City of Edmonds
Development Information

LOW IMPACT DEVELOPMENT (LID) STORMWATER BEST MANAGEMENT PRACTICES[1] (BMPs) SIMPLIFIED SIZING

This handout provides information on the simplified sizing of common LID stormwater BMPs. By using this Handout LID BMPs such as permeable paving, rain gardens and others can be easily sized to meet the requirements for Onsite Stormwater Management (Minimum Requirement #5) and/or Flow Control (Minimum Requirement #7). For more details on stormwater management requirements, see Handout #E72, Edmonds Community Development Code (ECDC) Chapter 18.30, including Exhibit A: *Edmonds Stormwater Code Supplement (Stormwater Supplement).*

INTRODUCTION

This handout helps you to:

1. Determine the applicability of the simplified sizing methods to your project.
2. Learn about the pre-designed LID BMPs.
3. Use the flow control credits and sizing factors to assist in the design of these LID BMPs for your project.

For supporting information, see the reference section at the end of this handout.

APPLICABILITY

The simplified BMP sizing applies to projects classified[2] as Small Site Projects and many classified as Large Site Projects. The approach described in this handout can be used to demonstrate compliance with both Minimum Requirement (MR) #5, Onsite Stormwater Management/LID Techniques for Controlling Runoff and MR #7, Flow Control.

The simplified sizing method only applies to projects that are subject to the Edmonds-specific flow control standards. To determine which flow control standards apply to your project, you must know your project classification, and drainage basin[2].

Project Classification

Projects are classified as either Large Site Projects, Small Site Projects, or Minor Site Projects. Large Site Projects in creek or lake basins may trigger the flow control requirements (MR#7) in the *Western Washington Phase II Municipal Stormwater Permit* (Ecology 2009) (*Permit*). Generally, if your site has 10,000 square feet (sf) or more or new plus replaced impervious surface area, it triggers *Permit* requirements. See Section 4.7 the *Stormwater Supplement* (Edmonds 2010*)* and Section 4.7 in Appendix I of the *Permit* to see if your site triggers this requirement. If your Large Site Project exceeds one of thresholds for MR#7, the project is subject to a different flow control standard than is used in this handout, and you may **not** use the simplified sizing method contain herein.

Project Size

Small Site Projects and Large Site Projects subject to the Edmonds-specific flow control standards are categorized in this handout by size:

- Category 1 Standard: projects with 2,000 to 5,000 sf of new plus replaced impervious surface area
- Category 2 Standard: projects with more than 5,000 sf but less than 10,000 sf of new plus replaced impervious surface area.

Project Drainage Basin

There are two types of drainage basins in Edmonds: creek/lake, and direct discharge into Puget Sound[2]. The type of drainage basin dictates the flow control standard and, therefore, the sizing of the LID BMP.

Edmonds-specific Flow Control Standard

The Edmonds-specific flow control standards for LID and other infiltration BMPs are provided in Table 1. Requirements vary by project size and the drainage basin in which the project site is located. Note that the *Stormwater Supplement* has the "LID Credit Option" that allows mitigation of less than 100% of the new and replaced impervious surface area if LID BMPs are used (see the *Stormwater Supplement* for details).

It is important to note that these flow control standards are based on the assumption that all disturbed and converted pervious surfaces have compost-amended soil (including compost/soil mix) to City standards (See handout E72 C for further explanation).

[1] Defined as a schedule of activities, prohibition of practices, maintenance procedures, and structural and/or managerial practices that, when used singly or in combination, prevent or reduce the release pollutants and other adverse impacts to waters of Washington State.

[2] See Handout #E72 for determining project classification, drainage basin, and other relevant site-specific issues.

Table 1. Edmonds-Specific flow Control Standards for LID and Infiltration BMPs.

Project Location	Edmonds-specific Flow Control Standards [a]	
	Category 1 Sites	Category 2 Sites
Creek or Lake Basin	The post-development 10-year recurrence interval flow shall not exceed 0.25 cfs per acre of impervious surface area.	The post-development 2-, 10-, and 100-year recurrence interval flows shall not exceed 0.07, 0.25, and 0.45 cfs per acre of impervious surface area, respectively.
Direct Discharge Basin[b]	The post-development 10- and 100-year recurrence interval flow shall not exceed 0.25 and 0.45 cfs per acre of impervious surface area, respectively.	

Notes:
cfs – cubic feet per second
[a] Large Site Projects in creek or lake basins that exceed the Phase II Permit thresholds are subject to a different flow control standard and may not use the simplified sizing method. Thresholds for Large sites are based on area of new and replaced impervious surfaces, area of converted pervious surfaces, and increases in the 100-year recurrence interval flow (see *Stormwater Supplement*).
[b] Small Site Projects and Large Site Projects in direct discharge basins may be exempt from Minimum Requirement #7 and the Edmonds-specific flow control requirements if a downstream capacity and erosion analysis per Minimum Requirement #10 shows no unacceptable downstream impact, or an alternative mitigation plan is approved (see *Stormwater Supplement*).

Site Soil Conditions
The simplified sizing approach applies to sites with a native soil design infiltration rates shown in the last column of Table 2[2]. The infiltration rate(s) on your project site can be evaluated by a qualified engineer using one of three approved methods: the USDA Soil Textural Classification, the ASTM Gradation Testing (D_{10} approach), or the Modified Pilot Infiltration Testing (PIT) Method. See Appendix C of the *Stormwater Supplement* and Engineering Handout #E72D for more information regarding soil testing requirements.
Important: the short-term or measured infiltration rate for the native soil on your project site must be corrected to acknowledge the effects of site variability and long-term clogging due to siltation and biomass buildup in the infiltration facility. The corrected or "design" rate must be used to design stormwater flow control facilities using the simplified method presented in this handout. For further guidance, see the *Stormwater Supplement*, Appendix C. and Engineering Handout #E72D.

PRE-DESIGNED FLOW CONTROL BMPS

The simplified sizing method was developed for the following LID BMPs:

- Permeable pavement surfaces
- Bioretention cells (rain gardens)
- Gravelless chambers
- Infiltration trenches
- Drywells

While other BMPs may be used to achieve Edmonds-specific stormwater flow control requirements, you must use a continuous hydrologic simulation model to size them as described in *Stormwater Supplement*. The design configuration, sizing method, and range of site infiltration rates for the pre-designed flow control BMPs are summarized in Table 2.

