
Targeted Drainage Report for:
Grandview North LLC – Apple Builders

December 2021



Prepared by:
Josh Hogan
Cascade Surveying & Engineering., Inc.

Table of Contents

Executive Summary	2
Vicinity Map	3
PROPERTY DESCRIPTION	3
DRAINAGE INFORMATION SUMMARY FORM	4
MR #1 Stormwater Site Plan Narrative	5
PROJECT DESCRIPTION	5
METHODOLOGY	5
EXISTING CONDITIONS	5
DEVELOPED CONDITIONS	6
UPSTREAM ANALYSIS	7
DOWNSTREAM ANALYSIS	7
FLOW CONTROL	7
RUNOFF TREATMENT	7
MR #2 Stormwater Pollution Prevention Plan Narrative	8
MR #3 Water Pollution Source Control	8
MR #4 Preservation of Natural Drainage Patterns	8
MR #5 On-Site Stormwater Management	8
MR #6 Runoff Treatment	9
MR #7 Flow Control	9
MR #8 Wetland Protection	9
MR #9 Operations & Maintenance	9
Appendices	10

List of Figures

Figure 1: Vicinity Map	3
------------------------------	---

List of Tables

Table 1: Existing Impervious Surfaces	6
Table 2: Proposed Onsite Surfaces	7



Executive Summary

The proposal is to construct a multi-use development with two buildings onsite. The west building will be located along the 67th Ave NE frontage. It will be a three-story building with retail units on the ground floor and residential units on the remaining floors. The east building will be located along the east property line. It will be a three-story residential building. A total of 102 residential units are proposed for this project. A parking area for 124 outside spaces, drive aisles, sidewalks, landscaping, and open space will be constructed as part of the project. Frontage improvements will be required in the form of replacing existing driveways not being used with curb, gutter, and replacing any non-ADA compliant trail. The site will fully infiltrate all stormwater runoff. The project will implement a design to meet the minimum requirements as outlined below:

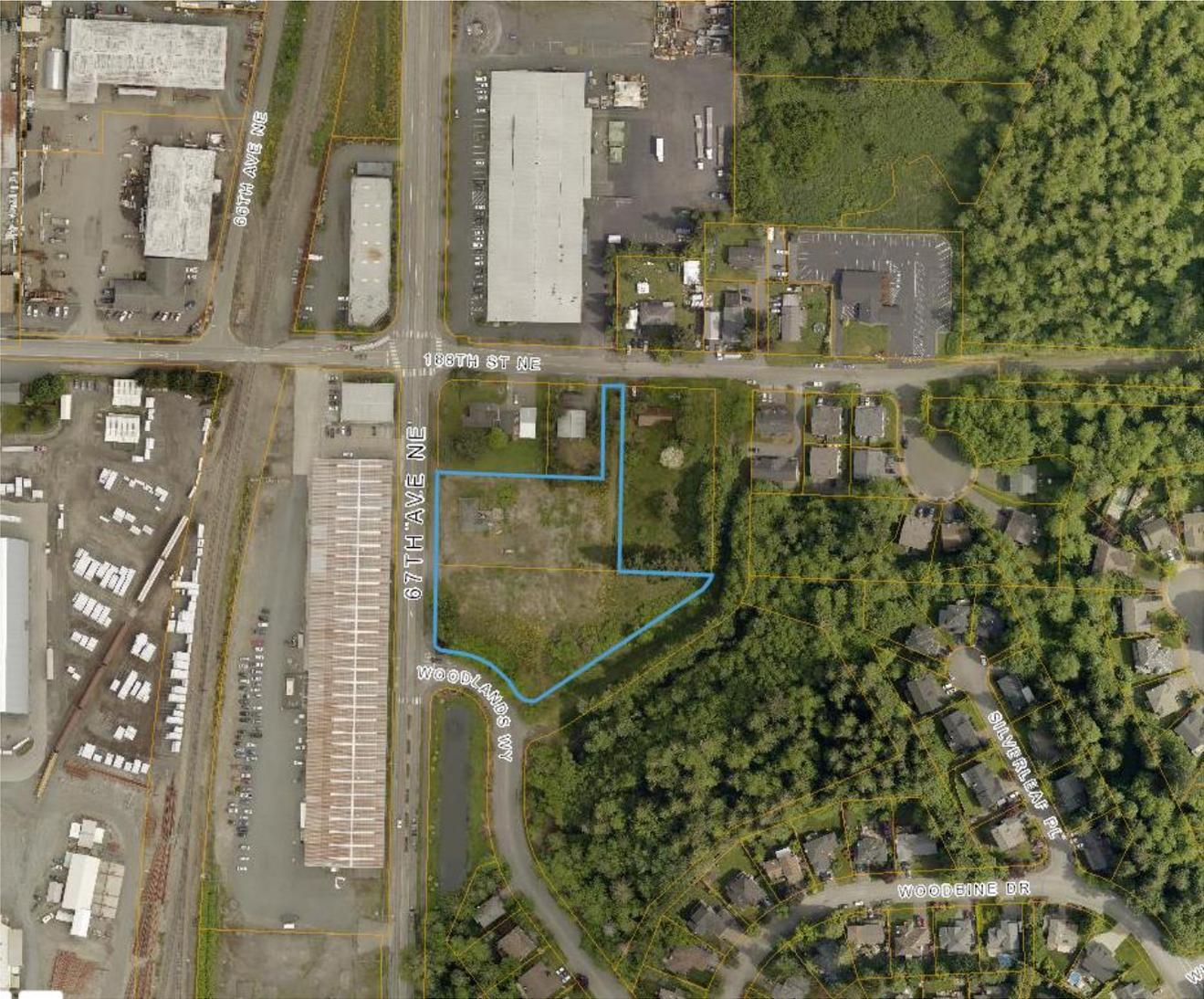
Compliance with Minimum Requirements:

1	<i>Prepare Stormwater Site Plan</i>	A stormwater site plan report and drawing are presented in this document.
2	<i>SWPPP</i>	A SWPPP will be submitted with the construction plans
3	<i>Water Pollution Source Control</i>	BMPs for source control will be noted in the SWPPP.
4	<i>Preserve Natural Drainage</i>	All stormwater runoff from the proposed development will be fully infiltrated given the existing well-drained soils on-site.
5	<i>On-site Stormwater Management</i>	All stormwater runoff from the proposed development will be collected and fully infiltrated on-site.
6	<i>Runoff Treatment</i>	Runoff treatment for the proposed parking lot areas will be provided through a water quality infiltration trench.
7	<i>Flow Control</i>	Flow control for the proposed development will be met using an infiltration trench to fully infiltrate all runoff on-site.
8	<i>Stormwater Discharge to Wetland</i>	There are no known wetlands existing within the area of disturbance or on-site.
9	<i>Inspection, Operation and Maintenance</i>	Operation & Maintenance Manual is provided in the appendix.

Vicinity Map

PROPERTY DESCRIPTION

The project site is in a portion of Section 23, Township 31 North, Range 05 East W.M. More specifically the site is located at 18705 67th Ave NE Arlington WA 98223. The property is identified by tax parcel #31052300200500 and #00738500103100 as shown below in Figure 1, highlighted in blue.



Not to scale (Source PDS Mapper)

Figure 1: Vicinity Map.

DRAINAGE INFORMATION SUMMARY FORM

Project Total Area: **2.50± acres**

Area of Disturbance: **2.50± acres**

Number of Lots (if applies): 2

Summary Table

Drainage Basin Information	Individual Basin Information
	A
On-site Sub-basin Area (acres)	2.50
Type of Storage Proposed	N/A
Appx. Dead Storage Vol (cf)	N/A
Appx. Live Storage Vol (cf)	N/A
Soil Type(s) (Natural Resource Conservation Service)	Lynnwood Loamy Sand
Pre-developed Discharge Rates	
Q (cfs.)	
2 yr.	0.0029
10 yr.	0.0107
50 yr./100 yr.	0.0284/0.0417
Redevelopment Area (acres)	
Post-development Runoff Rates (without quantity controls)	
Q (cfs.)	
2 yr.	1.0048
10 yr.	1.6195
50 yr./100 yr.	2.2647/2.5720
Post-development Runoff Rates (with quantity controls)	
Q (cfs.)	
2 yr.	0
10 yr.	0
50 yr./100 yr.	0
Offsite Upstream Area	
Number of acres	0

MR #1 Stormwater Site Plan Narrative

PROJECT DESCRIPTION

The proposal is to construct a multi-use development with two buildings onsite. The west building will be located along the 67th Ave NE frontage. It will be a three-story building with retail units on the ground floor and residential units on the remaining floors. The east building will be located along the southeast property line. It will be a three-story residential building. A total of 102 residential units are proposed for this project. A parking area for 124 onsite spaces, drive aisles, sidewalks, landscaping, and open space will be constructed as part of the project. Frontage improvements on 67th Ave NE will be required in the form of replacing existing driveways not being used with curb, gutter, and replacing any non-ADA compliant trail. Frontage improvements on Woodlands way will include replacing the rolled curb and sidewalk with curb, gutter, landscape strip and sidewalk. Offsite improvements to the utilities tract, known as 'Brierwood Loop' will consist of two lane road with parking, and sidewalk. Brierwood Loop will connect from Woodlands Way, south of the property, to 188th St NE, east of the property. There will be 32 parking spaces along the frontage of Brierwood Loop with an additional 30 offsite parking spaces along Brierwood Loop.

METHODOLOGY

Drainage calculations for the on-site area have been prepared using the 2019 Department of Ecology Stormwater Management Manual for Western Washington (DOE SMMWW). The site's drainage design meets Low Impact Development (LID) standards by fully infiltrating all stormwater runoff on-site. Infiltration trenches were sized using the 2012 Western Washington Hydrology Model (WVHM). The proposed onsite impervious surface will be approximately 80,870 sq ft, and the offsite impervious surface will be approximately 34,940 sq ft, the development will be required to meet minimum requirements (MRs) 1-9 according to Volume I of the Department of Ecology Stormwater Management Manual for Western Washington (DOE SMMWW).

EXISTING CONDITIONS

The 2.50 acre parcels are located in the neighborhood commercial with mixed use overlay zoning district in Arlington. The site is bounded by 67th Ave NE / Centennial Trail to the west, single family residences and 188th St NE to the north, Woodlands Way to the south and a single-family residence and utilities tract with a berm to the east. There is an existing driveway that connects to 67th Ave NE and a panhandle that provides access to 188th St NE to the north. An existing single-family residence is located on the northern parcel.

The existing 67th Ave NE frontage consists of a median lane with single travel lane, curb gutter, landscaping and a 12± ft asphalt trail known as Centennial Trail. The existing Woodlands Way frontage consists of a turn lane, single travel lane, rolled curb, sidewalk and landscaping.

The site is relatively flat with some manmade mounds in the southeast of the property. Manmade steep slopes are present on some of these mounds and will be removed during construction.

A geotechnical engineering report was prepared by Geotest Services, Inc. (See separate report). They excavated 6 test pits across the site, all to ± 11 ft deep. Their test pits found a 1 to 2 ft layer of undocumented fill top layer with varying layer of relict topsoil, above a layer of weather sand and gravel above unweather sand and gravel. Groundwater was not encountered in any of the test pits. Washington Department Ecology Well Log Viewer indicates a regional water table in the recessional outwash to be at a depth of 50 BGS in the vicinity of the site.

Geotest Services, Inc. performed one PIT test (See separate report) onsite. Geotest determined that an infiltration rate of 15.6 in/hr could be used for sizing infiltration facilities.

