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CITY OF MONROE

Preliminary Storm Drainage Report

Garibaldi PRD

CPH Project No. 0054-18-028

Monroe, WA



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PRELIMINARY STORM DRAINAGE REPORT

FOR
GARIBALDI PRD

MONROE, WA

TABLE OF CONTENTS

SECTION 1 – PROJECT OVERVIEW.....1
 FIGURE 1 – VICINITY MAP

SECTION 2 – EXISTING CONDITIONS SUMMARY.....3

SECTION 3 – OFF-SITE ANALYSIS.....4
 OFFSITE ANALYSIS
 UPSTREAM ANALYSIS
 DOWNSTREAM ANALYSIS

SECTION 4 – PERMANENT STORMWATER CONTROL PLAN.....6
 PERFORMANCE STANDARDS AND GOALS
 PRE-DEVELOPED SITE HYDROLOGY
 ON-SITE STORMWATER MANAGEMENT
 DEVELOPED SITE HYDROLOGY
 CONVEYANCE SYSTEM ANALYSIS AND DESIGN
 WATER QUALITY TREATMENT

SECTION 5 – CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN13

FIGURES.....
 FIGURE 2 – EXISTING SITE CONDITIONS
 FIGURE 3 – DEVELOPED SITE CONDITIONS
 FIGURE 4 – PREDEVELOPED DRAINAGE BASINS
 FIGURE 5 – DEVELOPED DRAINAGE BASINS

APPENDICES.....
 APPENDIX A – NRCS SOILS DATA AND GEOTECHNICAL REPORT
 APPENDIX B – WWHM INPUT PARAMETERS AND RESULTS
 APPENDIX C – CONVEYANCE CALCULATIONS
 APPENDIX D – DOWNSTREAM ANALYSIS
 APPENDIX E – OPERATIONS AND MAINTENANCE MANUAL

SECTION 1 – PROJECT OVERVIEW

This Preliminary Storm Drainage Report (SDR) describes the engineering analysis of the surface water conditions, proposed development improvements, and required storm drainage facilities for the Garibaldi PRD project located in Monroe, Washington. The report summarizes the design criteria for the storm drainage collection systems, associated flow control (i.e. detention) and water quality facilities, and temporary construction Best Management Practices (BMPs) proposed for the project. Figure 1 (Vicinity Map) illustrates the general location of the project site. Figures 2 and 3 of this report (see Figures section) illustrate the existing and proposed developed conditions of the project area, respectively.

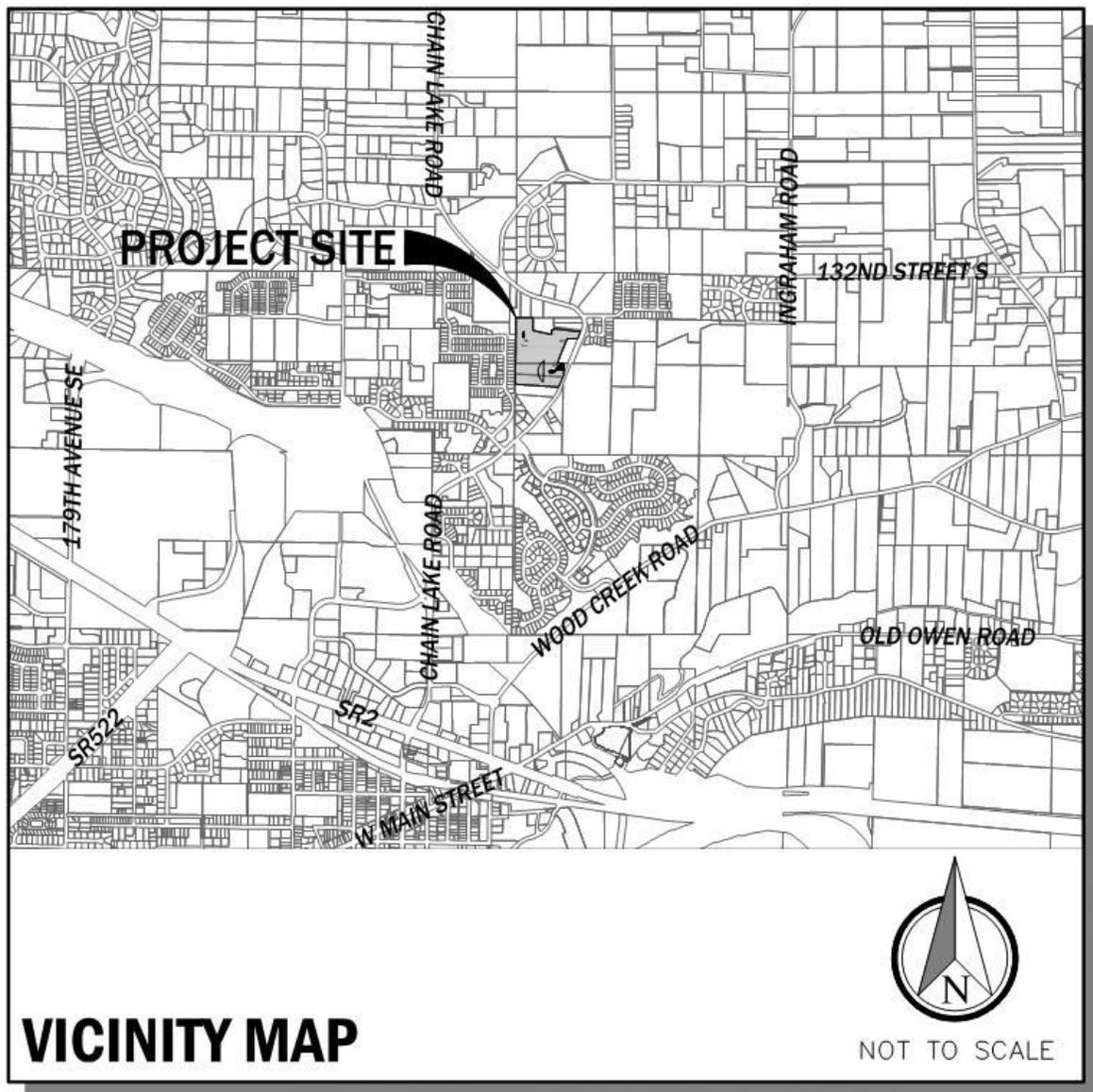


Figure 1 - Vicinity Map

The *Garibaldi PRD* project proposes to develop 90 new single-family residential lots, per the requirements of R-4 zoning, through the City of Monroe's planned residential development process (PRD). The development will include associated roadway, storm drainage, sewer, and water infrastructure improvements to serve these proposed lots. Park and recreational open space will be provided on-site per PRD guidelines. Frontage improvements to Chain Lake Road will be provided, including pavement widening, curb and gutter, planter and sidewalk improvements adjacent to the property. The project site consists of a 17.85-acre assemblage of five developed parcels containing single-family residences and their associated structures within the Monroe city limits. Existing access to Garibaldi PRD is provided via Chain Lake Road along the eastern boundary of the site. The site is more generally located in portions of the NE $\frac{1}{4}$ and SE $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 31, township 28 North, Range 7 East, W.M., Snohomish County, Washington.

The site generally descends from the northwestern property corner to the southeast with a total relief of approximately 110 feet. There is a ridgeline in the central portion of the site that creates two onsite drainage basins that do not converge within a $\frac{1}{4}$ mile downstream. The northern basin area is approximately 9.78 acres and conveys runoff over pastured and partially forested area and sheet flows to an existing ditch on the west side of Chain Lake Road. The southern basin is approximately 7.06 acres and conveys runoff over forested and partially pastured slope and sheet flows to an existing ditch along the west frontage of Chain Lake Road near the southeast corner of the subject property. The north basin ditch conveys runoff toward a culvert inlet that discharges southeast to a shallow, vegetated channel at the east side of Chain Lake road and flows southeasterly to a shallow, vegetated channel at the east side of Chain Lake Road and flows southeasterly through vegetated wetland areas. The south basin ditch conveys runoff southwesterly to a culvert outlet that discharges into a catch basin and continues in existing underground drainage infrastructure. A downstream analysis has been completed as part of this report in Section 3 to confirm downstream capacity for developed site runoff.

SECTION 2 – EXISTING CONDITIONS SUMMARY

The Garibaldi PRD project site is comprised of five adjoining parcels (Tax Parcel #'s 28073100202900, 28073100202800, 28073100201600, 28073100200800, and 28073100203900) with a total area of approximately 17.85 acres. It is located within the Woods Creek Drainage Basin, part of the Snohomish Watershed, WRIA 07. The site is bordered by single-family residences on all sides with access from Chain Lake Road to the east. The Eaglemont neighborhood borders the site to the west. Four of the parcels contain single-family residences and their associated structures. Each parcel varies in size and existing conditions. The first parcel is approximately 2.1 acres and consists of a single-family home, barn garage, and other outlying structures within a fenced perimeter. The second parcel is approximately 2.0 acres and consists of a single-family residence, detached garage, and other outlying structures with a fenced perimeter on its southern boundary. The third parcel is approximately 2.2 acres and consists of mostly undeveloped land in forested condition with a single-family home and outlying structures occupying the northwest corner of the parcel. The fourth parcel is approximately 2.7 acres and consists of vacant undeveloped land in forested conditions and a wetland buffer in the eastern half of the parcel. And the fifth parcel is approximately 8.9 acres with a single-family home, stable, barn, and other outlying structures within a fenced perimeter consisting of pasture conditions and has large, fenced pasture area adjacent to the frontage road.

The general soil classification of the developable portion of the site is characterized by the Natural Resources Conservation Service (NRCS) as Tokul gravelly medial loam, with 0 to 8 and 8 to 15 percent slopes. A preliminary geotechnical report has been completed and is provided in Appendix A, along with a copy of the NRCS Web Soil Survey data.

The site generally descends from the northwestern property corner to the southeast with a total relief of 110 feet. There is a ridgeline dividing the property into two separate basins. Approximately 7.06 acres of forested and pastured slope is located in the south basin. Surface runoff primarily sheet flows across the forested and pastured areas toward an existing ditch on the west side of Chain Lake Road near the southeast corner of the site. This ditch discharges to a shallow, vegetated channel at the western frontage of the existing road and flows easterly toward an existing culvert that conveys runoff across Chain Lake Road and continues in a shallow vegetated channel. Approximately 9.78 acres of forested and pastured slope is located in the north basin. The north basin runoff flows southeasterly and is eventually collected in a ditch along Chain lake Road north of the ridgeline. Flows are then conveyed to a culvert inlet that discharges to a shallow, vegetated channel at the east side of Chain Lake Road and flows southeasterly through vegetated wetland areas.

There is one stream located within one Category III wetland near the eastern property boundary in the central portion of the site. See Figure 2 for a map of existing site conditions. A downstream analysis has been completed as part of this report in Section 3 to confirm downstream capacity for developed site runoff.

SECTION 3 – OFF-SITE ANALYSIS

This section summarizes the analysis of the onsite and offsite drainage conditions for the project. The methodology of the analysis and reporting of these conditions is in general accordance with the Department of Ecology's 2012 Stormwater Management Manual for Western Washington (SWMM). This analysis includes research of available information, a site visit, an upstream analysis, and a downstream analysis. Research sources include aerial photography, GIS information, Snohomish County Planning and Development Services (PDS) Map Portal, survey data, and as-built plans for the adjacent Eaglemont neighborhood provided by the City of Monroe. The City of Monroe's Public Works Department was contacted to inquire about any recent and/or relevant drainage complaints in the project vicinity. Minor drainage complaints were made by property owners along the north and south basin downstream paths. According to the City, these complaints are regarding sheet flow runoff entering adjacent properties. As a result of the sheet flow runoff, ponding within the ditch has been the reason for these complaints. It is understood that these complaints have been addressed by the City and/or others. The City responded and noted no significant complaints from the property owners along either quarter-mile downstream paths from the project site.

Site Visit

A site visit was completed on November 1, 2018 at 2:30 PM to observe drainage conditions in the project vicinity and to inspect the downstream conveyance system and assess its capacity for mitigated site discharge. The weather was approximately 55° and cloudy with intermittent showers. There was 0.73" of precipitation measured that day and 2.47" total precipitation over the prior week. The result of this was that the ground was fully saturated and all conveyance facilities in the area were carrying significant flows, ideal conditions to inspect a drainage system.

Upstream Analysis

Based on the topography examined in the Snohomish County Planning and Development Services Map Portal (SCPDSMP), runoff flows onto and through the site from adjacent properties north and west of the site. Aerial imagery from SCPDSMP shows that the properties to the north and west are developed with private drainage infrastructure improvements. The properties to the west are part of the Eaglemont subdivision and are recently developed single family subdivision lots. The properties to the north are large residential parcels consisting of homes, associated structures, and large pasture areas with driveway slopes towards the existing ditch along the west side of Chain Lake Road. Based on a site visit, it was visually apparent that any runoff that flows onto and through the site is minimal. It appears that existing landscaped topography and private drainage infrastructure almost entirely reroutes runoff southerly and westerly to the Eaglemont subdivision and northerly and easterly toward the ditch along Chain Lake Road prior to entering the project site.

The existing ditch on the west side of Chain Lake Road collects upstream runoff and conveys it along the project frontage to the same point of convergence as the site's North Basin. The ditch carried visible flow during the site visit and was well below its full capacity. Proposed grading and improvements will reroute any runoff along the north property boundary to the ditch along Chain Lake Road.

Downstream Analysis

Site runoff sheet flows into the existing ditch on the west side of Chain Lake Road. The site is divided by a ridgeline into north and south drainage basins that do not converge within a quarter (0.25) mile downstream. See Appendix D for the Offsite Analysis Table (OAT), downstream analysis map, and photos. Refer to the map for locations of the numbered photos and structure symbols as listed in the OAT.