To apply the simplified method, BMPs must meet the specific prescribed design requirements (such as side slopes, ponding depth, and soil or gravel depth) presented in this section. To determine if a BMP is suitable for your project site, consult the *Stormwater Supplement* and the *Low Impact Development Technical Guidance Manual for Puget Sound* (WSU 2005). Site considerations include (but are not limited to) spatial constraints, slopes, and feasibility of infiltration.

BMP Descriptions

The BMPs with predetermined sizing factors and flow control credits are described below.

Permeable Pavement

Permeable pavement is a paving system that allows rainfall to percolate into an underlying aggregate storage reservoir where stormwater is stored and infiltrated to the underlying soil. A permeable pavement system consists of a pervious wearing course (e.g., porous asphalt, pervious concrete, paver blocks, concrete open celled paving grids, or plastic lattices filled with turf or stone) and an aggregate subbase course installed over native soil.

[2] If the design infiltration rate is less than 0.13 in/hr, the LID BMPs in this handout are considered not feasible. If the design infiltration rate for your site is 0.13 in/hr or greater and not represented in the ranges presented in Table 2 and you want to use one or more of the LID BMPs in this handout, contact the City Engineering Division.

Table 2. LID BMPs and Configurations for Simplified Sizing Method.

BMP	Design Configuration	BMP Sizing Method	Design Infiltration Rate (inches per hour)
LID Runoff Reduction Methods			
Permeable Pavement	0 to 5% Subgrade Slope	Flow Control Credit	≥ 0.13
LID Facilities			
Rain Gardens (Bioretention)	6- and 12-inch Ponding Depth	Sizing Factor	0.25 – 2.0
Infiltration Trench	1.5 and 3-foot Depth	Sizing Factor	0.25 – 2.0
Gravelless Chamber		Sizing Factor	0.25 – 2.0
Drywell	4 and 6-foot Depth	Sizing Factor	0.5 – 2.0

The permeable pavement BMP described here is designed to manage only the water that falls upon it, and is not intended to take stormwater run-on from other areas. A typical pavement design is shown in Figure A-1. For more specific design considerations, see the City Engineering Division's *Permeable Pavement Policy*.

Rain Gardens (Bioretention)

Bioretention facilities (also known as rain gardens) are shallow depressions with a designed soil mix and plants adapted to the local climate and soil moisture conditions. The healthy soil structure and vegetation promote infiltration, water storage, and slow release of stormwater flows to more closely mimic natural conditions. The simplified sizing approach applies only to bioretention facilities that do not have an underdrain to intercept infiltrated runoff, or an impermeable liner impeding infiltration to underlying soil. Sizing factors are provided for two design variations: a 6-inch and 12-inch ponding depth. A typical bioretention design is shown in Figure A-2.

Infiltration Trench

The infiltration trench BMP is based on guidance for downspout infiltration trench designs, presented in the Ecology Manual (Ecology 2005). A typical trench design is shown in Figure A-3. This BMP consists of an aggregate-filled trench where collected stormwater is temporarily stored and then infiltrated into the underlying soil. Sizing factors are provided for two design variations: a 1.5-foot and 3-foot aggregate depth in the trench. For both trench depths, the trench is 24 inches wide.

Gravelless Chamber

The gravelless chamber BMP is based on guidance presented in the *Kitsap County Stormwater Management Design Manual* (Kitsap County 1997). A typical chamber design is shown in Figure A-4. This BMP consists of a buried chamber, typically made of durable plastic or other prefabricated material, within which collected stormwater is temporarily stored and then infiltrated into underlying soil. Gravelless chambers create an underground cavity that can provide a greater void volume than infiltration trenches, and often require a smaller footprint because they can store more runoff than a trench filled with drain rock in a comparable space. Per Kitsap County requirements, the chamber must have a minimum void volume of 2.6 cubic feet per linear foot, and a minimum infiltrative surface of 2.8 square feet per linear foot. These same requirements are suitable for applications in Edmonds.

Drywell

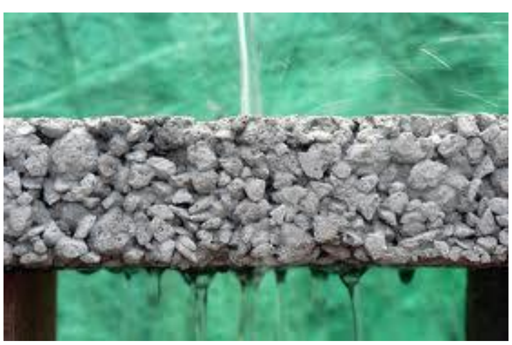
The drywell BMP is based on guidance for downspout infiltration drywell design, presented in the Ecology Manual (Ecology 2005). A typical drywell design is shown in Figure A-5. This BMP consists of an aggregate-filled hole where collected stormwater is temporarily stored and then infiltrated into the underlying soil. Drywells are similar to infiltration trenches but are typically deeper and require less site area. Sizing factors are provided for two drywell design variations: a 4-foot and a 6-foot aggregate depth.

BMP Design Requirements

To use the simplified sizing method, the BMP design requirements listed in Table 3 must be met. Additional requirements that you must account for in your design (including infiltration rate testing methods, infiltration rate correction factors, setbacks, and vertical separation from the bottom of the facility to the underlying water table) are presented in the *Stormwater Supplement* and the Ecology Manual (Ecology 2005).