According to NRCS the soils onsite are classified as Lynnwood Loamy Sand. (Appendix A). Lynnwood Loamy Sand is very deep, somewhat excessively drained soil, the surface layer is grayish brown loamy sand approximately 1 inch thick and the upper part of the subsoil is dark brown loamy sand approximately 14 inches thick. The substratum extends to a depth of 60 inches or more and is grayish brown sand. Lynnwood Loamy Sand is considered a hydraulic soil group A soil.

Table 1: Existing Impervious Surfaces

Area Description	Area (square feet)
Roof Area	1,547 sq ft
Gravel Drive	8,208 sq ft
Concrete	951 sq ft
Asphalt	362 sq ft
Total	11,068 sq ft

DEVELOPED CONDITIONS

The proposed conditions include mixed use buildings with 124 onsite parking spaces, drive aisles, and sidewalks for the impervious surfaces. The pervious surfaces onsite will include parking landscaping and open space. Frontage improvements on 67th Ave NE will include removing the existing driveway that will not be used and repairing sections of the trail not in compliance with ADA standards. Frontage improvements on Woodlands Way will include replacing the rolled curb and sidewalk with curb, gutter and sidewalk. No additional impervious surfaces are anticipated for 67th Ave NE or Woodlands Way improvements. Offsite Improvements to Brierwood Loop will include a two lane road with 62 parking spaces, and sidewalk. See Table 2 below for the breakdown of areas onsite.

Table 2: Proposed Onsite Surfaces

Area Description	Area (square feet)
Roof Area	30,811 sq ft
Asphalt Parking/Drive	42,956 sq ft
Concrete Sidewalk	3,065 sq ft
Concrete Dumpster Pad	501 sq ft
Sports Court Area	1,290 sq ft
Landscaping & Pervious Open Space	30,232 sq ft
Total	108,855 sq ft

Table 3: Proposed Offsite Surfaces

Area Description	Area (square feet)
Asphalt Parking/Drive	30,898 sq ft
Concrete Sidewalk	4,042 sq ft
Landscaping	8,890 sq ft
Total	43,830 sq ft

UPSTREAM ANALYSIS

The topography in the vicinity of the site is flat with well-draining soils so there is not expected to be any upstream basin. The site is bounded by developed roads to the west and south so all runoff from these areas will be collected through the existing roadway storm system. Minimal runoff may enter the site to the north and northeast of the site which is currently lawn. The developed conditions are not expected to have any upstream flow from these areas because of the finished grade and so have not been accounted for in the model.

DOWNSTREAM ANALYSIS

All runoff from the impervious surfaces will fully infiltrate. Fully infiltrating all runoff is anticipated to meet or lower the site's runoff from the predeveloped, native forested condition.

FLOW CONTROL

Flow control has been met through infiltration trenches. The infiltration trenches were sized for 100% infiltration of 8% of the 2- year peak flow through the full 50-year peak flow using the 2012 Western Washington Hydrology Model (WWHM). Specifics about the proposed flow control trenches are further discussed in MR 7.

RUNOFF TREATMENT

The parking lot infiltration trenches will have 18" of treatment soils beneath the trenches. The soils shall have a cation exchange capacity (CEC) of 5 milliequivalents CEC/100g of dry soil or better. This will provide runoff treatment for the pollution generating hard surfaces. The trenches were sized for 100% infiltration so all stormwater runoff will pass through the amended soils.

MR #2 Stormwater Pollution Prevention Plan Narrative

SWPP Report will be submitted independent to this report at civil construction review.

MR #3 Water Pollution Source Control

No known pollution generating activities described in volume IV, chapters 3 and 4 of the DOE SMMWW will be performed on-site during construction, or are proposed for the developed site following construction. Any sources of pollution that may result from the construction activity will be controlled according to SWPPP Element #9, Control Pollutants.

MR #4 Preservation of Natural Drainage Patterns

The sites topography is flat with well-draining soils. The proposed drainage system has been designed to fully infiltrate all stormwater runoff keeping in line with the natural drainage patterns of the site.

MR #5 On-Site Stormwater Management

Minimum Requirement #5 will meet LID performance standard and flow control requirements per Sections I-2.5.5 and I-2.5.7 of the 2014 Stormwater Management Manual for Western Washington (SMMWW). The post-developed conditions will have flow rates at or less than 8% of the 2-year peak flow through the full 50-year peak flow.

The runoff from the roof areas and other hard surfaces will be mitigated through separate infiltration trenches. Geotest Services, Inc. provided an infiltration rate of 15.6 in/hr from their pit test, this rate will be used for sizing the flow control trench for the roof area. The maximum infiltration rate that can be used to size an infiltration trench with treatment is 9 in/hr. This infiltration rate will be used to size the water quality trench mitigating the runoff from the other hard surfaces.

The flow control trench designed to mitigate runoff from the roof area requires a minimum bottom area of 1,100 sf with a depth of 3 ft. The water quality infiltration trench to mitigate runoff for the other hard surfaces and landscape areas requires a bottom area of 2,500 sf with a depth of 1.5 ft and 1.5 ft of treatment soils. The size and location of these trenches will be shown on the construction plans. The trenches have been sized in WWHM (Appendix B).

BMP T5.13 Post Construction Soil Quality and Depth:

Post Construction Soil Quality and Depth will be used on site to recondition those areas that were impacted due to construction activities. Those areas to be reconditioned will be identified on the construction plans. The existing on-site topsoil will be stockpiled for use to meet the post construction soil standard. If the quantity or quality of the stockpiled on-site topsoil is insufficient, the soil amendment areas can be tilled, and compost added to the soil prior to final seeding. The intent of this

BMP is to restore the pre-developed drainage characteristics of the soil. The specific requirements for the post construction soil quality and depth will be detailed on the construction plans.

MR #6 Runoff Treatment

Runoff treatment for the proposed parking lot and driveway areas will be provided through an 18" layer of treatment soils located beneath the trench that have a cation exchange capacity (CEC) of 5 milliequivalents CEC/100g of dry soil or better.

The trench is sized by achieving 100% infiltration using WWHM. Details on the proposed trench are outlined in the WWHM report provided in Appendix B.

MR #7 Flow Control

Flow control will be provided for the site by installing infiltration trenches. The infiltration trenches are designed using WWHM to infiltrate all runoff from 8% of the 2-year storm through the full 50-year storm. Details on the proposed trench are discussed in MR #5 and outlined in the WWHM report provided in Appendix B.

MR #8 Wetland Protection

There are no wetlands on site or within the area of disturbance.

MR #9 Operations & Maintenance

An operation and maintenance manual is provided in Appendix C.

Appendices

Appendix A - NRCS Soils Report

Appendix B - WWHM Report

Appendix C - Operations and Maintenance Manual

APPENDIX A – NRCS SOILS REPORT



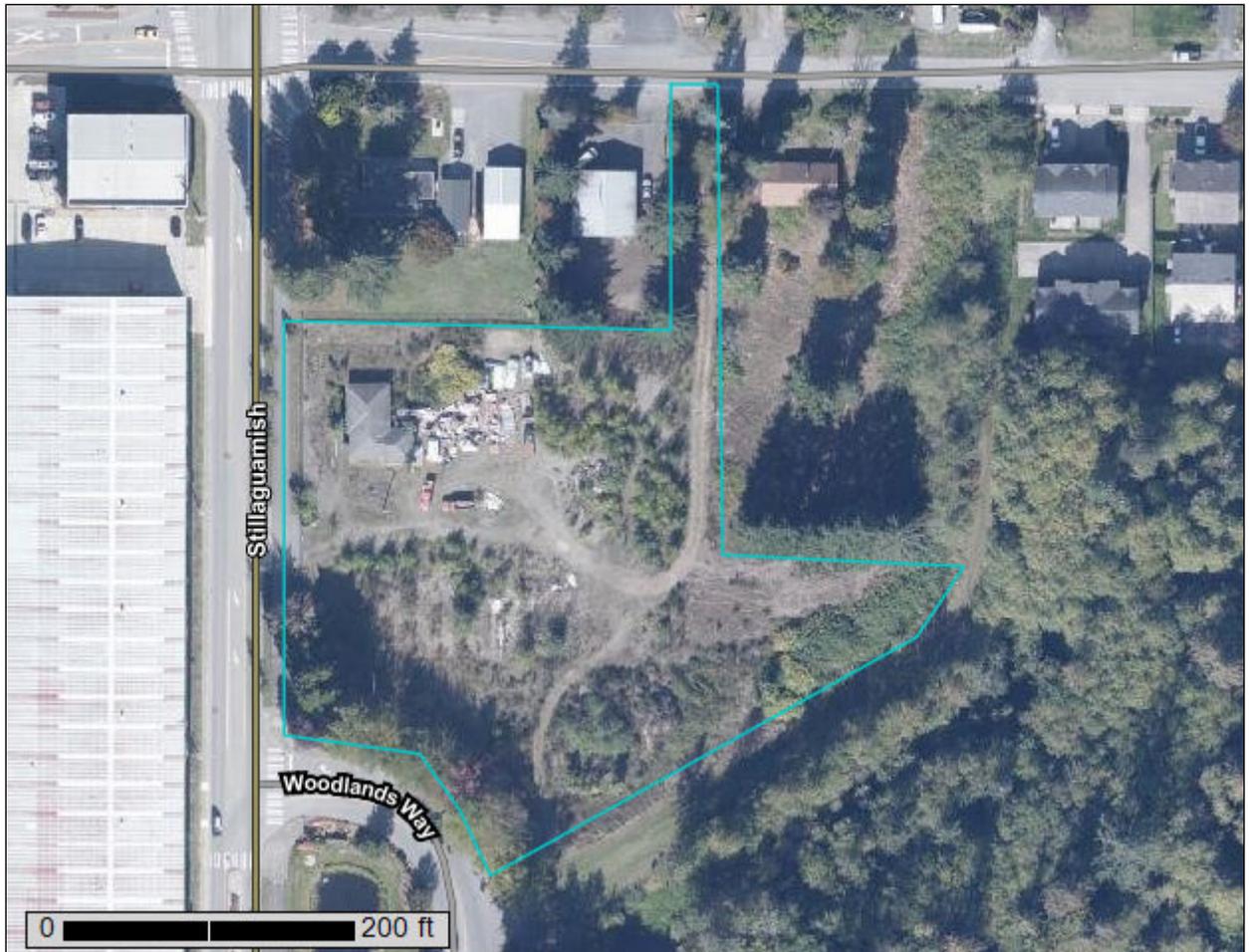
United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for Snohomish County Area, Washington



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface	2
How Soil Surveys Are Made	5
Soil Map	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	11
Map Unit Descriptions.....	11
Snohomish County Area, Washington.....	13
30—Lynnwood loamy sand, 0 to 3 percent slopes.....	13
References	15

