Engineering analysis and drainage plan

for

Marblemount quarry

January 15, 2019

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2 CERTIFICATION

ENGINEER'S DECLARATION

I, David Galbraith, Jr., a Professional Engineer registered in the State of Washington as a Civil Engineer, do hereby declare that the Engineering Analysis and Drainage Plan titled "Engineering Analysis and Drainage Plan – Marblemount Quarry" dated January 15, 2019, was prepared by me, or under my personal supervision, and that said Report was prepared in accordance with generally accepted engineering practices.

Respectfully,

2019.01.15 07:01:25 -08'00'

1-15-2019

David P. Galbraith Jr., P.E.

Registration No. 44679

Pacific Surveying & Engineering

3 INTRODUCTION

3.1 PURPOSE AND OBJECTIVES

This Engineering Analysis and Drainage Plan has been prepared on behalf of the Kiewit Infrastructure Co., the developer of the Marblemount Quarry in Skagit County, Washington. The purpose of this report is to evaluate the effects upon the surrounding environment due to changes to the existing stormwater runoff patterns resulting from the proposed development of the subject property, to detail the methods and assumptions used for this evaluation, and present mitigation design recommendations. Proposed mitigation measures include implementation of best management practices (BMPs) designed to assure post-development stormwater release rates do not exceed the required matching levels for the design frequency storm events, and to assure that the quality of stormwater runoff is not degraded.

This report functions as a combined 'Stormwater Management Plan' and 'Stormwater Pollution Prevention Plan' (SWPPP). The Stormwater Management Plan summarizes how the project will comply with the minimum requirements outlined in the Washington State Department of Ecology "Stormwater Management Manual for Western Washington", 2012 publication (hereinafter referred to as the WSDOE Manual) and Skagit County Code Section 14.32.

3.2 PROJECT BACKGROUND

General information for this project is as follows:

PROJECT NAME: Marblemount Quarry

LOCATION: The project site is located near 59248 Rockport Cascade Road near Marblemount, Washington. The site contains the following parcels:

- P45543
- P45541
- P128574
- P120304
- P45550

Lat/Long: 48.509054, -121.455042

Section, Township, Range of P45543: Southeast ¼ of Section 24, Township 35N, Range 10E of the W.M.

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3.3 PROJECT SUMMARY

The purpose of the proposed Marblemount Quarry project is to supply jetty stone for several projects of nationwide significance on the west coast of Oregon and especially the Mouth of the Columbia River. Jetty stone requires unique physical properties that few available quarry sources along the west coast of the Unites States can provide. The previous primary source of jetty stone was the Beaver Lake Quarry which is now nearly depleted. The rock at the Marblemount Quarry site meets the jetty stone requirements, which is why this site was selected. No other viable, ready-to-permit jetty stone sources have been identified.

The existing Marblemount Quarry is within the Mineral Resource Overlay (MRO) designation in the Skagit County Comprehensive Plan. A Conditional Use Permit was previously granted for quarry rock removal at this site; however, the scale of the quarry operations and footprint has expanded. This necessitates a modified and updated Special Use Permit, expansion of the MRO through a Skagit County Comprehensive Plan Amendment update, and Department of Natural Resources (DNR) Reclamation Plan

The proposed project includes site clearing, quarry operations, and reclamation of a bedrock quarry on Rockport Cascade Road approximately one mile south of Marblemount, WA.

The proposed project would occur in four steps:

1. Clearing and Building Access Road for Forest Practice Conversion;
2. Quarrying within the MRO Overlay Area;
3. Possible quarry expansion contingent on MRO boundary change, and
4. Quarry Reclamation.

3.4 APPLICATION OF STANDARDS

The portion of this mining operation that are subject to Skagit County Code Section 14.32 and the WSDOE Manual is the work associated with the following items:

- Construction of access from the Rockport Cascade Road to the mining operations areas including a gravel parking area and gravel roadways to proposed operations area
- Construction of portable offices/storage structures, truck loadout scale, a heavy equipment parking area, a fueling station, and maintenance shop on the site.
- Construction of a 6,700 LF access roadway from the base to the summit of the mining operations
- The stormwater facilities required to be constructed as a result of this work

The above items are being permitted under a Skagit County Grading Permit or Building Permit. Other mining activities and forest practices will be permitted though the Department of Natural Resources.

4 EXISTING CONDITIONS

4.1 LAND USE & ZONING

The parcels are located in Skagit County, outside of city limits and zoned RRc-NRL, IF-NRL, and SF-NRL with MRO overlays. The site contains two residences, access driveways and a historic logging road. This project is outside of the NPDES Permit Area identified in Skagit County Code Section 14.32.

4.2 VEGETATION

The predominant vegetation on the site includes some Douglas fir (*Pseudotsuga menzisii*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), paper birch (*Betula papyrifera*), bigleaf maple (*Acer macrophyllum*), Western swordfern (*Polystichum munitum*), oceanspray (*Holodiscus discolor*), snowberry (*Symphoricarpos albus*), salmonberry (*Rubus spectabilis)* salal (*Gaultheria shallon*), Indian plum (*Oemleria cerasiformis*) sword fern (*Polystichum munitum*), creeping buttercup (*Ranunculus repens*), piggyback plant (*Tolmiea menziesii*), Western bracken fern (*Pteridium aquilinum*), and various native and nonnative grasses.

4.3 EXISTING SOILS CONDITIONS

The NRCS Web Soil Survey (accessed online December 14, 2018 at https://websoilsurvey.sc.egov.usda.gov) indicates that there are three predominant soil units in the project area: (4) Andic Xerochrepts, warm-Rock outcrop complex, 65 to 90 percent slopes; (8) Barneston very cobbly sandy loam, 0 to 8 percent slopes, and (135) Squires very gravelly silt loam, 30 to 65 percent slopes.

The NRCS has identified the dominant soil type within the planned infiltration areas of the project limits as Barneston very cobbly sandy loam, 0 to 8 percent slopes (NRCS map unit 8). The parent material of the soil is loess and volcanic ash deposited over glacial outwash. The soil is in USDA Hydrologic Soil Group A (low runoff potential). The natural drainage class of the soil is somewhat excessively drained and the soil is not described as prone to flooding or ponding. See Appendix 7.2 for the Preliminary Soil Characterization Memo for additional information.

As described in the Preliminary Soil Characterization Memo (Appendix 7.2), a soil grab sample was obtained and tested by GeoTest Services, Inc. on October 26, 2018 to determine the Organic Content, Cation Exchange Capacity (CEC) and partial size analysis used for the determination of the initial saturated hydraulic conductivity (K_{sat}). The initial infiltration rate of **8.83 in/hr** was determined using the 2014 WSDOE empirical soil grain size analysis method. The CEC was determined to be 5 meq/100g and the OC was determined to be 1%. These results meet the Site Suitability Criteria for the use of the existing soil profile as a method for meeting WSDOE stormwater treatment requirements.

Based on the drinking water well logs reviewed in the Hydrogeologic Site Assessment, prepared by Element Solutions (January 16, 2019) and submitted concurrently with this report, the groundwater elevation within the project area was found to be approximately 28 feet below ground surface.

4.4 TOPOGRAPHY & DRAINAGE

The existing site terrain contains typical slopes between 40 to 70 percent; however slopes up to 100% exist. Based on field observations and interviews with local property owners, offsite runoff is very rare. During all site visits performed by Pacific Surveying and Engineering and Element Solutions, no offsite runoff was observed. Two Watercourses exist on the site, and both were observed to infiltrate into the subgrade at different locations due to the well-drained soil characteristics of the soil type encountered at the base of the talus slope.

The lowest point of the site is the historic gravel borrow pit in the southwest corner. No culvert crosses Rockport Cascade Road at this point, so in the case of large flow events, stormwater may flood over the existing roadway, as indicated by local property owner interviews.

In the event of these rare high flows, flooding over the roadway would continue southwest with the existing grade and either reach the Skagit River, or infiltrate into the subgrade.

Impervious surface areas for the site are tabulated in the Skagit County Impervious Surface Area Worksheet in Appendix 7.3 and below:

EXISTING HARD SURFACE AREAS

TOTAL ROOF AREA:	6,846 SF
TOTAL DRIVEWAY:	153,798 SF
TOTAL HARD SURFACE:	160,644 SF

PROPOSED HARD SURFACE AREAS

TOTAL NEW + REPLACED BUILDING AREA:	5,891 SF
TOTAL NEW + REPLACED ROAD AND PARKING AREA:	536,439 SF
TOTAL NEW + REPLACED HARD SURFACE:	542,330 SF

See the Existing Impervious Surface Exhibit in Appendix 7.4 to show the location of the existing impervious surface areas on the site. See the Proposed Impervious Surface Exhibit in Appendix 7.4 for a graphical description of the proposed impervious surfaces on the site subject to Skagit County Code Section 14.32 .

5 MINIMUM STORMWATER MANAGEMENT REQUIREMENTS

This project will comply with the minimum requirements outlined in the WSDOE "Stormwater Management Manual for Western Washington", 2012 publication and Skagit County Code Section 14.32. This project is classified as High Land Use Intensity per Table 14.32-040.2 of Skagit County Code. This project will create more than 20,000 square feet of new plus replaced hard surface area. Per Table 14.32.040-1 of the Skagit County Code, this project is subject to the following minimum requirements:

- Minimum Requirement 1: Stormwater Site Plan
- Minimum Requirement 2: Stormwater Pollution Prevention Plan
- Minimum Requirement 3: Stormwater Source Control
- Minimum Requirement 4: Preserve Natural Drainage
- Minimum Requirement 5: Onsite Stormwater Management
- Minimum Requirement 6: Stormwater Treatment
- Minimum Requirement 7: Stormwater Flow Control
- Minimum Requirement 8: Wetlands Protection
- Minimum Requirement 9: Operations and Maintenance

To meet these requirements, runoff from the site will be collected and conveyed to one of two presettling ponds to provide pretreatment, then directed to infiltration ponds for full infiltration of the site runoff in the 100-year flow event. This combination of infiltration and pretreatment will meet/exceed DOE Manual Standards as required by Skagit County Code.

The project has been divided into two different drainage basins based on the contributing areas of two different infiltration ponds. See the Proposed Basin Exhibit in Appendix 7.4 of this report for a graphical representation of the areas. Basin 1 consists of the proposed mine access roadway and the adjacent upslope forested area which drains to the roadway. Runoff from the proposed access roadway and upslope forested area is collected in an open ditch system and routed down to the Presettling Pond #1 to provide pretreatment and then to Infiltration Pond #1 via a spall weir for full infiltration in the infiltration pond.

Basin 2 consists of the remaining parking and operations area near the base of the site. This runoff will sheet flow southeast and be collected in an open ditch system and be routed to east to the Presettling Pond #2 and then to Infiltration Pond #2 via a spall weir for fill infiltration in the infiltration pond.

The following table indicates the areas of Basins 1 and 2 and the applicable WWHM 2012 land use type.

Basin Area Tabulation

BASIN 1	SF	AC
Road, Mod	413,113.00	9.48
Forest, A, Steep	2,931,995.00	67.31
TOTAL	3,345,108.00	76.79
BASIN 2	**SF**	**AC**
Road, Flat	123,326.00	2.83
Building Roof	5,891.00	0.14
Total	129,217.00	2.97
TOTAL PROJECT AREA	3,474,325.00	79.76

Flowrate Analysis (Cubic Feet per Second)

BASIN 1	PRE-DEVELOPED	POST-DEVELOPED UNMITIGATED	POST-DEVELOPED MITIGATED
2 YEAR	1.65	10.70	0
5 YEAR	6.44	17.62	0
10 YEAR	12.95	23.76	0
25 YEAR	26.96	33.67	0
50 YEAR	43.03	42.90	0
100 YEAR	65.23	53.97	0
BASIN 2	**PRE-DEVELOPED**	**POST-DEVELOPED UNMITIGATED**	**POST-DEVELOPED MITIGATED**
2 YEAR	0.04	2.31	0
5 YEAR	0.15	3.25	0
10 YEAR	0.31	3.94	0
25 YEAR	0.69	4.89	0
50 YEAR	1.17	5.66	0
100 YEAR	1.87	6.48	0
TOTAL	**PRE-DEVELOPED**	**POST-DEVELOPED UNMITIGATED**	**POST-DEVELOPED MITIGATED**
2 YEAR	1.68	13.02	0
5 YEAR	6.59	20.87	0
10 YEAR	13.27	27.70	0
25 YEAR	27.66	38.56	0
50 YEAR	44.19	48.56	0
100 YEAR	67.10	60.45	0

A flowrate analysis was performed using the WWHM2012 hydraulic modeling in the above table. This analysis is provided in Appendix 7.6. The table show the predeveloped flowrates predicted from the site, the post-developed unmitigated flowrates (the flow rates into each infiltration pond) and the post developed mitigated flowrates showing full infiltration of all stormwater runoff on the site in one of the two infiltration ponds.

5.1 REQUIREMENT NO. 1 – PREPARE STORMWATER SITE PLANS

We have completed the requirements of a stormwater site plan per the WSDOE Stormwater Management Manual. The required steps have been performed as follows:

5.1.1 COLLECT AND ANALYZE EXISTING CONDITIONS INFORMATION

Site visits were performed to determine the existing on-site and off-site drainage conditions. Downstream conveyance was investigated utilizing field surveyed topographic maps, as well as site visit observations. See Section 4 above for a detailed description of existing site conditions.

5.1.2 PREPARE PRELIMINARY DEVELOPMENT LAYOUT

Site development plans has been prepared which show the proposed gravel access roadways, parking area, buildings and mining road which extends to the top of the slope. Additionally, improvement plans are detailed in Appendix 7.5 Project Drawings.

5.1.3 PERFORM OFF-SITE ANALYSIS

A qualitative off-site analysis has been completed in accordance with the WSDOE Manual supplemental guidelines for Off-site analysis and Mitigation, Section 2.6.2, Volume I.

The site contains two watercourses as depicted in the Downstream Flowpath Exhibit in Appendix 7.4. Watercourse ‘A’ is seasonal and varies between a surface and subsurface drainage based on inflow and channel geomorphology. The watercourse becomes a seasonal surface water course above the proposed roadway, as shown on the Downstream Flowpath Exhibit, and flows west down the slope. At a local depression partway down the slope, the watercourse ponds and goes subsurface and eventually fully infiltrates into the subgrade. No flow of this watercourse was observed at the toe of the slope.

Watercourse ‘A’

Watercourse ‘B’ is a seasonal surface water course, beginning above the subject property and flowing southwest. The Watercourse cascades, splits, and even reforms again during its flow to the base of the slope. This water course becomes subsurface near the historic gravel borrow pit in the southwest corner of the site. No flow was observed past this point. No culvert crossing of Rockport Cascade Road exists at this location. Based on local property owner information, runoff may flood over Rockport Cascade Road only during high flow events.

Watercourse ‘B’

Watercourse ‘B’ Infiltrating near existing Gravel Pit

Gravel Pit

Other runoff from the site either joins with the described watercourses or infiltrates at the base of the talus slope similar to Watercourse 'A'. The well-drained nature of the subgrade results in primarily subsurface drainage from the site. Any runoff which did not infiltrate into the Gravel Pit would cross Rockport Cascade Road and continue west to the Skagit River or infiltrate subsurface along that flowpath.

5.1.3 (1) CONVEYANCE CALCULATIONS

Stormwater runoff from Basin 1, the access road, will be conveyed to Presettling Pond #1 using an open channel "Access Road Conveyance Ditch" and 36" culvert outfalling to the Presttling Pond. Stormwater runoff from Basin 2 will be conveyed to Presettling Pond #2 using an open channel "Site Improvements Conveyance Ditch". See the location of these conveyance systems on the Proposed Basin Map included in Appendix 7.4, and the geometry on the project plans in Appendix 7.5.

A hydraulic analysis was performed using the AutoCAD Mannings Equation Calculator Hydroflow Express Extension to adequately size the open channels and culvert using the 100-year flow rates. Mannings n-values were taken from the WSDOT Hydraulics Manual Appendix 4-1. See table below for a summary of the conveyance system capacity and 100-year design flowrate for the system. All ditches were analyzed flowing with at least 6" of freeboard.

BASIN 1	**100-YEAR FLOWRATE (CFS)**	**FACILITY CAPACITY (CFS)**
Access Road Conveyance Ditch	54.0	99.7
36" Access Road Outlet Culvert	54.0	74.3
BASIN 2		
Site Improvements Conveyance Ditch	6.5	12

5.1.4 DETERMINE APPLICABLE MINIMUM REQUIREMENTS

This project shall meet the minimum requirements for stormwater management as outlined in the WSDOE Stormwater Management Manual, 2012 publication and Skagit County Code Section 14.32.

5.1.5 PREPARE A PERMANENT STORMWATER CONTROL PLAN

A permanent stormwater control plan has been developed and presented herein, in accordance with the guidelines outlined in the section 3.1.5, Volume I of the WSDOE Manual.

5.1.5 (1) EXISTING SITE HYDROLOGY

Existing conditions are explained in detail in Section 4 and 5.1.3. Drainage Basin Diagrams and the Preliminary Soil Characterization can be found in Appendixes 7.4 and 7.2 respectively.

5.1.5 (2) DEVELOPED SITE HYDROLOGY

No alterations to existing hydrology will result from this project. All stormwater will be fully infiltrated into the existing subgrade as in the existing condition. Drainage Basin Diagrams and the Preliminary Soil Characterization can be found in Appendixes 7.4 and 7.2 respectively.

5.1.5 (3) PERFORMANCE STANDARDS AND GOALS

The project proposes to meet the performance standards and goals as set forth in the Skagit County Drainage Code and the WSDOE Manual.

5.1.6 PREPARE A CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN

Construction Stormwater Pollution Prevention Plan (SWPPP) and temporary erosion and sediment controls will be implemented, See section 5.2 below, during the construction of the project. Permanent stormwater control shall be implemented in the completed project as outlined above in Section 6.1.5 of this report.

5.1.7 COMPLETE THE STORMWATER SITE PLAN

The Stormwater site plan has been prepared according to WSDOE Manual.

5.1.8 CHECK COMPLIANCE WITH ALL APPLICABLE MINIMUM REQUIREMENTS

The stormwater management facilities proposed in this report comply with all of the applicable standards per the Skagit County Code Section 14.32.

5.2 REQUIREMENT NO. 2 – CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

A Stormwater Pollution Prevention Plan has been developed for this project. The SWPPP consists of two parts: a narrative and a set of site plan drawings. The narrative portion consists of the thirteen SWPPP elements described below in addition to other components of this stormwater report including descriptions of existing site conditions, proposed project, critical areas, soils, etcetera. The site plan drawings depict implementation of BMPs and outline construction sequencing and are a portion of the civil construction plan drawings, attached in Appendix 7.5, “Temporary Erosion & Sedimentation Control Plan.” See Appendix 7.7 for descriptions of the proposed BMP’s referenced below.

5.2.1 ELEMENT #1 ~ MARK CLEARING LIMITS

Prior to the commencement of construction activities, the limits of the clearing area will be marked in the field.

The minimum required soil stabilizing BMP’s are:

- C101: Preserve Natural Vegetation
- C102: Buffer Zones

5.2.2 ELEMENT #2 ~ ESTABLISH CONSTRUCTION ACCESS

Access points shall be stabilized with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking of sediment onto public roads. If sediment is tracked off site, the affected roadway will

be cleaned thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Sediment shall be removed from roads by shoveling, sweeping, or pick up and transport the sediment to a controlled sediment disposal area.

The minimum required soil stabilizing BMP's are:

- ❑ C105: Stabilized Construction Entrance
- ❑ C125: Topsoiling

5.2.3 ELEMENT #3 ~ CONTROL FLOW RATES

Properties and waterways downstream of development sites shall be protected from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site. All stormwater runoff will be 100% infiltrated into the existing site.

5.2.4 ELEMENT #4 ~ INSTALL SEDIMENT CONTROLS

Sediment ponds will be installed as one of the first steps in grading. Stormwater runoff from the disturbed portions of the site shall be routed through stabilized channels, including check dams.

The minimum required BMP are:

- ❑ C208: Gravel Check Dam

5.2.5 ELEMENT #5 ~ STABILIZE SOILS

All exposed and unworked soils shall be stabilized by applications of effective BMP's that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion

Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways, and drainage channels.

The minimum required soil stabilizing BMP's are:

- ❑ C101: Preserve Natural Vegetation
- ❑ C140: Dust Control
- ❑ C130: Surface Roughening

5.2.6 ELEMENT #6 ~ PROTECT SLOPES

Cut and fill slopes shall be constructed in a manner that will minimize erosion. Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations. Check dams shall be placed at regular intervals within channels that are cut down a slope. Soils on slopes shall be stabilized according to Element #5 above. In addition to BMPs listed in Element #5 above, the minimum required slope protection BMP's are:

- ❑ C130: Surface Roughening

5.2.7 ELEMENT #7 ~ PROTECT DRAIN INLETS

Storm drain inlets will be made operable during construction. Clean structures when sediment is deposited in the structure.

5.2.8 ELEMENT #8 ~ STABILIZE CHANNELS AND OUTLETS

Open channels shall be stabilized using armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches. Check dams shall be installed fifty feet on center in all open ditches.

The minimum required slope protection BMP's are:

- ❑ C207: Check Dams
- ❑ C209: Rock Lining Outlet Protection

5.2.9 ELEMENT #9 ~ CONTROL POLLUTANTS

All pollutants, including waste materials and demolition debris, that occur on-site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater. The minimum required BMP's are:

- ❑ C152: Sawcutting and Surface Pollution Prevention

5.2.10 ELEMENT #10 ~ CONTROL DE-WATERING

Dewatering is not anticipated on this project.

5.2.11 ELEMENT #11 ~ MAINTAIN BMPS

All temporary and permanent erosion and sediment control BMPs shall be inspected weekly, maintained and repaired as required to assure continued performance. Temporary erosion and sediment BMP's shall be removed within 30 days of final site stabilization.

- ❑ C150: Materials on Hand

5.2.12 ELEMENT #12 ~ MANAGE THE PROJECT

BMPs shall be inspected, maintained and repaired to assure continued performance of their intended function. The SWPPP shall be maintained and implemented as needed.

5.2.13 ELEMENT #13 ~ PROTECT LOW IMPACT DEVELOPMENT BMPS

Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the Bioretention and/or Rain Garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/rain garden soils, and replacing the removed soils with soils meeting the design specification.

Prevent compacting Bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.

Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements.

Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from the local stormwater manual or the manufacturer's procedures.

Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

5.3 REQUIREMENT NO. 3– STORMWATER SOURCE CONTORL

Upon completion of construction the following pollutant source control BMPs are recommended for implementation associated with the management and maintenance of the development, obtained from the WSDOE Manual, Volume 4:

- S407 BMPs for Dust Control at Disturbed Land Areas and Unpaved Roadways Parking Lots

- S409 BMPs for Fueling At Dedicated Stations
- S412 BMPs for Loading and Unloading Areas for Liquid or Solid Material
- S414 BMPs for Maintenance and Repair of Vehicles and Equipment
- S416 BMPs for Maintenance of Roadside Ditches
- S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems
- S421 BMPs for Parking and Storage of Vehicles and Equipment
- S428 BMPs for Storage of Liquids in Permanent Aboveground Tanks

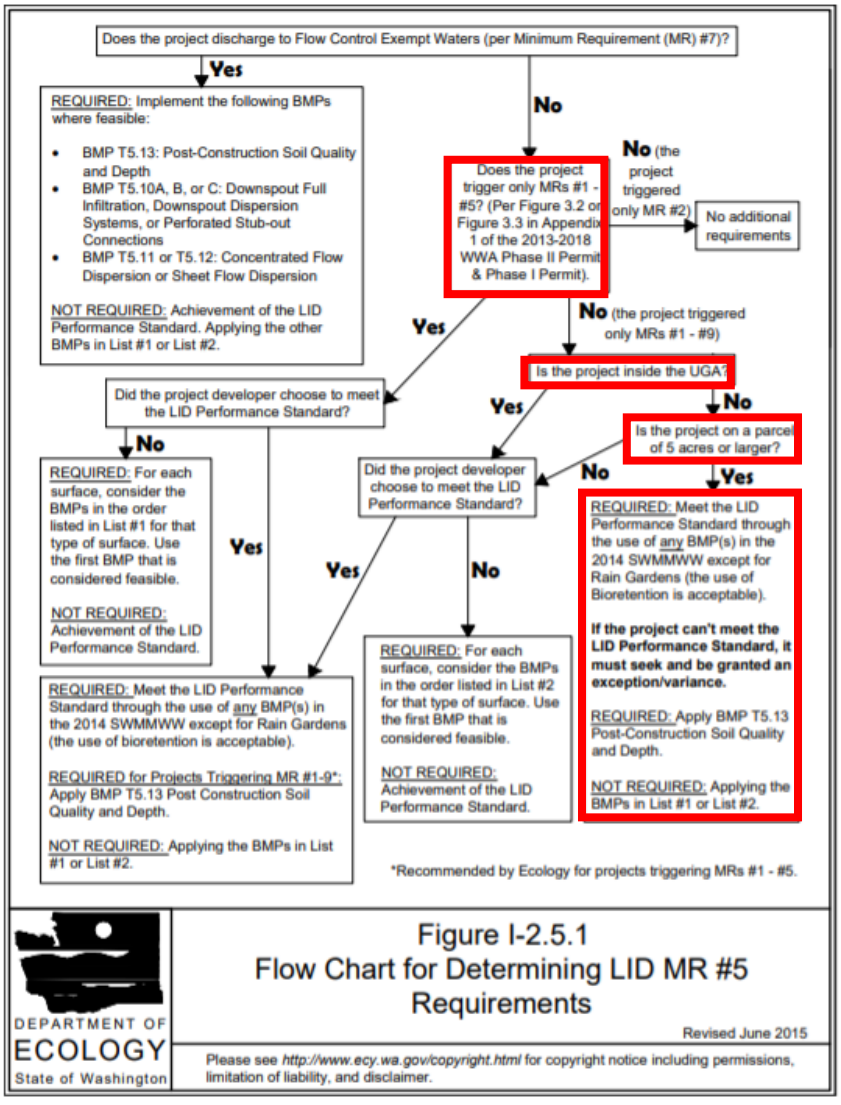
Detailed descriptions of each of the above Pollution Source-Specific BMPs are included in the Appendix 7.8.

5.4 REQUIREMENT NO. 4 – PRESERVATION OF NATURAL DRAINAGE SYSTEMS AND OUTFALLS

This project proposes to fully infiltrate all runoff from the site. As no defined surface drainage courses exist downstream of the site, the existing outfall of the site will remain subsurface.

5.5 REQUIREMENT NO. 5 – ON-SITE STORMWATER MANAGEMENT

The project, including both grading and all building activities, will meet on-site stormwater management requirements per the 2014 DOE Manual. This project does not discharge to flow control exempt waters, triggers minimum requirements 1-9, is outside the UGA and is on a parcel greater than 5 acres as shown in the Minimum Requirement #5 below. Accordingly, this project is required to meet the LID performance standard. This project does meet the LID performance standard as shown in the WWHM2012 modeling (Appendix 7.6) by fully infiltrating all runoff from the site.

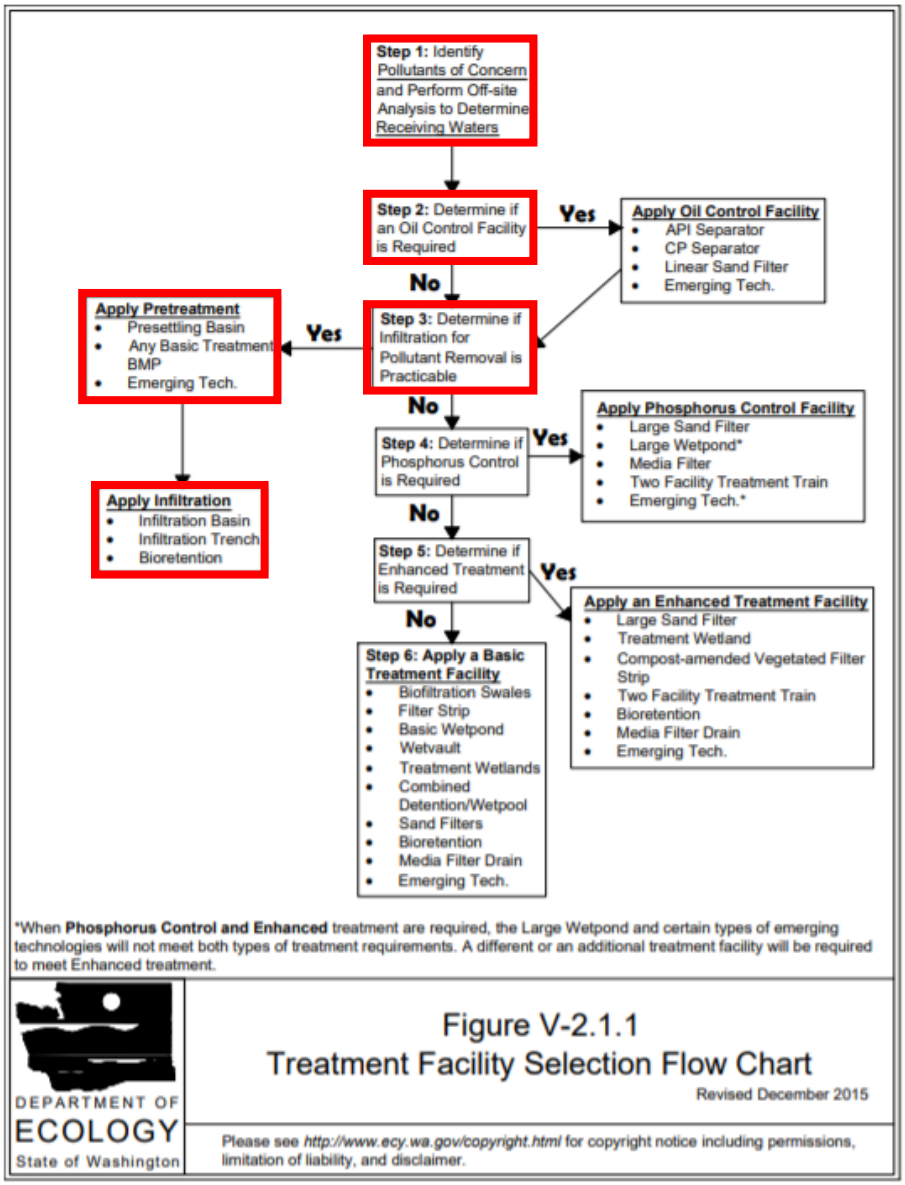


Minimum Requirement #5 Flow Chart

All disturbed areas will be restored per BMP T5.13 for soils quality and depth, this will include the roadway match slopes. BMP T5.13 includes requirements for soil quality pertaining to organic content and amendment rates. Notes and specifications for BMP T5.13 can be found in the temporary erosion and sediment control plan in Appendix 7.5.

5.6 REQUIREMENT NO. 6 – RUNOFF TREATMENT

The project proposes to create more than 5,000 SF of pollution generating hard surface (PGHS) and will therefore be required to meet runoff treatment standards. Per the WSDOE Manual Treatment Selection Flowchart (Figure V-2.2.1) reproduced below, infiltration with applied pretreatment was the selected method.



Treatment Selection Flow Chart

Stormwater runoff will enter one of two presettling basin wet ponds to provide stormwater pretreatment before the runoff will be routed to adjacent infiltration ponds. The presettling ponds will reduce the velocity of the incoming flow and remove suspended solids.

The presettling ponds were designed in accordance with BMP T6.10, which requires the size of the facilities to be at least 30% of the total volume of the 6-month, 24-hour storm (Water Quality Volume). See below for sizing calculations for the two presettling basins:

Presettling Basin #1:

Basin #1 WWHM2012 WQ Volume**: 1.74 ac-ft** (Appendix 7.6)

0.3 x 1.74 ac-ft x 43,560 cf /ac-ft = **22,738 cf**

Volume Provided: 6,000 sf x 4 ft depth = **24,000 cf**

Presettling Basin #2:

Basin #2 WWHM2012 WQ Volume**: 0.53 ac-ft** (Appendix 7.6)

0.3 x 0.53 ac-ft x 43,560 cf /ac-ft = **6,926 cf**

Volume Provided: 2,000 sf x 4 ft depth = **8,000 cf**

Oil control will be applied to the project as required by the NPDES Sand and Gravel General Permit Stormwater Pollution Prevention Plan, which is a separate document. The oil control requirements of this permit, including a specific Spill Control Plan, Spill Response and Spill Reporting will be implemented as required for the permit. Capital BMPs, as defined in the permit, will also be implemented as required to execute and maintain the permit.

Pollution generating impervious surfaces (PGIS) shall receive treatment by means of full infiltration in accordance with Chapter 3 of Vol. III of the DOE Manual. As described in Section 4.3, the soil lab results of the native soils indicated CEC content was determined to be 5/100g and OC was determined to be 1.0%. This is above the required 5 meg/100g CEC content and 1% OC per Site Suitability Criterial SSC-6 of the WSDOE Manual. As a result, the underlying soils are suitable to be used for treatment for the proposed infiltration facilities.

The groundwater table was determined to be approximately 28 feet below ground surface as described in the Hydrogeologic Site Assessment, prepared by Element Solutions (January 16, 2019) and submitted concurrently with this report. The bottom of proposed infiltration facilities are a maximum of 10 feet below existing grade. This provides the minimum 5’ separation as required by the Site Suitability Criteria SSC-5 for the infiltration facilities.

The proposed drawdown time of the infiltration ponds are less than the required 48 hours as described in SSC-4, Soil Infiltration Rate/Drawdown time. The maximum ponded depth of both ponds can be conservatively assumed to be the depth of the facility (4 feet = 48 inches).

$$48\ in\ \times \frac{1\ hr}{8.83\ in} = \ 5.4\ hr\ < 48\ hr$$

The infiltration ponds were sized using WWHM2012 to fully infiltrate the 100-year runoff flowrate with the infiltration rate of 8.83 in/hr as described recommended in the Preliminary Soil Characterization Memo included in Appendix 7.2. The WWHM2012 reports can be found in Appendix 7.6. Additional infiltration facility design details can be found in Appendix 7.5

5.7 REQUIREMENT NO. 7 – FLOW CONTROL

The project proposes to create more than 10,000 SF of hard surfaces and will therefore be required to meet flow control standards. The flow control will be met by fully infiltrating the runoff as described in the pervious section using two different infiltration ponds.

The sizing of all connecting spillways between the Presetting Ponds and for the Emergency Overflows are shown below:

Basin 1 Spillway/Emergency Overflow Capacity Calculation:

Overflow Height (H) = 1’

Q_{100} = 54 cfs

L = [Q_{100} / (3.21 x H $^{3/2}$)] - 2.4 H or 6 feet minimum

L = [54 / (3.21 x **(0.5)** $^{3/2}$)] - 2.4 x **(0.5)** = 14.4’ (15’ provided)

Basin 2 Spillway/Emergency Overflow Capacity Calculation:

Overflow Height (H) = 0.5’

Q_{100} = 6.5 cfs

L = [Q_{100} / (3.21 x H $^{3/2}$)] - 2.4 H or 6 feet minimum

L = [6.5/ (3.21 x **(0.5)** $^{3/2}$)] - 2.4 x **(0.5)** = 4.5’ or **6 feet minimum** ✓

5.8 REQUIREMENT NO. 8 – WETLANDS PROTECTION

The Biological Assessment (Element Solutions, January 15, 2019) which is being submitted concurrently with this report did not find any wetland on the site.

5.9 REQUIREMENT NO. 9 – OPERATIONS AND MAINTENANCE

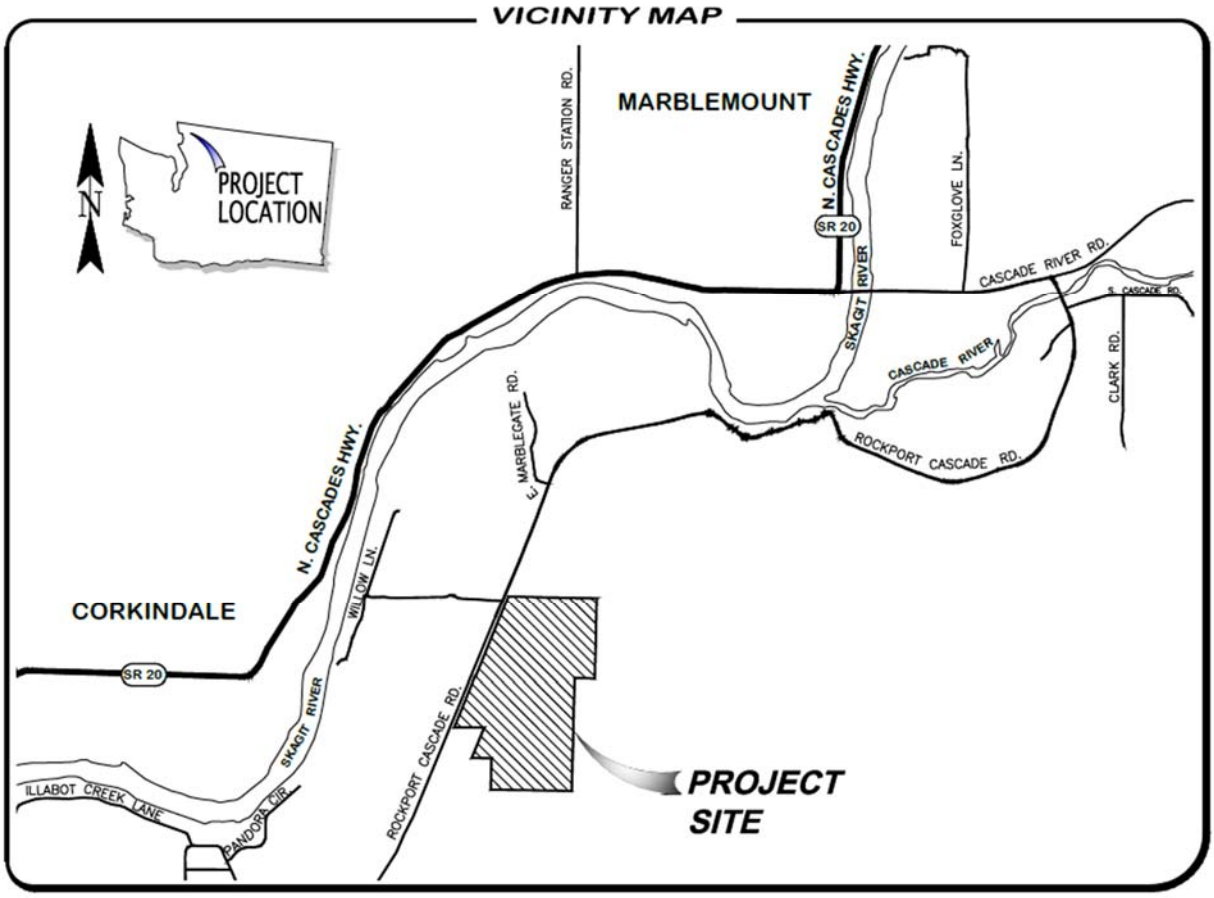
The operations and maintenance manual can be found in appendix 7.10

6 PRINCIPAL FINDINGS AND RECOMMENDATIONS

Detailed analysis has shown that all drainage requirements can be met for the proposed project site. All stormwater management associated with the proposed project shall comply with the Skagit County Code Section 14.32 and minimum requirements outlined in the WSDOE Manual.

7 APPENDIX

7.1 VICINITY MAP



APPENDIX

7.2 PRELIMINARY SOILS CHARACTERIZATION MEMO

January 16, 2019

Client: Kiewit Infrastructure Co.
Attn: Chuck Nylund
2200 Colombia House Blvd,
Vancouver, WA 98661
T | (o) 360.693.1478 / (m) 360.606.3023
E | chuck.nyland@kiewit.com

Subject: Preliminary Soil Characterization – Marblemount Quarry Project, Skagit Conty, WA

Dear Sir or Madam,

Element Solutions (Element) was retained by Chuck Nylund, on behalf of Kiewit Infrastructure Co., to provide professional "Surveying and Permitting" services to support the proposed mining project, located along Rockport Cascade Road, south of Marblemount, WA 98267. The proposed project actions include site clearing, operation, and reclamation of a preexisting bedrock quarry in Skagit County.

One (1) representative composite soil grab sample was collected from the Test Pit 1 (TP1) location for sieve analysis with hydrometer (ASTM D422/D1140 method), organic content, and cation exchange capacity (CEC) testing.

The following memorandum presents a summary of the mapped geology and soil characteristics at the subject site, field observations, lab testing results, and estimated initial infiltration rate (saturated hydraulic conductivity, or K_{sat}) for the subject property calculated empirically using the 2014 Washington State Department of Ecology (DOE) Stormwater Management Manual for Western Washington (SWMMWW) soil grain size analysis method. A 1:24,000-scale site vicinity map (Figure 1), a map depicting the location of the soil sample from TP1 (Figure 2), lab testing results, and a field photo array (Exhibit A) are attached in Appendix I.

Location and Physiography

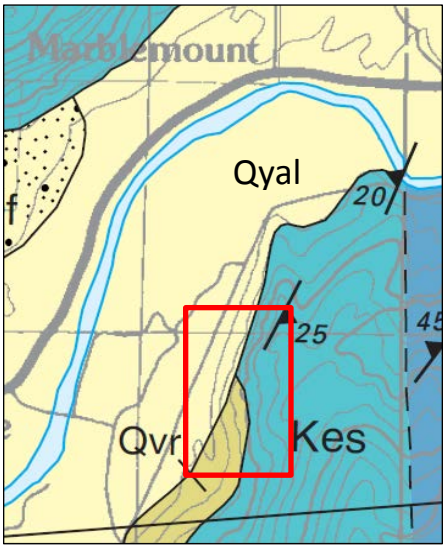
The study area is located in unincorporated Skagit County in the NE ¼ of the NW ¼ of Section 24 and the SW ¼ of Section 13, Township 35 North, and Range 10 East of the Willamette Meridian. The project limits involve the entirety of Skagit County Parcels: P45543, P128574, P120304, P45550, and parts of P45548 and P45541. The majority of the quarrying is planned to take place on parcel P45543, which has been used as a small-scale quarry (under 3 acres) in the past, and is located within the Mineral Resource Overlay (MRO)

designated in the Skagit County Comprehensive Plan. Parcel P45543 (outlined in red on the USGS topographic map illustration below) sits approximately 1.25 miles south of Marblemount and 0.5 miles east of the Skagit River. The 38-acre parcel consists of small stands of second-growth timber in the western portion of the site and a large (approximately 800-1,000-foot) rock face consisting mostly of the Shuksan greenschist deposit that would be quarried under the proposed project. Access to the site is possible from Rockport Cascade Road via a short gravel driveway and turnaround. Ground surface elevations in the study area vicinity range from 310 feet along the western parcel boundary to 1216 feet at the crest of the rock outcrop, 500 feet east of the eastern parcel boundary (all elevations NAVD 88).

Background Geology

1:100,000-scale geologic mapping conducted by the Washington Department of Natural Resources (DNR) indicates that the study area is underlain by Shuksan greenschist (Kes), Vashon stade (Qvr), and younger alluvium (Qyal). An illustration depicting the mapped geologic units and the approximate project location (outlined in red) is shown below.

Shuksan greenschist, the target mineral for the quarrying actions, is a member of the Easton Metamorphic suite, which also includes Darrington phyllite, a metasedimentary unit which stratigraphically overlies the Shuksan greenschist. The oceanic shale and sandstone protolith of the Darrington phyllite was deposited on top of the oceanic basalt protolith of the Shuksan greenschist, which originally formed in the Middle and Late Jurassic and was metamorphosed in the Early Cretaceous (Brown, 1987). The Shuksan greenschist is described as “a fine-grained but well-recrystallized metamorphic rock, commonly containing sodic amphiboles” (Tabor et. al, 2003).



The recessional outwash (Qvr) found in the study area, was deposited during the Pleistocene epoch, and is a part of the of the Vashon stade deposits of the Fraser glaciation of Armstrong and others (1965). The recessional outwash deposits are described as “stratified sand and gravel, moderately sorted to well sorted, and well-bedded silty sand to silty clay” (Tabor et. al, 2003).

The geologic unit mapped within the planned infiltration areas of the project limits is quaternary alluvium (Qyal). The younger alluvium was deposited during the Holocene epoch and is described as “Moderately sorted deposits of cobble gravel to pebbly sand along rivers and streams. Generally unvegetated surfaces; gradational with both units Qf and Qb” (Tabor et. al, 2003). The Qf unit is made up of alluvial-fan deposits of “poorly sorted cobble to boulder gravel” and the Qb unit is made up of poorly drained peat and alluvium bog deposits (Tabor et. al, 2003).

NRCS Soil Classification

The Natural Resource Conservation Service (NRCS) has identified the dominant soil type within the planned infiltration areas of the project limits as *Barneston very cobbly sandy loam, 0 to 8 percent slopes* (NRCS map unit 8). The parent material of the soil is loess and volcanic ash deposited over glacial outwash.

- The natural drainage class of the soil is *somewhat excessively drained*;
- The soil is not described as prone to flooding or ponding;
- The soil is in *USDA Hydrologic Soil Group A* (low runoff potential);
- The initial saturated hydraulic conductivity (K_{sat}) of the most restrictive layer of the soil is estimated by the NRCS to range from 1.98 to 5.95 inches per hour (in/hr).

In the 2012 (amended December 2014) Washington State Department of Ecology (WDOE) Stormwater Management Manual for Western Washington (SWMMWW), WDOE describes USDA Hydrologic Soil Group A soils as *"Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission."* (WDOE, 2014).

Soil Analysis

In-situ soil conditions and physical soil characteristics were evaluated qualitatively in the field by the geoscience professional, and a soil grab sample was obtained from representative soil horizons and provided to GeoTest Services, Inc. on October 26, 2018 for particle-size sieve analysis with hydrometer testing (ASTM D422/D1140 method), and Organic Content testing. Cation Exchange Capacity (CEC) testing was performed by Northwest Agricultural Consultants on October 29, 2018. The sample array and testing methods are indicated in Table 1; complete lab testing reports are attached in Appendix I.