Table 3. BMP Design Requirements for the Simplified Sizing Method

Design Criteria for All BMPs
▪ These BMPS shall not be used in: - The North Edmonds Earth Subsidence and Landslide Hazard Area (ESLHA)[3] - Upgradient (east) of the ESLHA - In a Landslide Hazard Area[4] - Within 5 feet of property lines and easements - Within 10 feet from underground storage tanks - Within 50 feet from proposed or existing septic systems or drain fields. - Where the depth to the top of the seasonal groundwater level is less than 1 foot from the bottom of the facility. ▪ The BMP must meet the following setback requirements from buildings: - If runoff is from an area less than 5,000 square feet, setback is 5 feet from a structure without a basement and 10 feet for a structure with a basement. - If runoff is from an area greater than or equal to 5,000 square feet, a structure shall not intersect with a 1Horizontal:1Vertical slope from the bottom edge of the facility. Minimum 5 feet from a structure without a basement and 10 feet for a structure with a basement. ▪ **An overflow path must be specified** such that runoff above the facility's design capacity does not cause: - Flooding of a building or emergency access - Erosion or downstream sedimentation - Slope failure.
Permeable Pavement
▪ The pavement shall not receive stormwater run-on from other areas ▪ Aggregate depth (for storage) must be at least 3 inches. ▪ For sites with more than 5,000 sf of impervious area with subgrade slopes greater than 2 percent, the flow control standard is not achieved. The mitigated area shall be calculated using the flow control credit (Table 4). ▪ Aggregate shall be washed gravel with a minimum void volume of 20 percent. ▪ Slope of the subgrade underlying the permeable pavement shall be less than 5 percent. ▪ No underdrain or impermeable layer shall be used. ▪ For subgrade slopes greater than 2 percent, higher flow control credit may be achieved if you design the system with subsurface, low permeability check dams to ensure water storage along the sloping subbase.



Permeable Concrete

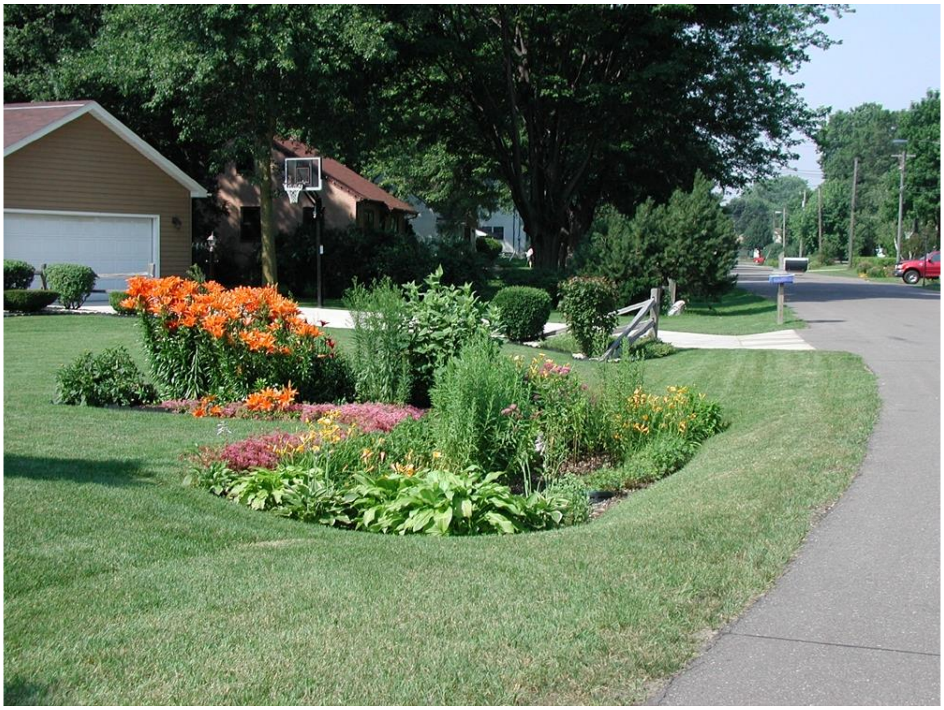
Permeable asphalt

[3] 1 See Edmonds Community Development Code (ECDC) Chapter 19.10.
[4] 2 See ECDC Chapter 23.80.

Table 3 (continued). BMP Design Requirements for the Simplified Sizing Method

Bioretention (Rain Garden)

- The site drainage area contributing runoff to an individual bioretention facility shall be sized to collect runoff from an area no larger than **5,000 square feet square feet** of impervious surface[5].
- Bioretention bottom area shall be sized using the simplified sizing method.
- Ponding depth shall be as specified (6 or 12 inches).
- Top area (total facility footprint) will be larger than the bottom area. You can calculate top area as a function of the bottom area, the side slopes, and the total facility depth (e.g., ponding and freeboard depth).
- Bottom area shall be flat (0 percent slope).
- The minimum freeboard measured from the invert of the overflow channel to the of the cell overtopping elevation shall be 6 inches.
- Rain garden shall not be placed on a slope 5% or greater
- Side slopes shall be no steeper than a ratio of 3H (horizontal):1V (vertical).
- Imported bioretention soil per the specification in Attachment 2 shall be used. This specification is included in this handout. This soil mix meets the Ecology treatment soil requirements, has a design infiltration rate of 3.0 inches per hour, and has 40 percent porosity.
- Bioretention soil depth shall be a minimum of 12 inches for flow control. If your bioretention facility will be used for water quality treatment in addition to flow control, the soil depth shall be a minimum of 18 inches.
- No underdrain or impermeable layer shall be used.



Raingarden

Table 3 (continued). BMP Design Requirements for the Simplified Sizing Method

[5] The area limitation is to ensure that bioretention facilities are small-scale and distributed. Also, the assumed infiltration rate correction factor applied bioretention soil mix is based on a contributing area that does not exceed 5,000 square feet of impervious surface.

Infiltration Trench
▪ Infiltration trench length shall be determined using the simplified sizing method. ▪ The infiltration rate used to determine the required length shall be the design, or "long-term," rate and must be calculated using correction factors in the *Stormwater Supplement.* ▪ Trench cross section shall be 24 inches wide by 18 inches deep, or 36 inches deep. ▪ The site drainage area contributing runoff to an individual infiltration trench shall be sized to collect runoff from an area no larger than **5,000 square feet square feet** of impervious surface. ▪ One pipe per trench. If multiple trenches are used, the spacing shall not be closer than 6 feet, measured on center. ▪ Trench aggregate shall have a minimum void volume of 30 percent (1-1/2 to 1-3/4 inch washed rock). ▪ The location of the overflow shall be above the washed rock trench. ▪ Trenches located under driving areas must have 2 feet of cover from top of wearing course to the top pipe.
Gravelless Chamber
▪ Chamber length shall be determined using the simplified sizing method. ▪ The infiltration rate used to determine the required length shall be the design, or "long-term," rate and must be calculated using correction factors in the Ecology Manual. ▪ Void (storage) volume provided by the chamber shall be at least 2.6 cubic feet per linear foot and infiltrative surface under the chamber footprint shall be at least 2.8 square feet per linear foot. ▪ Invert elevation of the overflow conveyance shall be set above the storage reservoir.

