City of Lewiston

Public Works Department
Stormwater Policy and Design Manual

Table of Contents

List of Tables

List of Figures

.

List of Appendices

Acknowledgements

The majority of information in this Stormwater Manual is derived from two sources, both of which are applicable to the situation in Lewiston: the Washington Dept. of Ecology's Stormwater Management Manual for Eastern Washington (Sept. 2004), Publication No. 04-10-076 http://www.ecy.wa.gov/biblio/0410076.html , and the City of Boise's Stormwater Management: A Design Manual (2007) http://www.cityofboise.org/public_works/services/water/storm_water/manual/index.aspx?id=design_manual . Users of this Stormwater Manual are encouraged to refer to either of these manuals for background information, more in-depth discussion and/or references.

Other significant references for this document are listed in Appendix H.

Executive Summary

The Lewiston Stormwater Policy and Design Manual (hereafter referred to as the "Stormwater Manual") defines the policies, minimum standards, requirements, and procedures for the design, construction, and maintenance of stormwater systems within the jurisdiction of the City of Lewiston (City).

Retention/Detention Policy. It is the policy of the City of Lewiston that:

1) the Water Quality Volume of Stormwater (the first 0.4 inches precipitation running off an impervious surface, the 2-year, 1-hour event, as defined in Section 2.3.6) shall be retained and infiltrated on or near the development site;
2) the runoff volume created by precipitation between 0.4 inches and 1.2 inches (2-year, 24-hour storm, Section 2.3.4) shall be retained or detained on site with a metered release over 72 hours maximum; and
3) the runoff volume for the part of a storm greater than 1.2 inches precipitation may be discharged to a stormwater conveyance system adequate to carry the flows (Section 2.3.7), as determined through a stormwater drainage basin flow analysis similar to that of the Lewiston Stormwater Master Plan.

Because of public health concerns, standing stormwater that cannot be infiltrated or otherwise disposed of on-site, and that meets Idaho's water quality standards, should be slowly drained over 72 hours in a manner that will not exceed the capacity of the stormwater drainage system. Drainage for public health purposes that exceeds the Retention/Detention Policy may occur only as the result of a stormwater management adjustment in writing from the City Engineer.

Preface

The Lewiston Stormwater Manual defines the policies, minimum standards, requirements, and procedures for the design, construction, and maintenance of stormwater systems that discharge or have potential to discharge to the stormwater system managed by the City of Lewiston (City). Every new development or redevelopment site in the City is expected to have a Stormwater Management Plan (SWMP) that incorporates the policies and standards of this Stormwater Manual.

This Stormwater Manual sets forth the criteria for the design of stormwater Best Management Practices (BMPs) that will be in place for the life of the building or other impervious surface being constructed. These BMPs are known generally as "Post-Construction BMPs" and form the basis of each site's Stormwater Management Plan.

The design criteria for post-construction BMPs in this Stormwater Manual are requirements of the City of Lewiston. These requirements are in addition to BMPs and Stormwater Pollution Prevention Plans (SWPPP) for construction sites as regulated by the Environmental Protection Agency (EPA) under the Construction General Permit (CGP). The design professional will need to select construction BMPs and post-construction BMPs that will best meet both regulatory environments and the needs of the development site.

As an integral part of the City's Stormwater Management Plan, this Stormwater Manual applies to all new site developments and redevelopment where stormwater will be discharged to the City's stormwater system. The goal is to protect public health and welfare, provide flood control, improve stormwater quality, reduce erosion and sedimentation, manage stormwater flow quantity, enhance riparian habitat, provide for improved quality of life, and reduce costs to the citizens of Lewiston over the long term. The Stormwater Manual contains appendices to supplement the information included in the main body.

If a particular development plan includes the City assuming ownership of some or all of the stormwater management facilities, the City may require construction standards different from those set forth in this Stormwater Manual.

1.0 Introduction

This Stormwater Manual Replaces City Council Resolution 80-100 in the definition, design, and management of stormwater in the City of Lewiston.

The Purpose of this Stormwater Manual is to define minimum requirements, standards, and procedures for new and redeveloped stormwater management facilities that discharge or have potential to discharge to the stormwater system managed by the City. The Stormwater Manual establishes stormwater management criteria and design standards for all new development and any redevelopment that results in the creation of 2,000 square feet or more of new impervious or semi-pervious surface.

The Goal is to develop a stormwater management system with the capacity to serve present and future needs of the residents and businesses in the City, minimizing adverse impacts, while discharging high quality water to our streams and rivers and recharging the aquifers.

The Users of this Stormwater Manual are development, design, and construction professionals working on commercial, industrial and public development projects.

Residential Users should refer directly to Appendix A for specific instructions.

In addition to this Stormwater Manual, the City has other regulatory and guidance tools available, listed below, to help meet this goal.

Lewiston Stormwater Master Plan (October 2001). "The Purpose of the Stormwater Master Plan is to provide a conceptual drainage plan to assist the City staff, City Council and citizens in making decisions toward a comprehensive and integrated storm drainage system that meets the needs of the community." The Master Plan provides preliminary storm drain layout and sizing, provides the City with a framework for prioritizing capital storm drain expenditures, identifies areas where further studies are needed, and helps meet regulatory requirements. This Stormwater Manual sets forth design standards to meet the goals of the Master Plan.

DEQ Catalog of Stormwater BMPs. The City's Stormwater Pollution Control Ordinance adopts the Idaho Department of Environmental Quality (DEQ) Catalog of

Stormwater Best Management Practices for Idaho Counties and Cities as the minimum requirements for BMPs to be put in place to control stormwater pollution. This Stormwater Manual sets out more detailed design criteria for a selected set of DEQ's "Permanent Stormwater Controls" thought to be most applicable to stormwater management needs of Lewiston.

Lewiston's NPDES Phase II permit for stormwater discharge. The Clean Water Act of 1972, as amended in 1987, prohibits the discharge of pollutants into waters of the United States unless the discharge complies with the National Pollutant Discharge Elimination System (NPDES) permit. The City was made subject to the Phase II Stormwater NPDES permitting (MS4 Permit) regulations in 2002. The MS4 Permit program requires the City to "develop, implement, and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers that receive discharges from areas of new development and significant redevelopment." Within this regulatory context, this Stormwater Manual sets forth design and development requirements to reduce pollution carried in stormwater runoff.

Stormwater Pollution Control Ordinance. Pending receipt of the Phase II NPDES Stormwater permit, City staff has a draft ordinance ready to bring before the City Council that contains measures to control stormwater pollution. This Stormwater Manual fills a need set forth by the ordinance by establishing stormwater design and development standards to meet the requirements of the ordinance.

Total Maximum Daily Loads (TMDLs). Currently, the Idaho Dept. of Environmental Quality has established TMDLs for several pollutants in both Lindsay Creek and Tammany Creek to meet State water quality standards. Under the City's MS4 Permit, properly designed and installed BMPs are the approved implementation tool for meeting the requirements of the TMDLs. This Stormwater Manual establishes design and development criteria to ensure that stormwater discharges from the City comply with Idaho's water quality standards.

1.1 Design Standards

This Stormwater Manual presents minimum stormwater system design standards for the City. These design standards apply to permanent stormwater system installations, as opposed to temporary stormwater management systems put in place during construction and regulated by EPA. In addition to the policy, ordinance, and regulatory documents cited in the previous section, the following guiding objectives shall be applied in the design of stormwater management systems for a specific site or project. The design professional shall consider the following standards when designing components of the Lewiston stormwater management system.

Distributed Stormwater Management System. Stormwater management will be distributed throughout the City as the responsibility of both the public and private sectors. The general management concept is as follows: The runoff from small precipitation events (and the early parts of larger events) shall be retained and managed on properties where they fall. Moderate storm runoff events shall be managed by small storages and infiltration areas throughout the City coupled with metered releases into the City-managed storm drainage system. Large runoff events that significantly overflow the storage and detention systems will be managed by the City through storm drains and regional detention ponds and/or treatment facilities.

Retention/Detention Policy. It is the policy of the City of Lewiston that:

1) the Water Quality Volume of Stormwater (the first 0.4 inches precipitation, First Flush, running off an impervious surface, as defined in Section 2.3.6) shall be retained and infiltrated on or near the development site (equivalent to the 2-year, 1-hour design storm event);

2) the runoff volume created by precipitation between 0.4 inches and 1.2 inches (2-year, 24-hour storm, Section 2.3.4) shall be retained or detained on site with a metered release to a stormwater conveyance system over 72 hours maximum; and

3) the runoff volume for the part of a storm greater than 1.2 inches precipitation may be discharged to a stormwater conveyance system adequate to carry the flows (Section 2.3.7), as determined through a stormwater drainage basin flow analysis similar to that of the Lewiston Stormwater Master Plan..

Because of public health concerns, standing stormwater that cannot be infiltrated or otherwise disposed of on-site, and that meets Idaho's water quality standards, should be drained over a 48-72-hour period in a manner that will not exceed the capacity of the stormwater system. Drainage for public health purposes that exceeds the Retention/Detention Policy may occur only as the result of a stormwater management adjustment in writing from the City Engineer.

Responsibility for Pollution and Runoff Control. Controlling pollutants and runoff entering the City's stormwater system is the responsibility of the owner or operator of the site generating the pollutants and runoff. This responsibility is demonstrated through a Stormwater Management Plan (SWMP) for every development site describing how stormwater will be managed and pollutants controlled.

Stormwater Management Plan. This Stormwater Manual requires a Stormwater Management Plan (SWMP) for all projects creating or redeveloping over 2,000 ft^^{2} of impervious surface. The SWMP is to describe all planned activities and BMPs that will insure compliance with the City's Retention/Detention Policy and insure that all discharges meet Idaho's water quality standards. .

For single-family residential development, or any project not requiring an approved Erosion and Sediment Control Plan, the SWMP is a document that will be reviewed by the City for compliance with the residential standards described herein before a Certificate of Occupancy will be granted.

For development requiring an Erosion and Sediment Control Plan, i.e., all commercial, industrial and public development and redevelopment, including residential subdivisions, a SWMP must be included. The amount of detail required in a SWMP is dependent on the amount of impervious surface being created and the impact the increased runoff might have on the existing stormwater system (see Section 2.2).

Operations and Maintenance Plan. This Stormwater Manual requires the development and City approval of a Stormwater Operations and Maintenance Plans (O&MP) for all commercial, industrial and public development and redevelopment, including residential subdivisions that will discharge stormwater to the City's stormwater system. The design objective is to create a plan that will, over time and through various owners, guarantee the continued maintenance and functioning of stormwater control BMPs on any given site. The City may require that any stormwater management responsibilities or limitations created by a SWMP or O&MP be recorded with the title of the property.

1.2 Design Definitions and Criteria

Stormwater System. The stormwater system consists of all conveyances and storages, whether public or private, including but not limited to buried pipes, open ditches, swales, curbs, gutters, roadways, streets, valley pans, parking lots, wetlands, retention/detention facilities, ponds, basins, pumping stations, and various engineered inlets, outlets and other structures. Some conveyances and storages of the stormwater system may be operational only during extreme storm and runoff events.

City's Stormwater System. That part of the stormwater system owned and/or operated by the City of Lewiston. Other parts of the stormwater system may be owned and/or operated by other governmental or semi-governmental organizations or private entities.

Pollutants of Concern. Pollutants of concern are pollutants identified in Lewiston's stormwater permit from EPA, Total Maximum Daily Loads (TMDLs) developed by the Idaho Department of Environmental Quality (DEQ), or other applicable regulatory documents. The most common water pollutants of concern in Lewiston are sediment, nutrients (nitrates and phosphates), pathogens/bacteria, temperature (heat), and oils/greases. The design objectives are 1) to identify all pollutants of concern specific to a particular development site, and 2) design stormwater treatment facilities to ensure that discharges meet water quality standards or other regulatory controls for these pollutants.

Stormwater Best Management Practices. Best Management Practices (BMPs) are the primary tools available for managing stormwater. BMPs may be either structural or managerial in nature, and any planned stormwater management system usually contains both. This Stormwater Manual sets forth design criteria for structural stormwater BMPs that include direct conveyance (channel or pipe flow), storage (detention and retention), filtration, and infiltration. The DEQ Catalog of Stormwater BMPs contains both structural and management BMPs and lists many BMPs not discussed herein which may be appropriate to your design needs. The design objective is to select a set of BMPs that will adequately address the water quality and quantity standards, objectives and policies stated in this section.

Stormwater Storage and Runoff. Stormwater is managed through a combination of on-site storage and infiltration, off-site storage and infiltration, and conveyance. The design objective is to quantify stormwater coming onto a site, both precipitation and run-on, and to account for how that stormwater will be managed on-site or near off-site through some combination of storage, infiltration, and conveyance.

Pre-Development Runoff. In this Stormwater Manual, Pre-Development Runoff refers to runoff and runoff rates that occurred prior to any land development, as the site existed with natural vegetation. Although data are unavailable, it is assumed that pre-development runoff from most areas in the City occurred only during short periods of high intensity rainfall when rainfall intensity exceeded the infiltration capacity of the soil. The design objective is to maintain runoff rate from any given site at no greater than the pre-development runoff.

Post Development Runoff. Site development significantly increases runoff potential by reducing infiltration capacity of the soil, by creating impervious surfaces such as roofs and paving, and by reducing the natural soil permeability through soil disturbance and compaction, etc. The design objective is to store and infiltrate the development-related increased runoff, either on-site or near off-site to the maximum extent practicable. Any necessary increased runoff shall be managed so it meets Idaho water quality standards and does not exceed the conveyance capacity of the receiving stormwater system. The conveyance capacity of the receiving system shall be analyzed based on techniques similar to those in the Lewiston Stormwater Master Plan and in consideration of runoff from throughout the whole stormwater drainage basin within which the project occurs

First Flush. Most water pollutants are moved into the stormwater conveyance system in the first 30 minutes or so of runoff during a storm event, the "First Flush." The design objective is to capture, treat and retain first flush stormwater on or near the development site, throughout the City, for all development.

Discharge Route. All stormwater runoff created by new impervious surface on a particular ownership shall have a defined discharge route. Normally that discharge route will be a City managed discharge route as evidenced by City ownership of the route, City identification of the route in the Stormwater Master Plan, or a stormwater routing easement to the City. In the absence of a defined discharge route for all stormwater created by new or redeveloped impervious surfaces, the increased runoff must be retained on site or otherwise managed by the property owner. The City reviews stormwater discharge routing plans as part of its approval of the Erosion and Sediment Control Plan.

Overflow. All stormwater management systems must be designed with a planned overflow in case of a storm event that exceeds the design capacity. The criteria are set out in Section 2.3.7.

Storm Intensity, Duration and Return Frequency. To design an adequate stormwater management system, both maximum storm intensity (inches per hour) and storm duration (hours) for a given return frequency (years) must be known. Generally, these numbers for calculations are acquired from modeled "design storms" developed by NOAA (National Oceanic and Atmospheric Administration) and the NRCS (Natural Resources Conservation Service). The design objective is to calculate stormwater flow rates and flow volumes that accurately reflect the results of storms over the City such that the designed stormwater management system will be adequate, neither over-sized nor under-sized.

Pervious, Semi-Pervious and Impervious Surfaces. Pervious surfaces are those surfaces, such as natural soils, that have the ability to absorb rainfall. Most of the soils in the Lewiston area have the capacity to absorb most all of the rainfall they intercept, such that, under natural conditions, very little rainfall runs off the surface as stormwater. Such things as paving and buildings create impervious and semi-pervious surfaces from which much of the rainfall runs off as stormwater. The design objective is to calculate the amount of semi-pervious and impervious surface being created by development of a site so that both the post-development runoff rate and runoff volume can be determined. For the purposes of this Stormwater Manual, the term impervious surface shall include semi-pervious surface.

1.3 Applicability

The standards in this Stormwater Manual apply to stormwater management installations where stormwater will be discharged to the City's stormwater system. For all commercial, industrial and public development projects, including residential subdivisions, the City Public Works Engineering Division reviews and approves Erosion and Sediment Control (E&SC) Plans which must include Stormwater Management Plans (SWMP) when more than 2,000 ft^^{2} of new or reconstructed impervious surface is created. The standards in this Stormwater Manual also apply to construction on a single residential parcel where stormwater runoff will discharge to the City's stormwater system.

> **Note:** A residential parcel is a single parcel of land used or planned to be used for a single family residence, or a duplex. A residential subdivision is a group of parcels being developed by one person or business for sale as residential parcels.

As part of the E&SC Plans, the City requires a written Stormwater Management Plan (SWMP). SWMPs describe the application of the standards of this Stormwater Manual. The City will review all SWMP submittals for general compliance with the City's rules and regulations, including compliance with the design objectives (Section 1.1) and design specifications (Section 3) in this Stormwater Manual.

In the cases of large, complex developments, or subdivisions that will be developed over time by different operators, different SWMPs may apply at different stages of the development. The original SWMP must recognize that subsequent SWMPs may be necessary over time and should specify the requirement in documentation filed with the City and passed down to subsequent operators. For example, a subdivision plat may specify that purchasers and developers of individual lots will need SWMPs for all impervious surfaces created on their lots. The City may require that any stormwater management responsibilities or limitations created by a SWMP must be recorded with the title of the property.

In cases where the City will be expected to assume ownership and management of the given stormwater facility, the City may impose more strict design standards to meet specific needs of the City.

Compliance with standards of this Stormwater Manual does not relieve the owner of any stormwater installation from the responsibility of ensuring all systems are safe or that calculations, plans, specifications, construction, and record drawings comply with generally accepted engineering standards, and other applicable local, state, and federal rules and regulations. Where any other law, ordinance, resolution, rule, or regulations of any kind also cover requirements in this document, the more restrictive shall govern.

This Stormwater Manual replaces the December 1997 Lewiston Stormwater Policy and Design Manual and the 1980 City Council Resolution 80-100.

If special conditions and/or environmental constraints are present, the City Engineer has the authority to impose more stringent design standards than those set forth in this Stormwater Manual. The City Engineer has the option of accepting alternatives to standard plans, specifications, and design details if the proposed alternatives meet or exceed the performance standards of this Stormwater Manual. The procedures for requesting stormwater management adjustments are presented in Section 2.4.3.

1.4 Inter-Jurisdictional Requirements

For projects within the City limits but governed by other jurisdictions (e.g., the State of Idaho or Nez Perce County), SWMPs must comply with the standards and requirements of the governing jurisdiction. The owner/developer shall provide proof of other governmental approval to be exempt from the requirements of this Stormwater Manual.

The City of Lewiston, when planning to receive stormwater from another governmental jurisdiction or agency, may require that agreements or permits be in place to ensure that the source jurisdiction will maintain water quality and quantity control over the stormwater discharges planned to be discharged to the City's stormwater system.

Design and construction professionals must recognize the need to comply with two stormwater regulatory environments at virtually every development site. The federal EPA regulates stormwater management during construction through the Construction General Permit (CGP) which requires the development of a SWPPP, a Stormwater Pollution Prevention Plan. This Stormwater Manual sets forth standards for post-construction stormwater management as needed by the City for all the goals stated in Section 1 of this document, and requires the development of a SWMP, a Stormwater Management Plan. A SWPPP and a SWMP may be developed as one document so long as the developer recognizes that it needs to address the requirements of both EPA and the City, the requirements of both the CGP and this Stormwater Manual.

Entities covered by an EPA-issued NPDES permit such as the Construction General Permit or a Multi-Sector General Permit (for industrial discharges to the stormwater system), or an MS4 permit, are permitted by EPA to discharge to waters of the U.S. and, therefore, can be assumed to meet the minimum stormwater quality requirements of the City. However, the City retains the right to require that such permitted entities demonstrate to the City that they are in compliance with their permit before allowing them to discharge to the City's stormwater system. In addition to EPA permit requirements, the permitted entities must meet all other stormwater volume planning and management requirements set forth in this Stormwater Manual.

In the absence of a more general agreement between jurisdictions regarding stormwater management, at a minimum, a Stormwater Operations and Maintenance Plan by the jurisdiction planning to discharge stormwater to the City's stormwater system, including provisions for stormwater monitoring and reporting, must be submitted to and approved by the City Engineer.

1.5 Modifications and Addenda

The City shall revise and update this Stormwater Manual as necessary through approval by the City Public Works Director to reflect corrections and advances in the field of stormwater management engineering. Users who request changes to the Stormwater Manual shall provide data to the City Public Work Director that provide justification for the change.

1.6 How to Use This Stormwater Manual

This Stormwater Manual specifies stormwater management requirements for new development and significant redevelopment sites. The City intends the Stormwater Manual to provide a site development professional with the resources and regulatory information necessary to develop a unique plan based on the specific site conditions.

Section 1 describes the regulatory, jurisdictional and policy scope for these design requirements. Particular attention is drawn to Section 1.1, Design Objectives. Section 2 presents the general criteria that apply to all new development, and to redevelopment that creates impervious surfaces greater than 2,000 square feet. Section 3 contains the design specifications for individual stormwater facilities (i.e., the system(s)) selected for installation.

2.0 Stormwater Management Plan

This section identifies general requirements for the development of the Stormwater Management Plan (SWMP).

2.1 Applicability

The guidance and standards in this Stormwater Manual apply to all new development and redevelopment that will discharge or have potential to discharge stormwater to the City's stormwater system.

For single-family residential sites, the SWMP is a document describing how stormwater will be managed over time on the individual property to meet the requirements of the City's Retention/Detention policy and discharge stormwater meeting Idaho water quality standards. The City will review the document to ensure that adequate stormwater BMPs are described and in place before a Certificate of Occupancy will be issued.

For all commercial, industrial and public building projects, including commercial residential developments and subdivisions, a SWMP must be included with the E&SC Plan. A qualified Idaho-licensed professional must stamp and sign the E&SC Plan.

In cases where the City will be expected to assume ownership and management of a given stormwater facility, the City may impose more strict design standards to meet specific needs of the City.

2.2 Erosion and Sediment Control Plan and Stormwater Management Plan

An E&SC Plan must include a specific Stormwater Management Plan (SWMP) when more than 2,000 square feet of new or redeveloped impervious surface will be created. The amount of information required in a SWMP is dependent of the size of the project. Smaller projects creating less than 20,000 square feet of new or redeveloped impervious surface may use the Short SWMP Checklist. Larger projects creating more than 20,000 square feet of impervious surface should use the Long SWMP Checklist. The Checklists are presented in Section 2.2.1.

In addition to a SWMP, a Stormwater Pollution Prevention Plan (SWPPP) is required by EPA for construction sites disturbing one or more acres, including offsite borrow and disposal areas. The EPA-required SWPPP is primarily oriented to BMPs that are needed during construction, whereas the City-required SWMP is oriented to post-construction, long-term stormwater management for the site. A SWPPP and a SWMP may be developed as one document so long as the developer recognizes that it needs to address the requirements of both EPA and the City, the requirements of both the EPA Construction General Permit and this Stormwater Manual. If they are developed as two documents, a draft of the SWPPP is required as part of the SWMP.

2.2.1 Stormwater Management Plan Checklist

The following requirements apply to all Stormwater Management Plans. Applicants shall submit all the information identified in the following list. Applicants shall also submit additional information specific to the type(s) of system(s) installed that verifies compliance with the Design Manual standards.

Access the City of Lewiston web site at for a SWMP checklist http://www.cityoflewiston.org/comdev/Building/Forms/COM%20DEV%20GUIDE%20FULL%20PACKET.pdf

Short SWMP Checklist

(For Development Creating <20,000 ft^2 of Impervious Surfaces)

Scaled Drawings Showing:

- ☐ Site location in the City
- ☐ Pre- and post-development stormwater flow channels and directions
- ☐ Post-development stormwater system showing sizes and elevations of all detention, retention, and conveyances facilities
- ☐ Escape routing and sizing for 50 year events
- ☐ All existing and proposed impervious and semi-pervious surfaces, showing size in square feet
- ☐ Locations and sizes of all planned construction BMPs
- ☐ Locations and sizes of all permanent structural BMPs with designated setbacks

Narrative SWMP to Include:

- ☐ Narrative of overall stormwater management plan, discussion of managerial and structural stormwater BMPs, and planned long term operation and maintenance of stormwater and stormwater BMPs on the site
- ☐ Description of existing and proposed surface water drainage system, including distance to waters of the U.S. and its 305(b)/303(d) and/or TMDL status
- ☐ Discussion of the basis for selection and operation of the planned stormwater BMPs and management system
- ☐ Soil, subsoil, and geologic properties pertinent to planned BMPs
- ☐ Infiltration data at locations for any infiltration facilities
- ☐ Depth to bedrock and/or water table if less than 10 ft below infiltration BMPs
- ☐ Description and sizes of stormwater infiltration, detention, retention, conveyance facilities
- ☐ Pre- and post-development runoff volume calculations for 2- and 10-year events
- ☐ Escape routing discussion
- ☐ Dimensions of all impervious surfaces
- ☐ Copies of any associated permits, easements, and discharge agreements
- ☐ Stormwater Operations and Maintenance (O&M) Plan

Long SWMP Checklist

(For Development Creating >20,000 ft^2 of Impervious Surfaces)

Stormwater Management Plan

- ☐ Four (4) copies of the SWMP for commercial, industrial and public developments & redevelopments, including commercial residential developments and subdivisons

Scaled Drawings Showing:

- ☐ Site location in the city and stormwater watershed
- ☐ Pre- and post-development stormwater flow channels and directions
- ☐ Stormwater run-on peak flows from off-site sources for 2-, 10-, 25-, and 100-year design storm sizes
- ☐ Post-development stormwater system showing sizes and elevations of all detention, retention, and conveyances facilities
- ☐ Escape routing and sizing for 50 year events
- ☐ All existing and proposed impervious and semi-pervious surfaces, showing sizes in square feet
- ☐ Locations and sizes of all planned construction BMPs

- ☐ Locations and sizes of all permanent structural BMPs with designated setbacks

Narrative SWMP to Include:

- ☐ Narrative of overall development plan, stormwater management objectives, planned managerial and structural stormwater BMPs, and long term operation and maintenance of stormwater and stormwater BMPs on the site
- ☐ Description of surface water drainage system, including distance to waters of the U.S. and its 305(b)/303(d) and/or TMDL status
- ☐ Description of stormwater flows and pollution issues/pollutants of concern to be managed
- ☐ Discussion of the basis for selection and operation of the planned stormwater management system
- ☐ Discussion of how the SWMP complies with the Stormwater Master Plan
- ☐ Soil, subsoil, and geologic properties pertinent to planned BMPs
- ☐ Infiltration data at locations for any infiltration facilities
- ☐ Depth to bedrock and/or water table if less than 10 ft below infiltration BMPs
- ☐ Description of stormwater infiltration, detention, retention, conveyance facilities
- ☐ Pre- and post-development peak stormwater flow rate calculations for 2-, 10-, 25- and 100-year events
- ☐ Pre- and post-development runoff volume calculations for 2-, 10-, 25- and 100-year events
- ☐ Post-development stormwater management calculations accounting for total volume
- ☐ Escape routing calculations and discussion
- ☐ Grade and dimensions of all impervious surfaces
- ☐ A table showing contributing area, average imperviousness, rain intensity and peak flow to each stormwater catch basin
- ☐ Flow intercepted by each inlet
- ☐ Summary of storm sewer pipes, capacities, and flow in each segment
- ☐ Copies of associated permits, easements, and discharge agreements
- ☐ Stormwater Operations and Maintenance (O&M) Plan

Additional Requirements:

- ☐ Plans using commercially developed stormwater management products shall provide complete copies of the design, sizing, installation and operations procedures for the products.
- ☐ Plans for construction sites with greater than 1 acre disturbance must list specifications for the EPA required Stormwater Pollution Prevention Plan (SWPPP)

- ☐ For private stormwater systems that will discharge stormwater to the City’s system, a signed agreement by the engineer of record to provide as-built plans to the City with certification that stormwater management systems have been built as planned.
- ☐ Development sites greater than 10 acres must include a comprehensive stormwater management plan including flood routing and computations for the 50-year storm event through the site, associated watershed and downstream to waters of the U.S.
- ☐ Multi-phase developments must include pertinent data from other phases

2.2.2 Stormwater Easements and Maintenance Road Access

All stormwater management and conveyance facilities and natural drainage channels shall be located in designated and reserved stormwater easements. Easements shall be located to provide access for routine inspection and maintenance, as specified in a Stormwater Operations and Maintenance Plan, and shall be sized for access of construction equipment during maintenance and repair work. If maintenance roads are necessary, they must be a minimum of 12 ft width, must have an HS-25 load capacity and a minimum inside turning radius of 30 ft.

2.3 Stormwater Management Design Criteria

Stormwater management systems may include storage (detention and retention), filtration, and infiltration, conveyance, and usually combine two or more of these facilities. This Stormwater Manual provides design criteria for conveyance, pretreatment, infiltration, evaporation, detention and retention facilities applicable within the City. Stormwater management system designs shall reduce discharges to the maximum extent practicable in accordance with policies, rules and regulations cited in Section 1.0.

The design of a stormwater management system has three components that must be addressed: 1) water quality volume, or first flush, which is the volume of stormwater that must be retained and treated on site, Section 2.3.6; 2) maximum runoff volume which is the total volume of stormwater that needs to be accounted for and managed by the stormwater system, Section 2.3.4; and 3) peak flow rates which is the flow for which conveyance capacity must be designed, Sections 2.3.5 and 2.3.7. Because each component is the result of different aspects of rainfall events, different calculation methods are required. The SWMP shall include calculations clearly identifying the design criteria being used for each component.

2.3.1 Public Safety Requirements

All stormwater control facilities shall incorporate appropriate safety measures in their design. These may include, but not be limited to, fencing; warning signs, stadia rod indicating depth at lowest point, and outlet structures designed to limit public access. For facilities designed to be accepted for management by the City, the design professional will need to consult with the City Engineer and receive his/her approval for public safety requirements. As per IDAPA 58.01, stormwater designs are required to address the risk of cross-connections to potable water supplies and distribution systems.

2.3.2 Design Storm

There are two storm types of interest for stormwater analyses in the Lewiston area. Short-duration thunderstorms can occur in late spring through early fall and are characterized by high intensity rainfall for short periods of time over localized areas. These types of storms can produce high rates of runoff and flash-flooding and are important where flooding, water quality, peak discharge and erosion are design considerations.

Long-duration general storms can occur at anytime of the year but are more common during the cool seasons. These storms are characterized by sequences of storm activity with intervening periods of little or no rainfall occurring over several days. Rainfall intensity is low to moderate with occasions of high intensity. Under naturally vegetated soil conditions in the City, almost all rainfall from these events is infiltrated; however, these types of events can create large volumes of runoff from impervious surfaces.

To facilitate designing facilities to manage runoff from these storms, Design Storms have been developed. Design Storms are developed with two components: a precipitation magnitude for a specified duration and a dimensionless storm pattern. The precipitation magnitude for the specified duration is determined based on a recurrence interval or frequency, in years, with published data typically available for 2, 5, 10, 25, 50, and 100 year returns. The selected precipitation magnitudes are used to scale the dimensionless storm pattern models producing model storm hydrographs. Generally, the model is used to predict the maximum intensity (in/hr) or the total rainfall (inches over some time period, usually inches/24 hr, that might be expected over a specified return period. The storm pattern models in most common use are those developed by the SCS (now NRCS), and are the ones used in this Stormwater Manual and presented in Appendix C.

Total rainfall over a given surface area and a given time period gives the total volume of rainfall. The maximum runoff volume then is developed from rainfall data for the predicted maximum storms (design storm) for a given return period. Table 1 shows the one- and 24-hour rainfall at Lewiston for various recurrence intervals. The 24-hour rainfall is to be used for total stormwater volume calculations for all sites.

Table 1. One-Hour and 24-Hour Precipitation for Various Recurrence Intervals at Lewiston, Idaho

Recurrence Interval (years)	24-hour rainfall (inches)	1-hour rainfall (inches)
2	1.2	0.4
5	1.6	0.55
10	2.0	0.66
25	2.2	0.8
50	2.6	0.9
100	2.8	1.1

For Your Information

Refer to Appendix B for design storm calculation methods and steps to calculate the peak discharge rates from pre- and post-development conditions and the required runoff volume to be retained or detained on-site.

2.3.3 Stormwater Design Calculation Methods

It is recommended that storm drain system design calculations use the Rational Method for peak flow rates and the Natural Resources Conservation Service (NRCS) Curve Number Method for maximum flow volumes from longer term storms. For projects >100 acres, the NRCS TR-55 method is recommended for all calculations.

The NRCS (formerly SCS) Curve Number Method (USDA-SCS. 1985. National Engineering Handbook, Section 4 - Hydrology. Washington, D.C.: USDA-SCS.) is the recommended method for all stormwater volume calculations unless the site is larger than 100 acres or hydrologically complicated, i.e., contains wetlands, streams, flood plains, breaklands, etc., requiring the use of TR-55 or another more robust model. Appendix B presents the steps for applying the Curve Number Method. A simplified calculation method is presented that includes several assumptions that must be met for its use. The design professional is to decide whether the simplifying assumptions apply, or whether the complete model is required. The method is well documented on line and in the literature, as well as in the Stormwater Management Manual for Eastern Washington.

The Rational Method may be used for projects less than 100 acres in size and shall be used only for determining peak discharge rates. This method is traditionally used to size storm sewers, channels, overflows, and stormwater pass-through structures. Appendix B specifies how and under what situations the Rational Method is to be used for stormwater flow rate calculations in the City.

Note: The minimum allowable size for stormwater drain pipe that will be accepted as part of the City's stormwater system is 12 inches.

The NRCS (formerly SCS) TR-55 Method may be used for any project and is recommended for projects 100 acres or greater in size or with complicated hydrology. For more information on the TR-55 Method, refer to the NRCS publication Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55), USDA, Soil Conservation Service, 1986. Appendix B presents steps to be followed in using the TR-55 Method. For these larger projects, the design engineer shall use storm sizes and return periods that are protective of health and welfare, the hydrology of the watershed in question, and the City's stormwater system. At a minimum, the design shall be adequate for 10-year return peak flows and 24-hr, 2-year return maximum flow volumes.

Water Quality Requirements. To meet stormwater quality goals, the City has established a minimum of 0.4 inches as the 'first flush' precipitation that must be retained and infiltrated. See section 2.3.6 for further discussion. The most important consideration should be BMP design to treat for pollutants of concern. The SWMP should clearly define the pollutants of concern and discuss how the selected BMP(s) will treat them.

The runoff volume of stormwater produced by 0.4 inches of precipitation over all newly created impervious and semi-pervious surfaces shall be retained and treated on site. Any necessary discharge of this water quality volume requires a written stormwater management adjustment from the City Engineer, and must be monitored to insure that the discharge meets water quality standards. See Appendix B for steps to calculate the water quality runoff volume for treatment.

2.3.4 Maximum Stormwater Volume Design Criteria

The overall goal of the City is to retain all development-created stormwater on site to the maximum extent practicable. Maximum retention on site helps alleviate the costly need to increase storm drain size downstream. Recognizing that attainment of this goal is not practical for all sites, the City has established minimum criteria for three increments of stormwater runoff.

The first 0.4 inches (equal to the 2-year, 1-hour design storm) of any rainfall event (the Water Quality Runoff Volume, Section 2.3.6) must be retained and treated on site. The second increment is the runoff volume accumulated between 0.4 and 1.2 inches rainfall, the 2-yr, 24 hour event. This volume is to be detained on site and may be discharged through a 72 hour metered release. Overflows must be sized and provided for volumes from a 50 year event. Any planned variation from these requirements must be approved through a written stormwater management adjustment from the City Engineer (Section 2.4.3 for stormwater management adjustment procedures).

Stormwater volume calculations using the NRCS Curve Number Method or TR-55 shall use a 24-hour design storm event. At a minimum, volumes shall be calculated for a 2-year return period (1.2 inches), a 25-year return period (2.2 inches), and a 50-year return period as the amount of precipitation that must be planned for in stormwater management calculations.

For an acre of impervious surface area with a Curve Number (CN) of 98, 1.2 inches precipitation (2-yr, 24-hr event) results in 3,600 cubic feet of water that must be retained and detained in designing a stormwater system. There is no technical justification for reducing the volume needing to be treated for pre-development runoff. This design storm rate (1.2 inches per 24 hours) can be fully infiltrated by most soils in the Lewiston area, i.e., runoff under natural conditions only occurs from storms that produce greater than 1.2 inches of rainfall per 24 hours. The 24-hour hydrograph for 1.2 inches precipitation is presented in Appendix C.

Various methods and BMPs are available to the design engineer to treat a given stormwater volume (Section 3). It may be processed through infiltration swales, spread through a biofiltration system, delivered to an infiltration gallery, delivered to a detention pond, delivered to an off-site treatment facility, etc. The sequencing and calculations for stormwater disposal shall be described in the SWMP.

2.3.5 Peak Flow Rate Design Criteria for Stormwater Conveyance

In general, the peak flow rate of runoff from any proposed land development shall not exceed the pre-development runoff rate. The City may allow an increase in flow rate over pre-development rates by written approval of the City Engineer.

Submitted stormwater designs shall provide the pre- and post-development flow rate calculations for the 10-year storm events using the Rational Method for sites less than 100 acres. The pre- and post-development flow rate calculations for 2, 10, 25, and 100-year return periods are required when using the TR-55 Method for sites greater than 100 acres, choosing the most protective design criteria for the whole development and watershed. Calculation methods are presented in Appendix B.

Conveyance systems shall convey the design storm with minimum impact or inconvenience to the public. Potential impacts and inconveniences of the conveyance system must be defined. The design of the conveyance system must also include easements and restrictions to protect the stormwater conveyance system in perpetuity. If the owner does not obtain the easements and restrictions necessary to maintain the conveyance system, the design plans may not be approved.

Stormwater discharges shall not be directed on to any adjacent property that has not received the runoff previously (i.e., under pre-development conditions) unless the adjacent property owner provides a written easement, consent, or on-site retention plan that has been notarized and recorded. Runoff from a proposed development cannot be diverted and released to any other owner's conveyance, storm drain, or stormwater facility unless specific consent and approval in writing (notarized and recorded) is granted by the entity which controls such conveyance, storm drain, or stormwater facility. Stormwater discharges shall not be increased in flow rate or degree of concentration over pre-development levels when released to any other owner's conveyance, storm drain, or stormwater facility unless specific consent and approval in writing (notarized and recorded) is granted by the entity which controls such conveyance, storm drain, or stormwater facility. . City review for these agreements and conditions is required prior to final approval.

Reference

See Appendix C for the Lewiston Rainfall Intensity: Duration and Frequency Relationship curves (IDF Curves). For precipitation frequency maps, access the Western Regional Climate Center web site at www.wrcc.dri.edu/pcpnfreq.html

2.3.6 Water Quality Design Criteria

To meet water quality objectives, the 'first flush' of pollutants from impervious surfaces shall be captured and treated on site, i.e., shall not be discharged to the City's stormwater system. "First Flush" generally contains most of the oil, grease, nutrients, debris and other pollutants that are captured and moved by stormwater. It is the intent that this water quality volume be infiltrated on site to the maximum extent practicable. The City will review SWMPs to ensure that infiltration of the stormwater quality volume is designed to occur on site.

The City has established that the first 0.4 inches (0.033 ft), equivalent to the 2-year, 1-hour design storm, as the first flush of precipitation on impervious surfaces that must be captured, retained and treated on site, or near off site. This results in approximately 33 cubic feet of required retention for every 1,000 square feet of impervious surface, or about 1,440 cubic feet for every acre of impervious surface. The First Flush from every storm must be captured and retained for treatment on site.

If a bioinfiltration swale with an infiltration rate of at least 1 inch per hour is chosen as the BMP to treat all of the stormwater, the bioinfiltration swale sized to meet water quality design is also adequate to meet the 2-year, 24-hour design needs. See the 24-hour hydrograph analysis in Appendix C. In other words, bioinfiltration swales adequate in size to treat the water quality volume of 33 cubic feet per 1,000 square feet impervious surface, when they have an infiltration rate of at least 1 inch per hour, are also adequate to store and infiltrate the stormwater from a 2-year, 24-hour event.

New development and significant redevelopment projects are expected to install stormwater systems that, by themselves or in combination with other BMPs, reduce or remove Total Suspended Solids (TSS) by 80%. The design removal rates listed in Table 2 are those removal rates currently accepted by the City. The City will provide updates to this table as new and improved TSS removal rates become available. When BMPs are located in line, one after another, TSS removal rates are to be calculated separately for each BMP. For example, given a stormwater discharge containing 200 mg/l TSS to be passed through a sediment forebay and then a wetland, the TSS removal calculation would be 80 mg/l removal by the sediment forebay resulting in 120 mg/l remaining from which a wetland would remove 50% resulting in a predicted outflow from the wetland of 60 mg/l.

Table 2. TSS Removal Rates for Stormwater Management BMPs

BMP	TSS Removal Rates	Comments
Sand Filter	80%	Pretreatment for off-site discharge or infiltration of water quality volume
Bioinfiltration Swale	80%	Treatment for off-site discharge or infiltration of water quality volume
Grass Buffer (Filter) Strip	85%	Based on 150 ft buffer length
Permeable Pavement	TBD	Depends on Seepage Bed design
Oil Water Separator	15%	Pretreatment for off-site discharge
Catch Basin Insert	TBD*	Pretreatment for off-site discharge
Gravity Separator	TBD*	Pretreatment for off-site discharge
Vault Filtration System	TBD*	Pretreatment for off-site discharge
Sediment Forebay	40%	Pretreatment for on-site BMPs
Infiltration Basin	85%	Treatment of 2-yr, 24-hr storm

Infiltration trench	85%	Treatment of 2-yr, 24-hr storm
Dry Detention Pond	40%	Water quantity control pond
Wet Extended Detention Pond	85%	Sediment forebay included or lengthened flow path
Evaporation Pond	85%	Treatment of water quality volume
Wetland	50%	Treatment of 2-yr, 24-hr storm

*The TSS removal rate will be determined during plan review and will be assessed based on the manufacturer's test data at the water quality design flow rate and TSS concentration of between 100 and 150 mg/l (approximate median TSS concentration typically found for this region), when available.

Reference

Refer to the City of Boise Non-Stormwater Disposal Best Management Practices Handbook for more information on source controls of pollutants. This document is available on the internet at:
www.cityofboise.org/public_works/services/water/storm_water.

2.3.6 Subsurface Water Design Criteria

Stormwater runoff can be treated and disposed of through infiltration using sand filters, infiltration swales, infiltration basins, infiltration trenches, permeable pavement systems, or other BMPs. However, additional measures to protect ground water quality may be appropriate (i.e., sand filtration or biofiltration) when designing for areas close to Tammany and Lindsay Creeks where nutrient TMDLs for nitrogen and phosphorus are in effect..

Pretreatment may be required for infiltration trench facilities if the site involves a land use with potential higher pollutant loads. A retrofit for additional pretreatment could include catch basin inserts, oil-water separators, drainage channels, water quality swales, and/or deep sump catch basins.