The north basin runoff is collected in an existing ditch on the west side of Chain Lake Road and conveys runoff to a 12" culvert inlet that directs flows easterly under the road and daylights into an open channel ditch on the east side of Chain Lake Road. The downstream path could not be followed further due to private property restrictions and dense vegetation. However, from aerial photos and the topography of the area it is believed that the runoff continues southeast as open channel flow and stream-like conveyance beyond the quarter (0.25) mile downstream threshold where a series of wetland areas and culverts convey surface water to the Skykomish river as part of the Snohomish river watershed. See Appendix D for photos and a summary table of the downstream system.

The south basin is collected in an existing ditch near the southeast corner of the site along Chain Lake Road. The ditch conveys runoff approximately 532 feet southwesterly to a 12" concrete culvert that directs flow under a private driveway. A series of 12" storm drainage pipes collects and conveys runoff along the below grade storm drainage system on the west side of Chain Lake Road to the quarter (0.25) mile downstream threshold. Runoff daylights into open channel ditch at approximate 1,340 feet downstream from the site. The downstream path appears to continue as open channel flow in the existing ditch. From aerial photos and the topography of the area it is believed that the runoff continues southerly as open channel flow and enters the existing underground storm drainage infrastructure for conveyance to the Skykomish river as part of the Snohomish river watershed. See Appendix D for photos and a summary table of the downstream system.

The downstream conveyance system appears to be properly functioning and has more than adequate capacity for its tributary drainage area. Runoff from the *Garibaldi PRD* project will meet flow control standards set forth by the Department of Ecology 2012 Stormwater Management Manual for Western Washington. This will result in mitigated peak flows leaving the site for all major storm events and therefore is not expected to have an adverse impact on the downstream system.

SECTION 4 – Permanent Stormwater Control Plan

Performance Standards, Goals and Facility Proposals

The storm drainage analysis and facilities design for this project are proposed in general accordance with the 2012 Department of Ecology Stormwater Management Manual for Western Washington (SMMWW), as amended in December 2014, and as adopted by current Monroe Municipal Code (MMC), section 15.01.025. The project is classified as New Development and will result in greater than 5,000 square-feet of new impervious surface, therefore all nine Minimum Requirements for stormwater management specified by the manual are applicable.

The hydrologic analysis of the runoff conditions for the project site was performed using the Western Washington Hydrologic Model 2012 (WWHM) software to generate peak design flow rates and volumes. A below-grade detention vault for each drainage basin is proposed to treat and detain runoff. Appendix B contains the WWHM model results for the proposed stormwater controls and water quality facilities proposed for the project. See Figure 3 for a map of the developed stormwater system.

Pre-developed Site Hydrology

Table 4.1 shows the pre-developed land use inputs used in the WWHM model and Table 4.2 summarizes the resulting peak design runoff rates. See Figure 3 for pre-developed drainage basins.

Table 4.1 – Pre-developed Drainage Subbasins

Basin	Land Use Area (ac)				
	Forested	Grass	Pasture	Impervious	Total
South Basin	7.06	0.00	0.00	0.00	7.06
North Basin	9.78	0.00	0.00	0.00	9.78
Upstream	0.00	0.00	9.00	1.89	10.89
Total Area (ac)	16.84	0.00	9.00	1.89	27.73

Table 4.2 – South Basin Pre-developed Peak Flows (POC 2)

Event	Flow Rate (cfs)
2-yr	0.261
10-yr	0.542
25-yr	0.724
50-yr	0.879
100-yr	1.052

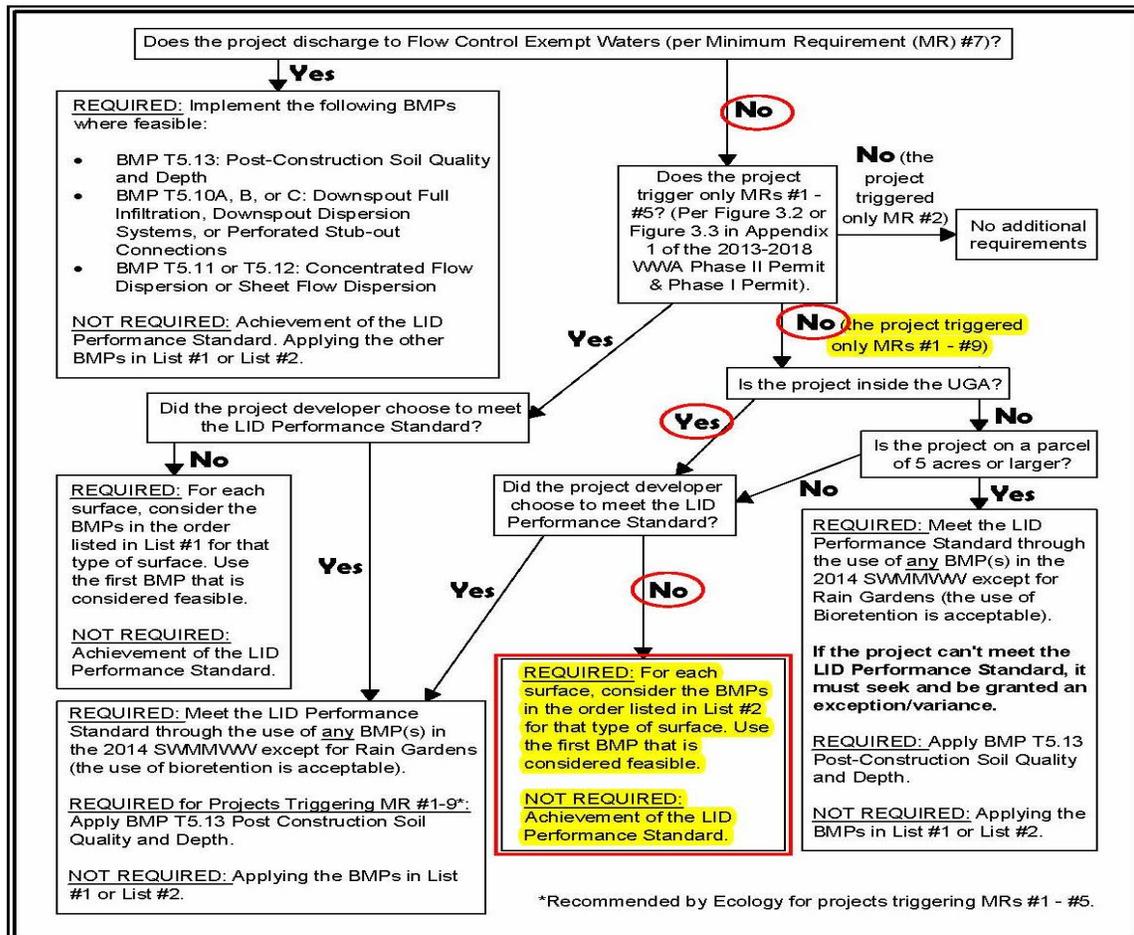
Table 4.3 – North Basin and Upstream Pre-developed Peak Flows (POC 1)

Event	Flow Rate (cfs)
2-yr	1.874
10-yr	3.711
25-yr	4.936
50-yr	5.997
100-yr	7.194

On-Site Stormwater Management

Minimum Requirement #5 addresses the application of on-site stormwater management BMPs with the intent to “infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts.” Requirements for this project are specified on Table I-2.5.1 and Figure I-2.5.1. These are included here with the relevant text highlighted.

Figure I-2.5.1 Flow Chart for Determining LID MR #5 Requirements



**Figure I-2.5.1
Flow Chart for Determining LID MR #5
Requirements**

Revised June 2015

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**Table I-2.5.1 On-Site Stormwater Management Requirements for
Projects Triggering Minimum Requirements #1 - #9**

Project Type and Location	Requirement
New development on any parcel inside the UGA, or new development outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911) ; or List #2 (applicant option).
New development outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911) .
Redevelopment on any parcel inside the UGA, or redevelopment outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911) ; or List #2 (applicant option).
Redevelopment outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911) .
Note: This table refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 36.70A RCW) of the State of Washington. If the Permittee is located in a county that is not subject to planning under the GMA, the city limits shall be used.	

The feasibility of the BMPs in DOE List #2 have been evaluated for the *Garibaldi PRD* project as a new development inside the UGA. BMPs listed were considered in order for each type of surface to determine if their use/application for this project was feasible based on the following criteria:

1. Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and
2. Competing Need Criteria listed in Chapter V-5 – On-Site Stormwater Management.

Lawn and landscaped areas:

1. Post-Construction Soil Quality and Depth in accordance with BMP T5.13

This BMP is feasible. All soils in lawn and landscaped areas will meet the design guidelines of BMP T5.13. This will be accomplished through one or more of the following implementation methods identified in the manual:

- a. retention of undisturbed native vegetation and soil, or
- b. amendment of existing site topsoil, or
- c. stockpiling and reuse of existing topsoil, or import of approved topsoil mix.

Roofs:**1. Dispersion in accordance with BMP T5.10A, BMP T5.10B, BMP T5.11, BMP T5.12, BMP T5.30**

These BMPs are not feasible. The site plan, which is in accordance with City of Monroe PRD requirements, does not retain the minimum amount of native vegetation required to apply the Full Dispersion BMP. There are also no feasible locations on site where the required vegetated flowpath length can be accommodated. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

2. Vegetated Roofs in accordance with BMP T5.17

This BMP is not feasible. The proposed single-family buildings do not support this BMP.

3. Minimal Excavation Foundations in accordance with BMP T5.19

This BMP is not feasible. The proposed site requires heavy equipment for grading that could disturb native soil.

4. Infiltration and Retention in accordance with BMP T5.10C, BMP T5.14A, BMP T5.14B, BMP T5.15

Infiltration and Retention BMPs are not feasible, which include Perforated Stub-out Connections, Rain Gardens, Bioretention, and other infiltration or retention BMPs. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

Other Hard Surfaces:**1. Dispersion in accordance with BMP T5.11, BMP T5.12, BMP T5.18, BMP T5.30**

These BMPs are not feasible. The site plan, which is in accordance with City of Monroe PRD requirements, does not retain the minimum amount of native vegetation required to apply the Full Dispersion BMP. There are also no feasible locations on site where the required vegetated flowpath length can be accommodated. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

2. Infiltration and Retention in accordance with BMP T5.14A, BMP T5.14B, BMP T5.15

Infiltration and Retention BMPs are not feasible, which include Rain Gardens, Bioretention, and other infiltration or retention BMPs. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

The National Resources Conservation Service (NRCS) Report is attached in Appendix A and indicates these soils are Tokul gravelly medial loam. These are till soils that are not conducive to infiltration.

Developed Site Hydrology

The Standard Flow Control Requirement, part of Minimum Requirement #7, will be applied and states that, "Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow."

Developed site conditions within the study area were modeled based on the sub-basin configurations shown in Figure 5 and the land use covers summarized in Table 4.4. The residential lots were modeled based on an expected maximum 60 percent impervious coverage as allowed by Monroe Municipal Code (MNC) Bulk Requirements Chapter 18.10.140. Impervious road and sidewalk surface, both on-site and frontage, was calculated from the proposed footprint shown on the improvement plans. The remaining lot area and open space area was modeled as pasture as allowed per Appendix III-C of the SMMWW since it will adhere to BMP T5.13. Due to the existing ridgeline that divides the site, there are two drainage basins that convey site runoff to two separate detention vaults. The basins for the developed South Basin and developed North Basin are shown and detailed in Figure 5. There are two sub-basins that cannot be conveyed to either vault due to grade restrictions and are modeled in WWHM as bypass.

Table 4.4 shows the developed land use inputs used in the WWHM model. Tables 4.5 and 4.6 summarizes the mitigated peak design flow rates.

Table 4.4- Developed Drainage Sub-basins

Basin	Land Use Area (ac)				
	Forested	Lawn	Pasture	Impervious	Total
Upstream Basin	0.000	0.000	9.000	1.890	10.890
Developed North Basin	0.000	0.000	3.153	5.856	9.009
Bypass (North)	0.000	0.000	0.043	0.101	0.144
Developed South Basin	0.000	0.000	2.244	4.167	6.411
Bypass (South)	0.000	0.000	0.585	0.664	1.249
Total Area	0.000	0.000	15.025	12.678	27.703

Table 4.5 – South Basin Developed Peak Flows (POC 2)

Event	Flow Frequency Return Periods at Point of Compliance (cfs)
2-yr	0.124
10-yr	0.214
25-yr	0.273
50-yr	0.323
100-yr	0.381

Table 4.6 – North Basin Developed and Upstream Peak Flows (POC 1)

Event	Flow Frequency Return Periods at Point of Compliance (cfs)
2-yr	0.866
10-yr	1.335
25-yr	1.620
50-yr	1.855
100-yr	2.110

The north vault will release mitigated flows to the onsite wetland via a dispersion trench. The design information is summarized in Table 4.7.

Table 4.7 – North Vault Design Information

Vault Live Storage Surface Area	7,560 sf
Live Storage Depth (incl. freeboard)	13.0 ft
Detention Volume	94,500 cf
Riser Height	12.5 ft
Riser Diam.	24 in
Orifice 1 Diam., Elev: 0.00 ft	3.875 in
Orifice 2 Diam., Elev: 8.70 ft	2.25 in
Orifice 3 Diam., Elev: 9.70 ft	2.50 in

The south vault will release mitigated flows to an existing catch basin within the. The design information is summarized in Table 4.8.