Drywell
▪ Drywell area shall be determined using the simplified sizing method. ▪ The infiltration rate used to determine the required area shall be the design, or "long-term," rate and must be calculated using correction factors per the Ecology Manual. ▪ The site drainage area contributing runoff to an individual drywell shall be sized to collect runoff from an area no larger than **5,000 square feet** of impervious surface. ▪ Minimum aggregate depth before overflow shall be as specified (4 or 6 feet). ▪ Drywell aggregate shall have a minimum void volume of 30 percent (1-1/2 to 1-3/4 inch washed rock).

FLOW CONTROL CREDITS AND SIMPLIFIED BMP SIZING

Pre-designed flow control BMPs can be evaluated using flow control credits (runoff reduction credits) or sizing equations (relating the facility size to the impervious area mitigated).

Flow Control Credits

Flow control credits apply only to the use of permeable pavement. The flow control credit values in Table 4 are based on how this BMP achieves the Edmonds-specific flow control standard. To use the credits, your permeable pavement system must meet the specific design requirements presented in Table 3.

Permeable pavement installed with subgrade slopes exceeding 2% do not receive 100 % credit for Category 2 Small Site Projects because of increased potential for lateral flow through the aggregate storage reservoir along the top of the lower permeability subsurface soil[6]. In these situations the mitigated impervious surface area is calculated as the product of the flow control credit and the permeable pavement area (Table 4). The area mitigated for Category 2 Small sites is calculated as follows:

Area Mitigated = 84% X Permeable Pavement Area

Note that full credit is not achieved in this example, and your site design would require additional flow control measures for the permeable pavement area to meet the flow control standard. The effective impervious area to be additionally mitigated will be 16% of the permeable pavement area. One alternative would be to use another BMP that a will achieve the full standard instead of the permeable pavement with greater than 2% slope. Contact the City Engineering Division for additional options.

[6] An exception to this is when permeable pavement installations on subgrade slopes between 2 and 5 percent are designed to include measures such as impermeable berms perpendicular to subgrade slope. Contact the Engineering Division for more information on this subject.

Table 4. Flow control credits for Permeable Pavement.

BMP	Flow Control Credit [a]	
	Category 1 Sites	Category 2 Sites
Permeable Pavement (up to 2% subgrade slope) [b]	100%	100%
Permeable Pavement (2-5% subgrade slope) [b]	100%[c]	84%[d]

[a] Impervious area mitigated by a BMP is calculated as: [Flow Control Credit (%)/100] x [Dispersed Area or Pavement Area]. Permeable pavement at a slope exceeding 2 percent does not achieve full (100%) credit, and as such the site design would require additional flow control measures to meet the flow control standard.

[b] Aggregate depth (for storage) must be at least 3 inches.

[c] Actual modeled credit is 94%, but 100% is granted

[d] If you wish to receive full flow control credit for a permeable pavement BMP on a slope between 2 and 5 percent, include subsurface berms in your design to provide a minimum of 3 inches of subsurface ponding in the storage aggregate reservoir. Permeable pavement installations on subgrade slopes greater than 5 percent do not receive flow control credit.

Sizing Factors

Sizing factors for LID and traditional infiltration facilities are provided by design soil infiltration rates in Table 5. You can use these factors to calculate the BMP size as a function of the impervious area draining to it, as follows:

> BMP Area (square feet) = Impervious Area (square feet) x Sizing Factor (%)/100, or
>
> BMP Length (feet) = Impervious Area (square feet) x Sizing Factor (%)/100

For example, the size of a bioretention cell with 6 inches of ponding storage depth at a Category 1 site with a native soil design infiltration rate of 0.5 inches per hour would be calculated as 6.8 % of the impervious area draining to it. For 1,200 square feet of contributing area, the bioretention cell area is calculated as:

> Bioretention Bottom Area = Impervious Area (1,200 square feet) x Sizing Factor (6.8/100) =
>
> 81.6 square feet.

Important: this bioretention area calculated in Table 5, is the bottom area. The top area (total facility footprint) will be larger than the bottom area. You can calculate top area as a function of the pre-sized bottom area, the side slopes, and the total facility depth (accounting for design ponding depth and additional freeboard depth).

Similarly, the length of an infiltration trench with 3 feet of aggregate storage depth where the native soil design infiltration rate is 0.25 inches per hour would be calculated as 5.4 percent of the impervious area draining to it. Area must be expressed in square feet, and length must be expressed in feet.

To use the sizing factors in Table 5 your BMP design must meet the specific design requirements in Table 3. To be conservative, design infiltration rates for the native soils must be rounded down to the nearest rate evaluated (e.g., if your site has a design infiltration rate of 0.75 inches per hour, the sizing factors for 0.5 inches per hour shall be used). You may linearly interpolate between the design depths evaluated (e.g., you can interpolate the required bottom area of your bioretention facility if the ponding depth will be between 6 and 12 inches using the values listed for those pre-sized ponding depths in Table 5), but you may not extrapolate beyond the design parameters used in the pre-sizing calculations (e.g., you cannot extrapolate the required bottom area for design ponding depths less than 6 inches or greater than 12 inches for bioretention facilities).

Water Quality Treatment using Infiltration Facilities

When sized to achieve either Category 1 or Category 2 site standards (Table 5), infiltration facilities infiltrate at least 98 percent of the influent runoff. Therefore, these facilities will also meet the City's water quality treatment standards when the native or imported soil on your site meets the treatment soil requirements set forth in the Ecology Manual (2005).

MAINTENANCE REQUIREMENTS

ECDC Section 18.30.090 requires privately-owned stormwater management facilities, such as LID BMPs be properly maintained. The owner of the property is the responsible party for such maintenance. The system must be kept in good working order. The entire system should be inspected once per year. An improperly maintained BMP may cause private property or street flooding. Contact the City Engineering Division for maintenance information.

The City may make periodic inspections of BMPs to ensure they are operating properly. ECDC Section

18.30.100 contains the enforcement provisions the City can use to ensure the system is properly maintained.

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Table 5. Bioretention and Infiltration BMP Sizing Factors.