For Your Information

Some types of high-risk site activities require additional pollutant source controls and secondary containment in case of accidental hazardous material or waste spills. Contact Lewiston Community Development at 746-1318 for more information about local building or fire code requirements.
http://www.cityoflewiston.org/comdev/Building/index.htm

For Your Information

The federal Underground Injection Control (UIC) program classifies infiltration trenches as Type V shallow injection wells.[1] Administered by the Idaho Department of Water Resources (IDWR), the UIC program requires an inventory of each Type V shallow injection well.

On-site infiltration of stormwater systems address sediment and other pollutants associated with sediment for 100% of the volume infiltrated. The volume infiltrated is either the water quality design volume (0.4 inches) or the full water quantity design volume for new development stormwater (24 hour 2-year return event for all sites).

2.3.7 Overflow Design Criteria

Because the City has chosen the relatively small 24-hour, 2-year design storm as the acceptable sizing criteria for detention and retention facilities, all plans for such facilities must show designs for overflow for storms that exceed the design storm. Overflows should be designed that will be adequate for a 50-year event. Since many facilities are designed with overflow devices into the City's storm drain system, calculations must show that the storm drain pipe sizing is adequate for the design overflow. If not, or no access to the underground storm drain system is possible, an overflow must be designed and built that will handle the excess. All overflows must be designed to prevent erosion with clearly identified routing of the overland flows shown on the SWMP.

2.3.8 Operations and Maintenance Plan Requirements

The applicant shall submit a Stormwater Operations and Maintenance (O&M) Plan as part of the SWMP. The O&M Plan shall identify specific maintenance personnel, techniques and schedules for each stormwater BMP used on the site. At a minimum, the O&M Plan shall identify the following:

- the stormwater system owner(s) and contact information
- the entity, party or parties, responsible for long-term operation and maintenance
- a copy of final system drawing designs along with design calculations
- a list of pollutant sources, controls and BMPs
- the routine and non-routine maintenance tasks to be conducted
- a schedule for inspections, trash & debris removal, and maintenance
- system failure, emergency procedures, if any, and replacement criteria to define the structure's performance requirements

[1] IDAPA 37.03.03, "Rules and Minimum Standards for the Construction and Use of Injection Wells in the State of Idaho," defines a shallow injection well as a well that is "less than or equal to 18 feet vertical depth below land surface," and "any excavation or artificial opening into the ground which meets the following three (3) criteria: a. a bored, drilled or dug hole, or is a driven mine shaft or a driven well point; b. is deeper than its largest straight-line surface dimension; and c. is used for or intended to be used for injection."

- documents establishing a legal framework by which the O&M Plan will be passed to successive owners of the property
- monitoring and reporting requirements (if any) when stormwater passes from one jurisdiction to another
- record keeping requirements

Ongoing facility operation and maintenance is a condition of design review. The property owner shall provide copies of the approved O&M Plan to the parties responsible for operation and maintenance of the system. In addition, the responsible party must also provide access to facility for inspections and operation and maintenance activities.

Records of inspections and maintenance are required. Facility operators responsible for operation and maintenance of the system shall retain and maintain these records for the most recent five-year period. The requirements for maintenance and record keeping apply to all stormwater systems located at the site.

Facility operators responsible for operation and maintenance shall conduct regularly scheduled inspections, and clean, and maintain the system when necessary to ensure operation according to the original design. The O&M Plan shall state the permissible maximum depth of sediment at the bottom of swales and still allow the required designed infiltration rate and clearly state proper sediment testing and disposal procedures.

Reference

The City of Boise's Operation and Maintenance Resource Guide provides stormwater system checklists for use by facility operators. To obtain a copy download it off the internet at: www.cityofboise.org/public_works/services/water/storm_water

2.3.9 Alternative Controls

Stormwater facilities and controls other than those identified in this Stormwater Manual may be proposed in the following situations (or as recommended by the City Engineer):

- where site constraints make it difficult to achieve the stormwater management standards with conventional systems
- where a new technology may provide a higher level of treatment or performance

When a new technology is proposed, the applicant shall submit the following additional information to the City:

A. Complete description of the alternative technology or product including:

1. size
2. technical description
3. capital costs
4. design life
5. installation process and costs (describe consequences if installed improperly, etc.)

6. operation and maintenance (O&M) requirements and costs[2]

B. Data on the effectiveness of the alternative technology:

1. data from laboratory testing and pilot or full-scale operation, and calculation of pollutant removal rate (e.g., TSS for off-site discharges)
2. operational details on any full-scale installations

C. Validation Information:

1. articles from peer-review, scientific, or engineering journals
2. any approvals or permits from other authorities
3. references from other installations
4. a monitoring plan to demonstrate BMP effectiveness

D. Mitigation measures if system fails to meet requirements

City staff will assess proprietary system pollutant removal based on the manufacturer's test data at the design flow rate and at the median first flush TSS concentration from the City's monitoring data.

2.4 Stormwater Management Plan Review Process and Procedures

The City will review all Stormwater Management Plans as part of the Erosion and Sediment Control Plan review process. The checklist for a SWMP is set forth in section 2.2.1, and all items in the checklist must be addressed in a SWMP.

For Your Information

Review and approval of plans (i.e., building permit application) **may be delayed** if the submitted SWMP does not include all of the components identified by the Checklist. Contact Community Development at 746-1318 to schedule a pre-application meeting to expedite building permit review.

2.4.1 Stormwater Management Plan Review and Approval

The City will review all Stormwater Management Plans for compliance with requirements set forth in this Stormwater Manual and the City Code.

Approval by the City does not relieve applicants from responsibility for ensuring system performance, safety, and compliance with other local, state, and federal regulations. Applicants shall ensure that calculations, designs, specifications, construction, and record drawings comply with acceptable engineering standards and this Stormwater Manual. City approval does not constitute a guarantee of system performance nor does it relieve the applicant of liability for the sufficiency, suitability or performance of facilities. For projects regulated by other jurisdictions applicants must comply with any additional or

[2] The applicant is to provide as much detail as possible for a complete evaluation, especially as new technologies may not have long term data on O&M requirements.

varying requirements and receive approval from those entities. Applicants shall provide proof of approval to the City as deemed necessary.

2.4.2 Stormwater Management Adjustment Approval Procedure

Compliance with these standards for some developments or sites may not be feasible. In these situations, the developer or engineer can request a “stormwater management adjustment” in relation to the Stormwater Manual standards. Stormwater management adjustment requests shall be submitted in writing to the City Engineer. The City’s decision to grant, deny, or modify the proposed stormwater management adjustment shall be made within 10 working days of receipt of request based upon evidence that the stormwater management adjustment request meets all of the following criteria:

- the applicant is subject to special circumstances that are peculiar to the applicant’s system or situation and not caused by the applicant’s actions
- substantial undue hardship would result from requiring strict compliance with the Stormwater Manual requirements and deprive the applicant of rights commonly enjoyed by other persons similarly situated under the terms of the ordinance
- the proposed stormwater management adjustment protects public health, safety and welfare to extent similar to the Stormwater Manual requirement(s)
- the proposed stormwater management adjustment will achieve the intended results of the Stormwater Manual standards through a comparable or superior design
- the adjustment will not adversely affect the City’s ability to operate and maintain the stormwater management system

A written appeal of the City Engineer’s decision may be submitted to the Public Works Department within 10 working days of receipt of the decision. If an appellant disagrees with the decision of the City Engineer and Public Works Department in relation to a particular stormwater management adjustment request, he or she may appeal the decision to the Lewiston City Council.

2.5 Redevelopment Stormwater Management Criteria

Redevelopment that must comply with this Stormwater Manual is defined as any redevelopment that creates greater than 2,000 square feet of new impervious surface. The criteria of this Stormwater Manual apply to all of the newly constructed (redeveloped) impervious surface.

2.5.1 Redevelopment Water Quantity Requirements

Additional stormwater created by impervious surfaces over 2,000 square feet should be retained on site following all the same criteria listed previously in this document. Given the limitations of many existing sites, however, the City allows detention with metered release over 72 hours maximum with a written stormwater management adjustment from the City Engineer (see Section 2.4.4). All commercial, industrial and public redevelopment projects require a SWMP.

2.5.2 Redevelopment Water Quality Requirements

Redevelopment sites must provide infiltration for a 0.4 inch rainfall runoff volume from the part of the impervious surfaces in excess of 2,000 square feet. This is required to satisfy the retention of First Flush on site.

All redevelopment applicants are required to submit an O&M Plan for the new stormwater systems. The O&M Plan shall conform to Section 2.3.8.

If the land use has a potential for higher pollutant loads, additional pretreatment may be required. Significant redevelopment projects that involve land uses with potential higher pollutant loads are required to operate and maintain stormwater systems that manage the particular pollutants associated with the land use.

Furthermore, if the redevelopment project results in greater than 2,000 square feet impervious surface, and proposes to discharge off-site, the applicable TSS removal rate is required for runoff for all the impervious surface at the site. This requirement is set so the City can meet its discharge water quality requirements.

If it is not feasible for the significant redevelopment project to meet these standards, the applicant may request a stormwater management adjustment. Please refer to Section 2.4.3 to review the City's stormwater management adjustment requirements and procedures.

3.0 Stormwater Systems BMP Design Standards

The stormwater Best Management Practices (BMPs) listed in this Stormwater Manual reduce the quantity of eroded material and chemical or biological contaminants in stormwater. These BMPs apply individually or in combination to attain water quantity and water quality requirements. By careful selection, stormwater system BMPs can meet both stormwater and landscaping requirements.

3.1 Stormwater Conveyance Facilities

Conveyance systems move surface water up to a specific design flow in order to protect property and the environment. These systems may convey natural stormwater, on-site discharges, or off-site discharges as allowed by the City or other receiving jurisdiction.

3.1.1 General Requirements for all Conveyance Systems

Final ownership of the system may affect the design, layout, and materials used in a system. The designer should specify the materials for the system and design the system for at least a 50-year life span, meeting City specifications.

For any part of the system that the City may be required to maintain, or for which the City will assume responsibility, the minimum diameter storm drain pipe size is 12 inches.

It is recommended that all stormwater pipes intended for private ownership and maintenance have a minimum diameter of 8 inches.

Additional operation and maintenance requirements unique to stormwater conveyance systems include the following specifications for maintenance vehicle access:

- HS-25 load capacity
- 12 ft or greater width
- 30 ft or greater inside turning radius

3.1.2 Closed Conduit

Closed conduits, or “pipelines,” for stormwater conveyance in the City’s stormwater system can range from 12 inch diameter up to and exceeding 10 ft diameter. Pipeline size is dependent on the amount of flow the pipe is designed to carry. The pipe may be made of a multitude of different materials including steel, concrete, or plastic, and must meet City specifications if it is planned to be part of the City’s stormwater system. Pipelines are used to convey and control stormwater flows from collection to discharge points or to convey flows through an area.

Setbacks and Separation Distances

Closed conduits shall not be located in the following areas:

- underneath any permanent or semi-permanent structure (e.g., buildings, sheds, decks, rockeries or retaining walls, etc.)

- within the 1:1 plane + 2 ft from the bottom edge of the pipe or conveyance to the nearest finished grade at a building or structure
- within the 1:1 plane + 2 ft from the bottom edge of the pipe or structure to the property line at finished grade when an easement is not provided on the adjacent property
- where such facilities interfere with other underground utilities
- less than 18 inches vertical distance from a crossing utility
- less than 10 feet from a potable water line
- where allowable design loads would be exceeded by surface load (e.g., traffic)
- within 2 ft of the property line

The crossing angle between utilities shall be between 45^{o} - 90^{o}.

Easements

The minimum easement width is 20 feet. The easement width, at a minimum, shall be the diameter of the pipe plus twice the depth to the bottom of the pipe (i.e., the horizontal distance for a 1:1 sloped trench on both sides of the pipe), plus four feet. Easements for open ditches shall extend a minimum of 12 feet from the top of the bank.

Pipe Connections

Maintenance access manholes or "clean-outs" are recommended at all junctions. Manholes are required at all junctions for pipes 12 inches or more in diameter.

All connections to the storm sewer shall be via access structures. Tees are not permitted. Piplines shall be straight between access structures. No angled fittings are permitted.

Change of Pipe Size

Downsizing of pipes is not a recommended practice and will only be allowed under special conditions (e.g., no hydraulic jump can occur, downstream pipe slope is significantly greater than the upstream slope, significant cost savings can be realized, velocities remain between 3 - 8 fps, etc.).

Changes of pipe size (increase or decrease) are allowed at junctions, changes in grade, changes in direction, or other locations where maintenance access is provided.

Velocity

The minimum design velocity target value in closed conduits flowing full is 2 fps. In some cases, achieving 2 fps may not be feasible. In those situations, supporting documentation shall be submitted with the plan and shall be reviewed with the City. Additional clean-outs or sedimentation structures may be required. Maximum velocities should not be more than 8 fps, unless the conduit is designed to accommodate higher velocities and appropriate energy dissipation facilities at the pipe outlet are incorporated into the design.

Hydraulic Capacity

Hydraulic capacity may be calculated by acceptable methods for closed conduits. Appropriate computations or backwater analyses shall be performed on surcharged, submerged, or low-pressure systems to determine actual water level in the system and to ensure that appropriate freeboard levels are maintained.

Systems being designed to pass off-site stormwater through a new development site shall be designed with sufficient capacity to contain the 10-year peak flow assuming existing conditions for all offsite tributary areas, the recommended sizing from the City's Storm Water Master Plan, or the existing sizing, whichever is largest. Closed system structures may overtop for runoff events that exceed the 10-year design capacity provided the overflow from a 50-year runoff is routed through a defined area and the event does not create or aggravate downstream erosion and flooding. Any overflow occurring on-site for runoff events up to and including the 50-year event must discharge at the historic location for the project site.

Operation and Maintenance

A well designed and installed pipeline needs little maintenance. However, even the best designed and installed pipeline needs maintenance eventually. Factors promoting the need for maintenance include age of the pipe, pipe slope, pipe material, conveyance material (e.g., sediment or oil /grease laden water), conditions and cover over the top of the pipe (e.g., vegetation or long-term traffic loadings). Other factors such as acidic or caustic soils also may have an impact on the lifespan and integrity of the pipe. Eventually, each pipeline will need maintenance or it will fail to provide the intended design service.

Pipe maintenance normally includes water flushing (jetting), removal of accumulated debris or removal of intrusive roots extending into the pipeline. In some cases, a visual inspection of the interior of the pipe can be accomplished to determine if pipe cleaning is warranted. However, most of the time the need for pipe maintenance can only be determined by drawing a small specially designed pipeline camera through the pipe. There are local firms who have the experience and equipment to accomplish this task.

The most common types of pipeline failure include pipe plugging or pipe collapse. Pipe plugging occurs when sediment and debris is carried into the pipeline and settles to the pipe bottom, gradually diminishing the pipes capacity until plugging occurs or when debris becomes trapped against pipe walls and causes the pipe to lose its conveyance capacity. The plug will become evident if water rises out of the pipeline through manholes or at pipe inlets. The best assurance to avoid pipe plugging is to locate debris structures at the inlet ends of all pipelines (these structures require periodic cleaning) and to design pipelines with a slope that will allow water to flow at velocities sufficient to keep entrained materials in suspension.

As a minimum, pipelines should be inspected on a regular basis to determine the need for maintenance. Recommended minimum inspection intervals are:

- once per year (i.e., annually)
- after the occurrence of flood events or exceptionally high flows in the conveyance system
- if surface water ponding is noted at any pipeline junctures

3.1.3 Open Channels

An open channel is a natural conveyance facility that exists at a topographic low point or is a constructed ditch or canal excavated into the ground at a specific alignment and grade. Open channels are used to convey stormwater flows from collection to discharge points or to convey flows through an area. Most constructed channels require erosion resistant channel lining.

Setbacks and Separation Distances

Open channels shall be located at sufficient distance from any structure and/or foundation to protect its integrity. Horizontal separation distances between open channels and piped, drinking water systems shall comply with IDAPA 58.01. Side slopes of open channels shall not be located closer than two (2) feet from property lines.

Velocity

Velocities in open channels at design flow should be less than the channel scour velocity. Armor or channel protection shall be provided if needed. Channels should be evenly graded to avoid stagnating water and pools. The minimum flow rate for any part of a channel shall be twenty-five times the water depth per minute. The maximum flow rate for any earthen-based channel in the City shall be 2.0 feet per second. Greater flow rates will require vegetation of other lining of the channel.

Hydraulic Capacity

Hydraulic capacity may be calculated by acceptable methods for open channels. The following freeboard requirements apply to design peak flows:

Table 3. Freeboard Depths for Different Channel Water Depths

Water Depth	Freeboard
0-12 inches	4 inches
12-24 inches	8 inches
>24 inches	12 inches

Open channel designs must provide sufficient capacity to convey and contain, at a minimum, the 25-year peak flow assuming existing conditions for any offsite tributary areas. Open channels must also convey as much of the 50-year peak flow as necessary to preclude creating or aggravating a downstream stormwater problem. Any on-site overflow occurring for runoff events up to and including the 50-year event must discharge at the historic location for the project site.

Manning's "n" Values

Reference

Refer to Appendix E for Manning's roughness coefficient "n" values.

Open Channel Safety

Take all practical safety precautions. Side slopes should not exceed 3:1. Channels with greater than 18 inches running water depth at any time should have a minimum 4-ft wide safety bench along the channel on both sides. If the safety bench is vegetated, it should mowed to allow access along the channel. As well, should the 18 inch depth be overtopped, the benches will act as floodplains to increase the cross section of the channel and decrease erosive capacity along the edges.

Environmental health should be given adequate consideration. Maintain adequate flow throughout the channel to avoid stagnating conditions.

Channels that will run greater than 12 inches water depth for any length of time should be considered for fencing. However, a fence can be a two-edged sword when it comes to safety and maintenance: it may keep animals and people out of the channel, but will also limit access for rescue or other purposes.

Operation and Maintenance

Open channels, by virtue of their exposure to human activity, atmospheric conditions and the erosive forces inherent in flowing water, will require periodic maintenance. The degree of maintenance is dependent on the location of the facility and the type of open channel. Some open channels are composed of concrete, stone or other durable material. Other types of open channels are constructed with earthen banks and bottom. The degree of maintenance will vary depending on the specific type of facility. Channels constructed of durable materials will normally require less maintenance than channels with earthen surfaces.

Maintenance of open channels is required to insure the conveyance capacity of the facility is maintained and that channel erosion does not occur. Open channels should be checked on a periodic basis, especially after large storm events, extended periods of high flow or immediately following periods of high intensity winds (erosion may occur during high flows, from scour caused by localized debris clumps, or debris may be blown into the channel from offsite or on-site sources and clog the channel). All debris should be removed to prevent channel plugging, channel scour and loss of channel conveyance. Any significant invert or bank erosion should be repaired or stabilized immediately. If not corrected, erosion normally becomes worse over time.

For open channels constructed with earthen banks and bottom, vegetation impacts on the facility need to be considered. Vegetation on channel banks is desirable to insure the stability of the channel banks. However, if vegetation growth becomes excessive, it will limit the conveyance capacity of the facility. If conveyance restrictions are apparent, the vegetation should be trimmed to restore capacity. Leave the roots of all vegetation in place to maintain bank stability. If the channel is constructed with safety benches above a normal high water level, these benches should be mowed to maintain access.

Emergent vegetation (spirogyra, elodea, watercress, etc.) in the conveyance channel may also constrict the capacity of the facility. Should this occur, emergent vegetation should be removed. Vegetation above the ordinary high water mark should also be evaluated primarily for its ability to retain bank stability without reducing channel capacity at maximum design flows.

Design of an open channel is typically based on an assumed roughness coefficient (Manning's "n" value, Appendix E). Specific maintenance requirements should be designed to maintain an open channel with an "n" value approximating that used in the original design calculations.

3.2 Pretreatment Facilities

This section includes standards for sand filters, oil/grit separators, and catch basin inserts. These systems can be used for pretreatment to intercept and remove contaminants either from a portion (i.e., water quality treatment volume) or the entire design storm volume. Pretreatment facilities are not used alone to treat stormwater runoff but rather in combination with other controls to improve water quality. Pretreatment facilities are typically used to reduce the maintenance frequency of the primary treatment system.

3.2.1 Sand Filter

Sand filters may be either pretreatment systems used prior to further treatment or may discharge directly to stormwater drains. They are self-contained beds of sand, frequently underlain with under drains, cells, and sometimes baffles. Sand filters may either be flow through systems with inlets and outlets or convey storm flows to free draining material (i.e., for final infiltration). Stormwater runoff is filtered through the sand, and in some designs may be subject to biological uptake.

Note: Sand Filters in general are maintenance intensive. Strong consideration should be given to long-term maintenance before a sand filter is proposed/designed.

The four most commonly used sand filter systems are the Austin Sand Filter, the Delaware Sand Filter, the Trench Filter, and the Pocket Sand Filter (Discussion and figures are from the Boise Stormwater Design Manual).

- Austin Sand Filter (Figure 3.1)

  The Austin Sand Filter, or surface sand filter, consists of a sedimentation chamber or pond followed by a surface sand filter with collector under drains in a gravel bed. Filtered runoff is conveyed to a storm drain or an infiltration system by gravity flow or pumping.

- Delaware Sand Filter (Figure 3.2)

  The Delaware Sand Filter, or perimeter system, consists of parallel sedimentation and sand filter trenches connected by a series of level weir notches to assure sheet flow onto the filter. Filtered runoff is conveyed to a storm drain or an infiltration system by gravity flow or pumping.

- Underground Sand Filter (Figure 3.3)

  The underground Sand Filter is placed underground but maintains essentially the same components as the Austin sand filter. The filter consists of a three-chamber vault. A 3 ft deep wet sedimentation chamber is hydraulically connected by an underwater opening to provide pretreatment by trapping grit and floating organic material. The second chamber contains an 18-24 inch sand filter bed and an under drain system including inspection/cleanout wells. A layer of plastic filter cloth with a gravel layer can be placed on top of the sand bed to act as a pre-planned failure plane that can be replaced when the filter surface becomes clogged. The third chamber collects the flow from the under drain system and directs flow to the downstream receiving stormwater or infiltration system.

- Pocket Sand Filter (Figure 3.4)

  The pocket Sand Filter has a shallow basin that may or may not contain a filter layer. The surface of the filter bed may be a vegetative cover or cobble-sized rocks. Pocket sand filters may also be incorporated into infiltration swale designs. Refer to Section 3.3.1 for more information on in-situ sand filter applications in infiltration swales.

Setbacks and Separation Distances

The following requirements apply to sand filters for on-site infiltration:

- a minimum of 100 ft separation from public and private wells
- a 5 ft vertical separation distance between the bottom of the sand filter and bedrock
- 100 ft separation distance from surface water supplies used as drinking water and a 50 ft separation distance from surface water supplies not used as drinking water, excluding stormwater and irrigation delivery systems
- a minimum 3 ft vertical separation distance from the bottom of the sand filter and the seasonal high ground water table
- current State of Idaho requirements for individual subsurface sewage disposal (IDAPA 58.01.03) require that all "temporary surface water" sources maintain a 50 ft horizontal separation distance between septic drain fields and a 25 ft horizontal separation distance between septic tanks

Additionally, sand filter closed conduits (i.e., subsurface) shall not be located in the following areas:

- underneath any permanent or semi-permanent structure (e.g. buildings, sheds, decks, rockeries or retaining walls, etc.)
- within the 1:1 plane + 2 ft from the bottom edge of the pipe or conveyance to the nearest finished grade at a building or structure
- within the 1:1 plane + 2 ft from the bottom edge of the pipe or structure to the property line at finished grade when an easement is not provided on the adjacent property
- where such facilities interfere with other underground utilities
- where allowable design loads would be exceeded by surface load (e.g., traffic)

The crossing angle between utilities shall be between 45^o - 90^o.

Sand filters shall not be located closer than two (2) feet from property lines.

Design

Sand filters should include pretreatment to allow for the settling of sediment and screening of debris that may clog the sand filter and reduce its life expectancy. Pretreatment systems commonly used are sedimentation basins, grass buffer strips, biofiltration swales, or catch basin inserts.

The sand bed shall include a minimum of 18 inches of sand meeting the ASTM 33 standard for fine aggregate.

Sand filters shall be sized using the following criteria. Sizing should also be based on anticipated sediment accumulation and maintenance.

- the sand filter shall be sized for water quality design storm requirements
- the maximum design depth of water over the sand shall be taken into consideration in the maintenance schedule in the O&M Plan
- the sand filter shall be designed to completely drain in 72 hours or less
- the design infiltration rate for sand filters (i.e., hydraulic conductivity) shall be set at 9 in/hour
- calculate the sand filter surface area using the following equation

$$A = \frac{WQV*/D}{kT(H+D)}$$

Where

WQV = Water quality volume to be treated (cubic feet)
D = filter bed depth (ft)
k = permeability of sand = 3.5 ft/day
H = average height of water above filter bed (ft)
T = design filter bed drain time (days) (2 recommended)

If infiltration into the underlying soil is not desired, the bottom of the system shall be lined with one of the following impermeable layers:

- a minimum 12 inch thick layer of clay
- a concrete liner with approved sealer or epoxy coating, at least 5 in, reinforced with steel wire mesh (use 6-gauge wire or larger with a 6 in x 6 in mesh or a geo-membrane layer)
- impermeable geo-textile liners such as PVC (poly vinyl chloride) or HDPE (high density polyethylene)

The bottom of the bed should be composed of gravel, measuring at least 4 - 6 inches in depth. The City recommends using 2 inch diameter washed drain rock. The inlet structure should be designed to spread the flow uniformly across the surface of the filter; use flow spreaders, weirs, or multiple orifices.

Sand filters should be sized for the water quality design storm, with an overflow or bypass if used for off-line BMPs. Stormwater conveyances should be fitted with flow splitters or weirs to route runoff to the sand filter. Excess runoff may bypass the sand filter and be directed through another BMP for water quantity control

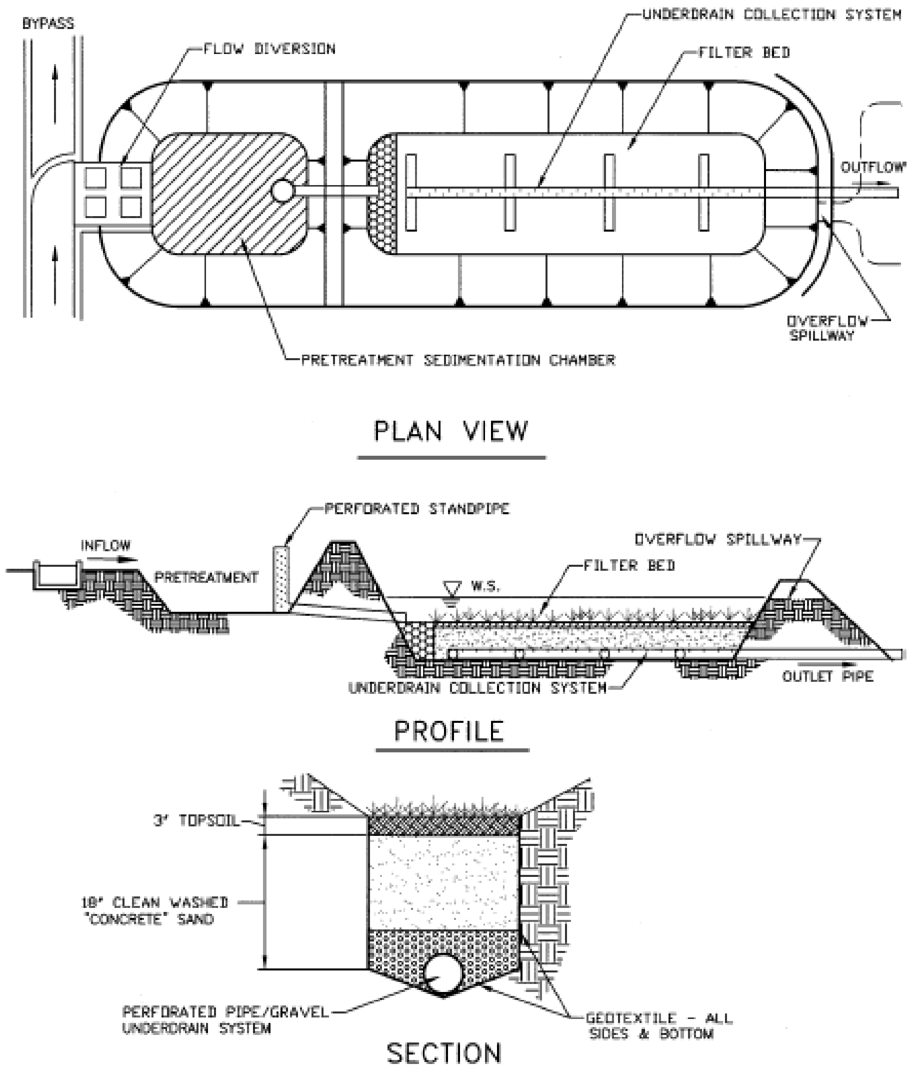
Unobstructed access shall be provided over the entire sand filter for maintenance, including inlet pipe and outlet structure. Ladder access is required when vault height exceeds 4 ft.

Operation and Maintenance

For the first six months after construction, facility operators should inspect sand filters after every storm. Thereafter, sand filters should be inspected every 6 months minimum. For systems with a filter chamber, the water level in the filter chamber should be monitored quarterly and after large storms for the first year.

Maintenance practices for sand filters should include periodic raking to remove surface sediment, trash, and debris. The top 2 inch layer of the sand filter should be replaced when the drawdown time approaches 48 hours after the pre-settling basin has emptied. Facility operators should remove any oil accumulations on the surface and recycle or disposed of according to local, state, and federal regulations. The sedimentation chamber should be pumped out when the sediment depth reaches 12 inches.

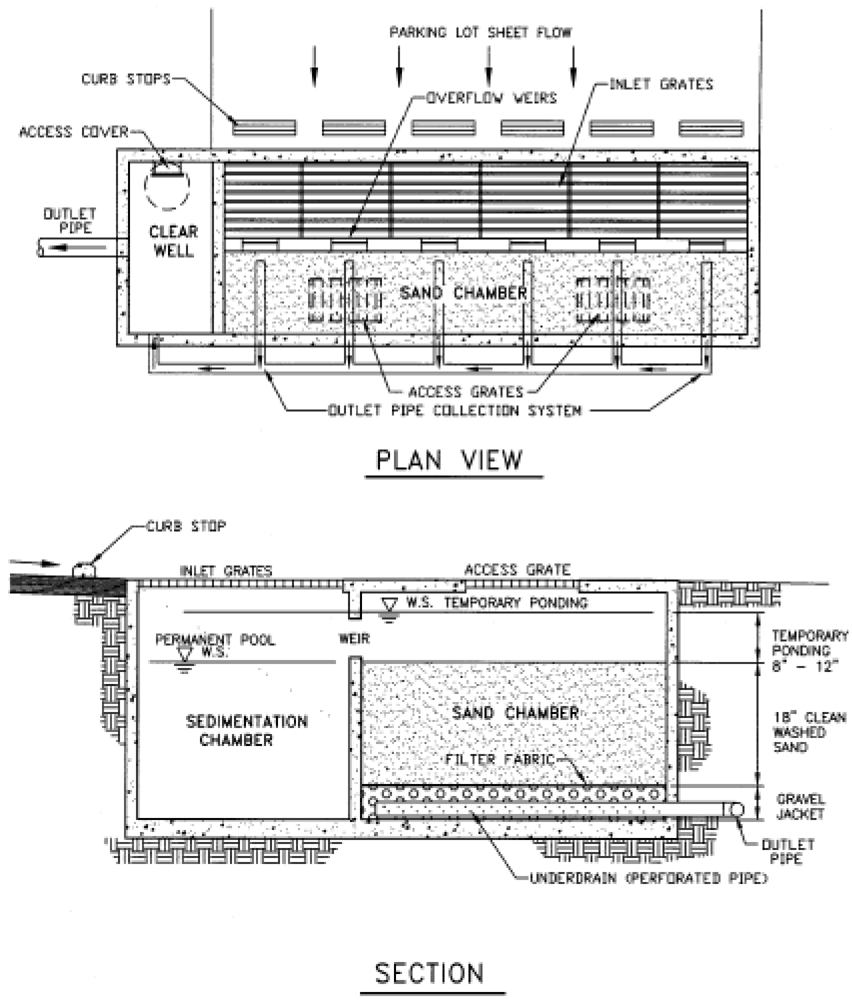
Figure 3.1 Austin Sand Filter



Austin Sand Filter

The Austin Sand Filter, or surface sand filter, consists of a sedimentation chamber or pond followed by a surface sand filter with collector under drains in a gravel bed. Filtered runoff is conveyed to a storm sewer or channel by gravity flow or pumping.

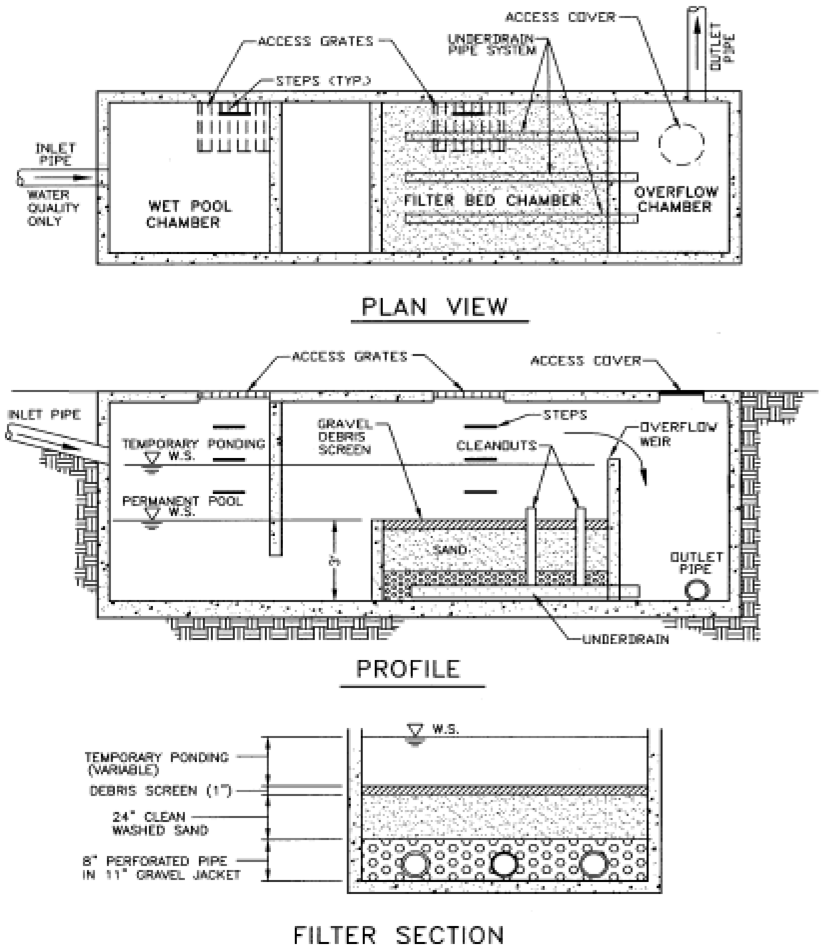
Figure 3.2 Delaware Sand Filter



The Delaware Sand Filter

Also known as the perimeter system, this filter consists of parallel sedimentation and sand filter trenches connected by a series of level weir notches to assure sheet flow onto the filter. Filtered runoff is conveyed to a storm sewer by gravity flow or pumping.

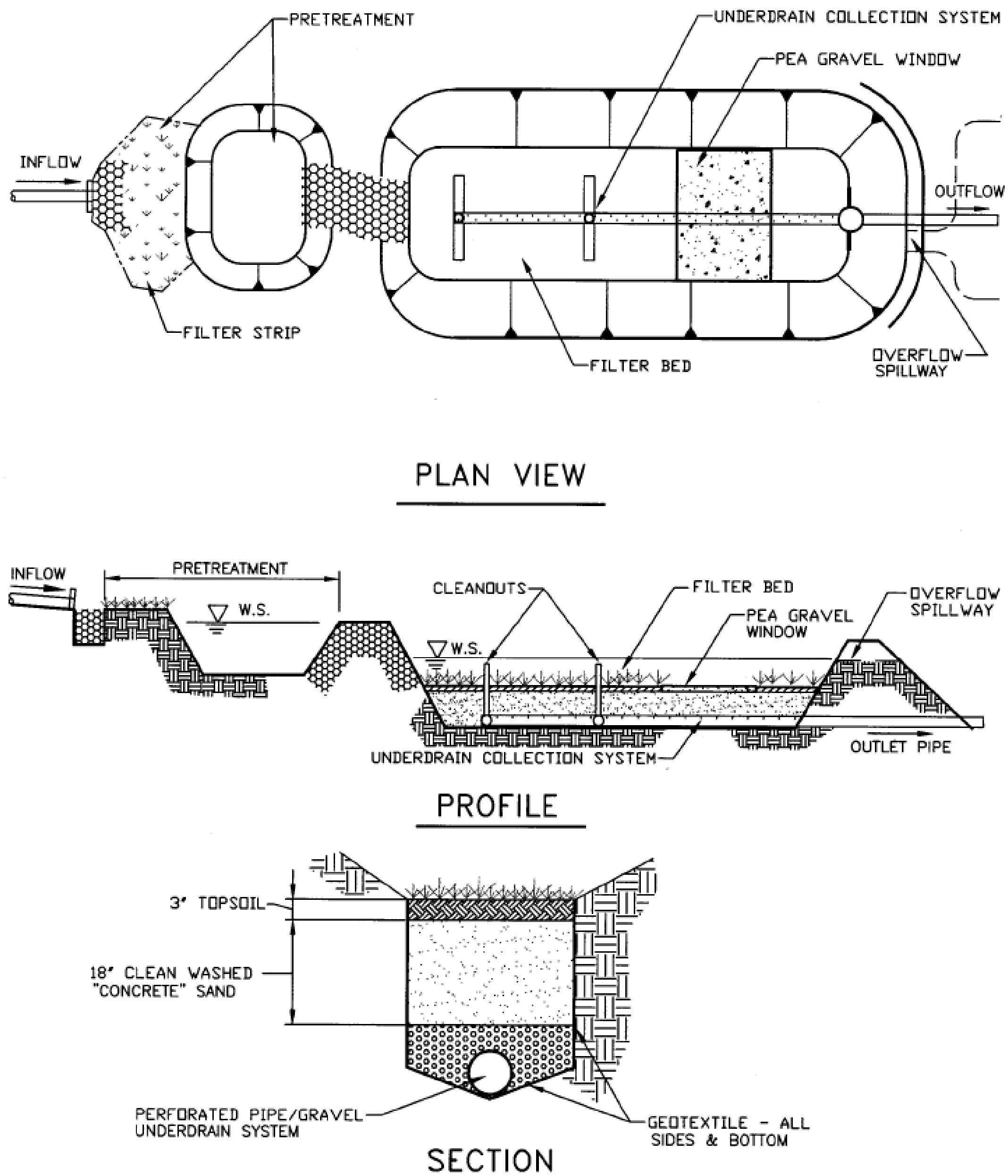
Figure 3.3 Underground Sand Filter



Underground Sand Filter

The underground Sand Filter is placed underground, but maintains essentially the same components as the Austin Sand Filter. The filter consists of a three-chamber vault. A 3′ deep wet sedimentation chamber is hydraulically connected by an underwater opening to provide pretreatment by trapping grit and floating organic material. The second chamber contains an 18-24″ sand filter bed and an under drain system including inspection/cleanout wells. A layer of plastic filter cloth with a gravel layer can be placed on top of the sand bed to act as a pre-planned failure plane that can be replaced when the filter surface becomes clogged. The third chamber collects the flow from the under drain system and directs flow to the downstream receiving drainage system.

Figure 3.4 Pocket Sand Filter



The **Pocket Sand Filter** has a shallow basin that may or may not contain a filter layer. The surface of the filter bed may be a vegetative cover or cobble-sized rocks. Pocket sand filters may be incorporated into infiltration swale designs.

3.2.2 Oil Water Separator

Oil water separators capture floatables, oil and grease, and sediment found in runoff: Their primary purpose is to separate oil and grease from water in a manner that the oil and grease can be removed from the stormwater system. An oil water separator usually includes or is preceded by a sediment forebay. Oil water separators require regular maintenance to remove collected floatables, sediment and oil products.

Two types of oil water separators discussed in this Stormwater Manual are the coalescing plate interceptor (CP) (Figure 3.5) and the conventional gravity separator (Figure 3.6) using the American Petroleum Institute (API) standards. Design criteria for both types are readily available in the literature or on the web and should be accessed by the design professional.