Laboratory Testing Results

A particle-size sieve analysis with hydrometer (ASTM D422/D1140 method), organic content, and cation exchange capacity (EPA 9081) testing was performed a single representative soil grab samples collected at the TP1 location. The results of the laboratory sieve analysis are summarized in Table 1 below:

Table 1: Laboratory Testing Results – Marblemount Quarry, Skagit County, WA

Sample ID	% Gravel		% Sand			% Fines		Organic Content %	Cation Exchange Capacity (CEC)	USCS Classification
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay			
TP1	34	25	10	13	11	6	1	1.0	5.0 meq/100g	GW-GM

Infiltration Characteristics

The saturated hydraulic conductivity or infiltration rate (K_{sat}) for the GW-GM soil unit encountered in the study area was estimated empirically using the 2014 WDOE SWMMWW soil grain size analysis method. Calculations were performed using the applicable laboratory sieve analysis coefficients and grain size distribution data from the particle-size sieve analyses; lab testing reports are attached in

Appendix I. These variables were input into the following equations, presented Volume III of the 2014 WDOE SWMMWW as adapted from Massmann, 2003 and Massmann et al., 2003:

$$log_{10}(K_{sat}) = -1.57 + 1.9D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

$$K_{sat}design = K_{sat}initial \times CF_t \times CF_v \times CF_m$$

The GW-GM soil sample from TP1 yielded an uncorrected K_{sat} value of 22.07 inches per hour (in/hr). A partial correction factor of 0.40 (CF_t) was then applied to this value, as specified in Table 3.3.1 of the 2014 WDOE SWMMWW, resulting in a corrected **initial infiltration rate of 8.83 in/hr for the GW-GM soil unit.**

Conclusions

Our desktop analysis and October 22, 2018 subsurface soil assessment at the Marblemount Quarry study area support the following conclusions:

- The dominant soil unit encountered at the TP1 location (at the base of the talus pile), is well-graded gravel with silt and sand (USCS Classification GW-GM, 7% fines).
    - NRCS soil mapping indicates the soil is in USDA Hydrologic Soil Group A.
- The **initial saturated hydraulic conductivity (K_{sa}) for the GW-GM soil unit is 8.83 in/hr,** as calculated empirically in accordance with the 2014 WDOE SWMMWW soil grain size analysis method.
- At the time of the October 22, 2018 field visit, no groundwater or ponded water was observed within the project limits of the site.
- Variability is possible within the mapped alluvium deposits in the project area, and infiltration could be restricted if bog deposits (Qb) are encountered.
- Although the capacity for site variability exists within the project limits, the potential impacts of encountering soil units with lower infiltration rate are relatively low risk due to the location and surrounding area.

Assumptions and Limitations

The depth and extent of excavations for this preliminary soil characterization was limited by reasonable feasibility constraints; no Small-Scale Pilot Infiltration Test (PIT) results were obtained during the assessment. No attempt to quantify, predict, or project groundwater depth is expressed or implied in this communication; groundwater elevations can vary significantly both spatially and temporally, and long-term ground water monitoring is often necessary to accurately constrain seasonal groundwater elevations.

References

Brown, E. H. (1986). Geology of the Shuksan Suite, North Cascades, Washington, USA. *Geological Society of America Memoirs*, *164*, 143-154.

Natural Resources Conservation Service, Web Soil Survey, U.S. Department of Agriculture. Accessed online January, 2019 at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

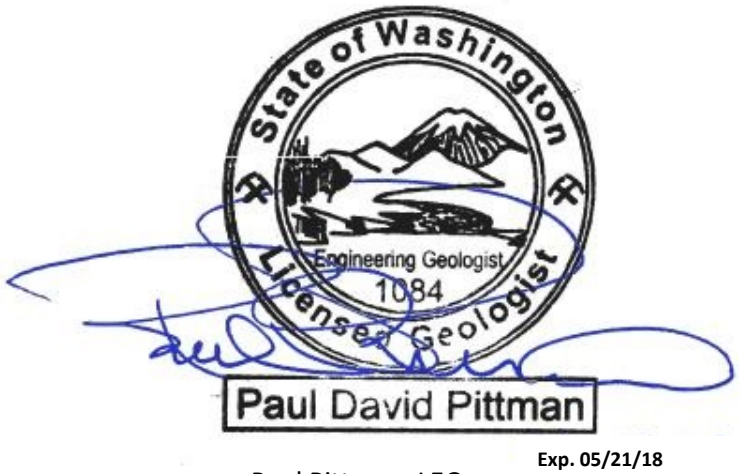
Tabor, R. W., Haugerud, R. A., Hildreth, W., & Brown, E. H. (2003). Geologic Map of the Mount Baker 30 by 60 Minute Quadrangle, Washington. SEA, 500, 500.

Washington State Department of Ecology, Stormwater Management Manual for Western Washington. Publication No. 14-10-055 (Replaces Publication No. 12-10-030). December 2014.

Closure

Thank you for the opportunity to contribute our expertise to your project. Please feel free to contact us at (360) 671-9172 or by email at info@elementsolutions.org if you have any questions or comments regarding this communication.

Sincerely,

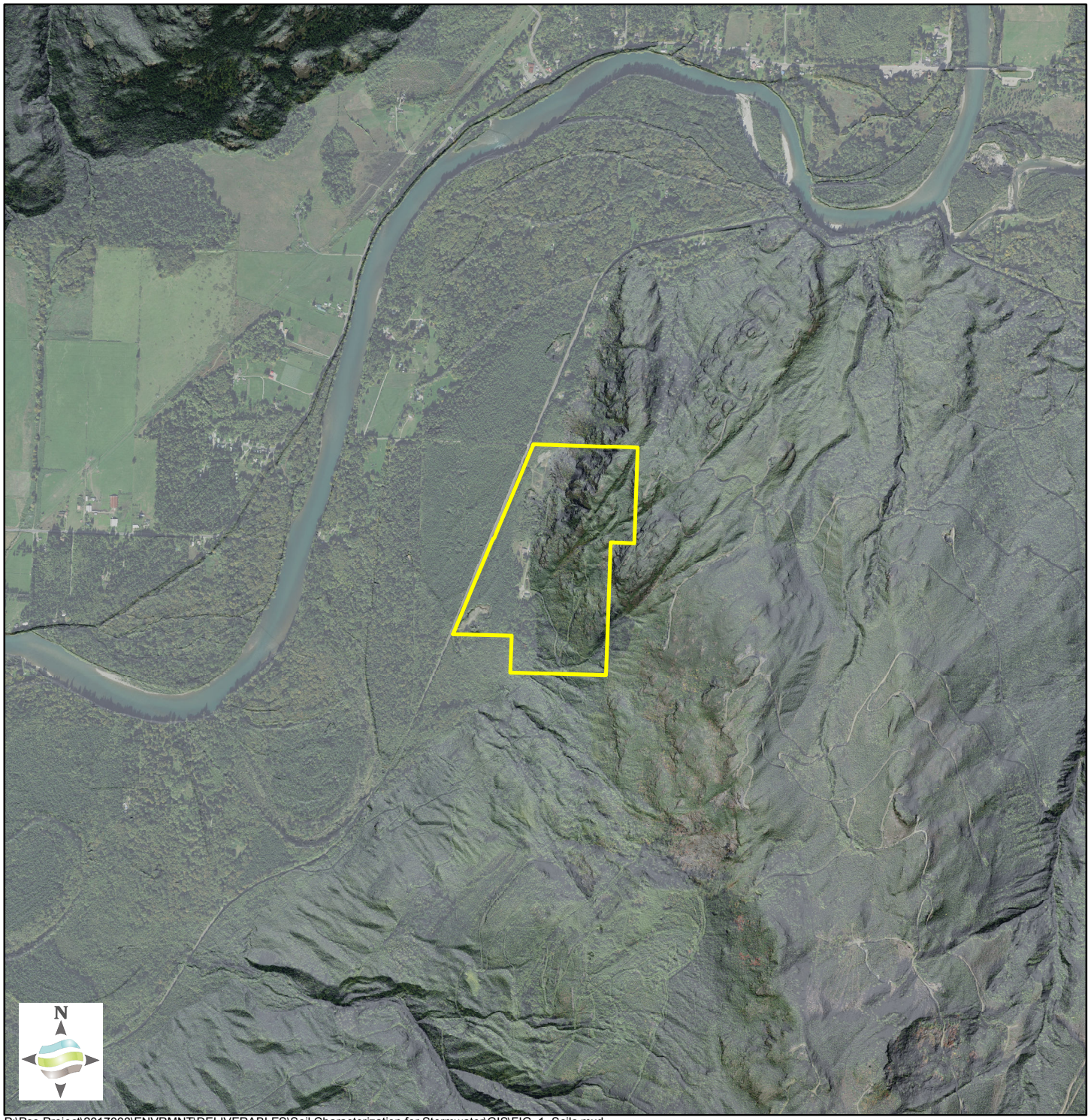


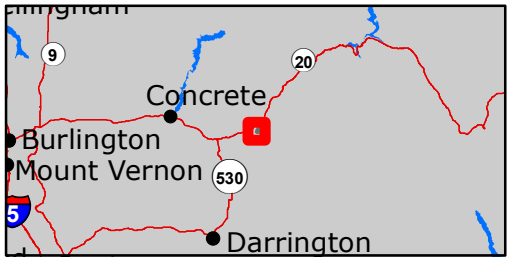
Ryan Cooper, BS
Field Scientist

Paul Pittman, LEG
Earth Sciences Manager - Principal
Exp. 05/21/18

Appendix I

1) Figure 1 – 1:24,000-Scale Site Vicinity Map for Marblemount Quarry, Skagit County, WA
2) Figure 2 – Test Pit Location Map for Marblemount Quarry, Skagit County, WA
3) ASTM D422/D1140 Sieve Analysis with Hydrometer Testing Report (TP1). GeoTest Services, Inc. Project No. 18-0806. October 26, 2018
4) EPA 9081 Cation Exchange Capacity Report (TP1). Northwest Agricultural Consultants. Report No. 46651-1. October 29, 2018
5) Exhibit A – Field Photos, Marblemount Quarry, Skagit County, WA. October 22, 2018





Data Credits:
USDA NAIP 2015
WSDOT 2018
QSI, USGS 2017

Project Limits

Feet
0 1,125 2,250 4,500

1:24,000

1 inch = 2,000 feet

909 Squalicum Wa Ste 111
Bellingham, WA 98225
info@elementsolutions.org
Phone: 360. 671. 9172

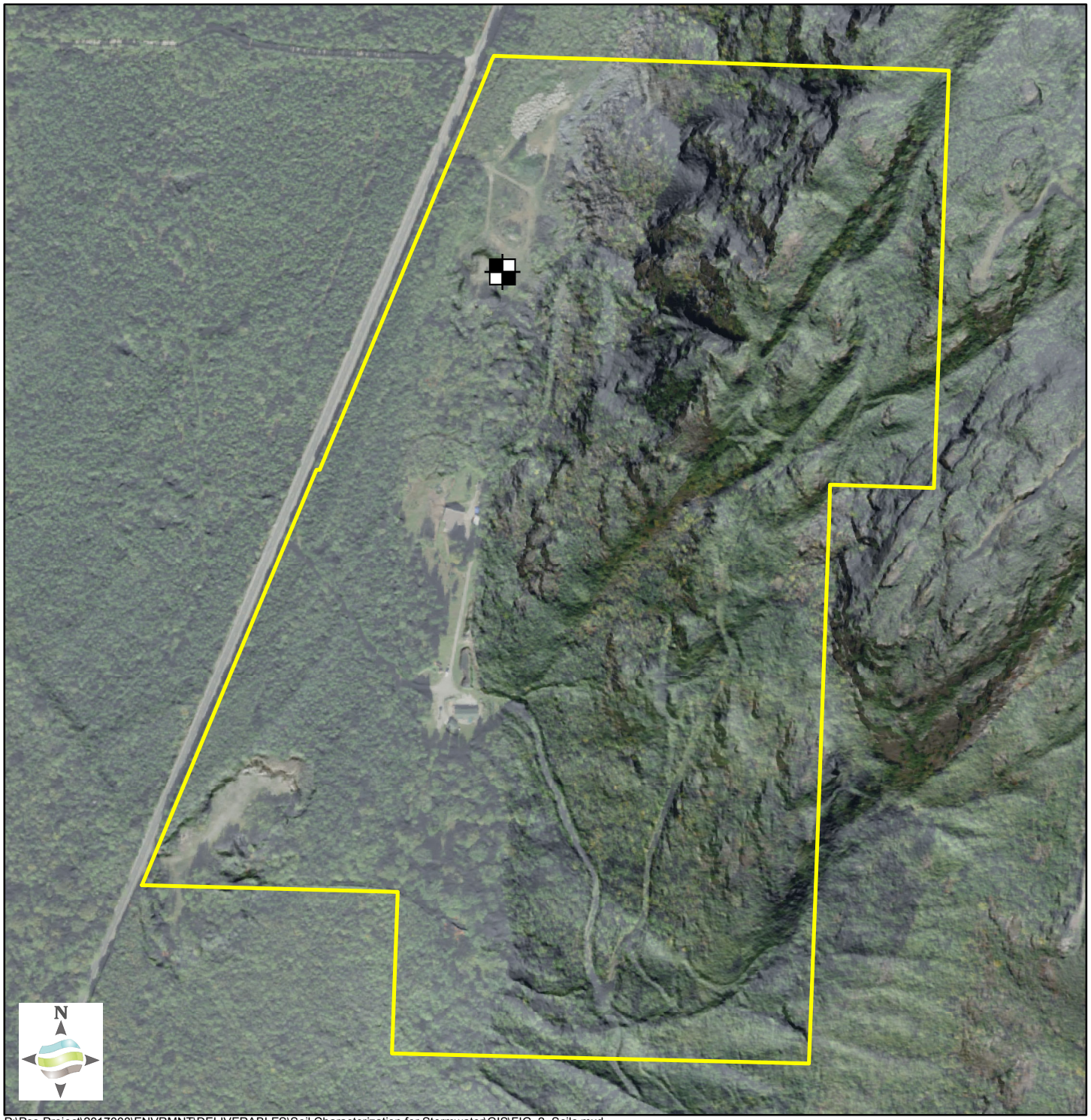
ELEMENT solutions

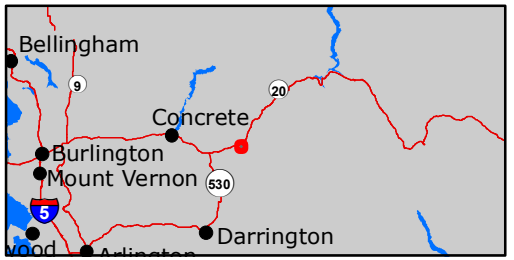
Figure 1

1:24,000-Scale Site Vicinity Map
Marblemount Quarry, Skagit County, WA

Date: 1/10/2019

P:\Pse Project\2017008\ENVRMNT\DELIVERABLES\Soil Characterization for Stormwater\GIS\FIG_1_Soils.mxd





Data Credits:
USDA NAIP 2015
WSDOT 2018
QSI, USGS 2017

Project Limits

TP1

Feet
0 260 520 1,040

1:5,500

1 inch = 458 feet

909 Squalicum Wa Ste 111
Bellingham, WA 98225
info@elementsolutions.org
Phone: 360. 671. 9172

ELEMENT solutions

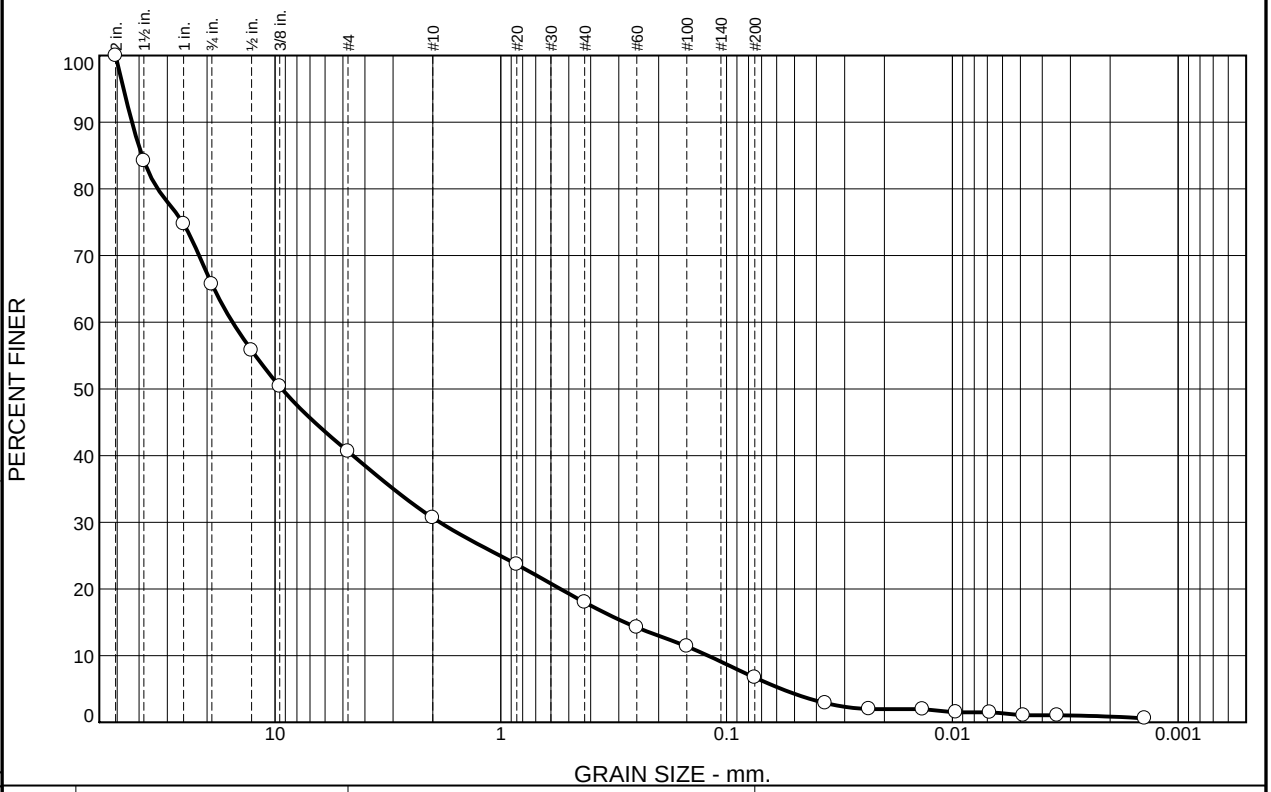
Figure 2

Test Pit Location Map
Marblemount Quarry, Skagit County, WA

Date: 1/10/2019

P:\Pse Project\2017008\ENVRMNT\DELIVERABLES\Soil Characterization for Stormwater\GIS\FIG_2_Soils.mxd

Sieve Analysis w/Hydrometer Test Report - ASTM D422/D1140



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	34	25	10	13	11	6	1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2"	100		
1-1/2"	84		
1"	75		
3/4"	66		
1/2"	56		
3/8"	50		
#4	41		
#10	31		
#20	24		
#40	18		
#60	14		
#100	11		
#200	6.7		
0.0365 mm.	2.9		
0.0234 mm.	2.0		
0.0135 mm.	2.0		
0.0096 mm.	1.5		
0.0068 mm.	1.5		
0.0048 mm.	1.1		
0.0034 mm.	1.1		
0.0014 mm.	0.6		

* (no specification provided)

Soil Description

Element Solutions Job #2017008
well-graded Gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 43.0163 D_{85}= 38.8503 D_{60}= 15.4200
D_{50}= 9.3169 D_{30}= 1.8630 D_{15}= 0.2823
D_{10}= 0.1208 C_u= 127.61 C_c= 1.86

Classification

USCS= GW-GM AASHTO=

Remarks

Organic Content: 1.0%

Location: Marblemount Quarry - Sampled by client
Sample Number: 9994

Date: 10-26-18

GEOTEST
741 Marine Drive
Bellingham, WA 98225
www.GeoTest-Inc.com

Client: Element Solutions
Project: Marblemount Quarry
Marblemount, WA, 98267
Project No: 18-0806 **Figure** SA001

Tested By: DK **Checked By:** DB

Northwest Agricultural Consultants

2545 W Falls Avenue
Kennewick, WA 99336
509.783.7450
www.nwag.com
lab@nwag.com

PAP-Accredited
NAPT

Element Solutions
1812 Cornwall Ave.
Bellingham, WA 98225

Report: 46651-1
Date: October 29, 2018
Project No: 2017008
Project Name: Marblemount Quarry

Sample ID	Cation Exchange Capacity
2017008	5.0 meq/100g
Method	**EPA 9081**

Exhibit A - October 22, 2015 Field Photos – Marblemount Quarry

Photo 1: Quarry Face and Talus Pile

Photo 2: Talus Pile; Near TP1

Photo 3: Alluvium Deposits

Photo 4: TP1 Location

Photo 5: Alluvium Deposits

Photo 6: Shuksan Greenschist Talus

APPENDIX

7.3 SKAGIT COUNTY IMPERVIOUS SURFACE WORKSHEET

Impervious/Hard Surface Worksheet

Planning & Development Services · 1800 Continental Place · Mount Vernon WA 98273
voice 360-416-1320 · inspections 360-416-1330 · www.skagitcounty.net/planning

Permit #:

Accepted by:

1. Provide your total expected land-disturbing activity: 5,208,490 sq ft

2. List amounts of all types of impervious or hard surfaces on your parcel. Use the "other" lines for categories not included in table.

Type of Impervious or Hard Surface	Existing (sq ft)	Proposed Replaced (sq ft)	Proposed New (sq ft)	Subtotal of New + Replaced
House + attached garage roof area	6,846		5,891	5,891
Detached garage + carport roof area:				
Accessory dwelling unit roof area				
Parking area				
Patio				
Driveway	153,798		536,439	536,439
Sidewalk				
Permeable pavement or vegetated roof (hard surface)				
Other:				
Other:				
Other:				
Other:				
Totals	160,644		542,330	542,330

3. Provide your total expected lot coverage as a percentage of your lot: 10 %

Definitions

"Impervious surface" means a non- vegetated surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A non-vegetated surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packen earthen materials, and oiled, macadam or other surfaces which similarly impeded the natural flow of stormwater. SCC 14.04.020.

"Hard surface" means an impervious surface, a permeable pavement, or a vegetated roof.

"Land disturbing activity" means any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to clearing, grading, filling and excavation. Compaction that is associated with stabilization of structures and road construction shall also be considered land disturbing activity. Vegetation maintenance practices, including landscape maintenance and gardening, are not considered land disturbing activity. Stormwater facility maintenance is not considered land disturbing activity if conducted according to established standards and procedures. SCC 14.04.020.

STORMWATER MANAGEMENT

Outside the NPDES Permit Area

a single-family residence on a lot < 1 acre triggers Minimum Requirements 1-9 when this total is

≥ 4000 sq ft

or when land-disturbing activity ≥ 14,000 sq ft

a single-family residence on a lot ≥ 1 acre triggers Minimum Requirements 1,2,4,9 when this total is

≥ 7000 sq ft

or when land-disturbing activity ≥ 14,000 sq ft

see the Stormwater Requirements handout for details and thresholds for other uses

Inside the NPDES Permit Area

Inside the NPDES permit area, complete compliance with Ecology's Stormwater Management Manual, including consideration of Low-Impact Development, is required.

