the entire width of the densely vegetated bottom, and may employ check dams and wide depressions to increase runoff storage and promote greater settling of pollutants. Often providing both treatment and conveyance of peak design flows, swales can reduce development costs by eliminating the need for separate conveyance systems. Biofiltration swales are best applied on a relatively small scale (generally less than 5 acres of impervious surface).

Swales which are incorporated in the streets are known as Green Streets. Green Streets incorporate curb extensions with biofiltration swales.

#### ***Applicable Locations:***

Along roadways, driveways, and parking lots.

#### ***Hydraulic Design Criteria:***

Design Flow: Water Quality Flow

Minimum Hydraulic Residence Time: 9 minutes

Maximum Water Design Depth: 0.5-feet

Minimum Freeboard: 1.0-foot (for facilities not protected from high flows)

Manning "n" Value: 0.24

Maximum Velocity: 2.0-fps based on 25-year flow

**Design Criteria:**

- Provide an energy dissipater at the entrance to swale, with a minimum length of 4-feet. It will be designed to reduce velocities and spread the flow across the treatment cross section.
- The use of intermediate flow spreaders maybe required.
- Minimum Length: 100-feet
- Minimum Slope: 0.5-percent
- Minimum Bottom Width: 2-foot
- Maximum Treatment Depth (measured from top of gravel): 0.5-feet
- Maximum Side Slope:
- In Treatment Area: 4H:1V
- Above Treatment Area: 2.5H:1V
- The treatment area shall have 2”-¾” river run rock placed 2.5 to 3 inches deep on high density jute or coconut matting over 12 inches of topsoil or base stabilization method as approved by the City. Extend river rock, topsoil, and high density jute or coconut matting to top of treatment area (or WQV level). Extend topsoil and low density jute matting to the edge of water quality tract or easement area.
- Provide an approved outlet structure for all flows.
- Where swales wrap 180-degrees forming parallel channels, freeboard must be provided between each of the parallel channels. A 1-foot (above ground surface) wall may be used above the treatment area to provide freeboard while enabling a narrower system. As an alternative, a soil-based berm may be used. The berm shall have a minimum top width of 1 foot and 2.5:1 side slopes.
- Where swales are designed with ditch inlets and outlet structures and design of maintenance access to such structures may be difficult due to swale location, swales may be designed as flowthrough facilities with unsumped structures. Maintenance access to one end of the facility will still be required.
- Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or soil by integrating them into the grading of the swale. Check dams shall be 12 inches in length, by the width of the swale, by 3 to 6 inches in height.
- Swale areas should be clearly marked before site work begins to avoid soil disturbance and compaction during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of swale areas.
- Swales are appropriate for all soil types. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended to support plant growth.
- Required setback from centerline of swale to property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.
- Wildflowers, native grasses, and ground covers used for maintained facilities maintained by the city shall be designed not to require mowing. Where mowing

cannot be avoided, facilities shall be designed to require mowing no more than once annually. Turf and lawn areas are not allowed for city-maintained facilities.

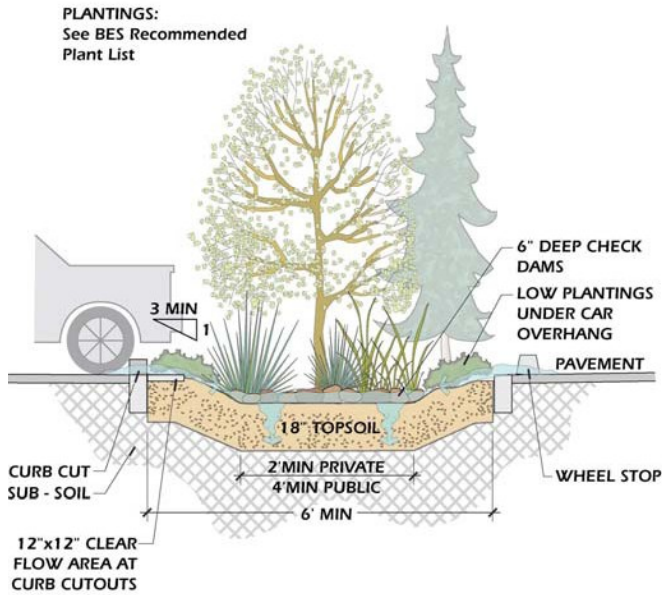


Figure 7. Vegetated Swale (Source City of Portland Stormwater Management Manual, 2004)

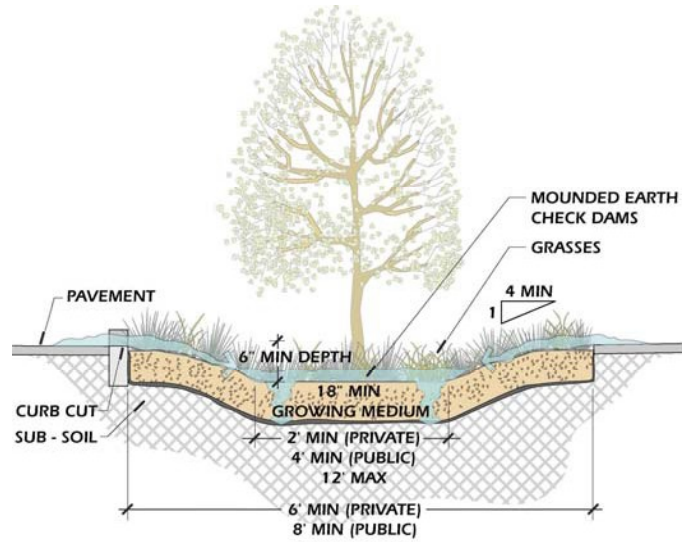


Figure 8. Grassy Swale (Source City of Portland Stormwater Management Manual, 2004)

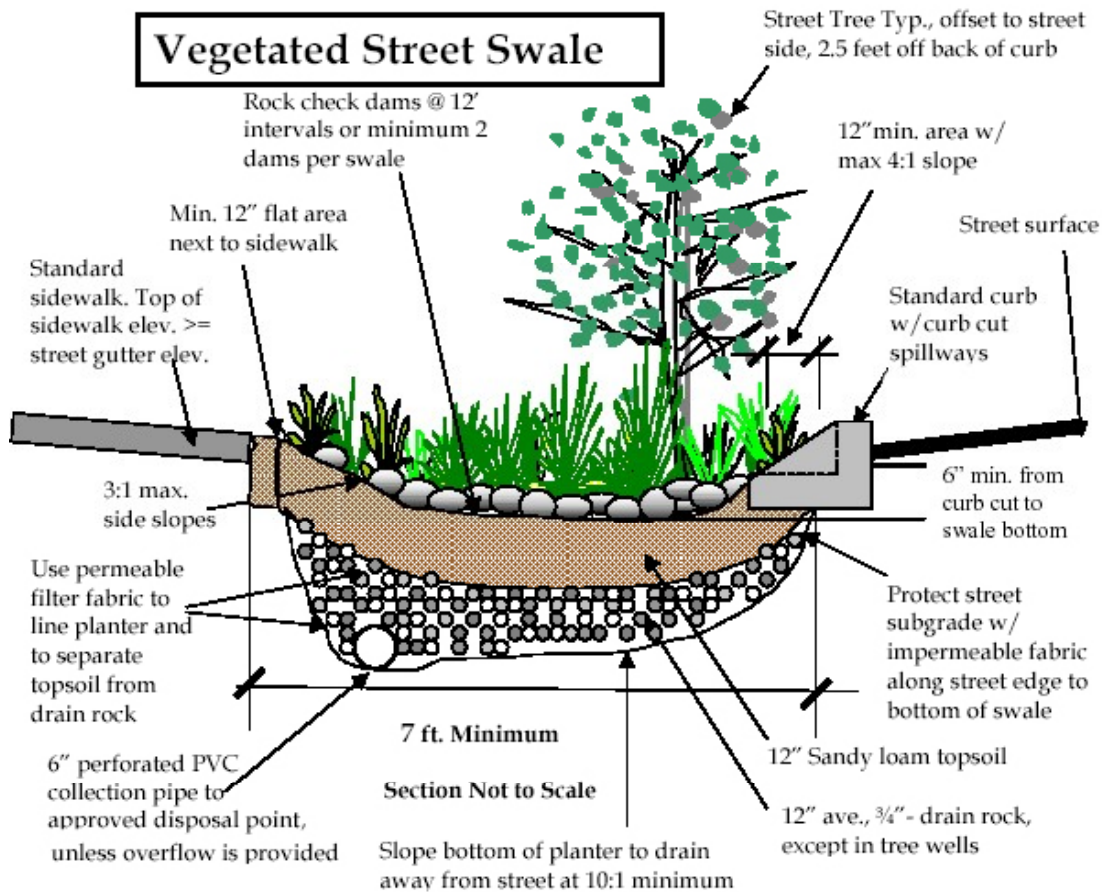


Figure 9. Vegetated Street Swale (Stormwater Management Manual, City of Portland, 2004)

## Vegetated Filter Strips

Filter strips are vegetated sections of land designed to accept runoff as overland sheet flow from upstream development. They may adopt any naturally vegetated form, from grassy meadow to emergent wetland to small forest. The dense vegetative cover facilitates pollutant removal. Filter strips differ from swales in that swales are concave conveyance systems, while filter strips are located parallel to the contributing area, have fairly level surfaces, and provide treatment of sheet flow.