Figure 3.5 Coalescing Plate (CP) Oil Water Separator

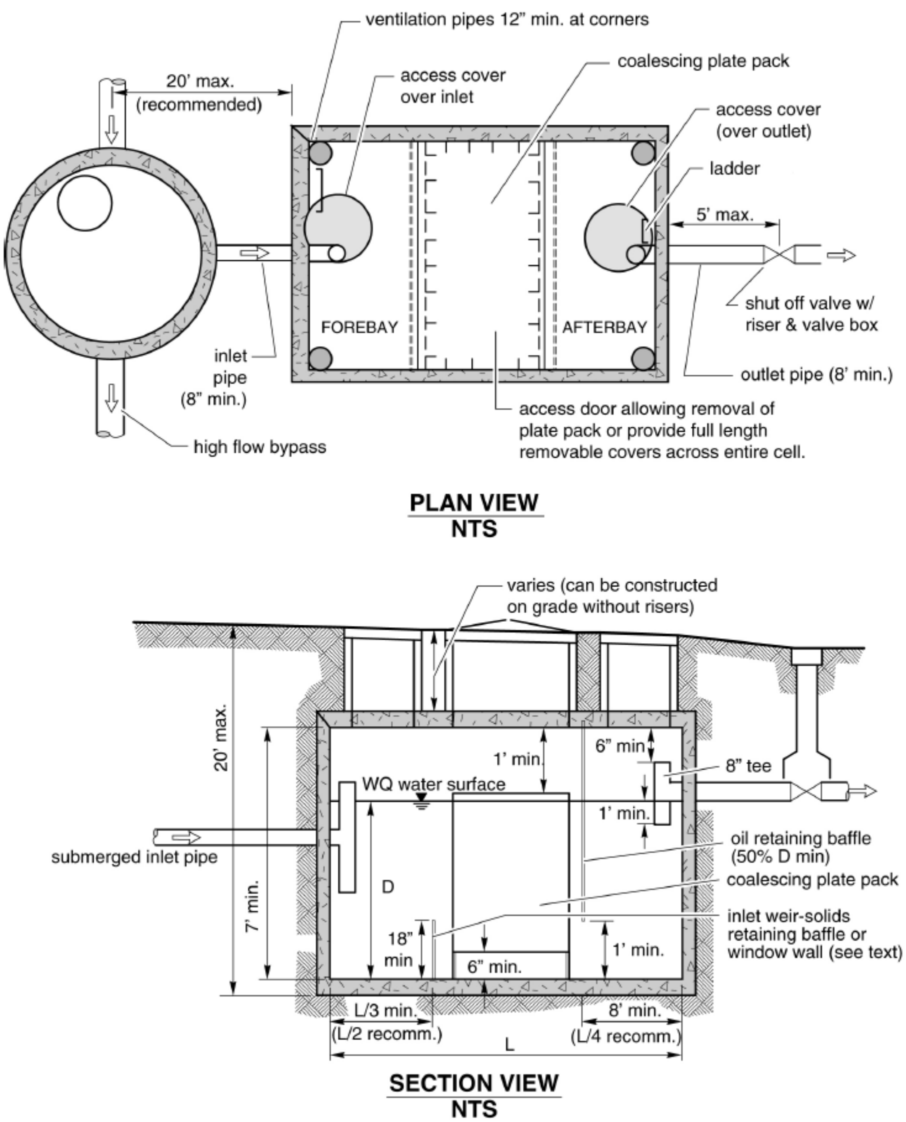


Figure 3.6 Conventional Gravity (API) Oil/Water/Grit Separator

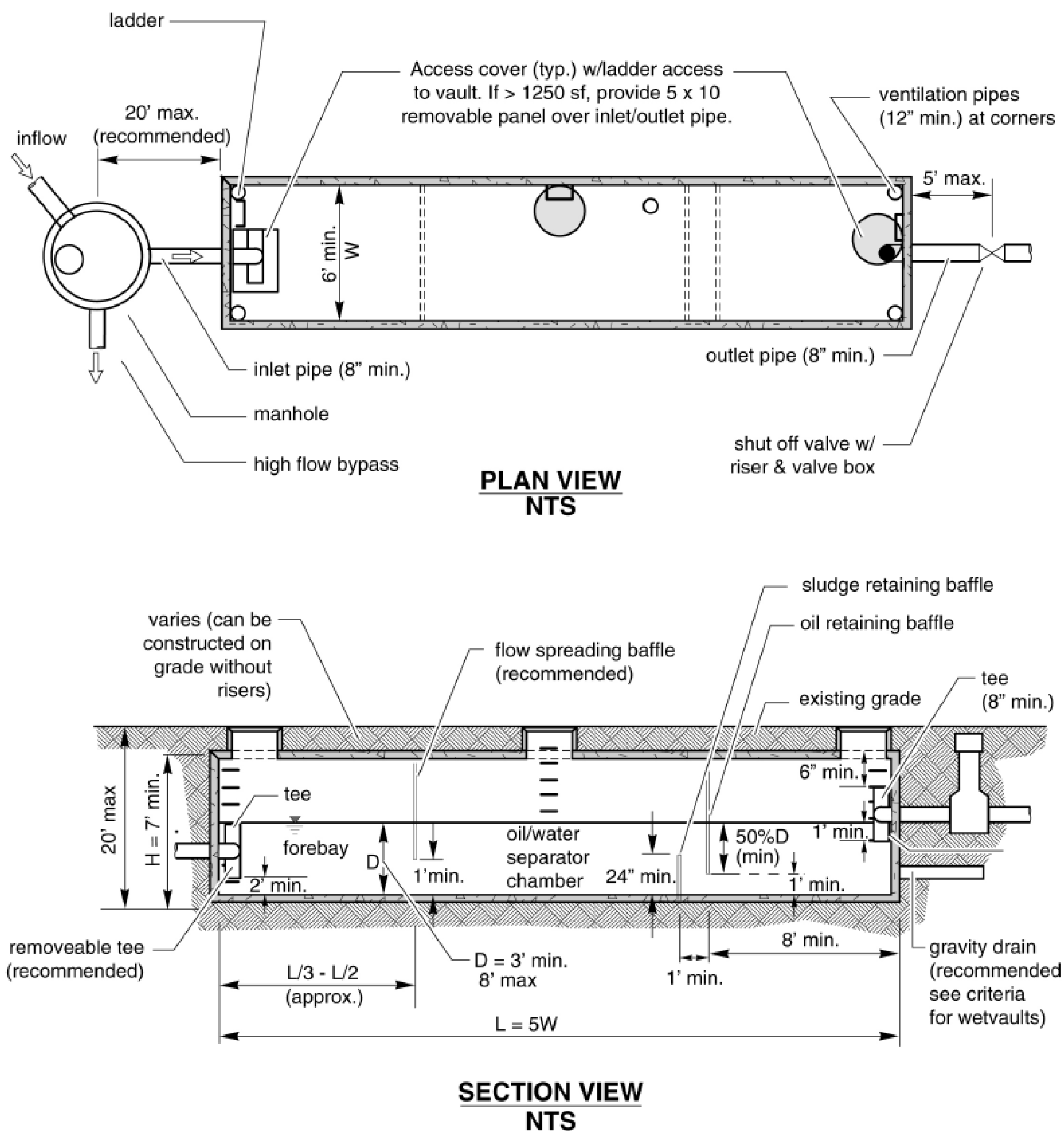


Figure 2: Typical API-Type (Baffle) Grit Chamber
Source: Washington Department of Ecology, 1999

Note: Oil water separators will not function for the removal of dissolved or emulsified oils or other hydrocarbons such as coolants, soluble lubricants, glycols, and alcohols.

American Petroleum Institute (API) separators are long vaults with baffles designed to remove sediment and hydrocarbon loadings from urban runoff. Large API separators may include sophisticated mechanical equipment for removing oil from the surface and settled solids from the bottom. Literature from the east coast refers to this multi-chambered (generally three chambers) design with baffles as a "water quality inlet."

Coalescing plate (CP) separators include a series of parallel inclined plates to encourage separation of materials of different densities. The plates are typically made of fiberglass or polypropylene and are closely spaced to improve the hydraulic conditions in the separator and promote oil removal.

An oil water separator can be exposed to flows that vary dramatically in rate and in oil concentration. The separator should be able to maintain its effectiveness at separating the liquids even when subjected to sudden variations in flow rate and oil concentration. It should be designed to handle the anticipated flow rate and contaminant concentrations under design storm operation. It should also be capable of accepting flow rate increases up to 125% of rated capacity for a short duration without causing remixing of the oil/water interface. In addition, it should be capable of treating a spill clean-up where the quantity of pure oil may be 10% of the volume of the separator.

Setbacks and Separation Distances

Oil water separators are not infiltration facilities. Consequently, applicable setback requirements are based upon setbacks from property lines and structures. Setbacks for oil separators are:

- property lines shall be a minimum of two (2) feet
- near side of separator shall be located outside of a 1:1 plane plus two (2) feet extending from the bottom edge of structure foundation to the bottom edge of oil separator

Design

An oil water separator shall be designed to include 1) an in inlet configured to uniformly distribute the flow to prevent disturbing the oil/water interface, 2) a forebay for settleable solids (sludge) that can be removed during regular maintenance, 3) an oil/water separator section where the neither the removal of floating oil nor flow through the device will disturb the oil water interface, and 4) a final compartment for clean water that will stabilize the hydraulic functioning the device and regulate the effluent discharge. Each of the three chambers should have manhole access for cleaning.

- Separators should be sized for the maximum flow rate from the water quality volume (0.4 inch over the impervious surface). Larger storms should not be allowed to enter the separator; the use of an isolation/diversion structure is recommended.
- The surface area of the sediment forebay should not be less than 20 square feet per10,000 square feet of impervious surface draining to the separator.
- The contributing area to any individual oil water separator shall not exceed one acre of impervious surface. Impervious surfaces such as roofs that would not be expected to have oil products mixed with the stormwater should be routed away from the separator and excluded from the design calculations.

- The maximum allowable velocity through the separator shall be no greater than 3.0 feet per minute. The separators, boxes, or vaults sizes are based on the greatest design storm runoff rate (i.e., maximum velocities through the separator).
- Certain site uses such as fuel farms or gas stations should consider coalescing plate or other oil absorbing inserts to capture heavier oil and grease loads.
- The system shall be designed for a 50-year life span. All metal parts should be corrosion-resistant. Acceptable materials include parts made of aluminum, concrete, stainless steel, fiberglass, or plastic. Metal parts that are exposed to runoff should not be painted since paint eventually wears off.
- Vault baffles should be made of concrete, stainless steel, fiberglass, reinforced plastic, or other acceptable material and should be securely fastened to the vault. Apply the HS-25 traffic load standard when locating systems in trafficked areas.
- The final design shall provide access to each compartment. If the length or width of any individual compartment exceeds 15 ft, an additional access point for each 15 ft is required.

Size the CP separator as follows:

1. The separator can be sized as an on-line component or off-line component of the system. If the separator is used off-line, size the separator for the water quality design storm (0.4 inches or 33 cubic feet per 1000 square feet impervious surface, over about 30 minutes) and divert larger storms using an isolation/diversion structure. In-line systems should be sized for the water quantity control design storm (2-year, 24 hour).
2. Place coalescing plates less that 3/4 of an inch apart and at an angle from 45° to 60° from the horizontal.
3. Calculate the projected (horizontal) surface area of plates required using the following equation:

$$Ap = Q/\text{Rise rate}$$

Where: Ap=projected surface area of the plate in square feet.

Note that the actual plate surface area, Ap=Aa / cosine H,

Where: H=angle of the plates with the horizontal in degrees, usually varies from 45-60°

Q = design flow (cfm)

Rise rate: 0.033 ft/min. For 60 micron droplets at 10°C.

Size the API separator as follows:

An API (American Petroleum Institute) separator is designed using Stokes' Law to determine the residence time required for oil/grease particles to rise. API recommends that turbulence should be controlled and that the horizontal flow velocity should not exceed 3 ft/min. It recommends a channel depth of 3 to 8 ft and a channel width of 6 to 20 ft with a depth to width ratio of 0.3 to 0.5. API also recommends a minimum channel length of 5 times the width.

In order to maintain laminar flow, the minimum orifice size from one section to the next shall be 1 foot in height and 0.9 the design width of the structure, e.g., a minimum of 1 foot (H) by 5.4 feet (W) for a 6-foot wide structure.

Operation and Maintenance

- The oil separator design shall provide access for inspection, proper maintenance, and monitoring activities, including clearance from oil separator structures to allow for cleaning equipment.
- Clean oil/water separators regularly, at least semi-annually, to keep accumulated oil from escaping during storms. They must be cleaned by October 15 to remove material that has accumulated during the dry season, after all spills, and after a significant storm.
- Coalescing plates may be cleaned in-situ or after removal from the separator. An eductor truck may be used for oil, sludge, and washwater removal.
- Remove the accumulated oil when the thickness reaches 1 inch. Remove sludge and sediment deposits when the thickness reach 6 inches.
- Train designated employees on appropriate separator operation, inspection, record keeping, and maintenance procedures.
- The owner should inspect the facility weekly.
- Oil absorbent pads are to be replaced as needed but should always be replaced in the fall prior to the wet season and in the spring.
- The effluent shutoff valve is to be closed during cleaning operations.
- Waste oil and residuals should be disposed in accordance with current local government health department requirements.
- Any standing water removed during the maintenance operation should be disposed to a sanitary sewer at a discharge location approved by the local government.
- Any standing water removed should be replaced with clean water to prevent oil carry-over through the outlet weir or orifice.

3.2.3 Catch Basin Insert

A catch basin insert is a device installed underneath a catch basin inlet that treats stormwater through filtration, settling, absorption, adsorption, or a combination of these mechanisms. Catch basin inserts may be required to provide additional pretreatment for off-site discharges to sensitive water bodies or at sites with risk for high pollutant loads.

Because performance varies widely among the different devices, a set of performance criteria will be used for these devices rather than design standards. Evaluation tests assume the use of suitable oil-absorbing/adsorbing media. Table 4 shows performance criteria for catch basin inserts.

Table 4. Performance Criteria and Evaluation Methods for Catch Basin Inserts[3]

	Criteria	Evaluation Methods
1	insert has ability to treat the water quality design flow for a minimum of 6 weeks under typical conditions	subject the system to the peak flow rate when new, and again after 4-6 weeks deployment all flow must pass through the treatment area without short-circuiting or bypass
2	insert has ability to create a positive seal around grate to prevent low-flow bypass	install and observe unit under low-flow conditions all flow must pass through the treatment area
3	media system functions so that its surface does not become blinded shortly after deployment and cause stormwater to bypass media before full use of media is realized	inspect media after 4-6 weeks deployment
4	media resists water saturation and maintains oil-absorbing properties for a minimum of 6 weeks	examine media after 4-6 weeks deployment for signs of water saturation and degradation media in acceptable conditions should still absorb oil and repel water
5	insert has means of preventing floating oil from escaping the unit	inspect the insert for the presences of an under-over weir at the high-flow relief if this or some comparable device exits, it is assumed that free oils will be retained
6	insert has means of preventing oil-soaked media from escaping the unit	when the insert is new, and again after 4-6 week deployment, subject it to the peak flow rate and observe whether media escapes
7	insert has ability to pass high flows without causing excessive ponding	blind all filtration surfaces with plastic sheeting and subject the insert to the required flow

[3] Adapted from King County Surface Water Design Manual, 1998

	Criteria	Evaluation Methods
		no ponding around the drain inlet should occur for the 10-year peak rate
8	manufacturer provides complete installation maintenance instructions	verify that instructions include information on the following: installation, creating an adequate seal, removal (including safety considerations), cleaning and replacement, decant and disposal of liquid waste, media disposal guidance

Setbacks and Separation Distances

Catch basin inserts shall be located in easily accessible areas for maintenance activities. Stormwater management plans shall not place inserts in areas with continuous vehicle parking. Redevelopment projects may have to modify parking to provide access to a catch basin insert.

Design

Depending on the adjacent land use and associated target pollutants, the insert may be fitted with oil-absorbent/adsorbent filter media. If the insert is installed in an existing catch basin, the insert shall be demonstrated to fit properly so that there is a positive seal around the grate to prevent low-flow bypass.

If the insert is installed in a new or redevelopment project, it shall be installed according to the manufacturer's recommendations. The insert should be installed in the catch basin after the site has been paved or stabilized (for new development) or after completion of construction (for a redevelopment site that is already paved).

Operation and Maintenance

Catch basin inserts shall be maintained at a frequency recommended by the manufacturer or when the filter media surface is covered with sediment. Clean accumulated oil, grease, sediments and floating debris from oil/grit separators on a regular schedule, depending on loading. The O&M Plan shall specify the cleaning schedule based on design parameters. Inspections may determine that cleaning is required more often, and the O&M Plan should be updated. In addition, the catch basin sump should be inspected for sediment accumulation. Full replacement or renewal of oil absorbent/adsorbent material, if present, shall be part of the required maintenance activities.

Filter media shall be disposed of in accordance with applicable regulations, including Solid Waste Ordinance (Title 5, Chapter 2) and hazardous waste regulations (40 CFR Parts 260-263, 266, 269, and 279). In most cases, dewatered filter media may be disposed of as solid waste.

3.2.4 Sediment Forebay

A sediment forebay or equivalent is an upstream pretreatment facility designed to remove sediment, primarily silts and sands. Sediment forebays are appropriate pre-treatment facilities for infiltration, detention and retention facilities when the goal is to contain a majority of the sediment in one location for easier access and maintenance. A sediment forebay often incorporates features of either a permanent pool (Section 3.4.3) or a dry detention pond (Section 3.4.2).

Sediment forebays are suitable in residential, commercial, and industrial sites and are appropriate in areas where sediment loading is expected to be high.

Setbacks and Separation Distances

Sediment forebays are pre-treatment facilities. Since infiltration can occur, compliance with standards applicable to infiltration facilities is required unless a design is supplied that limits infiltration.

Additional requirements include:

- side slopes of ponds shall not be located closer than two (2) feet from property lines
- a minimum of 100 ft separation from public and private wells
- a 100 ft separation distance from surface water supplies used as drinking water and a 50 ft separation distance from surface water supplies not used as drinking water, excluding stormwater and irrigation delivery systems
- a 10 ft separation from structural foundations[4]

Design

[4] This setback requirement can be less than 10 feet if approved by the structure foundation engineer.

A sediment forebay shall be a separate cell formed by barriers. A weir flow structure or physical separation with pipes may be utilized. If a rock or an earthen berm is constructed, it shall have a minimum top width of 4 ft and side slopes no steeper than 3:1 to provide separation from the permanent pool. A drainpipe should be included in the forebay to dewater the pool area for maintenance purposes. Minimum forebay size shall be equal to 15% of the water quality treatment volume, with an optimal volume equal to 25%. Forebay volume shall be in addition to permanent pool volume. In addition, a fixed vertical sediment depth marker should be installed in the forebay to measure sediment accumulation.

Sediment forebays can be any shape provided they have sufficient capacity to meet general design and water quality treatment requirements, and maintain at least a 3:1 length to width ratio. Calculations for the pond size and TSS removal rates shall be submitted with stormwater design plans for City review.

The ability for a sediment forebay to remove TSS is based on the time of retention during both the quiescent and non-quiescent settling periods, for representative sediment settling velocities.[5]

The size of a sediment forebay for peak discharge management is a function of the required time of retention, an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. The inflow, storage, and outflow relationships should be based on a storm duration that identifies a peak volume for the storm interval required.

Sediment forebays shall be designed for a sufficient detention time for TSS removal. Generally, forebays with lower velocities and longer retention times provide better removal efficiencies.

The forebay's permanent pool depth shall not exceed 12 ft, and have an average depth between 4 ft and 6 ft. The length from inlet to outlet should be as far apart as possible, with the length to width ratio at least 3:1 with side slopes of 3:1.

The critical parameters in determining the size of the forebays are the storage capacity and the maximum rate of runoff released from the basin. Outlets of sediment forebays are required to pass a flow rate necessary for extended quantity attenuation and TSS removal efficiencies.

If the forebay is designed to be dry between storm events, the design shall provide an average of 48 - 72 hours detention time. The outlet design shall incorporate a multi-stage riser that will allow water to drain over a design period, with an overflow for peak flows, while providing for TSS removal.

If the forebay is designed as a permanent wet pond, the pond should include safety benches as described in Section 3.4.3 and shown in Figure 3.15..

A landscaping plan for a sediment forebay and its buffer shall be submitted to indicate how aquatic and terrestrial areas will be stabilized with established vegetation. Whenever possible, wetland plants should be used in a forebay design, either along the aquatic bench or within shallow areas of the pool. .

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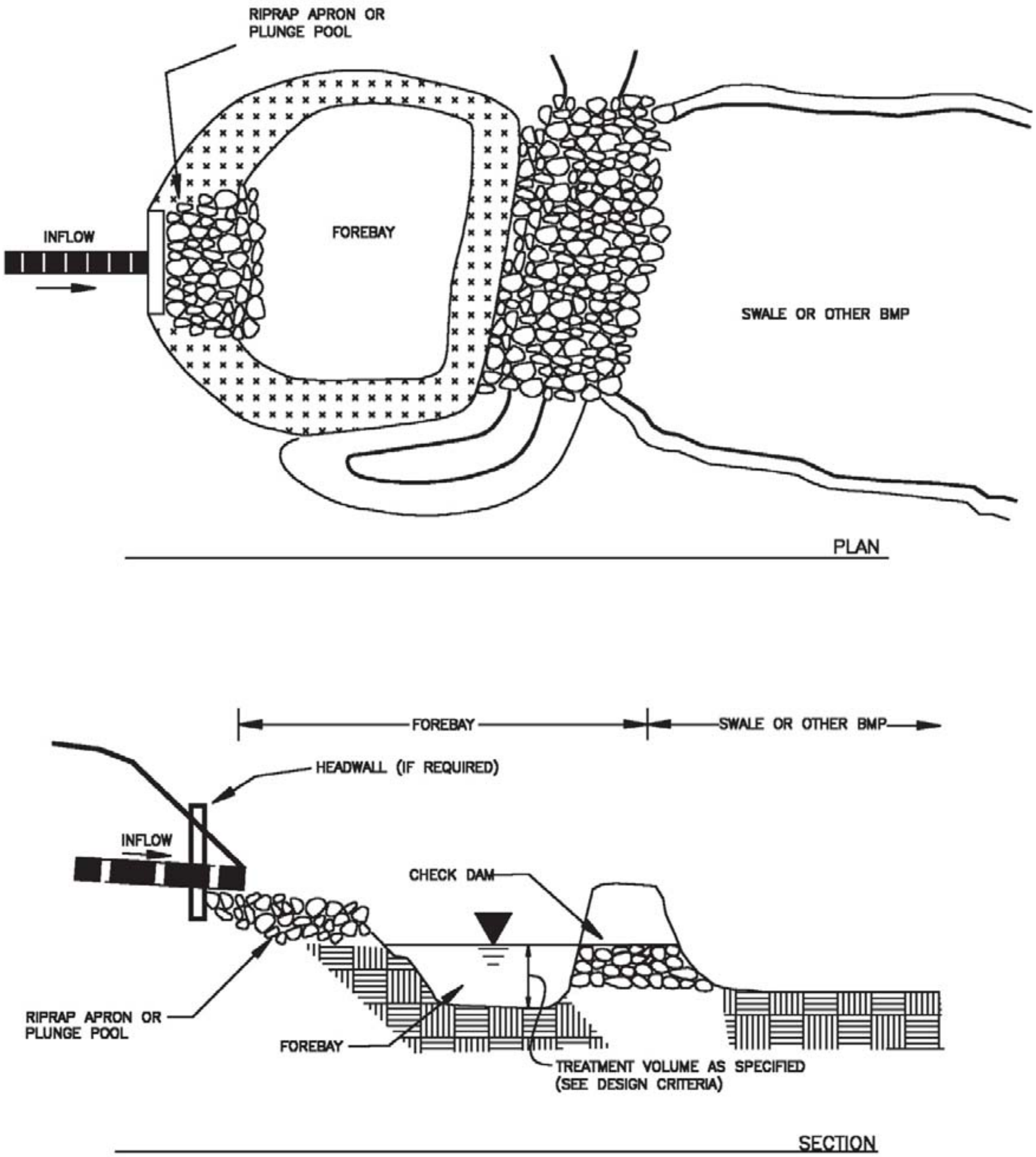
[5] Representative TSS size class distributions and settling velocities during both quiescent and non-quiescent periods are recommended.

Operation and Maintenance

Operation and maintenance guidelines for sediment forebays are the same as those listed in section 3.4.1 for all ponds. Additional or more specific maintenance and inspection include:

- sediment forebays should be inspected twice a year and after major storms for sediment loads, and cleaned out as necessary
- forebay inlet and outlet structures should be examined on an annual basis
- forebay safety benches, if any, should be inspected during the dry season
- forebay vegetation should be inspected and undesireable species removed

Figure 3.7 An Example of a Sediment Forebay



3.3. Infiltration Facilities

This section contains requirements for facilities that manage stormwater by subsurface disposal through infiltration. Requirements are included for infiltration swales, biofiltration swales, infiltration basins, infiltration trenches and permeable pavement.

Infiltration swales (Section 3.3.2) are vegetated depressed landscaped areas designed to collect, treat, and infiltrate stormwater runoff. Swales infiltrate stormwater runoff during storm events and protect ground water through natural treatment processes. Infiltration swales may include an in-situ sand filter as an aide to long-term operation and maintenance.

Bioinfiltration and biofiltration swales add an element of filtration due to the dense vegetation in the swale. Bioinfiltration swales (Section 3.3.3) utilize both infiltration and vegetative absorption to treat and infiltrate stormwater. Biofiltration swales are designed primarily for vegetation to absorb pollutants, but usually have an infiltration and/or evaporation component as well.

Vegetated filter strips (Section 3.3.4) are common, occurring almost without thought as treatment for runoff from sidewalks and driveways. Designed vegetated filter strips can be very effective for treating runoff from larger areas.

An infiltration basin (Section 3.3.5) impounds water in a surface pond until it infiltrates the soil. Infiltration basins do not maintain a permanent pool between storm events.

An infiltration trench (Section 3.3.6) receives runoff in a shallow excavated trench that has been backfilled with stone to form a below-grade reservoir. Infiltration trenches are typically located beneath landscaped or parking areas. Infiltration trenches may be preceded or followed by a sand filter or equivalent type of pretreatment as an aide to long-term operation and maintenance.

An infiltration trench covered by permeable pavement (Section 3.3.7) is a unique method for reducing impervious surface using the natural infiltration capacity of the site.

On-site dispersed and de-centralized stormwater infiltration and disposal systems based on low impact development principles are cost effective for our local community because they:

- eliminate the need to build extensive publicly owned regional treatment systems in order to protect receiving waters
- offer a viable treatment options for pollutants via sun, vegetation, root systems, soils, and filter sand
- include attractive landscaping
- offer viable alternatives to protect both surface and groundwater resources (e.g., at sites where infiltration trenches may be prohibited)
- promote groundwater recharge

3.3.1 General Design Criteria

For each infiltration facility, the applicant will be required to submit a written report as part of the SWMP that includes the general plan submittal requirements (see Section 2) and the following additional information:

1. discussion of site suitability for the planned BMP
2. infiltration rate, soil depth, soil texture, depth to any bedrock or seasonal high water table within 5 feet of bottom of the BMP
3. when using NRCS soil mapping of the site, a complete NRCS-type soil description verifying the existence at the site of the soil to which the data apply

4. written opinion of site suitability by a professional licensed in Idaho
5. recommended design infiltration rate

Geotechnical Report Requirements

Geotechnical reports are required for sites where an infiltration system is proposed and the soil survey data are inadequate or inappropriate. Especially for sites where the natural soils have been significantly stripped or disturbed, soil survey data will not be adequate. In general, geotechnical reports are to include enough information to address the following site information requirements:

- types of soil and subsurface materials surrounding and underlying the infiltration facility
- infiltration rates, locations, and test dates at the infiltration facility locations (i.e., within 20 feet of the facility unless the geotechincal professional provides an opinion that the substrate at the tested/observed location extends to the infiltration facility)
- permeability test method, reduction factor, and permeability of the soil and subsurface materials underlying the infiltration facility
- slope and geometry of the site
- proximity to surface water
- proximity of the seasonal high ground water table beneath the bottom of the infiltration facility
- proximity and classification of bedrock beneath the bottom of the infiltration facility

The infiltration rate shall be measured at a depth equal to the proposed bottom grade of the facility. Infiltration testing is discussed further in Appendix D.

A design infiltration rate should be developed from correlated or measured infiltration rate(s) for each infiltration facility. A qualified professional should recommend a design infiltration rate that considers the potential variability of the area in the immediate vicinity of the infiltration facility, possible degradation by construction practices, the reproducibility of the test method, and the applicability of the test method.

Post-Construction Infiltration Testing and Performance Evaluation

If the planned infiltration facility is to be accepted by the City as part of the City's stormwater system, or if the infiltration facility is going to discharge to the City's stormwater system, then the storm water infiltration facility must be tested after construction to see whether it meets design standards.

Some sites within the Lewiston area carry a high infiltration capacity. The City will not require post-construction infiltration tests when all the following conditions are met:

- the geotechnical report identifies that the site has well drained soils with infiltration rates greater than three (3) inches per hour and reported in the Stormwater Management Plan (Section 2.2.1).

- construction plans clearly identify the infiltration zones and establish protocols for keeping them free from compaction or modification during construction.
- inspections have been properly scheduled, conducted, and construction has been found to be compliant with the design plans and specifications.

For swale and basin designs that use the entire system (i.e., the entire length or bottom of the system, with or without in-situ sand filters) the additional conditions must also be met:

- any material used to back-fill the swale or basin must match the design infiltration rates
- broadcast, drilled, or hydro-seed grass planting or a low-clay content sod has been applied to the top soil along the swale or basin surface or, the design utilized an in-situ sand filter that infiltrates the entire design treatment volume

If the above criteria are not met, the City may require bulk infiltrations testing in accordance with the Post Construction Swale Testing requirements included in Appendix D of this Stormwater Manual.

If an infiltration test is required, the method and approximate location(s) where the test is to be conducted shall be submitted to the City for review. Infiltrations tests are not a substitute for proper scheduling of inspections and compliance with infiltration installation requirements. The City will evaluate the results of the inspections, infiltration tests, and all other aspects of the project before issuing the final occupancy permit.

Testing shall be conducted by a registered engineer or qualified testing firm. Infiltration tests must be witnessed and certified by the design engineer or the design engineer's designated representative.

Infiltration systems that do not fully drain the design storm volume within 72 hours maximum are considered to be in violation of the City stormwater policy and will be required to attain proper operation and function according to the City approved design.

If infiltration tests are unacceptable, the facility must be reconstructed. Prior to reconstruction, the design professional shall complete an investigation to determine the cause of unacceptable infiltration rate performance. Design shall be modified or alternate construction methods or materials (or both) shall be used in reconstruction of the system. Systems shall be retested after construction and shall meet minimum performance criteria as identified above. Final occupancy permits, where applicable, will not be granted until the reconstructed facility functions as designed.

Setbacks and Separation Distances

Setback and separation distance requirements for infiltration facilities are:

- a minimum of 2 ft setback, measured from the top of any sloped part of the facility from the property line.
- a 100 ft separation distance from public wells, private wells, and surface water supplies used as drinking water and a 50 ft separation distance from surface water

supplies not used as drinking water, excluding stormwater and irrigation delivery systems.

- current State of Idaho requirements for individual subsurface sewage disposal (IDAPA 58.01.03) require that all "temporary surface water" sources maintain a 50 ft horizontal separation distance between septic drain fields and a 25 ft horizontal separation distance from septic tanks.
- a minimum 3 ft vertical separation distance from the bottom of the infiltration facility to the seasonal high ground water table, with a minimum 2 ft of soil between the bottom of the infiltration basin and the high ground water table.
- a minimum 5 ft vertical separation distance from the bottom of the infiltration facility to bedrock or basalt.
- infiltration trenches shall have a 10 ft separation distance from the bottom of the facility to the high ground water table; this separation distance may be reduced to a minimum of 5 ft when a sand filter pretreatment system or equivalent is installed to treat the design storm volume.
- a 10 ft separation from structural foundations, if approved by the structural foundation engineer.

Design

All infiltration facilities shall fully drain within 72 hours maximum following a storm event.

The bottom of the system shall be constructed at least 12 inches into free-draining material. Appropriate permeable soil types are those that have an infiltration rate of 0.5 in/hour or greater, as initially determined from the NRCS Lewis-Nez Perce Counties Soil Survey values for saturated hydraulic conductivity for the particular soil series on the site. When soils cannot be correlated to those in the soil survey, field geotechnical tests (see Section 3.3.1 and Appendix D for more information on geotechnical reports and infiltrations tests) are required. For all infiltration facilities, a minimum field infiltration rate of 0.5 in/hr is required. Locations yielding a lower infiltration rate preclude these practices.

Infiltration facilities may require the construction of infiltration windows or trenches filled with clean sand or washed gravel down to soil or subsoil levels that have adequate infiltration rates.

Infiltration systems that are located at sites with a very high infiltration rate (i.e., > 20 in/hr) present a risk of short-circuiting (i.e., where the stormwater volume flows are not adequately filtered). For sites with infiltration rates that are more than10 in/hr, a minimum 12-inch filtration layer of ASTM C33 fine grade sand or equivalent is required at the bottom of the facility. Additionally, for sites with infiltration rates that are more than 20 in/hr, the design shall include measures to address the inherent risk of stormwater treatment short-circuiting.

Infiltration facilities must not be used on slopes greater than 25 (twenty-five) percent.

Table 5. Infiltration Facility Restrictions

Depth below the surface to ground water or bedrock	Vadose Zone Characteristics			
	Gravels, pebbly gravels, pebbles	**Sands, sands inter-bedded with silt and/or loams, silt loams,**	**Clay loams, silty clay loams, clays**	**Colluvium and various flood deposits**
< 5 feet	Infiltration facilities prohibited	Subject to further evaluation, infiltration trench prohibited	Infiltration facilities prohibited	Subject to further evaluation, infiltration trench prohibited
5-20 feet	Additional treatment required	No additional restrictions	Subject to further evaluation	Subject to further evaluation
21-100 feet	Additional treatment required	No additional restrictions	No additional restrictions	No additional restrictions
> 100 feet	Subject to further evaluation	No additional restrictions	No additional restrictions	No additional restrictions

Operation and Maintenance

Facility operators should inspect and clean the infiltration facilities when necessary. Generally, infiltration rates of ASTM C-33, fine grade sand, can be up to 20 in/hr when initially installed. Over time, as fine sediments accumulate within the facility, the infiltration rate will decrease. When the facility's infiltration rate slows to having standing water for 48 hours after a storm, the facility will require renovation to re-establish an adequate infiltration rate. Sediments shall be removed and disposed of properly. O&M Plans for infiltration facilities should include limitations for fertilizer and pesticide use in order to reduce the discharge of these materials to ground water.

3.3.2 Infiltration Swale

An infiltration swale (or bioinfiltration swale) is a depressed landscaped area designed to collect, treat, and infiltrate stormwater runoff. Infiltration swales can either have a continuous cover of vegetation or include a section of sand or gravel along the swale bottom, or be completely lined or filled with clean rock. As opposed to biofiltration swales (see Section 3.3.3), infiltration swales rely on infiltration as the treatment method, and are not necessarily designed as flow through treatment facilities. They require calculation of storage volumes and infiltration rates to demonstrate their function. Vegetation considerations however, may be the same as those for biofiltration (Section 3.3.3).

Setbacks and Separation Distances

Setbacks and separation distances for infiltration swales are the same as those listed in Section 3.3.1 (i.e., for all infiltration facilities).

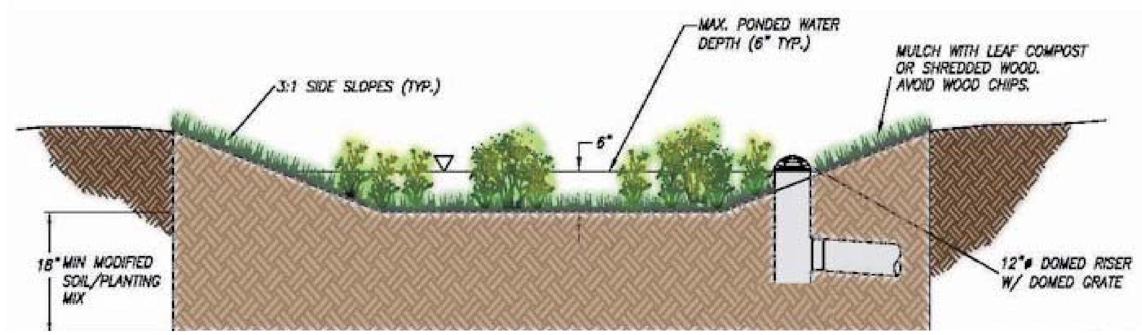
Design

Design requirements specific for infiltration swales include:

1. Swale bottom slopes shall be flat or sloped gently to a low point. Recommended grade for swales is 0% to 1%. A somewhat steeper grade may be necessary when a swale is part of a larger stormwater routing system.
2. Permeable soil (i.e., with an infiltration rate of 1.0 inches or more per hour) is to be maintained or installed for infiltration along the swale bottom.
3. During construction, construction equipment should be restricted from operating on the swale, thus limiting compaction and reduction of infiltration rates.
4. If curb cuts will be used to introduce flow to the swale, curb cut aprons shall be installed at a maximum height of 6 inches above the swale. Curb cuts shall be 12 - 36 inches wide.
5. Swales must be designed to contain and infiltrate the 2-yr, 24-hr design storm volume from its tributary area. Design storm volume depth of the swale is to be 1 ft maximum.
6. Energy dissipation shall be provided at the inlet. Appropriate means are sediment basins and rip rap pads. If rip rap is used, it should be sized for the expected runoff velocity.
7. All swales must have a well identified and stabilized overflow for situations when stormwater runoff exceeds their storage and infiltration capacity.
8. An in-situ sand drainage window or trench may be included in the swale design (Figure 3.9). The sand window is to have a minimum 18 inch depth of ASTM C33 for fine aggregate. The bottom of the sand window shall be located above any seasonal high ground water elevation. The sand is to be wrapped in geo-textile fabric with access to free draining substrate. Drain rock may also be located at the bottom in order to reduce the risk of wicking. Sand windows may require surface materials over the top in order to prevent wind and water erosion.
9. The swale side slopes shall be no more than 3:1.
10. The swale shall be covered with grass or a mixture of grass and other vegetation suitable for the swale environment, or lined/filled with clean rock. When sodded, the sodding soil must be permeable with a low clay content. The side slopes above the swale treatment area should be vegetated to prevent erosion. Additional grass or non-aggressive ground covers are appropriate.
11. Based on the site conditions, an under drain filled with drain rock is an optional addition to the swale design in order to provide additional storage volume. If

installed, the swale under drain shall be constructed using clean 2 inch washed drain rock. The rock shall be wrapped in geo-textile filter fabric, with a weight of greater than 4 oz/yd^2. The under drain will be a minimum depth of 12 inches deep. A 6 - 12 inch layer of ASTM C33 for fine gain aggregate shall be placed below the under drain.

Figure 3.8 Infiltration Swale



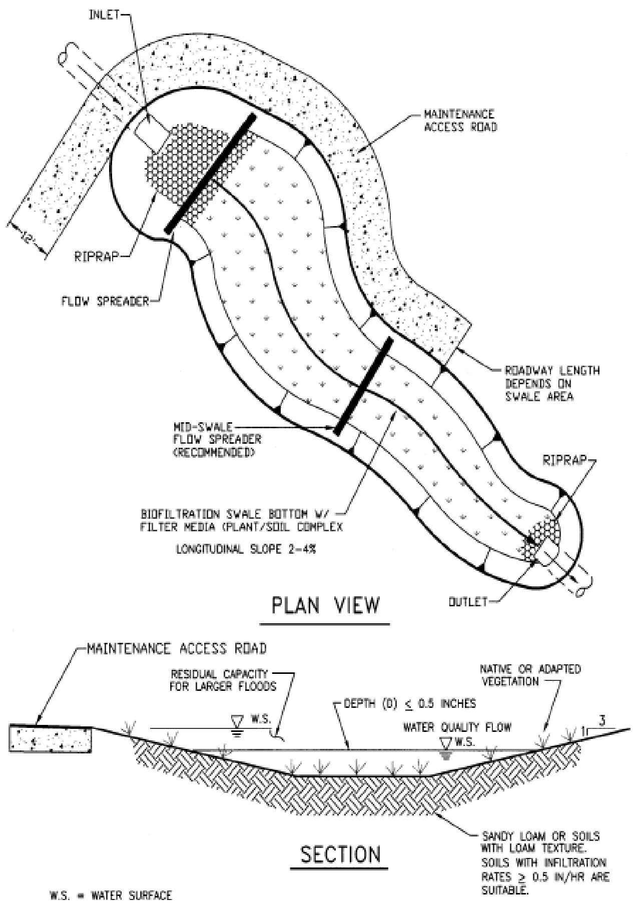
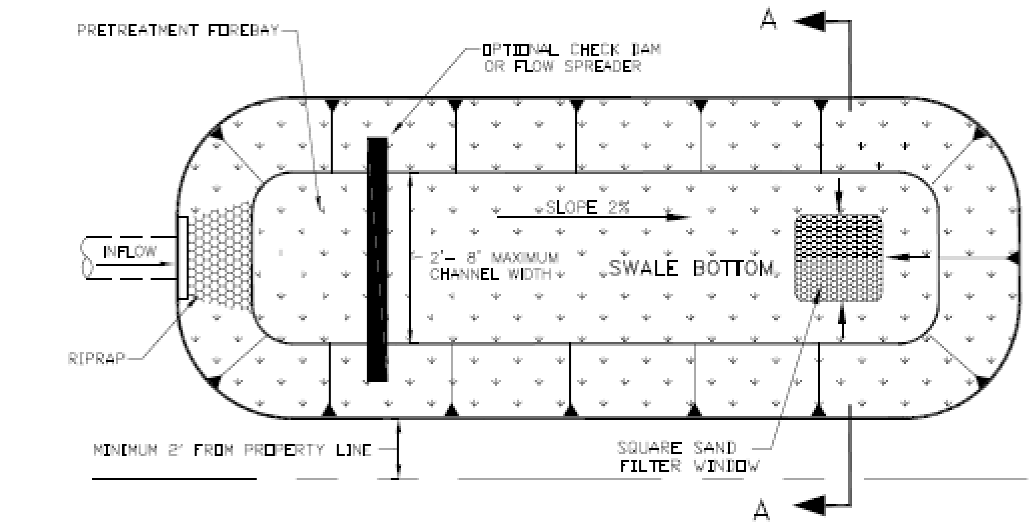
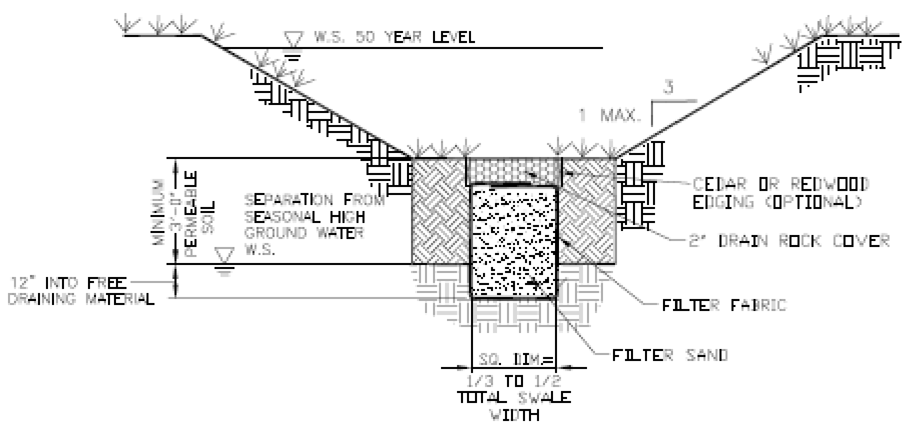


Figure 3.9 Infiltration Swale with Sand Window



PLAN VIEW



CROSS SECTION A – A

Design Calculations:

For sites under 10 acres, the following calculation may be used to size infiltration swales:

$$Vs=A(CN)(D)$$

where Vs=storage volume (ft3)

A= surface area of drainage basin (ft2)

CN= composite Curve Number for drainage basin

D= design storm (0.4 in = .033 ft)

See discussions in Appendix B for water quality storage volume calculations and Appendix C for the calculations showing the relationship to Total Runoff Volume storage. Infiltration swales sized to meet water quality requirements, if they have infiltration rates > 1 in/hr, will also adequately treat total runoff volumes.

Landscaping

Swales should not be used until vegetation is established. Barrier shrubs, such as barberry, planted around the swale should be considered when there is a possibility that the public could damage the swale or hinder its function.

Avoid using bark, floatable mulch, fertilizers after plant establishment, and pesticides in swale bottoms or sides. These materials tend to run off the planted area and into the swales reducing its treatment effectiveness. A more detailed landscaping discussion is given for biofiltration (Section 3.3.3).