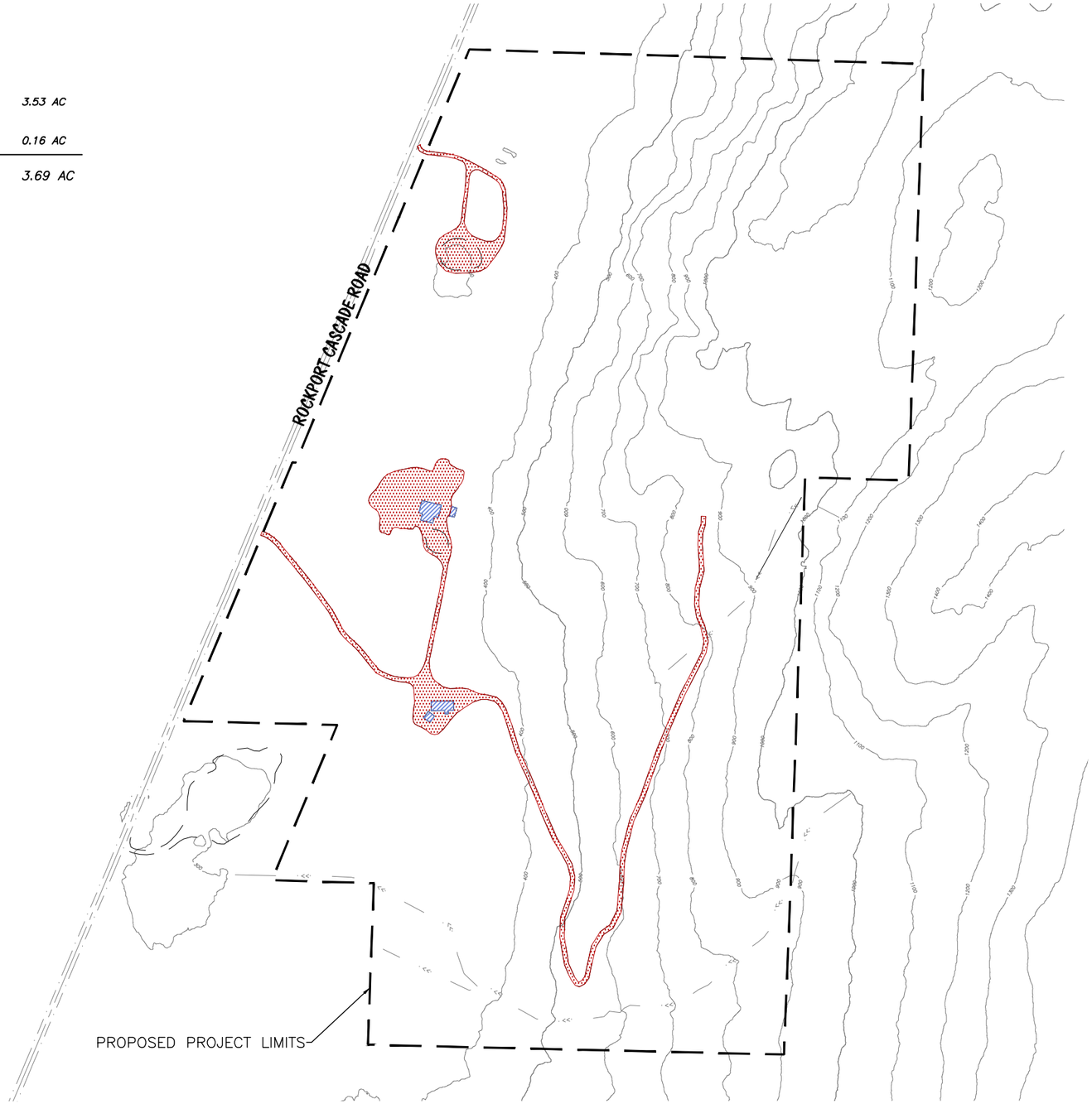
APPENDIX

7.4 DRAINAGE BASIN MAPS

PACIFIC SURVEY & ENGINEERING INC
909 SQUALICUM WAY · SUITE 111 · BELLINGHAM, WA 98225 PHONE: 360.671.7387 FAX: 360.671.4685 EMAIL: info@psesurvey.com www.psesurvey.com

EXISTING IMPERVIOUS SURFACE

EXISTING ROAD	153,798 SF	3.53 AC
EXISTING ROOF	+ 6,846 SF	0.16 AC
TOTAL EXISTING IMPERVIOUS SURFACE:	160,644 SF	3.69 AC



GRAPHIC SCALE
(us survey feet)
0 400
200 800

MARBLEMOUNT QUARRY

EXISTING IMPERVIOUS SURFACE EXHIBIT
MARBLEMOUNT, WASHINGTON

DATE: 01/15/2019 JOB NO. 2017008
FILE: P:\Pse Project\2017008\DWGs_SHEET\2017008_ecP_BASIN.dwg

SHEET 01 OF 04

PACIFIC SURVEY & ENGINEERING INC
909 SQUALICUM WAY · SUITE 111 · BELLINGHAM, WA 98225 PHONE: 360.671.7387 FAX: 360.671.4685 EMAIL: info@psesurvey.com www.psesurvey.com

PROPOSED IMPERVIOUS SURFACE

PROPOSED ROAD	536,439 SF	12.31 AC
PROPOSED ROOF	+ 5,891 SF	0.14 AC
TOTAL PROPOSED IMPERVIOUS SURFACE:	542,330 SF	12.45 AC

GRAPHIC SCALE
(us survey feet)
0 400
200 800

MARBLEMOUNT QUARRY	PROPOSED IMPERVIOUS SURFACE EXHIBIT MARBLEMOUNT, WASHINGTON	DATE: 01/15/2019 JOB NO. 2017008 FILE: P:\Pse Project\2017008\DWGs_SHEET\2017008_ecP_BASIN.dwg	SHEET 02 OF 04

PACIFIC SURVEY & ENGINEERING INC
909 SQUALICUM WAY · SUITE 111 · BELLINGHAM, WA 98225 PHONE: 360.671.7387 FAX: 360.671.4685 EMAIL: info@psesurvey.com www.psesurvey.com

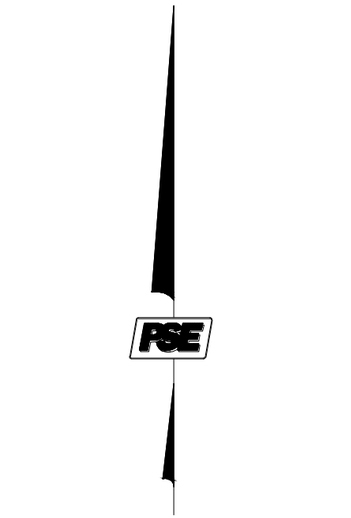
PROPOSED BASIN MAP

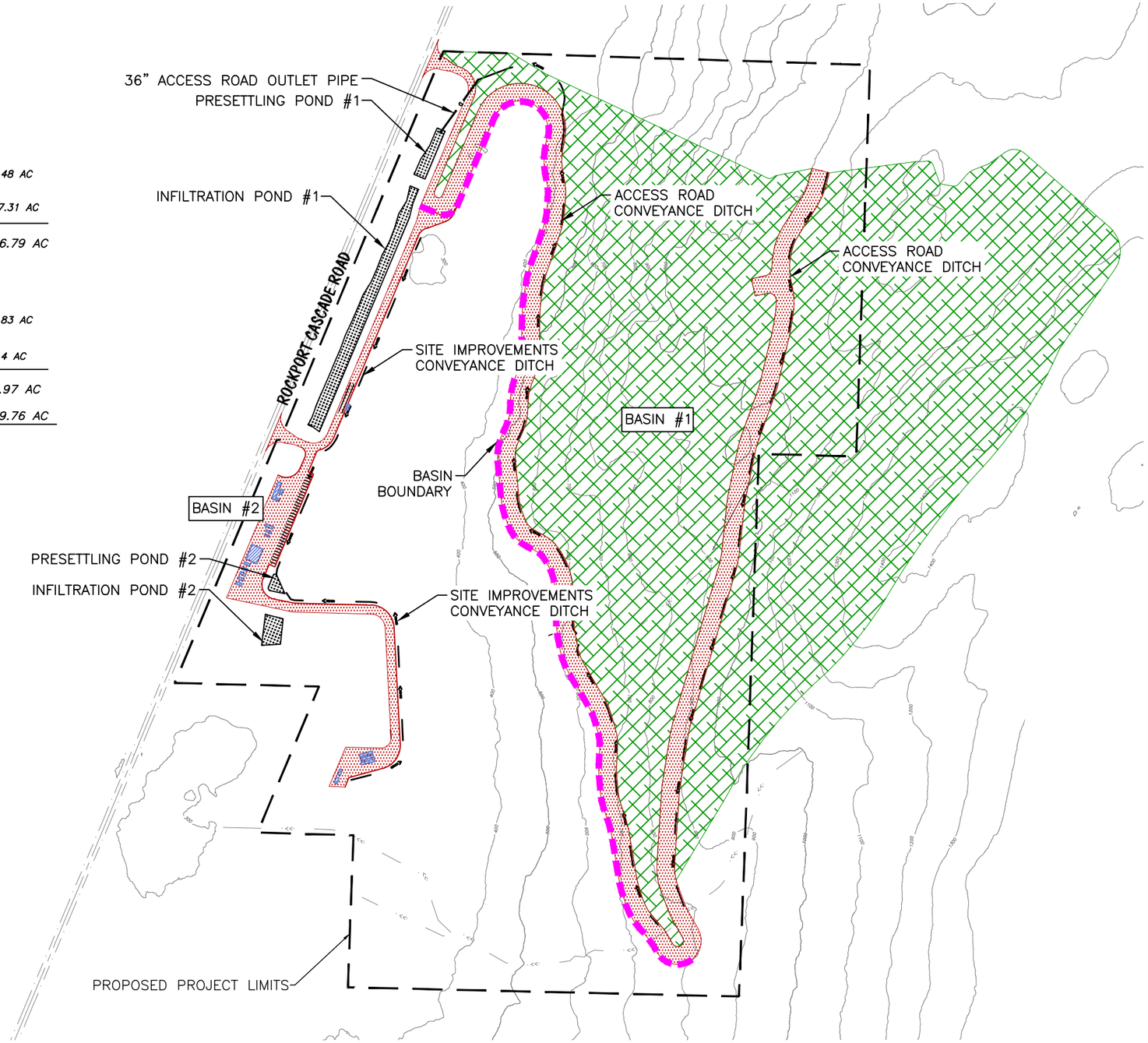
BASIN 1

	ROAD, MOD	413,113 SF	9.48 AC
	PASTURE, A, STEEP	+ 2,931,995 SF	67.31 AC
	TOTAL BASIN 1 AREA:	3,345,108 SF	76.79 AC

BASIN 2

	ROAD, FLAT	123,326 SF	2.83 AC
	BUILDING ROOF	+ 5,891 SF	.14 AC
	TOTAL BASIN 2 AREA:	129,217 SF	2.97 AC
	TOTAL PROJECT AREA:	3,474,325 SF	79.76 AC





MARBLEMOUNT QUARRY	PROPOSED BASIN EXHIBIT MARBLEMOUNT, WASHINGTON	DATE: 01/15/2019 JOB NO. 2017008 FILE: P:\Pse Project\2017008\DWGs_SHEET\2017008_ecP_BASIN.dwg	SHEET 03 OF 04

PACIFIC SURVEY & ENGINEERING INC
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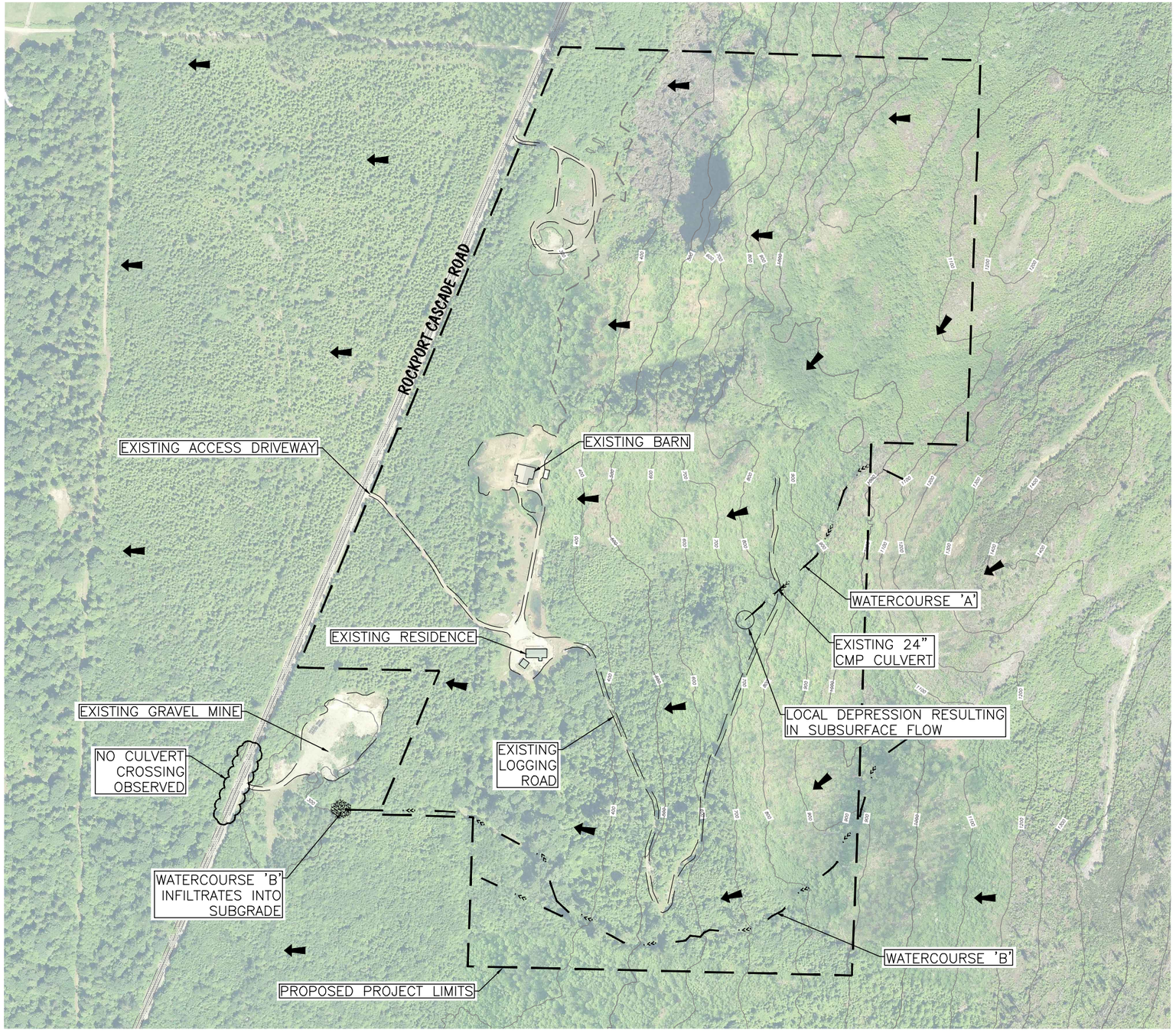
www.psesurvey.com

LEGEND

- FLOW DIRECTION ARROW (TYP.)
- TOE OF TALUS SLOPE

GRAPHIC SCALE
(us survey feet)
0 400
200 800



MARBLEMOUNT QUARRY

DOWNSTREAM FLOWPATH EXHIBIT
MARBLEMOUNT, WASHINGTON

DATE: 01/15/2019 JOB NO. 2017008
FILE: P:\Pse Project\2017008\DWGs_SHEET\2017008_ecP_BASIN.dwg

SHEET 04 OF 04

APPENDIX

7.5 PROJECT DRAWINGS

APPENDIX

7.6 WESTERN WASHINGTON HYDROLOGY MODEL

WWHM2012
PROJECT REPORT

Project Name: Marblemount Basin 1 Infiltration Pond
Site Name: Marblemount Quarry
Site Address:
City : Marblemount
Report Date: 1/15/2019
Gage : Burlington
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.67
Version Date: 2017/04/14
Version : 4.2.13

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	76.79
Pervious Total	76.79

Impervious Land Use	acre
Impervious Total	0
Basin Total	76.79

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	67.31
Pervious Total	67.31

Impervious Land Use	acre
ROADS MOD	9
Impervious Total	9
Basin Total	76.31

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Trapezoidal Pond 1
Bottom Length: 890.00 ft.
Bottom Width: 38.00 ft.
Depth: 5 ft.
Volume at riser head: 4.2183 acre-feet.
Infiltration On
Infiltration rate: 8.83
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 2484.626
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 2484.626
Percent Infiltrated: 100
Total Precip Applied to Facility: 198.379
Total Evap From Facility: 14.47
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 50 in.

Element Flows To:

Outlet 1	Outlet 2

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.776	0.000	0.000	0.000
0.0556	0.783	0.043	0.000	6.912
0.1111	0.790	0.087	0.000	6.912
0.1667	0.797	0.131	0.000	6.912
0.2222	0.804	0.175	0.000	6.912

0.2778	0.812	0.220	0.000	6.912
0.3333	0.819	0.265	0.000	6.912
0.3889	0.826	0.311	0.000	6.912
0.4444	0.833	0.357	0.000	6.912
0.5000	0.840	0.404	0.000	6.912
0.5556	0.847	0.451	0.000	6.912
0.6111	0.854	0.498	0.000	6.912
0.6667	0.862	0.546	0.000	6.912
0.7222	0.869	0.594	0.000	6.912
0.7778	0.876	0.642	0.000	6.912
0.8333	0.883	0.691	0.000	6.912
0.8889	0.890	0.740	0.000	6.912
0.9444	0.897	0.790	0.000	6.912
1.0000	0.905	0.840	0.000	6.912
1.0556	0.912	0.891	0.000	6.912
1.1111	0.919	0.941	0.000	6.912
1.1667	0.926	0.993	0.000	6.912
1.2222	0.933	1.044	0.000	6.912
1.2778	0.941	1.097	0.000	6.912
1.3333	0.948	1.149	0.000	6.912
1.3889	0.955	1.202	0.000	6.912
1.4444	0.962	1.255	0.000	6.912
1.5000	0.970	1.309	0.000	6.912
1.5556	0.977	1.363	0.000	6.912
1.6111	0.984	1.417	0.000	6.912
1.6667	0.991	1.472	0.000	6.912
1.7222	0.999	1.528	0.000	6.912
1.7778	1.006	1.583	0.000	6.912
1.8333	1.013	1.639	0.000	6.912
1.8889	1.020	1.696	0.000	6.912
1.9444	1.028	1.753	0.000	6.912
2.0000	1.035	1.810	0.000	6.912
2.0556	1.042	1.868	0.000	6.912
2.1111	1.049	1.926	0.000	6.912
2.1667	1.057	1.985	0.000	6.912
2.2222	1.064	2.044	0.000	6.912
2.2778	1.071	2.103	0.000	6.912
2.3333	1.079	2.163	0.000	6.912
2.3889	1.086	2.223	0.000	6.912
2.4444	1.093	2.283	0.000	6.912
2.5000	1.101	2.344	0.000	6.912
2.5556	1.108	2.406	0.000	6.912
2.6111	1.115	2.467	0.000	6.912
2.6667	1.123	2.530	0.000	6.912
2.7222	1.130	2.592	0.000	6.912
2.7778	1.137	2.655	0.000	6.912
2.8333	1.145	2.719	0.000	6.912
2.8889	1.152	2.783	0.000	6.912
2.9444	1.159	2.847	0.000	6.912
3.0000	1.167	2.911	0.000	6.912
3.0556	1.174	2.976	0.000	6.912
3.1111	1.182	3.042	0.000	6.912
3.1667	1.189	3.108	0.000	6.912
3.2222	1.196	3.174	0.000	6.912
3.2778	1.204	3.241	0.000	6.912
3.3333	1.211	3.308	0.000	6.912
3.3889	1.219	3.375	0.000	6.912

3.4444	1.226	3.443	0.000	6.912
3.5000	1.233	3.512	0.000	6.912
3.5556	1.241	3.580	0.000	6.912
3.6111	1.248	3.650	0.000	6.912
3.6667	1.256	3.719	0.000	6.912
3.7222	1.263	3.789	0.000	6.912
3.7778	1.271	3.860	0.000	6.912
3.8333	1.278	3.930	0.000	6.912
3.8889	1.286	4.002	0.000	6.912
3.9444	1.293	4.073	0.000	6.912
4.0000	1.300	4.145	0.000	6.912
4.0556	1.308	4.218	0.579	6.912
4.1111	1.315	4.291	1.637	6.912
4.1667	1.323	4.364	3.005	6.912
4.2222	1.330	4.438	4.624	6.912
4.2778	1.338	4.512	6.458	6.912
4.3333	1.345	4.586	8.479	6.912
4.3889	1.353	4.661	10.66	6.912
4.4444	1.360	4.737	13.00	6.912
4.5000	1.368	4.813	15.47	6.912
4.5556	1.375	4.889	18.06	6.912
4.6111	1.383	4.966	20.74	6.912
4.6667	1.390	5.043	23.51	6.912
4.7222	1.398	5.120	26.35	6.912
4.7778	1.406	5.198	29.24	6.912
4.8333	1.413	5.276	32.16	6.912
4.8889	1.421	5.355	35.10	6.912
4.9444	1.428	5.434	38.04	6.912
5.0000	1.436	5.514	40.97	6.912
5.0556	1.443	5.594	43.86	6.912

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:76.79
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:67.31
Total Impervious Area:9

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	1.645437
5 year	6.444187
10 year	12.95426
25 year	26.964264
50 year	43.025966

100 year	65.231584

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

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	26.170	0.000
1950	0.523	0.000
1951	17.215	0.000
1952	7.764	0.000
1953	0.305	0.000
1954	12.546	0.000
1955	0.961	0.000
1956	0.399	0.000
1957	2.535	0.000
1958	1.293	0.000
1959	2.719	0.000
1960	5.729	0.000
1961	1.076	0.000
1962	0.062	0.000
1963	3.764	0.000
1964	1.559	0.000
1965	0.826	0.000
1966	0.253	0.000
1967	1.681	0.000
1968	3.077	0.000
1969	0.990	0.000
1970	0.111	0.000
1971	15.605	0.000
1972	2.489	0.000
1973	1.406	0.000
1974	5.375	0.000
1975	30.709	0.000
1976	0.245	0.000
1977	0.386	0.000
1978	2.843	0.000
1979	1.185	0.000
1980	0.662	0.000
1981	1.263	0.000
1982	3.490	0.000
1983	1.229	0.000
1984	12.871	0.000
1985	1.023	0.000
1986	2.140	0.000
1987	0.264	0.000
1988	7.456	0.000
1989	1.649	0.000
1990	3.085	0.000

1991	7.362	0.000
1992	1.565	0.000
1993	1.866	0.000
1994	0.062	0.000
1995	0.061	0.000
1996	20.449	0.000
1997	68.043	0.000
1998	3.026	0.000
1999	0.392	0.000
2000	3.115	0.000
2001	0.061	0.000
2002	0.802	0.000
2003	0.062	0.000
2004	0.342	0.000
2005	0.984	0.000
2006	12.296	0.000
2007	3.573	0.000
2008	4.143	0.000
2009	2.072	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	68.0426	0.0000
2	30.7087	0.0000
3	26.1696	0.0000
4	20.4488	0.0000
5	17.2149	0.0000
6	15.6051	0.0000
7	12.8707	0.0000
8	12.5456	0.0000
9	12.2960	0.0000
10	7.7641	0.0000
11	7.4560	0.0000
12	7.3620	0.0000
13	5.7288	0.0000
14	5.3751	0.0000
15	4.1425	0.0000
16	3.7635	0.0000
17	3.5735	0.0000
18	3.4896	0.0000
19	3.1146	0.0000
20	3.0852	0.0000
21	3.0775	0.0000
22	3.0258	0.0000
23	2.8432	0.0000
24	2.7192	0.0000
25	2.5353	0.0000
26	2.4889	0.0000
27	2.1400	0.0000
28	2.0722	0.0000
29	1.8657	0.0000
30	1.6812	0.0000
31	1.6492	0.0000
32	1.5649	0.0000
33	1.5587	0.0000

34	1.4059	0.0000
35	1.2935	0.0000
36	1.2629	0.0000
37	1.2294	0.0000
38	1.1853	0.0000
39	1.0760	0.0000
40	1.0227	0.0000
41	0.9901	0.0000
42	0.9836	0.0000
43	0.9608	0.0000
44	0.8257	0.0000
45	0.8021	0.0000
46	0.6618	0.0000
47	0.5229	0.0000
48	0.3991	0.0000
49	0.3917	0.0000
50	0.3861	0.0000
51	0.3419	0.0000
52	0.3048	0.0000
53	0.2638	0.0000
54	0.2531	0.0000
55	0.2446	0.0000
56	0.1106	0.0000
57	0.0619	0.0000
58	0.0617	0.0000
59	0.0616	0.0000
60	0.0614	0.0000
61	0.0611	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.8227	259	0	0	Pass
1.2490	162	0	0	Pass
1.6753	119	0	0	Pass
2.1016	96	0	0	Pass
2.5279	84	0	0	Pass
2.9542	73	0	0	Pass
3.3805	63	0	0	Pass
3.8068	56	0	0	Pass
4.2331	51	0	0	Pass
4.6594	48	0	0	Pass
5.0857	47	0	0	Pass
5.5120	43	0	0	Pass
5.9383	41	0	0	Pass
6.3646	40	0	0	Pass
6.7909	38	0	0	Pass
7.2171	37	0	0	Pass
7.6434	33	0	0	Pass
8.0697	30	0	0	Pass
8.4960	29	0	0	Pass
8.9223	26	0	0	Pass