Table 4.8 – South Vault Design Information

Vault Live Storage Surface Area	10,240 sf
Live Storage Depth (incl. freeboard)	13.0 ft
Detention Volume	128,000 cf
Riser Height	12.5 ft
Riser Diam.	24 in
Orifice 1 Diam., Elev: 0.00 ft	1.375 in
Orifice 2 Diam., Elev: 8.30 ft	2.50 in
Orifice 3 Diam., Elev: 9.80 ft	1.50 in

Conveyance System Analysis and Design

The project proposes to collect on-site runoff and convey it to one of the stormwater detention vaults prior to release. The north vault will release mitigated flows through a level spreader to the on-site wetland. The south vault will release mitigated flows to an existing catch basin in the Chain Lake Road right-of-way. Surface runoff will be collected by roof drains, roadway and yard inlets, and a system of below grade pipes on the site.

An analysis of the capacity of the conveyance facilities for the project will be performed during final engineering using a standard backwater approach.

Water Quality Treatment

Basic water quality treatment, per Minimum Requirement #6, is required for surface water runoff from all new pollution generating surfaces created with development of the site. Water quality treatment will be provided by two water quality filter structures, with one being located upstream of each detention vault. Sizing and specifications of the water quality filters will be provided with the final storm drainage report.

SECTION 5 – Construction Stormwater Pollution Prevention Plan

Storm Water Pollution Prevention Plan (SWPPP)

1. *Mark Clearing Limits*

To prevent disturbance of project areas not designated for construction, a construction clearing limits fence or silt fence will be installed by the Contractor along the perimeter of the project site to protect existing native area outside of the mitigation area. These fences will be installed in accordance with the details and specifications provided in the Plans prior to any clearing and grading activities. All sensitive areas and buffers shall also be fenced prior to construction activities.

2. *Establish Construction Access*

Heavy truck and equipment access during construction shall be limited to locations from Chain Lake Road. The contractor shall employ appropriate BMP measures to prevent transport of sediment offsite by motor vehicles.

3. *Control Flow Rates*

The contractor will be responsible for installing temporary erosion control BMP's to control the release rate and water quality of surface water from active construction areas.

4. *Install Sediment Controls*

On-site sediment retention will be controlled by a combination of silt fences, temporary sediment traps, and temporary interceptor trenches as shown on the Plans. Appendix F includes sizing calculations for the proposed temporary sediment traps. The contractor shall inspect and provide regular maintenance of these facilities throughout the duration of construction to ensure maximum sediment control.

5. *Stabilize Soils*

Temporary and permanent cover measures will be provided by the Contractor to protect disturbed areas. Straw mulching is typically used to provide temporary protection from erosion at exposed soil areas. Plastic covering may also be used in order to protect cut and fill slopes, and/or to encourage grass growth in newly seeded areas. Disturbed areas that remain unworked for at least 7 days will be seeded and mulched to provide permanent cover measure and to limit erosion potential.

Water will be used by the Contractor as allowed by local agency regulations and applicable SWMM standards to prevent wind transport of exposed soils. Exposed soils will be sprayed until wet and re-sprayed as needed during dry weather periods.

6. *Protect Slopes*

The project does not require any disturbance of soils within steep slope or erosion hazard areas. Temporary and permanent seeding to stabilize exposed soil areas is expected to be sufficient for protecting on-site slopes—whether constructed or at disturbed native areas. Plastic covering may also be used to protect cut and fill slopes if seasonal limitations warrant and/or to encourage grass growth in newly seeded areas. The contractor shall take all practical efforts including installation of temporary interceptor ditches to direct potential storm water runoff away from the top of on-site slopes.

7. *Protect Drain Inlet*

All storm drain inlets made operable during construction or otherwise existing in the vicinity of work areas shall be protected using pre-manufactured filter fabric catch basin inserts to protect against construction storm water runoff entering the conveyance system. The Contractor will be responsible for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of these controls and remaining accumulated sediment upon completion of construction.
8. *Stabilize Channels and Outlets*

Methods of protection may include silt fence installation and maintenance, catch basin inserts, and temporary interceptor ditches. Vegetated areas shall be maintained whenever possible or practical to provide for natural filtration of construction storm water discharges.
9. *Control Pollutants*

Special provisions shall be taken to reduce the risk of pollutant contamination from the construction access, concrete handling/wash areas, and sawcutting/surfacing activities. No water used in or contacting areas of construction shall be allowed to drain directly towards on-site buffer areas or wetlands without prior treatment. Vehicle maintenance shall only be performed at approved on-site areas and only after proper containment devices are in place downstream of those areas. Any flammable or otherwise hazardous liquids shall be stockpiled only at the approved construction staging area.
10. *Control Dewatering*

Temporary dewatering efforts may be required to facilitate some elements of construction such as storm drainage and utilities installation. Any such dewatering volumes encountered will be collected and controlled using pumps and sediment traps or tanks. Discharge from these controlled onsite facilities will be dispersed to approved areas of native vegetation or otherwise treated using settling tanks or other mechanical filtration facilities prior to release to downstream systems as required to conform with General Construction Stormwater permit standards.
11. *Maintain BMPs*

All TESC measures will be inspected and maintained on a regular basis following the maintenance requirements identified for each in the Plans and/or the project's Storm Water Pollution Prevention Plan (SWPPP). An ESC supervisor will be designated by the Contractor and the name, address and phone number of the ESC supervisor will be given to the regulatory jurisdiction prior to the start of construction.

The ESC supervisor will inspect the site at least once a month during the dry season, weekly during the wet season, and within 24 hours of each runoff-producing storm event. An ESC maintenance report will be used as a written record of all maintenance in accordance with the project SWPPP
12. *Manage the Project*

The Contractor will be responsible for the phasing of erosion and sediment controls during construction so that they are adequately coordinated with all construction activities. The Contractor will be responsible for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of

these controls and cleaning of existing permanent storm drainage facilities upon completion of construction.

13. *Protect Low Impact Development BMPs*

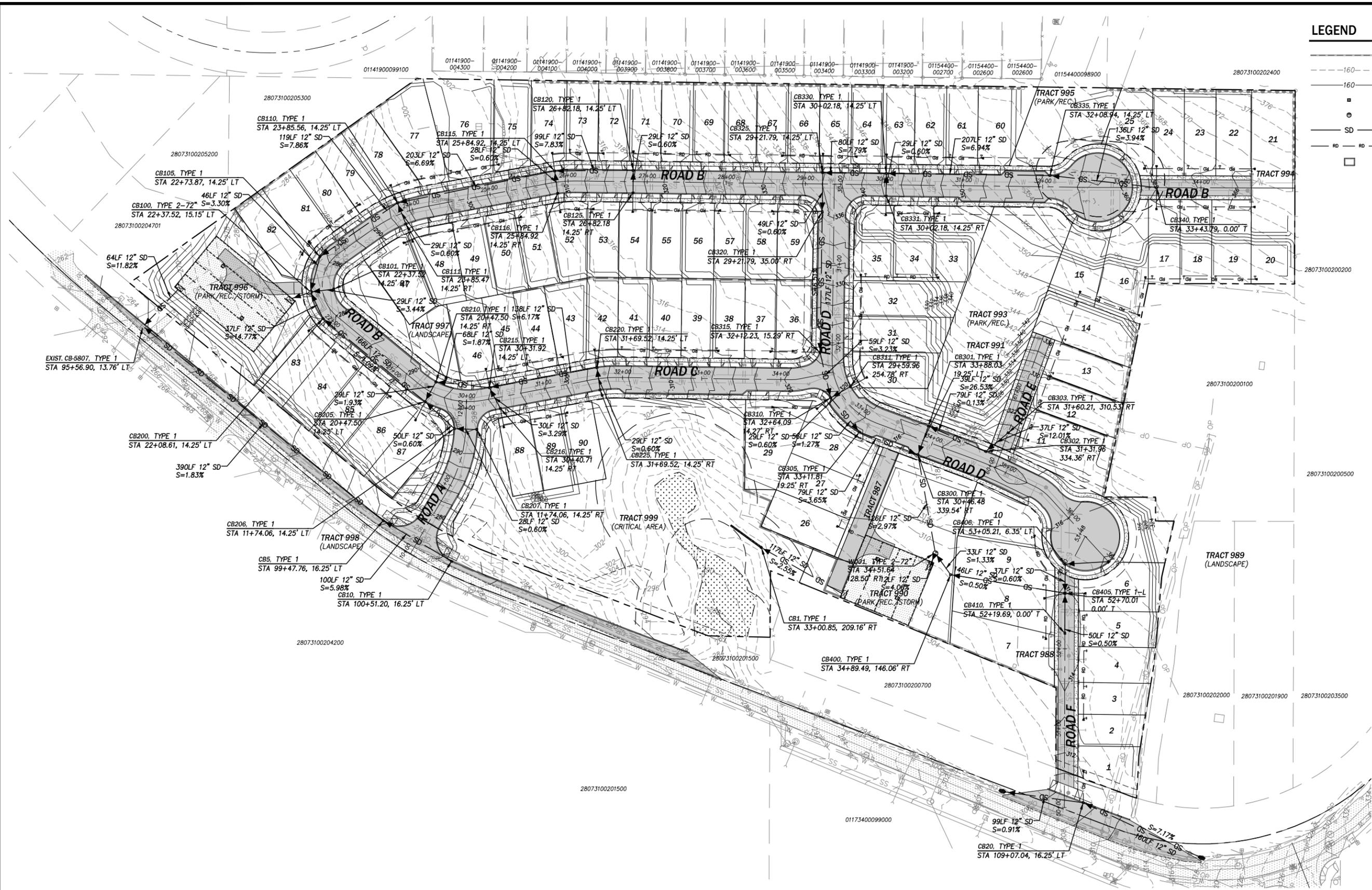
The project geotechnical engineer determined that the onsite soils are not favorable for infiltrative BMPs. As such, no low impact development BMPs are proposed with this project. No special protection is required.

FIGURES



LEGEND

- MSE RETAINING WALL
- - - 160 --- EXIST. TOPOGRAPHIC CONTOUR
- 160 — PROPOSED GRADE CONTOUR
- TYPE 1 STORM DRAINAGE CATCH BASIN
- TYPE 2 STORM DRAINAGE CATCH BASIN
- SD — STORM DRAINAGE PIPE (SEE NOTE 1)
- RD — RD — ROOF DRAIN CONNECTION (SEE NOTE 2)
- STORM DRAINAGE WQ VAULT

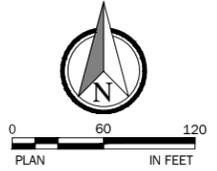


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Site Planning • Civil Engineering
Landscape Architecture • Land Use Consulting

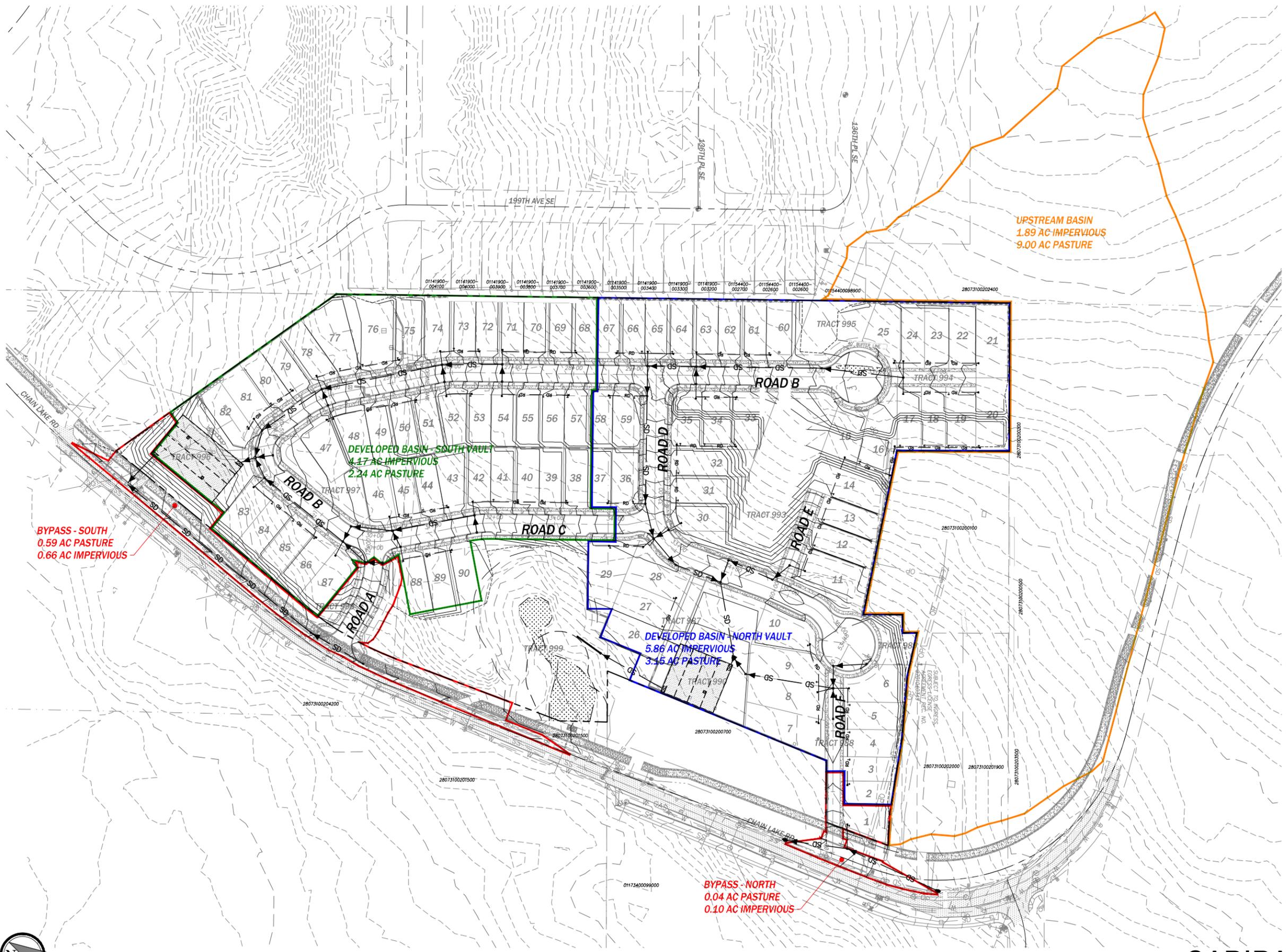
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GARIBALDI PRD
Figure 3 - Developed Site Conditions