Operation and Maintenance

If the swale specifications do not meet the standards in Section 3.3.1 under Post-Construction Infiltration Testing, the developer should consider and the City may require an infiltration test of the facility. When filled to the design volume, the swale must infiltrate and empty within 72 hours.

Following the establishment of swale vegetation, irrigation rates and water volume applied to the swale shall be monitored and maintained at minimal rates to maintain establishment of the vegetation. Monitoring, consisting of periodic visual inspections shall consider needs of plant materials as they are maturing and will likely result in adjustments over time to the amount of water being applied to swale vegetation.

Standing water in the bottom of a swale resulting from over watering is to be avoided. Water application rates in consideration of swale soil conditions should be done in a manner to preclude the propagation of undesirable insect species. This requirement shall also be included in the O&M Plan for the site development and, depending on the plant materials selected; the O&M Plan shall identify the appropriate plant and irrigation management steps to ensure swale vegetation growth and vigor. Designs should consider providing separate sprinkler irrigation zones for swale bottoms and swale sides.

Aeration of areas with sediment deposits may retain swale function. Sediment removal should include consideration of historical operating conditions of the swale and the potential for hazardous materials to be present in sediments. If testing and disposal of sediments is considered necessary, contact solid waste disposal experts at the City or Idaho Dept. of Environmental Quality.

In-situ sand windows slowly trap fine materials as part of the water quality treatment. Moreover, the accumulation of these fine materials may limit infiltration to unacceptable levels as the sand becomes clogged. Therefore, O&M Plans for in-situ sand windows are to specify that the sand filter's ability to infiltrate should be checked on an annual or semi-annual basis and are to be renovated when the infiltration rate drops below the minimum design rate.

O&M Plans for all infiltration facilities should include limitations for fertilizer and pesticide use in order to reduce the discharge of these materials into ground water.

Irrigation practices shall consider needs of plant materials, both as they are maturing and after they have been established. Final plant establishment and swale use will likely result in the adjustments to the amount of irrigation water being applied.

Sediment deposition in vegetated swales should be removed if vegetation growth is being inhibited for more than 10% of the swale area or if the sediment is blocking the stormwater inlet or the spread of water over the swale. Sand swales are to apply similar operation and maintenance as required for sand filters (see Section 3.2.1). Facility operators should anticipate annual sediment removal and/or spot reseeding. Aeration of sediment containing areas may also be required to retain swale function. If sediment is removed or the swale is reconstructed, the swale should be re-graded and reconstructed to meet the original design conditions.

3.3.3 Biofiltration Swale

Biofiltration swales (Figure 3.5) are water quality treatment systems that use low flows and plant materials for various physical and biological processes in the treatment of stormwater runoff. As opposed to infiltration swales (section 3.3.2), biofiltration swales are designed to rely more on biological filtration and less on infiltration as the stormwater treatment. Also, biofiltration swales are designed more as pass-through systems. Biofiltration swales are stormwater runoff systems that treat and then discharge stormwater runoff to another system.

Setbacks and Separations Distances

Side slopes of biofiltration swales shall not be located closer than two (2) feet from property lines.

Design

Biofiltration swales use biological activity, organic matter, particle settling and soil infiltration to treat pollutants in stormwater. The vegetation must be established prior to biofilter use for stormwater management. The side slopes of a biofilter should be vegetated to prevent erosion. Barrier shrubs, such as barberry, planted around the biofilter should be considered when there is a potential for people to damage the biofilter or hinder the biofilter's function. Other grasses or non-aggressive ground covers are appropriate if recommended by a landscape professional.

The biofilter must be sized to treat flows from 0.4 inch of precipitation for water quality and to pass 10-yr, 30-min design storm peak hydraulic flows.

When grasses are chosen as the biofiltering agent, the grass should be mowed to maintain an average height between 4 and 9 inches in general. Additionally, the maximum depth of flow shall be no more than 3 inches (i.e., the depth of the stormwater is not to exceed the height of the grass).

Access for mowing equipment and maintenance shall be provided. Consideration should be given to providing wheel strips in the bottom of the swale if vehicular access (other than grass mowing equipment) is needed.

Design and setback requirements specific for biofiltration swales include:

- a minimum length of 100 feet
- water velocity, as determined by Manning's "n", of 1.0 fps or less
- a Manning's "n" of 0.3 (i.e., for grass lined channels)
- longitudinal slope along the channel shall be 1 – 5 %
- ideal shape of the channel is trapezoidal
- any curb cuts shall be 1 – 3 ft wide with curb-cut bottom six inches above the bottom of the biofilter
- an appropriate flow spreading device at the swale inlet such as shallow weirs, stilling basins, and perforated pipes
- a sediment catch basin or a pre-settling device to control sediments at the swale inlet and allow for easy maintenance
- appropriate energy dissipation at the inlet such as a settling basin or rip rap pads
- if rip rap is used, the rip rap must be sized for the expected runoff velocity
- swale side slopes no steeper than 3:1
- swale bottom may be any width so long as provision is made to keep stormwater spread across all of it
- a maximum flow depth through the bottom of the swale should not be greater than 75% of the grass height (i.e., based on grass species selected for installation)

Design Calculations:

The standard design calculations for biofiltration swale sizing uses Mannings equation, the basic equation of open channel flow.

$$V=(1.49\ r^{2/3}\ s^{1/2})/n$$

or

$$Q=(1.49A\ r^{2/3}\ s^{1/2})/n$$

where V = Velocity (ft/s)
n = Manning's roughness coefficient
A = Cross-sectional flow area (ft2)

r = Hydraulic radius (ft) = A/wetted perimeter
s = Slope (ft/ft)
Q= Flow rate (cubic ft/s, cfs)

(1) Calculate design flow for both the peak flow from the 10-yr, 30-min storm (I = 1.1 in/hr) and the water quality treatment flow volume (assume I = 0.4 in/hr) using the Rational Method. The peak flow will need to be contained within the channel of the swale, and the water quality treatment flow must be less than 3 inches deep over the bottom of the swale.

(2) Swale shape. Trapezoidal is the most desirable swale shape; however, rectangular and triangular shapes can be used. The steps below assume that the hydraulic radius = depth of flow since the width of the swale is much greater than the depth of flow.

(3)) Calculate design flow depth for the water quality treatment. The design flow depth is calculated based on the width of the biofiltration strip and the longitudinal slope of the filter strip (parallel to the direction of flow) using a form of Manning's equation as follows:

$$Q = (1.486W\ df^{1.67}\ s^{0.5})/n$$

where:

Q = design flow, in cubic feet per second (cu ft/sec)
n = Manning's roughness coefficient =0.30
W = width of buffer strip perpendicular to the direction of flow (ft)
df = design depth of flow (ft), which is also assumed to be the hydraulic radius (maximum 3 inch, or 0.25 feet)
s = longitudinal slope of biofiltrations strip parallel to the direction of flow, in feet per foot averaged over the length of the filter strip; must be between 0.01 and 0.05 ft/ft).

Rearranging the above equation, the design depth of flow can be calculated using the following equation:

$$df = (n^*(Q/1.49Ws^{0.5}))^{0.6}$$

If the calculated flow depth exceeds 3" (0.25 feet), the design flow rate routed through the strip must be reduced, or the width of the biofilter must be increased.

(4) Calculate design flow velocity through buffer strip. The design flow velocity Vel is based on the design flow rate, the width of the filter strip, and the calculated design flow depth from Step 3 using the following equation:

$$Vel = Q/Wdf$$

where Vel = design flow velocity(ft/sec)
W = filter width (ft)
df = water depth (ft)

If the velocity exceeds 1.0 foot per second, a buffer strip may not be used. Either redesign the site to provide a gentler longitudinal slope for the strip or select a different water quality facility.

(5) Determine swale size for Peak Flow Rate. Using the peak flow rate from Step 1, use the Manning flow equation to determine the required depth for the swale for a peak flow rate. Use Manning's n = 0.04. Total depth of the swale shall be 6 inches deeper than the peak flow depth. Peak flow velocity should remain below 2 ft/sec.

Landscaping

Landscaping is a critical component of bioretention because of the natural ability for plant materials to treat pollutants in urban stormwater. The integration of landscaping also sets bioretention apart from other BMPs by allowing the stormwater practice to be distributed throughout the site, closer to the pollution sources, while improving the site aesthetics. With the proper landscaping application with of bioretention, most people interacting with the constructed environment will tend to admire the sites aesthetics and not even be aware that stormwater management exists on the site.

Minimize shading the other vegetation in the biofilter treatment area from adjacent trees. For example, a spacing of at least 20 ft (6 meters) is often appropriate for trees planted close to a biofilter. Avoid planting trees that would continuously shade the entire length of the biofilter. In addition, avoid using bark, mulch, fertilizers, and pesticides in these areas. These materials tend to run off the planted area and into the biofilter reducing its treatment effectiveness.

Key factors in the design of bioretention facilities are careful selection of plant materials that can tolerate highly variable hydrologic changes and an overall planting plan that ecologically and aesthetically blends the facility into the landscape. Designing for ease of maintenance is also a critical element of any landscape plan.

Bioretention facilities have a wide range of applications from suburban residential lots to ultra-urban streetscapes. It is the landscape designer's responsibility to analyze the surrounding site considerations and design a bioretention facility that maximizes water quality enhancement and landscape values. Landscape planning and design should ensure successful bioretention facilities and appropriate aesthetics, without discouraging individual creativity.

Clearly, the selection of plant materials should be dictated by the planned long-term maintenance of the facility. In the Lewiston area, a design using drought resistant plants that can tolerate occasional flooding would be a good choice. The NRCS or the Nez Perce County Extension Agent will usually provide good advice on plant selection.

Operation and Maintenance

Compared to other stormwater management measures, the required upkeep of vegetated swales is relatively low. In general, maintenance strategies for swales focus on sustaining the hydraulic and pollutant removal efficiency of the channel, as well as maintaining a dense vegetative cover.

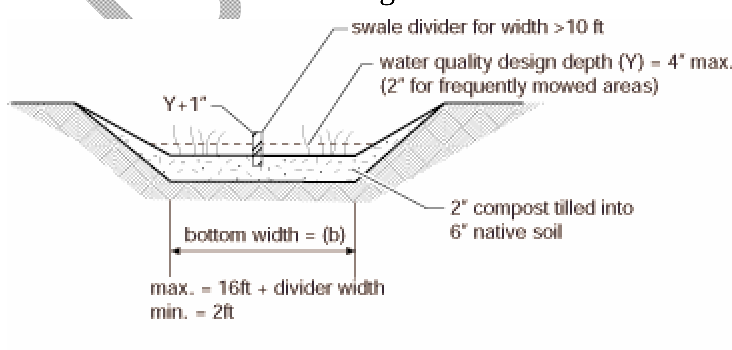
Experience has proven that proper maintenance activities ensure the functionality of vegetated swales for many years. The following schedule of inspection and maintenance activities is recommended:

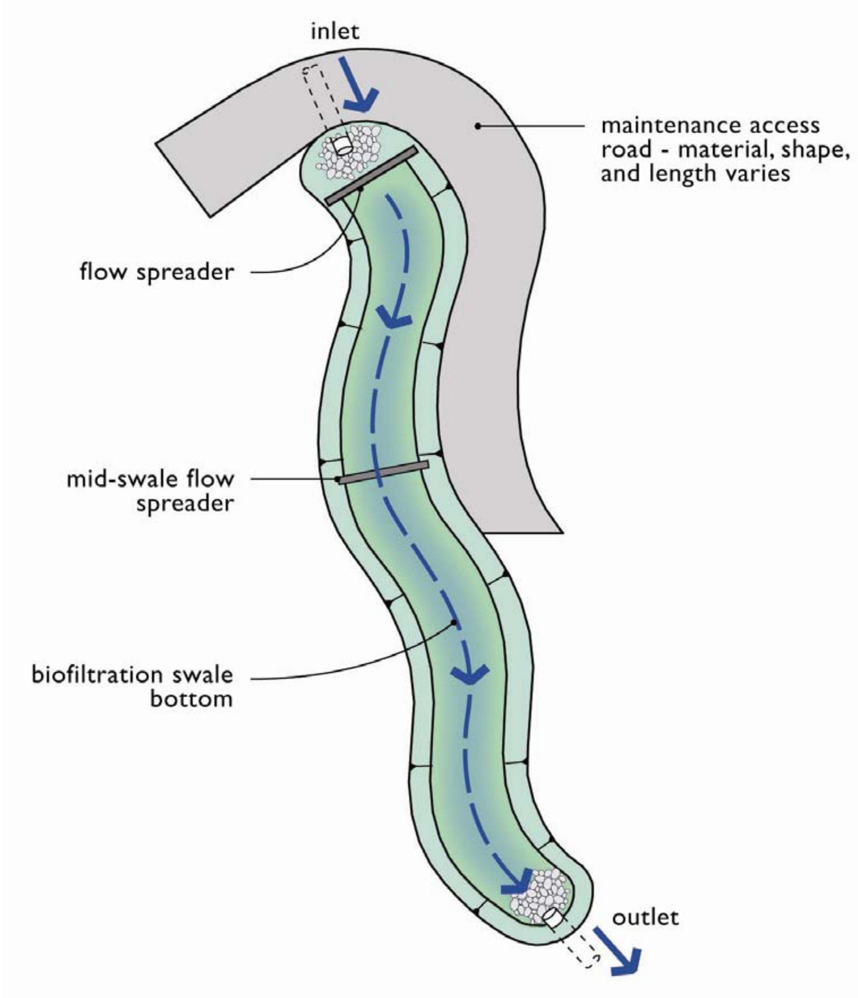
Maintenance activities to be done annually and within 48 hours after every major storm event (> 0.4 inch rainfall):

- Inspect and correct erosion problems, damage to vegetation, and sediment and debris accumulation
- Inspect vegetation on side slopes for erosion and formation of rills or gullies, correct as needed
- Inspect for pools of standing water; dewater and discharge to a sanitary sewer at an approved location and restore to design grade
- Mow and trim vegetation to ensure safety, aesthetics, proper swale operation, or to suppress weeds and invasive vegetation; dispose of cuttings in a local composting facility; mow only when swale is dry to avoid rutting
- Inspect for litter; remove prior to mowing
- Inspect for uniformity in cross-section and longitudinal slope, correct as needed
- Inspect swale inlet (curb cuts, pipes, etc.) and outlet for signs of erosion or blockage, correct as needed.

Sediment deposited at the head of biofiltration swales shall be removed if grass growth is being inhibited for more than 10% of the biofilter length or if the sediment is blocking the even spreading or entry of water to the remainder of the facility. The facility operator should anticipate annual sediment removal and spot reseeding. If flow channelization or erosion has occurred, the facility shall be re-graded, and then reseeded as necessary.

Figure 3.10 Biofiltration Swale General Design Parameters





3.3.4 Vegetated Filter Strip

Vegetated filter strips (vegetated buffer strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. A vegetated filter strip can be as simple as a grass strip between the sidewalk and the street. Filter strips function by slowing runoff velocities, providing infiltration into underlying soils and allowing sediment and other pollutants to settle. Filter strips were originally used as an agricultural treatment practice and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal. In addition, the public views them as landscaped amenities and not as stormwater infrastructure. Consequently, there is little resistance to their use.

Setbacks and Separation Distances

Since a vegetated filter strip is little more than landscaping, there are no particular setbacks applicable. However, the design must assure that all runoff from impervious surfaces be fully infiltrated on site and that any runoff does not exceed pre-development rates. If there is risk of runoff from a filter strip leaving the property, a vegetated berm should be provided along the edge of the vegetated strip, parallel to the flow direction, to keep flow on the property.

Design and Sizing Guidelines

- Maximum length (in the direction of flow towards the buffer) of the tributary area should be 150 ft for semi-pervious surfaces and 75 ft for impervious surfaces.
- Slopes of the filter strip should not exceed 25%.
- The surface of the vegetated filter strip shall be straight to convex on the contour.
- Minimum length (in direction of flow) of the vegetated filter strip should be two to three times the flow length of the tributary area.
- Width should be the same as the tributary area.
- Either grass or a diverse selection of drought tolerant, native vegetation should be specified. Vegetation whose growing season corresponds to the wet season is preferred.
- The ground surface at the upper edge of the filter strip (adjacent to the contributing drainage area) shall be at least 2 in lower than the edge of the impervious area contributing flows.
- The maximum depth of flow at the upper edge of the filter strip for optimum water quality shall be 1 in.
- As a designed stormwater management facility, the bottom end of the vegetated strip must provide adequate escape routing for any stormwater exceeding the capability of the strip to infiltrate the stormwater from the tributary area.

The runoff entering the buffer strip must not be concentrated. If the contributing drainage area is not smoothly graded to prevent concentration of flow, a flow spreader shall be installed at the edge of the pavement to uniformly distribute the flow along the entire width of the filter strip. At a minimum, a gravel flow spreader (gravel-filled trench) shall be placed on the contour between the impervious area contributing flows and the filter strip. The gravel flow spreader shall be a minimum of 6 inches deep and shall be 18 inches wide. Install a gravel spreader where the ground surface is not level so that the bottom of the gravel trench is level.

Similarly, if runoff is collected and channeled to a vegetated filter strip, a flow spreader must be installed adequate to spread the 2-yr, 24-hr storm at no greater the 1 inch deep over the upper edge of the filter strip.

The use of vegetated filter strips is limited to where the vegetative cover is robust and diffuse, and where shallow sheet flow characteristics are possible. Slopes should not exceed 25 percent or be less than 1 percent. The upstream boundary of the filter strip should be located contiguous to the impervious area. Use of a level spreading device (contoured vegetated berm, sawtooth concrete border, rock trench, etc) to facilitate overland sheet flow is recommended for larger facilities.

A major question that remains is how to size a vegetated filter strip for a given impervious surface. Research has conclusively demonstrated that they are effective on roadside shoulders where the contributing area is about twice the vegetated area. Vegetated filter strips have also been installed on the perimeter of large parking lots where they performed effectively. The design professional shall present a rationale for the sizing of a vegetated filter strip discussing the factors contributing to the suitability of the BMP.

The filter area should be densely vegetated with a mix of erosion-resistant plant species that effectively bind the soil and contribute to its development of porosity and permeability. Native or adapted grasses, shrubs, and trees are preferred because they generally require less fertilizer and are more drought resistant than exotic plants. Runoff flow velocities should not exceed about 1 fps across the vegetated surface.

For engineered vegetative strips, the facility surface should be graded straight to convex on the horizontal contour prior to placement of vegetation. Initial establishment of vegetation requires attentive care including appropriate watering, fertilization, and prevention of excessive flow across the facility until vegetation completely covers the area and is well established. Use of a permanent irrigation system may help provide maximal water quality performance. In arid or semi-arid climates, designers should specify drought-tolerant vegetation to minimize irrigation requirements.

Provide access at the upper edge of grass filter strips to enable maintenance of the inflow spreader throughout the strip width and allow access for mowing equipment.

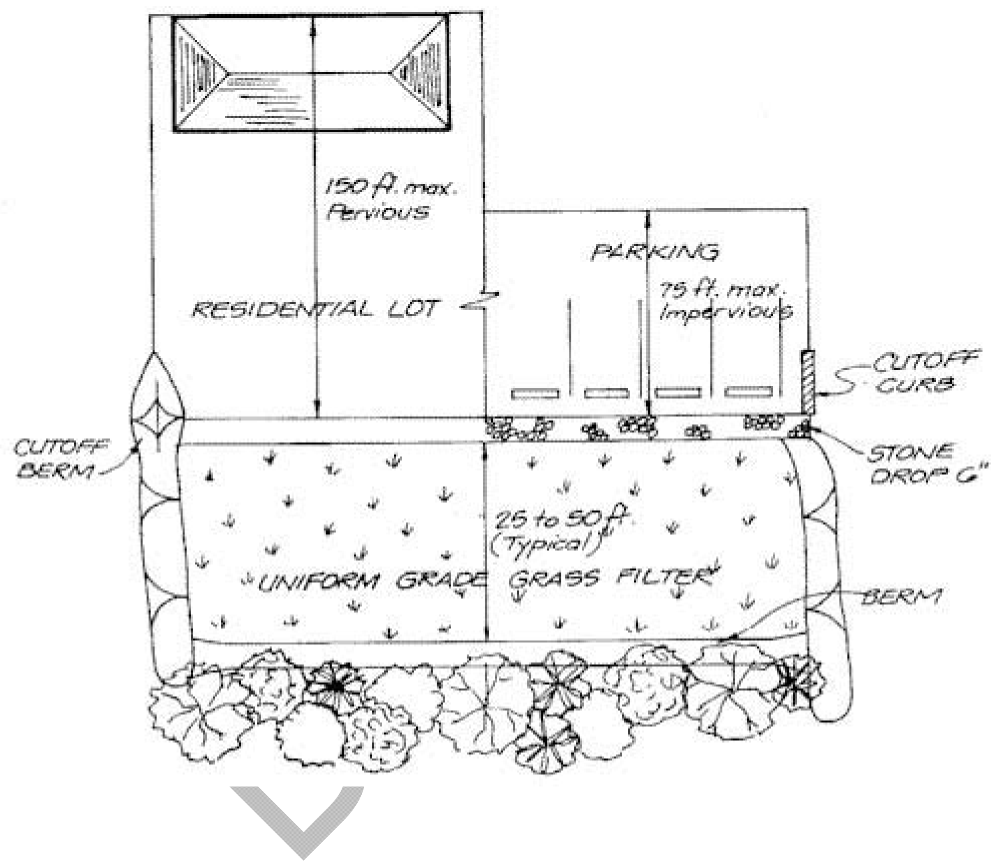
Maintenance

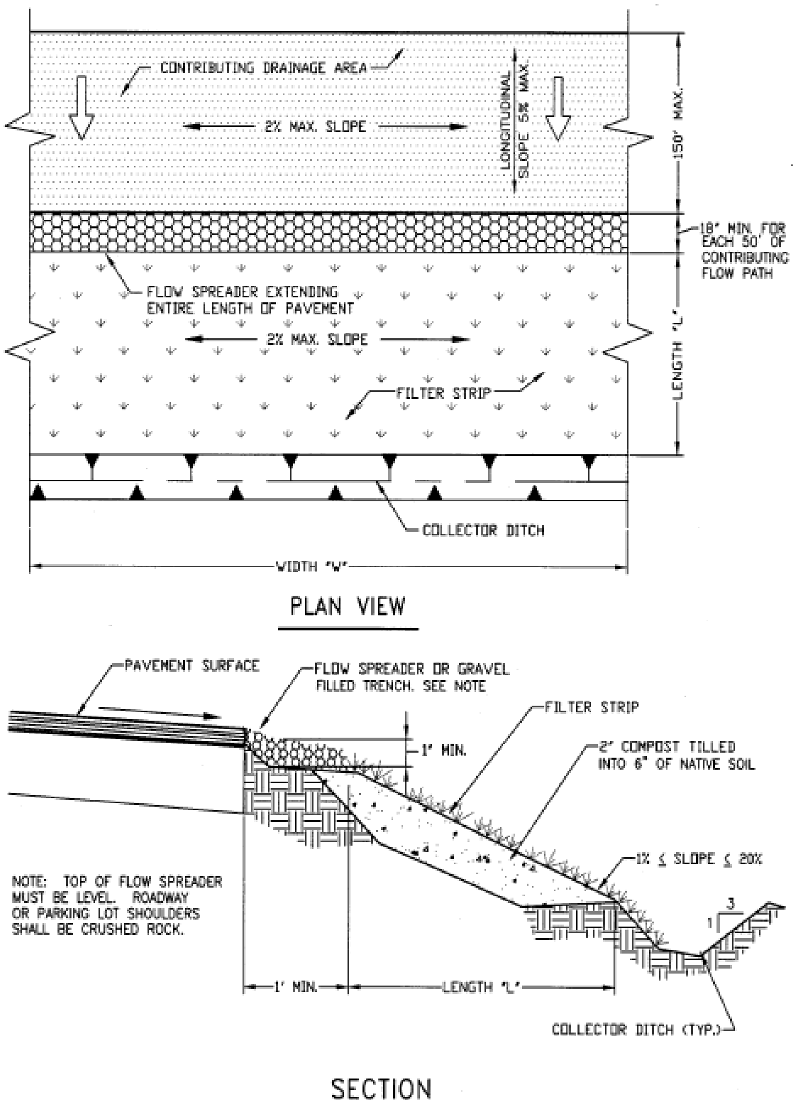
Filter strips require mainly vegetation management; therefore little special training is needed for maintenance crews. Typical maintenance activities and frequencies include:

- Inspect strips at least twice annually for erosion or damage to vegetation, preferably at the end of the wet season to schedule summer maintenance and before major fall run-off to be sure the strip is ready for winter. However, additional inspection after periods of heavy runoff is most desirable. The strip should be checked for debris and litter and areas of sediment accumulation.
- Recent research on biofiltration swales, but likely applicable to strips (Colwell et al., 2000), indicates that grass height and mowing frequency have little impact on pollutant removal; consequently, mowing may only be necessary once or twice a year for safety and aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in strip areas, particularly along highways. The need for litter removal should be determined through periodic inspection but litter should always be removed prior to mowing.

- Regularly inspect vegetated buffer strips for pools of standing water. Vegetated buffer strips can become a nuisance due to mosquito breeding in level spreaders (unless designed to dewater completely in 72 hours maximum), in pools of standing water if obstructions develop (e.g. debris accumulation, invasive vegetation), and/or if proper drainage slopes are not implemented and maintained.

Figure 3.11 Vegetated Buffer Strip





3.3.5 Infiltration Basin

An infiltration basin (Figure 3.12) impounds water in a surface pond until it infiltrates the soil. Infiltration basins do not maintain a permanent pool between storm events and should drain within 72 hours maximum after a design storm event. An infiltration basin is suitable in residential and commercial developments. However, infiltration basins should not be placed in locations where the basin could cause flooding to downstream properties or in natural drainages such that the basin would restrict inflows to the point of causing upstream flooding.

Setbacks and Separation Distances

Setbacks and separation distances for infiltration basins are the same as those listed in section 3.3.1 (i.e., for all infiltration facilities).

Design

In determining the size of the basin, the critical parameters are the storage capacity and the infiltration rate of the basin.

Including accessible forebays in large infiltration systems will prolong the overall life of the system and reduce the owner's maintenance costs. If a forebay is included it must have a minimum top width of 4 ft and side slopes no steeper than 3:1 in order to meet safety standards

Infiltration basins shall be constructed in appropriate soil types. Infiltration basins should be excavated in a manner that will minimize disturbance and compaction of the basin. The basin bottom should be flat to maximize infiltration. Infiltration basins should not be constructed where the contributing area has high erosion rates, on slopes greater than fifteen (15) percent, or within fill soils. If inlet and outlet channels are present, these must be stabilized.

Each infiltration basin should have additional pretreatment. The following are commonly used pretreatments:

- a grass channel
- a vegetated filter strip
- a bottom sand layer
- an upper filter fabric with 6 in sand layer
- a vegetated basin with deep-rooted turf

Design Calculations:

(1) Determine runoff volume for site using NRCS Curve Number Method.

(2) Infiltration basin siting is dependent upon percolation rate of surficial basin soils and maximum allowable time that ponding will be permitted. Allowable percolation rates for infiltration basins range from 0.5 in/hr to 9.0 in/hr. Maximum allowable ponding time is 72 hours.

(3) Given site configuration, depth to ground water, infiltration rate, and time of ponding, calculate depth of basin and basin area.

Basin Depth = (percolation rate)(ponding time)

$$\text{Basin Area} = \frac{\text{Disposal Volume}}{\text{Basin Depth}}$$

As a factor of safety, basin area to be used is for pond bottom only.

(4) Design emergency overflow spillway.

Note:

Calculations assume that pretreatment has been provided.

Operation and Maintenance

Infiltration basins should be inspected at least twice a year. Recommended inspection times are early spring (March or April) and late fall (September or October). Infiltration basins should also be inspected after each major storm event.

Inspections should note the status of basin vegetation, evidence of standing water in the basin, accumulated sediment in the bottom of the basin, unusual or unpleasant odors, and function of inlet and outlet structures, if present. Embankments should also be checked for erosion. If any of these conditions are noted, basin maintenance will likely be required.

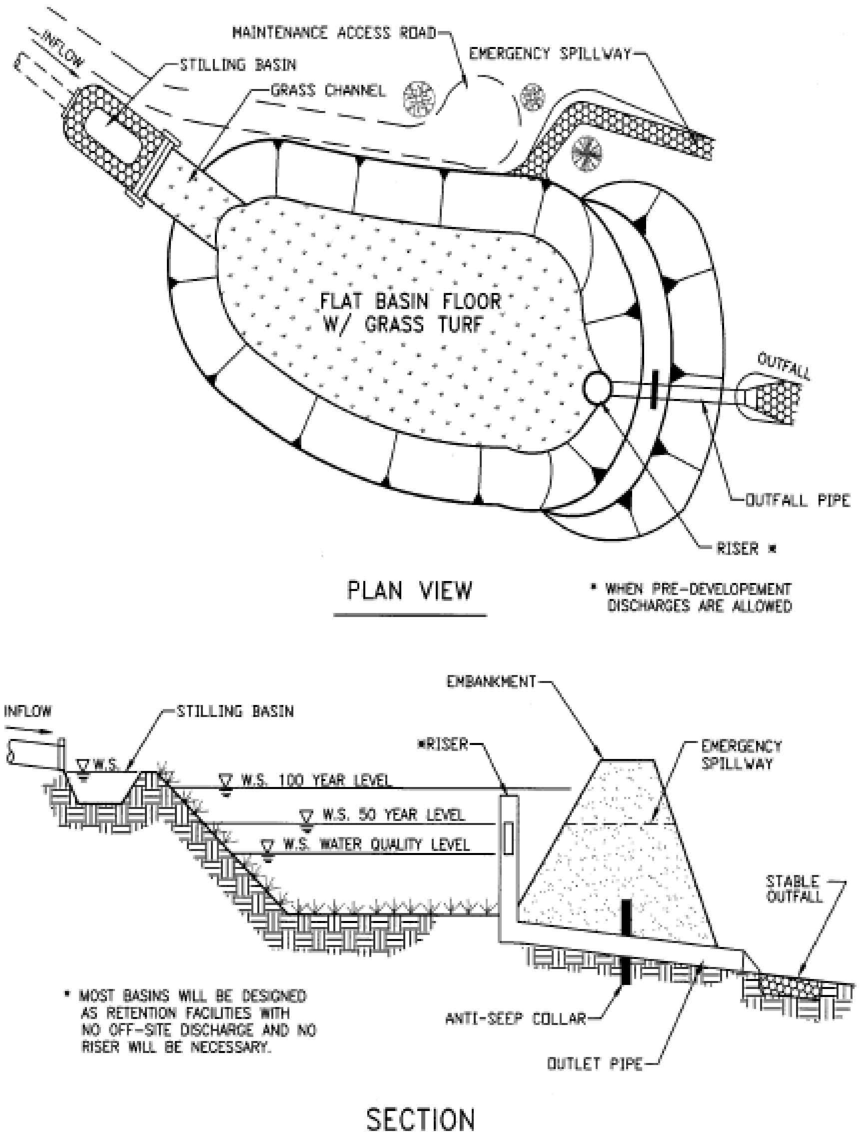
For eroded or barren areas, reseed or replant. Vegetation selection is important in choosing plant material that is compatible with on site moisture and soil conditions.

If standing water is present in the basin longer than 72 hours after a storm event, it is likely that surface basin soils have clogged. Removal, replacement, or reconditioning (e.g., aeration or plowing) of clogged soils may be required.

Over time, sediments entrained in stormwater will accumulate in the bottom of the basin. Eventually the sediment will limit the capacity of the basin and will limit the permeability of the basin bottom. Facility operators must remove sediment accumulations from the basin if sediment levels reach the depth identified in the basin's O&M Plan or results in inadequate infiltration rates.

The presence of unusual or unpleasant odors is indicative of inappropriate materials that have been carried into the basin by stormwater flows or are the result of decaying vegetation or other non stormwater related organic matter. The source of the odor should be located and odiferous material removed.

Figure 3.12 Infiltration Basin



3.3.6 Infiltration Trench/Seepage Bed/Dry Well

An infiltration trench receives runoff in a shallow excavated trench that has been backfilled with stone to form a below-grade reservoir. They are typically located beneath landscaped or parking areas and should drain within 72 hours maximum after a storm event. Infiltration trenches are also know as Seepage Beds when the gravel bed is wide and shallow, or Dry Wells when the length and width of the gravel bed is relatively equal.

Infiltration trenches are classified as shallow injection wells under the Underground Injection Control (UIC) program. Administered by the Idaho Department of Water Resources (IDWR), the UIC program includes an inventory requirement that is met through the City's building permit approval process. Please refer to the Glossary in this Stormwater Manual for the State of Idaho definition of an "injection well."

An infiltration trench can also be open to the surface and covered with landscaping rock. This type of system may be referred to as an open trench. If an infiltration trench is used for pretreatment and contains landscape rock, a 25ft grass buffer strip will also be required

Infiltration trenches are prohibited in the following situations:

- where there is existing soil and/or ground water contamination
- where there is fill material and the possibility of creating an unstable grade and potential for movement at the interface between the fill and in-situ soils

Additional pretreatment and spill control is required for infiltration trenches located at land uses that have a potential for high pollutant loads. See Section 2.3.3.1 for additional information.

Please note that the City may prohibit infiltration trench use depending on the site's vadose zone characteristics and depth to ground water. Final determination of infiltration trench use is determined by evaluating the natural, unaltered characteristics of the proposed location for the system.

Setbacks and Separation Distances

Setbacks and separation distances for infiltration trenches are the same as those listed in section 3.3.1 (i.e., for all infiltration facilities). Additional setbacks and separations distances required for infiltration trenches include:

1. Infiltration trenches must be separated a minimum of 5ft from ground water (vertical distance from bottom of facility to seasonal high ground water level).
2. A test boring shall be drilled to a sufficient depth to verify that a 5ft separation distance between the proposed bottom of the facility and seasonal high ground water table is met.
3. Each infiltration trench facility shall have at least one test boring or excavated hole, unless prior approval is obtained from the City Public Works Department.
4. Infiltration trenches must be separated 10ft from structures (e.g., foundations). Infiltration trench setbacks from structures may be less than 10ft if approved by the structure foundation engineer.
5. Infiltration trenches must be separated 20 ft from basements.

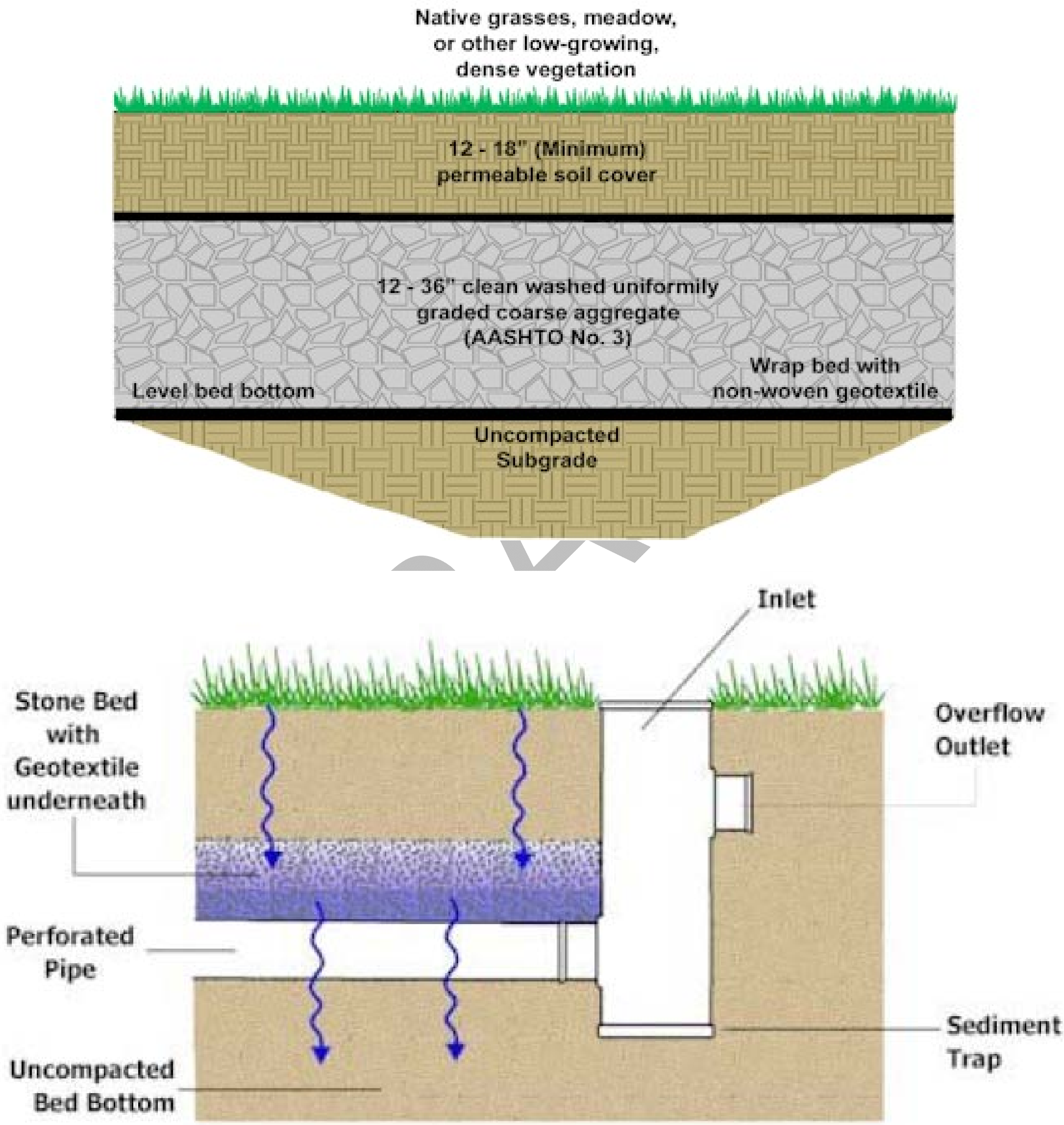
Design

Design requirements specific for infiltration trenches include:

1. Infiltration trenches should be designed to provide a direct method for removal of contaminants and sediments before direct discharge into the vadose zone.
2. A stone aggregate of clean, washed drain rock, 1.5 – 2.5 inch diameter should be used to provide the required void ratio of 40%. A different size aggregate may be used if the required 40% void ratio is certified.
3. The infiltration trench aggregate must be lined on the sides, bottom and top by an appropriate geo-textile fabric. If the trench is an open trench, the top fabric layer should be located 1 ft below the surface to prevent surface sediment from passing

through into the stone aggregate. Filter fabric should have a minimum weight of at least 4 oz/yd^2, a filtration rate of at least 0.08 in/second, and an equivalent opening size of 30 for non-woven fabric. The fabric on the bottom may be substituted with a 12 inch thick layer of ASTM C33 sand.

Figure 3.13 Infiltration trench



4. Infiltration trenches located at sites with infiltration rates greater than 9 in/hr have the potential for stormwater treatment bypass. The infiltration trench facilities located at these sites are required to have either up front pretreatment equivalent to sand filtration or the sides of the infiltration trench are to be wrapped with impermeable fabric or with a permeable barrier equivalent to sand filtration.

5. The bottom of a infiltration trench should be level so that infiltration occurs evenly across its surface.
6. Infiltration trenches **shall not be placed on areas of recent fill** or compacted fill. Any grade adjustment requiring fill shall be done using the stone subbase material. Areas of historical fill (>5 years) may be considered for infiltration trenches.
7. While infiltration trenches are typically sized to handle the volume from a 2-yr, 24-hr design storm, they must also be able to convey and mitigate the peak of the less-frequent, more intense storms (such as the 50-yr). Control in the beds is usually provided in the form of an outlet control structure. A modified inlet box with an internal concrete weir and low-flow orifice is a common type of control structure. The specific design of these structures may vary, depending on factors such as rate and storage requirements, but it always must include positive overflow from the system.
8. Infiltration trenches must have observation wells to determine how quickly the infiltration trench drains after a storm. Wells shall be placed every 2,000 ft^2 unless otherwise recommended by a geotechnical report. The observation well should be a perforated schedule 40 PVC pipe, 4 - 6 inch diameter, extending to the bottom of the bed where it is connected to a footplate. The observation well should be capped and locked to prevent vandalism or tampering (see Figure 3.11).
9. Infiltration trenches should be located for easy access by the equipment for maintenance of the pretreatment system and trench. If the infiltration trench is located in a landscaped area, the bed should be covered with native soils and planted in grass or, if the infiltration trench is an open trench, it must be covered with stone aggregate and protected from sediment build-up with a vegetated buffer strip 20 - 25 feet wide on either side (i.e., of the bed).

Design Calculations:

(1) Determine runoff volume for site using NRCS Curve Number Method.

(2) Infiltration trench sizing is dependent upon the infiltration rate of native materials and void ratio of infiltration trench media. Allowable percolation rates for infiltration trenches range from 0.5 in/hr. to 9 in/hr. Void ratio of bed media must be at least 0.4.

(3) Given site configuration and depth to ground water, estimate infiltration trench depth, length and width. Limit bottom of infiltration trench to no more than 10 ft below grade for ease of installation and construction safety.

(4) Calculate required infiltration trench volume based on the design storm runoff volume into the storage media divided by the void space. For example, a 1,000 cubic foot runoff volume requires a 2,500 cubic foot infiltration trench volume, given a 0.4 void space.

(5) The volume storage required may be reduced by the amount of infiltration into the soil at the bottom of the infiltration trench that occurs over the inflow time, using the hydrograph method shown in Appendix C. Assume that infiltration out of the infiltration trench into the soil will occur only in the bottom of the bed, and not into the walls.

Notes:

a. Calculations shown above assume there is adequate separation distance from bedrock and ground water, and that pretreatment has been provided.

Operation and Maintenance

If the infiltration trench specifications do not meet the standards in Section 3.3.1 under Post-Construction Infiltration Testing, the developer should consider and the City may require an infiltration test of the facility. When filled to the design volume, the infiltration bed must infiltrate and empty within plus or minus 50% of the time specified in the plans.

When ponding occurs at the surface or in the bed, corrective maintenance is required. Ponding indicates the bed or the pipe at the bottom of the bed is clogged. A field investigation may be warranted to determine the cause of infiltration trench clogging. The owner is required to repair, replace, or reconstruct the infiltration trench if it fails to operate as designed. A system fails to operate as designed when water is standing 72 hours or longer following a storm event, with risk of off site discharge. The maintenance and operation schedule for an infiltration system shall include such a provision. The owner is required to notify City if the owner plans to close or replace the infiltration system.

3.3.7 Permeable Pavement

The City of Lewiston encourages the use of permeable pavement in appropriate locations. In addition, the climate here is amenable to the long-term viability of permeable pavement coupled with a seepage bed as a suitable infiltration BMP. Permeable pavement includes pervious concrete, porous asphalt, and open-jointed block.