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

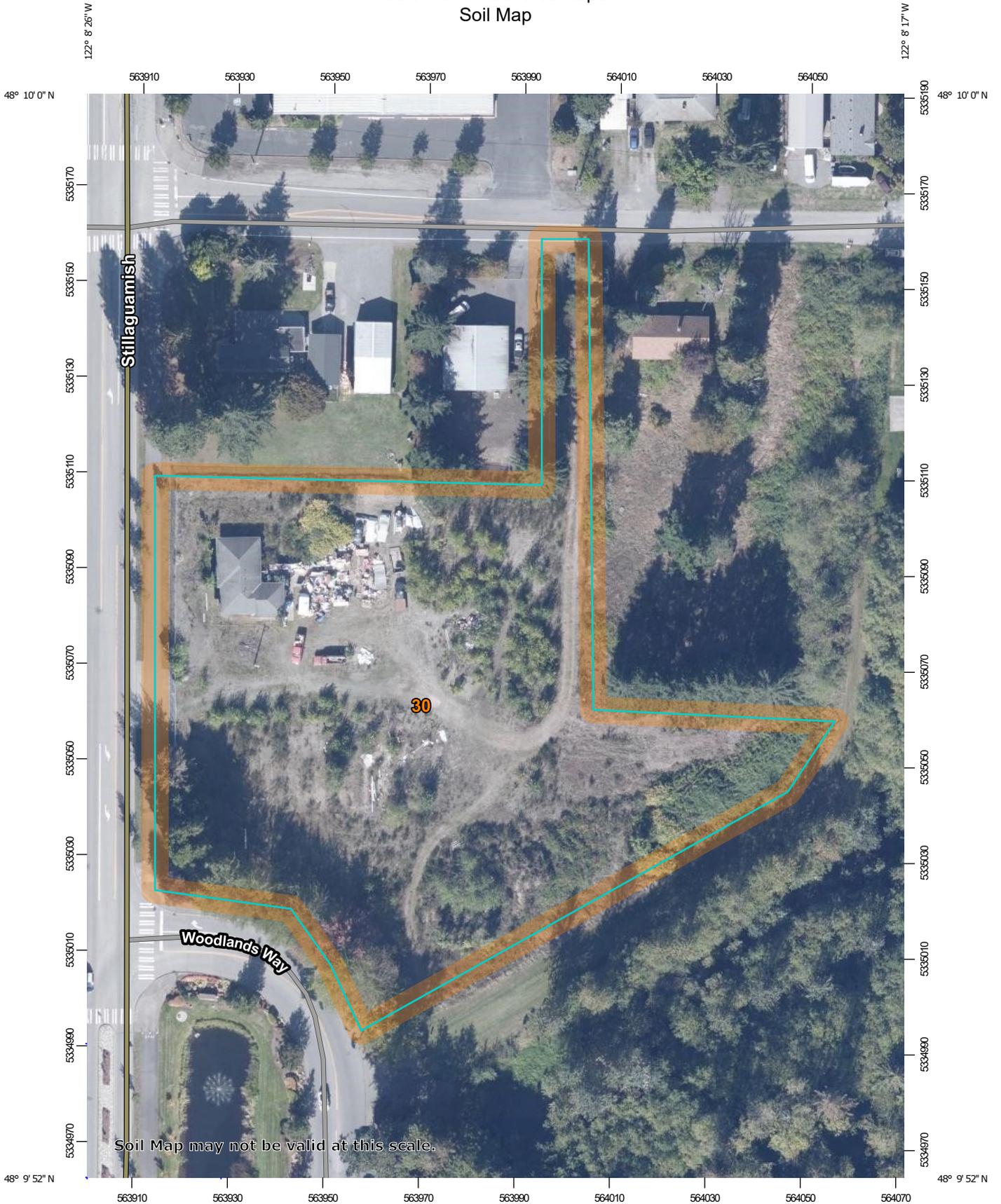
Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

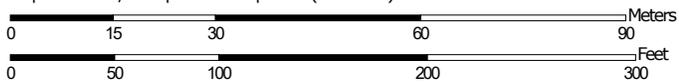
Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report Soil Map



Map Scale: 1:1,100 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features

-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features

Water Features

 Streams and Canals

Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
 Survey Area Data: Version 22, Jun 4, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2018—Oct 16, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
30	Lynnwood loamy sand, 0 to 3 percent slopes	2.6	100.0%
Totals for Area of Interest		2.6	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Custom Soil Resource Report

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Snohomish County Area, Washington

30—Lynnwood loamy sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2hym
Elevation: 50 to 600 feet
Mean annual precipitation: 40 to 65 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 180 to 200 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Lynnwood and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lynnwood

Setting

Landform: Outwash plains, terraces
Parent material: Glacial outwash

Typical profile

H1 - 0 to 1 inches: loamy sand
H2 - 1 to 29 inches: loamy sand
H3 - 29 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Forage suitability group: Droughty Soils (G002XN402WA)
Other vegetative classification: Droughty Soils (G002XN402WA)
Hydric soil rating: No

Minor Components

Custer, undrained

Percent of map unit: 5 percent
Landform: Depressions
Other vegetative classification: Wet Soils (G002XN102WA)
Hydric soil rating: Yes

Custom Soil Resource Report

References

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX B – WWHM REPORT

WWHM2012
PROJECT REPORT

General Model Information

Project Name: 22865 Infiltration 1
Site Name: Apple Builders
Site Address: 18625 67TH AVE NE
City: ARLINGTON
Report Date: 6/24/2021
Gage: Everett
Data Start: 1948/10/01
Data End: 2009/09/30
Timestep: 15 Minute
Precip Scale: 0.000 (adjusted)
Version Date: 2019/09/13
Version: 4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Onsite

Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Flat	2.165
A B, Forest, Mod	0.11
A B, Forest, Steep	0.224

Pervious Total 0

Impervious Land Use acre

Impervious Total 0

Basin Total 0

Element Flows To:		
Surface	Interflow	Groundwater

Mitigated Land Use

Parking & Landscaping

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	0.636
Pervious Total	0.636
Impervious Land Use	acre
ROADS FLAT	1.013
SIDEWALKS FLAT	0.136
Impervious Total	1.149
Basin Total	1.785

Element Flows To:

Surface	Interflow	Groundwater
Water Quality Trench	Water Quality Trench	

Roof Areas

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.714
Impervious Total	0.714
Basin Total	0.714

Element Flows To:

Surface	Interflow	Groundwater
Flow Control Trenches	Flow Control Trenches	

Routing Elements
Predeveloped Routing

Mitigated Routing

Water Quality Trench

Bottom Length:	250.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	1.5
Pour Space of material for first layer:	0.35
Material thickness of second layer:	1.5
Pour Space of material for second layer:	0.35
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	9
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	290.788
Total Volume Through Riser (ac-ft.):	0.044
Total Volume Through Facility (ac-ft.):	290.832
Percent Infiltrated:	99.98
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	2.9 ft.
Riser Diameter:	100 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.057	0.000	0.000	0.000
0.0444	0.057	0.000	0.000	0.520
0.0889	0.057	0.001	0.000	0.520
0.1333	0.057	0.002	0.000	0.520
0.1778	0.057	0.003	0.000	0.520
0.2222	0.057	0.004	0.000	0.520
0.2667	0.057	0.005	0.000	0.520
0.3111	0.057	0.006	0.000	0.520
0.3556	0.057	0.007	0.000	0.520
0.4000	0.057	0.008	0.000	0.520
0.4444	0.057	0.008	0.000	0.520
0.4889	0.057	0.009	0.000	0.520
0.5333	0.057	0.010	0.000	0.520
0.5778	0.057	0.011	0.000	0.520
0.6222	0.057	0.012	0.000	0.520
0.6667	0.057	0.013	0.000	0.520
0.7111	0.057	0.014	0.000	0.520
0.7556	0.057	0.015	0.000	0.520
0.8000	0.057	0.016	0.000	0.520
0.8444	0.057	0.017	0.000	0.520
0.8889	0.057	0.017	0.000	0.520
0.9333	0.057	0.018	0.000	0.520
0.9778	0.057	0.019	0.000	0.520
1.0222	0.057	0.020	0.000	0.520

1.0667	0.057	0.021	0.000	0.520
1.1111	0.057	0.022	0.000	0.520
1.1556	0.057	0.023	0.000	0.520
1.2000	0.057	0.024	0.000	0.520
1.2444	0.057	0.025	0.000	0.520
1.2889	0.057	0.025	0.000	0.520
1.3333	0.057	0.026	0.000	0.520
1.3778	0.057	0.027	0.000	0.520
1.4222	0.057	0.028	0.000	0.520
1.4667	0.057	0.029	0.000	0.520
1.5111	0.057	0.030	0.000	0.520
1.5556	0.057	0.031	0.000	0.520
1.6000	0.057	0.032	0.000	0.520
1.6444	0.057	0.033	0.000	0.520
1.6889	0.057	0.033	0.000	0.520
1.7333	0.057	0.034	0.000	0.520
1.7778	0.057	0.035	0.000	0.520
1.8222	0.057	0.036	0.000	0.520
1.8667	0.057	0.037	0.000	0.520
1.9111	0.057	0.038	0.000	0.520
1.9556	0.057	0.039	0.000	0.520
2.0000	0.057	0.040	0.000	0.520
2.0444	0.057	0.041	0.000	0.520
2.0889	0.057	0.042	0.000	0.520
2.1333	0.057	0.042	0.000	0.520
2.1778	0.057	0.043	0.000	0.520
2.2222	0.057	0.044	0.000	0.520
2.2667	0.057	0.045	0.000	0.520
2.3111	0.057	0.046	0.000	0.520
2.3556	0.057	0.047	0.000	0.520
2.4000	0.057	0.048	0.000	0.520
2.4444	0.057	0.049	0.000	0.520
2.4889	0.057	0.050	0.000	0.520
2.5333	0.057	0.050	0.000	0.520
2.5778	0.057	0.051	0.000	0.520
2.6222	0.057	0.052	0.000	0.520
2.6667	0.057	0.053	0.000	0.520
2.7111	0.057	0.054	0.000	0.520
2.7556	0.057	0.055	0.000	0.520
2.8000	0.057	0.056	0.000	0.520
2.8444	0.057	0.057	0.000	0.520
2.8889	0.057	0.058	0.000	0.520
2.9333	0.057	0.058	0.538	0.520
2.9778	0.057	0.059	1.919	0.520
3.0222	0.057	0.062	3.779	0.520
3.0667	0.057	0.064	6.016	0.520
3.1111	0.057	0.067	8.575	0.520
3.1556	0.057	0.070	11.41	0.520
3.2000	0.057	0.072	14.52	0.520
3.2444	0.057	0.075	17.85	0.520
3.2889	0.057	0.077	21.42	0.520
3.3333	0.057	0.080	25.18	0.520
3.3778	0.057	0.082	29.15	0.520
3.4222	0.057	0.085	33.30	0.520
3.4667	0.057	0.087	37.63	0.520
3.5111	0.057	0.090	42.12	0.520
3.5556	0.057	0.093	46.77	0.520
3.6000	0.057	0.095	51.58	0.520

3.6444	0.057	0.098	56.54	0.520
3.6889	0.057	0.100	61.63	0.520
3.7333	0.057	0.103	66.86	0.520
3.7778	0.057	0.105	72.21	0.520
3.8222	0.057	0.108	77.68	0.520
3.8667	0.057	0.110	83.27	0.520
3.9111	0.057	0.113	88.97	0.520
3.9556	0.057	0.115	94.78	0.520
4.0000	0.057	0.118	100.6	0.520

Flow Control Trenches

Bottom Length:	110.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	3
Pour Space of material for first layer:	0.35
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	15.6
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	137.517
Total Volume Through Riser (ac-ft.):	0.007
Total Volume Through Facility (ac-ft.):	137.524
Percent Infiltrated:	99.99
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	2.9 ft.
Riser Diameter:	100 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