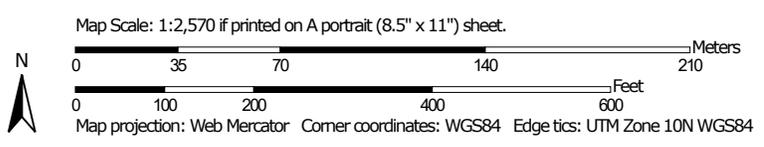
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APPENDIX A

NRCS SOILS REPORT AND GEOTECHNICAL REPORT

Soil Map—Snohomish County Area, Washington



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Snohomish County Area, Washington

Survey Area Data: Version 22, Jun 4, 2020

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

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

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

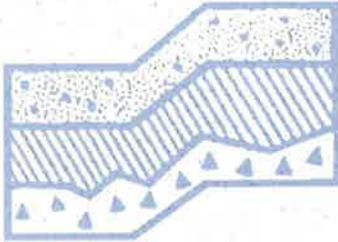
Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
72	Tokul gravelly medial loam, 0 to 8 percent slopes	9.8	57.7%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	7.2	42.3%
Totals for Area of Interest		17.0	100.0%

GEOTECHNICAL REPORT

**Garibaldi Property
13424 and 13624 Chain Lake Road
Monroe, Washington**

Project No. T-8079



Terra Associates, Inc.

Prepared for:

**Garibaldi Lake, LLC
Kirkland, Washington**

December 14, 2018



TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

December 14, 2018
Project No. T-8079

Ms. Melanie Davies
Garibaldi Lake, LLC
1010 Market Street
Kirkland, Washington 98033

Subject: Geotechnical Report
Garibaldi Property
13424 and 13624 Chain Lake Road
Monroe, Washington

Dear Ms. Davies:

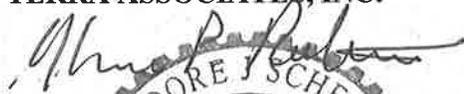
As requested, we conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our study indicates the site soils predominantly consist of glacial till deposits comprised of weathered and unweathered horizons of silty sand with gravel. Perched groundwater seepage was observed at depths of two to four feet in nine of the ten of the test pits excavated at the site.

In our opinion, there are no geotechnical conditions that would preclude the planned residential development. Buildings can be supported on conventional spread footings bearing on competent native soils or on structural fill placed on competent native soils. Floor slabs and pavements can be similarly supported.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.


Kevin P. Roberts, P.E.
Geotechnical Engineer


Theodore J. Schepper, P.E.
President



12-14-18

TABLE OF CONTENTS

	<u>Page No.</u>
1.0 Project Description.....	1
2.0 Scope of Work	1
3.0 Site Conditions.....	2
3.1 Surface	2
3.2 Soils	2
3.3 Groundwater	3
3.4 Geologic Hazards.....	3
3.4.1 Erosion Hazard Areas	3
3.4.2 Landslide Hazard Areas	3
3.4.3 Seismic Hazard Areas	4
3.5 Seismic Design Parameters.....	4
4.0 Discussion and Recommendations	4
4.1 General.....	4
4.2 Site Preparation and Grading	5
4.3 Excavations.....	6
4.4 Foundations.....	6
4.5 Slab-on-Grade Floors.....	7
4.6 Infiltration Feasibility	7
4.7 Stormwater Facilities	7
4.8 Utilities.....	8
4.9 Pavements	9
5.0 Additional Services.....	9
6.0 Limitations.....	9

Figures

Vicinity Map	Figure 1
Exploration Location Plan.....	Figure 2

Appendix

Field Exploration and Laboratory Testing	Appendix A
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**Geotechnical Report
Garibaldi Property
13424 and 13624 Chain Lake Road
Monroe, Washington**

1.0 PROJECT DESCRIPTION

We were provided Conceptual Site Plan prepared by CP|H Consultants, dated November 27, 2018. The site plan indicates the project consists of the construction of 61 residential building lots along with associated infrastructure improvements. A new roadway leading westward from Chain Lake Road will access the development. Based on an email from CP|H Consultants dated November 28, 2018, project stormwater will be directed to a single on-site detention vault facility located at the sites' southeast boundary. The moderately rolling site topography indicates that moderate grading will be required to achieve building and roadway elevations. We anticipate a combination of permanent cut and fill slopes and retaining walls will be used to achieve finished site grades.

We expect that the residential structures will be one- to two-story, wood-frame buildings, with their main floors framed over a crawl space or constructed at grade. Foundation loads should be relatively light, in the range of 2 to 3 kips per foot for bearing walls and 20 to 40 kips for isolated columns.

The recommendations contained in the following sections of this report are based on our understanding of the above design features. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and incorporated into project design and to amend or supplement our recommendations, if required.

2.0 SCOPE OF WORK

We explored subsurface conditions at the site by observing conditions in ten test pits excavated to a maximum depth of 10 feet below existing surface grades using a track-mounted mini-excavator. Based on the results of our field study, laboratory testing, and analyses, we developed geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic Hazards per Monroe Municipal Code
- Seismic design parameters per the current International Building Code (IBC)
- Site preparation and grading
- Excavations
- Foundations
- Slab-on-grade floors
- Infiltration feasibility
- Stormwater facilities
- Utilities
- Pavements

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment is beyond Terra Associates' purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The project site consists of 3 tax parcels totaling approximately 14 acres of land located at 13424 and 13624 Chain Lake Road in Monroe, Washington. The approximate location of the site is shown on Figure 1.

A single-family residence with several outbuildings currently occupies the largest northern parcel. This parcel is mainly open and vegetated with short grass. The southern and middle parcels, respectively, contain a single-family residence and greenhouse. These two parcels are primarily wooded with young to mature trees, with brush and lawn near the residence. Each of the parcels is accessed by graveled driveways leading westward from Chain Lake Road.

We observed at ground surface elevation the top surface of a large boulder (glacial erratic) in the vicinity of Test Pit TP-8. Based on its surface appearance, we estimate the buried boulder to be several feet in diameter.

At the northern parcel, existing surface gradients slope gently from northwest to southeast. Topography at the southern parcel is mostly level. A total topographic relief of approximately 90 feet exists from this sites' northwest to southeast corners. No standing or flowing water, springs, zones of emergent groundwater, or indications of soil erosion or instability were seen during our field exploration.

3.2 Soils

The soils observed in the test pits generally consist of about four to ten inches of sod and topsoil overlying weathered and unweathered horizons of glacial till deposits.

Each test pit showed a weathered horizon of till soils extending to depths ranging from 1.5 feet in Test Pit TP-9 to 3.5 feet in Test Pit TP-6. The weathered soils generally consist of silty fine sand and sand/silt with gravel and cobbles. This upper soil horizon has weathered to a medium dense condition.

Unweathered till soils were observed beneath the weathered layer in each test pit. These soils primarily consist of silty sand with variable gravel, cobble, and boulder contents. We observed the lower unweathered soils to be in a dense to very dense condition having varying degrees of cementation. The unweathered till soils were encountered to the total depths of each of our test pits.

The *Surficial Geologic Map of the Skykomish and Snoqualmie Rivers Area, Snohomish and King Counties, Washington*, by D.B. Booth (1990) shows the site underlain by Vashon till (Qvt). The soils we observed in our test pits are consistent with the published description of this soil unit.

Detailed descriptions of the subsurface conditions we observed in the test pits are presented on the Test Pit Logs in Appendix A. The approximate locations of the test pits are shown on Figure 2.

3.3 Groundwater

We observed groundwater seepage in all test pits except Test Pit TP-10. Light to heavy seepage flows were observed at depths ranging from two to four feet. The seepage primarily occurs as interflow, which is seepage perched within the basal portion of a weathered till layer on top of the underlying, relatively impermeable till soils. Observed differential flow rates from walls of the test pits indicate an overall northwest-to-southeast groundwater flow gradient.

Perched groundwater levels and flow rates will fluctuate seasonally, and typically reach their highest levels during and shortly following the wet winter and early spring months (November through April). Accordingly, we expect that the seepage flow rates and levels observed in the test pits were near their seasonal highs.

3.4 Geologic Hazards

We evaluated site conditions for the presence of “geologically hazardous areas” as defined in Section 20.05.120 of the Monroe Municipal Code (MMC). Discussions related to erosion, landslide, and seismic hazards are given below.

3.4.1 Erosion Hazard Areas

Section 20.05.120B.1. of the MMC defines erosion hazard areas as those areas “identified by the U.S. Department of Agriculture’s Natural Resources Conservation Service (NRCS) as having severe or very severe rill, and inter-rill erosion hazard...”

The NRCS has mapped the site soils as *Tokul gravelly medial loam, 0 to 8 percent slopes* and *Tokul gravelly medial loam, 8 to 15 percent slopes* at the sites’ southern northern areas, respectively. The erosion hazard of each of these soil types is described as slight, and therefore, do not meet the above criteria defining an erosion hazard area.

The site soils will be susceptible to erosion when exposed during construction. In our opinion, proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sedimentation control will adequately mitigate the erosion potential in the planned development area. Erosion protection measures as required by the City of Monroe will need to be in place prior to and during grading activity on the site.

3.4.2 Landslide Hazard Areas

We reviewed definitions of Landslide Hazard Areas listed in Section 20.05.120B.2. of the MMC. Based on our field observations, site slope gradients as shown on the site plan, and the inherent high strength of the soils underlying the site, no landslide hazard areas as defined by MMC exist at the site.

3.4.3 Seismic Hazard Areas

Section 20.05.120B.3. of the MMC defines seismic hazard areas as “areas that are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, soil liquefaction, lateral spreading, or surface failure.

Based on the site topography and the presence of glacially consolidated soils, it is our opinion that the risk for damage resulting from earthquake-induced slope failure, settlement, lateral spreading, surface failure, or soil liquefaction is negligible. Therefore, in our opinion, unusual seismic hazard areas do not exist at the site, and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

3.5 Seismic Design Parameters

Based on the site soil conditions and our knowledge of the area geology, per the 2015 International Building Code (IBC), site class “C” should be used in structural design. Based on this site class, in accordance with the 2015 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2015)

Spectral response acceleration (Short Period), S_{Ms}	1.171 g
Spectral response acceleration (1 – Second Period), S_{M1}	0.602 g
Five percent damped 0.2 second period, S_{Ds}	0.780 g
Five percent damped 1.0 second period, S_{D1}	0.401 g

The above values were determined using the United States Geological Survey (USGS) online ground motion parameter calculator accessed on December 10, 2018.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, there are no geotechnical conditions that would preclude the planned development. In general, structures can be supported on conventional spread footings bearing on competent native soils, or on structural fill placed on the competent native soils. Floor slabs and pavements can be similarly supported.

The majority of the soils at the site contain a sufficient amount of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Perched moderate to heavy groundwater seepage flows were observed within the basal portion of the weathered till at some of the test pit locations. Depending on planned site grades, some areas may require the construction interceptor drains to reduce potential seepage impacts to lots and roadways. Specific areas requiring additional subsurface drainage can be determined based on a review of the final grading plans.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and demolition debris should be stripped and removed from the site. We expect surface stripping depths of about 4 to 10 inches will be required to remove the topsoil. Organic soils will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas or for landscaping purposes.

Demolition of existing structures should include removal of existing foundations and abandonment of underground septic systems and other buried utilities. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Cut and fill operations can be initiated once clearing and grubbing operations are complete.

A representative of Terra Associates, Inc. should examine all bearing surfaces to verify that conditions encountered are as anticipated and are suitable for placement of structural fill or direct support of building and pavement elements. Our representative may request proofrolling exposed surfaces with a heavy rubber-tired vehicle to determine if any isolated soft and yielding areas are present. If unstable yielding areas are observed, they should be cut to firm bearing soil and filled to grade with structural fill. In pavement areas, if the depth of excavation to remove unstable soils is excessive, use of geotextile fabric such as Mirafi 500X or equivalent in conjunction with clean granular structural fill can be considered in order to limit the depth of removal.

The site soils at the site contain a sufficient amount of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. In addition, laboratory testing and the observed wet condition of the upper till soils indicate they are several percentage points above their optimum moisture contents required for compaction. The ability to use these soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. Soils that are too wet to properly compact could be dried by aeration during dry weather conditions, or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control (TESC) plan for the project.

We recommend removing cobbles larger than six inches and boulders from the fill prior to placement and compaction.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill.

For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as utilities and lower building level retaining walls, must be completed in accordance with local, state, and federal requirements. Based on the Washington State Safety and Health Administration (WSHA) regulations, the sites' upper medium dense soils would be classified as Type C soils. The dense to very dense, cemented till soils would be classified as Type A soils.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter. If there is insufficient lateral space to complete the excavations in the manners discussed above, or if excavations greater than 20 feet deep are planned, you may need to use temporary shoring to support the excavations.