9.3486	25	0	0	Pass
9.7749	25	0	0	Pass
10.2012	25	0	0	Pass
10.6275	24	0	0	Pass
11.0538	22	0	0	Pass
11.4801	22	0	0	Pass
11.9064	21	0	0	Pass
12.3327	19	0	0	Pass
12.7590	18	0	0	Pass
13.1853	13	0	0	Pass
13.6116	11	0	0	Pass
14.0379	11	0	0	Pass
14.4642	11	0	0	Pass
14.8905	10	0	0	Pass
15.3168	9	0	0	Pass
15.7431	8	0	0	Pass
16.1694	8	0	0	Pass
16.5956	7	0	0	Pass
17.0219	7	0	0	Pass
17.4482	6	0	0	Pass
17.8745	6	0	0	Pass
18.3008	6	0	0	Pass
18.7271	6	0	0	Pass
19.1534	6	0	0	Pass
19.5797	6	0	0	Pass
20.0060	6	0	0	Pass
20.4323	6	0	0	Pass
20.8586	5	0	0	Pass
21.2849	4	0	0	Pass
21.7112	4	0	0	Pass
22.1375	4	0	0	Pass
22.5638	4	0	0	Pass
22.9901	4	0	0	Pass
23.4164	4	0	0	Pass
23.8427	4	0	0	Pass
24.2690	4	0	0	Pass
24.6953	4	0	0	Pass
25.1216	4	0	0	Pass
25.5479	4	0	0	Pass
25.9741	4	0	0	Pass
26.4004	3	0	0	Pass
26.8267	3	0	0	Pass
27.2530	3	0	0	Pass
27.6793	3	0	0	Pass
28.1056	3	0	0	Pass
28.5319	3	0	0	Pass
28.9582	3	0	0	Pass
29.3845	3	0	0	Pass
29.8108	3	0	0	Pass
30.2371	3	0	0	Pass
30.6634	3	0	0	Pass
31.0897	2	0	0	Pass
31.5160	2	0	0	Pass
31.9423	2	0	0	Pass
32.3686	2	0	0	Pass
32.7949	2	0	0	Pass
33.2212	2	0	0	Pass

33.6475	2	0	0	Pass
34.0738	2	0	0	Pass
34.5001	2	0	0	Pass
34.9264	2	0	0	Pass
35.3526	2	0	0	Pass
35.7789	2	0	0	Pass
36.2052	2	0	0	Pass
36.6315	2	0	0	Pass
37.0578	2	0	0	Pass
37.4841	2	0	0	Pass
37.9104	2	0	0	Pass
38.3367	2	0	0	Pass
38.7630	2	0	0	Pass
39.1893	2	0	0	Pass
39.6156	2	0	0	Pass
40.0419	2	0	0	Pass
40.4682	2	0	0	Pass
40.8945	2	0	0	Pass
41.3208	2	0	0	Pass
41.7471	2	0	0	Pass
42.1734	2	0	0	Pass
42.5997	2	0	0	Pass
43.0260	2	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 1.7299 **acre-feet**
On-line facility target flow: 3.2082 **cfs.**
Adjusted for 15 min: 3.2082 **cfs.**
Off-line facility target flow: 1.7955 **cfs.**
Adjusted for 15 min: 1.7955 **cfs.**

LID Report

LID Technique	Used for Water Quality?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft.)	Cumulative Volumn Infiltration Credit	Percent Treated
Trapezoidal Pond 1 POC	Y	2261.01	2484.63	2484.63	Y	100.00
Total Volume Infiltrated		2261.01	2484.63	2484.63		100.00

2484.63 2484.63 Treat. Credit
2485 / 2485 = Treat. Credit = 100%
Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Marblemount Basin 1 Unmitigated
Site Name: Marblemount Quarry
Site Address:
City : Marblemount
Report Date: 1/15/2019
Gage : Burlington
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.67
Version Date: 2017/04/14
Version : 4.2.13

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	76.79
Pervious Total	76.79

Impervious Land Use	acre
Impervious Total	0
Basin Total	76.79

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Steep	67.31
Pervious Total	67.31

Impervious Land Use	acre
ROADS MOD	9.48
Impervious Total	9.48
Basin Total	76.79

Element Flows To:
Surface Interflow Groundwater

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:76.79
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:67.31
Total Impervious Area:9.48

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	1.645437
5 year	6.444187
10 year	12.95426
25 year	26.964264
50 year	43.025966
100 year	65.231584

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	10.70415
5 year	17.622369
10 year	23.759522
25 year	33.674454
50 year	42.903928
100 year	53.969163

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	26.170	36.005
1950	0.523	6.061
1951	17.215	27.901
1952	7.764	15.760
1953	0.305	14.297
1954	12.546	22.134
1955	0.961	7.227
1956	0.399	4.363
1957	2.535	16.225
1958	1.293	7.916
1959	2.719	9.962
1960	5.729	14.312
1961	1.076	7.154
1962	0.062	9.554
1963	3.764	10.838
1964	1.559	9.449
1965	0.826	20.200
1966	0.253	6.532
1967	1.681	13.262
1968	3.077	12.849
1969	0.990	8.360
1970	0.111	15.717
1971	15.605	23.287
1972	2.489	6.556
1973	1.406	9.123
1974	5.375	11.193
1975	30.709	37.298
1976	0.245	13.726
1977	0.386	7.168
1978	2.843	12.834
1979	1.185	9.532
1980	0.662	9.143
1981	1.263	9.714
1982	3.490	8.519
1983	1.229	9.239
1984	12.871	18.841
1985	1.023	12.117
1986	2.140	8.945
1987	0.264	6.832
1988	7.456	16.254
1989	1.649	7.223
1990	3.085	11.714
1991	7.362	14.400
1992	1.565	11.310
1993	1.866	6.644
1994	0.062	6.173
1995	0.061	5.403
1996	20.449	30.294
1997	68.043	82.418
1998	3.026	9.537
1999	0.392	6.610
2000	3.115	10.541
2001	0.061	7.638

2002	0.802	5.968
2003	0.062	7.366
2004	0.342	31.535
2005	0.984	8.639
2006	12.296	19.235
2007	3.573	10.425
2008	4.143	9.685
2009	2.072	8.551

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	68.0426	82.4180
2	30.7087	37.2979
3	26.1696	36.0053
4	20.4488	31.5350
5	17.2149	30.2938
6	15.6051	27.9011
7	12.8707	23.2867
8	12.5456	22.1339
9	12.2960	20.2003
10	7.7641	19.2346
11	7.4560	18.8411
12	7.3620	16.2540
13	5.7288	16.2250
14	5.3751	15.7601
15	4.1425	15.7166
16	3.7635	14.4003
17	3.5735	14.3117
18	3.4896	14.2970
19	3.1146	13.7256
20	3.0852	13.2622
21	3.0775	12.8489
22	3.0258	12.8344
23	2.8432	12.1169
24	2.7192	11.7137
25	2.5353	11.3097
26	2.4889	11.1929
27	2.1400	10.8376
28	2.0722	10.5405
29	1.8657	10.4250
30	1.6812	9.9615
31	1.6492	9.7143
32	1.5649	9.6852
33	1.5587	9.5544
34	1.4059	9.5371
35	1.2935	9.5319
36	1.2629	9.4493
37	1.2294	9.2386
38	1.1853	9.1434
39	1.0760	9.1231
40	1.0227	8.9451
41	0.9901	8.6393
42	0.9836	8.5508
43	0.9608	8.5192
44	0.8257	8.3601

45	0.8021	7.9156
46	0.6618	7.6380
47	0.5229	7.3665
48	0.3991	7.2267
49	0.3917	7.2227
50	0.3861	7.1680
51	0.3419	7.1538
52	0.3048	6.8320
53	0.2638	6.6445
54	0.2531	6.6104
55	0.2446	6.5564
56	0.1106	6.5323
57	0.0619	6.1733
58	0.0617	6.0613
59	0.0616	5.9684
60	0.0614	5.4030
61	0.0611	4.3629

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.8227	259	44425	17152	Fail
1.2490	162	25196	15553	Fail
1.6753	119	12818	10771	Fail
2.1016	96	6748	7029	Fail
2.5279	84	4128	4914	Fail
2.9542	73	2755	3773	Fail
3.3805	63	1859	2950	Fail
3.8068	56	1313	2344	Fail
4.2331	51	946	1854	Fail
4.6594	48	724	1508	Fail
5.0857	47	541	1151	Fail
5.5120	43	424	986	Fail
5.9383	41	343	836	Fail
6.3646	40	273	682	Fail
6.7909	38	226	594	Fail
7.2171	37	191	516	Fail
7.6434	33	162	490	Fail
8.0697	30	140	466	Fail
8.4960	29	124	427	Fail
8.9223	26	113	434	Fail
9.3486	25	101	404	Fail
9.7749	25	86	344	Fail
10.2012	25	77	308	Fail
10.6275	24	72	300	Fail
11.0538	22	69	313	Fail
11.4801	22	63	286	Fail
11.9064	21	61	290	Fail
12.3327	19	57	300	Fail
12.7590	18	53	294	Fail
13.1853	13	49	376	Fail
13.6116	11	47	427	Fail
14.0379	11	43	390	Fail

14.4642	11	37	336	Fail
14.8905	10	36	360	Fail
15.3168	9	35	388	Fail
15.7431	8	31	387	Fail
16.1694	8	28	350	Fail
16.5956	7	25	357	Fail
17.0219	7	25	357	Fail
17.4482	6	24	400	Fail
17.8745	6	23	383	Fail
18.3008	6	22	366	Fail
18.7271	6	22	366	Fail
19.1534	6	21	350	Fail
19.5797	6	18	300	Fail
20.0060	6	17	283	Fail
20.4323	6	14	233	Fail
20.8586	5	14	280	Fail
21.2849	4	12	300	Fail
21.7112	4	11	275	Fail
22.1375	4	11	275	Fail
22.5638	4	10	250	Fail
22.9901	4	10	250	Fail
23.4164	4	9	225	Fail
23.8427	4	9	225	Fail
24.2690	4	9	225	Fail
24.6953	4	9	225	Fail
25.1216	4	8	200	Fail
25.5479	4	8	200	Fail
25.9741	4	8	200	Fail
26.4004	3	8	266	Fail
26.8267	3	8	266	Fail
27.2530	3	8	266	Fail
27.6793	3	8	266	Fail
28.1056	3	6	200	Fail
28.5319	3	6	200	Fail
28.9582	3	6	200	Fail
29.3845	3	6	200	Fail
29.8108	3	6	200	Fail
30.2371	3	6	200	Fail
30.6634	3	5	166	Fail
31.0897	2	5	250	Fail
31.5160	2	5	250	Fail
31.9423	2	4	200	Fail
32.3686	2	4	200	Fail
32.7949	2	4	200	Fail
33.2212	2	4	200	Fail
33.6475	2	4	200	Fail
34.0738	2	4	200	Fail
34.5001	2	4	200	Fail
34.9264	2	4	200	Fail
35.3526	2	4	200	Fail
35.7789	2	4	200	Fail
36.2052	2	3	150	Fail
36.6315	2	3	150	Fail
37.0578	2	3	150	Fail
37.4841	2	2	100	Pass
37.9104	2	2	100	Pass
38.3367	2	2	100	Pass

38.7630	2	2	100	Pass
39.1893	2	2	100	Pass
39.6156	2	2	100	Pass
40.0419	2	2	100	Pass
40.4682	2	2	100	Pass
40.8945	2	2	100	Pass
41.3208	2	2	100	Pass
41.7471	2	2	100	Pass
42.1734	2	2	100	Pass
42.5997	2	2	100	Pass
43.0260	2	2	100	Pass

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 1.7422 **acre-feet**
On-line facility target flow: 3.2302 **cfs.**
Adjusted for 15 min: 3.2302 **cfs.**
Off-line facility target flow: 1.8075 **cfs.**
Adjusted for 15 min: 1.8075 **cfs.**

LID Report

LID Technique	Used for Water Quality	Total Volumn Percent Treatment?	Volumn Needs Treatment (ac-ft)	Through Facility (ac-ft)	Infiltration Volumn (ac-ft.)	Cumulative Volumn Infiltration Credit	Percent Infiltrated
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00
0%	No Treat. Credit						

Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Marblemount Basin 2 Infiltration Pond
Site Name: Marblemount Quarry Basin 2
Site Address:
City : Marblemount
Report Date: 1/16/2019
Gage : Burlington
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.67
Version Date: 2017/04/14
Version : 4.2.13

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 2
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Flat	2.97
Pervious Total	2.97

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.97

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 2
Bypass: No

GroundWater: No

Pervious Land Use	acre
Pervious Total	0

Impervious Land Use	acre
ROADS FLAT	2.83
ROOF TOPS FLAT	0.14
Impervious Total	2.97
Basin Total	2.97

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 2	Trapezoidal Pond 2	

Name : Trapezoidal Pond 2
Bottom Length: 75.00 ft.
Bottom Width: 75.00 ft.
Depth: 5 ft.
Volume at riser head: 0.7120 acre-feet.
Infiltration On
Infiltration rate: 8.83
Infiltration safety factor: 1
Total Volume Infiltrated (ac-ft.): 765.664
Total Volume Through Riser (ac-ft.): 0
Total Volume Through Facility (ac-ft.): 765.664
Percent Infiltrated: 100
Total Precip Applied to Facility: 34.012
Total Evap From Facility: 3.544
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 24 in.

Element Flows To:

Outlet 1	Outlet 2

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.129	0.000	0.000	0.000
0.0556	0.130	0.007	0.000	1.149
0.1111	0.131	0.014	0.000	1.149
0.1667	0.132	0.021	0.000	1.149
0.2222	0.133	0.029	0.000	1.149

0.2778	0.134	0.036	0.000	1.149
0.3333	0.136	0.044	0.000	1.149
0.3889	0.137	0.051	0.000	1.149
0.4444	0.138	0.059	0.000	1.149
0.5000	0.139	0.067	0.000	1.149
0.5556	0.140	0.075	0.000	1.149
0.6111	0.142	0.082	0.000	1.149
0.6667	0.143	0.090	0.000	1.149
0.7222	0.144	0.098	0.000	1.149
0.7778	0.145	0.106	0.000	1.149
0.8333	0.146	0.114	0.000	1.149
0.8889	0.148	0.123	0.000	1.149
0.9444	0.149	0.131	0.000	1.149
1.0000	0.150	0.139	0.000	1.149
1.0556	0.151	0.148	0.000	1.149
1.1111	0.153	0.156	0.000	1.149
1.1667	0.154	0.165	0.000	1.149
1.2222	0.155	0.173	0.000	1.149
1.2778	0.156	0.182	0.000	1.149
1.3333	0.158	0.191	0.000	1.149
1.3889	0.159	0.200	0.000	1.149
1.4444	0.160	0.208	0.000	1.149
1.5000	0.162	0.217	0.000	1.149
1.5556	0.163	0.226	0.000	1.149
1.6111	0.164	0.236	0.000	1.149
1.6667	0.165	0.245	0.000	1.149
1.7222	0.167	0.254	0.000	1.149
1.7778	0.168	0.263	0.000	1.149
1.8333	0.169	0.273	0.000	1.149
1.8889	0.171	0.282	0.000	1.149
1.9444	0.172	0.292	0.000	1.149
2.0000	0.173	0.301	0.000	1.149
2.0556	0.175	0.311	0.000	1.149
2.1111	0.176	0.321	0.000	1.149
2.1667	0.177	0.331	0.000	1.149
2.2222	0.179	0.341	0.000	1.149
2.2778	0.180	0.351	0.000	1.149
2.3333	0.181	0.361	0.000	1.149
2.3889	0.183	0.371	0.000	1.149
2.4444	0.184	0.381	0.000	1.149
2.5000	0.186	0.391	0.000	1.149
2.5556	0.187	0.402	0.000	1.149
2.6111	0.188	0.412	0.000	1.149
2.6667	0.190	0.423	0.000	1.149
2.7222	0.191	0.433	0.000	1.149
2.7778	0.192	0.444	0.000	1.149
2.8333	0.194	0.455	0.000	1.149
2.8889	0.195	0.465	0.000	1.149
2.9444	0.197	0.476	0.000	1.149
3.0000	0.198	0.487	0.000	1.149
3.0556	0.200	0.498	0.000	1.149
3.1111	0.201	0.510	0.000	1.149
3.1667	0.202	0.521	0.000	1.149
3.2222	0.204	0.532	0.000	1.149
3.2778	0.205	0.544	0.000	1.149
3.3333	0.207	0.555	0.000	1.149
3.3889	0.208	0.567	0.000	1.149

3.4444	0.210	0.578	0.000	1.149
3.5000	0.211	0.590	0.000	1.149
3.5556	0.213	0.602	0.000	1.149
3.6111	0.214	0.614	0.000	1.149
3.6667	0.216	0.626	0.000	1.149
3.7222	0.217	0.638	0.000	1.149
3.7778	0.219	0.650	0.000	1.149
3.8333	0.220	0.662	0.000	1.149
3.8889	0.222	0.674	0.000	1.149
3.9444	0.223	0.687	0.000	1.149
4.0000	0.225	0.699	0.000	1.149
4.0556	0.226	0.712	0.277	1.149
4.1111	0.228	0.724	0.784	1.149
4.1667	0.229	0.737	1.438	1.149
4.2222	0.231	0.750	2.205	1.149
4.2778	0.232	0.763	3.059	1.149
4.3333	0.234	0.776	3.979	1.149
4.3889	0.235	0.789	4.939	1.149
4.4444	0.237	0.802	5.917	1.149
4.5000	0.238	0.815	6.887	1.149
4.5556	0.240	0.828	7.826	1.149
4.6111	0.242	0.842	8.711	1.149
4.6667	0.243	0.855	9.523	1.149
4.7222	0.245	0.869	10.24	1.149
4.7778	0.246	0.882	10.86	1.149
4.8333	0.248	0.896	11.38	1.149
4.8889	0.249	0.910	11.81	1.149
4.9444	0.251	0.924	12.16	1.149
5.0000	0.253	0.938	12.46	1.149
5.0556	0.254	0.952	12.94	1.149

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:2.97
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:2.97

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.038092
5 year	0.150586
10 year	0.313669
25 year	0.694012
50 year	1.16668

100 year	1.869583

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

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.661	0.000
1950	0.012	0.000
1951	0.418	0.000
1952	0.182	0.000
1953	0.007	0.000
1954	0.301	0.000
1955	0.021	0.000
1956	0.009	0.000
1957	0.059	0.000
1958	0.030	0.000
1959	0.070	0.000
1960	0.132	0.000
1961	0.025	0.000
1962	0.002	0.000
1963	0.086	0.000
1964	0.036	0.000
1965	0.019	0.000
1966	0.006	0.000
1967	0.037	0.000
1968	0.072	0.000
1969	0.020	0.000
1970	0.003	0.000
1971	0.375	0.000
1972	0.058	0.000
1973	0.033	0.000
1974	0.127	0.000
1975	1.045	0.000
1976	0.006	0.000
1977	0.008	0.000
1978	0.066	0.000
1979	0.023	0.000
1980	0.015	0.000
1981	0.029	0.000
1982	0.082	0.000
1983	0.028	0.000
1984	0.309	0.000
1985	0.024	0.000
1986	0.049	0.000
1987	0.006	0.000
1988	0.201	0.000
1989	0.038	0.000
1990	0.071	0.000

1991	0.213	0.000
1992	0.035	0.000
1993	0.042	0.000
1994	0.002	0.000
1995	0.002	0.000
1996	0.496	0.000
1997	2.090	0.000
1998	0.071	0.000
1999	0.009	0.000
2000	0.073	0.000
2001	0.002	0.000
2002	0.018	0.000
2003	0.002	0.000
2004	0.008	0.000
2005	0.022	0.000
2006	0.298	0.000
2007	0.079	0.000
2008	0.097	0.000
2009	0.048	0.000

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.0899	0.0000
2	1.0445	0.0000
3	0.6607	0.0000
4	0.4963	0.0000
5	0.4178	0.0000
6	0.3749	0.0000
7	0.3089	0.0000
8	0.3009	0.0000
9	0.2976	0.0000
10	0.2125	0.0000
11	0.2010	0.0000
12	0.1820	0.0000
13	0.1322	0.0000
14	0.1266	0.0000
15	0.0971	0.0000
16	0.0864	0.0000
17	0.0816	0.0000
18	0.0787	0.0000
19	0.0728	0.0000
20	0.0718	0.0000
21	0.0712	0.0000
22	0.0706	0.0000
23	0.0702	0.0000
24	0.0664	0.0000
25	0.0591	0.0000
26	0.0580	0.0000
27	0.0492	0.0000
28	0.0481	0.0000
29	0.0423	0.0000
30	0.0377	0.0000
31	0.0373	0.0000
32	0.0362	0.0000
33	0.0352	0.0000

34	0.0326	0.0000
35	0.0299	0.0000
36	0.0292	0.0000
37	0.0283	0.0000
38	0.0247	0.0000
39	0.0236	0.0000
40	0.0233	0.0000
41	0.0225	0.0000
42	0.0205	0.0000
43	0.0202	0.0000
44	0.0190	0.0000
45	0.0184	0.0000
46	0.0152	0.0000
47	0.0119	0.0000
48	0.0092	0.0000
49	0.0090	0.0000
50	0.0078	0.0000
51	0.0076	0.0000
52	0.0072	0.0000
53	0.0060	0.0000
54	0.0058	0.0000
55	0.0055	0.0000
56	0.0025	0.0000
57	0.0024	0.0000
58	0.0024	0.0000
59	0.0024	0.0000
60	0.0024	0.0000
61	0.0024	0.0000

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0190	262	0	0	Pass
0.0306	160	0	0	Pass
0.0422	118	0	0	Pass
0.0538	97	0	0	Pass
0.0654	85	0	0	Pass
0.0770	70	0	0	Pass
0.0886	61	0	0	Pass
0.1002	58	0	0	Pass
0.1118	54	0	0	Pass
0.1234	51	0	0	Pass
0.1350	48	0	0	Pass
0.1466	47	0	0	Pass
0.1582	43	0	0	Pass
0.1697	40	0	0	Pass
0.1813	35	0	0	Pass
0.1929	34	0	0	Pass
0.2045	33	0	0	Pass
0.2161	29	0	0	Pass
0.2277	27	0	0	Pass
0.2393	27	0	0	Pass

0.2509	27	0	0	Pass
0.2625	27	0	0	Pass
0.2741	27	0	0	Pass
0.2857	26	0	0	Pass
0.2973	26	0	0	Pass
0.3089	23	0	0	Pass
0.3204	22	0	0	Pass
0.3320	21	0	0	Pass
0.3436	20	0	0	Pass
0.3552	20	0	0	Pass
0.3668	18	0	0	Pass
0.3784	17	0	0	Pass
0.3900	16	0	0	Pass
0.4016	14	0	0	Pass
0.4132	13	0	0	Pass
0.4248	12	0	0	Pass
0.4364	12	0	0	Pass
0.4480	12	0	0	Pass
0.4596	12	0	0	Pass
0.4711	10	0	0	Pass
0.4827	10	0	0	Pass
0.4943	9	0	0	Pass
0.5059	8	0	0	Pass
0.5175	8	0	0	Pass
0.5291	8	0	0	Pass
0.5407	8	0	0	Pass
0.5523	7	0	0	Pass
0.5639	7	0	0	Pass
0.5755	7	0	0	Pass
0.5871	6	0	0	Pass
0.5987	6	0	0	Pass
0.6103	6	0	0	Pass
0.6218	5	0	0	Pass
0.6334	5	0	0	Pass
0.6450	5	0	0	Pass
0.6566	5	0	0	Pass
0.6682	3	0	0	Pass
0.6798	3	0	0	Pass
0.6914	3	0	0	Pass
0.7030	3	0	0	Pass
0.7146	3	0	0	Pass
0.7262	3	0	0	Pass
0.7378	3	0	0	Pass
0.7494	3	0	0	Pass
0.7610	3	0	0	Pass
0.7725	3	0	0	Pass
0.7841	3	0	0	Pass
0.7957	3	0	0	Pass
0.8073	3	0	0	Pass
0.8189	3	0	0	Pass
0.8305	3	0	0	Pass
0.8421	3	0	0	Pass
0.8537	3	0	0	Pass
0.8653	3	0	0	Pass
0.8769	3	0	0	Pass
0.8885	3	0	0	Pass
0.9001	3	0	0	Pass