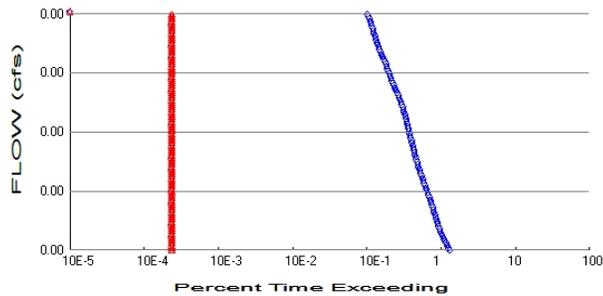
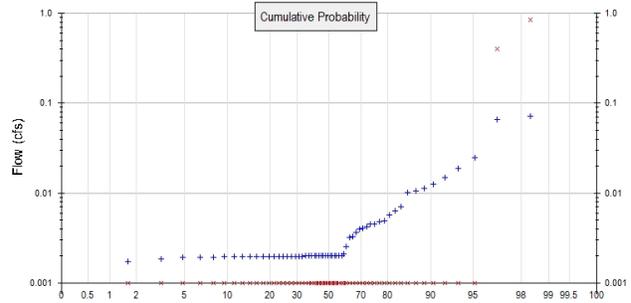
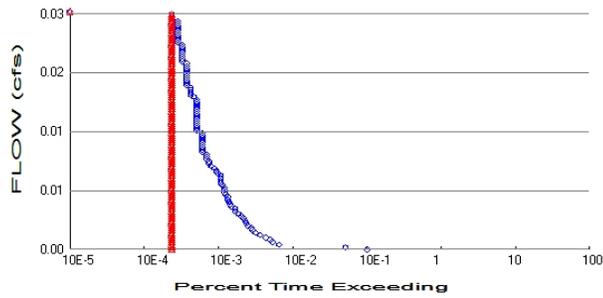
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.025	0.000	0.000	0.000
0.0333	0.025	0.000	0.000	0.397
0.0667	0.025	0.000	0.000	0.397
0.1000	0.025	0.000	0.000	0.397
0.1333	0.025	0.001	0.000	0.397
0.1667	0.025	0.001	0.000	0.397
0.2000	0.025	0.001	0.000	0.397
0.2333	0.025	0.002	0.000	0.397
0.2667	0.025	0.002	0.000	0.397
0.3000	0.025	0.002	0.000	0.397
0.3333	0.025	0.002	0.000	0.397
0.3667	0.025	0.003	0.000	0.397
0.4000	0.025	0.003	0.000	0.397
0.4333	0.025	0.003	0.000	0.397
0.4667	0.025	0.004	0.000	0.397
0.5000	0.025	0.004	0.000	0.397
0.5333	0.025	0.004	0.000	0.397
0.5667	0.025	0.005	0.000	0.397
0.6000	0.025	0.005	0.000	0.397
0.6333	0.025	0.005	0.000	0.397
0.6667	0.025	0.005	0.000	0.397
0.7000	0.025	0.006	0.000	0.397
0.7333	0.025	0.006	0.000	0.397
0.7667	0.025	0.006	0.000	0.397
0.8000	0.025	0.007	0.000	0.397
0.8333	0.025	0.007	0.000	0.397

0.8667	0.025	0.007	0.000	0.397
0.9000	0.025	0.008	0.000	0.397
0.9333	0.025	0.008	0.000	0.397
0.9667	0.025	0.008	0.000	0.397
1.0000	0.025	0.008	0.000	0.397
1.0333	0.025	0.009	0.000	0.397
1.0667	0.025	0.009	0.000	0.397
1.1000	0.025	0.009	0.000	0.397
1.1333	0.025	0.010	0.000	0.397
1.1667	0.025	0.010	0.000	0.397
1.2000	0.025	0.010	0.000	0.397
1.2333	0.025	0.010	0.000	0.397
1.2667	0.025	0.011	0.000	0.397
1.3000	0.025	0.011	0.000	0.397
1.3333	0.025	0.011	0.000	0.397
1.3667	0.025	0.012	0.000	0.397
1.4000	0.025	0.012	0.000	0.397
1.4333	0.025	0.012	0.000	0.397
1.4667	0.025	0.013	0.000	0.397
1.5000	0.025	0.013	0.000	0.397
1.5333	0.025	0.013	0.000	0.397
1.5667	0.025	0.013	0.000	0.397
1.6000	0.025	0.014	0.000	0.397
1.6333	0.025	0.014	0.000	0.397
1.6667	0.025	0.014	0.000	0.397
1.7000	0.025	0.015	0.000	0.397
1.7333	0.025	0.015	0.000	0.397
1.7667	0.025	0.015	0.000	0.397
1.8000	0.025	0.015	0.000	0.397
1.8333	0.025	0.016	0.000	0.397
1.8667	0.025	0.016	0.000	0.397
1.9000	0.025	0.016	0.000	0.397
1.9333	0.025	0.017	0.000	0.397
1.9667	0.025	0.017	0.000	0.397
2.0000	0.025	0.017	0.000	0.397
2.0333	0.025	0.018	0.000	0.397
2.0667	0.025	0.018	0.000	0.397
2.1000	0.025	0.018	0.000	0.397
2.1333	0.025	0.018	0.000	0.397
2.1667	0.025	0.019	0.000	0.397
2.2000	0.025	0.019	0.000	0.397
2.2333	0.025	0.019	0.000	0.397
2.2667	0.025	0.020	0.000	0.397
2.3000	0.025	0.020	0.000	0.397
2.3333	0.025	0.020	0.000	0.397
2.3667	0.025	0.020	0.000	0.397
2.4000	0.025	0.021	0.000	0.397
2.4333	0.025	0.021	0.000	0.397
2.4667	0.025	0.021	0.000	0.397
2.5000	0.025	0.022	0.000	0.397
2.5333	0.025	0.022	0.000	0.397
2.5667	0.025	0.022	0.000	0.397
2.6000	0.025	0.023	0.000	0.397
2.6333	0.025	0.023	0.000	0.397
2.6667	0.025	0.023	0.000	0.397
2.7000	0.025	0.023	0.000	0.397
2.7333	0.025	0.024	0.000	0.397
2.7667	0.025	0.024	0.000	0.397

2.8000	0.025	0.024	0.000	0.397
2.8333	0.025	0.025	0.000	0.397
2.8667	0.025	0.025	0.000	0.397
2.9000	0.025	0.025	0.000	0.397
2.9333	0.025	0.025	0.538	0.397
2.9667	0.025	0.026	1.522	0.397
3.0000	0.025	0.026	2.797	0.397

Analysis Results

POC 1



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area: 2.499
 Total Impervious Area: 0

Mitigated Landuse Totals for POC #1

Total Pervious Area: 0.636
 Total Impervious Area: 1.863

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.002944
5 year	0.006549
10 year	0.010668
25 year	0.018973
50 year	0.028395
100 year	0.04169

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.002	0.000
1950	0.006	0.000
1951	0.004	0.000
1952	0.002	0.000
1953	0.002	0.000
1954	0.015	0.000
1955	0.011	0.000
1956	0.002	0.000
1957	0.002	0.000
1958	0.002	0.403
1959	0.005	0.000
1960	0.004	0.000
1961	0.010	0.848
1962	0.002	0.000
1963	0.002	0.000
1964	0.007	0.000
1965	0.002	0.000
1966	0.002	0.000
1967	0.004	0.000
1968	0.002	0.000
1969	0.002	0.000
1970	0.002	0.000
1971	0.010	0.000
1972	0.002	0.000
1973	0.002	0.000
1974	0.006	0.000
1975	0.002	0.000
1976	0.005	0.000
1977	0.002	0.000
1978	0.002	0.000
1979	0.004	0.000
1980	0.002	0.000
1981	0.002	0.000
1982	0.003	0.000
1983	0.002	0.000
1984	0.002	0.000
1985	0.004	0.000
1986	0.019	0.000
1987	0.013	0.000
1988	0.002	0.000
1989	0.002	0.000
1990	0.002	0.000
1991	0.002	0.000
1992	0.002	0.000
1993	0.002	0.000
1994	0.002	0.000
1995	0.003	0.000
1996	0.025	0.000
1997	0.065	0.000
1998	0.002	0.000
1999	0.002	0.000
2000	0.004	0.000
2001	0.002	0.000
2002	0.002	0.000
2003	0.001	0.000
2004	0.002	0.000

2005	0.002	0.000
2006	0.072	0.000
2007	0.002	0.000
2008	0.003	0.000
2009	0.002	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0716	0.8484
2	0.0654	0.4034
3	0.0250	0.0000
4	0.0190	0.0000
5	0.0148	0.0000
6	0.0126	0.0000
7	0.0112	0.0000
8	0.0105	0.0000
9	0.0101	0.0000
10	0.0070	0.0000
11	0.0063	0.0000
12	0.0057	0.0000
13	0.0049	0.0000
14	0.0048	0.0000
15	0.0045	0.0000
16	0.0045	0.0000
17	0.0042	0.0000
18	0.0040	0.0000
19	0.0040	0.0000
20	0.0036	0.0000
21	0.0033	0.0000
22	0.0032	0.0000
23	0.0026	0.0000
24	0.0021	0.0000
25	0.0020	0.0000
26	0.0020	0.0000
27	0.0020	0.0000
28	0.0020	0.0000
29	0.0020	0.0000
30	0.0020	0.0000
31	0.0020	0.0000
32	0.0020	0.0000
33	0.0020	0.0000
34	0.0020	0.0000
35	0.0020	0.0000
36	0.0020	0.0000
37	0.0020	0.0000
38	0.0020	0.0000
39	0.0020	0.0000
40	0.0020	0.0000
41	0.0020	0.0000
42	0.0020	0.0000
43	0.0020	0.0000
44	0.0020	0.0000
45	0.0020	0.0000
46	0.0020	0.0000
47	0.0020	0.0000
48	0.0020	0.0000
49	0.0020	0.0000

50	0.0020	0.0000
51	0.0020	0.0000
52	0.0020	0.0000
53	0.0020	0.0000
54	0.0020	0.0000
55	0.0019	0.0000
56	0.0019	0.0000
57	0.0019	0.0000
58	0.0019	0.0000
59	0.0018	0.0000
60	0.0017	0.0000
61	0.0014	0.0000

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0002	27934	5	0	Pass
0.0002	26822	5	0	Pass
0.0003	25709	5	0	Pass
0.0003	24725	5	0	Pass
0.0003	23720	5	0	Pass
0.0003	22972	5	0	Pass
0.0003	22052	5	0	Pass
0.0003	21350	5	0	Pass
0.0003	20736	5	0	Pass
0.0003	20247	5	0	Pass
0.0004	19778	5	0	Pass
0.0004	19312	5	0	Pass
0.0004	18826	5	0	Pass
0.0004	18416	5	0	Pass
0.0004	18005	5	0	Pass
0.0004	17618	5	0	Pass
0.0004	17218	5	0	Pass
0.0004	16882	5	0	Pass
0.0005	16478	5	0	Pass
0.0005	16087	5	0	Pass
0.0005	15652	5	0	Pass
0.0005	15278	5	0	Pass
0.0005	14844	5	0	Pass
0.0005	14448	5	0	Pass
0.0005	14052	5	0	Pass
0.0005	13712	5	0	Pass
0.0006	13374	5	0	Pass
0.0006	13004	5	0	Pass
0.0006	12637	5	0	Pass
0.0006	12339	5	0	Pass
0.0006	12010	5	0	Pass
0.0006	11683	5	0	Pass
0.0006	11415	5	0	Pass
0.0006	11137	5	0	Pass
0.0007	10904	5	0	Pass
0.0007	10652	5	0	Pass
0.0007	10395	5	0	Pass
0.0007	10151	5	0	Pass
0.0007	9916	5	0	Pass
0.0007	9728	5	0	Pass
0.0007	9544	5	0	Pass
0.0007	9368	5	0	Pass
0.0008	9195	5	0	Pass
0.0008	9056	5	0	Pass
0.0008	8838	5	0	Pass
0.0008	8641	5	0	Pass
0.0008	8472	5	0	Pass
0.0008	8331	5	0	Pass
0.0008	8164	5	0	Pass
0.0008	8002	5	0	Pass
0.0009	7867	5	0	Pass
0.0009	7743	5	0	Pass
0.0009	7602	5	0	Pass