A permeable pavement infiltration facility consists of a porous surface course underlain by a stone bed of uniformly graded and clean-washed course aggregate, 1-1/2 to 2-1/2 inches in size, with a void space of 35%, essentially a special version of an infiltration trench (Section 3.3.6). Stormwater percolates through the surface, is temporarily held in the voids of the seepage bed, and then slowly infiltrates into the underlying, uncompacted soil mantle. The seepage bed is designed with an overflow control structure so that during large storm events, the storage volume is limited, and at no time does the water level rise to the pavement level. A layer of non-woven geotextile filter fabric separates the aggregate from the underlying soil, preventing the migration of fines into the bed. The bed bottoms should be level and uncompacted. If new fill is required, it should consist of additional washed stone and not compacted soil.

Permeable pavement is well suited for parking lots, walking paths, sidewalks, playgrounds, plazas, tennis courts, and other similar uses. Permeable pavement can be used in driveways if the homeowner is aware of the stormwater functions of the pavement.

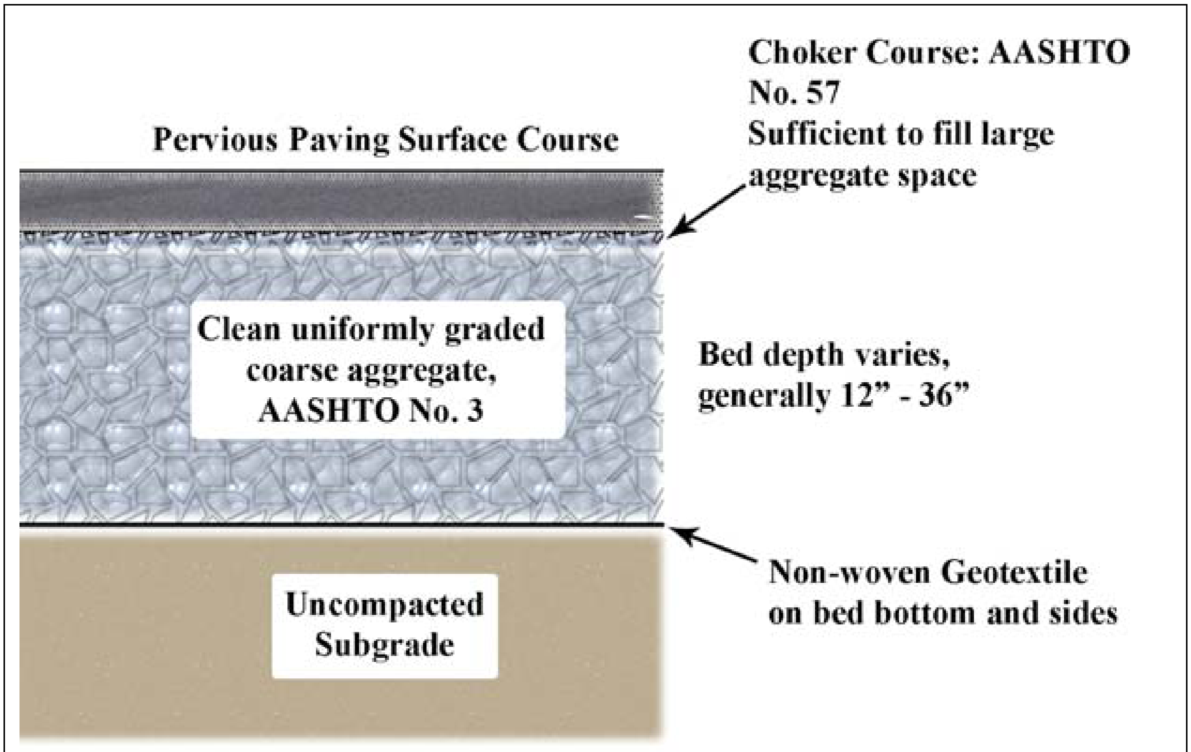
Properly installed and maintained, permeable pavement has a significant life-span, and existing systems that are more than twenty years in age continue to function. Because water drains through the surface course and into the subsurface seepage bed, freeze-thaw cycles do not adversely affect permeable pavement.

Permeable pavement is most susceptible to failure because of poor management during construction. It is important that the construction be undertaken in such as way as to prevent:

- Compaction of underlying soil
- Contamination of stone subbase with sediment and fines
- Tracking of sediment onto pavement
- Drainage of sediment laden waters onto porous surface or into constructed bed

Staging, construction practices, and erosion and sediment control must all be taken into consideration when using permeable pavements. Studies have shown that porous systems have been very effective in reducing contaminants such as total suspended solids, metals, and oil and grease. When designed, constructed, and maintained according to the following guidelines, permeable pavement with underlying infiltration systems can dramatically reduce both the rate and volume of runoff, recharge the groundwater, and improve water quality.

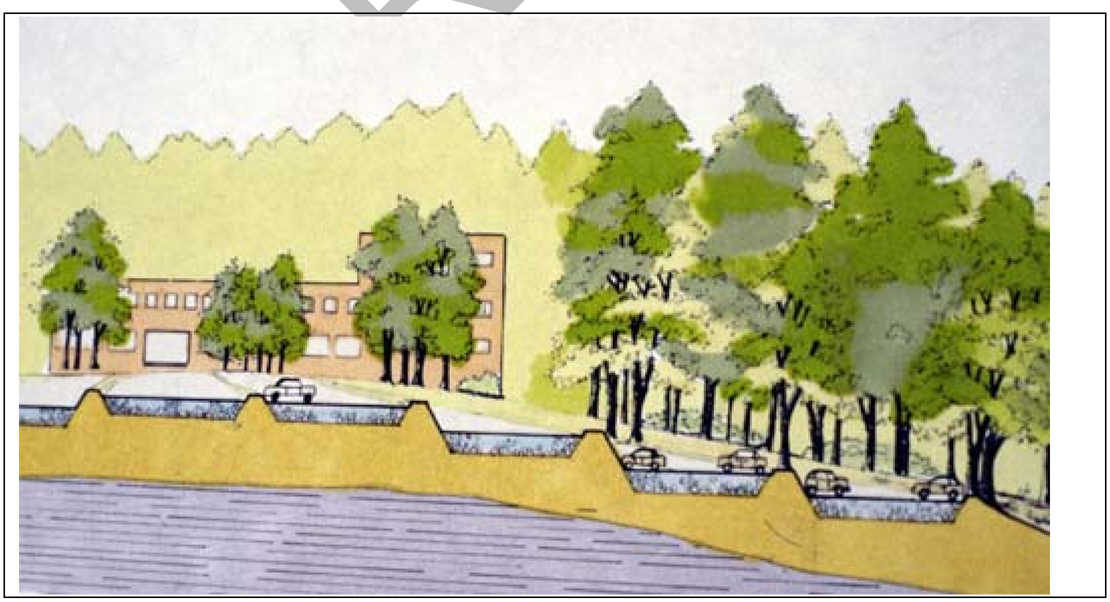
In northern climates, permeable pavements have less of a tendency to form black ice and often require less plowing. Sand and gravel should never be used on porous pavements, although salt may be used on porous asphalt, and commercial deicers may be used on porous concrete. Porous asphalt and concrete surfaces provide better traction for walking paths in rain or snow conditions.



Design Considerations

1. Soil investigation and infiltration testing (Appendix D) required.
2. General design criteria for infiltration systems (Section 3.3.1) must be met.
3. The capability of the site for potential permeable pavement and infiltration trenches shall be determined early in the design process, as effective permeable pavement design requires consideration of grading.
4. Orientation of the parking bays along the existing contours will significantly reduce the need for cut and fill.
5. Permeable pavement and infiltration trenches **shall not be placed on areas of recent fill** or compacted fill. Any grade adjustment requiring fill shall be done using the stone subbase material. Areas of historical fill (>5 years) may be considered for porous pavement.
6. The bed bottom is not compacted, however the stone subbase is placed in lifts and lightly rolled according to the specifications.
7. During construction, the excavated bed may serve as a temporary sediment basin or trap. This will reduce overall site disturbance. The bed shall be excavated to within six (6) inches of the final bed bottom elevation for use as a sediment trap or basin. Following construction and site stabilization, sediment shall be removed and final grades established.
8. **Bed Bottoms must be level**. Sloping bed bottoms will lead to areas of ponding and reduced distribution.

9. **All systems shall be designed with an overflow system**. Water within the subsurface stone bed should never rise to the level of the pavement surface. Inlet boxes can be used for cost-effective overflow structures. All beds shall infiltrate within 72 hours.
10. Perforated pipes along the bottom of the bed may be used to evenly distribute runoff over the entire bed bottom. Continuously perforated pipes shall connect structures (such as cleanouts and inlet boxes). Pipes shall lay flat along the bed bottom and provide for uniform distribution of water. Depending on size, these pipes may provide additional storage volume.
11. Roof drains and area inlets may be connected to convey runoff water to the infiltration trench. However, filtration of the additional runoff is required to prevent the conveyance of sediment and debris into the bed.
12. Infiltration areas should be located within the immediate project area in order to control runoff at its source. Expected use and traffic demands shall also be considered in permeable pavement placement.
13. **Control of sediment is critical**. Rigorous installation and maintenance of erosion and sediment control measures is required to prevent sediment deposition on the pavement surface or within the stone bed. Nonwoven geotextile may be folded over the edge of the pavement until the site is stabilized. **Any sediment deposited on the surface shall be removed by a vacuum sweeper and shall not be power-washed into the bed.**
14. **Infiltration trenches may be placed on a slope by benching or terracing parking bays.** Orienting parking bays along existing contours will reduce site disturbance and cut/fill requirements.

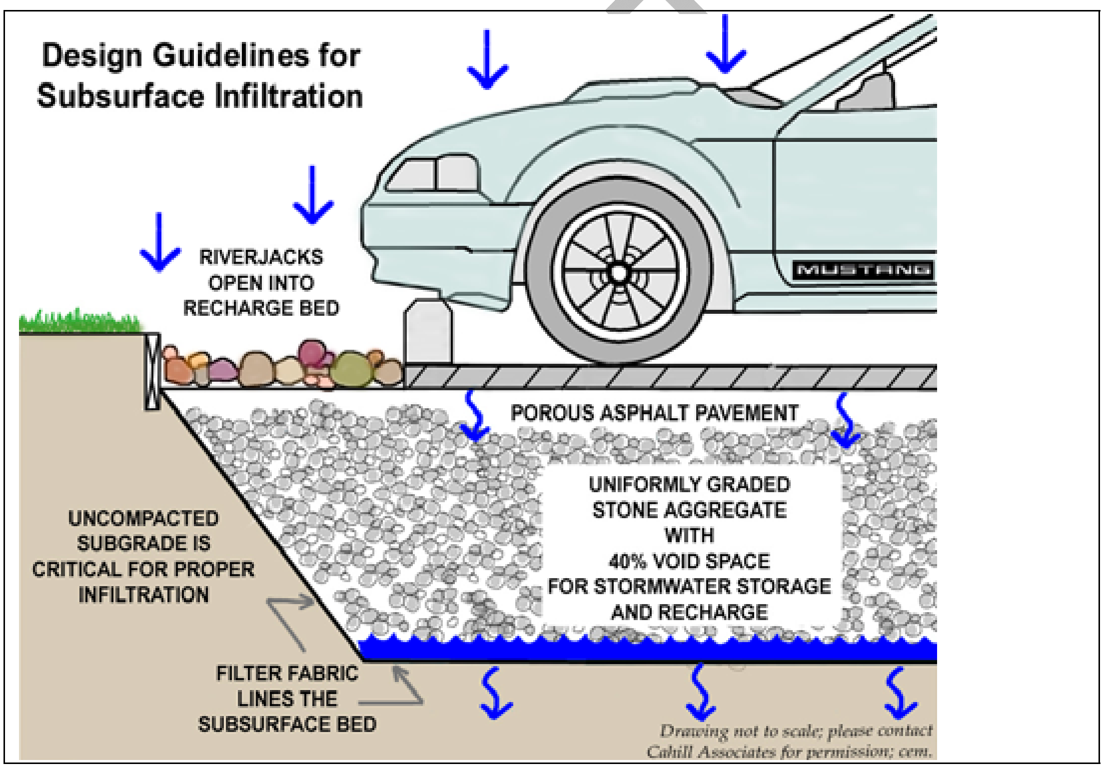


15. The underlying seepage bed is typically 12-36 inches deep and comprised of clean, uniformly graded aggregate with 30 - 40% void space. AASHTO No.3, which ranges 1.5- 2.5 inches in gradation, is often used. Depending on local aggregate availability, both larger and smaller size aggregate has been used.

The critical requirements are that the aggregate be **uniformly-graded**, **clean washed**, and contain 30 - 40% void space. The depth of the bed is a function of stormwater storage requirements, frost depth considerations, and site grading. Seepage beds are typically sized to mitigate the increased runoff volume from a 2-yr, 24-hr design storm.

16. While most porous pavement installations are underlain by an aggregate bed, alternative subsurface storage products may also be employed. These include a variety of proprietary, interlocking plastic units that contain much greater storage capacity than aggregate, at an increased cost.

17. All permeable pavement installations must have a backup method for water to enter the stone storage bed in the event that the porosity of the pavement fails or is altered. In uncurbed lots, this backup drainage may consist of an unpaved 2 ft wide stone edge drain connected directly to the bed between the wheel stops. In curbed lots, inlets with 12 inch sediment traps may be required at low spots. Backup drainage elements will ensure the functionality of the infiltration system if the porous pavement is compromised.



18. In areas with poorly-draining soils, seepage beds below porous pavement may be designed to slowly discharge to adjacent wetlands or bioretention areas. Only in extreme cases (i.e. industrial sites with contaminated soils) may the aggregate bed be lined to prevent infiltration.

19. In those areas where the threat of spills and groundwater contamination is quite likely, pretreatment systems, such as filters and wetlands, may be required before any infiltration occurs. In hot spot areas, such as truck stops, and fueling stations, the appropriateness of permeable pavement must be carefully

considered. A stone infiltration bed located beneath standard pavement, preceded by spill control and water quality treatment, may be more appropriate.

20. The use of porous pavement must be carefully considered in areas where the pavement may be seal coated or paved over due to lack of awareness, such as individual home driveways. In those situations, a system that is not easily altered by the property owner may be more appropriate. An example is a seepage bed constructed under a conventional driveway with more standard inlets. Educational signage at porous pavement installations may guarantee its prolonged use in some areas.

For further discussion of pervious concrete and porous asphalt, refer to the following web sites:

http://www.concreteresources.net/

http://www.forester.net/sw_0305_porous.html

For open-jointed blocks, refer to "Permeable Interlocking Concrete Pavements" at the following web site:

http://www.icpi.org/design/specs_details.cfm

For a broad narrative discussion of all types of porous pavements, refer to a book like *Porous Pavements* by Bruce Ferguson. It is available on-line from Amazon or Barnes and Noble.

Maintenance Issues

The primary goal of permeable pavement maintenance is to prevent the pavement surface and/or underlying infiltration bed from being clogged with fine sediments. To keep the system clean throughout the year and prolong its life span, the pavement surface should be vacuumed biannually with a commercial cleaning unit**. Pavement washing systems or compressed air units are not recommended.**

All inlet structures within or draining to the infiltration beds should also be cleaned out biannually.

Planted areas adjacent to permeable pavement should be well maintained to prevent soil washout onto the pavement. If any washout does occur it should be cleaned off the pavement immediately to prevent further clogging of the pores. Furthermore, if any bare spots or eroded areas are observed within the planted areas, they should be replanted and/or stabilized at once. Planted areas should be inspected on a semiannual basis. All trash and other litter that is observed during these inspections should be removed.

Superficial dirt does not necessarily clog the pavement voids. However, dirt that is ground in repeatedly by tires can lead to clogging. Therefore, trucks or other heavy vehicles should be prevented from tracking or spilling dirt onto the pavement. Furthermore, all construction or hazardous materials carriers should be prohibited from entering a permeable pavement lot.

Special Maintenance Considerations:

Prevent Clogging of Pavement Surface with Sediment

- Vacuum pavement 2 or 3 times per year

- Maintain planted areas adjacent to pavement
- Immediately clean any soil or fine debris deposited on pavement
- Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface
- Clean inlets draining to the infiltration bed twice per year

Winter Maintenance

Winter maintenance for a pervious parking lot may be necessary but is usually less intensive than that required for a standard asphalt lot. By its very nature, a pervious pavement system with subsurface aggregate bed has superior snow melting characteristics compared to standard pavement. The underlying stone bed tends to absorb and retain heat so that freezing rain and snow melt faster on pervious pavement. Therefore, ice and light snow accumulation are generally not as problematic. However, snow will accumulate during heavier storms. Abrasives such as sand or cinders should not be applied on or adjacent to the pervious pavement. Snow plowing is fine, provided it is done carefully (i.e. by setting the blade slightly higher than usual, about an inch). Salt is acceptable for use as a deicer on the pervious pavement, though nontoxic, organic deicers, applied either as blended, magnesium chloride-based liquid products or as pretreated salt, are preferable.

Repairs

Potholes in permeable pavement are unlikely; though settling might occur if a soft spot in the subgrade is not removed during construction. For damaged areas of less than 50 square feet, a declivity could be patched by any means suitable with standard pavement, with the loss of porosity of that area being insignificant. The declivity can also be filled with pervious mix. If an area greater than 50 sq. ft. is in need of repair, approval of patch type should be sought from either the engineer or owner. Under no circumstance should the pavement surface ever be seal coated. Any required repair of drainage structures should be done promptly to ensure continued proper functioning of the system.

3.4 Ponds

Ponds are stormwater facilities designed to retain or detain stormwater runoff. They provide stormwater runoff quantity storage, water quality treatment, and may be used for peak flow attenuation. The different ponds recommended in Lewiston include dry detention ponds, wet extended detention ponds, wetlands, and evaporation ponds.

Detention ponds collect and temporarily hold stormwater runoff from a site and release it at a slower, metered rate. They are used to attenuate peak flows, mitigate downstream impacts, and alleviate flooding problems. Depending on detention times and their configuration, they can provide significant water quality improvement.

A wet extended detention pond is a pond designed to treat and release surface and stormwater runoff from a site, while maintaining a permanent pool. An evaporation pond is a pond designed to collect and hold surface and stormwater runoff from a site until it evaporates. Ponds are suitable for residential, commercial, and industrial developments, depending on the availability of space and a suitable site.

3.4.1 General Design Criteria

Ponds must be designed for both storage of the design storm volumes and flows(or pass through) of stormwater events that exceed the design storage. Ponds should be planned as multistage systems with different storage volumes and pass-through rates for each stage. Ponds may only be used at sites where a receiving body or structure can accept pond discharges and overflows. Ponds designed to meet on-site detention requirements shall not be located in regulatory floodplains. Sites should be evaluated for soils, depth to bedrock, and depth to water table. Requirements depend on pond type.

Ponds may be excavated below the surface of the ground, or they may be created by a dam or a dike. Dams and dikes for stormwater control ponds require city-approved plans.

Setbacks and Separation Distances

Requirements include:

- side slopes of ponds shall not be located closer than two (2) feet from property lines
- a minimum of 100 ft separation from public and private wells
- a 100 ft separation distance from surface water supplies used as drinking water and a 50 ft separation distance from surface water supplies not used as drinking water, excluding stormwater and irrigation delivery systems
- a 10 ft separation from structural foundations[6]

Design

The following design requirements apply to all ponds permitted by the City:

- Pond volumes must be large enough to treat the total volume from a 50-year, 24-hour storm plus freeboard, in addition to any water already in storage at the time of the storm, with the following discharge dispositions (Figure 3.15):
    - >50-yr storm volume discharged through overflow
    - 2-yr to 50-yr volume discharged at the 10-yr, 30-min maximum flow rate
    - Water quality to 2-yr volume retained or discharged over 72 hours maximum
    - Water quality volume (0.4 inches) retained on site, or treated and discharged at a metered rate over 72 hours maximum.
- All ponds must have a overflow capable of handling a 100-year storm event without erosion or other failure.
- The various pond volume stages shall be calculated using a 30-min time interval hyetograph printed in Appendix C and available electronically from the Stormwater Program Coordinator, 746-3671, ext 273.
- The system should be designed for at least a 50-year life.

[6] This setback requirement can be less than 10 feet if approved by the geotechnical engineer.

- The receiving system must be capable of accommodating overflow from a 50 year storm event, both volume and rate. If the receiving system is not capable of accommodating the overflow, an alternate must be planned.
- Outlet pipes shall be at least 12 in diameter. If riser pipes are used, they shall be 1½ times the cross sectional area of the outfall pipe.
- All pipe joints are to be watertight
- The channel immediately below the pond outfall shall be protected against erosion and shall transition to natural or piped drainage conditions in the shortest distance possible

Once the design volume and TSS removal efficiencies have been calculated, the resulting pond size shall be increased an additional 15% in order to accommodate long-term sediment storage.

Vegetative Buffers

Vegetative buffer strips shall be established around the perimeter of the pond for erosion control and additional sediment and nutrient removal. Buffer strips should include all areas between the normal pond water surface elevation to the top of the pond embankment.

Pond Safety

Take all practical safety precautions. Side slopes should not exceed 3:1. Ponds with greater than 48 inches standing water at any time should have a 3-ft wide bench around the pond 18 inch below the surface water level (Figure 3.15). Environmental health should be given adequate consideration. Ponds should be designed and managed to minimize mosquito breeding.

Ponds that will contain greater than 12 inches water for any length of time should be considered for fencing. However, a fence can be a two-edged sword when it comes to safety and rescue: it may keep animals and people out of the pond, but will also limit access for rescue should that be needed.

Freeboard Requirements

Open ponds shall be designed with freeboard above the maximum design water elevation in accordance with the following criteria.

Table 6. Freeboard Required for Different Pond Depths

Water Depth	Freeboard
1-12 inches	4 inches
12-24 inches	8 inches
24-36 inches	12 inches
> 36 inches	18 inches

Emergency Spillway Requirements

Emergency spillways are required on all ponds. The spillway shall be sized to safely pass a minimum 100-year storm event. If the facility is considered a dam by IDWR, additional requirements may apply. The emergency spillway shall be protected against erosion by some measure of hardening.

In addition, the emergency spillway elevation shall be at the maximum water surface with freeboard above the depth of flow in the spillway.

Dams and Embankments

A wet pond may be categorized as a dam by state code if the vertical distance between the high water elevation and the downstream flow line exceeds 10 ft or the pond impounds more than 50 acre-feet of water.

The design top elevation of all dams and embankments, after all settlement has taken place, shall equal, or exceed the maximum water surface elevation in the pond. The design top elevation shall be the maximum routed hydrograph water surface elevation plus the required freeboard height. The design height of the dam or embankment is defined as the vertical distance from the top down to the bottom of the deepest cut. The height shall be increased by the amount needed to assure that the design will be maintained after settling. Where necessary, the engineer shall require consolidation tests of the undisturbed foundation soil to more accurately determine the necessary increase.

The widths of the tops of pond dams and embankments are given in Table 7.

Table 7. Minimum Top Widths for Different Dam/Embankment Heights

Dam Height	Top Width
0-5 feet	10 feet
5-10 feet	12 feet
10-15 feet	14 feet

A certified soils investigation is required on all ponds > 1 ft deep. At a minimum, it shall include soil property information along the centerline of the pond bottom, the centerline of the proposed dam or embankment, in the emergency spillway location, and the planned borrow area. It should include recommendations on dam and embankment fill material, cutoff trenches, compaction, linings, and any other special design requirements.

Maximum side slopes for all dams and embankments are 3:1 on the upstream or impoundment side and 2:1 on the downstream side, or as approved by IDWR.

All earth fill shall be free from brush, roots, and organic material that may decompose. All spill ways must end in native materials and be designed to move flow without erosion into the existing channel.

Ponds > 1 ft deep require anti-seep cutoff walls at least 8 in thick or other control methods around outlet pipes. Cutoff walls are to be constructed parallel to the dam or embankment centerline. Walls should be constructed of impervious soil or concrete, piling, plastic sheeting or other material as approved by IDWR.

The fill material in all earth dams and embankments shall be compacted. For ponds > 1 ft deep, the minimum field compaction shall be 95% of the maximum laboratory density. Certification of compaction shall be provided by an independent testing laboratory and reviewed by the design engineer.

Operation and Maintenance

Ponds require regular inspections and maintenance if they are expected to function correctly for a 50-yr life span. Facility operators should inspect ponds at least once a year and following any significant storm event. Pond facilities requiring inspection include:

- Early to mid spring is a good time for pond inspection, before major vegetation begins to grow.
- Water levels should be as they have been designed. High water levels may indicate blockages to outlets, whereas low water levels may indicate short circuiting or unwanted drainage.
- Vegetative cover on embankments, perimeter, and inside the pond should be in good condition and unwanted vegetation should not be invading. Generally trees should not be allowed to invade any structural part of a pond system.
- Perimeter fencing, if present, should be maintained in good condition, with some access to the pond provided. If gate is locked closed, be sure that appropriate individuals have access to the locks.
- Inlet and outlet structures should be checked to be sure they are operating correctly and not becoming blocked with debris, sediment or weeks. Inlet structures should be checked for erosion, sediment deposition, channel scour, and plugging. Outlet structures should be inspected for clogging or plugging, short-circuiting of outlet flows, and washouts.
- Emergency spillways must always remain open and clear to passage of potential flood waters.
- Facility operators should check pond embankments for erosion, holes excavated by rodents or other animals, and vegetative cover both above and at bank levels. Unwarranted human activity is the most common way in which embankments and dikes are jeopardized.
- The accumulated sediments shall be measured annually by examining the pond depth. The accumulated sediments must be removed when the pond volume approaches the design volume and treatment capacity (i.e., is close to or exceeds 15% of the total pond volume).
- Any debris accumulated in the pond should be removed annually.
- Facility operators should note the presence of objectionable or noxious odors and remedy any superficial, structural, aesthetic, or facility capacity shortcomings.

3.4.2 Dry Detention Pond

Dry detention ponds collect and temporarily hold stormwater runoff from a site and release it at a slower rate than it is collected. They are used to attenuate peak flows, mitigate downstream impacts, remove pollutants, and alleviate flooding problems. Dry detention ponds do not maintain a permanent pool between storm events. Detention ponds are suitable in residential, commercial, and industrial developments.

Dry detention ponds are the BMP of choice if a particular development site must discharge the 2-yr, 24-hr stormwater volume into the City's stormwater system. In this circumstance, they should be designed to capture all runoff above the pre-development level and discharge it slowly over 72 hours maximum.

Dry detention ponds are suitable in most urban and suburban environments. They can be a landscaping feature, or they may serve other purposes, such as parking, or pasture, or playgrounds.

Setbacks and Separation Distances

Setbacks and separation distances for dry detention ponds are the same as those listed in section 3.4.1 (i.e., for all pond facilities).

Design

Dry detention ponds can be any shape as long as they have sufficient capacity to meet general design and treatment requirements (Section 3.4.1). Calculations for the pond size are to be submitted with the stormwater design plans for City review and permit approval.

The ability for a dry detention pond to remove TSS is evaluated based on the time of retention (i.e., flow path and volume) for representative sediment settling velocities. TSS removal is improved when a settling pond is included as a pre-treatment.

The size of a dry detention pond is determined by developing an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. The inflow, storage, and outflow relationships should be based on a 2-yr, 50-yr and 100-yr 24-hour storm duration that identifies a peak detention pond volume for the storm interval required.

The outlet design shall incorporate a multi-stage riser that will allow water to be drained over an extended period meeting the general requirements for volume retention. The outlet shall be designed to drain the full volume of the pond in 72 hours maximum. The outlet structure shall be designed to prevent clogging and plugging. The outlet structure shall be protected and durable long term, especially if the structure is in an area easily accessible by the public.

Dry detention ponds shall be excavated in a manner that will minimize disturbance and compaction of the pond. If the pond can be constructed in material with an infiltration rate of greater than 1 inch/hour, several inches of water may be left below the lowest outlet orifice to infiltrate. The design professional will need to weigh the potential for sedimentation in the pond against drainage of the pond for health and safety reason, and maintenance to remove accumulated sediment.

Ponds shall be designed to contain computed storage volume plus 15% of the computed storage volume to adequately accommodate sediment deposition.

The inlet shall be protected against erosion or scour. Riprap or other material may be required at the inlet to provide for energy dissipation. A settling basin at the inlet is recommended. A overflow outlet designed to prevent erosion is required as specified in section 3.4.1.

Dry detention ponds shall be stabilized with vegetation or rock to control dust and improve pond aesthetics. A landscaping plan for a dry extended detention pond and its buffer shall be submitted to indicate how semi-aquatic and terrestrial areas will be stabilized with established vegetation. Bottom and banks of all dry extended detention ponds shall be stabilized with gravel, rock, vegetation, or other acceptable material to control dust and prevent erosion.

Operation and Maintenance

Operation and maintenance guidelines for dry detention pond are the same as those listed in section 3.4.1 (i.e., for all ponds). In addition dry detention ponds should be mowed 2 to 3 times per year. If the dry detention pond is used for some other purpose between storm events, inspections should insure the any activity taking place in the pond is not jeopardizing the function of the pond in the case of a storm event.

3.4.3 Wet Extended Detention Pond (Wet Pond)

A wet extended detention pond is a constructed pond designed to retain a volume of water to allow for the settling of particles and associated pollutants. The pond also provides additional storage above the wet pond volume, generally enough additional storage for a design storm event. A wet extended detention pond incorporates both a permanent pool and extended detention volume above the permanent pool.

A wet extended detention pond is suitable in residential, commercial, and industrial sites and is appropriate in areas where nutrient loadings are expected to be high.

Setbacks and Separation Distances

Setbacks and separation distances for wet extended detention pond are the same as those listed in section 3.4.1 (i.e., for all ponds).

Design

Wet extended detention ponds can be any shape as long as they have sufficient capacity to meet general design and water quality treatment requirements of Section 3.4.1. Calculations for the pond size and TSS removal rates are to be submitted with the stormwater design plans for City review.

The ability for a wet extended detention pond to remove TSS is based on the time of retention, during both the quiescent and non-quiescent settling periods, for representative sediment settling velocities. Generally, however, because of the nature of maintaining a wet pond, TSS removal is quite good. Ponds may need to be lined to be able to maintain water levels in the permanent wet pond.

The size of the detention part of the wet extended detention pond is a function of the required time of retention, an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. The inflow, storage, and outflow relationships should be based on a storm duration that identifies a peak detention pond volume for the storm intervals (2-yr, 50-yr and 100-yr, 24-hr) required.

The critical parameters in determining the size of the wet extended pond are the storage capacity and the runoff from its drainage basin. The permanently wet part of the pond should be large enough for water quality treatment, i.e., 0.4 in from all impervious surfaces in the drainage basin. Additional detention storage will be needed up to at least the 2-yr, 24-hour runoff volume. The detention design shall provide an average of 48 - 72 hours detention time.

The pond's permanent pool depth shall not exceed 12 ft, and have an average depth between 4 ft and 6 ft year round. The length from inlet to outlet should be as far apart as possible, with the length to width ratio generally approximately 3:1. Side slopes of wet extended detention ponds should be 3:1. A source of water in addition to stormwater may be necessary to maintain the wet pond at sufficient water depth.

In cases where it will be difficult to maintain a healthy wet pond year round, the wet pond portion of the system may be designed more as an evaporation pond, a periodically flooded wetland, or an infiltration basin. Special design criteria will be required, but should generally follow the criteria of one of those three BMPs found in this Stormwater Manual

Wet extended detention ponds may include an optional sediment forebay or equivalent upstream pretreatment. If installed, forebays shall be separate cells formed by acceptable barriers. A weir flow structure or physical separation with pipes may be utilized. If a rock or an earthen berm is constructed, it shall have a minimum top width of 4 ft and side slopes no steeper than 3:1 to provide separation from the permanent pool. A drainpipe should be included in the forebay to dewater the pool area for maintenance purposes. Minimum forebay size shall be 15% of the water quality treatment volume, with an optimal volume equal to 25%. Forebay volume shall be in addition to permanent pool volume. In addition, a fixed vertical sediment depth marker should be installed in the forebay to measure sediment accumulation.

Outlets of wet extended detention ponds are required to pass a flow rate necessary for extended quantity attenuation and TSS removal efficiencies. The outlet design shall incorporate a multi-stage riser that will allow water to drain over a minimum period that allows the peak outflow to stay at metered rates, while providing for TSS removal.

Two benches, a "safety bench" and an "aquatic bench," shall surround the perimeter of all permanent deep wet extension ponds (i.e., where the pools are at least 4 ft deep). The combined minimum width of both benches shall be 8 ft. A safety bench is a bench that extends landward from the normal water level edge to the toe of the pond side slope. An aquatic bench is a bench under the water around the pond (Figure 3.15). The maximum water depth over aquatic benches is 18 in below the normal surface elevation of the pool. Additionally, the pond slope between the top of the bank and aquatic benches shall not exceed 3:1.

A landscaping plan for a wet extended detention pond and its buffer shall be submitted to indicate how aquatic and terrestrial areas will be stabilized with established vegetation. Whenever possible, wetland plants should be used in a pond design, either along the aquatic bench or within shallow areas of the pool. All pond areas above the wet pond level shall be stabilized with gravel, rock, vegetation, or other acceptable material to control dust and prevent erosion.

Special consideration needs to be given to the ecologic health of any wet pond where water will be standing year round. Ideally, this pond will support healthy communities of flora and fauna. Design of such ponds must consider maintenance of water quality and quantity over the year, the control of nuisance flora and fauna, and the health and safety of such a facility.

Design Calculations:

(1) Calculate the volume of stormwater runoff from all impervious surfaces in the pond drainage basin for the 2-yr, 50-yr and 100-yr, 24-hr design storms and the 0.4 inch water quality volume.

(2) Determine pond volumes for the different stages, i.e, the volumes above the permanent pond elevation. This volume shall be increased by 15% to accommodate sediment deposition. Pond configuration (shape and depth) is dependent on topography and outlet conditions. Ponds must be benched in accordance with standards.

(3) Design outlet structure. Outlet structure will normally be comprised of a vertical riser pipe with orifices or a weir(s), or combinations of both. The outlet structure is to be designed to limit discharge rates as follows:

- Water quality volume (0.4 inch ppt.) is to be stored in the pond and must be within the natural variability of the permanent pond level
- The difference between the water quality volume and the 2-yr, 24-hour storm volume is to be stored in the pond. However, if pond water elevation is a concern for the health of the pond, this volume of water may released slowly down to the highest permanent pond water surface elevation.
- The difference between the 2-yr, 24-hr storm volume and the 50-yr, 24-hr volume is to be detained in the pond and released over 48 – 72 hours through a metered orifice(s) so flow increases as the pond level rises, with peak flow at the full 50-yr, 24-hr volume being no greater than the 10-yr, 30-min storm flow rate.
- Volumes greater than the 50-yr, 24-hr storm are to be released through an overflow device designed to prevent erosion.

(4) The outlet structure shall also have a drainage pipe in the bottom of the pond with a secured valve that may be unlocked and opened to drain the pond, if necessary.

Typical orifice and weir formulas are shown below.

Orifice Equation

$$Q = cA(2gh)^{1/2}$$

Where:

Q = flow rate in ft^3/sec.

c = orifice coefficient (normally, a coefficient of between .6 and .65 is used.)

A = area of orifice (ft^2)

g = gravitational constant = 32.2 ft/sec^2

h = head on orifice, in feet (vertical distance between orifice centerline and water surface elevation at structure)

Weir Equation

$$Q = cLh^{3/2}$$

Where

Q = flow rate in ft^3/sec.

c = weir coefficient. This coefficient is dependent on the type of weir used.

L = length of weir crest (ft)

h = head above weir crest (vertical distance between weir crest and water surface elevation at structure

(5) Based on pond size and allowable flow rates, estimate sizes of outlet orifices/weirs. Note that this design does not require calculation of pre-development flows since they are included. As discussed in Section 2.3.4 storms up to the 2-yr, 24-hr level do not produce runoff from Lewiston's soils under natural, or pre-development, conditions. Once the volume surpasses this level in the pond, the outlet structure is to be designed to start discharging at an increasing rate as volume increases, roughly equivalent to what might have been a pre-development discharge rate for such storms.

(6) Generate stage-discharge and stage-storage curves. With the stage-storage and stage-discharge information, route the hydrograph through the pond. Routing shall be in accordance with established engineering practices. Compare routed pond outflow hydrograph with minimum design requirements. Adjust either pond configuration or outlet controls as required, to meet outlet requirements.

(7) Design emergency overflow spillway. Emergency overflow spillway should be designed to pass a 100-year flood event. Design and siting of spillway shall assume that the other outlet structures are not operational, i.e., in case the metered outlets are plugged or not functional for any reason.

Operation and Maintenance

Operation and maintenance guidelines for wet extended detention pond are the same as those listed in section 3.4.1 for all ponds. Additional or more specific items requiring maintenance and inspection include:

- sediment forebays
- forebay inlet and outlet structures
- wet pond safety benches
- testing of the emergency drainage device

3.4.4 Evaporation Pond

Evaporation ponds are retention ponds that provide water quantity and water quality control. It is a constructed pond designed to store stormwater runoff and release it through evaporation. The pond should be designed to be dry for at least one month each year.

An evaporation pond is suitable in commercial and industrial sites. It is appropriate in areas where soil types do not allow infiltration (shallow bedrock, heavy clay soils, etc.) It has the serious limitation having stagnant water present throughout much of the year.

Setbacks and Separation Distances

Setbacks and separation distances for evaporation ponds are the same as those listed in section 3.4.1 (i.e., for all ponds).

Design

An evaporation pond shall be sized using the following criteria. Two steps are used in calculating the appropriate size for evaporation ponds. The first step is to calculate a month-to-month mass balance of runoff inflow and runoff evaporation (Table 8):

Inflow = (CN)*(Precipitation)*(Area)

Where: CN = weighted Curve Number for the drainage area

Evaporation = (monthly evaporation rate)*(pond surface area)

The extent of runoff areas and assumed pond sizes determine the inflow and evaporation volumes. The monthly differences between inflow and evaporation are calculated over a one-year period. One month should show a negative volume to indicate a dry pond condition. This process will also identify the month when the pond will reach maximum volume.

Table 8. Evaporation Pond Mass Balance Design Form

	Average Precip.	Pond Inflow	Evapora-tion Rate	Monthly Evap.	Monthly Storage	Cum Storage
	(inches)	(ft^3)	(in/mo)	(ft^3)	(ft^3)	(ft^3)
Oct						
Nov						

Dec						
Jan						
Feb						
Mar						
Apr						
May						
June						
July						
Aug						
Sept						

Notes: April is normally the month of maximum pond stormwater storage
At least one month should show a negative pond volume indicating a dry pond condition

The second step is to calculate additional pond storage required if the evaporation pond is already full (in April, for example) in the face of an additional 2-yr, 24-hr event. This additional storage may be treated as dry detention and metered off the top of the evaporation pond over 72 hours maximum.

The final evaporation pond size is calculated by adding the maximum monthly pond storage (i.e., from step one) to the 24-hour storm of record runoff (i.e., from step two) plus and additional 15%. This additional 15% allows for sedimentation and debris storage.

Finally, additional temporary volume storage and discharge must be supplied for storms greater than the 2-yr, 24-hr event. These may be discharged as described in section 3.4.1.

Bottom and side slopes of all evaporation ponds shall be stabilized with vegetation, gravel, rock, or other acceptable material to control dust and prevent erosion.

Designs of evaporation ponds are to take all practical safety precautions. For example, side slopes of evaporation ponds are not to exceed 3:1 slope and safety benches are to be included if the water depth is greater than 4 ft at any time.

Operation and Maintenance

Primary concern in the operation of an evaporation pond is the control insect breeding, weeds, and the development of unpleasant odors. An operations and maintenance plan addressing these issues should be in place for every evaporation pond.

Facility operators should inspect evaporation ponds at least once per year, preferably in the month of September or October when the pond should be dry, and after each major storm event to check for leakage or overflow. Facility operator can easily maintain the function of an evaporation pond by keeping the pond bottom at an elevation and grade that allows stormwater to spread evenly. This maximizes the pond surface area and resultant evaporation capacity. In order to maintain the pond's evaporation capacity, the pond bottom may need to be graded at periodic intervals to remove or spread sediments or vegetation that block the passage of water. Facility operators need to inspect other evaporation pond elements as well such as inlet structures and emergency outlets. Any erosion or channel irregularities at these locations should be repaired.

3.4.5 Wetlands

Wetlands may be constructed for two main reasons: to replace or mitigate impacts when natural wetlands are filled or impacted, or to treat stormwater runoff. Stormwater treatment wetlands are shallow, man-made ponds that are designed to treat stormwater through the biological processes associated with emergent aquatic vegetation.

A stormwater wetland occupies about the same surface area as a wet pond, but has the potential to be better integrated into the landscape because of the abundance of emergent aquatic vegetation. The most critical factor for a successful design is the provision of an adequate supply of water for most of the year.

Stormwater treatment wetlands are used to capture and transform pollutants, just as wet ponds and biofilter swales are, and over time pollutants accumulate with the sediment. To remain functional, vegetation must occasionally be harvested and sediment dredged. In general wetlands perform well to remove sediment, metals, and pollutants that bind to humic or organic acids. Phosphorus removal is variable.

A wetland is suitable on residential, commercial and industrial sites. It is appropriate in areas where soil permeability is moderate or moderately slow, and where the depth to an impermeable surface from the bottom of the wetland may be only a few feet. Wetlands are a good water quality facility choice in areas with high winter ground water levels.

Setbacks and Separation Distances

Setbacks and separation distances for wetlands are the same as those listed in section 3.4.1 for all ponds.

Design

Careful planning is needed to be sure sufficient water will be retained to sustain good wetland plant growth. Irrigation or another source of water input may be needed in the summer months to maintain the aquatic vegetation. Water loss by both infiltration and evapotranspiration are important design concerns.

Wetlands employ some of the same design features as wet ponds. However, instead of gravity settling being the dominant treatment process, pollutant removal mediated by aquatic vegetation and the microbial community assocated with the vegetation becomes the dominant treatment process. Rather than total water volume being the primary design criteria, factors which affect plant vigor and biomass are the primary concerns.

Stormwater treatment wetlands shall consist of two cells: a sediment forebay cell (section 3.2.5) and the wetland cell. Since wetlands are water quality BMPs, the design volume shall be water quality volume of 0.4 inch precipitation runoff from the total impervious surface draining to the wetland. A minimum 3:1 length-to-width ratio is recommended. Complex geometries are recommended with the goal of the longest flow path possible for the terrain.

Since wetland vegetation and function are difficult to restore if they become clogged with sediment, the sediment forebay should be designed to capture the majority of sediment and provide for easy removal of such sediment. The sediment forebay should be 4-8 ft deep with a minimum of 1 ft sediment storage. The sediment forebay should be about one-third the volume of the wetland.