0.9117	3	0	0	Pass
0.9232	3	0	0	Pass
0.9348	3	0	0	Pass
0.9464	3	0	0	Pass
0.9580	3	0	0	Pass
0.9696	3	0	0	Pass
0.9812	3	0	0	Pass
0.9928	3	0	0	Pass
1.0044	3	0	0	Pass
1.0160	3	0	0	Pass
1.0276	3	0	0	Pass
1.0392	3	0	0	Pass
1.0508	2	0	0	Pass
1.0623	2	0	0	Pass
1.0739	2	0	0	Pass
1.0855	2	0	0	Pass
1.0971	2	0	0	Pass
1.1087	2	0	0	Pass
1.1203	2	0	0	Pass
1.1319	2	0	0	Pass
1.1435	2	0	0	Pass
1.1551	2	0	0	Pass
1.1667	2	0	0	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.8087 **acre-feet**
On-line facility target flow: 1.283 **cfs.**
Adjusted for 15 min: 1.283 **cfs.**
Off-line facility target flow: 0.7237 **cfs.**
Adjusted for 15 min: 0.7237 **cfs.**

LID Report

LID Technique	Used for Water Quality?	Total Volumn Percent Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft.)	Cumulative Volumn Infiltration Credit	Percent Water Quality Treated	Comment
Trapezoidal Pond 2 POC	Y	696.79	765.70	765.66	Y	99.99	765.66
Total Volume Infiltrated		696.79	765.70	765.66		99.99	766 / 766 = 10

Treat. Credit
Treat. Credit = 100%
Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Marblemount Basin 2 Unmitigated
Site Name: Marblemount Quarry Basin 2 Unmitigated
Site Address:
City : Marblemount
Report Date: 1/15/2019
Gage : Burlington
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.67
Version Date: 2017/04/14
Version : 4.2.13

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 2
Bypass: No

GroundWater: No

Pervious Land Use	acre
A B, Forest, Flat	2.97
Pervious Total	2.97

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.97

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : Basin 2
Bypass: No

GroundWater: No

Pervious Land Use	acre
Pervious Total	0

Impervious Land Use	acre
ROADS FLAT	2.83
ROOF TOPS FLAT	0.14
Impervious Total	2.97
Basin Total	2.97

Element Flows To:
Surface Interflow Groundwater

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:2.97
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:2.97

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.038092
5 year	0.150586
10 year	0.313669
25 year	0.694012
50 year	1.16668
100 year	1.869583

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	2.313144
5 year	3.247744
10 year	3.936415
25 year	4.888716
50 year	5.659582
100 year	6.484655

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.661	3.580
1950	0.012	1.583
1951	0.418	3.131
1952	0.182	3.415
1953	0.007	3.805
1954	0.301	2.100
1955	0.021	1.624
1956	0.009	1.132
1957	0.059	3.845
1958	0.030	1.601
1959	0.070	2.361
1960	0.132	2.440
1961	0.025	1.551
1962	0.002	2.601
1963	0.086	1.684
1964	0.036	2.503
1965	0.019	5.071
1966	0.006	1.868
1967	0.037	3.679
1968	0.072	3.144
1969	0.020	1.899
1970	0.003	3.619
1971	0.375	2.250
1972	0.058	1.336
1973	0.033	2.411
1974	0.127	1.722
1975	1.045	3.170
1976	0.006	4.042
1977	0.008	1.837
1978	0.066	3.404
1979	0.023	2.306
1980	0.015	2.320
1981	0.029	2.711
1982	0.082	2.266
1983	0.028	1.983
1984	0.309	2.068
1985	0.024	3.017
1986	0.049	1.681
1987	0.006	1.803
1988	0.201	3.093
1989	0.038	2.196
1990	0.071	2.033
1991	0.213	3.101
1992	0.035	2.789
1993	0.042	1.186
1994	0.002	1.553
1995	0.002	1.381
1996	0.496	3.078
1997	2.090	5.832
1998	0.071	2.459
1999	0.009	1.264
2000	0.073	3.057
2001	0.002	2.092

2002	0.018	1.520
2003	0.002	1.924
2004	0.008	7.908
2005	0.022	2.461
2006	0.298	2.398
2007	0.079	2.080
2008	0.097	2.065
2009	0.048	2.475

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	2.0899	7.9079
2	1.0445	5.8321
3	0.6607	5.0709
4	0.4963	4.0423
5	0.4178	3.8446
6	0.3749	3.8047
7	0.3089	3.6789
8	0.3009	3.6195
9	0.2976	3.5797
10	0.2125	3.4145
11	0.2010	3.4039
12	0.1820	3.1700
13	0.1322	3.1444
14	0.1266	3.1310
15	0.0971	3.1007
16	0.0864	3.0929
17	0.0816	3.0778
18	0.0787	3.0574
19	0.0728	3.0172
20	0.0718	2.7893
21	0.0712	2.7111
22	0.0706	2.6007
23	0.0702	2.5031
24	0.0664	2.4746
25	0.0591	2.4614
26	0.0580	2.4588
27	0.0492	2.4403
28	0.0481	2.4108
29	0.0423	2.3978
30	0.0377	2.3605
31	0.0373	2.3198
32	0.0362	2.3058
33	0.0352	2.2660
34	0.0326	2.2497
35	0.0299	2.1958
36	0.0292	2.1004
37	0.0283	2.0922
38	0.0247	2.0798
39	0.0236	2.0684
40	0.0233	2.0645
41	0.0225	2.0327
42	0.0205	1.9831
43	0.0202	1.9238
44	0.0190	1.8989

45	0.0184	1.8680
46	0.0152	1.8373
47	0.0119	1.8034
48	0.0092	1.7225
49	0.0090	1.6839
50	0.0078	1.6809
51	0.0076	1.6244
52	0.0072	1.6010
53	0.0060	1.5825
54	0.0058	1.5534
55	0.0055	1.5510
56	0.0025	1.5199
57	0.0024	1.3809
58	0.0024	1.3363
59	0.0024	1.2636
60	0.0024	1.1860
61	0.0024	1.1316

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0190	262	215813	82371	Fail
0.0306	160	182061	113788	Fail
0.0422	118	157849	133770	Fail
0.0538	97	141252	145620	Fail
0.0654	85	127135	149570	Fail
0.0770	70	114858	164082	Fail
0.0886	61	105639	173178	Fail
0.1002	58	97233	167643	Fail
0.1118	54	90218	167070	Fail
0.1234	51	83459	163645	Fail
0.1350	48	78176	162866	Fail
0.1466	47	73064	155455	Fail
0.1582	43	68444	159172	Fail
0.1697	40	64509	161272	Fail
0.1813	35	60573	173065	Fail
0.1929	34	57322	168594	Fail
0.2045	33	53814	163072	Fail
0.2161	29	50606	174503	Fail
0.2277	27	47847	177211	Fail
0.2393	27	45088	166992	Fail
0.2509	27	42713	158196	Fail
0.2625	27	40168	148770	Fail
0.2741	27	37751	139818	Fail
0.2857	26	35634	137053	Fail
0.2973	26	33495	128826	Fail
0.3089	23	31698	137817	Fail
0.3204	22	29773	135331	Fail
0.3320	21	27912	132914	Fail
0.3436	20	26330	131650	Fail
0.3552	20	24661	123305	Fail
0.3668	18	23271	129283	Fail
0.3784	17	21838	128458	Fail

0.3900	16	20574	128587	Fail
0.4016	14	19312	137942	Fail
0.4132	13	18125	139423	Fail
0.4248	12	17130	142750	Fail
0.4364	12	16097	134141	Fail
0.4480	12	15169	126408	Fail
0.4596	12	14224	118533	Fail
0.4711	10	13344	133440	Fail
0.4827	10	12581	125810	Fail
0.4943	9	11772	130800	Fail
0.5059	8	11103	138787	Fail
0.5175	8	10442	130525	Fail
0.5291	8	9828	122850	Fail
0.5407	8	9293	116162	Fail
0.5523	7	8654	123628	Fail
0.5639	7	8207	117242	Fail
0.5755	7	7743	110614	Fail
0.5871	6	7296	121600	Fail
0.5987	6	6896	114933	Fail
0.6103	6	6541	109016	Fail
0.6218	5	6216	124319	Fail
0.6334	5	5912	118240	Fail
0.6450	5	5595	111900	Fail
0.6566	5	5319	106380	Fail
0.6682	3	5065	168833	Fail
0.6798	3	4838	161266	Fail
0.6914	3	4620	154000	Fail
0.7030	3	4436	147866	Fail
0.7146	3	4244	141466	Fail
0.7262	3	4051	135033	Fail
0.7378	3	3899	129966	Fail
0.7494	3	3720	124000	Fail
0.7610	3	3585	119500	Fail
0.7725	3	3420	114000	Fail
0.7841	3	3290	109666	Fail
0.7957	3	3157	105233	Fail
0.8073	3	3024	100800	Fail
0.8189	3	2913	97100	Fail
0.8305	3	2778	92600	Fail
0.8421	3	2648	88266	Fail
0.8537	3	2532	84400	Fail
0.8653	3	2432	81066	Fail
0.8769	3	2336	77866	Fail
0.8885	3	2233	74433	Fail
0.9001	3	2139	71300	Fail
0.9117	3	2055	68500	Fail
0.9232	3	1983	66100	Fail
0.9348	3	1903	63433	Fail
0.9464	3	1813	60433	Fail
0.9580	3	1741	58033	Fail
0.9696	3	1685	56166	Fail
0.9812	3	1598	53266	Fail
0.9928	3	1533	51100	Fail
1.0044	3	1472	49066	Fail
1.0160	3	1425	47500	Fail
1.0276	3	1370	45666	Fail
1.0392	3	1308	43600	Fail

1.0508	2	1262	63100	Fail
1.0623	2	1223	61150	Fail
1.0739	2	1184	59200	Fail
1.0855	2	1134	56700	Fail
1.0971	2	1092	54600	Fail
1.1087	2	1049	52450	Fail
1.1203	2	1003	50150	Fail
1.1319	2	971	48550	Fail
1.1435	2	937	46850	Fail
1.1551	2	894	44700	Fail
1.1667	2	864	43200	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.5256 **acre-feet**
On-line facility target flow: 0.8341 **cfs.**
Adjusted for 15 min: 0.8341 **cfs.**
Off-line facility target flow: 0.4703 **cfs.**
Adjusted for 15 min: 0.4703 **cfs.**

LID Report

LID Technique	Used for Water Quality	Total Volumn Percent Treatment?	Volumn Needs Treatment (ac-ft)	Through Facility (ac-ft)	Infiltration Volumn (ac-ft.)	Cumulative Volumn Infiltration Credit	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	
0.00	0%	No Treat. Credit					

Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

APPENDIX

7.7 CONSTRUCTION SITE SOURCE CONTROL & STORMWATER RUNOFF CONVEYANCE BMPS

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.

- As required by local governments.
- Phase construction to preserve natural vegetation on the project site for as long as possible during the construction period.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

  Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can typically tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile

system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- *Excavations* - Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:

  Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint if roots will be exposed for more than 24-hours.

  Backfill the trench as soon as possible.

  Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken to protect these trees.
- The windthrow hazard of Pacific silver fir and madrona is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.
- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.
- Thinning operations in pure or mixed stands of Grand fir, Pacific silver fir, Noble fir, Sitka spruce, Western red cedar, Western hemlock, Pacific dogwood, and Red alder can cause serious disease problems.

Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

- If tree roots have been exposed or injured, "prune" cleanly with an appropriate pruning saw or loppers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C102: Buffer Zones

Purpose

Creation of an undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Conditions of Use

Natural buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can be used to protect natural swales and can be incorporated into the natural landscaping of an area.

Critical-areas buffer zones should not be used as sediment treatment areas. These areas shall remain completely undisturbed. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method in protecting sensitive areas and buffers. Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Vegetative buffer zones for streams, lakes or other waterways shall be established by the local permitting authority or other state or federal permits or approvals.

Maintenance Standards

Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed. Replace all damaged flagging immediately.

BMP C105: Stabilized Construction Entrance / Exit

Purpose

Stabilized Construction entrances are established to reduce the amount of sediment transported onto paved roads by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction provide stabilized construction entrances for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure 4.1.1 for details. Note: the 100' minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100').

Construct stabilized construction entrances with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

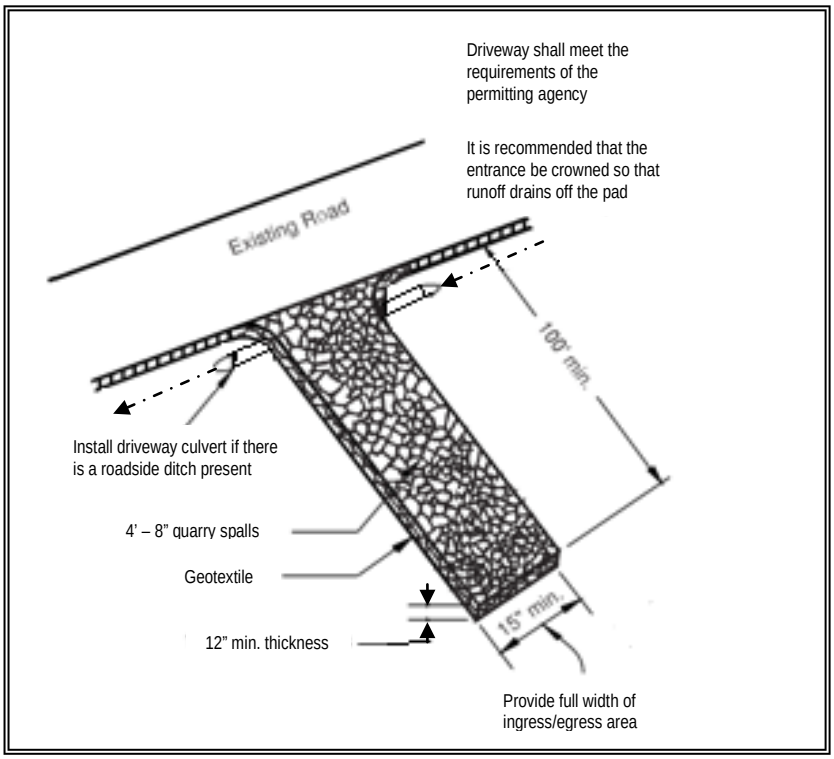


Figure 4.1.1 – Stabilized Construction Entrance

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C125: Topsoiling / Composting

Purpose

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding. Note that this BMP is functionally the same as BMP T5.13 (see Chapter 5 of Volume V of this manual) which is required for all disturbed areas that will be developed as lawn or landscaped areas at the completed project site.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective

biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.
- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted conditions if functioning properly.
- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.
- Restore, to the maximum extent practical, native soils disturbed during clearing and grading to a condition equal to or better than the original site condition's moisture-holding capacity. Use on-site native topsoil, incorporate amendments into on-site soil, or import blended topsoil to meet this requirement.
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.
- Beware of where the topsoil comes from, and what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using off-site topsoil.

Design and Installation Specifications

Meet the following requirements for disturbed areas that will be developed as lawn or landscaped areas at the completed project site:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
    - A minimum depth of 8-inches. Scarify subsoils below the topsoil layer at least 4-inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.

- A minimum organic content of 10% dry weight in planting beds, and 5% organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
- A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
- If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.
- Mulch planting beds with 2 inches of organic material

- Accomplish the required organic content, depth, and pH by returning native topsoil to the site, importing topsoil of sufficient organic content, and/or incorporating organic amendments.When using the option of incorporating amendments to meet the organic content requirement, use compost that meets the compost specification for Bioretention (See BMP T7.30 in Chapter 7 of Volume V of this manual), with the exception that the compost may have up to 35% biosolids or manure.
- Sections three through seven of the document entitled, *Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington,* provides useful guidance for implementing whichever option is chosen. It includes guidance for pre-approved default strategies and guidance for custom strategies. Check with your local jurisdiction concerning its acceptance of this guidance. It is available through the organization, Soils for Salmon. As of this printing the document may be found at: http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.
- Take care when applying top soil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural ground water recharge.
- Stripping shall be confined to the immediate construction area. A 4-inch to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Do not place topsoil while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2H:1V.
- Between October 1 and April 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil.
  - Within 2 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- Between May 1 and September 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil if the stockpile will remain in place for a longer period of time than active construction grading.
  - Within 7 days complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
  1. Re-install topsoil within 4 to 6 weeks.
  2. Do not allow the saturation of topsoil with water.
  3. Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Conditions for Use

- All slopes steeper than 3H:1V and greater than 5 vertical feet require surface roughening to a depth of 2 to 4 inches prior to seeding..
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 4.1.5 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3H:1V) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes steeper than 3H:1V but less than 2H:1V should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.
- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

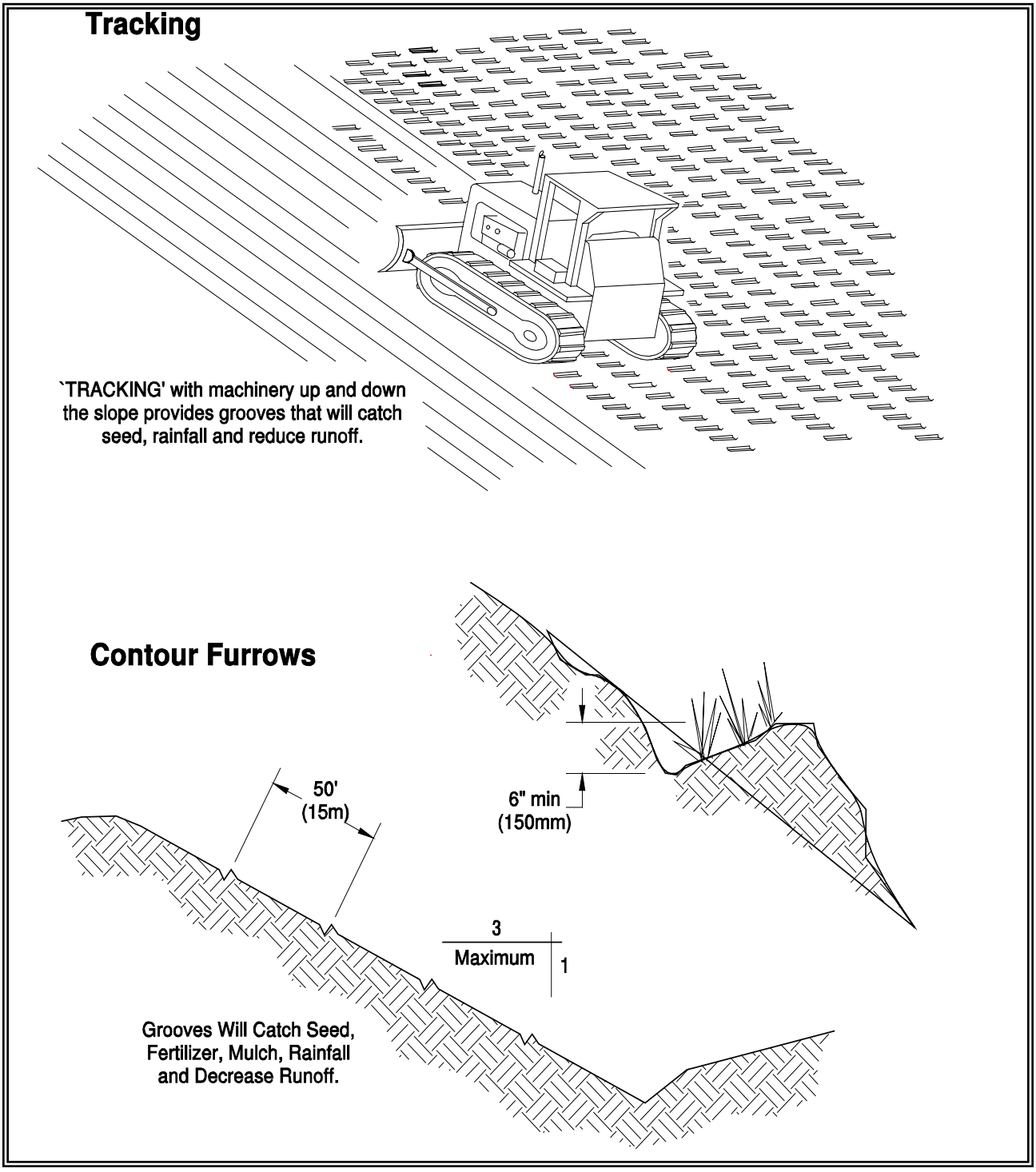


Figure 4.1.5 – Surface Roughening by Tracking and Contour Furrows

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control. Use of PAM could be a cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.

- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use of paved roadways by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP.

Maintenance Standards Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric and steel "T" posts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available for use on several projects.
- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

Material
Clear Plastic, 6 mil
Drainpipe, 6 or 8 inch diameter
Sandbags, filled
Straw Bales for mulching,
Quarry Spalls
Washed Gravel
Geotextile Fabric
Catch Basin Inserts
Steel "T" Posts
Silt fence material
Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel "T" posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate ground water or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose process water in a manner that does not violate ground water or surface water quality standards.
- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

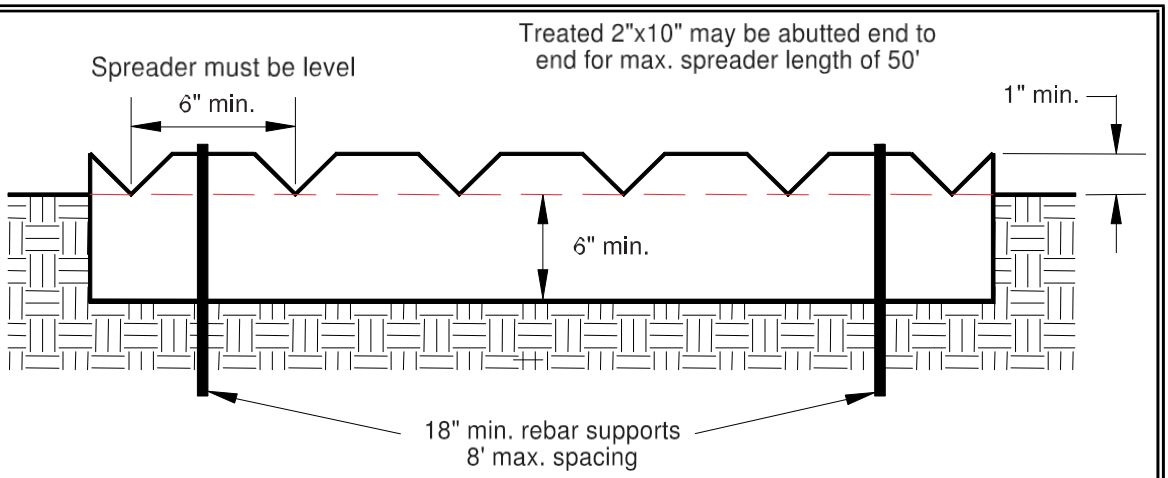


Figure 4.2.6 – Detail of Level Spreader

BMP C207: Check Dams

Purpose Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.

- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.
- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.

- Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure 4.2.7 depicts a typical rock check dam.