0.0009	7469	5	0	Pass
0.0009	7328	5	0	Pass
0.0009	7176	5	0	Pass
0.0009	7056	5	0	Pass
0.0009	6911	5	0	Pass
0.0010	6791	5	0	Pass
0.0010	6624	5	0	Pass
0.0010	6464	5	0	Pass
0.0010	6310	5	0	Pass
0.0010	6139	5	0	Pass
0.0010	5957	5	0	Pass
0.0010	5790	5	0	Pass
0.0010	5602	5	0	Pass
0.0011	5456	5	0	Pass
0.0011	5223	5	0	Pass
0.0011	5061	5	0	Pass
0.0011	4917	5	0	Pass
0.0011	4793	5	0	Pass
0.0011	4644	5	0	Pass
0.0011	4528	5	0	Pass
0.0011	4389	5	0	Pass
0.0012	4269	5	0	Pass
0.0012	4156	5	0	Pass
0.0012	4042	5	0	Pass
0.0012	3929	5	0	Pass
0.0012	3837	5	0	Pass
0.0012	3711	5	0	Pass
0.0012	3604	5	0	Pass
0.0012	3478	5	0	Pass
0.0013	3367	5	0	Pass
0.0013	3240	5	0	Pass
0.0013	3161	5	0	Pass
0.0013	3076	5	0	Pass
0.0013	3003	5	0	Pass
0.0013	2920	5	0	Pass
0.0013	2858	5	0	Pass
0.0013	2774	5	0	Pass
0.0014	2731	5	0	Pass
0.0014	2661	5	0	Pass
0.0014	2607	5	0	Pass
0.0014	2547	5	0	Pass
0.0014	2485	5	0	Pass
0.0014	2425	5	0	Pass
0.0014	2366	5	0	Pass
0.0014	2316	5	0	Pass
0.0015	2250	5	0	Pass
0.0015	2173	5	0	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0015	2173	5	0	Pass
0.0017	1101	5	0	Pass
0.0020	140	5	3	Pass
0.0023	114	5	4	Pass
0.0026	106	5	4	Pass
0.0028	93	5	5	Pass
0.0031	78	5	6	Pass
0.0034	68	5	7	Pass
0.0036	61	5	8	Pass
0.0039	59	5	8	Pass
0.0042	54	5	9	Pass
0.0045	51	5	9	Pass
0.0047	49	5	10	Pass
0.0050	47	5	10	Pass
0.0053	43	5	11	Pass
0.0056	40	5	12	Pass
0.0058	36	5	13	Pass
0.0061	36	5	13	Pass
0.0064	32	5	15	Pass
0.0066	31	5	16	Pass
0.0069	30	5	16	Pass
0.0072	29	5	17	Pass
0.0075	29	5	17	Pass
0.0077	27	5	18	Pass
0.0080	26	5	19	Pass
0.0083	26	5	19	Pass
0.0085	26	5	19	Pass
0.0088	24	5	20	Pass
0.0091	23	5	21	Pass
0.0094	23	5	21	Pass
0.0096	23	5	21	Pass
0.0099	23	5	21	Pass
0.0102	21	5	23	Pass
0.0104	20	5	25	Pass
0.0107	19	5	26	Pass
0.0110	17	5	29	Pass
0.0113	16	5	31	Pass
0.0115	16	5	31	Pass
0.0118	15	5	33	Pass
0.0121	15	5	33	Pass
0.0123	15	5	33	Pass
0.0126	13	5	38	Pass
0.0129	13	5	38	Pass
0.0132	13	5	38	Pass
0.0134	13	5	38	Pass
0.0137	13	5	38	Pass
0.0140	13	5	38	Pass
0.0143	13	5	38	Pass
0.0145	13	5	38	Pass
0.0148	13	5	38	Pass
0.0151	11	5	45	Pass
0.0153	11	5	45	Pass
0.0156	11	5	45	Pass

0.0159	11	5	45	Pass
0.0162	11	5	45	Pass
0.0164	11	5	45	Pass
0.0167	11	5	45	Pass
0.0170	11	5	45	Pass
0.0172	11	5	45	Pass
0.0175	11	5	45	Pass
0.0178	11	5	45	Pass
0.0181	11	5	45	Pass
0.0183	11	5	45	Pass
0.0186	11	5	45	Pass
0.0189	10	5	50	Pass
0.0191	9	5	55	Pass
0.0194	9	5	55	Pass
0.0197	9	5	55	Pass
0.0200	9	5	55	Pass
0.0202	8	5	62	Pass
0.0205	8	5	62	Pass
0.0208	8	5	62	Pass
0.0211	8	5	62	Pass
0.0213	8	5	62	Pass
0.0216	8	5	62	Pass
0.0219	8	5	62	Pass
0.0221	8	5	62	Pass
0.0224	8	5	62	Pass
0.0227	8	5	62	Pass
0.0230	7	5	71	Pass
0.0232	7	5	71	Pass
0.0235	7	5	71	Pass
0.0238	7	5	71	Pass
0.0240	7	5	71	Pass
0.0243	7	5	71	Pass
0.0246	7	5	71	Pass
0.0249	7	5	71	Pass
0.0251	6	5	83	Pass
0.0254	6	5	83	Pass
0.0257	6	5	83	Pass
0.0259	6	5	83	Pass
0.0262	6	5	83	Pass
0.0265	6	5	83	Pass
0.0268	6	5	83	Pass
0.0270	6	5	83	Pass
0.0273	6	5	83	Pass
0.0276	6	5	83	Pass
0.0279	5	5	100	Pass
0.0281	5	5	100	Pass
0.0284	5	5	100	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Water Quality Trench POC	<input type="checkbox"/>	264.66			<input type="checkbox"/>	99.98			
Flow Control Trenches POC	<input type="checkbox"/>	125.15			<input type="checkbox"/>	99.99			
Total Volume Infiltrated		389.80	0.00	0.00		99.99	0.00	0%	No Treat Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

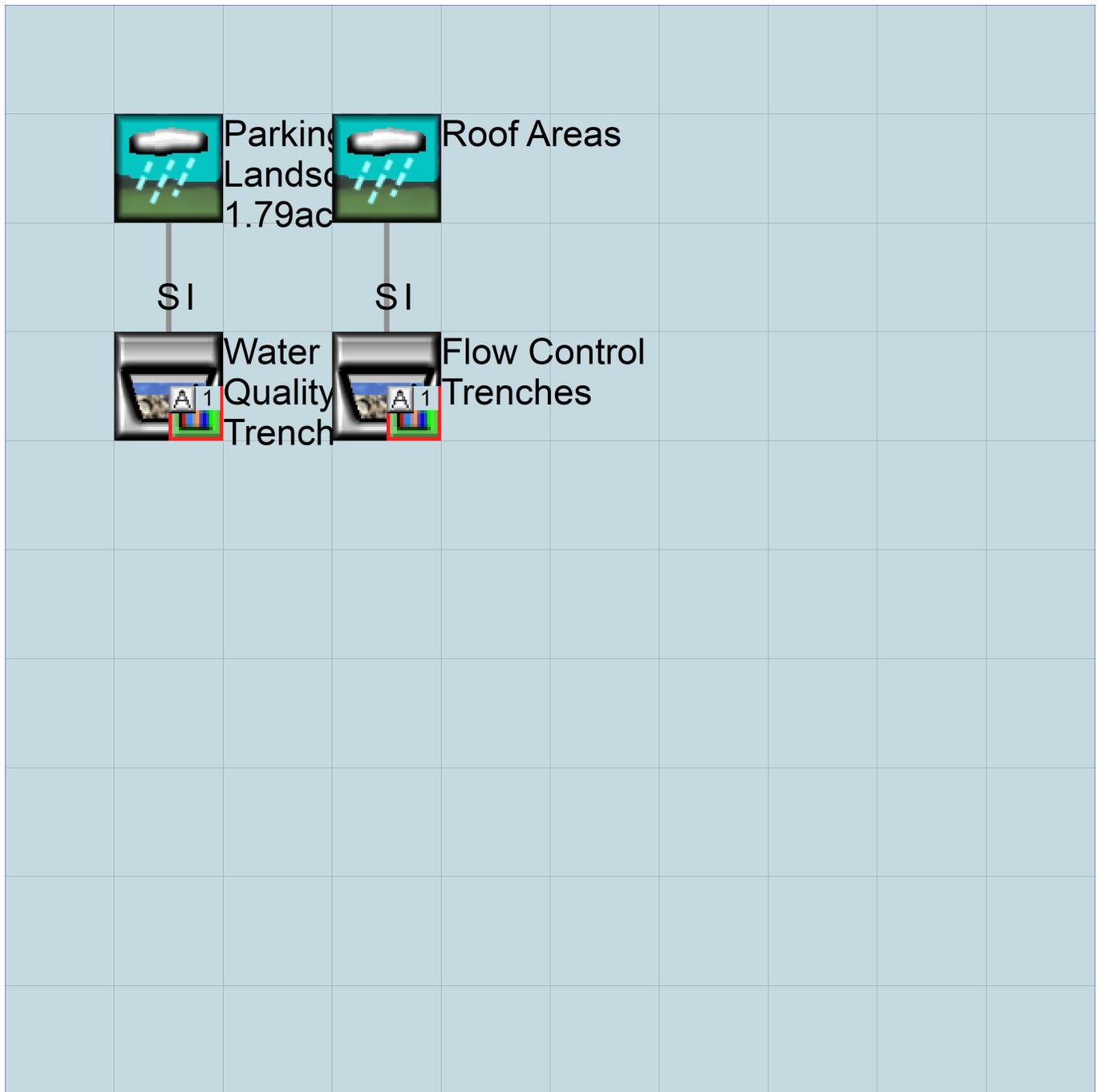
No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Onsite
2.50ac

Mitigated Schematic



APPENDIX C – OPERATION AND MAINTENANCE MANUAL

STORMWATER FACILITY MAINTENANCE MANUAL



**FOR PUBLIC & PRIVATELY OWNED
STORMWATER FACILITIES**

**PREPARED BY:
CASCADE SURVEYING & ENGINEERING, INC.**

June 2021

TABLE OF CONTENTS

TABLE OF CONTENTS 2

INTRODUCTION..... 3

CATCH BASIN 4

CATCH BASIN INSERT 7

CONVEYANCE STORMWATER PIPE..... 9

OIL WATER SEPARATOR CATCH BASIN 10

INFILTRATION TRENCH..... 12

YARD DRAIN & CLEANOUT 14

COMPOST-AMENDED SOILS 18

GENERAL GROUNDS KEEPING & LANDSCAPE PLANTINGS CARE 23

INTRODUCTION

Background

All residential, commercial, and industrial developments have some form of stormwater drainage facilities. Stormwater facilities generally drain to roadside ditches, underground storm pipe systems, streams, lakes, or to groundwater from infiltration facilities. Stormwater facilities generally consist of pipes, catch basins, swales, ditches, ponds, oil/water separators, underground infiltration trenches, and any other structure that collects, conveys, controls, and treats stormwater.

Stormwater facilities are either privately owned or publicly owned. Private stormwater facility owners consist of individual residential property owners, a home owners' association, commercial and industrial land owners. Privately owned stormwater facilities are generally installed on private property within the bounds of the private land, in a separate tract, or in an easement on land owned by others.

Publicly owned stormwater facilities are usually owned and operated by a city, county, state, or federal entities. In either case, the owner of the system is responsible for operating and maintaining all elements of the facility.

Purpose

The objective of this manual is to ensure that stormwater control facilities are adequately maintained and operated properly.

This manual is intended to meet all storm system operation and maintenance requirements listed under the 2010 Snohomish County Engineering Design and Development Standards.

Storm system maintenance is necessary to protect streams, lakes, wetlands, and groundwater. Proper maintenance assures that storm systems operate as they were designed, and that they are cleaned of pollutants that they trap, such as sediment and oils, so that the storm system is not overwhelmed and becomes a pollutant source.