A berm should separate the sediment forebay cell from the wetland pond cell. If the sediment forebay is at the same elevation as the pond , the berm may be submerged when the system is full from a storm event. On the other hand, if elevations allow and the sediment forebay is to function more as a detention basin and be drained slowly through the wetlands to provide extra water during the summer, the berm needs to be engineered to the requirements of a wet pond. Slopes for the berm should be no more and 3H:1V; the slope facing wetland might slope very gently to form part of the wetland floor.

Currently, there is no single accepted method for computing volume requirements for constructed wetlands. Total volume storage after a storm event may be designed to be up to 3.5 ft deep, with a 1 ft draw down within 24 hours so as not to drown out the aquatic vegetation. An overflow for all peak flows up to a 50-yr event should be provided no more than 3.5 ft above the bottom of the wetland.

The permanent pool area within the wetland should provide a residence time of at least 14 days and should have varying depths up to 2.5 ft. Ideally, the permanent pool should not be drained by an outlet, but rather through evapotranspiration and infiltration. Local infiltration and evapotranspiration data are essential to produce reliable results.

If the underlying soils are too permeable for the wetland to retain water, the wetland may need a low permeability liner. If a liner is used, a minimum of 2 ft of native soil amended with good topsoil or compost must be placed over the liner.

The wetland needs to include a slowly draining, i.e., shallower, portion in addition to the permanent pool. The slowly draining portion should release the design runoff volume over a period of at least 5 days, with no more than half the volume being released within 2.5 days. Many wetland plants can adapt to periods of summer drought, so a limited drought period is allowed in the wetland cell.

Table 9. Distribution of Water Depths in a Wetland Cell

Depth Range	Percent of Cell
0.1 to 1 feet	25-40%
1-2 feet	40-55%
2-2.5 feet	20%

If the wetland basin is constructed to detain stormwater from the 2.5 to 3.5 ft depth, this volume should be calculated and its disposition described as it is drained from the wetland basin over 24 hours. Similarly, if the 2.5 to 3.5 ft volume provides inadequate storage for the 50-year, 24-hour storm event, the disposition of any overflow water should be planned and an erosion resistant overflow outlet provided.

Bottom and side slopes of all wetlands shall be stabilized with vegetation, gravel, rock, or other acceptable material to control dust and prevent erosion.

Designs of wetlands are to take all practical safety precautions. For example, side slopes of evaporation ponds are not to exceed 3:1 slope.

Appropriate plant species must be established. It is recommended that the design should consider the Washington State Dept. of Ecology Restoring Wetlands in Washington, Pub. #93-17 as a guiding document. Similar documents are available.

For Your Information: Construction of a naturalistic design can be easily accomplished by first excavating the entire area to a 1.5 foot average depth. Then soil subsequently excavated to form deeper areas can be deposited to raise other areas until the distribution of depths indicated in the design is achieved.

Operation and Maintenance

Access and maintenance roads shall be designed and provided, particularly to the sediment forebay.

Facility operators should inspect wetlands at least once per year, preferably in the month of September or October when the wetland should be at it driest, and after each major storm event to check for leakage or overflow. Adequate monitoring must be provided to ensure that the aquatic vegetation has sufficient water to survive. Bottom contours and water depths should be checked. Vegetation species should be monitored to insure that the desired species are maintaining themselves and not be crowded out by undesireables. Nuisance plants should be removed. The condition of the overflow and metered release systems should be checked.

Facility operators can easily maintain the function of a wetland by keeping the sedimentation pond clean and functioning. The sedimentation pond should be cleaned at least once every 2 years. This maximizes the lifetime of wetland aquatic plants and biota for removing pollutants. In order to restore the wetland's capacity to absorb and treat pollutants, vegetation in the wetland may need to be harvested at some interval. Also, if the pond begins to fill with sediment so water depths are hard to maintain, the wetland may need to be cleaned. Any erosion or channel irregularities in the wetland, on the berms or on the facility banks should be repaired.

Figure 3.14 Dry Detention Pond

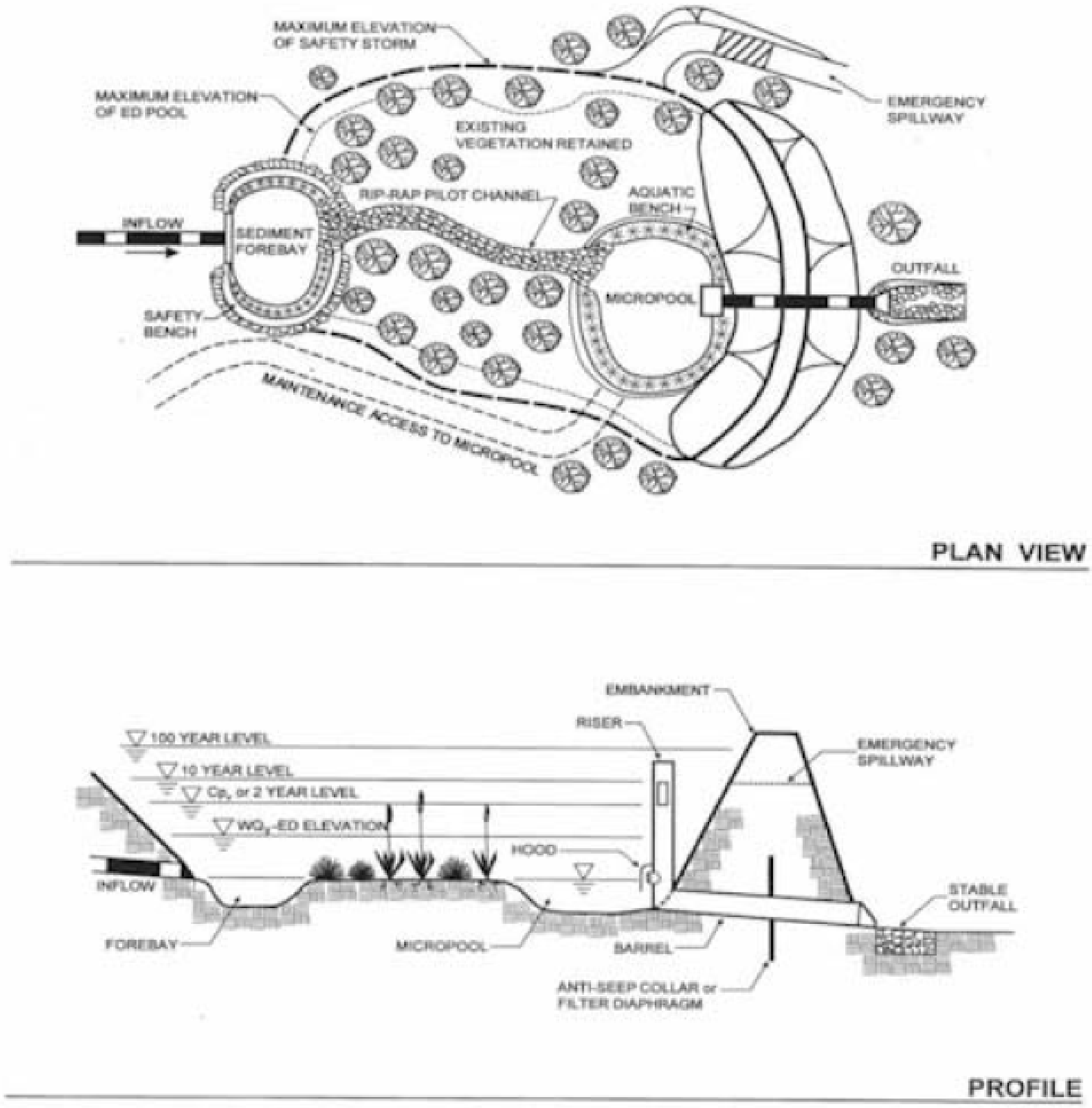


Figure 3.15 Wet Extended Detention Pond

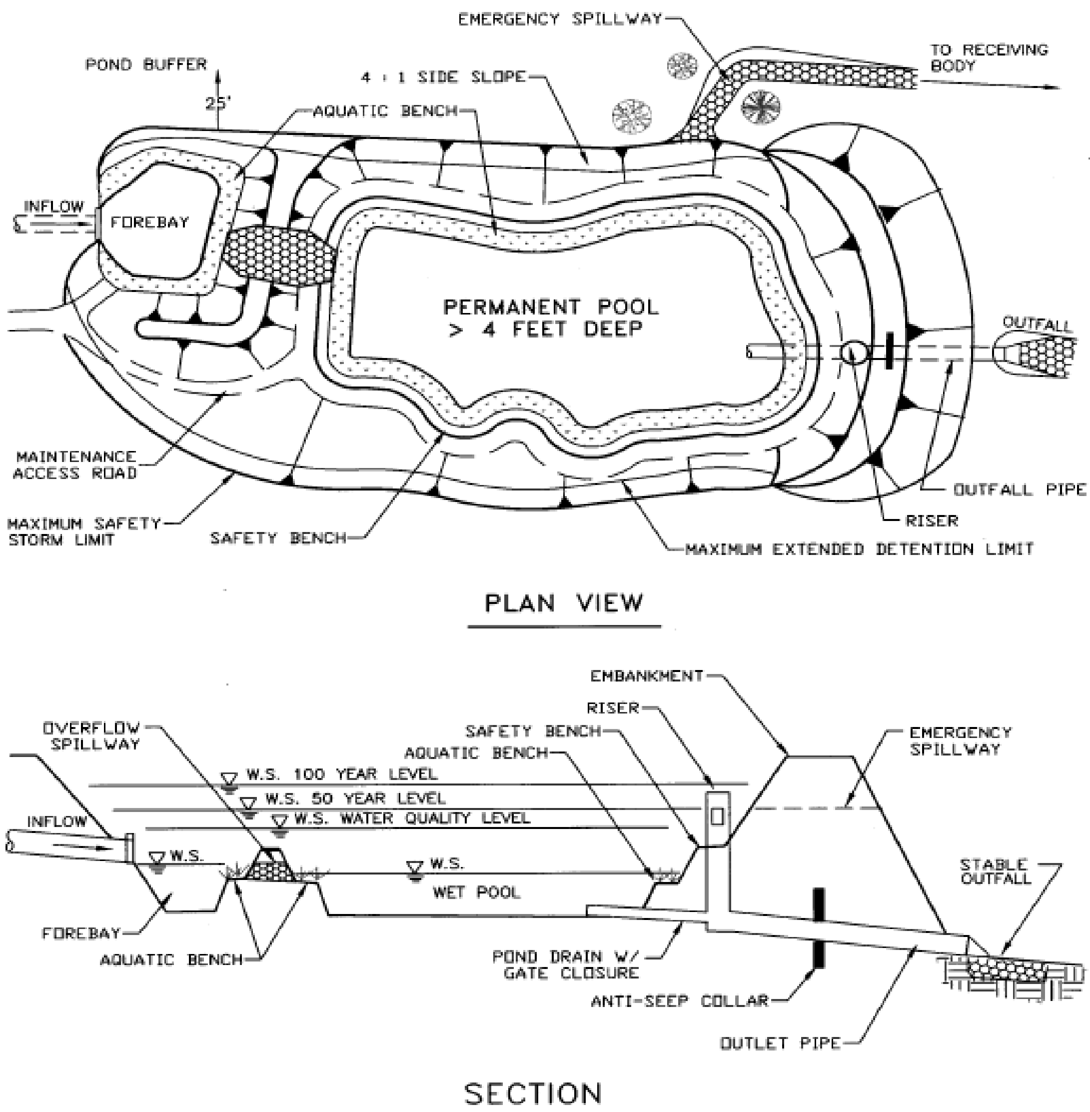
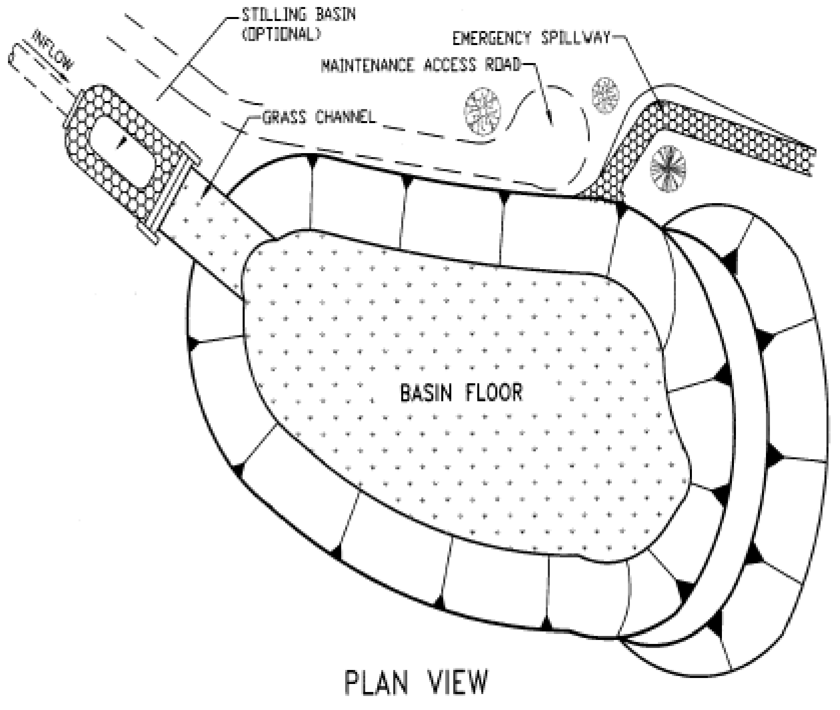


Figure 3.16 Evaporation Pond



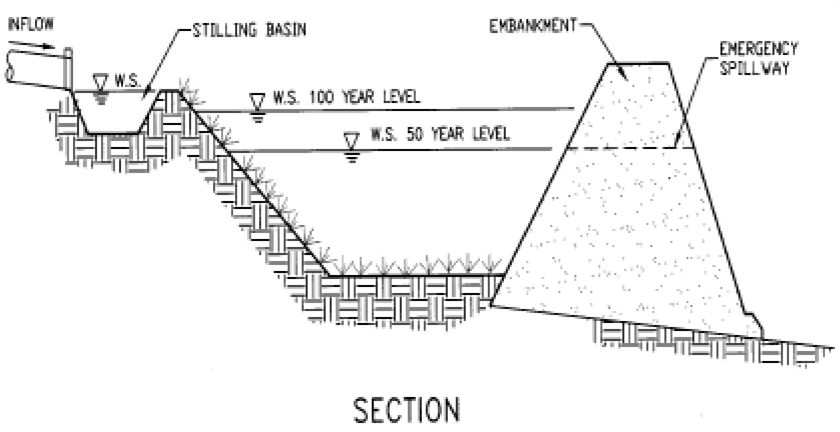
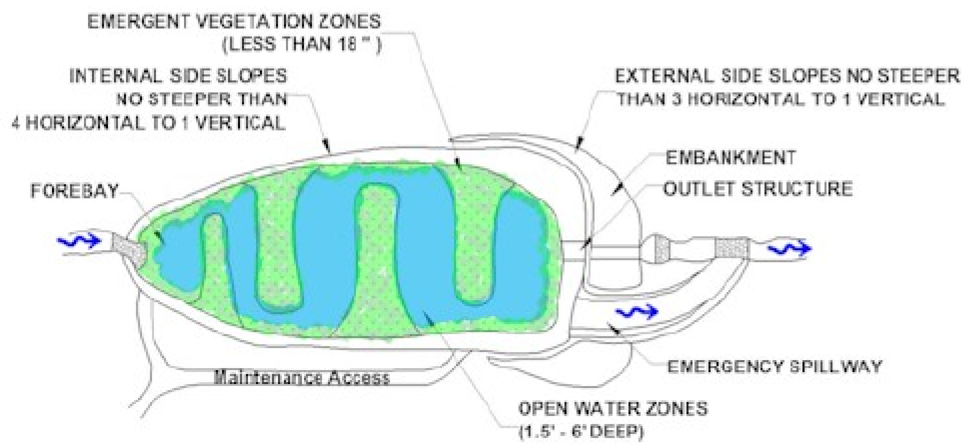
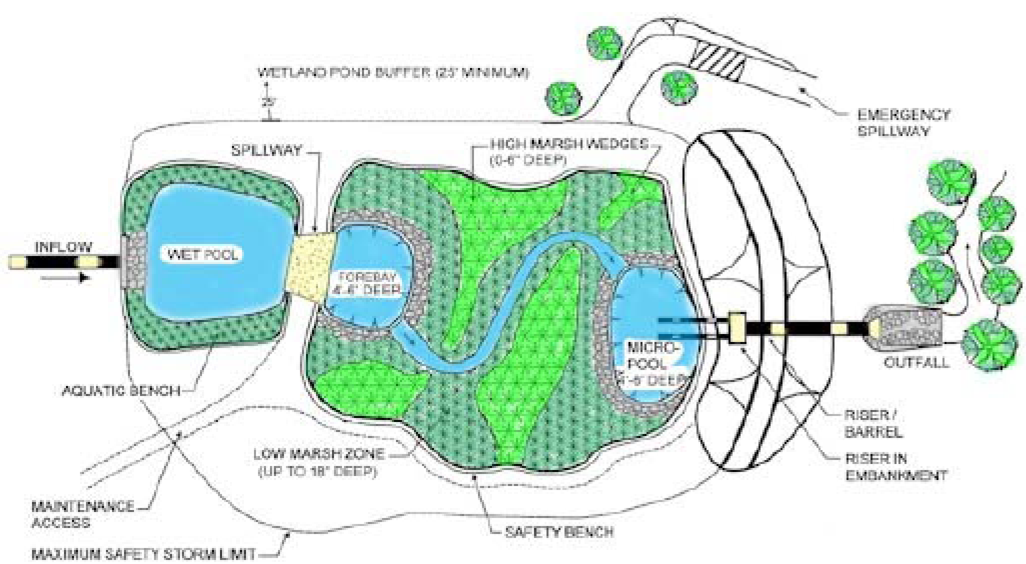


Figure 3.17 Wetlands

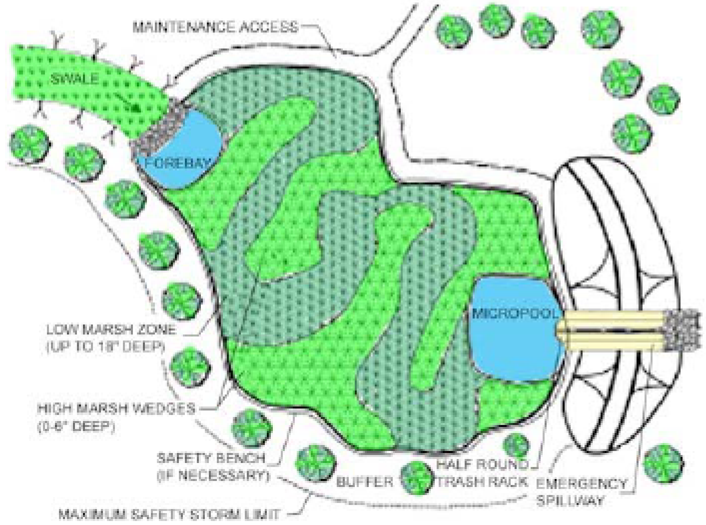
- **Alternating bands of deeper water and shallow marsh.**

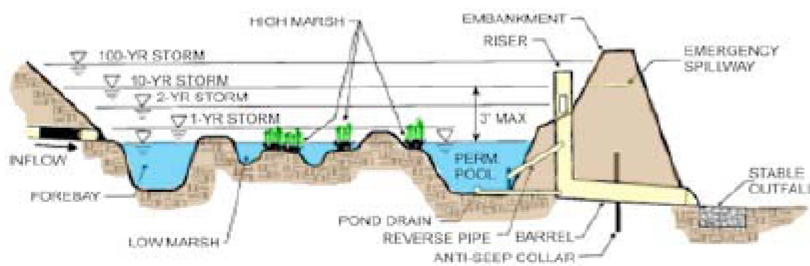


- **Wet Pond/Wetland System**



- Pocket Wetland





END OF TEXT -APPENDICES FOLLOW

Appendix A

DESIGN GUIDE
RESIDENTIAL STORMWATER INFILTRATION SYSTEMS

Introduction

This guide is designed to aid homeowners in designing, building, maintaining and documenting a residential stormwater infiltration system. For a complete reference on stormwater design, refer to Lewiston's *Stormwater Policy and Design Manual* available on the City's website or from the Public Works Division.

Remember: None of your stormwater should discharge to your neighbor's property without their express approval. It is downright unneighborly to do so. Control your stormwater on your property, and discharge it to an approved stormwater conveyance system if you cannot.

When is an infiltration system required? An infiltration system may be required if the total impervious surface created by new construction or reconstruction is over 2,000 square feet. In some cases, infiltration systems may be a requirement of a subdivision, in which case it will be a recorded requirement for your building lot. A properly designed, constructed, and maintained infiltration system is one of the most effective ways of managing runoff from residential areas and can enhance landscaping.

What is an infiltration system? Infiltration is the soaking of surface water into the ground. For Lewiston residences, the City suggests that you choose one of four recommended infiltration systems: a swale (including bioinfiltration swales), an infiltration trench, permeable paving, and/or a vegetated filter strip. Each is described in more detail below. As an alternative, you may choose any of the BMPs described in Lewiston's *Stormwater Policy and Design Manual.* Or you may design your own infiltration system. You may mix and match infiltration systems, depending on which fits better on your lot for different parts of your impermeable surfaces and your landscape design.

Who can design an infiltration system? A homeowner or a contractor may use this guidance to design a residential infiltration system. A professional may be necessary to help you verify the infiltration rate. This homeowners guide assumes that all residential sites in the City have an infiltration rate of at least 0.5 inches/hour. If you believe that the infiltration of the soils on your lot may be less, you may need professional guidance for determining the infiltration rate. For sites with proposed on-site sewage disposal systems, the same professional can design the stormwater infiltration system.

If I am unable to design a system using this guidance, what do I do? Contact a professional engineer licensed in the State of Idaho. They can help you design a system that meets the requirements of the Lewiston *Stormwater Policy and Design Manual*.

What is required to get a final inspection on my building permit? Final inspection and approval of construction requires approval of the stormwater infiltration system by the City's Engineering Department.

Driveway Runoff. The designer must consider runoff from the proposed driveway since driveways attach to City streets and are often sloped to discharge stormwater to the City street. Small portions of driveway runoff may be allowed to discharge to a City street, but in general, sufficient detail must be shown to demonstrate to the satisfaction of the City that most driveway runoff will be treated on site. The City must approve plans to discharge driveway runoff to the City system.

General Guidance

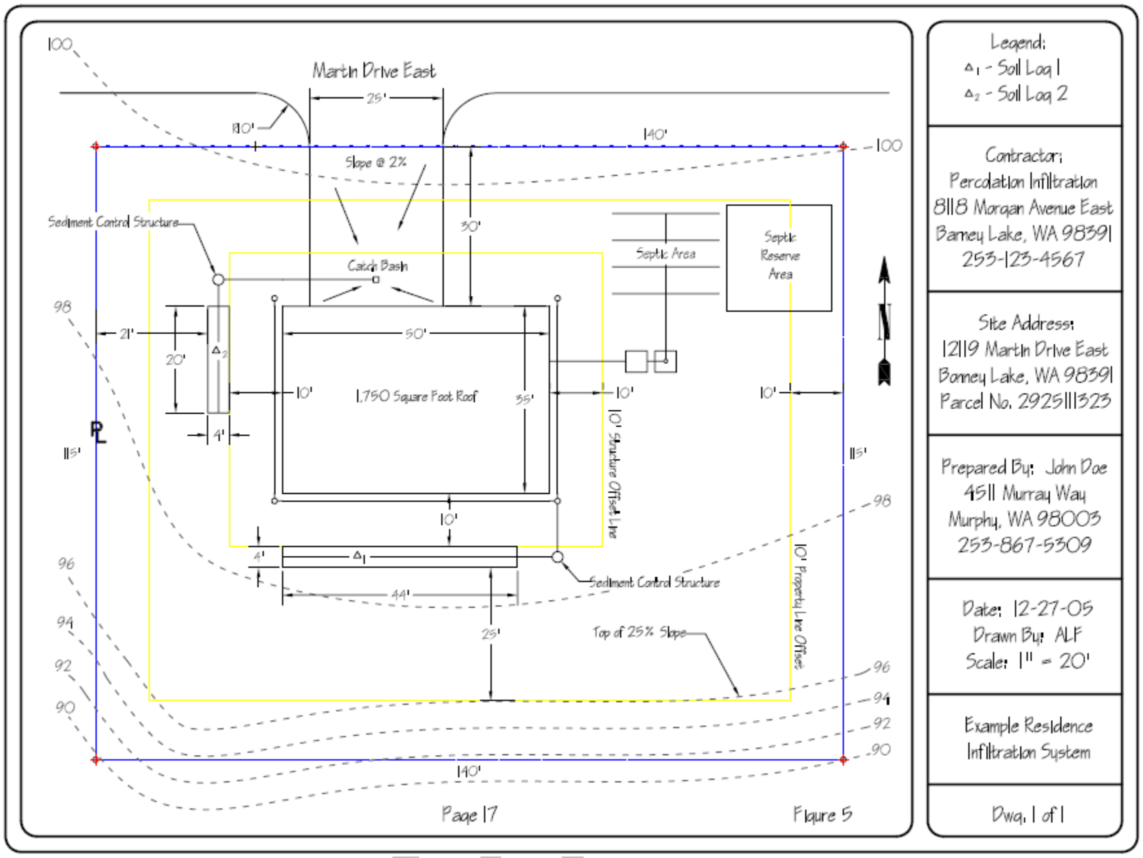
1. Start by preparing an accurate, to scale site plan of your property. Include the name, address, and telephone number of the person preparing the site plan. Show a north arrow, date, site address, property lines and dimensions, natural drainage channels, wetlands, gullies, wells and underground storage tanks. Show all easements, buffer areas and/or other areas where building activity is restricted. If possible, show elevation contour lines at 2-foot intervals. Draw a line offset 2 feet inside the property line. Use the easement line if your lot fronts a road or street. In some cases, you may be allowed to locate an infiltration system in a street right of way, but will need permission from the City to do so. Infiltration systems must be 10 feet minimum from any slope steeper than 25% and 2 feet minimum from any property line.

2. Draw a location of the house foot print on the site plan, including other existing and proposed structures and other impervious surfaces such as patios, driveways, garages, etc. Draw a line offset 10 feet from the house outline. Swales and infiltration trenches must be 10 feet minimum from any structure. Consider a larger distance from basements. They should be 20 feet from any structure on your neighbor's property.

3. Determine the number of square feet of the roof, driveway and other impervious surfaces. Use the horizontal area of your roof -- do not have to worry about the pitch of the roof. Use the roof area and not the floor area. They will be different on a multi-story house. Be sure to include the roof overhang in your impervious area measurement. Note on your map the areas (square feet) for the various parts of your impervious surfaces, and where or how their runoff will discharge to the rest of your lot.

4. The remaining area is available, minus the area needed for any on-site sewage disposal systems and reserve areas, for the infiltration system. If you are utilizing an on-site sewage system (septic system) you will have to coordinate the location of both systems. Swales and infiltration trenches must be located at least 10 feet from a septic drain field, reserve area, septic tank or pump chamber.

Figure A-1. Example Residential Site Plan.



5. **5.** Locate an area(s) for the infiltration system(s) on the site plan. It needs to be located down slope from the driveway and house so the stormwater drains to it. Infiltration trenches and swales should be oriented parallel to the contour lines. You may have different infiltration systems for different sections of your impervious surface, e.g., you might have a swale in the front yard for runoff from the front of the house and a lawn infiltration area in the back yard for runoff from the back of the house. Be sure to consider how a chosen infiltration system might fit into your landscaping design.

6. **6.** With your area of impervious surface(s), your lot configuration, and your landscaping design goals, choose and size the stormwater BMPs as described below.

Vegetated Filter Strip (Lawn) Requirements for Infiltration

Section 3.3.4 of the *Lewiston Stormwater Policy and Design Manual* presents the technical requirements for vegetated filter strips, which include lawns. In most residential stormwater management, lawns can and should play an important role. .

Both the Curve Number method and the hydrograph method described in the technical parts of this Stormwater Manual indicate that an area of lawn equal to the area of the impervious surface served should be able to infiltrate all the runoff of a first flush (0.4 inches). If the lawn area is increased to three times the area of impervious surface, the

Curve Number method indicates that the lawn will minimally infiltrate all the precipitation at the height of a 2-year event, i.e., 1.2 inches over 24 hours.

Vegetated Filter Strip, including Lawns

First Flush Requirements: 0.4 inches infiltrated

1) Infiltration rate > 0.5 inches per hour
2) One infiltration test for every 1,000 square feet of lawn claimed
3) A flow spreader so stormwater spreads over all the vegetated area claimed
4) Vegetated area equal to the area of impervious surface served

2-year, 24-hour Storm Requirements: 1.2 inches detained

1) Infiltration rate > 0.5 inches per hour
2) One infiltration test for every 1,000 square feet of lawn claimed
3) A flow spreader so stormwater spreads over all the vegetated area claimed
4) Vegetated area equal to three times the impervious surface served

Operations & Maintenance Plan Requirements: For residential sites, the City assumes that the owner will maintain the BMPs in a functional condition. An owner should periodically reconsider whether the BMPs are functioning properly.

The other major consideration for a lawn or vegetated filter strip to be an appropriate infiltration system is that a flow spreading device must be installed to spread flow from the impervious surface over the whole vegetated infiltration surface.

For a lawn to infiltrate stormwater at these rates, it must be in good shape and the soils under it cannot be compacted. The lawn needs to be relatively smooth and gently sloped.

Infiltration Swale/Bioinfiltration Swale Design

Sections 3.3.2 and 3.3.3 of the Lewiston Stormwater Policy and Design Manual presents the technical requirements for infiltration swales and bioinfiltration swales.

The volume storage requirements for infiltration swales have been in place for some time for residential development.

The minimum water quality volume (V) equation is:

$$\mathbf{V = A*P/12}$$

Where:

V = volume in cubic feet of storm water to be retained/infiltrated
A = area in square feet of impervious surface on the development site
P = precipitation inches (0.4 inch or 1.2 inch)

Stormwater Quality Volumes – Residential Only

When swales are used to treat all the storm water as per the volumes and areas designated for residential development in Table A-2, these swales will also treat all the storm water from a 2-year, 24-hour storm. The hydrograph with these results is presented in Appendix C.

This minimum retention volume is to improve water quality by capturing and retaining first flush in the storm water system.

Table A-2

RESIDENTIAL STORM WATER STORAGE REQUIREMENTS

Impervious Area (ft^2)	Storage Required (ft^3)
2,000	66
3,000	99
4,000	132
5,000	165
5,500	182
6,000	198
6,500	215
7,000	231
7,500	248
8,000	264
8,500	281
9,000	297
9,500	314
10,000	330
11,000	363
12,000	396
13,000	429
14,000	462
15,000	495
20,000	660
25,000	825
30,000	990

6" Deep Ditch Storage (ft^3)						
	Length (ft)					
Width (ft)	**50**	**100**	**150**	**200**	**250**	**300**
0.5	6	13	19	25	31	38
1	13	25	38	50	63	75
1.5	19	38	56	75	94	113
2	25	50	75	100	125	150
2.5	31	63	94	125	156	188
3	38	75	113	150	188	225
3.5	44	88	131	175	219	263
4	50	100	150	200	250	300
4.5	56	113	169	225	281	338
5	63	125	188	250	313	375

12" Deep Ditch Storage (ft^3)						
	Length (ft)					
Width (ft)	**50**	**100**	**150**	**200**	**250**	**300**
0.5	13	25	38	50	63	75
1	25	50	75	100	125	150
1.5	38	75	113	150	188	225
2	50	100	150	200	250	300
2.5	63	125	188	250	313	375
3	75	150	225	300	375	450
3.5	88	175	263	350	438	525
4	100	200	300	400	500	600
4.5	113	225	338	450	563	675
5	125	250	375	500	625	750

6" Deep Swale With 3:1 Side Slope Storage (ft^3)						
	Length (ft)					
Width (ft)	**10**	**20**	**30**	**40**	**50**	**60**
5	14	31	49	66	84	101
10	35	78	120	163	205	248
15	56	124	191	259	326	394
20	78	170	263	355	448	540
25	99	216	334	451	569	686
30	120	263	405	548	690	833
35	141	309	476	644	811	979
40	163	355	548	740	933	1125
45	184	401	619	836	1054	1271
50	205	448	690	933	1175	1418

12" Deep Swale With 3:1 Side Slope Storage (ft^3)						
	Length (ft)					
Width (ft)	**10**	**20**	**30**	**40**	**50**	**60**
5	39	81	124	166	209	251
10	85	178	270	363	455	548
15	131	274	416	559	701	844
20	178	370	563	755	948	1140
25	224	466	709	951	1194	1436
30	270	563	855	1148	1440	1733
35	316	659	1001	1344	1686	2029
40	363	755	1148	1540	1933	2325
45	409	851	1294	1736	2179	2621
50	455	948	1440	1933	2425	2918

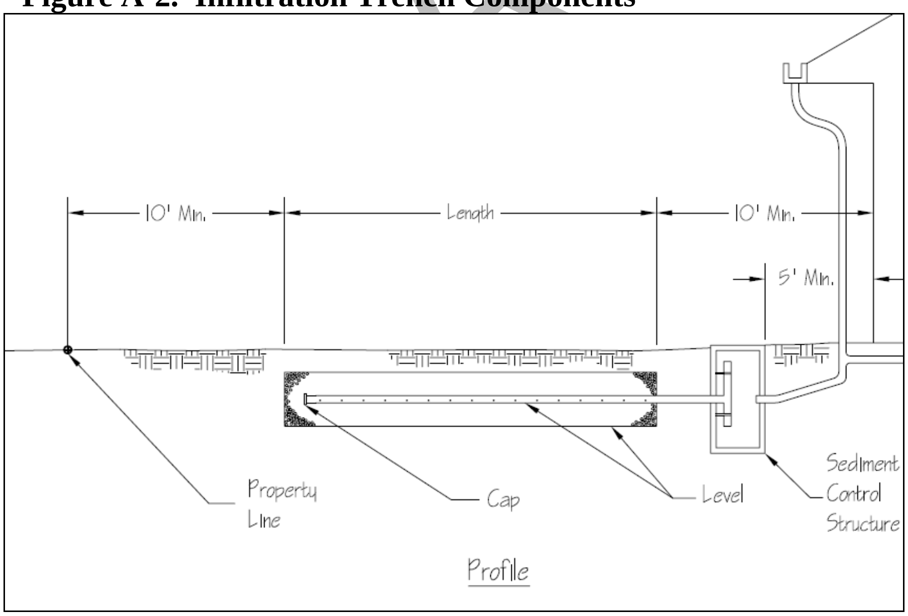
Infiltration Trench Design Procedure and Tips

Section 3.3.6 of the Lewiston Stormwater Policy and Design Manual presents the technical requirements for infiltration trenches. In most residential stormwater management, infiltration trenches may be underground or come to the surface and be capped by landscaping rock. Infiltration trenches function well for infiltration of stormwater from roof downspouts and from driveways.

An infiltration trench system is similar to the septic drain fields that are used to dispose of wastewater from a house. The system is composed of three elements: 1) a pipe that conveys runoff from downspouts and catch basing to a sediment control structure 2) the sediment control structure which filters out sediment and debris; and 3) a clean drain rock filled trench where the runoff percolates into the soil. The drain rock filled trench must be at least 20 feet from any building foundation.

Infiltration trenches are also known as seepage beds when the trench is wider than it is deep. Seepage beds are often placed under driveways, especially driveways with permeable pavement. Infiltration trenches can also be known as dry wells when the length and width are relatively equal. All serve the same function and you may design your infiltration trench/seepage bed/dry well to the dimensions that fit your site and needs.

Figure A-2. Infiltration Trench Components



Sizing an Infiltration Trench: Sizing an infiltration trench requires you to consider several variables: the infiltration rate of your soil (I); the volume of stormwater from your impermeable surfaces (V); the depth to a high water table, bedrock, or an impermeable layer; the area you have to work with, and the thickness of the drain rock bed you intend to install (D).

Step 1. Calculate the volume of water to be infiltrated (V). For the first flush (0.4 inches) V = Impervious Surface Area served times 0.033 (0.4 inches = 0.033 feet). For example, if you have 1,000 square feet of impervious surface planned to discharge into the trench, the volume of runoff is 1000 x 0.033 = 33.3 cubic feet.

For a 2-year, 24-hour storm (1.2 inches), the actual runoff is reduced by an amount determined by the Curve Number method (Appendix B). Taking this natural reduction in runoff into account, the volume (V) to be treated is the impervious surface area times 0.0825. Using the same example, the runoff from 1,000 square feet impervious surface is 1,000 x 0.0825 = 82.5 cubic feet.

Step 2. You must make a determination about the depth to bedrock or other impermeable layer. An infiltration trench will not work unless it has at least 18 inches of permeable soil material below the bottom of the trench. Many trenches in Lewiston have failed because the bottom of the trench was essentially right on top of bedrock or an impermeable soil layer. You can dig hole with a shovel, or you can use an auger. It is important that you get down 5 to 6 feet. Bedrock or a white calcium carbonate layer is a sign of trouble.

Step 3. Decide how thick you want your drain rock bed to be (D). Generally, the City recommends you use a trench 3 feet wide by 3.5 feet deep. The bottom of the trench must be located at least 18 inches above the seasonal high groundwater or impermeable layer, including bedrock. Generally you should have at least 6 inches of topsoil over the top of the drain rock, although it may be open to the surface with six inches of cobbles underlain by filter cloth. As an example, if your site has an impermeable layer at 5 feet below the surface, the maximum trench depth possible is 3.5 feet (6 inches cover + 3 gravel bed + 18 inches separation = 5 feet).

Step 4. Determine the correct trench size (square footage = A) using the following equation:

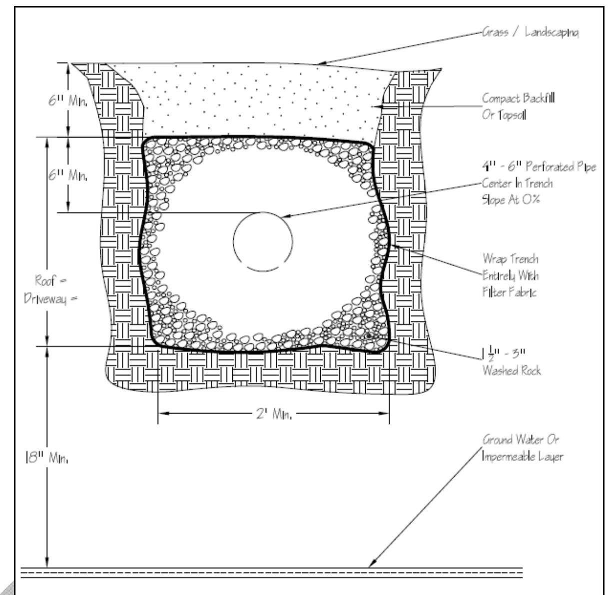
$$A = \frac{V}{0.35D + 2I}$$

Where: A = surface area of the trench in square feet
V = Volume of runoff from the impervious surface in cubic feet
D = Thickness of the drain rock bed in the trench in feet
I = Soil infiltration rate in inches/hour (assume 1 inch/hour)

Using the example above of 1,000 square feet impervious surface resulting in a volume V of 82.5 cubic feet, if one uses a 3 foot deep bed of clean gravel (D) and an infiltration rate of 1 inch per hour (I), the required surface area of the trench is 27 square feet.

Step 5. Select the trench dimensions. The City recommends gravel beds 3 feet wide by 3 feet but the trench dimension is one of personal choice. The amount of room available and ease of construction may be used in determining the best width for your site. Completing the example above, if the trench surface area must be 27 square feet, and you choose the recommended width of 3 feet, then the length of the trench would be 9 feet (27 divided by 3). You can make the required trench shorter by increasing its width, or the thickness of the gravel bed. However, if you decide to change the thickness of the gravel bed, you will need to redo the calculations from Step 3.

Figure A-3. Infiltration Trench Cross Section Detail



Complete the final site plan incorporating the infiltration system (length(s), width(s), and location(s) on site) and accompanying sediment control structures and tight lines. Sediment control structures cannot be located within 5 feet of any structure.

Table A-1 presents lengths of 3 foot by 3 foot trench needed for different areas of impervious surface

Table A-1. Infiltration trench lengths (ft) for different impervious surface areas for a trench 3 feet wide by 3 feet deep.

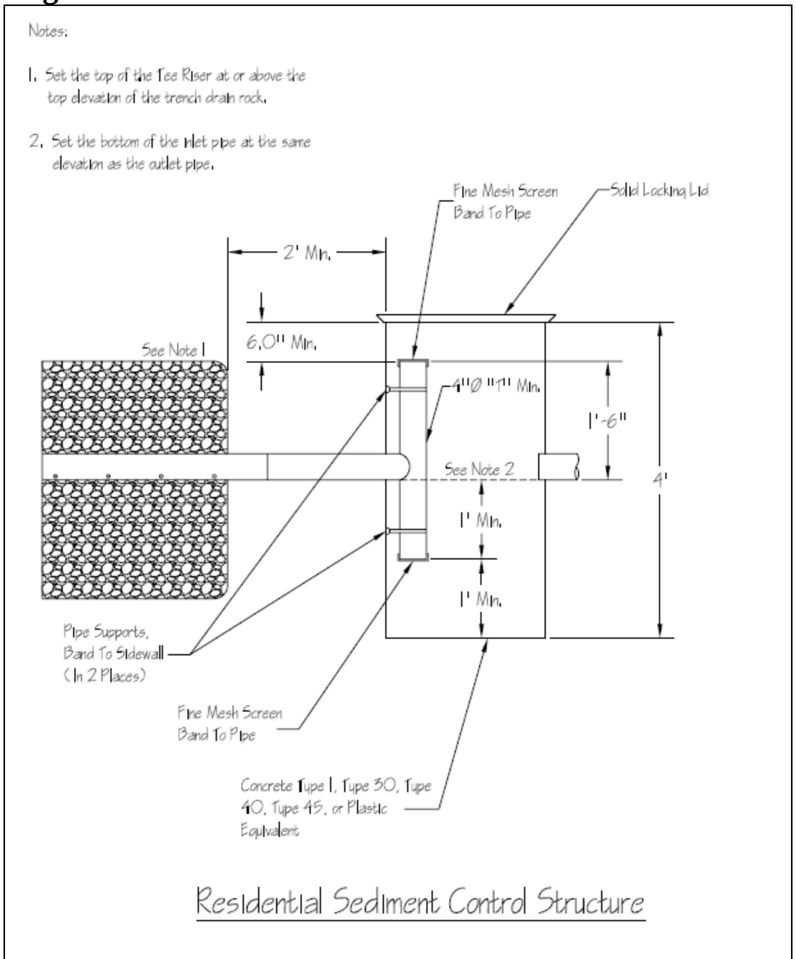
		Contributing Impervious Surface Area						
Infiltration Rate (in/hr)	Precipitation Event (in)	**500 (ft^2)**	**750 (ft^2)**	**1,000 (ft^2)**	**2,000 (ft^2)**	**3000 (ft^2)**	**4,000 (ft^2)**	**8,000 (ft^2)**
0.5*	0.4	2.7	4.0	5.4	10.7	16.1	21.5	42.9
0.5*	1.2	6.7	10.1	13.4	26.8	40.2	53.7	107.3
1.0	0.4	1.8	2.7	3.6	7.2	10.8	14.4	28.9
1.0	1.2	4.5	6.8	9.0	18.0	27.0	36.1	72.1
1.5	0.4	1.4	2.0	2.7	5.4	8.1	10.9	21.7
1.5	1.2	3.4	5.1	6.8	13.6	20.4	27.2	54.3
2.0	0.4	1.1	1.6	2.2	4.4	6.5	8.7	17.4
2.0	1.2	2.7	4.1	5.4	10.9	16.3	21.8	43.6
3.0	0.4	0.8	1.2	1.6	3.1	4.7	6.2	12.5
3.0	1.2	2.0	2.9	3.9	7.8	11.7	15.6	31.2
5.0	0.4	0.5	0.7	1.0	2.0	3.0	4.0	8.0
5.0	1.2	1.2	1.9	2.5	5.0	7.5	10.0	19.9
9.0	0.4	0.3	0.4	0.6	1.2	1.7	2.3	4.6
9.0	1.2	0.7	1.1	1.4	2.9	4.3	5.8	11.5

* Note: The City will assume an infiltration rate of 0.5 inches per hour if no specific infiltration rate test data are provided.