Maintenance Standards

Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C207. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

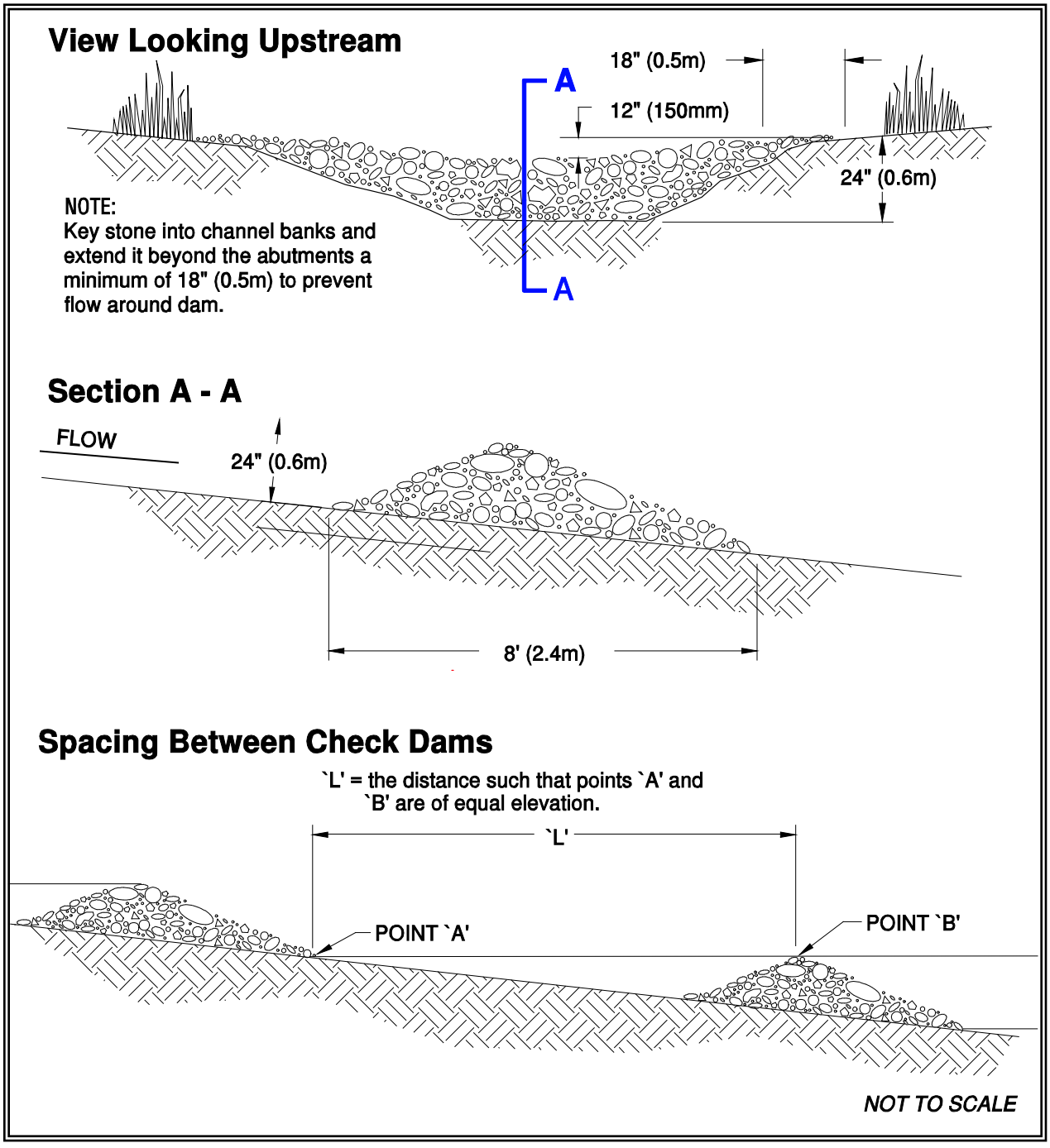


Figure 4.2.7 – Rock Check Dam

BMP C209: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of use

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation or 1-foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the culvert.

- Standard wingwalls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. (See WSDOT Hydraulic Manual, available through WSDOT Engineering Publications).
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for riprap outlet protection:
    1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
    2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 48-inch riprap. Minimum thickness is 2 feet.
    3. For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion.

- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a HPA. See Volume V for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater if sediment builds up.

APPENDIX

7.8 SOURCE CONTROL BMPS

S407 BMPs for Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots

Description of Pollutant Sources: Dust can cause air and water pollution problems particularly at demolition sites and in arid areas where reduced rainfall exposes soil particles to transport by air.

Pollutant Control Approach: Minimize dust generation and apply environmentally friendly and government approved dust suppressant chemicals, if necessary.

Applicable Operational BMPs:

- Sprinkle or wet down soil or dust with water as long as it does not result in a wastewater discharge.
- Use only local and/or state government approved dust suppressant chemicals such as those listed in Ecology Publication #96-433, *Techniques for Dust Prevention and Suppression*.
- Avoid excessive and repeated applications of dust suppressant chemicals. Time the application of dust suppressants to avoid or minimize their wash-off by rainfall or human activity such as irrigation.
- Apply stormwater containment to prevent the conveyance of sediment into storm drains or receiving waters.

- Ecology prohibits the use of motor oil for dust control. Take care when using lignin derivatives and other high BOD chemicals in areas susceptible to contaminating surface water or ground water.
- Consult with Ecology and the local permitting authority on discharge permit requirements if the dust suppression process results in a wastewater discharge to the ground, ground water, storm drain, or surface water.

Recommended Additional Operational BMPs for Roadways and Other Trafficked Areas:

- Consider limiting use of off-road recreational vehicles on dust generating land.
- Consider graveling or paving unpaved permanent roads and other trafficked areas at municipal, commercial, and industrial areas.
- Consider paving or stabilizing shoulders of paved roads with gravel, vegetation, or local government approved chemicals.
- Encourage use of alternate paved routes, if available.
- Vacuum sweep fine dirt and skid control materials from paved roads soon after winter weather ends or when needed.
- Consider using pre-washed traction sand to reduce dust emissions.

Additional Recommended Operational BMPs for Dust Generating Areas:

- Prepare a dust control plan. Helpful references include: Control of Open Fugitive Dust Sources (EPA-450/3-88-088), and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA-450/2-92-004).
- Limit exposure of soil (dust source) as much as feasible.
- Stabilize dust-generating soil by growing and maintaining vegetation, mulching, topsoiling, and/or applying stone, sand, or gravel.
- Apply windbreaks in the soil such as trees, board fences, tarp curtains, bales of hay, etc.

S409 BMPs for Fueling At Dedicated Stations

Description of Pollutant Sources: A fueling station is a facility dedicated to the transfer of fuels from a stationary pumping station to mobile vehicles or equipment. It includes above or underground fuel storage facilities. In addition to general service gas stations, fueling may also occur at 24-hour convenience stores, construction sites, warehouses, car washes, manufacturing establishments, port facilities, and businesses with fleet vehicles. Typical causes of stormwater contamination at fueling stations include leaks/spills of fuels, lube oils, radiator coolants, and vehicle washwater.

Pollutant Control Approach: New or substantially remodeled* fueling stations must be constructed on an impervious concrete pad under a roof to keep out rainfall and stormwater run-on. The facility must use a treatment

BMP for contaminated stormwater and wastewaters in the fueling containment area.

* *Substantial remodeling includes replacing the canopy, or relocating or adding one or more fuel dispensers in such a way that modify the Portland cement concrete (or equivalent) paving in the fueling area.*

For new or substantially remodeled Fueling Stations:

Applicable Operational BMPs:

- Prepare an emergency spill response and cleanup plan (per S426 BMPs for Spills of Oil and Hazardous Substances) and have designated trained person(s) available either on site or on call at all times to promptly and properly implement that plan and immediately cleanup all spills. Keep suitable cleanup materials, such as dry adsorbent materials, on site to allow prompt cleanup of a spill.
- Train employees on the proper use of fuel dispensers. Post signs in accordance with the Uniform Fire Code (UFC) or International Fire Code (IFC). Post "No Topping Off" signs (topping off gas tanks causes spillage and vents gas fumes to the air). Make sure that the automatic shut-off on the fuel nozzle is functioning properly.
- The person conducting the fuel transfer must be present at the fueling pump during fuel transfer, particularly at unattended or self-serve stations.
- Keep drained oil filters in a suitable container or drum.

Applicable Structural Source Control BMPs:

- Design the fueling island to control spills (dead-end sump or spill control separator in compliance with the UFC or IFC), and to treat collected stormwater and/or wastewater to required levels. Slope the concrete containment pad around the fueling island toward drains; either trench drains, catch basins and/or a dead-end sump. The slope of the drains shall not be less than 1 percent (Section 7901.8 of the UFC, Section 5703.6.8 of the IFC).
- Drains to treatment facilities must have a normally closed shutoff valve. The spill control sump must be sized in compliance with Section 7901.8 of the UFC; or
- Design the fueling island as a spill containment pad with a sill or berm raised to a minimum of four inches (Section 7901.8 of the UFC) to prevent the runoff of spilled liquids and to prevent run-on of stormwater from the surrounding area. Raised sills are not required at the open-grate trenches that connect to an approved drainage-control system.
- The fueling pad must be paved with Portland cement concrete, or equivalent. Ecology does not consider asphalt an equivalent material.

- The fueling island must have a roof or canopy to prevent the direct entry of precipitation onto the spill containment pad (see Figure 2.2.1). The roof or canopy should, at a minimum, cover the spill containment pad (within the grade break or fuel dispensing area) and preferably extend several additional feet to reduce the introduction of windblown rain. Convey all roof drains to storm drains outside the fueling containment area.

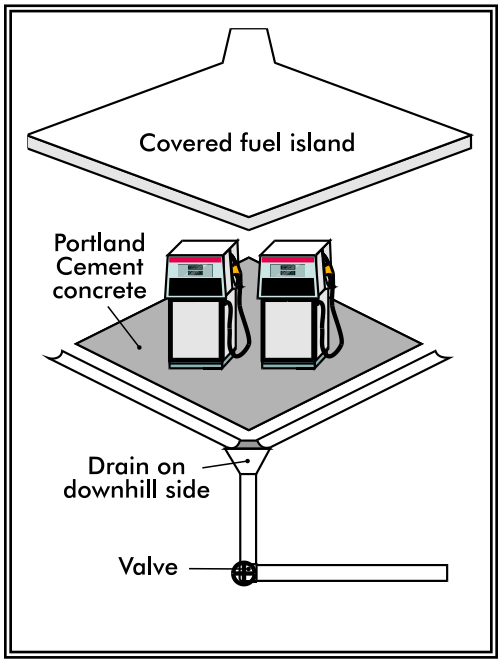


Figure 2.2.1 – Covered Fuel Island

- Convey stormwater collected on the fuel island containment pad to a sanitary sewer system, if approved by the sanitary authority, or to an approved treatment system such as an oil/water separator and a basic treatment BMP. (Basic treatment BMPs are listed in Volume V and include media filters and biofilters). Discharges from treatment systems to storm drains or surface water or to the ground must not display ongoing or recurring visible sheen and must not contain oil and grease.
- Alternatively, collect stormwater from the fuel island containment pad and hold for proper off-site disposal.
- Approval from the local sewer authority is required for conveyance of any fuel-contaminated stormwater to a sanitary sewer. The discharged stormwater must comply with pretreatment regulations (WAC 173-216-060). These regulations prohibit discharges that could "cause fire or explosion." State and federal pretreatment regulations define an explosive or flammable mixture, based on a flash point determination

of the mixture. Stormwater could be conveyed to a sanitary sewer system if it is determined not to be explosive.

- Transfer the fuel from the delivery tank trucks to the fuel storage tank in impervious contained areas and ensure that appropriate overflow protection is used. Alternatively, cover nearby storm drains during the filling process and use drip pans under all hose connections.

Additional BMP for Vehicles 10 feet in height or greater

A roof or canopy may not be feasible at fueling stations that regularly fuel vehicles that are 10 feet in height or greater, particularly at industrial or WSDOT sites. At those types of fueling facilities, the following BMPs apply, as well as the applicable BMPs and fire prevention (UFC requirements) of this BMP for fueling stations:

- If a roof or canopy is impractical, the concrete fueling pad must be equipped with emergency spill control including a shutoff valve for drainage from the fueling area. Maintain the valve in the closed position in the event of a spill. An electronically actuated valve is preferred to minimize the time lapse between spill and containment. Clean up spills and dispose of materials off-site in accordance with S406 BMPs for Spills of Oil and Hazardous Substances.
- The valve may be opened to convey contaminated stormwater to a sanitary sewer, if approved by the sewer authority, or to oil removal treatment such as an API or CP oil/water separator, catchbasin insert, or equivalent treatment, and then to a basic treatment BMP. Discharges from treatment systems to storm sewer or surface water or to the ground must not display ongoing or recurring visible sheen and must not contain greater than a significant amount of oil and grease.

S412 BMPs for Loading and Unloading Areas for Liquid or Solid Material

Description of Pollutant Sources: Operators typically conduct loading/unloading of liquid and solid materials at industrial and commercial facilities at shipping and receiving, outside storage, fueling areas, etc. Materials transferred can include products, raw materials, intermediate products, waste materials, fuels, scrap metals, etc. Leaks and spills of fuels, oils, powders, organics, heavy metals, salts, acids, alkalis, etc. during transfer may cause stormwater contamination. Spills from hydraulic line breaks are a common problem at loading docks.

Pollutant Control Approach: Cover and contain the loading/unloading area where necessary to prevent run-on of stormwater and runoff of contaminated stormwater.

Applicable Operational BMPs:

At All Loading/ Unloading Areas:

- A significant amount of debris can accumulate at outside, uncovered loading/unloading areas. Sweep these surfaces frequently to remove loose material that could contaminate stormwater. Sweep areas temporarily covered after removal of the containers, logs, or other material covering the ground.
- Place drip pans, or other appropriate temporary containment device, at locations where leaks or spills may occur such as hose connections, hose reels and filler nozzles. Always use drip pans when making and

breaking connections (see Figure 2.2.2). Check loading/ unloading equipment such as valves, pumps, flanges, and connections regularly for leaks and repair as needed.

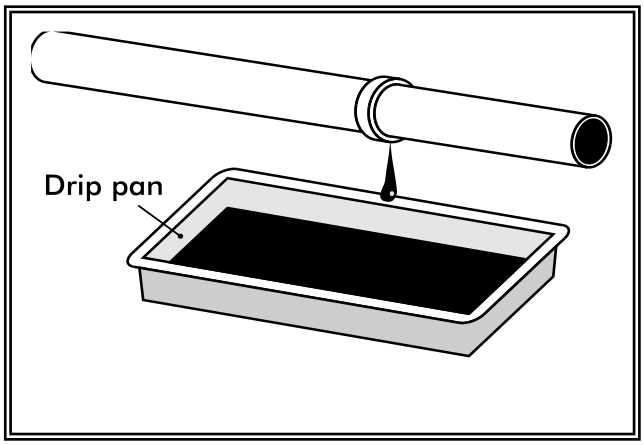


Figure 2.2.2 – Drip Pan

At Tanker Truck and Rail Transfer Areas to Above/Below-ground Storage Tanks:

- To minimize the risk of accidental spillage, prepare an "Operations Plan" that describes procedures for loading/unloading. Train the employees, especially fork lift operators, in its execution and post it or otherwise have it readily available to all employees.
- Report spills of reportable quantities to Ecology.
- Prepare and implement an Emergency Spill Cleanup Plan for the facility (See S406 BMPs for Spills of Oil and Hazardous Substances) which includes the following BMPs:
  - Ensure the cleanup of liquid/solid spills in the loading/unloading area immediately, if a significant spill occurs, and, upon completion of the loading/unloading activity, or, at the end of the working day.
  - Retain and maintain an appropriate oil spill cleanup kit on-site for rapid cleanup of material spills. (See S406 BMPs for Spills of Oil and Hazardous Substances).
  - Ensure that an employee trained in spill containment and cleanup is present during loading/unloading.

At Rail Transfer Areas to Above/below-ground Storage Tanks: Install a drip pan system as illustrated (see Figure 2.2.3) within the rails to collect spills/leaks from tank cars and hose connections, hose reels, and filler nozzles.

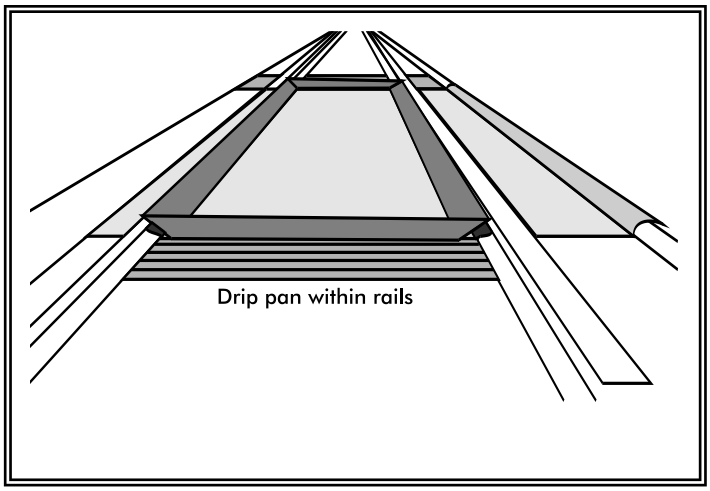


Figure 2.2.3 – Drip Pan Within Rails

Loading/Unloading from/to Marine Vessels: Facilities and procedures for the loading or unloading of petroleum products must comply with Coast Guard requirements specified in Appendix IV-D R.5.

Transfer of Small Quantities from Tanks and Containers: Refer to BMPs Storage of Liquids in Permanent Above-Ground Tanks, and Storage of Liquid, Food Waste, or Dangerous Waste Containers, for requirements on the transfer of small quantities from tanks and containers, respectively.

Applicable Structural Source Control BMPs:

At All Loading/ Unloading Areas:

- Consistent with Uniform Fire Code requirements (Appendix IV-D R.2) and to the extent practicable, conduct unloading or loading of solids and liquids in a manufacturing building, under a roof, or lean-to, or other appropriate cover.
- Berm, dike, and/or slope the loading/unloading area to prevent run-on of stormwater and to prevent the runoff or loss of any spilled material from the area.
- Place curbs along the edge of the shoreline, or slope the edge such that the stormwater can flow to an internal storm sewer system that leads to an approved treatment BMP. Avoid draining directly to the surface water from loading areas.
- Pave and slope loading/unloading areas to prevent the pooling of water. Minimize the use of catch basins and drain lines within the

interior of the paved area or place catch basins in designated "alleyways" that are not covered by material, containers, or equipment.

- Retain on-site the necessary materials for rapid cleanup of spills.

Recommended Structural Source Control BMP: For the transfer of pollutant liquids in areas that cannot contain a catastrophic spill, install an automatic shutoff system in case of unanticipated off-loading interruption (e.g. coupling break, hose rupture, overfill, etc.).

At Loading and Unloading Docks:

- Install/maintain overhangs, or door skirts that enclose the trailer end (see Figures 2.2.4 and 2.2.5) to prevent contact with rainwater.
- Design the loading/unloading area with berms, sloping, etc., to prevent the run-on of stormwater.

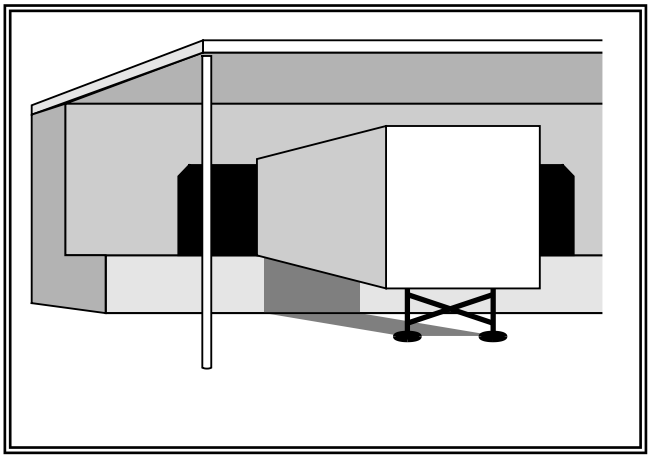


Figure 2.2.4 – Loading Dock with Door Skirt

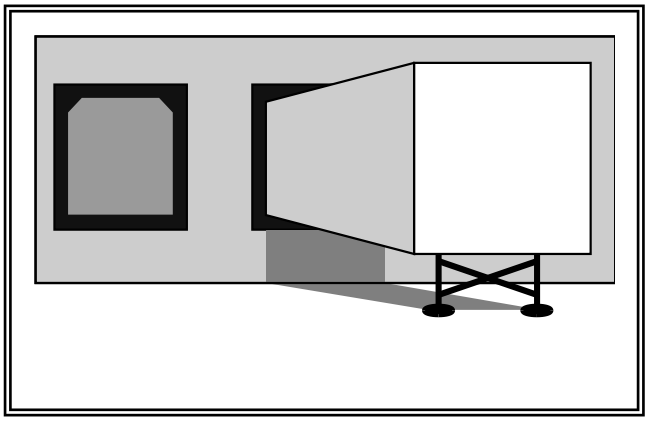


Figure 2.2.5 – Loading Dock with Overhang

Ecology's Baseline General Permit Requirements:

Industries with log yards are required to obtain coverage under the Industrial Stormwater General Permit for discharges of stormwater associated with industrial activities. The permit requires preparation and on-site retention of an Industrial Stormwater Pollution Prevention Plan (SWPPP). Required and recommended operational, structural source control, and treatment BMPs are presented in detail in Ecology's Guidance Document: *Industrial Stormwater General Permit Implementation Manual for Log Yards*, Publication # 04-10-031. Ecology recommends that all log yard facilities obtain a copy of this document.

S414 BMPs for Maintenance and Repair of Vehicles and Equipment

Description of Pollutant Sources: Pollutant sources include parts/vehicle cleaning, spills/leaks of fuel and other liquids, replacement of liquids, outdoor storage of batteries/liquids/parts, and vehicle parking.

Pollutant Control Approach: Control of leaks and spills of fluids using good housekeeping and cover and containment BMPs.

Applicable Operational BMPs:

- Inspect all incoming vehicles, parts, and equipment stored temporarily outside for leaks.
- Use drip pans or containers under parts or vehicles that drip or that are likely to drip liquids, such as during dismantling of liquid containing parts or removal or transfer of liquids.
- Remove batteries and liquids from vehicles and equipment in designated areas designed to prevent stormwater contamination. Store cracked batteries in a covered non-leaking secondary containment system.
- Remove liquids from vehicles retired for scrap.
- Empty oil and fuel filters before disposal. Provide for proper disposal of waste oil and fuel.
- Do not pour/convey washwater, liquid waste, or other pollutants into storm drains or to surface water. Check with the local sanitary sewer authority for approval to convey water to a sanitary sewer.
- Do not connect maintenance and repair shop floor drains to storm drains or to surface water.
- To allow for snowmelt during the winter, install a drainage trench with a sump for particulate collection. Use the drainage trench for draining the snowmelt only and not for discharging any vehicular or shop pollutants.

Applicable Structural Source Control BMPs:

- Conduct all maintenance and repair of vehicles and equipment in a building, or other covered impervious containment area that is sloped to prevent run-on of uncontaminated stormwater and runoff of contaminated water.
- Operators may conduct maintenance of refrigeration engines in refrigerated trailers in the parking area. Exercise due caution to avoid the release of engine or refrigeration fluids to storm drains or surface water.
- Park large mobile equipment, such as log stackers, in a designated contained area.