Stormwater System Inspection Schedule

The drainage system should be monitored periodically. For the first year after completion of construction, the system should be monitored after every large storm event (> 1-in in 24-hrs), and, during the period Oct. 1- Mar. 31 inspections should be conducted monthly. From April 1- Sept. 30, the facility should be monitored on a quarterly basis. Once the performance characteristics of the facility have been verified, the monitoring schedule can be reduced to an annual basis unless the performance data indicate that a more frequent schedule is required.

Catch Basin

A catch basin is an underground concrete structure typically fitted with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two types.

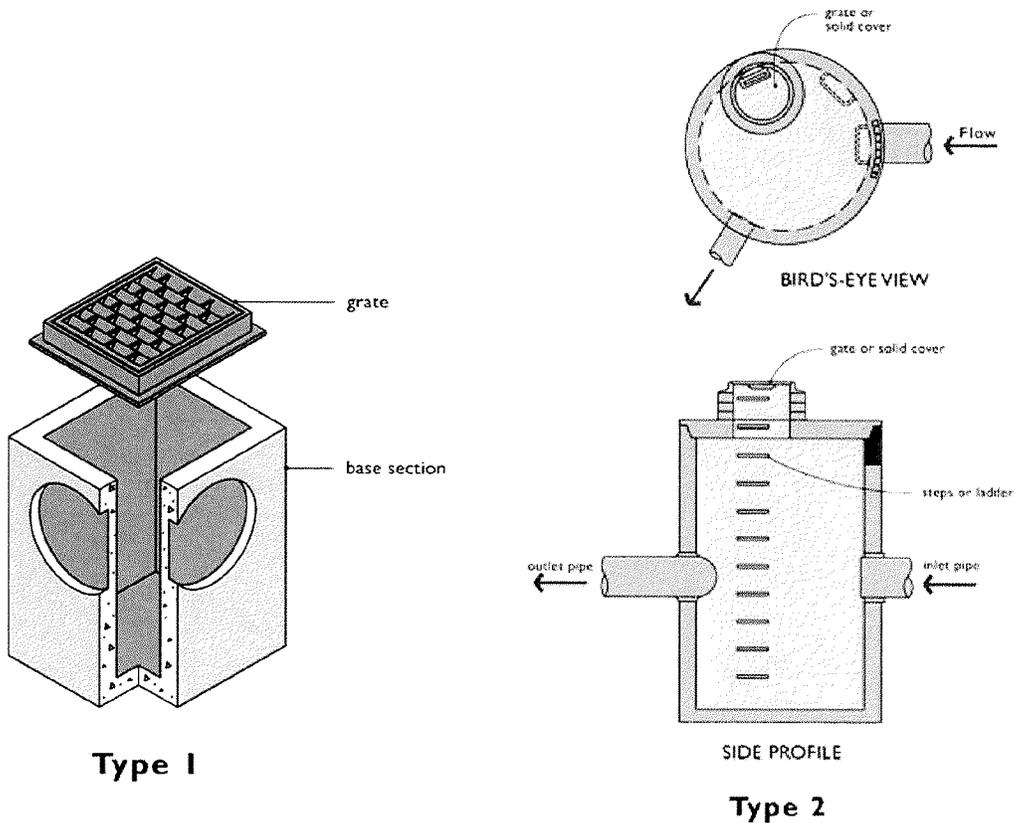
A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

Type 2 catch basins, also commonly referred to as storm manholes, are round concrete structures ranging in diameter from 4 feet to 8 feet. Type 2 catch basins are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Type 2 catch basins typically have manhole steps mounted on the side of the structure to allow access.

Both types typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

The most common tool for cleaning catch basins is a truck with a tank and vacuum hose (vector truck) to remove sediment and debris from the sump. A catch basin may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Catch basins are typically associated with all stormwater facilities.



Catch Basins

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.	

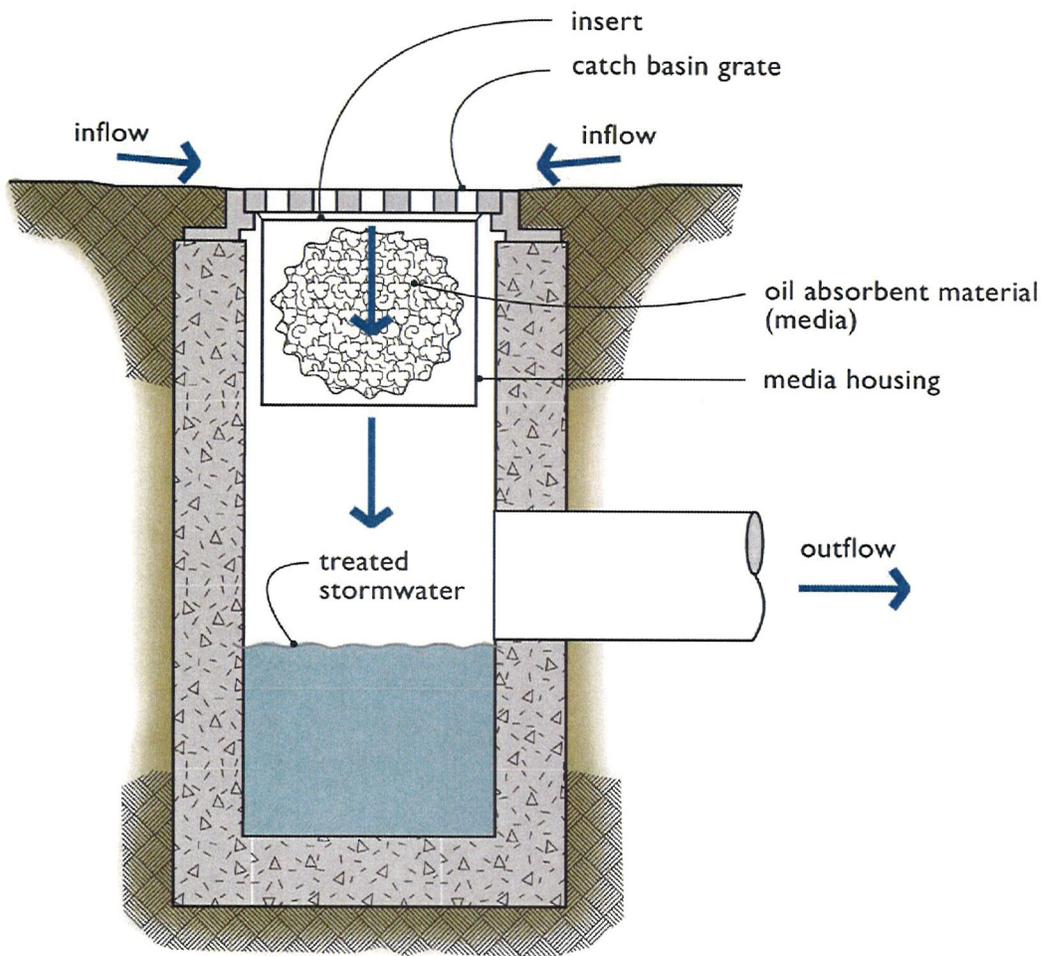
Catch Basins (Continued)			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure (Intent is to keep cover from sealing off access to maintenance).	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Catch Basin Insert

Catch basin inserts are becoming more widely used to trap sediment and oil entering catch basins. Most involve some type of filter media and oil-absorbent pads. Filters avoid flooding by overflowing when they become clogged or when there are high storm flows.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow



Catch Basin Insert

Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Conveyance Stormwater Pipe

Inlet and outlet stormwater pipes convey stormwater in, through, and out of stormwater facilities.

Storm sewer pipes convey stormwater. Pipes are built from many materials and are sometimes perforated to allow stormwater to infiltrate into the ground. Stormwater pipes are cleaned to remove sediment or blockages when problems are identified. Stormwater pipes must be clear of obstructions and breaks to prevent localized flooding. All stormwater pipes should be in proper working order and free of the possible defects listed below.

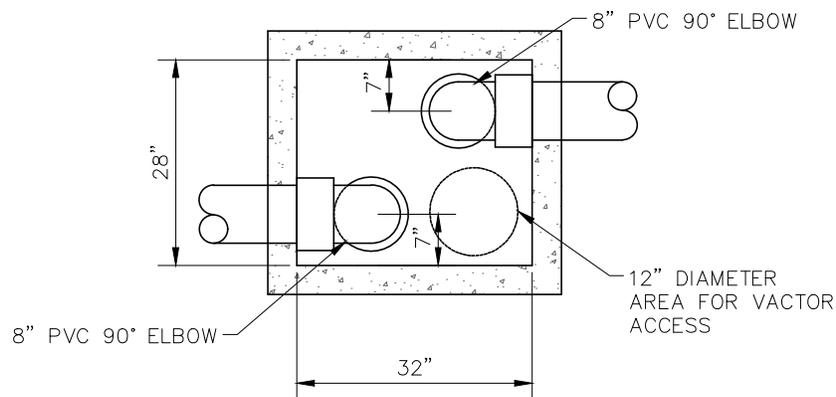
Conveyance Storm Pipe			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Obstructions, Including Roots	Root enters or deforms pipe, reducing flow.	Use mechanical methods to remove root. Do not put root-dissolving chemicals in storm sewer pipes. If necessary, remove the vegetation over the line.
	Pipe Dented or Broken	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Pipe Rusted or Deteriorated	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired and/or replaced.
	Sediment & Debris	Sediment depth is greater than 20% of pipe diameter.	Install upstream debris traps (where applicable) then clean pipe and remove material
	Debris barrier or Trash Rack Missing	Stormwater pipes > than 18 inches need debris barrier	Debris barrier present on all stormwater pipes 18 inches and greater

Oil/Water Separator (CATCH BASIN)

An oil/water separator is an underground vault that treats stormwater by mechanically separating oil from water. The oil rises to the surface and floats on the water and sediment settles to the bottom. Oil/water separators are typically utilized in locations where high oil concentrations in the stormwater runoff are anticipated (e.g. service and fuel stations). Oil/water separators are most commonly used as the first pre-treatment facility in a series of stormwater management facilities.

Facility objects that are typically associated with an oil/water separator include:

- access road or easement
- control structure/flow restrictor



NOTE :

REFER TO
ARLINGTON
STANDARD DETAIL
SD-120 FOR
VARIATION OF OIL/
WATER SEPARATOR

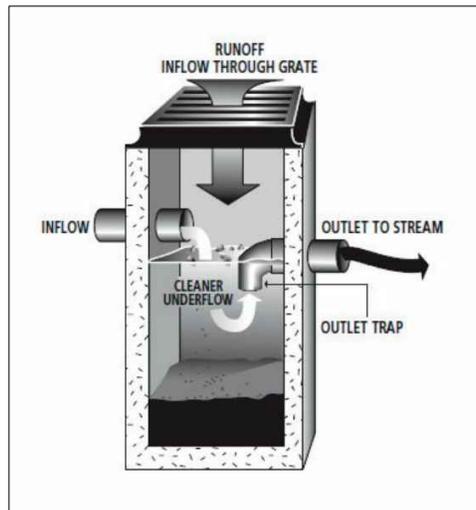


IMAGE FROM KING COUNTY STORMWATER POLLUTION PREVENTION MANUAL

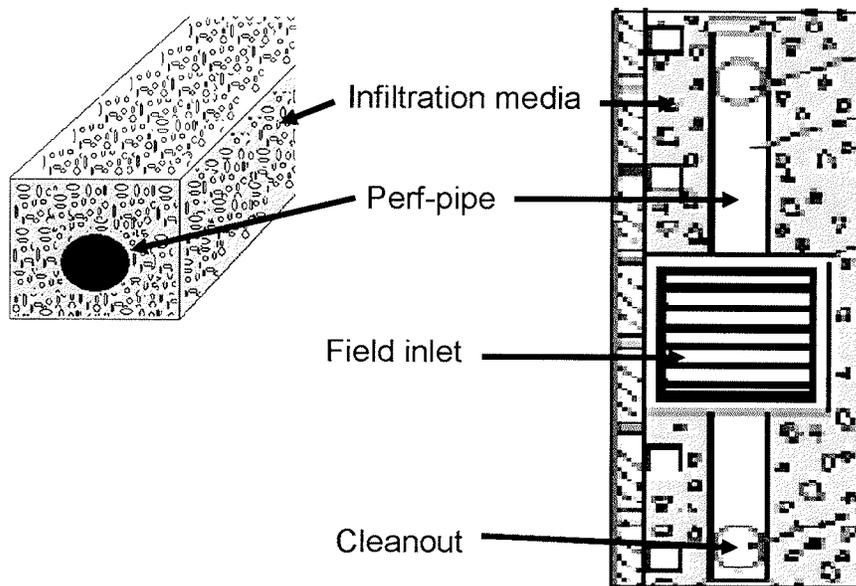
Baffle Oil/Water Separator (API Type)				
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed	
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality (i.e. obvious oil or other contaminants present)	Effluent discharge from vault should be clear without thick visible sheen.	
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.	
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.	
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.	
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.	
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.	
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
			Maintenance person judges that structure is unsound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
			Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regouted and secure at basin wall.
			Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.	
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.	