BMP	Facility Overflow Depth	Native Soil Design Infiltration Rate (inches/hour)	Sizing Factor (% of contributing impervious area)		Sizing Equation
			Category 1 Sites [a]	Category 2 Sites [b]	
Bioretention Cell [c,d]	6 inch ponding depth	0.25	9.7%	9.7%	Bioretention Bottom Area (square feet) = Impervious Area (square feet) x Sizing Factor (%)/100
		0.5	6.8%	6.8%	
		1.0	5.0%	5.2%	
		1.5	4.1%	4.4%	
		2.0	3.6%	3.9%	
	12 inch ponding depth	0.25	6.2%	6.2%	
		0.5	4.2%	4.2%	
		1.0	3.1%	3.2%	
		1.5	2.5%	2.6%	
		2.0	2.2%	2.3%	
Infiltration Trench [e]	1.5 foot depth of aggregate	0.25	9.1%	9.1%	Infiltration Trench Length (feet) = Impervious Area (square feet) x Sizing Factor (%)/100
		0.5	6.2%	6.2%	
		1.0	3.8%	4.0%	
		1.5	2.9%	3.1%	
		2.0	2.3%	2.9%	
	3 foot depth of aggregate	0.25	5.4%	5.4%	
		0.5	4.0%	4.0%	
		1.0	2.6%	2.6%	
		1.5	2.1%	2.1%	
		2.0	1.8%	2.0%	
Gravelless Chamber [e]	NA	0.25	3.7%	3.7%	Gravelless Chamber Length (feet) = Impervious Area (square feet) x Sizing Factor (%)/100
		0.5	2.7%	2.7%	
		1.0	1.9%	1.9%	
		1.5	1.5%	1.6%	
		2.0	1.3%	1.4%	
Drywell [c]	4 foot depth	0.5	6.2%	6.2%	Drywell Area (square feet) = Impervious Area (square feet) x Sizing Factor (%)/100
		1.0	4.3%	4.4%	
		1.5	3.5%	3.6%	
		2.0	3.0%	3.1%	
	6 foot depth	0.5	4.7%	4.8%	
		1.0	3.4%	3.5%	
		1.5	2.8%	2.9%	
		2.0	2.4%	2.5%	

[a] Sizing factors developed to limit the post-development 10-year recurrence interval flow to 0.25 cubic feet per second (cfs) per acre of impervious surface area.

[b] Sizing factors developed to limit recurrence interval flow rates to: 2yr=0.07 cfs/acre; 10yr=0.25 cfs/acre; and 100yr=0.45 cfs per acre of impervious surface area.

[c] BMP area is calculated as a function of impervious area draining to it: BMP Area (square feet) = Impervious Area (square feet) x Sizing Factor (%)/100.

[d] Sizing factors are for bioretention facility bottom area. Total footprint area may be calculated based on side slopes (3H:1V), ponding depth, and freeboard.

[e] BMP length is calculated as a function of impervious area draining to it: BMP Length (feet) = Impervious Area (square feet) x Sizing Factor (%)/100.

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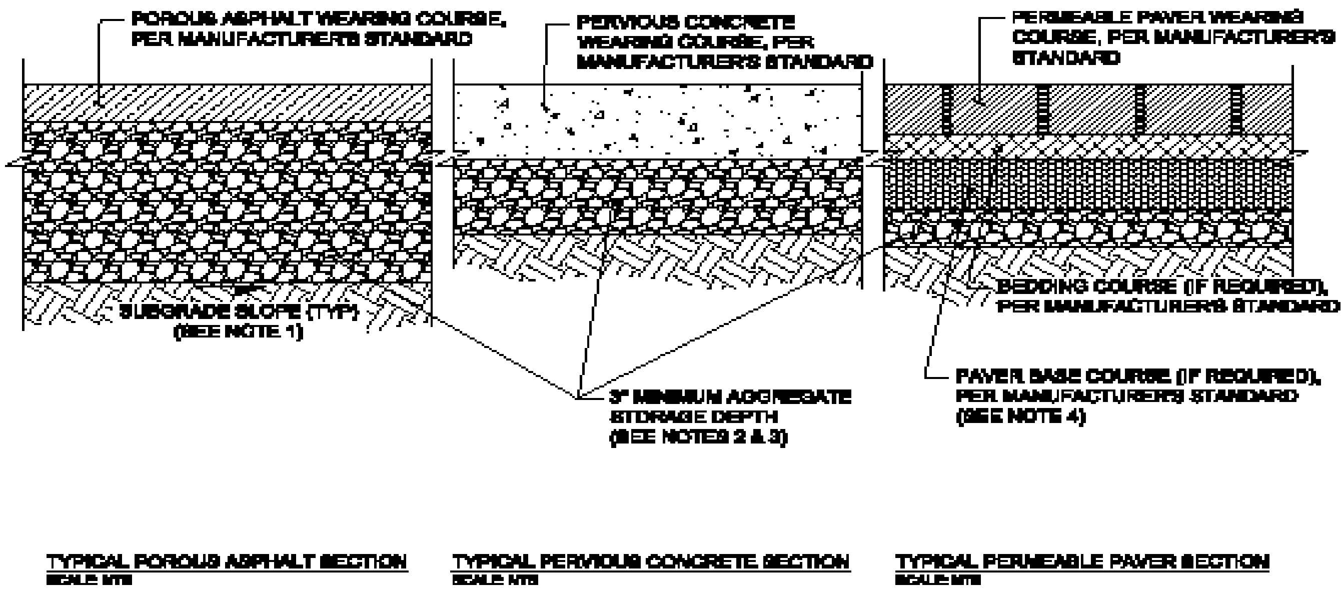
Attachment 1

Typical Designs of Low Impact Development Best Management Practices

Note: These are not standard details and are for reference only



NOTES:

1. SUBGRADE SLOPE MUST BE LESS THAN 5% FOR ALL PERMEABLE PAVEMENT.
2. AGGREGATE SHALL BE WASHED GRAVEL WITH A MINIMUM VOID VOLUME OF 20%.
3. MINIMUM AGGREGATE STORAGE DEPTH FOR FLOW CONTROL IS 3 INCHES. ADDITIONAL DEPTH MAY BE REQUIRED DEPENDING ON PERMEABLE PAVEMENT WEARING COURSE AND ANTICIPATED LOADING AND SLOPE. ADHERE TO MANUFACTURER'S STANDARDS.
4. PAVER BASE COURSE MAY BE USED TO MEET STORAGE AGGREGATE DEPTH REQUIREMENTS IF IT MEETS REQUIREMENTS SPECIFIED IN NOTE 2.