Additional applicable BMPs:

- S409 BMPs for Fueling at Dedicated Stations
- S410 BMPs for Illicit Connections to Storm Drains
- S412 BMPs for Loading and Unloading Areas for Liquid or Solid Material
- S426 BMPs for Spills of Oil and Hazardous Substances
- S427 BMPs Storage of Liquid, Food Waste, or Dangerous Waste Containers
- S428 BMPs for Storage of Liquids in Permanent Aboveground Tanks
- S429 BMPs for Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products
- S431 BMPs for Washing and Steam Cleaning Vehicle/Equipment/Building Structures

Note this applicable treatment BMP for contaminated stormwater.

Applicable Treatment BMPs: Convey contaminated stormwater runoff from vehicle staging and maintenance areas to a sanitary sewer, if allowed by the local sewer authority, or to an API or CP oil and water separator followed by a basic treatment BMP (See Volume V), applicable filter, or other equivalent oil treatment system.

Recommended Additional Operational BMPs:

- Store damaged vehicles inside a building or other covered containment, until successfully removing all liquids.
- Clean parts with aqueous detergent based solutions or non-chlorinated solvents such as kerosene or high flash mineral spirits, and/or use wire brushing or sand blasting whenever practicable. Avoid using toxic liquid cleaners such as methylene chloride, 1,1,1-trichloroethane, trichloroethylene or similar chlorinated solvents. Choose cleaning agents that can be recycled.
- Inspect all BMPs regularly, particularly after a significant storm. Identify and correct deficiencies to ensure that the BMPs are functioning as intended.

- Avoid hosing down work areas. Use dry methods for cleaning leaked fluids.
- Recycle greases, used oil, oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic fluids, transmission fluids, and engine oils (see Appendix IV-C).
- Do not mix dissimilar or incompatible waste liquids stored for recycling.

S416 BMPs for Maintenance of Roadside Ditches

Description of Pollutant Sources: Common road debris including eroded soil, oils, vegetative particles, and heavy metals can be sources of stormwater pollutants.

Pollutant Control Approach: Maintain roadside ditches to preserve the condition and capacity for which they were originally constructed, and to minimize bare or thinly vegetated ground surfaces. Maintenance practices should provide for erosion and sediment control (Refer to BMP *Landscaping and Lawn/Vegetation Management*).

Applicable Operational BMPs:

- Inspect roadside ditches regularly to identify sediment accumulations and localized erosion.
- Clean ditches on a regular basis, as needed. Keep ditches free of rubbish and debris.
- Vegetation in ditches often prevents erosion and cleanses runoff waters. Remove vegetation only when flow is blocked or excess sediments have accumulated. Conduct ditch maintenance (seeding, fertilizer application, harvesting) in late spring and/or early fall, where possible. This allows re-establishment of vegetative cover by the next wet season thereby minimizing erosion of the ditch as well as making the ditch effective as a biofilter.
- In the area between the edge of the pavement and the bottom of the ditch, commonly known as the "bare earth zone," use grass vegetation, wherever possible. Establish vegetation from the edge of the pavement, if possible, or at least from the top of the slope of the ditch.
- Maintain diversion ditches on top of cut slopes constructed to prevent slope erosion by intercepting surface drainage to retain their diversion shape and capability.
- Do not leave ditch cleanings on the roadway surfaces. Sweep, collect, and dispose of dirt and debris remaining on the pavement at the completion of ditch cleaning operations.
- Consider screening roadside ditch cleanings, not contaminated by spills or other releases and not associated with a stormwater treatment system such as a bioswale, to remove litter. Separate screenings into soil and vegetative matter (leaves, grass, needles, branches, etc.) categories. Compost or dispose of the vegetative matter in a municipal waste landfill. Consult with the jurisdictional health department to discuss use or disposal options for the soil portion. For more information, please see *Recommendations for Management of Street Wastes*, in Appendix IV-G of this volume.
- Roadside ditch cleanings contaminated by spills or other releases known or suspected to contain dangerous waste must be handled following the Dangerous Waste Regulations (Chapter 173-303 WAC). If testing determines materials are not dangerous waste but contaminants are present, consult with the jurisdictional health department for disposal options.
- Examine culverts on a regular basis for scour or sedimentation at the inlet and outlet, and repair as necessary. Give priority to those culverts conveying perennial and/or salmon-bearing streams and culverts near streams in areas of high sediment load, such as those near subdivisions during construction.

Recommended Treatment BMPs:

Install biofiltration swales and filter strips – (See Chapter 9, Volume V) to treat roadside runoff wherever practicable and use engineered topsoils wherever necessary to maintain adequate vegetation. These systems can improve infiltration and stormwater pollutant control upstream of roadside ditches.

S417 BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Description of Pollutant Sources: Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities such as ponds and vaults, oil/water separators, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Volume V. Oil and grease, hydrocarbons, debris, heavy metals, sediments and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

Pollutant Control Approach: Provide maintenance and cleaning of debris, sediments, and oil from stormwater collection, conveyance, and treatment systems to obtain proper operation.

Applicable Operational BMPs:

Maintain stormwater treatment facilities per the operations and maintenance (O&M) procedures presented in Section 4.6 of Volume V in addition to the following BMPs:

- Inspect and clean treatment BMPs, conveyance systems, and catch basins as needed, and determine necessary O&M improvements.
- Promptly repair any deterioration threatening the structural integrity of stormwater facilities. These include replacement of clean-out gates, catch basin lids, and rock in emergency spillways.
- Ensure adequacy of storm sewer capacities and prevent heavy sediment discharges to the sewer system.
- Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and discharge to a sanitary sewer if approved by the sewer authority, or truck to an appropriate local or state government approved disposal site.
- Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT Type 1L basins) may have as little as 12 inches sediment storage below the invert. These catch basins need frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system

owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.

- Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catchbasin.
- Post warning signs; “Dump No Waste - Drains to Ground Water,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets *where possible*.
- Disposal of sediments and liquids from the catch basins must comply with “Recommendations for Management of Street Wastes” described in Appendix IV-G of this volume.

Additional Applicable BMPs: Select additional applicable BMPs from this chapter depending on the pollutant sources and activities conducted at the facility. Those BMPs include:

- S425 BMPs for Soil Erosion and Sediment Control at Industrial Sites
- S427 BMPs for Storage of Liquid, Food Waste, or Dangerous Waste Containers
- S406 BMPs for Spills of Oil and Hazardous Substances
- S410 BMPs for Illicit Connections to Storm Drains
- S430 BMPs for Urban Streets

S421 BMPs for Parking and Storage of Vehicles and Equipment

Description of Pollutant Sources: Public and commercial parking lots such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and parking lot driveways, can be sources of toxic hydrocarbons and other organic compounds, including oils and greases, metals, and suspended solids.

Pollutant Control Approach: If the parking lot is a **high-use site** as defined below, provide appropriate oil removal equipment for the contaminated stormwater runoff.

Applicable Operational BMPs:

- If washing a parking lot, discharge the washwater to a sanitary sewer, if allowed by the local sewer authority, or other approved wastewater treatment system, or collect washwater for off-site disposal.

- Do not hose down the area to a storm sewer or receiving water. Vacuum sweep parking lots, storage areas, and driveways regularly to collect dirt, waste, and debris.

Applicable Treatment BMPs: An oil removal system such as an API or CP oil and water separator, catch basin filter, or equivalent BMP, approved by the local jurisdiction, is necessary for parking lots meeting the threshold vehicle traffic intensity level of a *high-use site.*

Vehicle High-Use Sites

Establishments subject to vehicle high-use intensity are significant sources of oil contamination of stormwater. Examples of potential high use areas include customer parking lots at fast food stores, grocery stores, taverns, restaurants, large shopping malls, discount warehouse stores, quick-lube shops, and banks. If the PGIS for a high-use site exceeds 5,000 square feet in a threshold discharge area, an oil control BMP from the Oil Control Menu (in Volume V) is necessary. A high-use site at a commercial or industrial establishment has one of the following characteristics: (Gaus/King County, 1994)

- Is subject to an expected average daily vehicle traffic (ADT) count equal to or greater than 100 vehicles per 1,000 square feet of gross building area: or
- Is subject to storage of a fleet of 25 or more diesel vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.).

S428 BMPs for Storage of Liquids in Permanent Aboveground Tanks

Description of Pollutant Sources: Aboveground tanks containing liquids (excluding uncontaminated water) may be equipped with a valved drain, vent, pump, and bottom hose connection. Aboveground tanks may be heated with steam heat exchangers equipped with steam traps, if required. Leaks and spills can occur at connections and during liquid transfer. Oil and grease, organics, acids, alkalis, and heavy metals in tank water and condensate drainage can also cause stormwater contamination at storage tanks.

Pollutant Control Approach: Install secondary containment or a double-walled tank. Slope the containment area to a drain with a sump. Operators may need to discharge stormwater collected in the containment area to

treatment such as an API or CP oil/water separator, or equivalent BMP. Add safeguards against accidental releases including protective guards around tanks to protect against vehicle or forklift damage, and tagging valves to reduce human error. *Tank water and condensate discharges are process wastewater that may need an NPDES Permit.*

Applicable Operational BMPs:

- Inspect the tank containment areas regularly for leaks/spills, cracks, corrosion, etc. to identify problem components such as fittings, pipe connections, and valves
- Place adequately sized drip pans beneath all mounted taps and drip/spill locations during filling/unloading of tanks. Operators may need valved drain tubing in mounted drip pans.
- Vacuum sweep and clean the tank storage area regularly, if paved.
- Replace or repair tanks that are leaking, corroded, or otherwise deteriorating.
- All installations shall comply with the Uniform Fire Code (Appendix IV-D R.2) and the National Electric Code.

Applicable Structural Source Control BMPs:

- Locate permanent tanks in impervious (Portland cement concrete or equivalent) secondary containment surrounded by dikes as illustrated in Figure 2.2.12, or use UL Approved double-walled tanks. The dike must be of sufficient height to provide a containment volume of either 10 percent of the total enclosed tank volume or 110 percent of the volume contained in the largest tank, whichever is greater.
- Slope the secondary containment to drain to a dead-end sump or equivalent, for the collection of small spills.
- Include a tank overfill protection system to minimize the risk of spillage during loading.

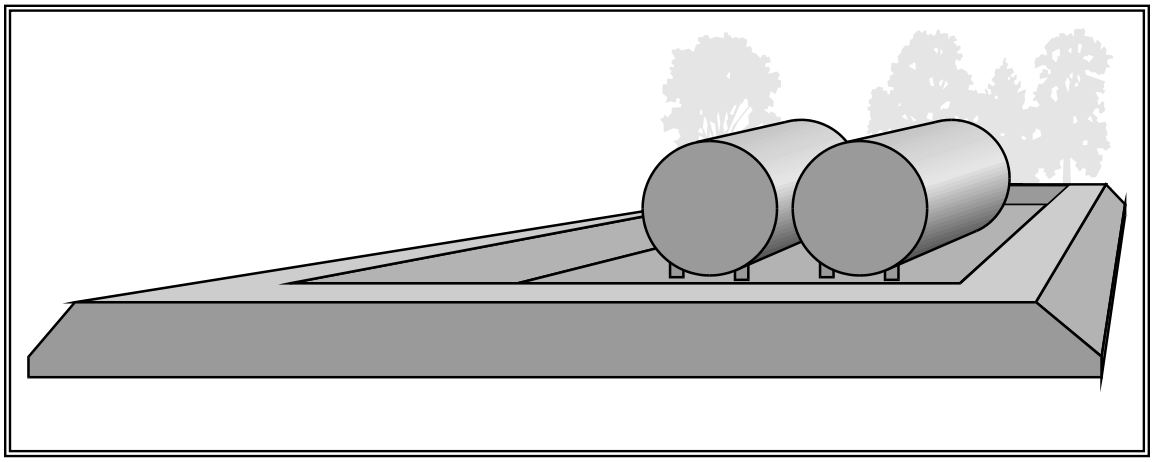


Figure 2.2.12 – Above-ground Tank Storage

Note this applicable treatment BMP for stormwater from petroleum tank farms.

Applicable Treatment BMPs:

- For an uncovered tank containment area, equip the outlet from the spill-containment sump with a normally closed shutoff valve. Operators may open this valve manually or automatically, only to convey contaminated stormwater to approved treatment or disposal, or to convey uncontaminated stormwater to a storm sewer. Evidence of contamination can include the presence of visible sheen, color, or turbidity in the runoff, or existing or historical operational problems at the facility. Use simple pH tests with litmus or pH paper for areas subject to acid or alkaline contamination.
- At petroleum tank farms, convey stormwater contaminated with floating oil or debris in the contained area through an API or CP-type oil/water separator (Volume V, Treatment BMPs), or other approved treatment prior to discharge to storm drain or surface water.

APPENDIX

7.9 OPERATIONS AND MAINTENANCE MANUAL

MARBLEMOUNT QUARRY

MARBLEMOUNT, WASHINGTON

OPERATION & MAINTENANCE PLAN

FOR

PRIVATELY AND PUBLICLY OWNED AND MAINTAINED STORMWATER FACILITIES

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January, 2019

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SECTION 1.0 DESCRIPTION OF PROGRAM

This document is an Operations and Maintenance Program for all privately and publicly owned stormwater facilities within the Marblemount Quarry Project.

The relevant facilities include all stormwater conveyance pipelines, catch basins and infiltration facilities on the project site.

The private stormwater include:

1) All drains, storm sewers, catch basins, and clean outs located near or on the Marblemount Quarry site.

2) The presettling ponds and infiltration ponds located on the Marblemount Quarry site.

This program is based on guidelines presented in the Department of Ecology Stormwater Management Manual for Western Washington (2012).

It is assumed that:

1) The owners of the Marblemount Quarry will learn themselves, or train designated personnel on appropriate inspection, record keeping, and maintenance procedures;

2) The owners of the Marblemount Quarry will prepare, regularly update, and implement an Operation and Maintenance Record for Stormwater Management Facilities. The Record will include all operations and maintenance documentation of the practices recommended herein;

3) The designated operators or owners will inspect stormwater facilities bi-annually to ensure proper operation. Inspections will also be made during and immediately after a large storm event of greater than 1 inch of rainfall in 24 hours.

The facility-specific maintenance standards presented are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, the exceeding of these conditions at any time between inspections and / or maintenance does not automatically constitute a violation of these standards.

However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

SECTION 2.0 MAINTENANCE & OPERATION PROGRAM

The components of the subject stormwater conveyance system are designed to operate with minimum maintenance: however, some maintenance will be required. This document describes each of these components, how they are supposed to operate, and what maintenance activities should be followed. A checklist in Appendix A is to be copied and used throughout routine inspections.

Stormwater generated over the Marblemount Quarry project area will be collected and conveyed to one of two presettling ponds for pretreatment via an open channel ditch system, then directed to infiltration ponds for full infiltration. See Infiltration checklist in Appendix A for maintenance procedures for all infiltration areas.

The stormwater conveyance system is designed to operate trouble-free for many years. There are no operational needs for the system other than the maintenance functions in Appendix A.

APPENDIX "A" MAINTENANCE CHECKLIST

4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table 4.5.2 Maintenance Standards

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	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.~~
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See “Side Slopes of Pond”	

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & 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 regrouted 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.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
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 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.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 7 – Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

APPENDIX

7.10 CONVEYANCE CALCULATIONS

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jan 17 2019

Access Roadway Conveyance Ditch

Trapezoidal

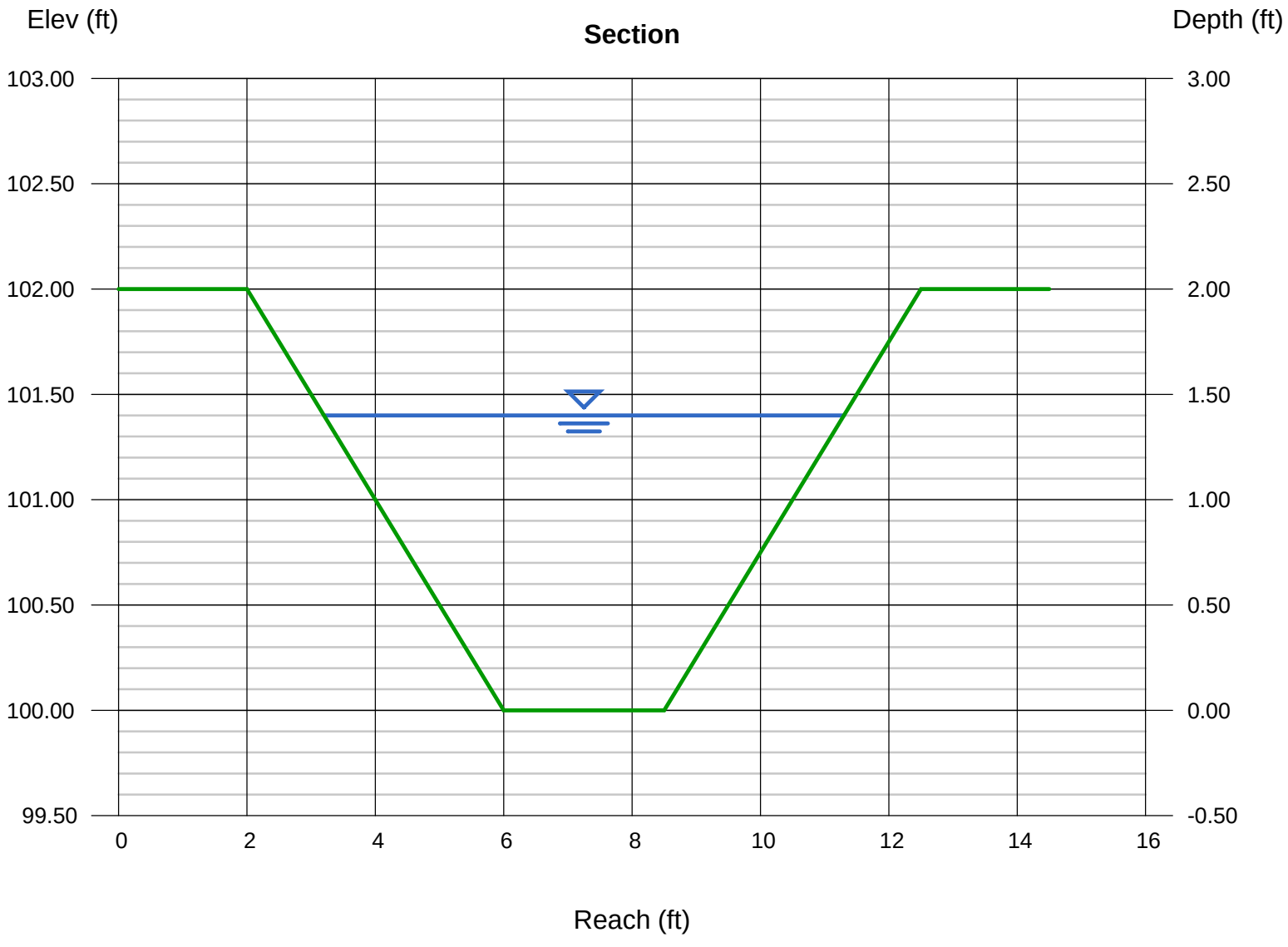
Bottom Width (ft)	= 2.50
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 12.50
N-Value	= 0.035

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 1.40
Q (cfs)	= 99.70
Area (sqft)	= 7.42
Velocity (ft/s)	= 13.44
Wetted Perim (ft)	= 8.76
Crit Depth, Yc (ft)	= 2.00
Top Width (ft)	= 8.10
EGL (ft)	= 4.21



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jan 17 2019

36 inch Access Road Outlet Pipe

Circular

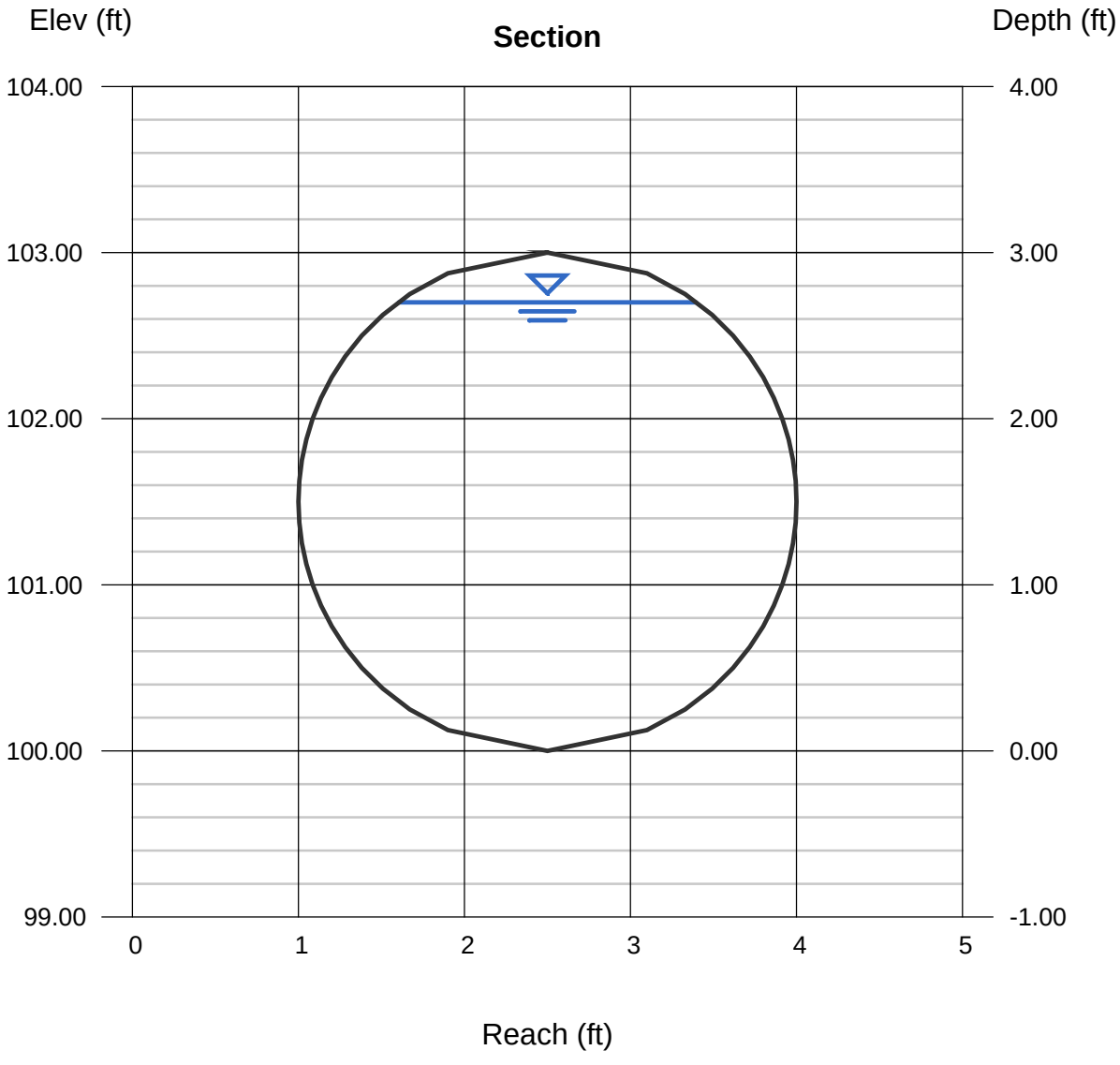
Diameter (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.93
N-Value	= 0.012

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 2.70
Q (cfs)	= 74.28
Area (sqft)	= 6.70
Velocity (ft/s)	= 11.08
Wetted Perim (ft)	= 7.50
Crit Depth, Yc (ft)	= 2.72
Top Width (ft)	= 1.80
EGL (ft)	= 4.61



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jan 17 2019

Site Improvements Conveyance Ditch

Triangular

Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.40
N-Value	= 0.035

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 1.40
Q (cfs)	= 12.02
Area (sqft)	= 5.88
Velocity (ft/s)	= 2.04
Wetted Perim (ft)	= 8.85
Crit Depth, Yc (ft)	= 1.00
Top Width (ft)	= 8.40
EGL (ft)	= 1.46