Infiltration Trench

A stormwater infiltration trench is a closed basin built by excavating below existing ground. Infiltration trenches temporarily store stormwater runoff during rain events. Infiltration trenches do not discharge to a downstream conveyance system or nearby surface water. Instead, infiltration trenches rely on the ability of the site's soils to infiltrate the stormwater into the ground.

Facility objects that are typically associated with an infiltration trench include:

- access road or easement
- fence, gate, and water quality sign
- bioswale
- sediment trap
- field inlet



Infiltration Trench			
Drainage System Feature	Potential Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed Or Not Needed
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants in or around facility. • Identify and remove source	No contaminants or pollutants present.
	Observation Well	Sediment depth greater than one foot above stone aggregate or the surface inlet.	No sediment in infiltration trench.
	Drainage Slow	Decreased capacity that indicates slow drainage.	Verify facility design rate. Clean perforated drain pipe. Do not allow removed sediment and water to discharge back into the storm sewer.

Yard Drain & Cleanout

What is a Yard Drain?

A Yard Drain is similar to a Type 1 Catch Basin but smaller (most are 12 to 18 inches in diameter).

- Currently, the most frequently used type of yard drain is a high density polyethylene (HDPE) pipe:
 - set vertically on end,
 - with the bell end up fitted with a grate, and
 - the bottom end resting on washed drain rock.
- There are older versions which are made of either polyvinylchloride (PVC) or Concrete Pipe.

How does a Yard Drain work?

Yard Drain systems usually consist of several yard drains and 6"-8" diameter HDPE pipe between them. They are designed for use in private residential or commercial property and not for use in public or private streets and roads.

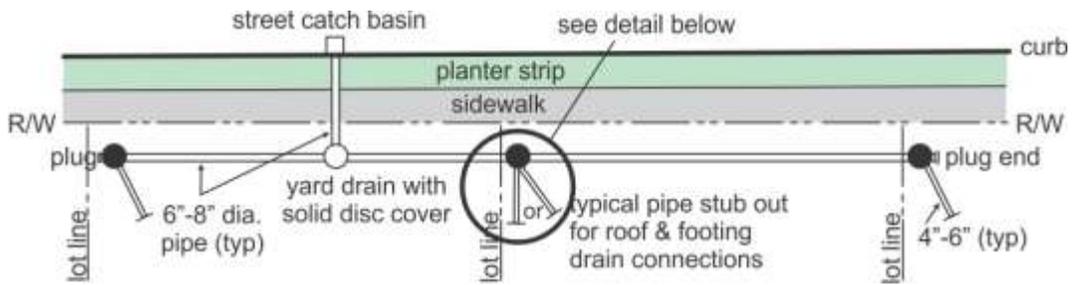
- They function as an intermediary stormwater conveyance system that connects roof and building foundation footing drains (4"-6" diameter HDPE pipe) to the main stormwater conveyance system of:
 - **Type 1 or 2 Catch Basins**, and
 - 12" and larger diameter HDPE pipe.
- Typically, in residential subdivisions these systems can be located along lot lines.
- Yard Drains also have commercial property applications, often being installed to connect building roof and footing drains To the parking area and driveway drainage systems.

NOTE: If Yard Drains are not visible, it is possible that Cleanouts were installed as a substitute. This is generally the case when the depth from the top of the **Yard Drain** grate to what would be the top of the washed drain rock exceeds 42". (See drawings below.)

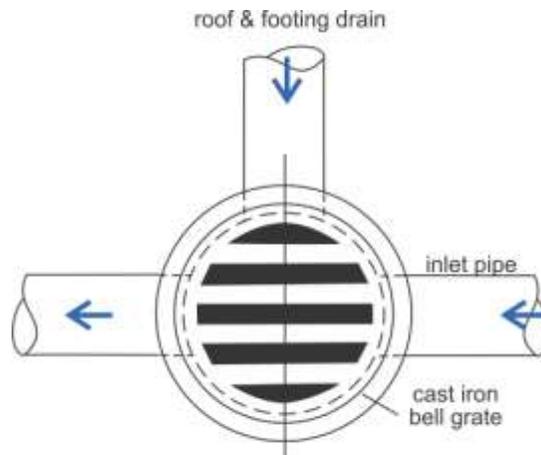
Common maintenance needs

The most common tool for cleaning Yard Drains or Cleanouts is a yard hose. Cleaning by a vactor truck with its very high pressure and volume washing and vacuum system can destroy both the older Yard Drains or Cleanouts and pipe. It is better to use a low pressure washing system and scoop out by hand any mud and debris collecting in the Yard Drains or Cleanouts.

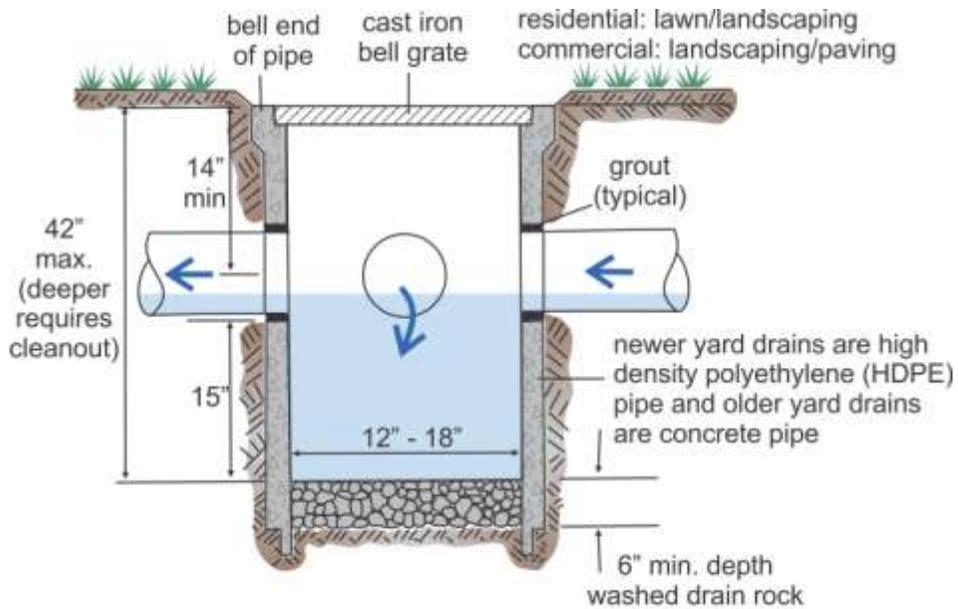
Yard Drain



BIRD'S-EYE VIEW
TYPICAL YARD DRAIN PLACEMENT FOR RESIDENTIAL LOTS

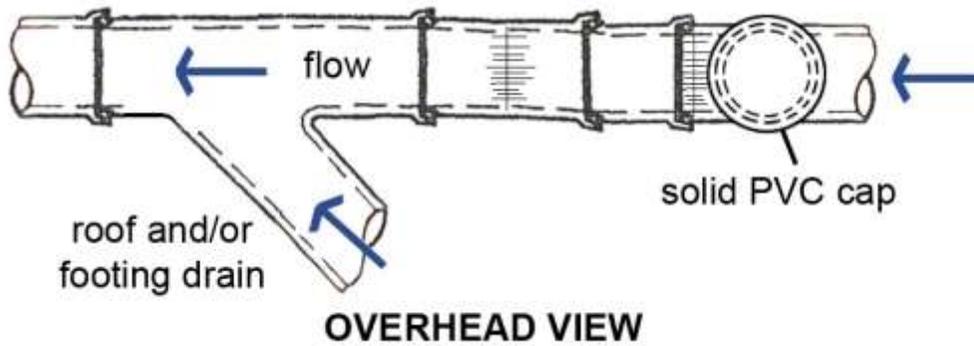
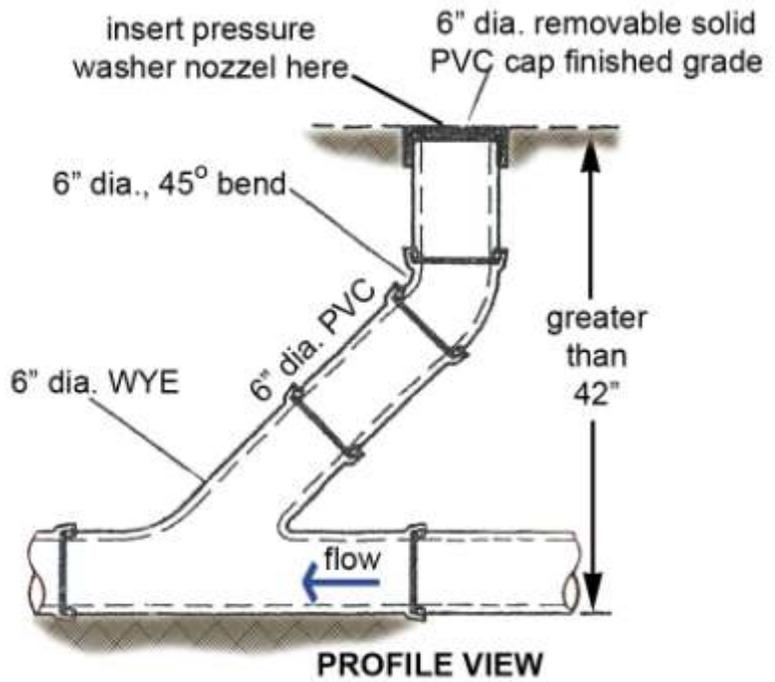


BIRD'S-EYE VIEW



SECTION VIEW

Cleanout



Yard Drain & Cleanout

Drainage system feature	Potential defect	Conditions when maintenance is needed	Results expected when maintenance is performed or not needed
Metal Grates	Excessive accumulation of trash, debris, sediment and vegetation	<ul style="list-style-type: none"> Obstruction Immediately in front of the drain grate or covering it is reducing flow causing ponding or partial flow bypass. 	<ul style="list-style-type: none"> Obstruction removed.
		<ul style="list-style-type: none"> Obstructing more than 1/3 of inlet or outlet pipe diameter. 	<ul style="list-style-type: none"> Obstruction removed.
		<ul style="list-style-type: none"> Decaying and generating odors that could cause complaints or dangerous gases (e.g., methane). 	<ul style="list-style-type: none"> Vegetation removed.
	Not in place	<ul style="list-style-type: none"> Missing or only partially in place. 	<ul style="list-style-type: none"> Grate in place, repaired or replaced.
	Damaged	<ul style="list-style-type: none"> Broken 	<ul style="list-style-type: none"> Grate repaired or replaced.
Sump	Sediment, accumulation	<ul style="list-style-type: none"> Sediment exceeds 60 percent of the sump depth. Measure from bottom of basin to invert of the lowest, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe. 	<ul style="list-style-type: none"> Sediment removed.
Structure	Cracks in wall	<ul style="list-style-type: none"> Cracks in wall 	<ul style="list-style-type: none"> Basin repaired or replaced. Pipe is re-grouted and secure at basin wall.
	Settlement or misalignment	<ul style="list-style-type: none"> Settlement or misalignment 	<ul style="list-style-type: none"> Basin raised, realigned, repaired or replaced.
	Pollutants in water or sediment	<ul style="list-style-type: none"> Most commonly occurring are herbicides and insecticides. Identify and remove source. 	<ul style="list-style-type: none"> Pollutants removed.