### **Applicable Locations:**

Parking lots, residential or small business streets. Treat stormwater from small drainage areas.

### **Design Considerations:**

- When designing vegetated filters, slopes should be kept as flat as possible to prevent erosion. Spreading the flow evenly across the filter is also important in ensuring that the facility functions correctly and avoids flow channeling.
- Vegetated filter areas should be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of filter areas. Flow spreaders must be constructed perfectly level to distribute flows evenly across the filter.

- Vegetated filters are appropriate for all soil types. Unless existing vegetated areas are used for the filter, topsoil shall be used within the building foundations unless lined with impermeable fabric.
- Maximum allowable vegetated filter slopes are 10%. Terraces may be used to decrease ground slopes. Minimum slopes are 0.5%.
- Required setback from property lines is 5 feet, and 10 feet from building foundations unless lined with impermeable fabric.
- Unless used for very long, narrow projects such as pathways and trails, vegetated filters cannot be used to manage flow from more than 2,000 square-feet of impervious area. Filters shall be a minimum of 10 feet wide x 10 feet long. A simplified approach sizing factor of 0.2 may be used to receive credit for pollution reduction and flow control. A high-flow by-pass mechanism will not be required in these cases, but a high-flow overflow must be provided at the downstream end of the filter to an approved disposal point.
- Check dams shall be constructed of durable, non-toxic materials such as rock, brick, or concrete, or graded into the native soils. Check dams shall be 12 inches in length, by the width of the filter, by 3 to 5 inches in height.

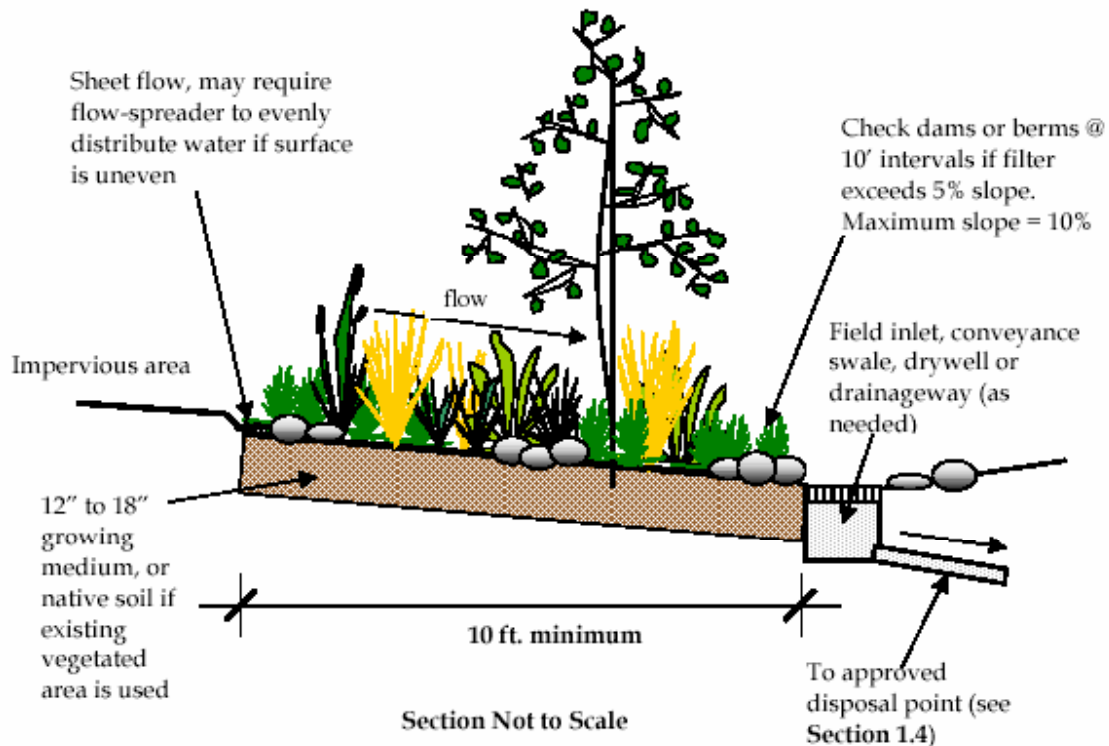


Figure 11. Vegetated Filter Strip (Stormwater Management Manual, City of Portland, 2004)



## Extended Dry Basin

Dry detention ponds are vegetated basins designed to fill during storm events and slowly release the water over a number of hours. Dry detention ponds are designed primarily for flow control. Additional water quality facilities are required to meet pollutant reduction requirement unless the bottom of the flow path of the pond should be designed as a vegetated or grass swale in order to meet pollution reduction requirements.

Dry Detention ponds have the opportunity for use as multi-purpose detention facilities. Such facilities include: parking lots, rooftops, sports fields, and recessed plazas.

### **Applicable Locations:**

High density areas, where land availability is limited.

### **Hydraulic Design Criteria:**

- Permanent Pool Depth: 0.4-feet
- Permanent pool is to cover the entire bottom of the basin.
- Water Quality Detention Volume: Water Quality Volume (WQV) + Required Storage
- Water Quality Drawdown Time: 48 hours

$$\text{Orifice Size: USE: } D = 24 * [ (Q / (C[2gH]^{0.5}) / \pi )^{0.5}$$

Where:  $D$  (in) = diameter of orifice

$$Q(\text{cfs}) = WQV(\text{cf}) / (48 * 60 * 60)$$

$$C = 0.62$$

$$H(\text{ft}) = 2/3 \times \text{temporary detention height to centerline of orifice.}$$

- Maximum Depth of Water Quality Pool (not including Permanent Pool): 4-feet.
- Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.

### **Design Criteria:**

- Minimum of 2 cells, with the first cell (forebay) at least 10% of surface area. The forebay shall also constitute 20% of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
- Inlet and outlet structures shall be designed to avoid direct flow between structures without receiving treatment (i.e. short circuiting of flow). The minimum length-to-width ratio is 3:1, at the maximum water surface elevation. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short-circuiting.
- Minimum Bottom Width: 4-feet
- Maximum Side Slopes in Basin Treatment Area: 3H:1V
- Minimum Freeboard: 1-foot from 25-year design water surface elevation.

- The treatment area shall have high density jute or coconut matting over 12 inches of topsoil or base stabilization method as approved by the City. If required by the City, 2"-¾" river run rock shall be placed 2.5 to 3 inches deep in areas where sustained flow is anticipated to occur. Extend river rock (if required), topsoil, and high density jute or coconut matting to top of treatment area (or WQV level). Extend topsoil and low density jute matting to the edge of water quality tract or easement area
- Provide an approved outlet structure for all flows.
- The Design Engineer shall certify that the pond storm sewer design is in compliance with all requirement in this document and that at normal design water surface that the upstream storm sewer will not be in a surcharged condition for longer than 24 hours
- Adequate grading and drainage must be provided to allow full use of facilities primary purposes following a storm event.
- Facility must be designed to minimize potential safety risks, potential property damage and inconvenience to the facility's primary purpose.
- Detention Basins designed to function as multi-use/recreational facilities, shall be located in a separate tract, defined easement, or designated open space.
- Minimum distance from the edge of the pond maximum pond water surface to property lines and structures: 20 feet, unless an easement with adjacent property owner is provided.
- Distance from the toe of the pond berm embankment to the nearest property line: one-half of the berm height (minimum distance of 5 feet).
- Minimum distance from the edge of the maximum pond water surface to septic tank, distribution box, or septic tank drain field: 50 feet.
- Surrounding slopes shall not exceed 10%. Minimum distance from the edge of the maximum pond water surface to the top of a slope greater than 15 percent: 200 feet, unless a geotechnical report is submitted and approved by the City.
- Minimum distance from the edge of the maximum pond water surface to a well: 100 feet.
- Access routes to the pond for maintenance purposes must be shown on the plans.

## **Constructed Water Quality Wetland**

A constructed wetland is a shallow, sometimes intermittent, pool constructed to provide suitable conditions for the growth of wetland plants for the purposes of stormwater management. Constructed wetlands often consist of a combination of shallow trenches, marshes, and ponded sections, with a wide variety of vegetation types. Stormwater wetlands are designed to maximize pollutant removal through uptake by plants, retention, and settling.

Created wetlands, are distinct from constructed wetlands, are considered mitigation for an activity, and are *not* used for stormwater management. They are treated as natural wetlands, and are subject to the same protections.