For Type A soils, side slopes can be laid back at a slope inclination of 0.75:1 or flatter. For temporary excavation slopes less than 8 feet in height in Type A soils, the lower 3.5 feet can be cut to a vertical condition, with a 0.75:1 slope graded above. For temporary excavation slopes greater than 8 feet in height up to a maximum height of 12 feet, the slope above the 3.5-foot vertical portion will need to be laid back at a minimum slope inclination of 1:1.

Deep excavations that expose perched seepage in till can likely be dewatered by conventional sump-pumping procedures along with a system of collection trenches. Temporary dewatering trenches upgradient of excavations may also be considered in areas of heavy interflow seepage.

The above information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.4 Foundations

Residential structures may be supported on conventional spread footing foundations bearing on competent native soils or on structural fill placed above the native soils. Foundation subgrades should be prepared as recommended in Section 4.2 of this report.

Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab. We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-fourth inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab, and can actually serve as a water supply for moisture transmission through the slab that can subsequently affect floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

4.6 Infiltration Feasibility

Based on our study, it is our opinion that subsurface conditions observed in the test pits are not favorable for stormwater infiltration. This is due primarily to the relatively high fines content and dense and/or cemented nature of the till-like soils.

4.7 Stormwater Facilities

Current information indicates a stormwater detention vault is planned for the project. As an option, we are also providing geotechnical recommendations for stormwater pond design and construction.

Detention Vault

Vault foundations supported by the very dense till soils may be designed for an allowable bearing capacity of 5,000 pounds per square foot (psf). For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used. Friction at the base of the vault foundations and passive earth pressures will provide resistance to the lateral loads. These values are provided in Section 4.4.

The magnitude of earth pressures developing on the vault walls will depend in part on the quality and compaction of the wall backfill. To prevent development of hydrostatic pressure and uplift on the vault, wall drainage must be installed. Vault wall drainage should consist of a minimum 4-inch diameter perforated PVC pipe placed around the perimeter of the vault at an elevation no higher than its dead storage elevation. The drain pipe should be enveloped in drainage aggregate that extends as a 12-inch thick layer to the top of the vault. Alternatively, prefabricated drainage panels such as Miradrain G100N can be substituted for the 12-inch gravel drainage layer. The panels should extend at least six inches into the drainage aggregate surrounding the perforated drain pipe.

With the recommended wall backfill and drainage, we recommend designing the vault walls for an earth pressure imposed by an equivalent fluid weighing 50 pcf. Any portion of the wall for which drainage cannot be provided should be designed for an earth pressure equivalent to a fluid weighing 85 pcf. For evaluating walls under seismic loading, an additional uniform earth pressure equivalent to $8H$ psf, where H is the height of the below-grade wall in feet, can be used. These values assume a horizontal backfill condition. Where applicable, a uniform horizontal traffic surcharge value of 75 psf should be included in design of vault walls.

Detention Pond

Based on the results of our test pit explorations, we expect that very dense till soils would be exposed at stormwater detention pond bottom elevations. If fill berms will be constructed, the berm locations should be stripped of topsoil, duff, and soils containing organic material prior to the placement of fill. The fill berms should be constructed by placing structural fill in layers no more than 12 inches thick and compacting the lifts to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). Material used to construct pond berms should consist of predominately granular soils with a maximum size of 3 inches and a minimum of 20 percent fines. The results of laboratory testing indicate that till soils would meet this gradational requirement. Terra Associates, Inc. should examine and test on-site soils, or imported materials proposed for use as berm fill prior to their use.

Because of exposure to fluctuating stored water levels, soils exposed on the interior side slopes of the ponds may be subject to some risk of periodic shallow instability or sloughing. Establishing interior slopes at a 3:1 gradient will significantly reduce or eliminate this potential. Exterior berm slopes and interior slopes above the maximum water surface should be graded to a finished inclination no steeper than 2:1. Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

4.8 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or City of Monroe requirements. At minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. Soils excavated on-site should generally be suitable for use as backfill material. However, the vast majority of the upper site soils are fine grained and moisture sensitive; therefore, moisture conditioning may be necessary to facilitate proper compaction. If utility construction takes place during the winter, it may be necessary to import suitable wet weather fill for utility trench backfilling.

4.9 Pavements

Pavement subgrade should be prepared as described in the Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tire construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For residential access, with traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following options for pavement sections:

- Two inches of hot mix asphalt (HMA) over four inches of crushed rock base (CRB)
- Full depth HMA – 3 ½ inches

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

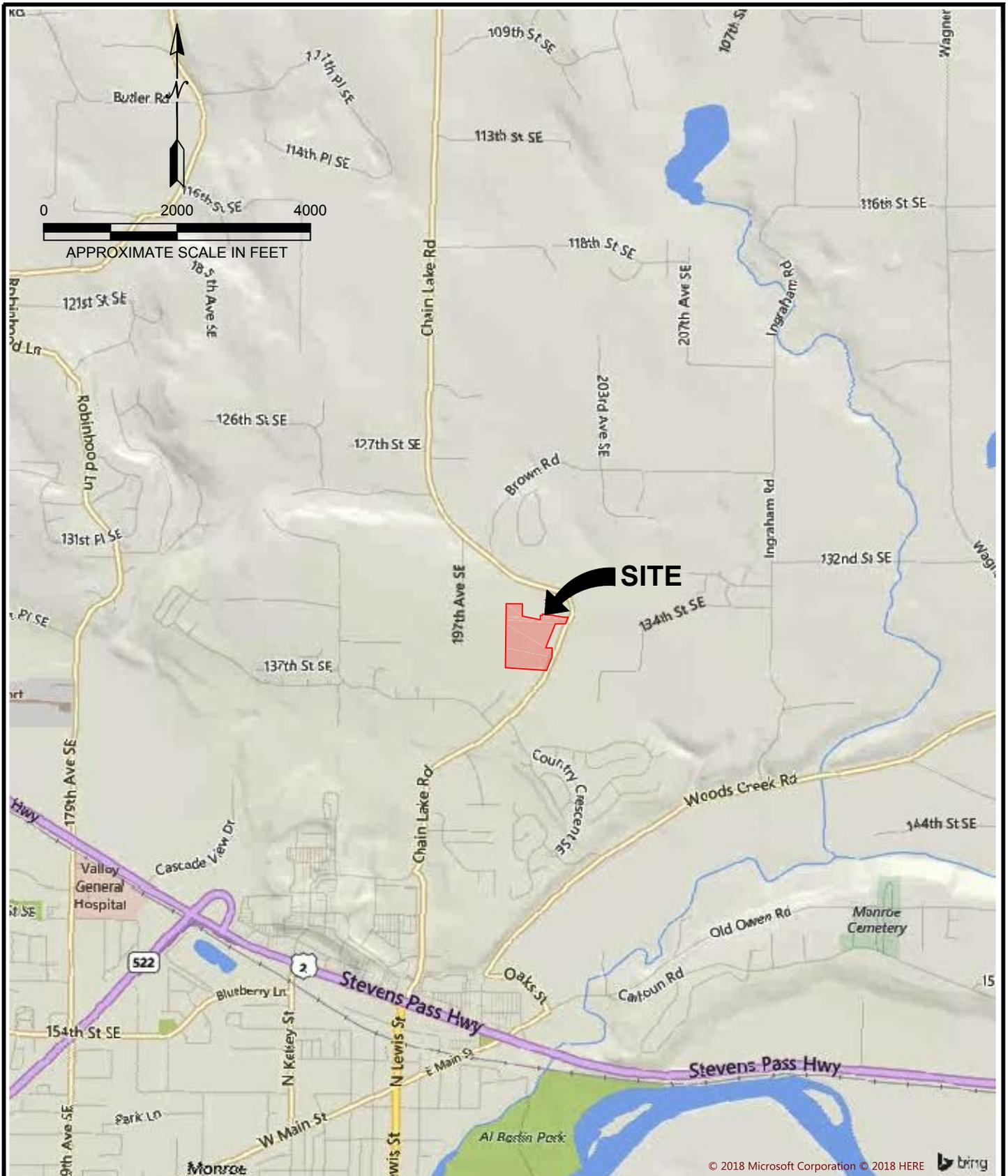
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

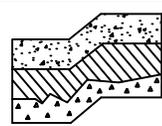
We prepared this report in accordance with generally accepted geotechnical engineering practices. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Garibaldi Property project in Monroe, Washington. This report is for the exclusive use of Garibaldi Lake, LLC and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on data obtained from our on-site test pits. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.



REFERENCE: <https://www.bing.com/maps>

ACCESSED 12/13/18



Terra Associates, Inc.
 Consultants in Geotechnical Engineering
 Geology and
 Environmental Earth Sciences

VICINITY MAP
 GARIBALDI PROPERTY
 MONROE, WASHINGTON

Proj.No. T-8079	Date: DEC 2018	Figure 1
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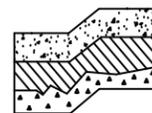
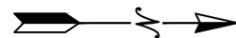
NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE: SITE PLAN PROVIDED BY CPH CONSULTANTS.

LEGEND:

 APPROXIMATE TEST PIT LOCATION



Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
GARIBALDI PROPERTY
MONROE, WASHINGTON

Proj.No. T-8079

Date: DEC 2018

Figure 2

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Garibaldi Property
Monroe, Washington

On November 29, 2018, we investigated subsurface conditions at the site by excavating 10 test pits to a maximum depth of 10 feet below existing surface grades using a Takeuchi TB145 mini-excavator. The test pit locations are shown on Figure 2. The test pit locations were approximately determined in the field by sighting and pacing from existing surface features. The Test Pit Logs are presented on Figures A-2 through A-11.

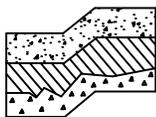
A geologist from our office maintained a log of each test pit as it was excavated, classified the soil conditions encountered, and obtained representative soil samples. All soil samples were visually classified in the field in accordance with the Unified Soil Classification System. A copy of this classification is presented as Figure A-1.

Representative soil samples obtained from the test pits were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Pit Logs. Grain size analyses were performed on six of the soil samples. The results are shown on Figures A-12 and A-13.

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION	
COARSE GRAINED SOILS	More than 50% material larger than No. 200 sieve size	GRAVELS More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
			Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
				GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	More than 50% material smaller than No. 200 sieve size	SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
				SP	Poorly-graded sands, sands with gravel, little or no fines.
			Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
				SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS	SILTS AND CLAYS Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.	
			CL	Inorganic clays of low to medium plasticity. (Lean clay)	
			OL	Organic silts and organic clays of low plasticity.	
	SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.	
			CH	Inorganic clays of high plasticity. (Fat clay)	
			OH	Organic clays of high plasticity.	
HIGHLY ORGANIC SOILS			PT	Peat.	

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS	<u>Density</u>	<u>Standard Penetration Resistance in Blows/Foot</u>		2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
	Very Loose Loose Medium Dense Dense Very Dense	0-4 4-10 10-30 30-50 >50		2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
COHESIVE	<u>Consistency</u>	<u>Standard Penetration Resistance in Blows/Foot</u>		WATER LEVEL (Date)
	Very Soft Soft Medium Stiff Stiff Very Stiff Hard	0-2 2-4 4-8 8-16 16-32 >32	Tr	TORVANE READINGS, tsf
			Pp	PENETROMETER READING, tsf
			DD	DRY DENSITY, pounds per cubic foot
			LL	LIQUID LIMIT, percent
			PI	PLASTIC INDEX
		N	STANDARD PENETRATION, blows per foot	



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**UNIFIED SOIL CLASSIFICATION SYSTEM
 GARIBALDI PROPERTY
 MONROE, WASHINGTON**

Proj.No. T-8079

Date: DEC 2018

Figure A-1

LOG OF TEST PIT NO. TP-1

FIGURE A-2

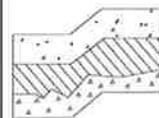
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 365 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2.5 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(5 inches SOD)		
1		Brown silty fine SAND/SILT, few gravels, moist to wet. (SM/ML) (Weathered till)	Medium Dense	45.9
2				
3		Gray-brown silty SAND, some gravel, few cobbles, fine to medium sand, moderately cemented, moist. (SM) (Till)		
4				
5				
6			Very Dense	12.7
7				
8				
9		Test pit terminated at approximately 9 feet. Moderate perched groundwater seepage at 2.5 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-2

FIGURE A-3

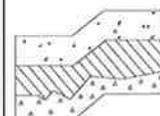
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 349 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 3 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(7 inches TOPSOIL)		
1		Brown silty fine SAND/SILT, few gravels, moist to wet. (SM/ML) (Weathered till)	Medium Dense	23.7
2		*2 feet: 2-foot boulder.		
3		Gray-brown silty SAND, some gravel, few cobbles, trace boulders, fine to medium sand, moderately cemented, moist. (SM) (Till)	Very Dense	14.0
4				
5				
6				
7				
8				
9		Test pit terminated at approximately 9 feet. Moderate perched groundwater seepage at 3 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-3

FIGURE A-4

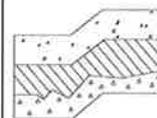
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 309 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(6 inches TOPSOIL)		
1		Light brown mottled silty fine SAND, few gravels, moist to wet. (SM) (Weathered till)	Medium Dense	
2				16.6
3		Gray-brown silty SAND, some gravel and cobbles, fine to medium sand, wet. (SM) (Till)		
4			Dense	
5				
6		*6 feet: Moist, moderately cemented, very dense.		
7			Very Dense	10.3
8				
9		Test pit terminated at approximately 9 feet. Moderate perched groundwater seepage at 2 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-4