TYPICAL PERMEABLE PAVEMENT

CITY OF EDMONDS

Figure A-1. **Typical permeable pavement.**

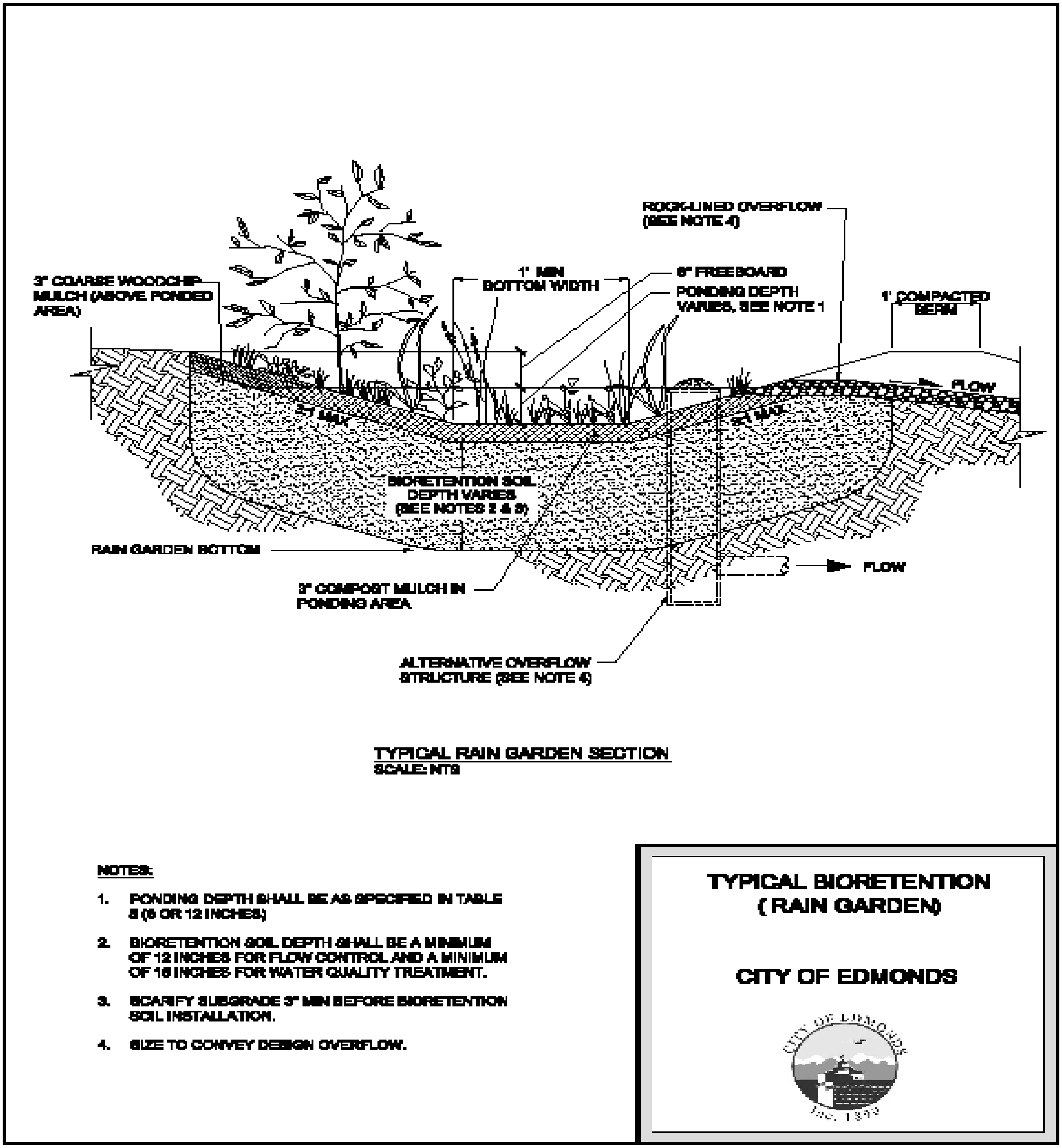


Figure A-2. Typical bioretention (rain garden).