Wetlands can be sources of wildlife habitat, enhancing the aesthetic value of an area and providing opportunities for passive recreation and public education.

Constructed wetlands remove pollutants through gravitational settling, wetland plant uptake, adsorption, filtration, and microbial decomposition. Deep water areas such as wet ponds improve the sedimentation, photosynthetic, biological, and chemical removal of pollutants.

The actual pollutant removal efficiency of constructed wetlands depends on many variables. Numerous field studies indicate these systems are able to remove the majority of the settleable solids and particulate pollutants in stormwater. These detention facilities can also prevent increases in water temperature with a well established vegetated canopy.

**Applicable Locations:**

Larger Commercial or residential projects where land is available to treat a large drainage area.

**Hydraulic Design Criteria:**

- Permanent Pool Volume: 0.55 x Water Quality Volume (WQV)
- Water Quality Detention Volume: Water Quality Volume (WQV) + Storage Volume
- Water Quality Drawdown Time: 48 hours

$$\text{Orifice Size: USE: } D = 24 * [ (Q / (C[2gH]^{0.5}) / \pi )^{0.5}$$

Where:  $D$  (in) = diameter of orifice

$$Q(\text{cfs}) = WQV(\text{cf}) / (48 * 60 * 60)$$

$$C = 0.62$$

$$H(\text{ft}) = 2/3 \times \text{temporary detention height to centerline of orifice.}$$

- Maximum Depth of Permanent Pool: 2.5-feet or as limited by issuing jurisdiction
- Maximum velocity through the wetland should average less than 0.01-fps for the water quality flow. Design should distribute flows uniformly across the wetland.
- Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.
- Provide for a basin de-watering system with a 24-hour maximum drawdown time.

**Design Criteria:**

- Minimum of 2 cells, with the first cell (forebay) at least 10% of surface area. The forebay shall also constitute 20-percent of the treatment volume. Where space limits multi-cell design, use one cell with a forebay at the inlet to settle sediments and distribute flow across the wet pond.
- Permanent pool depth to be spatially varied throughout wetland.
- Provide a perimeter zone 10 to 20-feet wide, which is inundated during storm events.
- Maximum Side Slopes for Wetland Planting: 5H:1V
- Maximum Side Slopes for Non-Wetland Planting: 3H:1V
- Overexcavate by a minimum of 20-percent to allow for sediment deposition.

- Minimum Freeboard: 1-foot from 25-year design water surface elevation.
- Provide an approved outlet structure for all flows. A detailed hydraulic analysis must be performed by a Professional Engineer, showing compliance with flow control standards
- All ponds shall have an emergency overflow spillway or structure designed to convey the 100- year, 24-hour design storm for post-development site conditions, assuming the pond is full to the overflow spillway or structure crest. The overflow shall be designed to convey these extreme event peak flows around the berm structure for discharge into the downstream conveyance system. The overflow shall be designed and sited to protect the structural integrity of the berm. This will assure that catastrophic failure of the berm is avoided, property damage is avoided, and water quality of downstream receiving water bodies is protected.

## **Sand Filters**

Stormwater filtering systems have been used successfully in ultra-urban areas due to their relatively small footprint and moderate physical and head drop requirements. A number of filtering systems have been developed for use in heavily urbanized areas. Filters typically contain the same basic components: a sedimentation area to retain the largest particles; and a chamber containing the filter medium that captures soluble pollutants.

A typical sand filter consists of a flow spreader, sand bed, and an underdrain. Pretreatment is required for removal of larger particulates and reduce velocities. Sand filters can be used in residential, commercial and industrial area, where debris, large particulates, and oil & grease will not clog the filter. Sand filters can be located either above or below ground.

### ***Applicable Locations:***

Small Commercial and industrial areas projects. Small footprint allows for installation in areas where land availability is limited.

### ***Design Requirements:***

- Sand filters must be lined with an impermeable liner.
- Facility storage depth must be at least 12 inches, unless a larger-than-required planter square-footage is used. Minimum sand filter width is 18 inches. Filter slopes shall be less than 0.5%.
- Required setback from property lines is 5 feet, unless the sand filter height is less than 30 inches. Required setback from building structures is 10 feet, unless the sand filter is properly lined. Special attention needs to be paid to the filter waterproofing if constructed adjacent to building structures.
- Sand filter walls shall be made of stone, concrete, brick, or wood. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.
- Sand filters sized with the simplified approach shall be designed to receive less than 15,000 square-feet of impervious area runoff. For these projects, a simplified approach sizing factor of 0.06 may be used to receive credit for pollution reduction and flow control. For projects with more than 15,000 square feet of impervious surface, additional facilities may be required to meet flow control requirements. A high-flow overflow must be provided to an approved

disposal point. Sand filters shall be designed to pond water for less than 4 hours after each storm event.

- Plantings are optional in sand filters. For aesthetic purposes, potted plants may be submerged in the sand filter.
- The sand filter inlet structure shall spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. This flow shall be spread in a manner that prevents roiling or otherwise disturbing the filter medium.
- The length-to-width ratio of the filter shall be 2:1 or greater.
- Sand used as filter medium shall be certified by a testing laboratory as meeting or exceeding the specifications presented below:
- The filter bed medium shall consist of clean medium to fine sand with no organic material, or other deleterious materials and meeting the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8"	100
#4	95-100
#8	80-100
#16	45-85
#30	15-60
#50	3-15
#100	<4

- The underdrain piping system shall consist of appropriately sized (minimum 4-inch diameter) collector manifold with perforated lateral branch lines. The pipe used in this conveyance system shall be schedule 40 polyvinyl chloride (PVC) material or an approved equal. Lateral spacing shall not exceed 10 feet. The underdrain laterals shall be placed with positive gravity drainage to the collector manifold. The collector manifold shall have a minimum 1 percent grade toward the discharge point. All laterals and collector manifolds shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.
- The sand bed configuration may be either of the two configurations shown in Figure 12. All depths shown are final depths. The effects of consolidation and/or compaction must be taken into account when placing medium materials. The surface of the filter medium shall be level.

Sand Bed with Gravel Filter (Figure 12:A)

- The top layer shall be a minimum of 18 inches of approved sand.
- The sand shall be placed over an acceptable geofabric material covering a layer of ½- to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
- No gravel is required below the underdrain piping system.
- The piping shall be underlain with an impermeable liner.

Sand Bed Using Trench Design (Figure 12:B)

- The top layer shall be a minimum of 12 inches of approved sand.
- The sand shall be placed over an acceptable geotextile fabric material covering a layer of ½ to 2-inch washed drain rock. The finished depth of this drain rock shall be sufficient to provide a minimum of 2 inches of cover over the underdrain piping system.
- The piping and gravel shall be underlain with an impermeable liner.