FIGURE A-5

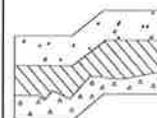
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 312 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(8 inches TOPSOIL)		
1		Light brown mottled silty fine SAND/SILT, few gravels, moist to wet. (SM/ML) (Weathered till)	Medium Dense	
2				32.2
3		Gray-brown silty SAND, some gravel, few cobbles, trace boulders, fine to medium sand, weakly cemented, moist to wet. (SM) (Till)		
4				
5				
6			Dense	
7				
8				10.7
9		Test pit terminated at approximately 9 feet. Light perched groundwater seepage at 2 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-5

FIGURE A-6

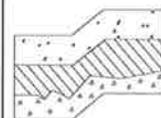
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Brush APPROX. ELEV: 326 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 4 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(6 inches TOPSOIL)		
1		Brown silty SAND, few gravels, fine sand, moist. (SM) (Weathered till)	Medium Dense	
2				
3		Brown-gray silty SAND, some gravel, few cobbles, fine to medium sand, strongly cemented, moist to wet. (SM) (Till)		38.4
4				
5		*5 feet: Very difficult digging.		
6			Very Dense	
7				9.6
8				
9		Test pit terminated at 9 feet due to excavator refusal. Light perched groundwater seepage at 4 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-6

FIGURE A-7

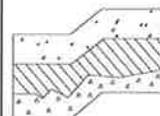
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Brush APPROX. ELEV: 322 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2.5 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(6 inches TOPSOIL)		
1		Brown silty SAND, few gravels, fine sand, moist. (SM) (Weathered till)	Medium Dense	35.8
2		*2.5 feet: Wet		
3				
4		Brown-gray silty SAND, some gravel and cobbles, fine to medium sand, wet. (SM) (Till)	Very Dense	11.7
5		*5 feet: Very difficult digging.		
6				
7				
8				
9				
10		Test pit terminated at approximately 10 feet. Moderate perched groundwater seepage at 2.5 feet. No caving.		
11				
12				
13				
14				
15				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-7

FIGURE A-8

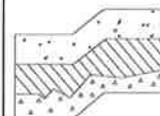
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Brush APPROX. ELEV: 318 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 3 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(8 inches TOPSOIL/DUFF)		
1		Brown silty SAND, some gravel, fine sand, moist. (SM) (Weathered till) *1-foot: Breached an abandoned 4-inch PVC drainline.	Medium Dense	20.8
3		Gray-brown mottled silty SAND, some gravel and cobbles, trace boulders, fine to medium sand, moist to wet. (SM) (Till)		
4				
5			Very Dense	
6				9.8
7				
8				
9		Test pit terminated at approximately 8.5 feet. Light perched groundwater seepage at 3 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-8

FIGURE A-9

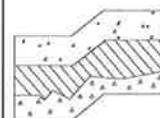
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 338 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2.5 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(5 inches SOD)		
1		Brown silty SAND, some gravel, fine sand, moist. (SM) (Weathered till)	Medium Dense	29.9
2		*1-foot: 18-inch boulder.		
3		Gray-brown mottled silty SAND, some gravel and cobbles, trace boulders, fine to medium sand, moist. (SM) (Till)	Very Dense	13.1
4				
5				
6				
7				
8				
9				
10		Test pit terminated at approximately 9.5 feet. Heavy perched groundwater seepage at 2.5 feet. No caving.		
11				
12				
13				
14				
15				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-9

FIGURE A-10

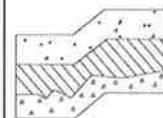
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Grass APPROX. ELEV: 348 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: 2.5 Feet DEPTH TO CAVING: N/A

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(4 inches TOPSOIL)		
1		Brown silty SAND, few gravels, fine sand, moist. (SM) (Weathered till)	Loose	52.2
2		Gray-brown mottled silty SAND, some gravel, few cobbles, trace boulders, fine to medium sand, moderately cemented, moist. (SM) (Till)		
3				
4				
5			Very Dense	
6				14.0
7				
8				
9		Test pit terminated at approximately 9 feet. Light perched groundwater seepage at 1.5 feet. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-10

FIGURE A-11

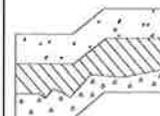
PROJECT NAME: Garibaldi Property PROJ. NO: T-8079 LOGGED BY: KR

LOCATION: Monroe, Washington SURFACE CONDITIONS: Brush APPROX. ELEV: 303 Feet

DATE LOGGED: November 29, 2018 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

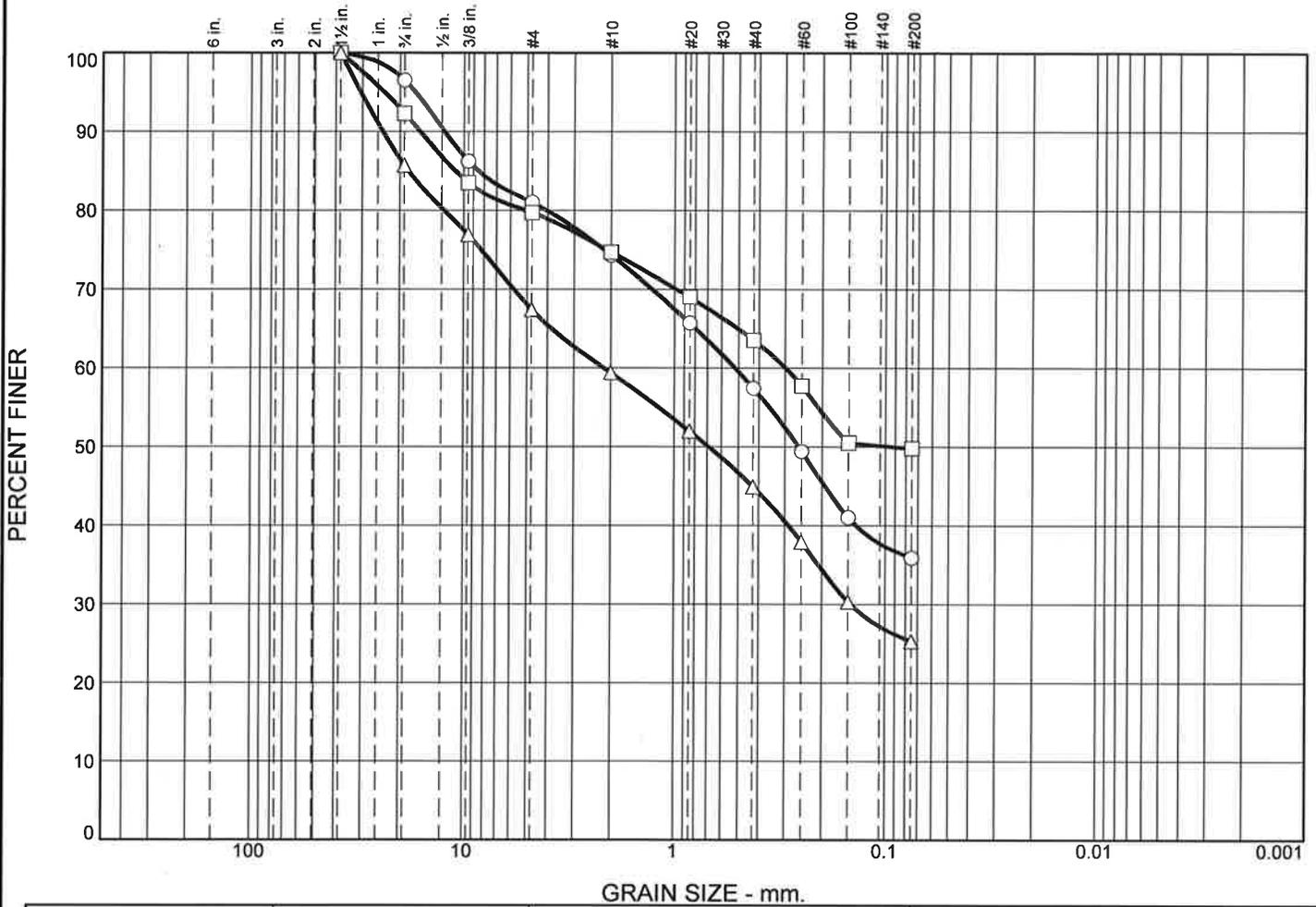
Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		(10 inches TOPSOIL)		
1		Brown SILT with fine sand, few gravels, moist. (ML) (Weathered till)	Medium Dense	
2				
3				38.7
4		Brown-gray mottled silty SAND, some gravel, few cobbles, fine to medium sand, moderately cemented, moist. (SM) (Till)		
5				
6			Very Dense	
7				
8				8.7
9		Test pit terminated at approximately 9 feet. No groundwater. No caving.		
10				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	3.5	15.5	6.7	16.9	21.5	35.9	
□	0.0	7.7	12.6	5.0	11.2	13.7	49.8	
△	0.0	14.3	18.3	8.0	14.5	19.6	25.3	

	LL	PL	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
○			8.5605	0.5198	0.2590					
□			10.9888	0.2990	0.0914					
△			18.2182	2.1557	0.6888	0.1462				

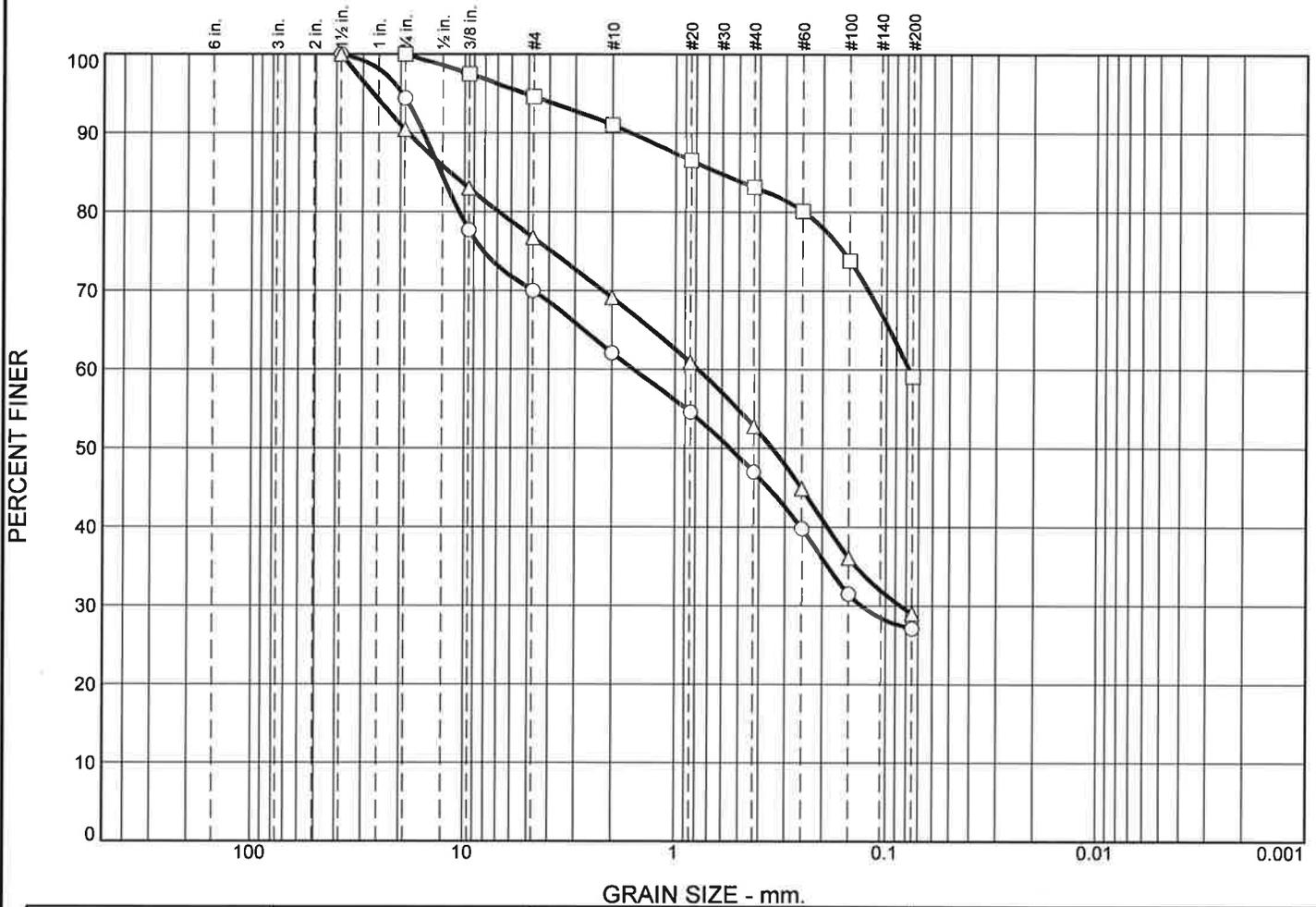
Material Description	USCS	AASHTO
○ Silty SAND	SM	
□ Silty SAND	SM	
△ Silty SAND	SM	

<p>Project No. T-8079 Client: Garibaldi Lake, LLC</p> <p>Project: Garibaldi Property</p> <p>○ Location: TP-1 Depth: -6 feet</p> <p>□ Location: TP-3 Depth: -2 feet</p> <p>△ Location: TP-5 Depth: -7 feet</p> <p style="text-align: center;">Terra Associates, Inc.</p> <p style="text-align: center;">Kirkland, WA</p>	<p>Remarks:</p>
--	--

Figure A-12

Tested By: FQ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines			
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay		
○	0.0	5.6	24.4	7.9	15.1	19.9	27.1			
□	0.0	0.0	5.4	3.6	7.9	24.0	59.1			
△	0.0	9.6	13.7	7.6	16.3	23.8	29.0			
⊗	LL	PL	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
○			12.8907	1.5730	0.5495	0.1308				
□			0.6343	0.0779						
△			11.6942	0.7809	0.3464	0.0849				