Compost-amended Soils

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. Compaction from construction can reduce the soils natural ability to provide these functions. Establishing a minimum soil quality and depth in the post-development landscape can regain some of these stormwater functions including increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals. Sufficient organic content is a key to soil quality. Soil organic matter can be attained through numerous amendments such as compost, composted woody material, biosolids, and forest product residuals.

Key Maintenance Considerations

Key maintenance considerations for compost-amended soils include the replenishment of soil media as needed (as a result of erosion) and addressing compacted, poorly draining soils. Site uses should protect vegetation and avoid compaction.

Key Operations to Preserve Facility Function

The full benefits of compost-amended soils are realized when desired soil media depths are maintained and soil compaction is minimized. Care should be taken to prevent compaction of soils via vehicular loads and/or excessive foot traffic, especially during wet conditions.

Maintenance Standards and Procedures

Table 18 provides the recommended maintenance frequencies, standards, and procedures for compost-amended soils. The level of routine maintenance required and the frequency of corrective maintenance actions may increase for facilities prone to erosion due to site conditions such as steep slopes or topography tending to concentrate flows.

Table 18. Maintenance Standards and Procedures for Compost-amended Soils.

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
General				
Soil media (maintain high organic soil content)	A		Vegetation not fully covering ground surface or vegetation health is poor	<ul style="list-style-type: none"> • Maintain 2 to 3 inches of mulch over bare areas in landscape beds • Add plants if sufficient space • Re-seed bare turf areas until the vegetation fully covers ground surface
		Ongoing	None (routine maintenance)	Return leaf fall and shredded woody materials from the landscape to the site when possible in order to replenish soil nutrients and structure
		Ongoing	None (routine maintenance)	On turf areas, “grasscycle” (mulch-mow or leave the clippings) to build turf health
		Ongoing	None (routine maintenance)	Avoiding use of pesticides (bug and weed killers), like “weed & feed”, which damage the soil
		A	None (routine maintenance)	<ul style="list-style-type: none"> • Where fertilization is needed (mainly turf and annual flower beds), a moderate fertilization program should be used which relies on compost, natural fertilizers or slow-release synthetic balanced fertilizers • Follow IPM protocols for fertilization procedures (see “Additional Maintenance Resources” in Bioretention Facilities section for more information on IPM protocols)
Soil media (maintain infiltration)	A ^b		Soils become waterlogged, do not appear to be infiltrating	<ul style="list-style-type: none"> • To remediate compaction, aerate soil, till to at least 8-inch depth, or further amend soil with compost and re-till • If areas are turf, aerate compacted areas and topdress them with 1/4 to 1/2 inch of compost to renovate them • If drainage is still slow, consider investigating alternative causes (e.g., high wet season groundwater levels, low permeability soils) • Also consider site use and protection from compacting activities

^a Frequency: A= Annually; B= Biannually (twice per year); M = monthly; S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval); W = At least one inspection/maintenance visit should occur during the wet season (for debris/clog related maintenance, this maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).

^b Inspection should occur during storm event.

IPM – Integrated Pest Management



Table 18 (continued). Maintenance Standards and Procedures for Compost-amended Soils.

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
General (cont'd)				
Erosion/ Scouring	A, W, S		Areas of potential erosion are visible	<ul style="list-style-type: none"> Identify and address cause of erosion (e.g., concentrate flow entering area, channelization of runoff) and stabilize damaged area (regrade, rock, vegetation, erosion control matting) For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made.
Grass/ Vegetation		A	Less than 75% of planted vegetation is healthy with a generally good appearance.	<ul style="list-style-type: none"> Take appropriate maintenance actions (e.g., remove/ replace plants) If problem persists, evaluate if vegetation is appropriate for the location (e.g., exposure, soil, soil moisture)
Noxious weeds		M (March – October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	<ul style="list-style-type: none"> By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately Reasonable attempts must be made to remove and dispose of class C noxious weeds Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions

^a Frequency: A= Annually; B= Biannually (twice per year); M = monthly; S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).; W = At least one inspection/maintenance visit should occur during the wet season (for debris/clog related maintenance, this maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).

^b Inspection should occur during storm event.

IPM – Integrated Pest Management

Table 18 (continued). Maintenance Standards and Procedures for Compost-amended Soils.

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
General (cont'd)				
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	<ul style="list-style-type: none"> Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate Follow IPM protocols for weed management(see “Additional Maintenance Resources” in Bioretention Facilities section for more information on IPM protocols)

^a Frequency: A= Annually; B= Biannually (twice per year); M = monthly; S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).; W = At least one inspection/maintenance visit should occur during the wet season (for debris/clog related maintenance, this maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).

^b Inspection should occur during storm event.

IPM – Integrated Pest Management

Equipment and Materials

Table 19 includes recommendations for equipment and materials commonly used to maintain compost-amended soils. Some of the equipment and materials will be used for routine maintenance activities, while other equipment and materials will be necessary for specialized maintenance.

Table 19. Compost Amended Soils Equipment and Materials List.	
General landscaping equipment	
<input type="checkbox"/>	Gloves
<input type="checkbox"/>	Pincer-type weeding tool
<input type="checkbox"/>	Soil knife
<input type="checkbox"/>	Pruners
<input type="checkbox"/>	Loppers
<input type="checkbox"/>	Hoe
<input type="checkbox"/>	Rake
<input type="checkbox"/>	Wheelbarrow
<input type="checkbox"/>	Shovel
<input type="checkbox"/>	Push broom
<input type="checkbox"/>	Garbage bags (for disposal of noxious weeds)
General landscaping materials	
<input type="checkbox"/>	Arborist wood chip mulch (around trees and woody plants)
<input type="checkbox"/>	Compost or leaf mulch (around annuals)
<input type="checkbox"/>	Fertilizer (natural fertilizers or slow-release synthetic balanced fertilizers)
Specialized equipment*	
<input type="checkbox"/>	Deep tine aerator and compost (or compost/sand mixture) to fill aeration holes (if necessary to correct overly compacted soil)
<input type="checkbox"/>	Flame weeder or hot water weeder
<input type="checkbox"/>	Rototiller
<input type="checkbox"/>	Soil probe

* Items not required for routine maintenance

Skills

The skills required for the maintenance of compost-amended soils are listed in the text box to the right. Additional specialized skills may also be required for corrective maintenance of compost-amended soils such as: horticulturalists, arborists, erosion control specialists, and soil scientists.

Skills Needed for Maintenance of Compost-amended Soils

- Landscaping skills (e.g., general plant care)
- Landscaper for major maintenance

General Grounds Keeping and Landscape Plantings Care

Integral part of stormwater facility maintenance program

Establishing a Grounds Keeping and Landscape Plantings Care plan should not only be an integral part of any residential subdivision or commercial property stormwater facility maintenance program, but should be incorporated into the property management program as well.

Depending on a stormwater facility's function and the overall intent of the project design, general grounds keeping ranges from:

- Making a stormwater facility and its surrounding area neat and tidy, to
- Keeping the facility and its surroundings wild and natural.

Required care

Required grounds keeping and maintenance of landscape plantings care includes:

- Cultivating the various desirable plant and tree species essential for a stormwater facility's function
- Eliminating or controlling undesirable species, especially noxious weeds (see below).
- Controlling plant and tree growth is an ongoing process throughout the growing season and into the rainy season especially
 - on earthen berms and
 - around physical structures such as concrete flow and overflow structures.
- It is also important to keep access roads, gates and fences clear of trees and brush.

Control noxious weeds

Noxious weeds need to be eliminated or vigorously controlled.

- Common noxious weeds found in or near stormwater runoff facilities include: Knotweeds, Yellow Archangel, Atlantic and English Ivy, Yellow Flag Iris, Fragrant Water Lily and Purple or garden Loosestrife.
- The less noxious, but still obnoxious plants and trees also need to be vigorously controlled, such as reed canary grass, blackberry and morning glory vines, scotch broom, cottonwood and alder trees.
- For more information about noxious weeds go to the Snohomish County Noxious Weed Board website:
 - http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/Road_Maint/Noxious_Weeds/control_boards.htm
 - http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/Road_Maint/Noxious_Weeds/weeds_list.htm

Maintenance for aesthetic reasons encouraged

Maintenance for aesthetic reasons, ranging from totally "wild and natural" to totally "manicured" is ***strongly encouraged but not required***.

- Going beyond what is only required can not only improve a facility's appearance but also enhance its function as well.
- Taking this approach can help even more to:
 - Reduce the potential for flooding property,
 - Provide for a more healthy fish and critter habitat,
 - Improve residential property values, and
 - Make commercial property more attractive for clients and customers.

General Grounds Keeping and Landscape Plantings Care

Drainage system feature	Potential defect	Conditions when maintenance is needed	Results expected when maintenance is performed or not needed
Facility Site	Poisonous or nuisance Vegetation	<ul style="list-style-type: none"> Any vegetation which may constitute a hazard to maintenance personnel or the public. Evidence of noxious weeds as defined by State or local regulations. <p>NOTE: Apply herbicides in accordance with requirements of Snohomish County Noxious Weed Board.</p>	<ul style="list-style-type: none"> Poisonous or nuisance vegetation eliminated. <p>NOTE: Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies is required.</p>
Facility Site	Weeds (nonpoisonous)	<ul style="list-style-type: none"> Weeds growing in more than 20% of the landscaped area (trees and shrubs only). 	<ul style="list-style-type: none"> Weeds present in less than 5% of the landscaped area.
	Insect hazard or poisonous vegetation	<ul style="list-style-type: none"> Any presence of poison ivy or other poisonous vegetation or insect nests. 	<ul style="list-style-type: none"> No poisonous vegetation or insect nests present in landscaped area.
	Trash & debris litter	<ul style="list-style-type: none"> See ponds checklist 	<ul style="list-style-type: none"> See ponds checklist.
	Erosion of ground surface	<ul style="list-style-type: none"> Noticeable rills are seen in landscaped areas. 	<ul style="list-style-type: none"> Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
Trees and Shrubs	Dead or damaged	<ul style="list-style-type: none"> Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub. 	<ul style="list-style-type: none"> Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
		<ul style="list-style-type: none"> Trees or shrubs that have been blown down or knocked over. 	<ul style="list-style-type: none"> Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.

Drainage system feature	Potential defect	Conditions when maintenance is needed	Results expected when maintenance is performed or not needed
		<ul style="list-style-type: none"> Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots. 	<ul style="list-style-type: none"> Place stakes and rubber coated ties around young trees/shrubs for support.
Visual Buffer Screen	Missing or broken parts in visual screen	<ul style="list-style-type: none"> Any gap in screen that permits easy entry to facility 	<ul style="list-style-type: none"> Shrubs replaced to for a solid screen.
	Unruly shrubbery and vegetation	<ul style="list-style-type: none"> Shrubbery is growing out of control or is infested with weeds. 	<ul style="list-style-type: none"> Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.