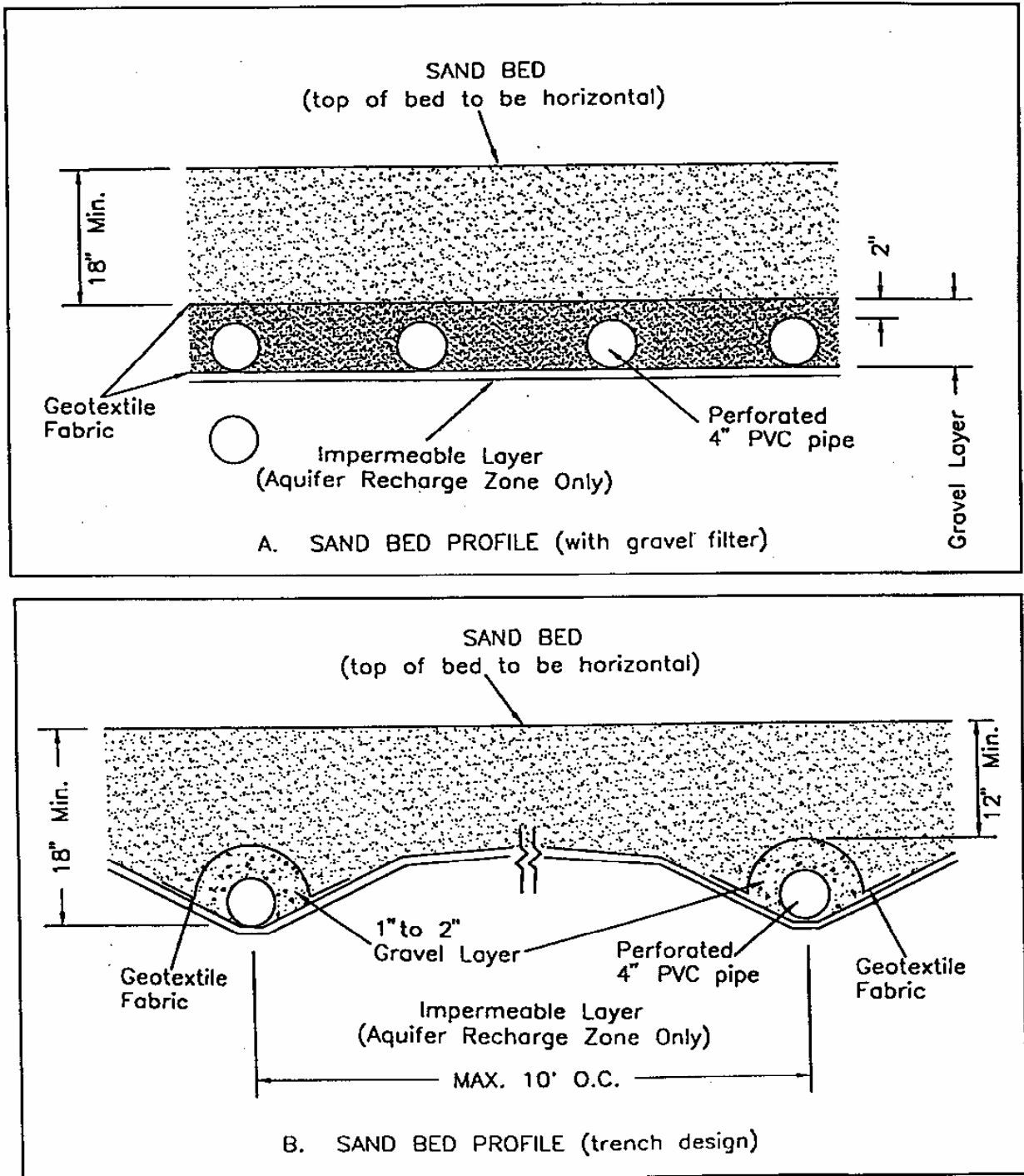
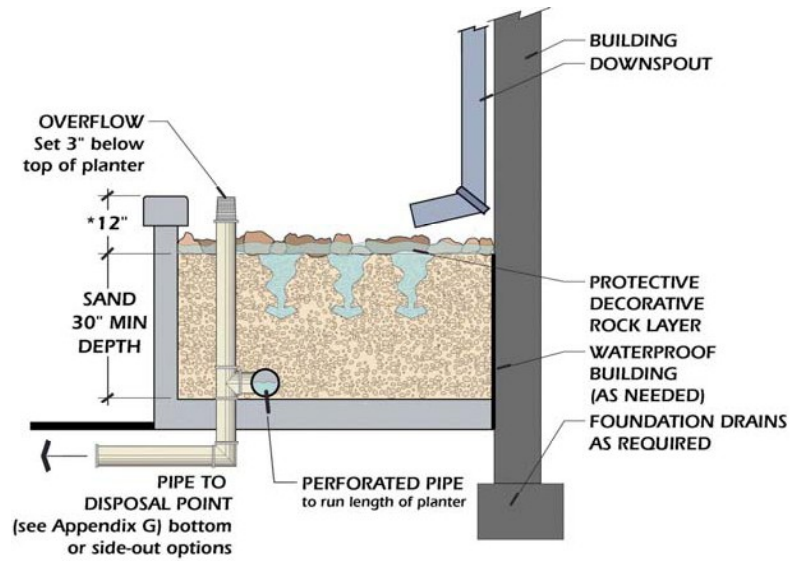


Figure 12. Sandfilters (Source City of Portland Stormwater Management Manual, 2004)



\*Water reservoir depth may be reduced  
if planter surface area is increased.

Figure 13. Downspout Sandfilter (Source City of Portland Stormwater Management Manual, 2004)

### 3.4 Other Water Quality Treatment Facilities

The use of other forms of water quality treatment is allowed with the approval of the City. However, the applicant must provide evidence of the ability of the facility to meet the City's performance criteria and long term maintenance requirements.



## **4.0 WATER QUANTITY FACILITY DESIGN**

### **4.1 Hydraulic Design Criteria:**

a. Detention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report.

Acceptable analysis programs include:

1. HYD;
2. HEC-1;
3. HEC-HMS;
4. SWMM;
5. HYDRA;
6. HYDROCAD
7. Others as approved.

b. Stormwater quantity on-site detention facilities shall be designed to capture runoff so the post-development runoff rates from the site do not exceed the pre-development runoff rates from the site, based on a 2 through 25-year, 24-hour return storm. Specifically, the 2, 10, and 25-year post development runoff rates will not exceed their respective 2, 10, and 25-year pre-development runoff rates; unless other criteria are identified in an adopted watershed management plan or subbasin master plan.

c. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway. Vortex valve discharge control should be considered to optimize effective pond volume.

d. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway to be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.

### **4.2 Design Criteria:**

a. The facility can be a combined water quality and quantity facility provided it meets all relevant criteria. If a water quality component is not incorporated into the detention facility additional water quality treatment must be provided.

b. Interior side slopes up to the Maximum Water Surface: 3H:1V

c. If interior slopes need to be mowed – maximum side slope: 4H:1V

d. Maximum Exterior Side Slopes: 2H:1V, unless analyzed for stability by a geotechnical engineer.

e. Over excavate by a minimum of 20-percent to allow for sediment deposition.

f. Minimum Freeboard: 1-foot from 25-year design water surface elevation.

g. Provide an approved outlet structure for all flows.

h. Detention facilities shall be designed to protect public and private property.

i. Facilities shall be designed to minimize mosquito habitat. Facilities should be designed such that water is not allowed to pond for greater than 72 hours. In facilities that are designed to hold standing water, regular monitoring is required for the presence of mosquitoes.

- j. An Operations and Maintenance Plan must be developed.
- k. A geotechnical report may be required to evaluate the suitability of the proposed facility location.

### **4.3 Walls in Water Quantity Facilities**

- a. Retaining walls may serve as pond walls if the design is prepared and stamped by a registered professional engineer and a fence is provided along the top of the wall. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.
- b. Walls that are 4 feet or higher must meet all of the following criteria:
  - 1. Be approved by a licensed structural or geotechnical engineer;
  - 2. The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water quantity tract or easement shall be clearly documented on the plat or in alternate form as approved by the City.

STRUCTURAL BMP SELECTION CHARACTERISTICS																
BMP Types	Ultra-Urban	Area Served (acres)	BMP Area	Min. Req'd (feet)	Summer Head Temp Increase <sup>d</sup>	Contaminant Removal Percentage					Metals	Capital Costs	Maintenance	Effective Life (years)		
						TSS	Bacteria <sup>c</sup>	BOD	Oil & Grease	TP					TN	O&M Costs
Ext. Detention Pond*	no	2 (min)	10-20%	3-6	Yes	46-98	NA	25-45 <sup>d</sup>	NA	20-94	28-50	24-89	Mod	Annual Inspection	Low	20-50
Underground Det. Tanks	yes	1-2	0.5-1%	5-8	No	NA	NA	10-20 <sup>d</sup>	NA	NA	NA	NA	Mod to High	Frequent cleanout	High	50-100
Infiltration Trench*	yes	2-4	2-4%	3-8	No	75-99	60-100	70-90	NA	50-75	45-70	75-99	Mod to High	Sediment and debris removal	Mod	10-15
Infiltration Basin*	no	2-20	2-4%	3-4	No	75-99	60-100	70-90	NA	50-70	45-70	50-90	Mod	Mowing	Mod	5-10
Bioretentation*	yes	1-50	4-10%	2-3	No	75	NA	NA	NA	50	50	75-80	Mod	Mowing / plant replacement	Low	5-20
Catch Basins and Inlets	yes	<1	none		No	20-40	NA	10-20 <sup>d</sup>	NA	10-20 <sup>d</sup>	10-20 <sup>d</sup>	10-20 <sup>d</sup>	Low	Frequent Cleanout	Low	?
Catch Basin Inserts	yes	<1	none	1-2	No	NA	NA	up to 90	NA	NA	NA	NA	Low	Frequent Cleanout	Mod to High	10-20
Control Structures/Flow Restrictors	yes				No	20-40	NA	10-20 <sup>d</sup>	NA	10-25 <sup>d</sup>	10-20 <sup>d</sup>	10-25 <sup>d</sup>	Low	Frequent Cleanout	Low to Mod	
Manufactured Systems	yes	1-10	none	4	No	NA	NA	up to 96	NA	NA	NA	NA	Mod	Periodic cleanout	Mod	50-100
Premanufactured Vaults <sup>b</sup>	yes	no limits	0.5-1%	low	No	86	NA	high	48	NA	NA	36	Mod to High	Periodic cleanout and inspection	Mod	50-100
Storm Vault Vortech	yes		0.5-1%	low	No	80	NA	high	67	54	NA	NA	Mod to High	Frequent cleanout	Mod	50-100
Multi-Chambered Treatment Train	yes	0.2-2.5	0.5-1.5%	4-6	No	83	NA	NA	NA	NA	NA	95	High	Sand filter cleaning and replacement of oil absorbent material	High	5-20
Oil-Grit Separators (Coalescent Plate)	yes	1-2	<1%	3-6	No	20-40	NA	10-20 <sup>d</sup>	50-80	<10	<10	<10	Mod	Frequent Cleanout	High	50-100
Ditches (with vegetation)	yes				Yes	0-50	NA	0-25 <sup>d</sup>	0-25 <sup>d</sup>	0-25 <sup>d</sup>	0-25 <sup>d</sup>	0-25 <sup>d</sup>	Low	Frequent Cleanout	Low to Mod	
Vegetated Swales	yes	2-4	10-20%	2-6	Yes	30-90	NA	50-80	NA	20-85	0-50	0-90	Low to Mod	Mowing	Low	5-20
Vegetated Filter Strips	no	NA	25%	Neg	Yes	27-70	NA	50-80	NA	20-40	20-40	2-80	Low	Mowing	Low	20-50
Constructed Wetlands	no	1 (min)	10%	1-8	Yes	65	NA	40-80	NA	25	20	35-65	Mod to High	Annual Inspection / Plant replacement	Mod	20-50