Material Description	USCS	AASHTO
○ Silty SAND	SM	
□ SILT	ML	
△ Silty SAND	SM	

Project No. T-8079 Client: Garibaldi Lake, LLC Project: Garibaldi Property	Remarks:
○ Location: TP-7 Depth: -6 feet □ Location: TP-10 Depth: -2.5 feet △ Location: TP-10 Depth: -8 feet	
Terra Associates, Inc. Kirkland, WA	

Figure A-13

Tested By: FQ

APPENDIX B

WWMH INPUT PARAMETERS AND RESULTS

Basin ID	Area (SF)	Imp. (SF)	Pervious (SF)
Tract 987	3917	3917	0
Tract 988	7041	6885	156
Tract 989	7134	0	7134
Tract 990	26913	2000	24913
Tract 991	4530	4530	0
Tract 992	1724	0	1724
Tract 993	29608	0	29608
Tract 994	4191	4191	0
Tract 995	9572	0	9572
Tract 996	30366	0	30366
Tract 997	7810	0	7810
Tract 998	1999	0	1999
Tract 999	2892	0	2892
ROW	142499	23008	119491
Lots	233621	140173	93448
Total	513817	184704	329113

Bypass			
Areas	Area (SF)	Imp. (SF)	Pervious (SF)
Bypass #1	54390	28907	25483
Bypass #2	7594	5980	1614

North Basin Lots			
Lot #	Area (SF)	Imp. (SF)	Pervious (SF)
1	4036	2422	1614
2	3362	2017	1345
3	3622	2173	1449
4	4374	2624	1750
5	4576	2746	1830
6	5669	3401	2268
7	6956	4174	2782
8	6334	3800	2534
9	6094	3656	2438
10	5601	3361	2240
11	6509	3905	2604
12	4451	2671	1780
13	4212	2527	1685
14	7177	4306	2871
15	5155	3093	2062
16	7069	4241	2828
17	4232	2539	1693
18	4232	2539	1693
19	5290	3174	2116
20	6644	3986	2658
21	6779	4067	2712
22	4894	2936	1958
23	4368	2621	1747
24	4384	2630	1754
25	4842	2905	1937
26	5000	3000	2000
27	5000	3000	2000
28	5784	3470	2314
29	7033	4220	2813
30	4494	2696	1798
31	5354	3212	2142
32	6067	3640	2427
33	5653	3392	2261
34	4750	2850	1900
35	4616	2770	1846
36	3861	2317	1544
37	4000	2400	1600
38	3800	2280	1520
39	3670	2202	1468
40	5738	3443	2295
41	3987	2392	1595
42	3988	2393	1595
43	3990	2394	1596
44	3991	2395	1596
45	3993	2396	1597
46	3994	2396	1598
47	3996	2398	1598
Total	233621	140173	93448

South Basin Lots			
Lot #	Area (SF)	Imp. (SF)	Pervious (SF)
38	4000	2400	1600
39	4000	2400	1600
40	4000	2400	1600
41	4000	2400	1600
42	4039	2423	1616
43	5118	3071	2047
44	4052	2431	1621
45	4052	2431	1621
46	4530	2718	1812
47	5095	3057	2038
48	4969	2981	1988
49	4000	2400	1600
50	4000	2400	1600
51	4000	2400	1600
52	4875	2925	1950
53	3800	2280	1520
54	3800	2280	1520
55	3800	2280	1520
56	3800	2280	1520
57	3800	2280	1520
58	3997	2398	1599
59	3999	2399	1600
60	4000	2400	1600
61	4002	2401	1601
62	4003	2402	1601
63	4007	2404	1603
64	4665	2799	1866
65	5321	3193	2128
66	9013	5408	3605
67	6969	4181	2788
68	4784	2870	1914
69	3905	2343	1562
70	3862	2317	1545
71	4179	2507	1672
72	4780	2868	1912
73	4858	2915	1943
74	4858	2915	1943
75	4858	2915	1943
76	4828	2897	1931
77	3999	2399	1600
78	4000	2400	1600
79	4000	2400	1600
Total	186617	111970	74647

Developed North Basin			
North Basin	Area (SF)	Imp. (SF)	Pervious (SF)
Tract 987	3917	3917	0
Tract 988	7041	6885	156
Tract 989	7134	0	7134
Tract 990	26913	2000	24913
Tract 991	29608	0	29608
Tract 992	9572	0	9572
Tract 993	29608	0	29608
Tract 994	4191	4191	0
Tract 995	9572	0	9572
Tract 998	1999	0	1999
ROW	70648	63583	7065
Lots	233621	140173	93448
Total	433824	220749	213075

Developed South Basin			
Basin ID	Area (SF)	Imp. (SF)	Pervious (SF)
Tract 996	30366	0	4043
Tract 997	7810	0	7810
Tract 999	2892	0	2892
ROW	71855	64670	7186
Lots	186617	111970	74647
Total	299540	176640	96577

WWHM2012
PROJECT REPORT

General Model Information

Project Name: Garibaldi_Combined_210303
Site Name: Garibaldi
Site Address:
City: Monroe, WA
Report Date: 3/3/2021
Gage: Everett
Data Start: 1948/10/01
Data End: 2009/09/30
Timestep: 15 Minute
Precip Scale: 1.200
Version Date: 2019/09/13
Version: 4.2.17

POC Thresholds

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

Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Predev-S

Bypass:	No
GroundWater:	No
Pervious Land Use C, Forest, Mod	acre 7.06
Pervious Total	7.06
Impervious Land Use	acre
Impervious Total	0
Basin Total	7.06

Element Flows To:		
Surface	Interflow	Groundwater

Predev-N

Bypass:	No
GroundWater:	No
Pervious Land Use C, Forest, Mod	acre 9.781
Pervious Total	9.781
Impervious Land Use	acre
Impervious Total	0
Basin Total	9.781

Element Flows To:		
Surface	Interflow	Groundwater

Predev-Upstream

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 9
Pervious Total	9
Impervious Land Use ROADS MOD	acre 1.89
Impervious Total	1.89
Basin Total	10.89

Element Flows To:		
Surface	Interflow	Groundwater

Mitigated Land Use

Dev-S

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 2.244
Pervious Total	2.244
Impervious Land Use ROADS MOD	acre 4.167
Impervious Total	4.167
Basin Total	6.411

Element Flows To:		
Surface	Interflow	Groundwater
Vault-S	Vault-S	

Bypass-S

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 0.585
Pervious Total	0.585
Impervious Land Use ROADS MOD	acre 0.664
Impervious Total	0.664
Basin Total	1.249

Element Flows To:		
Surface	Interflow	Groundwater
Vault-S	Vault-S	

Dev-N

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 3.153
Pervious Total	3.153
Impervious Land Use ROADS MOD	acre 5.856
Impervious Total	5.856
Basin Total	9.009

Element Flows To:		
Surface	Interflow	Groundwater
Vault-N	Vault-N	

Upstream-N

Bypass:	No
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 9
Pervious Total	9
Impervious Land Use ROADS MOD	acre 1.89
Impervious Total	1.89
Basin Total	10.89

Element Flows To:		
Surface	Interflow	Groundwater
Vault-N	Vault-N	

Bypass-N

Bypass:	Yes
GroundWater:	No
Pervious Land Use C, Pasture, Mod	acre 0.043
Pervious Total	0.043
Impervious Land Use ROADS MOD	acre 0.101
Impervious Total	0.101
Basin Total	0.144

Element Flows To:		
Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault-S

Width: 80 ft.
Length: 128 ft.
Depth: 13.5 ft.
Discharge Structure
Riser Height: 12.5 ft.
Riser Diameter: 24 in.
Orifice 1 Diameter: 1.375 in. Elevation:0 ft.
Orifice 2 Diameter: 2.5 in. Elevation:8.3 ft.
Orifice 3 Diameter: 1.5 in. Elevation:9.8 ft.
Element Flows To:
Outlet 1 Outlet 2

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.235	0.000	0.000	0.000
0.1500	0.235	0.035	0.019	0.000
0.3000	0.235	0.070	0.028	0.000
0.4500	0.235	0.105	0.034	0.000
0.6000	0.235	0.141	0.039	0.000
0.7500	0.235	0.176	0.044	0.000
0.9000	0.235	0.211	0.048	0.000
1.0500	0.235	0.246	0.052	0.000
1.2000	0.235	0.282	0.056	0.000
1.3500	0.235	0.317	0.059	0.000
1.5000	0.235	0.352	0.062	0.000
1.6500	0.235	0.387	0.065	0.000
1.8000	0.235	0.423	0.068	0.000
1.9500	0.235	0.458	0.071	0.000
2.1000	0.235	0.493	0.074	0.000
2.2500	0.235	0.528	0.077	0.000
2.4000	0.235	0.564	0.079	0.000
2.5500	0.235	0.599	0.081	0.000
2.7000	0.235	0.634	0.084	0.000
2.8500	0.235	0.670	0.086	0.000
3.0000	0.235	0.705	0.088	0.000
3.1500	0.235	0.740	0.091	0.000
3.3000	0.235	0.775	0.093	0.000
3.4500	0.235	0.811	0.095	0.000
3.6000	0.235	0.846	0.097	0.000
3.7500	0.235	0.881	0.099	0.000
3.9000	0.235	0.916	0.101	0.000
4.0500	0.235	0.952	0.103	0.000
4.2000	0.235	0.987	0.105	0.000
4.3500	0.235	1.022	0.107	0.000
4.5000	0.235	1.057	0.108	0.000
4.6500	0.235	1.093	0.110	0.000
4.8000	0.235	1.128	0.112	0.000
4.9500	0.235	1.163	0.114	0.000
5.1000	0.235	1.198	0.115	0.000
5.2500	0.235	1.234	0.117	0.000
5.4000	0.235	1.269	0.119	0.000
5.5500	0.235	1.304	0.120	0.000

5.7000	0.235	1.339	0.122	0.000
5.8500	0.235	1.375	0.124	0.000
6.0000	0.235	1.410	0.125	0.000
6.1500	0.235	1.445	0.127	0.000
6.3000	0.235	1.481	0.128	0.000
6.4500	0.235	1.516	0.130	0.000
6.6000	0.235	1.551	0.131	0.000
6.7500	0.235	1.586	0.133	0.000
6.9000	0.235	1.622	0.134	0.000
7.0500	0.235	1.657	0.136	0.000
7.2000	0.235	1.692	0.137	0.000
7.3500	0.235	1.727	0.139	0.000
7.5000	0.235	1.763	0.140	0.000
7.6500	0.235	1.798	0.141	0.000
7.8000	0.235	1.833	0.143	0.000
7.9500	0.235	1.868	0.144	0.000
8.1000	0.235	1.904	0.146	0.000
8.2500	0.235	1.939	0.147	0.000
8.4000	0.235	1.974	0.202	0.000
8.5500	0.235	2.009	0.234	0.000
8.7000	0.235	2.045	0.258	0.000
8.8500	0.235	2.080	0.278	0.000
9.0000	0.235	2.115	0.295	0.000
9.1500	0.235	2.151	0.311	0.000
9.3000	0.235	2.186	0.326	0.000
9.4500	0.235	2.221	0.339	0.000
9.6000	0.235	2.256	0.352	0.000
9.7500	0.235	2.292	0.364	0.000
9.9000	0.235	2.327	0.395	0.000
10.050	0.235	2.362	0.417	0.000
10.200	0.235	2.397	0.436	0.000
10.350	0.235	2.433	0.453	0.000
10.500	0.235	2.468	0.468	0.000
10.650	0.235	2.503	0.483	0.000
10.800	0.235	2.538	0.497	0.000
10.950	0.235	2.574	0.511	0.000
11.100	0.235	2.609	0.524	0.000
11.250	0.235	2.644	0.536	0.000
11.400	0.235	2.679	0.549	0.000
11.550	0.235	2.715	0.560	0.000
11.700	0.235	2.750	0.572	0.000
11.850	0.235	2.785	0.583	0.000
12.000	0.235	2.820	0.594	0.000
12.150	0.235	2.856	0.605	0.000
12.300	0.235	2.891	0.615	0.000
12.450	0.235	2.926	0.625	0.000
12.600	0.235	2.962	1.306	0.000
12.750	0.235	2.997	3.268	0.000
12.900	0.235	3.032	5.790	0.000
13.050	0.235	3.067	8.399	0.000
13.200	0.235	3.103	10.64	0.000
13.350	0.235	3.138	12.20	0.000
13.500	0.235	3.173	13.29	0.000
13.650	0.000	0.000	14.21	0.000

Vault-N

Width: 90 ft.
 Length: 84 ft.
 Depth: 13.5 ft.
 Discharge Structure
 Riser Height: 12.5 ft.
 Riser Diameter: 24 in.
 Orifice 1 Diameter: 3.875 in. Elevation:0 ft.
 Orifice 2 Diameter: 2.25 in. Elevation:8.7 ft.
 Orifice 3 Diameter: 2.5 in. Elevation:9.7 ft.
 Element Flows To:
 Outlet 1 Outlet 2