Infiltration Trench Sediment Control Structures

Sediment control structures are important for keeping debris out of the infiltration trench. The “T” with its screens keeps leaves, needles, twigs, roofing gravel, etc., from clogging the perforated pipe and/or the washed rock. Several different types of structures can be used. Generally, a concrete catch basin that has a depth of at least 4 feet is used. Some installations utilize a plastic structure. When choosing a concrete structure, consider using a Type 1, Type 30, Type 40 or a 24 inch diameter Type 45 catch basin. Plastic equivalents are acceptable. The inlet pipe (from the house) should be set at the same elevation as the outlet pipe. If the inlet is set above the outlet pipe, the in-flowing water will splash and cause turbulence. This may suspend sediment and cause the suspended sediment to be deposited in the perforated pipe or washed rock.

Figure A-4. Infiltration Trench Sediment Control Structure.



The Trench

Infiltration systems cannot be constructed in fill or severely compacted soils (an area that has been driven over repeatedly). Infiltration systems shall be a minimum of 25 feet from any slope steeper than 25%. Trench bottoms shall be a minimum of 18 inches above seasonal high groundwater or impermeable layer (hard pan or bedrock). The end of the trench must be located within 100 feet of the sediment control structure. If your calculations show a trench longer than 100 feet, you will need to split it into two separate trenches. You may want to include a cleanout port on the end of the perforated pipe so debris could be vacuumed out. All infiltration trenches must be located downstream of the sediment control structure. The drain rock shall be wrapped entirely with filter fabric. Geotextile fabric or roofing felt shall be placed on top of the drain rock prior to back filling.

Operation and Maintenance of an Infiltration Trench

If an infiltration trench is not properly maintained, it can fail after a few short years. When properly maintained, they can function for 20 to 50 years. The most important factor is to prevent anything other than clean water from entering the trench portion of the system. Leaves, needles, grass clippings, plastic bags, toys, oil/grease, mud, roofing gravel, etc. can clog a system and necessitate costly repairs or replacement of the system. The following is a list of hints to keep your system in good working order:

- Inspect the sediment control structure several times a year. The most important time is in the fall before the heavy rains of winter begin. If there is less than 6 inches of clearance between the debris and the bottom of the outlet tee, clean the sump. A wet/dry shop vacuum may be useful as a cleaning devise.
- Clean and inspect both screens. Replace corroded and/or damaged screens as necessary.
- Clean gutters several times a year. Do not flush debris into the system with a hose. Clean out gutters with a plastic scoop or shop vacuum.
- Sweep driveways with a broom several times a year. Do not flush debris into the system with a hose.

How to tell if your infiltration system is working properly

The simple answer is if you put water in, and it goes away, it's probably working. Listed below are several ways to troubleshoot the system if it is not working properly:

- Is water bubbling out of the connection where the downspout connects to the drain line? If it is, the screens may be clogged, the infiltration trench may be clogged, or a pipe may be plugged or broken. Check and clean the screens if necessary. If the screens are clean, check to see that the pipes from the downspout to the sediment control structure are clear. A plumber's "snake" or garden hose may be helpful to check and/or clean out the pipe.
- If you have a catch basin located in the driveway, is it backed up? Check to make sure the catch basin outlet is not clogged. Also check to make sure that the pipe from the catch basin or downspout to the sediment control structure is clear. Are the screens and pipe leading to the sediment control structure clean and clear? If possible, check the perforated pipe in the trench. Is it full of sediment and debris?
- If the system is not clogged, but the system will not drain, try digging a hole about 1 or 2 feet away from the edge of the trench, at about the midpoint. Dig it as deep as the infiltration trench. If it is full of water as you dig, you may have a high groundwater problem. Contact an engineer for further advice.

Permeable Paving and Gravel Driveways or Parking Areas

The City of Lewiston encourages the use of permeable paving and/or gravel driveways and parking lots to the maximum extent practicable on residential lots as a means to increase infiltration and reduce stormwater runoff. The difficult part for this set of BMPs is an assessment of their performance.

The design requirements for permeable pavement are discussed in Section 3.3.7 of this Stormwater Manual. The individual homeowner usually installs permeable paving as an architectural feature, rather than a stormwater management device. Different types of permeable paving have different infiltration rates, which need to be determined on an individual basis. Still, a seepage bed under permeable pavement can by used to infiltrate a substantial amount of stormwater from the rest of the property.

Gravel driveways and parking lots can also infiltrate significant amounts of stormwater. However, the infiltration rates from graveled surfaces can range from near zero when highly compacted with lots of soil, to high when the gravel layer is thick and kept clean under low traffic conditions. The primary concern for runoff from graveled areas during large storm events is that it often carries a high sediment load which needs to be captured and treated.

Generally, the City will assume a runoff rate from gravel surfaces calculated using the Curve Number (CN) Method (Appendix B), unless specific infiltration data are provided. This means that some additional storage and infiltration will be required in addition to the graveled driveway or parking lot if the system is going to meet either the 0.4 inch or 1.2 inch requirements. For example, a low berm around the graveled parking lot to increase the time the stormwater has to percolate into the soil would likely allow the system to meet the 1.2 inch requirements. Or flow from the graveled parking lot or driveway could be directed into a small swale. A bermed gravel parking lot can also be used to collect and infiltrate considerable stormwater from other areas, with up to 6 inches providing storage for infiltration over a couple of days with little or no damage to vehicles parked there.

Additional storage or treatment is needed for about 40% of the volume if the graveled surface is semi-permeable using the standard CN method. For the 0.4 inch retention level, storage will be needed for 0.16 inches runoff, and for the 1.2 inch detention and treatment level, detention and treatment will be needed for 0.43 inches of runoff.

Appendix B
Calculating Water Quality Volume, Maximum Runoff Volume, Peak Discharge Rate, and Water Quality Treatment Effectiveness

This document covers the basic steps to calculate the peak discharge rates from pre- and post-development conditions, the volume of storm water to be treated (detained/retained/infiltrated) onsite from specified storms, and the volume of storm water that needs to be treated on site for water quality purposes. The two preferred methods of calculation are the Natural Resources Conservation Service (NRCS) Curve Number (CN) Method for disturbance areas < 100 acres for runoff volume, and the Rational Method for disturbance areas < 100 acres for runoff rates. For area > 100 acres, the NRCS TR-55 Method or some other more robust model is recommended. Generally, the calculation method to be chosen depends on the goal, as follows:

A. Minimum Water Quality Volume treatment set at 0.4 inches. The 2-year, 1-hour storm, for all impervious surfaces.
B. Storage Volume for areas < 100 acres using the NRCS Curve Number Method for on-site storm water storage design;
C. Peak Discharge Rate for areas < 100 acres using the Rational Method for storm drain design:
D. Peak Discharge Rate for areas > 100 acres using the NRCS TR-55 Method for storm drain design:
E. Storage Volume for areas > 100acres using the NRCS TR-55 Method for on-site storm water storage design;
F. Water Quality treatment volume calculations.

Note: There are significant differences between the water quality volume calculated in section A below and total runoff volumes calculated in sections B and E. The water quality volume calculations simply determine the amount of stormwater that must be stored and treated from every storm – 0.4 inches from all impervious surfaces. Total runoff volume calculations relate design criteria to design storms and a set of BMPs. The minimum requirement is that the amount of precipitation from a 2-yr, 24-hour storm, i.e., 1.2 inches, must be captured and treated. Lewiston frequently has high intensity storms producing up to an inch of precipitation in less than an hour, or rain-on-snow-on frozen ground events such that infiltration may be limited. The design professional should design BMP systems to address the range of situations.

A <u>Minimum Storm Water Quality Volume for Retention/Infiltration</u>

A minimum of 0.4 inches, of stormwater retention/infiltration must be provided for all newly created impervious surfaces and redevelopment surfaces in excess of 1,000 square feet. This minimum storage and treatment of ‘first flush’ is a requirement necessary for the City to begin meeting the Idaho water quality standards and the City’s NPDES permit for storm water. The requirement for this volume storage as infiltration swales has been in place for some time for residential development.

The minimum water quality volume (V) equation is:

V = A*P/12

Where:

V = volume in cubic feet of storm water to be retained/infiltrated
A = area in square feet of impervious surface on the development site
P = precipitation inches (0.4 in)

This minimum retention volume is to improve water quality by capturing and retaining first flush in the storm water system.

B. Maximum Runoff Volume (NRCS Curve Number Method)

The NRCS Curve Number (CN) method is the recommended method for computing storage volumes for volume based storm water treatment BMPs.

The rainfall-runoff equation of the Curve Number Method relates a land area's runoff depth (R = storm water runoff depth) to the precipitation it receives and to its natural storage capacity. The amount of runoff from a given watershed is solved with the following set of equations:

$$R = \frac{(P - 0.2S)^2}{P + 0.8S}$$

$$S = \frac{1000}{CN} - 10$$

$$R = 0 \quad \text{when} \quad P < 0.2S$$

Where:

R = the actual direct runoff depth (storm water runoff depth) (inches)
P = the total rainfall depth over the area (inches) (1.2 inches for the 2-year, 24-hour design storm for Lewiston)
S = the potential abstraction or potential maximum natural detention over the area due to infiltration, storage, etc (inches)
CN = the runoff curve number (Table B-2)

The runoff depth (R) multiplied by contributing area results in the volume of storm water runoff. Units must be adjusted to result in cubic feet or the desired volume measure.

The set of equations above is a simplified version of the NRCS Curve Number Method with a number of assumptions. The design professional should read the following discussions of various factors to be sure that the assumptions are met. The above equations may need to be modified for specific design conditions. Further information is widely available on line, in references, and from the National Engineering Handbook – Section 4: Hydrology (NEH-4, SCS, 1985.

(1) Area Calculations (A)

(a) Calculations may be done on a soil by soil basis, land use by land use, or a composite of the drainage area. Area calculations will depend on the type of calculations to be done. A drainage area is often only a construction site, although storm water run-on needs to be accounted for in a design.
(b) Since the design storm for total volume (1.2 in/24-hr) does not produce any runoff under natural vegetation or good condition lawns, it is usually adequate to calculate the storm water volume from areas with decreased permeability, i.e., areas of impervious surfaces and areas of reduced permeability.
(c) For larger areas (> 10 acres), it is important to calculate areas for subbasins that have single drainage points, and that have relatively uniform drainage characteristics

(2) Precipitation (P)

(a) The design storm precipitation is 1.2 inches over 24 hours, the 2-year, 24-hour design storm event (see Chapter 2, Table 1).
(b) The water quality storm precipitation is 0.4 inches, the 2-year, 1-hour storm. All sites are required to retain this level of precipitation on-site.
(c) The City is amending the Stormwater Master Plan, which recommends using the 25-yr, 24-hr design storm, i.e., 2.2 inches. Experience in other cities indicates this results in excessive storage. Lewiston is adopting the 1.2 inch precipitation level but may have to raise the amount if this level of storm water storage proves insufficient and the flows continue to exceed system capacity.

(3) Determine the Curve Number (CN).

(a) Select the appropriate CN from Table B-2 for the land uses (cover types) and soils.
(b) The higher the CN, the higher the potential for runoff.
(c) Most soils on slopes < 30% in Lewiston are Soil Hydrologic Group B. The design professional should insure that this is true for a particular site. Soils maps and data are available from the NRCS on line.
(d) Composite CNs may be created by weighting each CN by its area
    i. $CN_{comp} = (CN_1*A_1 + CN_2 * A_2 + \ldots + CN_x * A_x) / A_{total}$
(e) A CN is an empirically derived runoff coefficient that reflects the relations among land use, soil type, vegetative cover, interception, infiltration, surface storage and runoff. Extrinsic factors that may have altered any of these characteristics should lead the design professional to carefully examine the CN selected.
    i. Soil compaction by equipment or other means
    ii. Any cutting or filling of soil material on the site
    iii. Previous construction on the site
    iv. Shallow soils to bedrock or a hardpan
(f) Any cutting that removes over a foot of topsoil or filling with material with different texture and porosity of the topsoil on a site leads to the requirement of an infiltration test (Appendix D) before a CN can be chosen. The CN should be that recommended in a soils report of the site. Since this also applies to the design of any infiltration BMPs that might be planned for a

disturbed site, the design professional should acquaint themselves with infiltration rates of all conditions on a site before beginning any plans.

(4) Calculate Potential Maximum Natural Detention (S)

(a) "S" is referred to as the potential abstraction factor, or the maximum natural detention factor, a factor for infiltration, storage, evaporation, and other losses from runoff.

(5) Conditions for R = 0

(a) If $P < 0.2 * S$, then R (runoff depth) is zero. Since S increases as CNs decrease, the conclusion is that there comes a point where infiltration and other losses to runoff for a selected rainfall become great enough that runoff is zero.

(b) For a 1.2 inch design rainfall, land uses and vegetative conditions with CNs less than 60 (Table B-2) would have zero runoff.

(6) Calculate Total Runoff Volume (V)

(a) Total runoff volume is calculated by multiplying the runoff depth (R) in inches by the surface area being considered, adjusting units to get the desired volume parameters.

Table B-2. Runoff Curve Numbers (CNs) for Selected Agricultural, Suburban, and Urban Areas

	CNs for hydrologic soil group			
Cover type and hydrologic condition	A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, landscaping, etc.)[1]				
Poor condition (grass cover <50% of the area)	68	79	86	89
Fair condition (grass cover on 50% to 75% of the area)	49	69	79	84
Good condition (grass cover on >75% of the area)	39	61	74	80
Impervious areas:				
Open water bodies: lakes, wetlands, ponds etc.	100	100	100	100
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	98	98	98	98
Porous pavers and permeable interlocking concrete (assumed as 85% impervious and 15% lawn)				
Fair lawn condition (weighted average CNs)	95	96	97	97
Gravel (including right-of-way)	76	85	89	91
Dirt (including right-of-way)	72	82	87	89
Pasture, grassland, or range-continuous forage for grazing				
Poor condition (ground cover <50% or heavily grazed with no mulch).	68	79	86	89
Fair condition (ground cover 50% to 75% and not heavily grazed)	49	69	79	84
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80
Cultivated agricultural lands				
Row Crops (good) e.g., corn, sugar beets, soy beans	64	75	82	85
Small Grain (good) e.g., wheat, barley, flax	60	72	80	84
Meadow (continuous grass, protected from grazing and generally mowed for hay)	30	58	71	78
Brush (brush-weed-grass mixture with brush the major element)				
Poor (<50% ground cover)	48	67	77	83
Fair (50% to 75% ground cover)	35	56	70	77
Good (>75% ground cover)	30[2]	48	65	73
Woods-grass combination (orchard or tree farm)[3]				
Poor	57	73	82	86
Fair	43	65	76	82
Good	32	58	72	79
Woods				
Poor (Forest litter, small trees, and brush destroyed by heavy grazing or regular burning	45	66	77	83
Fair (Woods are grazed but not burned, and some forest litter covers the soil)	36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil)	30	55	70	77

Herbaceous (mixture of grass, weeds, and low-growing brush, with brush the minor element)[4]			
Poor (<30% ground cover)	80	87	93
Fair (30% to 70% ground cover)	71	81	89
Good (>70% ground cover)	62	74	85
Sagebrush with grass understory[4]			
Poor (<30% ground cover)	67	80	85
Fair (30% to 70% ground cover)	51	63	70
Good (>70% ground cover)	35	47	55
For a more detailed and complete description of land use curve numbers refer to chapter two (2) of the Soil Conservation Service's Technical Release No. 55 , (210-VI-TR-55, Second Ed., June 1986).			

[1] Composite CNs may be computed for other combinations of open space cover type.
[2] Actual curve number is less than 30; use CN = 30 for runoff computations.
[3] CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.
[4] Curve numbers have not been developed for group A soils.
[5.] Table derived from Stormwater Management Manual for Eastern Washington.

C Peak Discharge Rate (Rational Method)

The Rational Method is the preferred method for computing peak runoff rates for flow based runoff treatment BMPS such as biofiltration swales, oil/water separators, and conveyance systems. For conveyance systems, many of the sizes are already determined in the Lewiston Stormwater Master Plan. In addition, the City has determined that the minimum storm drain pipe diameter is 12 inches for any storm water drains that will become part of the City's system. The Rational Method should only be used for areas less than 100 acres.

(calculate for pre- and post-development)

$$Q_p = CIA$$

Where:

A = contributing area (acres)
C = dimensionless runoff coefficient (Tables B-3 & B-4)
Tc = time of concentration (minutes)
I = average rainfall intensity (in/hr) for a duration equal to the time of concentration and for the recurrence interval chosen for design
Q_p = peak discharge

(1) Calculate the site area (A).

(a) Use USGS topographic maps, site visits, GIS, and other available information.

(2) Determine the runoff coefficient (C).

(a) This value is obtained from Table B-3 based on pre-development and post-development conditions. For mixed surfaces, determine a weighted coefficient using the following formula:

$$C = [(C1 * A1) + (C2 * A2) \ldots + (Cn * An)]/A$$

(3) Calculate the time of concentration in minutes (Tc).

(a) This is the time required for the surface runoff to flow from the most hydraulically remote part of the drainage basin to the location for which the flow rate is being calculated. The length of this pathway must be determined.

(b) The time of concentration (minutes) over a duration equal to the time of concentration for the contributing area can be estimated using the surface flow time curve (Figure 2) in Appendix C

(c) If the runoff pathway passes through several different types of ground covers and conveyance systems, flow segments, travel time Tt should be calculated for each flow segment and summed by using Appendix C Figure 2 several times, or using the following set of equations.

i. (Tc) = Tt1 +Tt2 +… + Ttn

ii. $Tt = L / (k * (S)^{0.5})$ or $Tt = L^{1.5} / (k * (dH)^{0.5})$

Where:

Tc = Time of concentration (minutes)

Tt = Travel time of flow segment (minutes)

L = Length of segment (feet)

k = Ground cover coefficient from Table B-5

S = Slope of segment (feet/feet)

dH = Change in elevation of segment (feet)

(4) Determine the average rainfall intensity (I).

(a) This value obtained from the intensity-duration-frequency curves found in Figure 1, Appendix C based on the time of concentration (Tc) from step (3).

(b) .This value may be calculated by the equation $I = m/(Tc)^n$ where m and n for a 10-year event are 8.24 and 0.635, respectively.

(5) Calculate the peak discharge (Qp).

(a) $Q_p = (C) * (i) * (A)$

(b) Calculate pre-development Q_p.

(c) Calculate post-development Q_p

(6) Calculate the difference between pre- and post-development flow rates.

Table B-3. Recommended "C" Coefficients for the Rational Method

Description of Runoff Area	Runoff Coefficient "C"
Impervious Surfaces	
Streets, Asphalt, Concrete, Walks	0.90 -0.95
Roofs	0.90 -0.95
Business	
Central Business Area	0.70-0.95
District and Local Areas	0.50-0.70
Residential	
Single Family	0.35-0.45
Multi-Family Detached	0.40-0.60
Multi-Family Attached	0.60-0.75
Residential Lot > 0.5 acre	0.25-0.40
Industrial and Commercial	0.50-0.80

Parks and Cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad Yard Areas	0.20-0.40
Unimproved Areas	0.10-0.30
Generally Accepted for Lewiston	0.20
Landscaped Areas	0.20

Table B-4. Recommended "C" Values for Soil Hydrologic Groups, Well-Vegetated Conditions i.e., Pervious Surfaces, Different Slopes.

Slope	**Percent**	**A Soils**	**B Soils**	**C Soils**	**D Soils**
Flat	0-2%	0.04	0.07	0.11	0.15
Average	2-6%	0.09	0.12	0.15	0.20
Steep	>6%	0.13	0.18	0.23	0.28

Table B-5. Values of Ground Cover Coefficient k.

Cover or Channel Type	Size	K
Forest with heavy ground cover		150
Minimum tillage cultivation		280
Short pasture grass or lawn		420
Nearly bare ground		600
Small roadside ditch w/ grass		900
Paved area		1,200
Gutter flow	4 in. deep	1,500
	6 in. deep	2,400
	8 in. deep	3,100
Storm sewer	12 in. diameter	3,000
	18 in. diameter	3,900
	24 in. diameter	4,700
Open channel flow (n = 0.40)	1 ft. deep	1,100
In a narrow channel (w/d = 1)	2 ft. deep	1,800
	4 ft. deep	2,800
Open channel flow (n = 0.40)	1 ft. deep	2,000
In a wide channel (w/d = 9)	2 ft. deep	3,100
	4 ft. deep	5,000

Source: WSDOT Hydraulics Manual, January 1997

D. Peak Discharge Rate (TR-55 Method)

Calculate Peak Discharge Rate (Qp) for the site.

(a) Q_p = (Qu) * (A) * (R) * (Fp)

(b) Calculate pre-development and post development Q_p.

Use the following steps, where:

A = contributing drainage area to site
CN = curve number
Tc = time of concentration
P = rainfall from specified event
Ia = initial abstraction
Qu = unit peak discharge
R = site runoff
Fp = pond and wetland adjustment factor
Qp = peak discharge

(1) Calculate the contributing drainage area to site (A).
(a) Use topographic maps, GIS, site visits, and other available information.

(2) Calculate the Runoff Curve Number (CN).
(a) Use NRCS maps and site visits to determine soils and land uses (cover types) within development area and surrounding watershed.
(b) Determine the Hydrologic Soils Group for soils identified in (a).
(c) Determine land use, cover type, treatment, hydrologic condition, % impervious, and % connected/unconnected impervious area ratio.
(d) Develop a composite land use and Hydrologic Soil Group map from the information in (a)-(c).
(e) Select CNs from Table 2.
(f) Compute a weighted CN for the entire drainage area.

(3) Calculate the site Time of concentration (Tc).
(a) Determine sheet flow, shallow concentrated flow and channel flow from the most hydraulically distant point in the drainage area to the drainage discharge point at the boundary site.

(4) Determine rainfall distribution type:
(a) Use Type II for Idaho.

(5) Determine percentage of ponds and wetlands in the drainage area:
(a) Measure from USGS topographic sheet.

(6) Select design frequency storms to be evaluated.

(7) Determine the 24-hour site rainfall amounts (P) for each design storm.
(a) Use NOAA Atlas II or Table 1.

(8) Determine Initial Abstraction (Ia). Initial abstraction is a representation of interception, initial infiltration, surface depression storage, and evapo-transpiration.
(a) This value obtained from TR-55 chart based on the site's composite CN.

(9) Calculate the Ia/P ratio.

(10) Determine the Unit Peak Discharge (Qu).
(a) This value obtained from TR-55 chart based on the Ia/P ratio and the Tc.

(11) Determine the site runoff (R).

(a) This value obtained from TR-55 chart based on the CN and the rainfall P.

(12) Determine the Pond and Wetland Adjustment Factor (Fp).

(a) This value obtained from TR-55 chart based on percentage of ponds and wetlands.

(13) Calculate the final Peak Discharge Rate (Qp) for the site.

(a) Q_p = (Qu) * (A) * (R) * (Fp)

(b) Calculate pre-development and post development Q_p.

E. Volume to Store On-Site for Control of Peak Discharge Rates (TR-55 Method)

Qo = peak outflow from detention system
Qi = peak inflow to detention system
Vs= volume of storage for detention system
V_r= volume of runoff

(1) Calculate the contributing drainage area (A).

(a) Use value from (D1) above.

(2) Determine rainfall distribution type.

(a) Use Type II for Idaho.

(3) Select design frequency storms to be evaluated.

(4) Determine the peak inflow (Qi) into the water quantity facility (BMP).

(a) This value is typically the post-development peak discharge rate (Q_p) from (D13) above.

(5) Determine the peak outflow (Qo) from the water quantity facility (BMP).

(a) This value is the pre-development peak discharge (Q_p) from (D13) above.

(6) Calculate the outflow to inflow ratio (Qo/Qi).

(a) This curve value obtained from the TR-55 graph/chart (Appendix C) based on the Qo/Qi ratio and the rainfall distribution type. The Vs/Vr ratio will typically be a value between 0.1 and 0.6.

(7) Find the volume of storage to volume of runoff (Vs/Vr) ratio.

(a) This curve value is obtained from the TR-55 graph/chart (Appendix C, Figure 3) based on the Qo/Qi ratio and the rainfall distribution type. The Vs/Vr ratio will typically be a value between 0.1 and 0.6.

(8) Determine the site runoff (R).

(a) Use value from (D11) above.

(9) Calculate the runoff volume (V_r).

(a) V_r = (R)* (A)

(10) Calculate the storage volume (Vs) to be allocated for the water quantity facility (BMP).

(a) This is the volume that must be stored onsite to maintain the peak discharge rates from the specified frequency storm events.

(b) Vs = (Vr) * (Vs/Vr) [Vs/Vr from (E7) above].

(11) Repeat steps (4)-(10) to determine the required storage volumes for other required design storm frequencies identified in step (3).

NOTE: Outlets from detention facilities must be designed to replicate pre-development discharge conditions for all storm events. This may require evaluating additional storm events to properly design pond outlets.

F. WATER QUALITY VOLUME TREATMENT

When surface storm water management BMPs are used, they must be designed to treat the Water Quality Volume (V_{wq}). The performance standard for treatment is removal of 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that the performance standard for surface management BMPs is met when:

(a) Suitable nonstructural practices such as parking lot sweeping for source control and pollution prevention are implemented;
(b) Storm water management best management practices (BMPs) are sized to capture the V_{wq} or treat the water quality design flow; and
(c) Storm water management BMPs are maintained as designed.

NOTE: The application of this standard has been simplified to estimate a site's annual TSS load for compliance with this standard. The calculations have been set up so that every site's annual TSS load entering the first BMP in the system is 1 (i.e. 100%).

(1) For each drainage area, list the storm water BMPs and their order in the engineered system, beginning with the first BMP collecting storm water from the site. For example, pretreatment and conveyance BMPs will typically precede the pollutant removal BMPs. For each drainage area, list the BMPs and their respective order with their estimated TSS removal rates.
(2) The TSS removal rates are not additive from one BMP to the next, instead the estimated removal rates must be applied consecutively as the TSS load passes through each BMP technology. For the purposes of this calculation, represent the estimated annual TSS load as 1.00 (i.e., 100%).
(3) For each drainage area, apply the BMP estimated removal rate in the order in which they occur in the storm water system. The equation for this calculation is:

Final TSS Removal Rate = (TSS Average Annual Load * BMP 1 Removal Rate) + (Remaining TSS Load After Preceding BMP * BMP 2 Removal Rate) + (Remaining TSS After Preceding BMP * BMP 3 Removal Rate).

(4) After all of the BMPs in the initial storm water system design have been accounted for and their estimated removal rates applied, the Final TSS Removal Rate for each drainage area should be equal to or better than 80% (0.80) or the sliding scale standard, where applicable. If the Final TSS

Removal Rate is lower than the Standard for any of the drainage areas, the system should be redesigned in order to meet the Standards.

Note: It is imperative to compute the Final TSS Removal Rates for each individual drainage area. Rooftops, if serviced solely by their own BMPs, such as swales, should be considered a separate drainage system.

WATER QUALITY VOLUME CALCULATED FROM THE PEAK RUNOFF RATE

The volume for the water quality design storm can be calculated using the same steps used for the water quantity storm and substituting the applicable recurrence interval when selecting the value for the average rainfall intensity.

Water Quality Volume -- Rational Method

$$\mathbf{V_{wq} = CiTA,}$$

where V_{wq} = water quality volume
C = runoff coefficient for impervious surfaces
i = storm intensity = 0.4 inches/hr = 0.0333 ft/hr
T = storm duration = 1 hour
A = total impervious area (ft^2)

OR $$\mathbf{V_{wq} = (C) * (0.0333\ ft/hr) * (1hr) * A = C * (0.0333\ ft) * A}$$

Water Quality Volume -- Curve Number Method

CN = curve number
A = site development area
P = rainfall from specified event
R = site runoff

1) **Calculate the contributing drainage area to site (A).**
   a) Use topographic maps, GIS, site visits, and other available information.
2) **Select water quality design storm.**
   a) For this value, P= 0.4 inches or 0.03333 feet.
3) **Calculate Site Runoff (R) as in Section B above.**

4) **Determine V_{wq}**
   a) V_{wq} = R * A

Appendix C

Reference Graphs and Tables

Figure 1. Rainfall Intensity, Duration, and Frequency Relationship

Appendix C

Hydrologic/Hydraulic Graphs

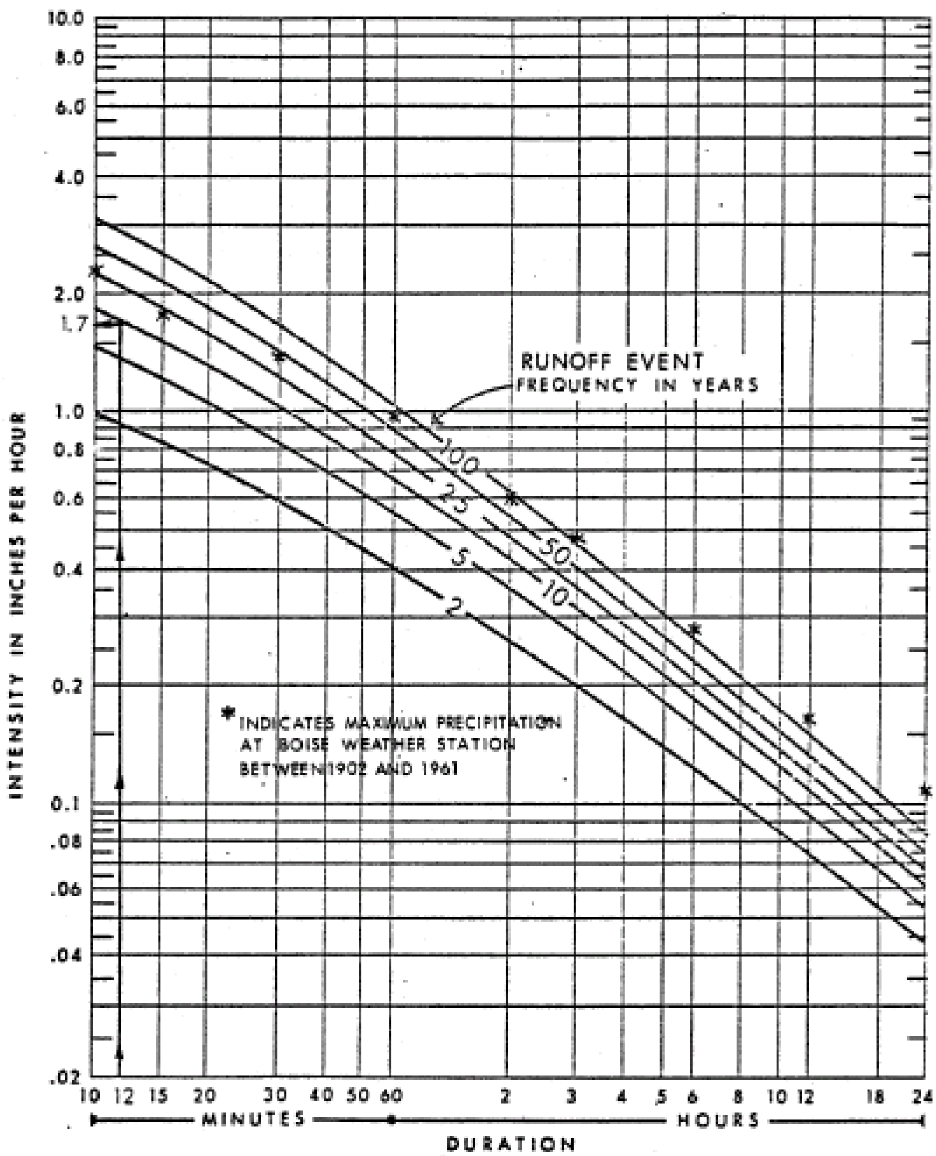


Figure 1.
Rainfall Intensity, Duration and Frequency Relationship

Figure 2. Surface Flow Time Curves

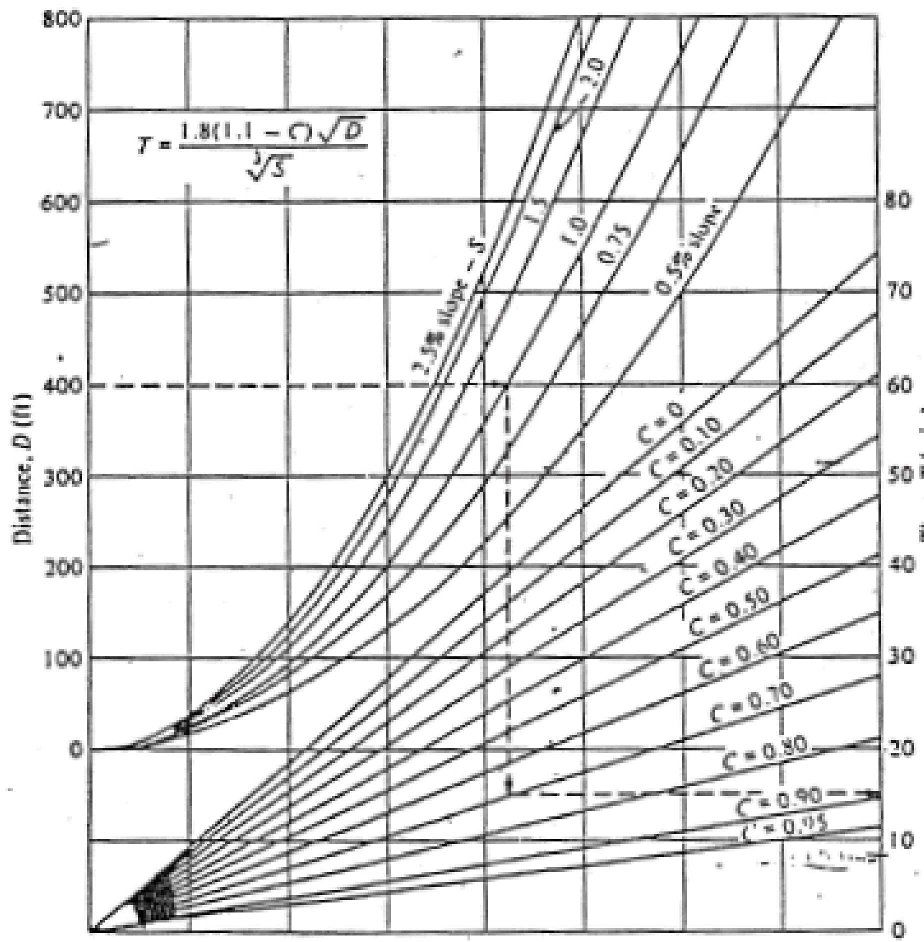


Figure 2.
Surface Flow Time Curves

Figure C-3. Approximate detention basin routing for rainfall types, I, IA, II, and III

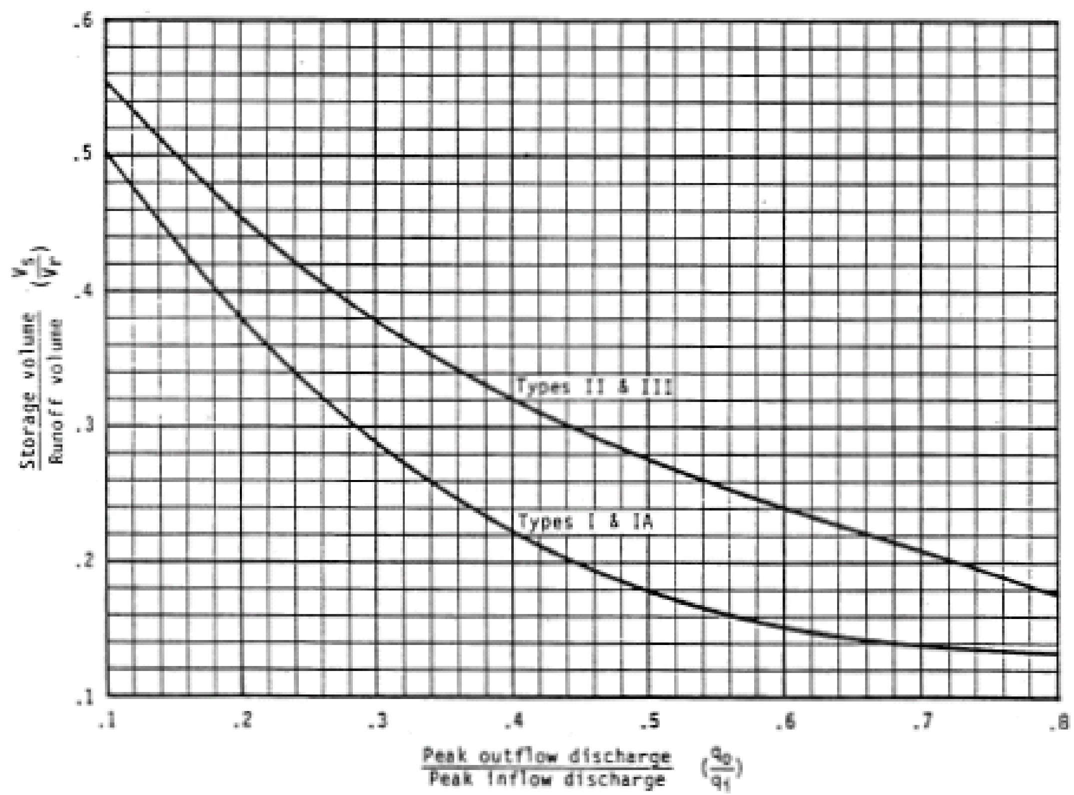


Figure 3.
Approximate detention basin routing for rainfall types I, IA, II, and III

Table C-1. 2-year, 24-hour hydrograph with bioinfiltration calculations for 10,000 ft^2 impervious area.

Time	Incremental Rainfall	Cumulative Rainfall	2yr 24hr	2-yr CN	Imperv	Imperv	Swale	Swale	totalH20	Infiltrat	Infiltrat	Storage
(hours)			1.2 in	.99 in	area	runoff	size	ppt	input	rate soil	vol	vol
			in	in	ft^2	ft^3	ft^2	ft^3	ft^3	1in/hr(ft/hr)	ft^3	ft^3
0	0	0	0	0	10000	0.0000	330	0	0.0000	0.08	26.4	0
1	0.0140	0.0140	0.0168	0.01386	10000	11.5500	330	0.462	12.0120	0.08	26.4	0
2	0.0220	0.0360	0.0264	0.02178	10000	18.1500	330	0.726	18.8760	0.08	26.4	0
3	0.0270	0.0630	0.0324	0.02673	10000	22.2750	330	0.891	23.1660	0.08	26.4	0
4	0.0310	0.0940	0.0372	0.03069	10000	25.5750	330	1.023	26.5980	0.08	26.4	0.198
5	0.0357	0.1297	0.04284	0.035343	10000	29.4525	330	1.1781	30.6306	0.08	26.4	4.2306
6	0.0511	0.1808	0.06132	0.050589	10000	42.1575	330	1.6863	43.8438	0.08	26.4	17.4438
7	0.0640	0.2448	0.0768	0.06336	10000	52.8000	330	2.112	54.9120	0.08	26.4	28.512
8	0.0849	0.3297	0.10188	0.084051	10000	70.0425	330	2.8017	72.8442	0.08	26.4	46.4442
9	0.1555	0.4852	0.1866	0.153945	10000	128.2875	330	5.1315	133.4190	0.08	26.4	107.019
10	0.0929	0.5781	0.11148	0.091971	10000	76.6425	330	3.0657	79.7082	0.08	26.4	53.3082
11	0.0720	0.6501	0.0864	0.07128	10000	59.4000	330	2.376	61.7760	0.08	26.4	35.376
12	0.0620	0.7121	0.0744	0.06138	10000	51.1500	330	2.046	53.1960	0.08	26.4	26.796
13	0.0471	0.7592	0.05652	0.046629	10000	38.8575	330	1.5543	40.4118	0.08	26.4	14.0118
14	0.0358	0.7950	0.04296	0.035442	10000	29.5350	330	1.1814	30.7164	0.08	26.4	4.3164
15	0.0282	0.8232	0.03384	0.027918	10000	23.2650	330	0.9306	24.1956	0.08	26.4	0
16	0.0239	0.8471	0.02868	0.023661	10000	19.7175	330	0.7887	20.5062	0.08	26.4	0
17	0.0215	0.8686	0.0258	0.021285	10000	17.7375	330	0.7095	18.4470	0.08	26.4	0
18	0.0206	0.8892	0.02472	0.020394	10000	16.9950	330	0.6798	17.6748	0.08	26.4	0
19	0.0209	0.9101	0.02508	0.020691	10000	17.2425	330	0.6897	17.9322	0.08	26.4	0
20	0.0209	0.9310	0.02508	0.020691	10000	17.2425	330	0.6897	17.9322	0.08	26.4	0
21	0.0202	0.9512	0.02424	0.019998	10000	16.6650	330	0.6666	17.3316	0.08	26.4	0
22	0.0190	0.9702	0.0228	0.01881	10000	15.6750	330	0.627	16.3020	0.08	26.4	0
23	0.0170	0.9872	0.0204	0.01683	10000	14.0250	330	0.561	14.5860	0.08	26.4	0
24	0.0128	1.0000	0.01536	0.012672	10000	10.5600	330	0.4224	10.9824	0.08	26.4	0
			1.2	0.99	Totals	825					**Total**	**337.656**

Discussion of Table C-1

1. Derived from the Stormwater Management Manual for Eastern Washingington: Regional Storm Hyetograph Values for the Central Basin region. The Table can be entered in a spreadsheet and used to calculate needed volume of bioinfiltration for any impervious area. The spreadsheet can be supplied by the City's Storm Water Program Coordinator.