STRUCTURAL BMP SELECTION CHARACTERISTICS															
BMP Types	Ultra-Urban	Area Served (acres)	BMP Area	Min. Req'd (feet)	Summer Head Temp Increase <sup>a</sup>	Contaminant Removal Percentage					Metals	Capital Costs	Maintenance	O&M Costs	Effective Life (years)
						TSS	Bacteria <sup>c</sup>	BOD	Oil & Grease	TP					
Natural Streams/Wetlands	no				Yes	50-95	50-98	40-80	40-90	20-85	40-90	Low	Regular inspection / debris removal / erosion control	Low to Mod	
Vegetated Rock Filters	yes	2-5	3-5%	2-4	No	95	78	NA	82	75	21-80	High	Regular inspection and cleanout	High	5-20
Underground Sand Filters	yes	2-5	2-3%	1-8	No	70-90	NA	NA	43-70	30-50	22-91	High	Annual Media Removal	High	5-20
Surface Sand Filters	no	2-5	2-3%	5-8	No	75-92	NA	NA	27-80	27-71	33-91	Mod	Biannual media removal	Mod	5-20
Organic Media Filters	yes	2-5	2-3%	5-8	No	90-95	90	NA	49	55	48-90	High	Annual media removal	High	5-20
Porous Pavements	no	2-4	NA	NA	No	82-95	NA	NA	60-71	80-85	33-99	Low	Semi annual vacuum cleaning	Mod	15-20

General Source: FHWA-EP-00-002 Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring, February 2000.

NA means Not Applicable or Not Available

- a. Open systems exposed to solar radiation that do not infiltrate assumed to increase water temperature in summer.
- b. Per manufacturer's monitoring reports.
- c. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs (Thomas R. Schueler, July 1987), bacteria removal data for infiltration noted bacteria as fecal coliform, pp. 1-6, 2-13. Data for other BMPs is from FHWA; data falls within the 60%-100% removal range, and is presumed to apply to fecal coliform bacteria.
- d. Estimated based on 50% particulate fraction

\* Structural BMPs designed to percolate to groundwater must be approved by the City and are generally approved only if all other disposal options are infeasible.

APPENDIX D  
STORMWATER FACILITY  
OPERATION AND MAINTENANCE REQUIREMENTS

## **DRY DETENTION PONDS**

### ***Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)***

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Determine if pipe is in good condition:
    - If more than 1 inch of settlement, add fill material and compact soils.
    - If alignment is faulty, correct alignment.
    - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.
- Embankment, Dikes, Berms & Side Slopes retain water in the pond.
  - Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
  - Structural deficiencies shall be corrected upon discovery:
    - If cracks exist, repair or replace structure.
    - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.
- Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity. Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
- Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
  - Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
- Remove Debris and sediment from ponding area. Debris and sediment shall be tested and disposed of in accordance with federal and state regulations.
- Vegetation shall be healthy and dense enough to protect underlying soils from erosion.
  - Grass (where applicable) shall be mowed to 4"-9" high and grass clippings shall be removed.
  - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.

- Nuisance or prohibited vegetation (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining ponds shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the facility shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the wet pond shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the pond. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the pond shall be filled.

**If used at this site, the following will be applicable:**

- Signage shall clearly convey information.
  - Broken or defaced signs shall be replaced or repaired.
- Fences shall be maintained to preserve their functionality and appearance.
  - Collapsed fences shall be restored to an upright position.
  - Jagged edges and damaged fences and shall be repaired or replaced.

# BIOFILTRATION

## Swales

### ***Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)***

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Swale Inlet (such as curb cuts or pipes) shall maintain a calm flow of water entering the swale.
  - Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.
  - Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation.
  - Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Rock splash pads shall be replenished to prevent erosion.
- Side Slopes shall be maintained to prevent erosion that introduces sediment into the swale.
  - Slopes shall be stabilized and planted using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Swale Media shall allow stormwater to percolate uniformly through the landscape swale. If the swale does not drain within 48 hours, it shall be tilled and replanted according to design specifications.
  - Annual or semi-annual tilling shall be implemented if compaction or clogging continues.
  - Debris in quantities that inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
- Swale Outlet shall maintain sheet flow of water exiting swale unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
  - Outlets such as drains and overland flow paths shall be cleared when 50% of the conveyance capacity is plugged.
  - Sources of sediment and debris shall be identified and corrected.
- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.
  - Mulch shall be replenished as needed to ensure survival of vegetation.
  - Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned.



- Fallen leaves and debris from deciduous plant foliage shall be removed.
- Grassy swales shall be mowed to keep grass 4” to 9” in height.
- Nuisance and prohibited vegetation (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when swale function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
- Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining swales shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the swale shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the swale shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the swale. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurensensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the swale shall be filled.
- If Check Dams are used in the facility they shall control and distribute flow.
  - Causes for altered water flow shall be identified, and obstructions cleared upon discovery.
  - Causes for channelization shall be identified and repaired.

## **Vegetated Filter Strips**

### ***Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)***

All facility components and vegetation shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Flow Spreader shall allow runoff to enter the vegetative filter as predominantly sheet flow.
  - Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
- Sediment build-up near or exceeding 2” in depth shall be removed.
- Filter Inlet shall assure unrestricted stormwater flow to the vegetative filter.
  - Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
  - Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation.
  - Inlet shall be cleared when conveyance capacity is plugged.
  - Rock splash pads shall be replenished to prevent erosion.
- Filter Media shall allow stormwater to percolate uniformly through the vegetative filter.
  - If the vegetative filter does not drain within 48 hours, it shall be regraded and replanted according to design specifications. Established trees shall not be removed or harmed in this process.
  - Debris in quantities more than 2” deep or sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
- Check Dams shall direct and control flow.
  - Causes for altered water flow and channelization shall be identified, and obstructions cleared upon discovery.
  - Cracks, rot, and structural damage shall be repaired.
- Filter Outlet shall allow water to exit the vegetative filter as sheet flow, unless a collection drainpipe is used.
  - Sources of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are deeper than 2 inches.
  - Outlet shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.

- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance and prohibited vegetation (such as blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.
- Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining vegetated filters shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the vegetative filter shall be safe and efficient. Egress and ingress routes shall be maintained to design standards.
  - Obstacles preventing maintenance personnel and/or equipment access to the facility shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the vegetated filter. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurensensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the vegetated filter shall be filled.

## CONSTRUCTION WETLAND

### ***Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)***

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Inlet shall assure unrestricted stormwater flow to the wetland.
  - Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Determine if pipe is in good condition:
    - If more than 1 inch of settlement, add fill material and compact soils.
    - If alignment is faulty, correct alignment.
    - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.
- Fore bay traps coarse sediments, reduces incoming velocity, and distributes runoff evenly over the wetland. A minimum 1-foot freeboard shall be maintained.
  - Sediment buildup exceeding 50% of the facility capacity shall be removed every 2-5 years, or sooner if performance is being affected.
- Embankment, Dikes, Berms & Side Slopes retain water in the wetland.
  - Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
  - Structural deficiencies shall be corrected upon discovery:
    - If cracks exist, repair or replace structure.
    - If erosion channels deeper than 2 inches exist, stabilize surface. Sources of erosion damage shall be identified and controlled.
- Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity.
  - Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
- Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
  - Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
  - Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
  - Rocks or other armament shall be replaced when only one layer of rock exists above native soil.
- Sediment & Debris Management shall prevent loss of wetland volume caused by sedimentation.
  - Wetlands shall be dredged when 1 foot of sediment accumulates.