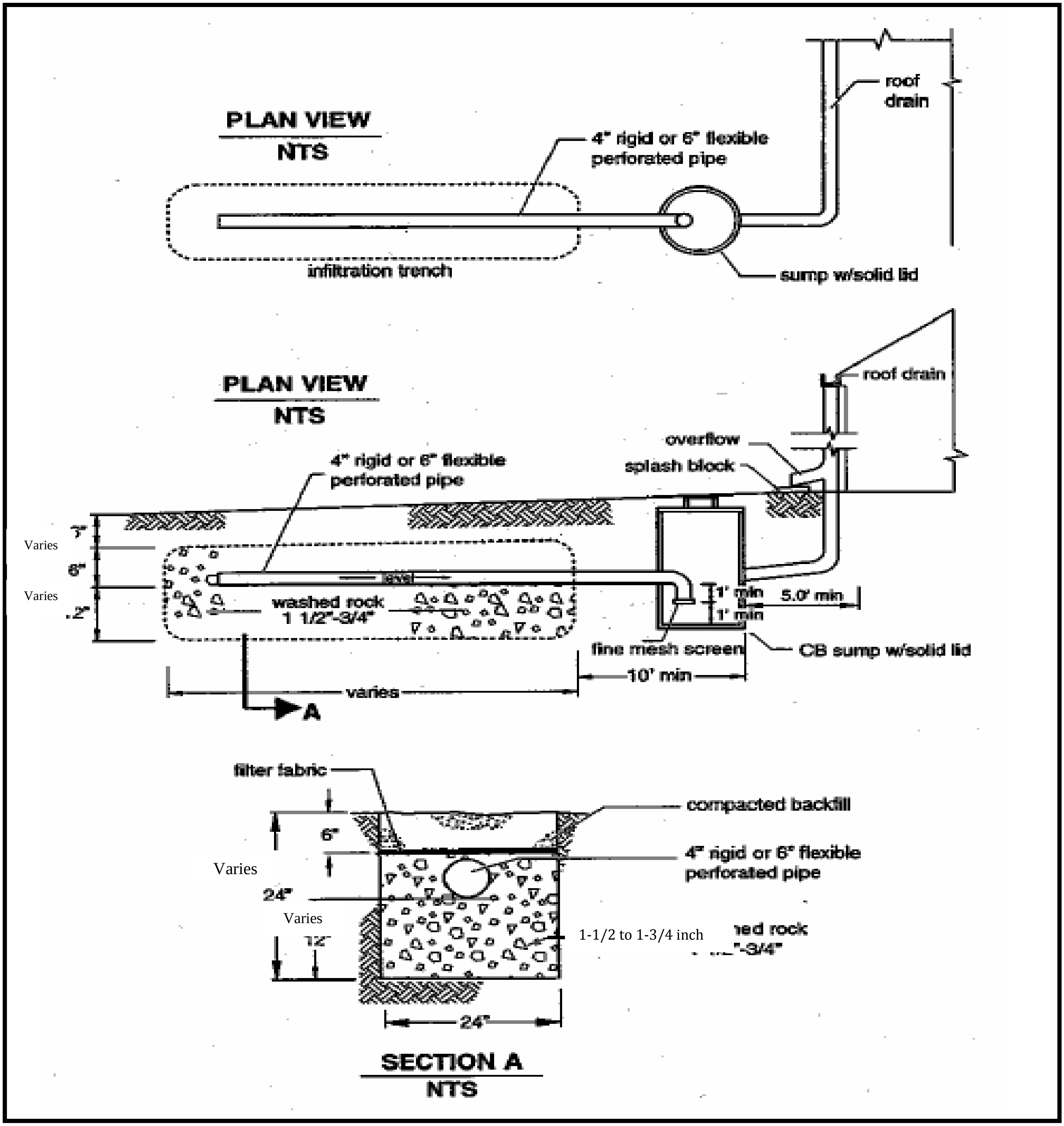
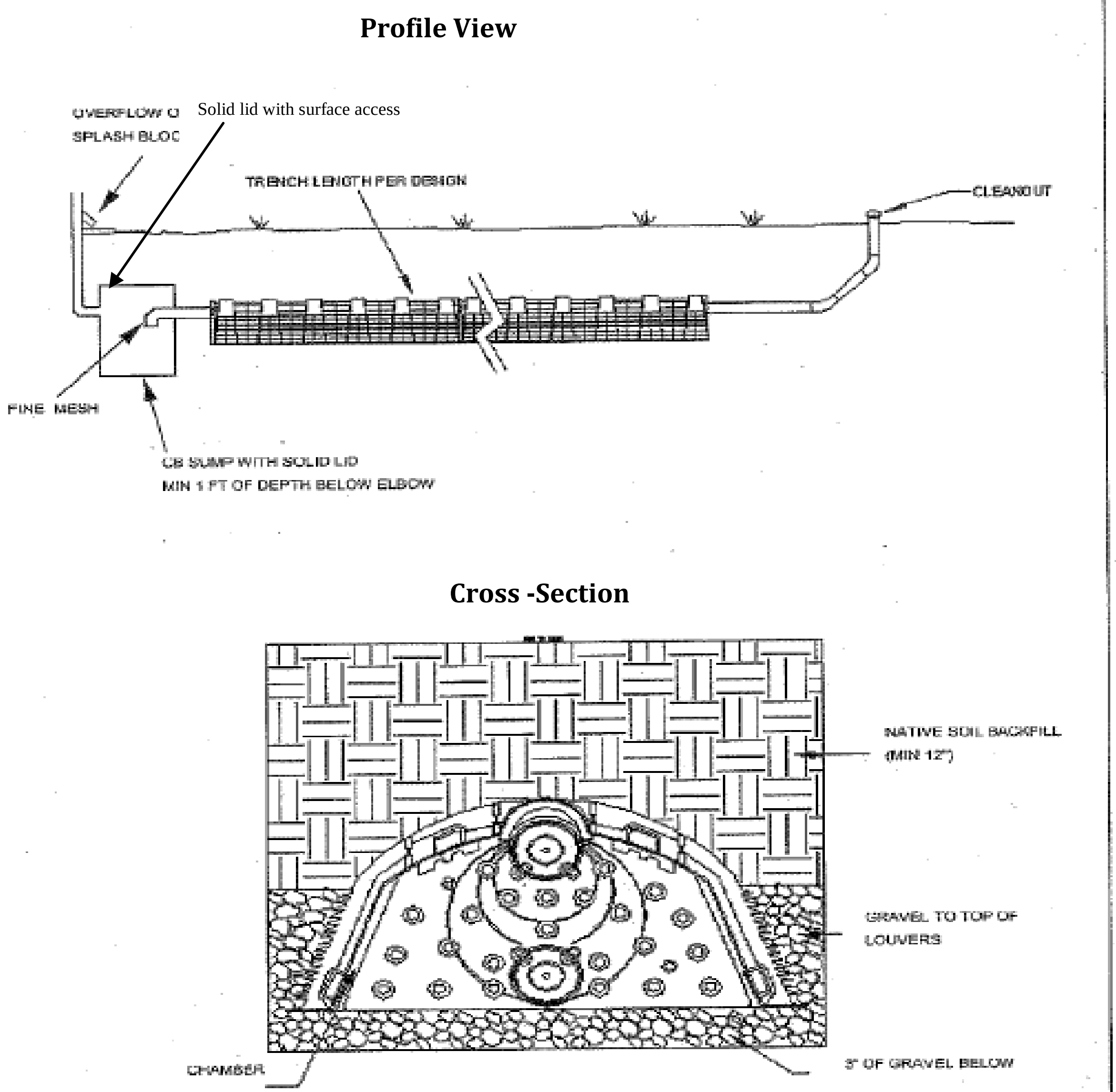


Figure A-3. Typical downspout infiltration trench (Figure 3.2 in Volume III of Washington State Department of Ecology's *Stormwater Management Manual for Western Washington* [Ecology 2005]).

Figure 5-27 Gravelless Trench



A gravelless infiltration chamber trench designed per figure 5-27. The Void space per linear foot shall be at least 2.6 cubic feet. The infiltrative surface per linear foot shall be at least 2.8 sq ft.

The following products are known to meet these gravelless chamber criteria

Infiltrator© High Capacity by Infiltrator Systems, Inc.
EnviroChamber© High Capacity by Hancor, Inc.
Stormtech© SC-310 by Infiltrator Systems, Inc

Figure A-4. Typical gravelless chamber (Figure 5.27 in Appendix 5A of the Kitsap County *Stormwater Management Design Manual* [Kitsap County 1997]).