2. The Eastern Washington Manual hyetograph gives time by one-half hour increments. This table accumulates two half hour increments into one-hour increments, shown in Time column. "Time", "Incremental Rainfall" and "Cumulative Rainfall" are the hyetograph. They show a unitless distribution pattern of rainfall over a 24-hour period

3. The hyetograph is converted to a design storm hydrograph for a particular area by multiplying in the actual rainfall. The "2 yr 24 hr" column shows the hydrograph for the 1.2 inch design storm. The column "2 yr CN" shows the hydrograph for that storm reduced to 0.99 inch based on the NRCS Curve Number Method calculations from Appendix B. This assumes the runoff depth (R) from the Curve Number Method is equivalent to precipitation in the Hydrograph Method where all storage, infiltration and other losses are accounted for. Note that the hour 9 increment is the highest. The peak, of course, does not necessarily occur at hour 9 of real storms. The hydrograph is a statistical representation of 24-hour storms that occur in this area, a 'design storm'.

Note that the CN adjustment is applied to the whole storm, not to each time increment separately. The CNs were developed for whole storms. Calculations on a time increment basis of the hydrograph applies "S" for each time increment, resulting in increasing underestimation of runoff depth (R) with increasing number of time increments used.

4. As an example calculation, the table is set up to 10,000 square feet of impervious area. In a spreadsheet, any value for impervious area can be input to generate the volume storage needed.

5. Impervious area runoff for each hour increment is calculated by multiplying the area by the Curve Number adjusted precipitation rate, from Appendix B.

6. Swale area is set at 33 square feet per 1000 square feet of impervious area (0.033 * Imperv area). The is based on the determination described in Section 2.3.5 of the Manual that 0.4 inch precipitation on an impervious surface results in 33 cubic feet of storm water per 1000 square feet of impervious area that must be retained on site for water quality purposes. The cubic feet volume is converted to square feet area based on the assumption of an infiltration BMP one-foot deep with vertical walls. BMP designs require significantly more area (Table B-1) per unit volume (because of sloping walls and shallower depths), meaning that actual soil infiltration volumes are higher than this example shows.

7. Swale ppt calculates the amount of rainfall on the swale area as a storm water input to the system.

8. Total H20 input is the sum of runoff from the impervious surface and precipitation on the swale

9. Infiltration rate is set at 1 in/hr (0.08 ft/hr) which is a reasonable but conservative infiltration rate for vegetated soils in a more-or-less natural condition in this area.

10. Infiltration volume is calculated for the total area of the swale times the infiltration rate.
11. Storage volume is the volume of storm water in each hour increment that exceeds the infiltration volume.
12. The Total in the lower right corner is the total volume of storm water that must be stored by hour 14. Beyond hour 14, volume above ground decreases as infiltration once again exceeds precipitation runoff. Note that the Total in the corner is roughly equal to the "Swale size", which is true for whatever value of "Imperv area" is entered. The "Swale size" is in fact the storage capacity of the swale in cubic feet (see 6 above).

Since the Total volume to be stored is always roughly equal to swale volume, given the conditions of these calculations, infiltration swales designed for water quality treatment (33 cubic feet storage per 1000 square feet impervious area) are also adequate for treatment of the 1.2 inch, 24-hour, 2-year design storm.

Table C-2 Regional Storm Hyetograph Values for the Central Basin, Washington

Note: From the Stormwater Management Manual for Eastern Washington. The hyetograph for the Central Basin, rather than the Palouse, is selected because it was developed for areas with less than 14 inches precipitation. This hyetograph is available digitally from the Lewiston Storm Water Program Coordinator, 208-746-3671, Ext 273. This hyetograph may be used to develop hydrographs for stormwater design calculations for the City of Lewiston. Table C-1 above is an example.

Time (hours)	Incremental Rainfall	Cumulative Rainfall	
0.0	0.0000	0.0000	
0.5	0.0054	0.0054	
1.0	0.0086	0.0140	
1.5	0.0100	0.0240	
2.0	0.0120	0.0360	
2.5	0.0130	0.0490	
3.0	0.0140	0.0630	
3.5	0.0150	0.0780	
4.0	0.0160	0.0940	
4.5	0.0170	0.1110	
5.0	0.0187	0.1297	
5.5	0.0228	0.1525	
6.0	0.0283	0.1808	
6.5	0.0305	0.2113	
7.0	0.0335	0.2448	
7.5	0.0365	0.2813	
8.0	0.0484	0.3297	
8.5	0.0622	0.3919	
9.0	0.0933	0.4852	
9.5	0.0527	0.5380	
10.0	0.0402	0.5782	
10.5	0.0372	0.6154	
11.0	0.0348	0.6502	
11.5	0.0331	0.6833	
12.0	0.0289	0.7122	

Time (hours)	Incremental Rainfall	Cumulative Rainfall	
12.5	0.0252	0.7374	
13.0	0.0219	0.7593	
13.5	0.0191	0.7783	
14.0	0.0167	0.7950	
14.5	0.0148	0.8098	
15.0	0.0134	0.8232	
15.5	0.0123	0.8355	
16.0	0.0116	0.8471	
16.5	0.0110	0.8581	
17.0	0.0105	0.8686	
17.5	0.0103	0.8789	
18.0	0.0103	0.8892	
18.5	0.0104	0.8996	
19.0	0.0105	0.9100	
19.5	0.0105	0.9205	
20.0	0.0104	0.9309	
20.5	0.0102	0.9412	
21.0	0.0100	0.9512	
21.5	0.0097	0.9609	
22.0	0.0093	0.9702	
22.5	0.0087	0.9789	
23.0	0.0083	0.9872	
23.5	0.0078	0.9950	
24.0	0.0050	1.0000	

Appendix D

Permeability Testing Procedures

General Notes

1. For seepage beds, infiltration basins, and infiltration swales, a minimum field infiltration rate of 0.5 inches per hour is required. Areas yielding a lower rate preclude these practices. For sites with infiltration rates that are more than 9 inches per hour, a 12-inch layer of ASTM C33 fine grade, clean sand is required at the bottom of the facility.

2. For permeable pavement, infiltration galleries, dry wells, and any other more technical infiltration facilities, it is assumed that a design professional will determine infiltration rates as needed to design the facility.

3. The number of required test borings or pits is based on the size of the proposed facility.

4. Testing is to be conducted by a qualified professional registered in the State of Idaho.

Initial Evaluation

An initial evaluation is conducted to determine whether infiltration testing is necessary, to screen unsuitable sites, and to reduce testing costs. The initial evaluation should consider the following or other sources of information:

- an existing on-site infiltration test at the location of the proposed BMP that establishes the infiltration rate, depth to seasonal water table and/or depth to bedrock, or

- a technical report of the site prepared by a qualified professional specifically identifying the infiltration rate within the range set forth above, or

- Natural Resources Conservation Service (NRCS) Lewis and Nez Perce County Soil Map showing the soil series with accompanying hydraulic conductivity and an on-site NRCS-style soil description demonstrating that the mapped soil series exists on-site in relatively undisturbed condition.

The initial evaluation must demonstrate that infiltration rates of between 0.5 and 9.0 inches per hour exist at the site. If the results of initial evaluation as determined by a qualified professional show that a saturated flow infiltration rate of greater than 0.5 in/hour is probable, then no further testing is required prior to the design and installation of seepage bed, infiltration basin, and infiltration swale BMPs.

Note that a performance infiltration validation test may be required after construction of the infiltration facility is complete. The design professional needs to be sure the infiltration assumptions are correct because any necessary reconstruction of the facility to meet design requirements shall be at the developer's expense.

Concept Design Testing

If the initial evaluation does not demonstrate that infiltration rates on the site are adequate for the proposed BMPs, then infiltration testing is required. One infiltration test is required for every 1,000 square feet of planned infiltration area. For infiltration facilities greater than 1,000 square feet, one additional infiltration test is required for each additional 1,000 square feet of infiltration area. If tests show uniform subsurface characteristics throughout the proposed stormwater facility location, then only 1 infiltration test/2,000 square feet is required.

Documentation

Infiltration testing data shall be documented, and include a description and citation of the infiltration testing method.

As part of a design submittal, the infiltration facility must be sized and documented with sizing calculations consistent with this Stormwater Manual. The sizing of an infiltration facility is related to the design infiltration rate, among other factors. Infiltration rates should be based on either existing documentation of the infiltration rate or in-situ tests that measure infiltration.

A qualified professional should recommend a design infiltration rate that considers the potential variability of the area in the immediate vicinity of the infiltration facility, and possible degradation by construction practices. Measured or documented infiltration rates should be appropriately reduced to develop the design infiltration rate.

Calculations for the sizing of an infiltration facility should include the following information for each infiltration area:

- The test method or documentation used to determine an infiltration rate,
- The reduction factor used to develop a design infiltration rate, and
- The design infiltration rate (inches per hour).

A performance infiltration validation test is required after construction of the infiltration facility is complete. Drainage design professionals should review the condition of the subgrade of infiltration facilities during construction to verify that the exposed subgrade condition is similar to the assumed design condition.

Test Pit/Boring Requirements

Table 10. *Dig a standard test pit or soil boring to a depth of at least 5 feet below the proposed facility bottom*

Table 11. *Determine depth to seasonal groundwater table (if within 5 feet of proposed bottom) upon initial digging or drilling.*

Table 12. *Determine depth to bedrock (if within 5 feet of proposed bottom)*

Table 13. *The location of the infiltration testing shall be within 10 feet of the BMP location and shall be representative of the proposed BMP site.*

Infiltration Testing Requirements

The design professional shall select and document the infiltration testing method to be used that will be appropriate for the planned facility.

Infiltration testing shall be conducted to determine the saturated flow infiltration rate of the soil material at the bottom of the planned BMP, and 24 inches below the bottom the planned BMP.

Upon completion of the testing, the test pit or soil boring hole must be backfilled and flagged for location.

Post-Construction Infiltration Performance Testing

Post construction infiltration testing is required of all infiltration BMPs that are 1) to be accepted by the City as part of the City's storm water management system, or 2) will discharge overflows to the City's storm water management system. The City may request infiltration testing by the owner of a facility who applies for credits against the City's Stormwater Utility fee. The City may request either bulk infiltration testing or site specific testing using a standardized infiltration testing method.

Bulk infiltration testing consists of filling the facility with water to the 2-year storm event level to test the infiltration rate. The facility should infiltrate the water at a minimum rate identified in the design calculations. For large infiltration facilities with capacities greater than 1,000 cubic feet, a bulk infiltration testing protocol should be submitted to the City at the time of submission of the construction plan

An acceptable infiltration test is one where design storm water volume is infiltrated within the design period. For example, where 75% of the test volume is infiltrated within the first 24-hour period and all water is infiltrated within the next 24-hour period (i.e., 48 hours from the start of the test).

If the infiltration tests cannot satisfy the above criteria, the infiltration facility must be reconstructed. An investigation to determine the cause of unacceptable infiltration rate performance is important prior to reconstruction.

For those situations where an infiltration facility fails the infiltration test, the City of Lewiston is to be notified of the failure, the reasons for the failure, and plans for correcting the problem. If a modified design is required, the design professional shall submit the modified plan to City for approval before reconstruction commences.

Home Owner Infiltration Swale Test Guidance

In Lewiston, the City is recommending that all home owners install infiltration swales or other infiltration BMPs to collect storm water from impervious surfaces on their property. It is recommended that home owners test their private infiltration swales for adequate infiltration.

1. Identify swale/basin size to determine type and number of tests required.

2. For a bulk infiltration test of larger systems, enclose sections of the swale/basin to provide for infiltration tests with approximately 2,000 gallon capacities. If in-situ sand filters have been included in the constructed swale, the proportion of the swale with and without sand filtration is to reflect the overall swale drainage design objectives. For

example, if the design storm is to be infiltrated proportionately 25% through the vegetated or permeable soil section and 75% through in-situ sand filters, then the size and location of the swale test shall approximate these same proportions.

3. Place a stake and note the elevation within the swale or swale section to be tested that reflects 25% of the design storm volume (maximum swale/basin volume at the end of the first 24 hour test period).

4. Fill the swale/basin or the section of the swale/basin to be tested with the design test volume. Filling procedures should use low velocity and spreading techniques in order to prevent any erosion or damage to the swale. Make a note as to the time and date that the swale basin is filled to the testing limit.

5. Examine the test section 24 hours later and note whether the test volume has decreased by 75% within the first 24 hour period. Swale/basin will pass testing if all water has infiltrated into the system. If water remains in the test section (25% of test volume or less), proceed to next step.

6. Examine the test section once more 48 hours and again at 72 hours after filling with the test volume. The swale/basin will pass testing if all water has infiltrated into the system within 72 hours. If water remains in the system after the 72 hour test period, infiltration test shall be considered a failure.

Appendix E

Values of Manning's "n" Roughness Coefficient

Type of Channel and Description	Minimum	Normal	Maximum
A. Closed conduits flowing partly full			
A-1. Metal			
a. Steel			
1. Lockbar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
b. Cast Iron			
1. Coated	0.010	0.013	0.014
2. Uncoated	0.011	0.014	0.016
c. Wrought Iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
d. Corrugated Metal			
1. Subdrain	0.017	0.019	0.021
2. Storm Drain	0.021	0.024	0.030
A-2. Non-metal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Morter	0.011	0.013	0.015
b. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections, and some debris	0.011	0.013	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc. straight	0.013	0.015	0.017

Type of Channel and Description	Minimum	Normal	Maximum
B. Lined or Built-up Channels			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	0.012	0.012
2. Painted	0.012	0.013	0.013
b. Corregated	0.021	0.025	0.030
B-2. Non-metal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Concrete			
1. Float finish	0.013	0.015	0.016
2. Finished, with gravel on bottom	0.015	0.017	0.020
3. Unfinished	0.014	0.017	0.020
4. Gunite, good section	0.016	0.019	0.023
5. Gunite, wavy section	0.018	0.022	0.025
6. On good excavated rock	0.017	0.020	---
7. On irregular excavated rock	0.022	0.027	---
c. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
d. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
e. Asphalt			
1. Smooth	0.013	0.013	---
2. Rough	0.016	0.016	---
f. Vegetal lining	0.030	---	0.500

Type of Channel and Description	Minimum	Normal	Maximum
C. Excavated or Dredged			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredge			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140

Type of Channel and Description	Minimum	Normal	Maximum
D. Natural Streams			
D-1. Minor streams (top width at flood stage <100 ft.)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts/deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches weedy, deep pools	0.050	0.070	0.080
8. Sluggish reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

Type of Channel and Description	Minimum	Normal	Maximum
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
D-3. Major streams (top width at flood stage > 100 feet) The *n* value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	---	0.060
b. Irregular and rough section	0.035	---	0.100

Appendix F

Installing Infiltration Facilities – Strategies for Success

For Your Information

The following information on infiltration facility construction, plant selection, plant establishment, and irrigation is provided for the benefit of the Lewiston Stormwater Policy and Design Manual user. Practices and recommendations listed herein are not mandatory requirements.

Infiltration Facility Construction

1. Avoid wet weather periods and do not conduct soil work or excavate swales when the soils are saturated, unworkable, or standing water is noted.
2. Before the site is disturbed, the area selected for the infiltration system should be secured to prevent heavy equipment from compacting underlying soils. Construction traffic should be diverted away from swale areas before and during construction. If possible, swale areas should be temporarily fenced or barricaded until swale construction is complete.
3. When possible, swale(s) should be constructed with tracked excavation equipment to avoid sub-grade compaction during the construction process. If the sub-grade does become compacted, it should be ripped or scarified as appropriate to restore undisturbed ground infiltration conditions.
4. Runoff should be diverted away from the completed infiltration system during all phases of construction, until the site is completely stabilized. Excessive sediment loading during construction can severely impact the long-term performance of infiltration facilities.
5. Ensure adequate swale percolation and plant establishment by collecting three representative samples of the soil to used in the swale's surface layer and submit to a soil testing laboratory. Have the lab test for soil pH, percent organic matter, available phosphorus, available potassium, and mechanical analysis to determine percent sand, silt, and clay. Soil amendments to improve soil characteristics should than be added based on the lab test results.
6. Reduce installation costs by using on-site soil whenever soil percolation rates are appropriate.

7. Excavate the swale to design grades and consult licensed professional to field verify that free draining, subsurface native materials exist at the native soil interface.
8. Rip the sub-soil along the bottom and sides of the swale.
9. Backfill the excavated swale according to design specifications and plant selection. When establishing shrubs place approximately half of the total amount of top soil required and work into top of loosened (i.e., ripped) sub-grade to create a transition layer, then place the remainder of the planting soil. This transition layer is not necessary when establishing grasses.
10. Soil depths should be at least 6" deep for ground cover plants (grasses) and 12" - 18" deep for shrubs.
11. Bring the soil constituents up to the levels recommended by the soils testing laboratory or licensed professional into the upper 4" of topsoil.

For Your Information

Stormwater system performance is a condition of design review. Soils or sods with high clay contents may not meet the percolation requirements for established swales. Specify soil textures for soils or sods.

Infiltration Facility Plant Selection

1. For irrigated landscapes, ensure successful swale plant establishment by selecting more water tolerant plants such as sedges and fescues (grass) for the bottom center of the swale.
2. For desert, non-irrigated landscapes where the existing vegetation is primarily native dry land shrubs, grasses, and forbs, ensure successful swale plant establishment by selecting dry land seeds and shrubs. In these areas additional care to reduce the area disturbed and appropriate plant selection and establishment protocols are recommended.

Plant Establishment

1. Scarify areas that may have become compacted to a depth of at least 8".
2. Fine grade planting areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades.

3. Moisten prepared planting areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create muddy soil conditions. Prepare a "fluff" layer of 1”- 3" of soil where the seed or sod will root rapidly. The floor of the swale should be flat or sloped gently to a low point. Recommended grade for sloped swales is 1% - 2 %.
4. Lay sod, seed, or plant shrubs within 24 hours from time of scarifying. Do not plant dormant sod or when ground is frozen.
5. Hydroseeding alone or in combination with sod can be a successful strategy for plant establishment in irrigated landscapes. Select seed mixes that are able to establish in poor soils and have a high drought tolerance. Using hydroseed either in strips between sod areas or by itself will help ensure adequate percolation and root development.
6. If sod is used it should be aerated during the first couple of years to ensure adequate percolation. A sand dressing following the aeration is also recommended. Another good option is to select grass sods grown on sandy soils or treat the sod for root growth (e.g., by washing out the clay materials).
7. The following recommendations on bed preparation apply to sod installation:
   a) The sod should be lain "butted up" - the pieces are put together as tightly as possible without overlapping. They are also staggered like bricks in a wall. The long axis of the rectangular sod is laid perpendicular to the slope. This will reduce erosion.
   b) The sod is rolled to firm it against the graded surface and inspected for any gaps that need to be closed or for debris that needs to be removed. Where applicable the sod should be set approximately 3" below the top of the inlet to insure that the growth of grass will not block the inlet.
   c) The sod should be fresh, and once laid, kept damp until roots are well established.
8. The following recommendations on bed preparation apply to hydroseeded installation:
   a) Slightly moisten seed bed area prior to planting and lightly rake to assure complete contact of seed with soil.
   b) Apply dry fresh undamaged seed uniformly over the area. Avoid windy periods.

c) Protect seedbed and seedling from disturbance by trucks or equipment until the swale vegetation is established.

9. The following recommendations on bed preparation apply to drill seed installation:

   a) Seeding by the drill method should occur on slopes of less than 4 horizontal to 1 vertical.

   b) Seed shall be thoroughly mixed before placing in the drill or seeder box.

   c) Slightly moisten seed bed area prior to planting.

   d) Seed shall be placed no deeper than ½" and be well covered.

   e) Seeding shall not be done when wind interferes with seed placement.

   f) Drill spacing shall not exceed 9".

   g) Mulch with approved grass or wood fiber mulch and synthetic tackifier at the rate of 1,000 to 2000 pounds per acre.

   h) Protect seedbed from disturbance by trucks or equipment until the seed is established.

Irrigation

1. When designing irrigation distribution systems, consider provision of different irrigation zones within the swale (e.g., swale bottom will take less water than swale sides).
2. Irrigation application rates and frequency of application should be monitored and adjusted as required during and after establishment of ground cover. Over watering can inhibit root growth, create undesirable ponding conditions, cause erosion, decrease percolation rates of key soils, and be an overall detriment to stormwater facility performance.
3. For non-irrigated dry land desert sites, the optimal seeding time is in the fall, between mid September and mid-October. Other options are either after the third week in November (to insure the seed does not germinate prior to freezing) or as soon as the soil is workable (e.g., not muddy) in the spring. Otherwise, supplemental water is recommended to ensure proper seed germination during times of low precipitation.

Appendix G
Glossary

anti-vortex device - A device designed and placed on the top of a riser or at the entrance of a pipe to prevent the formation of a vortex in the water at the entrance.

applicant - A property owner, or any person or entity designated as the responsible party in an application for a development proposal, permit, or approval.

aquifer - A porous water bearing geologic formation generally restricted to materials capable of yielding an appreciable supply of water.

attenuation - Increasing the time it takes water to move through a site to a point of discharge by restricting flow or routing stormwater through vegetated surfaces, thereby increasing the time of concentration and lowering the peak rate of discharge.

baffle - Guides, grids, grating or similar devices placed in a pond to deflect or regulate flow and create a long flow path.

base course – A layer placed below a surface course to extend pavement thickness; may be called simply "base."

beneficial use -Any of the various uses which may be made of the water of an area, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, cold water biota, salmond spawning, wildlife habitat, and aesthetics.

Best Management Practice (BMPs) - Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "waters of the United States.'' BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage

biofiltration - The use of a long, gently sloped vegetated ditch to remove pollutants from stormwater. Grass is the most common vegetation, but wetland vegetation can be used if the soil is saturated.

bollard - A post (may or may not be removable) used to prevent vehicular access.

biofiltration swale - A long, gently sloped vegetated ditch to remove pollutants from stormwater.

buffer - The zone which protects aquatic resources by providing protection of slope stability and attenuation of runoff.

CFR – The Code of Federal Regulations.

channel - A natural stream that conveys water; a ditch or channel excavated for the flow of water.

channel scour velocity - The speed at which concentrated flowing water can erode the channel bed and/or banks.

check dam - A small dam constructed in a gully or other small watercourse to decrease flow velocity (by reducing the channel gradient), minimize scour, and promote deposition of sediment.

City – The City of Lewiston, Idaho.

Clean Water Act - Federal Water Pollution Control Act enacted by Public Law 92-500 as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; 33 USC 1251 et seq.

conduit - Any channel or pipe for transporting the flow of water.

contamination - The impairment of water by waste to a degree that creates a hazard to public health.

conveyance - Any natural or manmade channel or pipe in which concentrated water flows.

course – A layer in pavement structure.

Curve Number (CN) - A numerical representation of a given area's hydrologic soil group, plant cover, impervious cover, interception and surface storage derived in accordance with Natural Resources Conservation Service methods. This number is used to convert rainfall depth into runoff volume.

design storm - A rainfall event of specific return frequency and duration that is used to calculate the runoff volume and peak discharge rate to a BMP.

detention - The temporary storage of storm runoff in a BMP with the goals of controlling peak discharge rates and providing gravity settling of pollutants.

detention structures - Water holding structures which control the rate at which stormwater drains after a storm event, allowing for sedimentation of suspended solids, and treatment of other pollutants.

detention time - The amount of time a small conceptual volume of water is likely present in a BMP.

developer - Any individual, company, partnership, joint venture, corporation, association, society or group that has made, or intends to make, application to the City for permission to construct improvements.

development - Any construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any structure within the jurisdiction of the City of Lewiston as well as any manmade change or alteration to the landscape, including but not limited to mining, drilling, dredging, grading, paving, excavating and filling.

Director of Public Works - The Director of the Lewiston Public Works Department

discharge - A release or flow of stormwater from a conveyance to a water body or receiving system.

diversion structure - A structure which changes the natural discharge location or runoff flows onto or away from an adjacent downstream property.

drainage area - That area contributing runoff to a single point.

drainage window - A small area backfilled with drain rock in the bottom of a swale which serves as an overflow for larger storm events. Also known as a landscape drain or a rock window.

drop structure - A structure for dropping water to a lower level and dissipating surplus energy; a fall. The drop may be vertical or inclined.

easement - The legal right to use a parcel of land for a particular purpose, but may restrict the owner's use of the land.

emergency spillway - A dam spillway that is designed and constructed to discharge flow in excess of the principal spillway design discharge.

energy dissipator - A designed device such as an apron of rip-rap or a concrete structure placed at the end of a water transmitting apparatus such as pipe, paved ditch or paved chute for the purpose of reducing the velocity, energy and turbulence of the discharged water.

extended detention - A stormwater design feature that provides for the gradual release of a volume of water over a 48 to 72 hour interval in order to increase settling of pollutants and protect downstream channels from frequent storm events.

filter fabric - Textile of relatively small mesh or pore size that is used to allow water to pass through while keeping sediment out or to prevent both runoff and sediment from passing through.

filter layer – Any layer inserted between two other layers, or between a pavement layer and the subgrade, to prevent particles of one from migrating into the void space of the other.

filter media - The sand, soil, or other organic material in a filtration device used to provide a permeable surface for pollutant and sediment removal.

floodplain - Areas adjacent to a stream or river that are subject to flooding or inundation during a storm event that occurs, on average, once every 100 years (or has a likelihood of occurance of 1/100 in any given year).

flow splitter - An engineered, hydraulic structure designed to divert a percentage of stormwater to a BMP located out of the primary channel or conveyance system or to direct stormwater to a parallel pipe system or to bypass a portion of baseflow around a BMP.

forebay - Storage space located near a stormwater BMP inlet that serves to trap incoming coarse sediments before they accumulate in the main treatment area. Also known as a sediment forebay.

freeboard - The distance between the maximum water surface elevation anticipated in design and the top of retaining banks or structures. Freeboard is provided to prevent overtopping due to unforeseen conditions.

geotextile – A permeable manufactured fabric; sometimes called a “filter fabric.”

grade - 1. The slope or finished surface of a road, channel, canal bed, readbed, top of embankment, bottom of excavation, or natural ground; any surface prepared for the support of construction, like paving or laying a conduit. 2. To finish the surface of a canal bed, roadbed, top of embankment or bottom of excavation.

grading - The cutting and/or filling of the land surface to a desired slope or elevation.

grass channel - An open vegetated channel used to convey runoff and to provide treatment by filtering pollutants and sediments.

grass filter strip - A grassy slope located adjacent and parallel to a paved area such as a parking lot, driveway, or roadway. The filter strip is graded to maintain sheet flow of stormwater runoff over the entire width of the strip.

ground water - Water stored underground that fills the spaces between soil particles or rock fractures. A zone underground with enough water to withdraw and use for drinking water or other purposes is called an aquifer.

hydraulic gradient - The slope of the hydraulic grade line. Includes static and kinetic head.

hyetograph - A chart or graphic representation of the average distribution of rain over the surface of the earth.

hydrograph - A graph or table of runoff rate, inflow rate or discharge rate, past a specific point over time.

hydrologic soil group - A Natural Resource Conservation Service classification system in which soils are categorized into four runoff potential groups. The groups range from A soils, with high permeability and little runoff production, to D soils, which have low permeability rates and produce much more runoff.

illicit connection - Any physical connection to a publicly maintained storm drain system composed of non-stormwater which has not been permitted by the public entity responsible for the operation and maintenance of the system.

illicit discharge - Any discharge to a storm drain that is not composed entirely of stormwater, except as authorized and pursuant to a NPDES permit

impervious surface - A surface which prevents or retards the penetration of water into the ground, including, but not limited to, roofs, sidewalks, patios, driveways, parking lots, concrete and asphalt paving, gravel, compacted native surface and earthen materials, and oiled, macadam, or other surfaces which similarly impede the natural infiltration of stormwater.

industrial stormwater permit - A NPDES permit issued to a commercial industry or group of industries which regulates the pollutant levels associated with industrial stormwater discharges or specifies on-site pollution control strategies. Also known as the Multi-Sector General Permit (MSGP).

infiltration - The penetration of water through the ground surface into sub-surface soil.

infiltration rate - The rate at which stormwater percolates into the subsoil measured in inches per hour.

infiltration swale - An open drainage channel explicitly designed to retain and promote the infiltration of stormwater runoff through an underlying fabricated soil media.

inflow protection - A water handling device used to protect the transition area between any water conveyance (dike, swale, or swale dike) and a sediment trapping device.

injection well - Any excavation or artificial opening into the ground which meets the following three (3) criteria: a. It is a bored, drilled or dug hole, or is a driven mine shaft or a driven well point; and b. It is deeper than its largest straight-line surface dimension; and c. It is used for or intended to be used for injection.

inlet - An entrance into a ditch, storm sewer, or other waterway.

landscape plan - A plan showing the form and species of plants and procedures for planting to stabilize and beautify earthwork or to increase the functionality of a drainage structure.

level spreader - A device for distributing stormwater uniformly over the ground surface as sheet flow to prevent concentrated, erosive flows and promote infiltration.

local agency - One or more of the agencies involved with providing review, approval or oversight of the site's (a) activities; (b) pollution prevention controls; or (c) stormwater discharge.

micro-pool - A smaller permanent pool which is incorporated into the design of larger stormwater ponds to avoid resuspension of particles and minimize impacts to adjacent natural areas.

multi-sector general permit (MSGP) - A NPDES permit issued to a commercial industry or group of industries which regulates the pollutant levels associated with industrial stormwater discharges or specifies on-site pollution control strategies.

municipal separate storm sewer system (MS4) - includes, but is not limited to, those facilities located within the City and owned and operated by a public entity by which stormwater may be collected and conveyed to waters of the United States, including any roads with drainage systems, public streets, inlets, curbs, gutters, piped storm drains and retention or detention basis, which are not part of a Publicly Owned Treatment Works ("POTW) as defined at 40 CFR Section 122.2.

National Pollutant Discharge Elimination System (NPDES) permit - A stormwater discharge permit issued by the U.S. EPA to insure compliance with the federal Clean Water Act.

non-stormwater discharge - Any discharge that is not entirely composed of stormwater.

non-structural BMPs - Stormwater runoff treatment techniques which rely on management and education to reduce pollution levels, do not require construction of pollution control structures/BMPs.

observation well - A test well installed in an seepage bed (infiltration trench) to monitor draining times after installation.

off-line treatment - A stormwater management system designed to manage a storm event by diverting a percentage of stormwater events from a stream or storm drainage system.

oil separator - An underground retention system designed to separate trash, debris, sediments, and oil and grease from stormwater runoff.

on-line - A stormwater management system designed to manage stormwater in its original stream or drainage channel.

open channels - Also known as swales, grass channels, ditches, biofilters, etc. These systems may used for the conveyance, detention, retention, infiltration and filtration of stormwater runoff.

outfall - The point, location, or structure where wastewater or drainage discharges from a storm drain pipe, ditch, or other conveyance to a receiving body of water.

outlet protection - Stone, rip-rap, concrete or asphalt aprons installed to reduce the speed of concentrated stormwater flows, thereby reducing erosion and scouring at stormwater outlets and paved channel sections.

overlay – A layer applied on top of a preexisting or otherwise complete pavement.

owner or operator - The owner or operator of any facility or activity subject to regulation under the federal NPDES program including operational and day-to-day control over facility activities.

pavement – Any treatment or covering of the earth surface to bear traffic.

pavement structure – A combination of courses of material placed on subgrade or make a pavement.

peak discharge rate - the maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

percolation - The downward movement of water through soil or other medium.

permeability - The quality of a soil that enables water or air to move through it. Usually expressed in inches/hour or inches/day.

permeable surfaces - Areas characterized by materials that allow stormwater to infiltrate the underlying soils (e.g., soil covered or vegetated area).

permissible velocity - The highest average velocity at which water may be carried safely in a channel or other conduit. The highest velocity that can exist through a substantial length of a conduit and not cause scour of the channel. A safe, non-eroding or allowable velocity.

person - Any individual, firm, association, club, organization, corporation, partnership, business trust, company or other entity which is recognized by law as the subject of rights or duties.

pervious surface - A vegetated area of the urban landscape where rainfall is intercepted by vegetation, and infiltrated into soil.

phased development - A large project that is under one common ownership that will be developed in stages over a period of time. It may encompass one or more drainage basins.

pollutant - Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water, and as otherwise defined in 40 CFR 122.2.

pond buffer - The area immediately surrounding a pond which acts as a filter to remove pollutants and provide infiltration of stormwater prior to reaching the pond. Provides a separation barrier to adjacent development.

precipitation - Any form of rain or snow.

pretreatment - Techniques employed in stormwater BMPs to provide storage or filtering to help trap coarse materials before they enter the system.

primary conveyance system - A conveyance system that consists of catch basin, drop inlets, streets, street gutters, and conduit system.

redevelopment - A project for which a building permit is required that proposes to add, replace and/or alter impervious surfaces affecting the existing drainage system, other than routine maintenance, resurfacing, or repair. Project seeking to significantly demolish existing facilities shall not receive credit for existing impervious surfaces. Proposed development on sites that have not been occupied for longer than two years shall be considered new development, not redevelopment.

reservoir – Any portion of a pavement that stores or transmits water; a reservoir may overlap or be combined with other pavement layers such as base and subbase; sometimes called a “reservoir base,” “drainage layer,” or “drainage blanket.”

residential parcel – a parcel of land that is being used or is planned to be used for a single family residence, or a duplex.

retention - The holding of runoff in a basin without release except by means of evaporation or infiltration.

retrofit - The creation or modification of stormwater management systems in developed and urbanized areas through techniques for improving water quality. A retrofit can consist of the construction of a new BMP in the developed area, the enhancement of an older stormwater system, or a combination of improvement and new construction.

rip-rap - Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves); also applies to brush or pole mattresses or brush and stone, or similar materials used for soil erosion control.

riser pipe - A vertical pipe extending from the bottom of a pond BMP that is used to control the discharge rate from a BMP for a specified design storm.

runoff - That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into the receiving waters.

roughness coefficient - A factor in velocity and discharge formulas representing the effect of channel roughness on energy losses in flowing water. Manning's "n" is a commonly used roughness coefficient.

runoff coefficient (C) - A value derived from a site impervious cover value that is applied to a given rainfall volume to yield a corresponding runoff volume.

safety bench - A flat area above the permanent pool and surrounding a stormwater pond designed to provide a separation to adjacent slopes.

sand filter - A technique for treating stormwater, whereby runoff is diverted into a self-contained bed of sand.

sediment basin - A settling pond with controlled stormwater release structure used to collect and store sediment. The basin detains sediment-laden runoff from larger drainage areas long enough to allow most of the sediment to settle out.

sediment forebay - Storage space located near a stormwater BMP inlet that serves to trap incoming coarse sediments before they accumulate in the main treatment area.

sedimentation - The process of depositing soil particles, clays, sands, or other sediments that were picked up by flowing water.

seepage bed - A shallow, excavated underground reservoir that has been backfilled with stone. Stormwater runoff diverted into the reservoir gradually filtrates from the bottom of the trench into the subsoil or vadose zone.

setbacks - The minimum distance requirements for locating structural BMPs in relation to roads, property lines, wells, septic fields, other structures.

sheet flow - Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

significant sources of pollutants - A land use or activity that generates higher concentrations of hydrocarbons, trace metals or toxicants than are typically found in stormwater runoff.

site - The legal boundaries of the parcel or parcels of land for which an applicant has or should have applied for authority from the City of Lewiston to carry out a development activity including drainage improvements.

source control - A practice or structural measure to prevent pollutants from entering stormwater runoff or other environmental media.

spillway - The open or closed channel, or both, used to convey excess water from a reservoir. It may contain gates, either manually or automatically controlled to regulate the discharge of excess water.

stabilization - The proper placing, grading and/or covering of soil, rock, or earth to ensure its resistance to erosion, sliding or other movement.

Standard Industrial Classification (SIC) - Classifies establishments by type of activity in which they are engaged for purposes of facilitating the collection, tabulation, presentation, and analysis of data relating to establishments; and for promoting uniformity and comparability in the presentation of statistical data collected by various agencies of the United States Government, state agencies, trade associations, and private research organizations.

stormwater - Runoff from a storm event, or snow melt runoff that flows off the land surface from impervious surfaces or that cannot be absorbed by the soil.

stormwater management - The process of collection, conveyance, storage, treatment, and disposal of stormwater to ensure control of the magnitude and frequency of runoff and to minimize the hazards associated with flooding. Also includes implementing controls to reduce the discharge of pollutants including management practices, control techniques and systems, design and engineering methods.

stormwater management plan (SWMP) - Details of the drainage system, structures, BMPs, concepts and techniques that will be used to control stormwater, including drawings, engineering calculations, computer analyses, maintenance and operations procedures, and all other supporting documentation.

structure foundation - the underlying support base of anything constructed, erected, except fences, which requires permanent location on the ground or is attached to something having location on the ground.

structural BMPs - Devices which are constructed to provide treatment of stormwater runoff.

subbase – A layer of material placed below a base course to further extend pavement thickness.

subgrade – The soil underlying a pavement structure and bearing its ultimate load.

surface course – The pavement layer that directly receives the traffic load; this layer presents a pavement's surface qualities such as accessibility, travel quality, appearance, and resistance to direct traffic abrasion.

surface trench - an infiltration facility that is a shallow excavated trench backfilled with stone and open to the ground surface.

Technical Release No. 55 (TR-55) - A watershed hydrology model developed by the Soil Conservation Service (now NRCS) used to calculate runoff peaks and volumes and provides a simplified routing for storm events through watersheds, valleys and/or ponds.

time of concentration - The time of concentration is the travel time for a unit of water from the most hydraulically remote point in the contributing area to the point under study.

Total Suspended Solids (TSS) - The total amount of particulate matter which is suspended in the water column.

trash rack - Grill, grate or other device at the intake of a channel, pipe, drain or spillway for the purpose of preventing oversized debris from entering the structure.

treatment - The act of applying a procedure or chemicals to a substance to remove undesirable pollutants.

under-drain - Plastic pipes with holes drilled through them, installed on the bottom of an infiltration BMP, or sand filter, which are used to collect and remove excess runoff.

U.S. EPA - United States Environmental Protection Agency

vadose zone - The zone between the land surface and the water table. It includes the root zone, intermediate zone, and capillary fringe. The pore spaces contain water at less than atmospheric pressure, as well as air and other gases. Also called the unsaturated zone.

variance- A modification of the requirements of the Ordinance.

Water Quality Volume (V_{wq}) - The volume of runoff created by the first 0.4 inches of precipitation, also know as “first flush”. This volume of water is required to be retained and treated on site as a tool to maintain water quality.

Waters of the State - All the accumulations of water, surface and underground, natural and artificial, public and private, or parts thereof which are wholly or partially within, which flow through or border upon the state.

Waters of the United States - Waters as defined in 40 CFR 122.2.

wetland - An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

wetted perimeter - The length of the wetted surface of the channel.

Appendix H

References

Camp, Dresser, & McKee for Stormwater Quality Task Force; *California Stormwater Best Management Practice Handbook*, March 1993.

Caraco, Deborah and Richard Clayton; *Stormwater BMP Design Supplement for Cold Climates*, Center for Watershed Protection, Ellicott City, MD, December 1997.

Center for Watershed Protection (CWP); *Design of Stormwater Filtering Systems*, Prepared for: Chesapeake Research Consortium. Solomons, MD. and USEPA Region V. Chicago, IL 1996.

City of Bellevue; *Surface Water Engineering Standards*, March 1996.

City of Boise; *Stormwater Management: A Design Manual* 2007 http://www.cityofboise.org/Departments/Public_Works/Services/WaterQuality/Stormwater/page10117.aspx

City of Boise; *Boise Stormwater BMP Guidebook*, January 1997.

City of Lewiston; *Lewiston Stormwater Master Plan*, October 2001, Lewiston ID

City of Lewiston, Public Works Dept.; *Lewiston Storm Water Policy And Design Manual*, December 1997. Lewiston ID

City of Portland Environmental Services; *City of Portland Stormwater Quality Facilities, A Design Guidance Manual*, June 1995.

City of Spokane; *Guidelines for Stormwater Management*, Spokane Co. Public Works, Spokane, Washington, 1995.

Clayton, Richard and Thomas Schueler; *Design of Stormwater Filtering Systems*, Center for Watershed Protection, Silver Spring, MD, December 1996.

Fairfax County, Virginia; *Public Facilities Manual*. 2001 http://www.fairfaxcounty.gov/dpwes/publications/pfm/pfm_main.htm

Horner, Richard; *Biofiltration for Storm Runoff Water Quality Control*, University of Washington, Seattle, 1994.

Izzard; *Airport Drainage,* Federal Aviation Agency, Department of Transportation, Advisory Circular, AIC 150-5320-5B, Washington, D.C., 1970

King County, Washington, Water and Land Resources Division, *Surface Water Design Manual,* 2005. http://dnr.metrokc.gov/wlr/dss/manual.htm

Kirpich, Z.P. ,*Time of Concentration of Small Agricultural Watersheds*, Civil Engineering, 10(6):362, 1940.

Schueler, Thomas; *Final Report: National Performance Database for Urban BMPs.* Prepared for Chesapeake Research Consortium. Center for Watershed Protection. Silver Spring, MD, 1997.

State of Idaho, Dept. of Environmental Quality; *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties*, 2005. http://www.deq.idaho.gov/water/data_reports/storm_water/catalog/

State of Maryland; *Maryland Stormwater Design Manual*, Volumes I & II, October 2000. http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

State of Massachusetts, Dept. of Environmental Protection; *Stormwater Management, Volume 2; Stormwater Technical Handbook*, March 1997.

State of Pennsylvania, Dept. of Environmental Protection; *Pennsylvania Stormwater Best Management Practices Manual* (Draft 2007) http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/stormwatermanagement/BMP%20Manual/BMP%20Manual.htm

State of Virginia, Dept. of Conservation and Recreation. *Erosion and Sediment Control Handbook*. 1992 http://www.dcr.virginia.gov/soil_&_water/e&s-ftp.shtml

State of Washington, Dept. of Ecology; *Stormwater Management Manual for Eastern Washington*. September 2004. Publication No. 04-10-076 http://www.ecy.wa.gov/biblio/0410076.html

U.S. Department of Agriculture., Soil Conservation Service; *Urban Hydrology for Small Watersheds*, Technical Release No. 55, 2nd ed., Soil Conservation Service. Available from NTIS, Springfield, VA.

U.S. Department of Agriculture, Soil Conservation Service. 1993. *National Engineering Handbook*, Section 4, Hydrology (NEH-4).

U.S. Department of Agriculture, Soil Conservation Service; *SCS National Engineering Handbook.* Washington, D.C, U.S. Department of Agriculture,1985.

U. S. Environmental Protection Agency; *Guidance Specifying Management Measures For Sources of Nonpoint Pollution in Coastal Waters*, Office of Water, Washington, D.C. #840-B-92-002.