- Gauges located at the opposite ends of the wetland shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.
- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.
- Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas.
  - Mulch shall be replenished when needed.
  - Vegetation, large shrubs or trees that limit access or interfere with wetland operation shall be pruned.
  - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
  - Nuisance or prohibited vegetation (such as blackberries or English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
  - Dead vegetation shall be removed to maintain less than 10% of area coverage or when wetland function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
  - Vegetation producing foul odors shall be eliminated.
- Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- Training and/or written guidance information for operating and maintaining treatment wetlands shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.
- Access to the wetland shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the wetland shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- Insects & Rodents shall not be harbored in the constructed treatment wetland. Pest control measures shall be taken when insects/rodents are found to be present.
  - If sprays are considered, then a mosquito larvicide, such as Bacillus thurensensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
  - Holes in the ground located in and around the constructed treatment wetland shall be filled.

If used at this site, the following will be applicable:

- Signage shall clearly convey information.

- Broken or defaced signs shall be replaced or repaired.
- Fences shall be maintained to preserve their functionality and appearance.
  - Collapsed fences shall be restored to an upright position.
  - Jagged edges and damaged fences shall be repaired or replaced.

## **SAND FILTERS**

### ***Operations and Maintenance (adapted from the City of Portland Stormwater Management Manual, 2004)***

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

- Filter Inlet shall allow water to uniformly enter the sand filter as calm flow, in a manner that prevents erosion.
  - Inlet shall be cleared of sediment and debris when 40% of the conveyance capacity is plugged.
  - Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.
  - Sediment accumulation shall be hand-removed if it is more than 4 inches thick.
  - Rock splash pads shall be replenished to prevent erosion.
- Reservoir receives and detains stormwater prior to infiltration. If water does not drain within 2-3 hours of storm event, sources of clogging shall be identified and correction action taken.
  - Debris in quantities more than 1 cu ft or sufficient to inhibit operation shall be removed routinely (e.g., no less than quarterly), or upon discovery.
  - Structural deficiencies in the sand filter box including rot, cracks, and failure shall be repaired upon discovery.
- Filter Media shall allow stormwater to percolate uniformly through the sand filter. If water remains 36-48 hours after storm, sources of possible clogging shall be identified and corrected.
  - Sand filter shall be raked and if necessary, the sand/gravel shall be excavated, and cleaned or replaced.
  - Sources of restricted sediment or debris (such as discarded lawn clippings) shall be identified and prevented.
  - Debris in quantities sufficient to inhibit operation shall be removed no less than quarterly, or upon discovery.
  - Holes that are not consistent with the design structure and allow water to flow directly through the sand filter to the ground shall be filled.
- Underdrain Piping (where applicable) shall provide drainage from the sand filter, and Cleanouts (where applicable) located on laterals and manifolds shall be free of obstruction, and accessible from the surface.
  - Underdrain piping shall be cleared of sediment and debris when conveyance capacity is plugged. Cleanouts may have been constructed for this purpose.
  - Obstructions shall be removed from cleanouts without disturbing the filter media.
- Overflow or Emergency Spillway conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow spillway shall be cleared of sediment and debris when 50% of the conveyance capacity is plugged.
- Source of erosion damage shall be identified and controlled when erosion channels are forming.
- Rocks or other armament shall be replaced when sand is exposed and eroding from wind or rain.



# Appendix F.2

## Catch Basin Recommendations

**TO:** Mike Faught, City of Stayton Public Works Director

**FROM:** James Bledsoe, P.E. and Roland Rocha, E.I.T.

**DATE:** October 11, 2007

**SUBJECT: Storm Water Catch Basin Recommendations**

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Keller Associates has prepared this summary of storm water catch basin considerations in response to your request for a standard storm water catch basin recommendation. The question regarding a standard catch basin implies three main considerations: Hydraulics (is it going to capture the flow?), Maintenance (can it be easily accessed and cleaned?), and Water Quality capabilities.

### **Hydraulics**

In the draft standards submitted by Tetra-Tech, the ODOT hydraulics manual and Hydraulic Engineering Circular No. 22 (HEC 22) were referenced. The ODOT manual generally follows HEC 22 which is the more detailed of the two. These manuals recommend site specific calculations to determine the best catch basin for the area. The calculations consider the slope, anticipated sediment loads, flow rates, street width, and other factors. Therefore, as far as hydraulics are concerned, there is not a "one size fits all" catch basin.

### **Maintenance**

We've contacted the city's current contractor, C-More Pipe, and inquired about catch basin needs from a maintenance point of view. Apparently, the vacuum hoses used to clean out the debris are not a concern, but the cameras used for TV inspection and the root cutting tools are. The contractor's camera is about 3ft in length, and the root cutters range from 16" to 25" in length. Therefore, the ideal catch basin for maintenance access would be 3'X3'.

### **Water Quality**

Water quality catch basins will typically have a grit chamber and an oil/water separator feature. There are generally two types of oil/water separators available, namely gravity and coalescing separators. Information and figures on the gravity separators are included in Attachment 1 and information and figures on the coalescing separators are included in Attachment 2.

The basic difference between the two types is that the gravity separators are simple, they remove some oil, and cost less, while the coalescing separators are complex, remove more oil, and cost quite a bit more.

The city of Portland and the city of Salem recommend oil/water separator catch basins only in high-risk areas. The type of separator depends on the application. Salem's stormwater manual specifically recommends their use in the following areas:

- Petroleum Storage Yards
- Vehicle Maintenance Facilities
- Manufacturing areas
- Transportation facilities
- Fueling stations
- High-use commercial parking lots
- Commercial truck operations
- Auto parts stores

Another consideration with oil/water separators is the need for more frequent cleaning, and the added difficulty and cost associated with disposing of the accumulated pollutants. Stayton's current contractor, C-More Pipe, has never dealt with disposal of this kind and does not know what types of regulations are in place. An EPA publication (Attachment 2) suggests the waste trapped in oil/water separators typically contains polyaromatic hydrocarbons, trace metals, phthalates, phenol toluene, and methylene chloride. With these pollutants, the waste may not be suitable for traditional landfill disposal.

### **Recommendations**

Hydraulic sizing and spacing of catch basins should follow the ODOT and HEC 22 standards as recommended in the draft standards included in the storm water master plan. These standards should dictate the catch basin size and type, unless maintenance access requires a larger size.

Where maintenance access to the storm water lines relies on the catch basin, the catch basin opening should be a minimum of 3 ft in the direction of lines to be accessed. In some cases this will require a minimum of a 3ft square catch basin.

Given the higher capital and operational costs associated with water quality catch basins, Keller Associates recommends the city consider an approach similar to the cities of Portland and Salem as they reevaluate and adopt new storm water standards.



**Attachment No. 1**  
Gravity Oil Water Separators



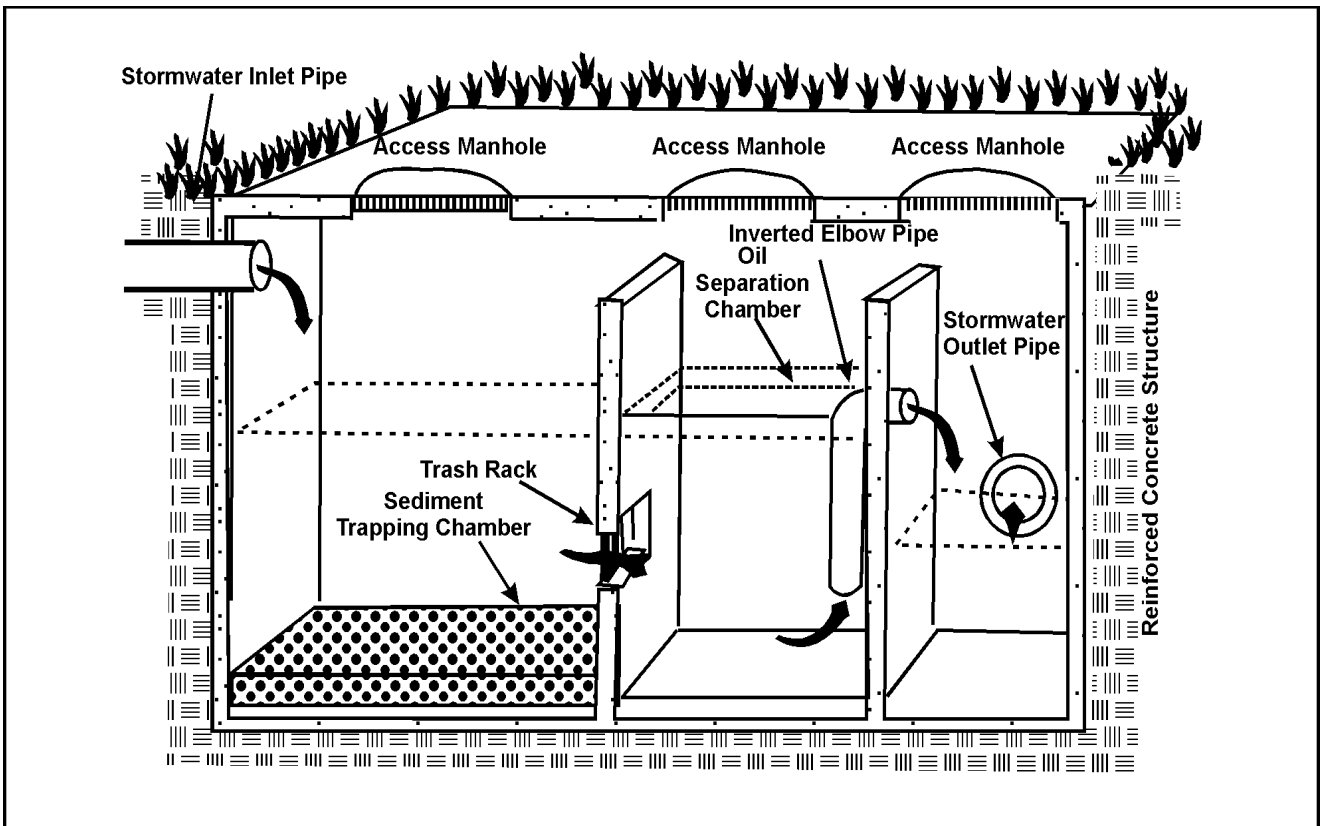
# Storm Water Technology Fact Sheet Water Quality Inlets