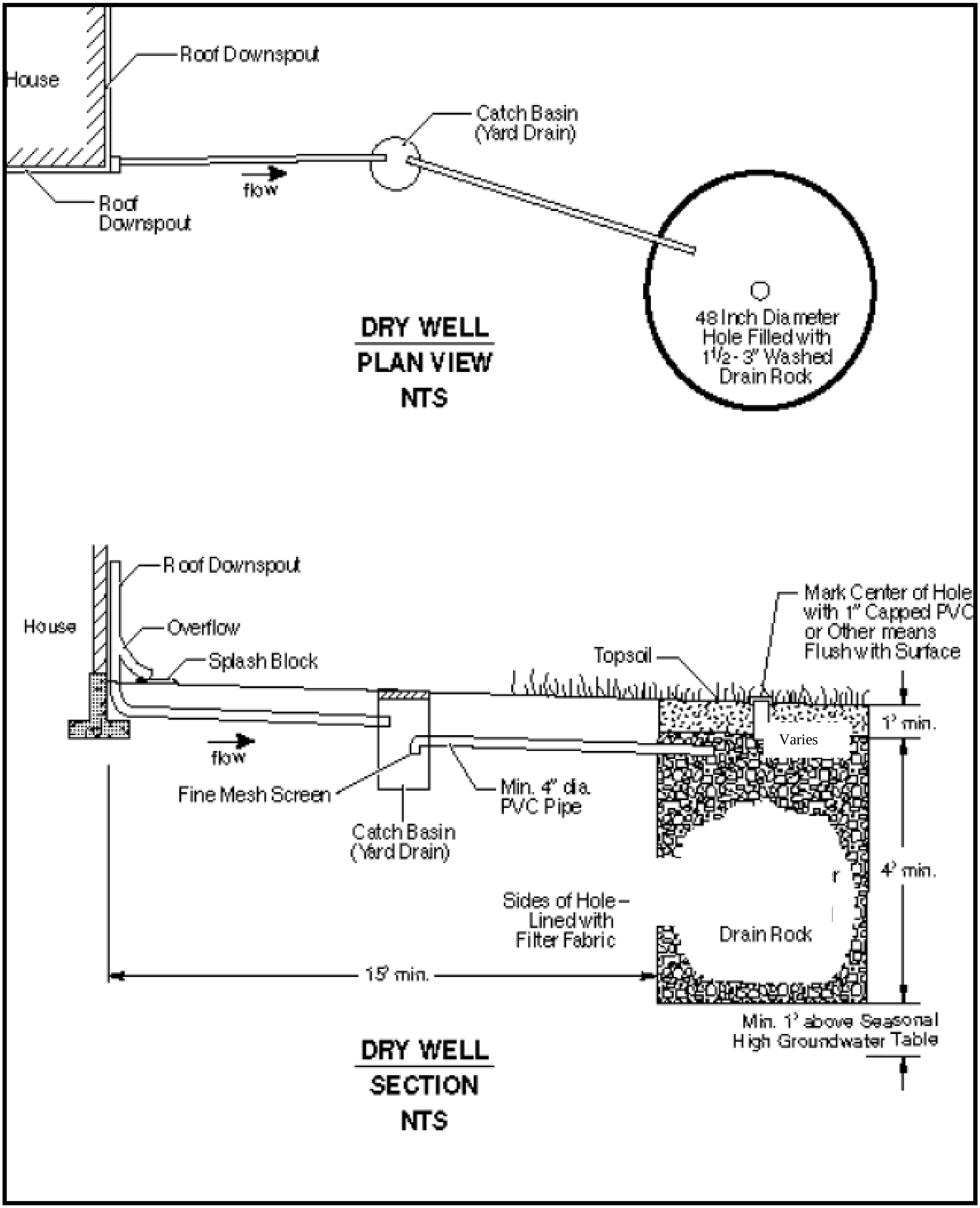


Figure A-5. Typical drywell (Figure 3.4 in Volume III of Washington State Department of Ecology's *Stormwater Management Manual for Western Washington* [Ecology 2005])

Attachment 2

RAIN GARDEN (BIORETENTION) SOIL MIX SPECIFICATIONS

Bioretention Soil shall consist of a well-blended mixture by volume of 3 parts mineral aggregate and 2 parts compost meeting the requirements below.

MINERAL AGGREGATE

Mineral aggregate shall be analyzed by an accredited lab using #200, #100, #60, #40, #20, #10, #4, 3/8 and 1-inch sieves; and meets the following:

Sieve Size	Percent Passing
3/8”	100
No. 4	95-100
No. 10	75-90
No. 40	25-40
No. 100	4-10
No. 200	2-5

Efforts should be made to use aggregate with gradation meeting Coefficient of Uniformity (CU)[7] equal to 6 or above; and Coefficient of Curvature (CC)[8] of 1 to 3.

As a substitute “Fine Aggregate for Portland Concrete,” 90-3.1(2)B, Class 1 (WDOT 2010) can be used.

COMPOST

Compost is defined by the Washington Dept. of Ecology as: the result of the biological degradation of Type I or III feedstocks, under controlled conditions designed to promote aerobic decomposition, per WAC 173-350-220, and meet the following physical criteria. The Department of Ecology has a current list of composting facilities that meet this standard. Go to http://www.ecy.wa.gov/programs/swfa/compost/ and look for “Current Composting Facilities in Washington.” As of December 2010, the following suppliers were on Ecology’s list of approved compost suppliers in Snohomish County:

- Bailand Farms Yardwaste (Bailey) Compost
- Cedar Grove Composting Co.
- Lenz Enterprises Inc
- Misich Farms/Riverside Topsoils
- Pacific Topsoils (PTI)

Some of these suppliers’ compost can be found at local home improvement stores in 1 or 1.5 cubic feet bags.

For additional information go to: http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf.

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[7] $CU = \frac{D_{60}}{D_{10}}$ The ratio of the diameter of a grain size, in millimeters, indicated by the gradation curve at the 60-percent passing (by weight), to the the diameter of a grain size, in millimeters, indicated by the gradation curve at the 60-percent passing (by weight).

[8] $CC = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ D_{30} is the grain size, in millimeters, indicated by the gradation curve at the 30-percent passing level. D_{10} and D_{60} as described in footnote no. 1.