## DESCRIPTION

Water quality inlets (WQIs), also commonly called oil/grit separators or oil/water separators, consist of a series of chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil) from storm water. Most WQIs also contain screens to help retain larger or floating debris, and many of the newer designs also include a coalescing unit that

helps to promote oil/water separation. WQIs typically capture only the first portion of runoff for treatment and are generally used for pretreatment before discharging to other best management practices (BMPs).

A typical WQI, as shown in Figure 1, consists of a sedimentation chamber, an oil separation chamber, and a discharge chamber. The basic WQI design is often modified to improve performance. Possible



Source: Berg, 1991.

FIGURE 1 PROFILE OF A TYPICAL WATER QUALITY INLET

modifications include: an additional orifice and chamber that replace the inverted pipe elbow; the extension of the second chamber wall up to the top of the structure; or the addition of a diffusion device at the inlet. The diffusion device is intended to dissipate the velocity head and turbulence and distribute the flow more evenly over the entire cross-sectional area of the sedimentation chamber (API, 1990).

The addition of a coalescing unit to the WQI can dramatically increase its effectiveness in oil/water separation while also greatly reducing the size of the required unit. Coalescing units are made from oil-attracting materials, such as polypropylene or other materials. These units attract small oil droplets, which begin to concentrate until they are large enough to float to the surface and separate from the storm water. Without these units, the oil and grease particles must concentrate and separate naturally. This requires a much larger surface area; and therefore, units that do not use the coalescing process must be larger than units utilizing a coalescing unit.

WQIs can be purchased as pre-manufactured units (primarily oil/water separator tanks) or constructed on site. Suppliers of pre-manufactured units (e.g., Highland Tank and Manufacturing, Jay R. Smith Manufacturing, etc.) can also provide modifications of the typical design for special conditions.

## **APPLICABILITY**

WQIs are widely used in the U.S. and can be adapted to all regions of the country. They are often used where land requirements and cost prohibit the use of larger BMP devices, such as ponds or wetlands. WQIs are also used to treat runoff prior to discharge to other BMPs.

Because of their ability to remove hydrocarbons, WQIs are typically located at sites with automotive-related contamination or at other sites that generate high hydrocarbon concentrations (MWWCOG, 1993). For example, WQIs may be ideal for small, highly impervious areas, such as gas stations, loading areas, or parking areas (Schueler, 1992). Many WQIs, particularly those installed at industrial sites, serve the dual purpose of treating storm water

runoff from contaminated areas, and serving as collection and treatment units for washdown processes or petroleum spills.

Higher residual hydrocarbon concentrations in trapped sediments cause maintenance and residual disposal costs associated with WQIs to be higher than those of other BMPs. Therefore, planners should carefully evaluate maintenance and residual disposal issues for the site before selecting a WQI. Possible alternatives to the WQI include sand filters, oil absorbent materials, and other innovative BMPs (e.g., Stormceptor System).

## **ADVANTAGES AND DISADVANTAGES**

WQIs can effectively trap trash, debris, oil and grease, and other floatables that would otherwise be discharged to surface waters (Schueler, 1992). In addition, a properly designed and maintained WQI can serve as an effective BMP for reducing hydrocarbon contamination in receiving water sediments. While WQIs are effective in removing heavy sediments and floating oil and grease, they have demonstrated limited ability to separate dissolved or emulsified oil from runoff. WQIs are also not very effective at removing pollutants such as nutrients or metals, except where the metals removal is directly related to sediment removal.

Several major constraints can limit the effectiveness of WQIs. The first is the size of the drainage area. WQIs are generally recommended for drainage areas of 0.4 hectares (1 acre) or less (Berg, 1991, NVPDC, 1992). Construction costs often become prohibitive for larger drainage areas. However, because WQIs are primarily designed for specific industrial sites that have the potential for petroleum-contaminated process washdown, spills, and storm water runoff, sizing considerations are not usually a problem.

Sediment can also cause problems for WQIs. There are several reasons for this. First, high sediment loads can interfere with the ability of the WQI to effectively separate oil and grease from the runoff. Second, during periods of high flow, sediment residuals may be resuspended and released from the WQI to surface waters. A 1993 Metropolitan Washington Council of Governments (MWWCOG)

long-term study evaluating the performance and effectiveness of more than 100 WQIs found that pollutants in the WQI sediments were similar to those pollutants found in downstream receiving water sediments (the tidal Anacostia River). This information suggests that downstream sediment contamination is linked to contaminated runoff and pass-through from WQIs (MWCOG, 1993). Third, WQI residuals accumulate quickly and require frequent removal. There is also some concern that because the collected residuals contain hydrocarbon by-products, the residuals may be considered too toxic for conventional landfill disposal. The 1993 MWCOG study found that the residuals from WQIs typically contain many priority pollutants, including polyaromatic hydrocarbons, trace metals, phthalates, phenol, toluene, and possibly methylene chloride (MWCOG, 1993). Based on these considerations, WQIs should not be implemented at sites that generate large amounts of sediment in the runoff unless the runoff has been pretreated to reduce the sediment loads to manageable levels.

WQIs are also limited by maintenance requirements. Maintenance of underground WQIs can be easily neglected because the WQI is often "out of sight and out of mind." Regular maintenance is essential to ensuring effective pollutant removal. As discussed above, lack of maintenance will often result in resuspension of settled pollutants.

Finally, WQIs generally provide limited hydraulic and residuals storage. Due to the limited storage, WQIs do not provide adequate storm water quantity control.

## **DESIGN CRITERIA**

Prior to WQI design, the site should be evaluated to determine if another BMP would be more cost-effective in removing the pollutants of concern. WQIs should be used when no other BMP is feasible. The WQI should be constructed near a storm drain network so that flow can be easily diverted to the WQI for treatment (NVPDC, 1992). Any construction activities within the drainage area should be completed before installation of the WQI, and the drainage area should be revegetated so that the sediment loading to the WQI is minimized.

Upstream sediment control measures should be implemented to decrease sediment loading.

WQIs are most effective for small drainage areas. Drainage areas of 0.4 hectares (1 acre) or less are often recommended. WQIs are typically used in an off-line configuration (i.e., portions of runoff are diverted to the WQI), but they can be used as on-line units (i.e., receive all runoff). Generally, off-line units are designed to handle the first 1.3 centimeters (0.5 inches) of runoff from the drainage areas. Upstream isolation/diversion structures can be used to divert the water to the off-line structure (Schueler, 1992). On-line units receive higher flows that will likely cause increased turbulence and resuspension of settled material, thereby reducing WQI performance.

As discussed above, oil/water separation tank units are often utilized in specific industrial areas, such as airport aprons, equipment washdown areas, or vehicle storage areas. In these instances, runoff from the area of concern will usually be diverted directly into the unit, while all other runoff is sent to the storm drain downstream from the oil/water separator. Oil/water separation tanks are often fitted with diffusion baffles at the inlets to prevent turbulent flow from entering the unit and resuspending settled pollutants.

WQIs are available as pre-manufactured units or can be cast in place. Reinforced concrete should be used to construct below-grade WQIs. The WQIs should be water tight to prevent possible ground water contamination.

## **Chamber Design**

Structural loadings should be considered in the WQI design (Berg, 1991), particularly with respect to the sizing of the chambers. When the combined length of the first two chambers exceeds 4 meters (12 feet), the chambers are typically designed with the length of the first and second chamber being two-thirds and one-third of the combined length of the unit, respectively. Each of the chambers should have a separate manhole to provide access for cleaning and inspection.

The State of Maryland design standards indicate that the combined volume of the first and second chambers should be determined based on 1.1 cubic meters (40 cubic feet) per 0.04 hectares (0.10 acres) draining to the WQI. In Maryland, this is equivalent to capturing the first 0.33 centimeters (0.133 inches) of runoff from the contributing drainage area.

Permanent pools within the chambers help prevent the possibility of sediment resuspension. The first and second chambers should have permanent pools with depths of 1.2 meters (4 feet). If possible, the third chamber should also contain a permanent pool (NVPDC, 1992).

The first and second chambers are generally connected by an opening covered by a trash rack, a PVC pipe, or other suitable material pipe (Berg, 1991). If a pipe is used, it should also be covered by a trash rack or screen. The opening or pipe between the first and second chambers should be designed to pass the design storm without surcharging the first chamber (Berg, 1991). The design storm will vary depending on geographical location and is generally defined by local regulations.

In the standard WQI, an inverted elbow is installed between the second and third chamber. The elbow should extend a minimum of 1 meter (3 feet) into the second chamber's permanent pool. Because oil will naturally separate from, and float on top of, the water, water will be forced through the submerged elbow and into the third chamber while oil will be retained in the second chamber (NVPDC, 1992). The depth of the elbow into the permanent pool should be. The size of the elbow or the number of elbows can be adjusted to accommodate the design flow and prevent discharge of accumulated oil (Berg, 1991).

Pre-manufactured oil/water separation tanks do not usually follow the separated-chamber design; instead, these units often rely on baffle units to separate the different removal process. Particulates are thus retained near the inlet to the tank, while oil/water separation takes place closer to the tank outlet.

## PERFORMANCE

WQIs are primarily utilized to remove sediments from storm water runoff. Grit and sediments are partially removed by gravity settling within the first two chambers. A WQI with a detention time of 1 hour may expect to have 20 to 40 percent removal of sediments. Hydrocarbons associated with the accumulated sediments are also often removed from the runoff through this process. The WQI achieves slight, if any, removal of nutrients, metals and organic pollutants other than free petroleum products (Schueler, 1992).

The 1993 MWCOG study discussed above found that an average of less than 5 centimeters (2 inches) of sediments (mostly coarse-grained grit and organic matter) were trapped in the WQIs. Hydrocarbon and total organic carbon (TOC) concentrations of the sediments averaged 8,150 and 53,900 milligrams per kilogram, respectively. The mean hydrocarbon concentration in the WQI water column was 10 milligrams per liter. The study also indicated that sediment accumulation did not increase over time, suggesting that the sediments become re-suspended during storm events. The authors concluded that although the WQI effectively separates oil and grease from water, re-suspension of the settled matter appears to limit removal efficiencies. Actual removal only occurs when the residuals are removed from the WQI (Schueler 1992).

A 1990 report by API found that the efficiency of oil and water separation in a WQI is inversely proportional to the ratio of the discharge rate to the unit's surface area. Due to the small capacity of the WQI, the discharge rate is typically very high and the detention time is very short. For example, the MWCOG study found that the average detention time in a WQI is less than 0.5 hour. This can result in minimal pollutant settling (API, 1990). However, the addition of coalescing units in many current WQI units may increase oil/water separation efficiency. Most coalescing units are designed to achieve a specific outlet concentration of oil and grease (for example, 10-15 parts per million oil and grease).



## OPERATION AND MAINTENANCE

The key to the performance of WQIs is maintenance. When properly maintained, WQIs should experience very few separation, clogging, or structural problems.

Basic maintenance should consist of regularly checking and cleaning out the sediment that has accumulated in the WQI. A lack of regular clean-outs can lead to the resuspension of collected sediments; therefore, WQIs should be inspected after every storm event to determine if maintenance is required. At a minimum, each WQI should be cleaned at the beginning of each season (Berg, 1991). The required maintenance will be site-specific due to variations in sediment and hydrocarbon loading. Maintenance should include clean out, disposal of the sediments, and removal of trash and debris. The clean out and disposal techniques should be environmentally acceptable and in accordance with local regulations. Since WQI residuals contain hydrocarbon by-products, they may require disposal as hazardous waste. Many WQI owners coordinate with waste haulers to collect and dispose of these residuals. Since WQIs can be relatively deep, they may be designated as confined spaces. Caution should be exercised to comply with confined space entry safety regulations if it is required.

Oil/water separator tank units can be fitted with sensing units that will indicate when the units need to be cleaned. Because most of oil/water separator tank units are designed for specific industrial applications, their maintenance schedule should be closely tied to the industrial process schedule. However, these units should also be inspected after rain events.

## COSTS

The construction costs for WQIs will vary greatly depending on their size and depth. The construction costs (in 1993 dollars) for cast-in-place WQIs range from \$5,000 to \$16,000, with the average WQI costing around \$8,500 (Schueler, 1992). For the basic design and construction of WQIs, the pre-manufactured units are generally less

expensive than those that are cast in place (Berg, 1991).

Maintenance costs will also vary greatly depending on the size of the drainage area, the amount of the residuals collected, and the clean out and disposal methods available (Schueler, 1992). The cost of residuals removal, analysis, and disposal can be a major maintenance expense, particularly if the residuals are toxic and are not suitable for disposal in a conventional landfill.

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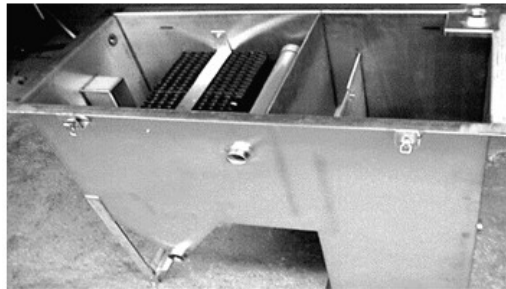
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## Oil/Water Separators



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Oil/water separators are devices used to remove free and dispersed oil and other petroleum products from ground water recovery, industrial wastewater and/or storm water systems. Oil/water separators use several techniques, depending on the type and application or intended use of the separation system. Onion Enterprises has typically used a coalescing separation system instead of conventional gravity. The performance of these systems is based primarily on the relatively low solubility of petroleum products in water and the difference between the specific gravity of water and the specific gravities of petroleum compounds.

Oil/water separator are not designed to separate other products such as solvents, detergents, or metals. The illustration below represents a very simple example of the separation phases in an oil/water diameter oil droplet will rise about 6 inches in water in ten minutes. A 20 micron diameter oil droplet will take over two hours to rise the same distance. In a typical gravity type oil/water separator an oil droplet must rise approximately 48 inches to reach the surface of the water and be removed from the flow. Because of this, many of the smaller droplets pass through convention type oil/water separators unaffected. Addition of inclined coalescing plates will allow the droplet to separate after rising only 3/4 inch before hitting the upper plate and being removed from the water flow.

**Description of operation:** There are two basic types of separators: conventional and coalescing. Often, gravity type oil/water separators do not remove enough oil to meet regulatory requirements. In these cases, coalescing oil/water separators are needed to enhance separation. Oily wastewater influent is introduced to the inlet of the separator.

Coalescing (binding together) the smaller oil droplets makes them larger and more buoyant, causing them to rise faster. Many coalescing oil/water separators use inclined plates to reduce the distance the oil droplets have to rise to be removed from the flow; thereby, increasing the separation efficiency of a typical gravity type separator.

Coalescence type separators are a highly efficient solution. These oil/water separators have been designed to accelerate the process which oil and water do naturally - separate. This separation is accomplished with no moving parts and is based on principles as consistent as gravity and buoyancy. The operation of the coalescence type separator is based on the use of relatively close tolerance 1/2' to 1.25' or larger spacing) surface areas which reduce the distance an oil droplet must travel before it reaches a collection surface. The coalescence plates are constructed of materials which are hydrophobic (water repelling) and oleophilic (oil attracting). When the oil droplet comes in contact with the plate it reaches a zone of zero velocity and adheres to the surface. The coalescence surfaces multiply the effectiveness of the natural action of oil and water to separate.

As the media plate becomes coated with continuously agglomerating oil, the oil begins to form droplets. These droplets then coalesce or migrate upward. The media plates are set at 45-60 degree angles with respect to horizontal. This creates a condition which accelerates the vertical movement of the oil on them. The oil coating the media surface accumulates at the top edge of the media where it detaches as a droplet and floats to the surface of the separation chamber. Once it breaks away from the media, the oil then resides on the surface of the water. There are now two zones of liquid in the separator - oil and water. The oil which has separated overflows a fixed weir into a collection chamber for subsequent removal. The clear water underflows the oil and is discharged from the system on a continuous basis.

**Separation Process:** The water/solids mixture enters the clarifier and is spread out horizontally,

distributed through an energy and turbulence diffusing device. The mixture enters an influent chamber that begins the settling process by equalizing the flow into a non-turbulent, homogenized, downward flow path. When the flow exits this chamber it is redirected into a horizontal and then vertical flow path. Once it begins the vertical path the flow encounters the slant plates where the solids come into contact with the plates, effectively separating from the flow. The solids slide down the plates and are deposited in the sludge hopper located under the slant plate pack.



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