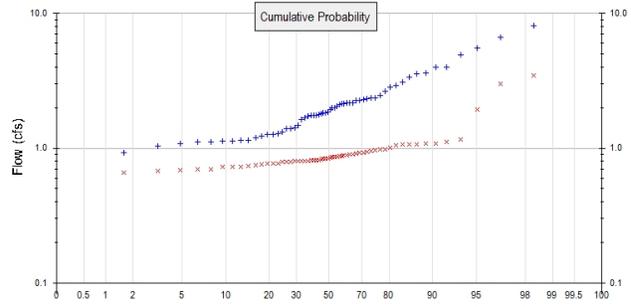
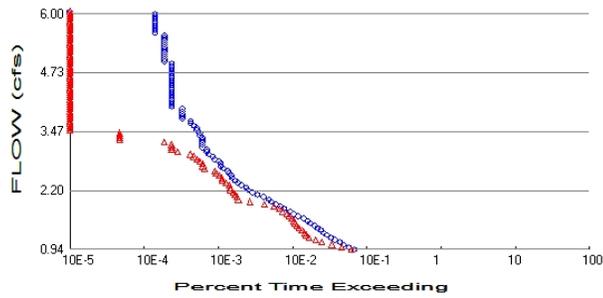
Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.173	0.000	0.000	0.000
0.1500	0.173	0.026	0.157	0.000
0.3000	0.173	0.052	0.223	0.000
0.4500	0.173	0.078	0.273	0.000
0.6000	0.173	0.104	0.315	0.000
0.7500	0.173	0.130	0.352	0.000
0.9000	0.173	0.156	0.386	0.000
1.0500	0.173	0.182	0.417	0.000
1.2000	0.173	0.208	0.446	0.000
1.3500	0.173	0.234	0.473	0.000
1.5000	0.173	0.260	0.499	0.000
1.6500	0.173	0.286	0.523	0.000
1.8000	0.173	0.312	0.546	0.000
1.9500	0.173	0.338	0.569	0.000
2.1000	0.173	0.364	0.590	0.000
2.2500	0.173	0.390	0.611	0.000
2.4000	0.173	0.416	0.631	0.000
2.5500	0.173	0.442	0.650	0.000
2.7000	0.173	0.468	0.669	0.000
2.8500	0.173	0.494	0.687	0.000
3.0000	0.173	0.520	0.705	0.000
3.1500	0.173	0.546	0.723	0.000
3.3000	0.173	0.572	0.740	0.000
3.4500	0.173	0.598	0.756	0.000
3.6000	0.173	0.624	0.773	0.000
3.7500	0.173	0.650	0.789	0.000
3.9000	0.173	0.676	0.804	0.000
4.0500	0.173	0.702	0.820	0.000
4.2000	0.173	0.728	0.835	0.000
4.3500	0.173	0.755	0.849	0.000
4.5000	0.173	0.781	0.864	0.000
4.6500	0.173	0.807	0.878	0.000
4.8000	0.173	0.833	0.892	0.000
4.9500	0.173	0.859	0.906	0.000
5.1000	0.173	0.885	0.920	0.000
5.2500	0.173	0.911	0.933	0.000
5.4000	0.173	0.937	0.946	0.000
5.5500	0.173	0.963	0.960	0.000
5.7000	0.173	0.989	0.972	0.000
5.8500	0.173	1.015	0.985	0.000

6.0000	0.173	1.041	0.998	0.000
6.1500	0.173	1.067	1.010	0.000
6.3000	0.173	1.093	1.022	0.000
6.4500	0.173	1.119	1.034	0.000
6.6000	0.173	1.145	1.046	0.000
6.7500	0.173	1.171	1.058	0.000
6.9000	0.173	1.197	1.070	0.000
7.0500	0.173	1.223	1.081	0.000
7.2000	0.173	1.249	1.093	0.000
7.3500	0.173	1.275	1.104	0.000
7.5000	0.173	1.301	1.115	0.000
7.6500	0.173	1.327	1.127	0.000
7.8000	0.173	1.353	1.138	0.000
7.9500	0.173	1.379	1.148	0.000
8.1000	0.173	1.405	1.159	0.000
8.2500	0.173	1.431	1.170	0.000
8.4000	0.173	1.457	1.181	0.000
8.5500	0.173	1.483	1.191	0.000
8.7000	0.173	1.509	1.201	0.000
8.8500	0.173	1.536	1.265	0.000
9.0000	0.173	1.562	1.297	0.000
9.1500	0.173	1.588	1.324	0.000
9.3000	0.173	1.614	1.349	0.000
9.4500	0.173	1.640	1.371	0.000
9.6000	0.173	1.666	1.392	0.000
9.7500	0.173	1.692	1.451	0.000
9.9000	0.173	1.718	1.508	0.000
10.050	0.173	1.744	1.551	0.000
10.200	0.173	1.770	1.589	0.000
10.350	0.173	1.796	1.624	0.000
10.500	0.173	1.822	1.656	0.000
10.650	0.173	1.848	1.686	0.000
10.800	0.173	1.874	1.716	0.000
10.950	0.173	1.900	1.744	0.000
11.100	0.173	1.926	1.771	0.000
11.250	0.173	1.952	1.797	0.000
11.400	0.173	1.978	1.822	0.000
11.550	0.173	2.004	1.847	0.000
11.700	0.173	2.030	1.871	0.000
11.850	0.173	2.056	1.895	0.000
12.000	0.173	2.082	1.918	0.000
12.150	0.173	2.108	1.941	0.000
12.300	0.173	2.134	1.963	0.000
12.450	0.173	2.160	1.985	0.000
12.600	0.173	2.186	2.676	0.000
12.750	0.173	2.212	4.650	0.000
12.900	0.173	2.238	7.183	0.000
13.050	0.173	2.264	9.803	0.000
13.200	0.173	2.290	12.05	0.000
13.350	0.173	2.316	13.63	0.000
13.500	0.173	2.343	14.72	0.000
13.650	0.229	3.017	15.65	0.000

Analysis Results

POC 1



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area: 18.781
 Total Impervious Area: 1.89

Mitigated Landuse Totals for POC #1

Total Pervious Area: 12.196
 Total Impervious Area: 7.847

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	1.874363
5 year	2.890012
10 year	3.711169
25 year	4.936075
50 year	5.996576
100 year	7.194398

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.865891
5 year	1.132829
10 year	1.334725
25 year	1.619717
50 year	1.85479
100 year	2.110352

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	2.468	0.804
1950	2.355	0.889
1951	1.637	0.827
1952	1.745	0.730
1953	1.998	0.696
1954	5.559	0.805
1955	2.269	0.986
1956	1.469	0.925
1957	2.261	1.001
1958	4.929	0.959

1959	1.763	0.861
1960	2.171	0.949
1961	8.055	1.071
1962	1.923	0.873
1963	3.086	0.915
1964	2.107	0.840
1965	1.108	0.793
1966	1.125	0.672
1967	2.157	0.906
1968	1.800	1.060
1969	6.677	0.788
1970	1.288	0.701
1971	2.140	0.854
1972	2.371	0.942
1973	1.827	0.729
1974	3.347	0.772
1975	2.142	0.743
1976	1.259	0.880
1977	1.124	0.770
1978	1.145	0.682
1979	3.583	1.057
1980	2.041	0.816
1981	1.225	0.769
1982	1.408	1.077
1983	2.632	0.808
1984	1.673	0.928
1985	1.751	0.975
1986	3.963	1.946
1987	1.771	1.118
1988	1.724	0.818
1989	1.826	0.661
1990	1.393	0.839
1991	1.398	0.864
1992	1.845	0.734
1993	1.328	0.753
1994	1.089	0.813
1995	1.191	0.874
1996	2.336	1.080
1997	4.001	3.444
1998	1.994	0.797
1999	1.036	0.794
2000	2.845	0.802
2001	0.758	0.623
2002	0.919	0.840
2003	1.144	0.732
2004	2.306	1.072
2005	1.108	0.899
2006	3.626	1.164
2007	2.933	0.861
2008	2.167	3.019
2009	1.271	0.815

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.0551	3.4442
2	6.6769	3.0194
3	5.5595	1.9464

4	4.9288	1.1645
5	4.0010	1.1176
6	3.9631	1.0800
7	3.6260	1.0774
8	3.5833	1.0723
9	3.3467	1.0706
10	3.0857	1.0604
11	2.9329	1.0570
12	2.8446	1.0015
13	2.6323	0.9861
14	2.4683	0.9748
15	2.3706	0.9594
16	2.3550	0.9486
17	2.3356	0.9417
18	2.3061	0.9277
19	2.2692	0.9249
20	2.2609	0.9149
21	2.1714	0.9056
22	2.1667	0.8994
23	2.1571	0.8889
24	2.1420	0.8804
25	2.1402	0.8743
26	2.1066	0.8726
27	2.0412	0.8637
28	1.9979	0.8610
29	1.9944	0.8606
30	1.9225	0.8536
31	1.8451	0.8403
32	1.8273	0.8397
33	1.8260	0.8394
34	1.7996	0.8269
35	1.7712	0.8181
36	1.7628	0.8163
37	1.7512	0.8147
38	1.7451	0.8135
39	1.7238	0.8078
40	1.6731	0.8048
41	1.6366	0.8037
42	1.4693	0.8023
43	1.4080	0.7975
44	1.3983	0.7940
45	1.3934	0.7932
46	1.3277	0.7880
47	1.2885	0.7717
48	1.2714	0.7699
49	1.2592	0.7688
50	1.2249	0.7531
51	1.1911	0.7429
52	1.1447	0.7336
53	1.1438	0.7316
54	1.1246	0.7298
55	1.1238	0.7290
56	1.1081	0.7008
57	1.1076	0.6959
58	1.0890	0.6825
59	1.0363	0.6724
60	0.9194	0.6613
61	0.7581	0.6234

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.9372	1439	1316	91	Pass
0.9883	1214	980	80	Pass
1.0394	1050	724	68	Pass
1.0905	920	527	57	Pass
1.1416	799	437	54	Pass
1.1927	698	353	50	Pass
1.2438	626	323	51	Pass
1.2949	562	310	55	Pass
1.3460	511	284	55	Pass
1.3971	462	260	56	Pass
1.4482	420	244	58	Pass
1.4993	373	233	62	Pass
1.5504	338	221	65	Pass
1.6015	300	206	68	Pass
1.6527	255	191	74	Pass
1.7038	222	177	79	Pass
1.7549	200	156	78	Pass
1.8060	165	141	85	Pass
1.8571	146	119	81	Pass
1.9082	128	89	69	Pass
1.9593	111	57	51	Pass
2.0104	104	40	38	Pass
2.0615	86	38	44	Pass
2.1126	72	36	50	Pass
2.1637	62	34	54	Pass
2.2148	53	31	58	Pass
2.2659	51	31	60	Pass
2.3170	43	30	69	Pass
2.3681	39	27	69	Pass
2.4192	36	24	66	Pass
2.4703	33	24	72	Pass
2.5214	32	22	68	Pass
2.5725	30	20	66	Pass
2.6236	29	19	65	Pass
2.6748	25	14	56	Pass
2.7259	23	13	56	Pass
2.7770	23	13	56	Pass
2.8281	22	12	54	Pass
2.8792	19	11	57	Pass
2.9303	18	10	55	Pass
2.9814	16	9	56	Pass
3.0325	15	6	40	Pass
3.0836	15	5	33	Pass
3.1347	13	5	38	Pass
3.1858	13	5	38	Pass
3.2369	13	4	30	Pass
3.2880	13	1	7	Pass
3.3391	13	1	7	Pass
3.3902	12	1	8	Pass
3.4413	12	1	8	Pass
3.4924	11	0	0	Pass
3.5435	11	0	0	Pass
3.5946	10	0	0	Pass

3.6457	9	0	0	Pass
3.6969	9	0	0	Pass
3.7480	7	0	0	Pass
3.7991	7	0	0	Pass
3.8502	7	0	0	Pass
3.9013	7	0	0	Pass
3.9524	7	0	0	Pass
4.0035	5	0	0	Pass
4.0546	5	0	0	Pass
4.1057	5	0	0	Pass
4.1568	5	0	0	Pass
4.2079	5	0	0	Pass
4.2590	5	0	0	Pass
4.3101	5	0	0	Pass
4.3612	5	0	0	Pass
4.4123	5	0	0	Pass
4.4634	5	0	0	Pass
4.5145	5	0	0	Pass
4.5656	5	0	0	Pass
4.6167	5	0	0	Pass
4.6678	5	0	0	Pass
4.7190	5	0	0	Pass
4.7701	5	0	0	Pass
4.8212	5	0	0	Pass
4.8723	5	0	0	Pass
4.9234	5	0	0	Pass
4.9745	4	0	0	Pass
5.0256	4	0	0	Pass
5.0767	4	0	0	Pass
5.1278	4	0	0	Pass
5.1789	4	0	0	Pass
5.2300	4	0	0	Pass
5.2811	4	0	0	Pass
5.3322	4	0	0	Pass
5.3833	4	0	0	Pass
5.4344	4	0	0	Pass
5.4855	4	0	0	Pass
5.5366	4	0	0	Pass
5.5877	3	0	0	Pass
5.6388	3	0	0	Pass
5.6899	3	0	0	Pass
5.7411	3	0	0	Pass
5.7922	3	0	0	Pass
5.8433	3	0	0	Pass
5.8944	3	0	0	Pass
5.9455	3	0	0	Pass
5.9966	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

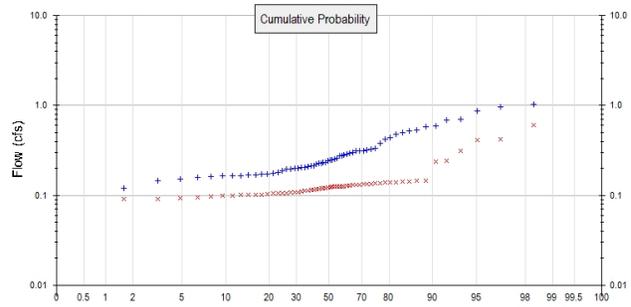
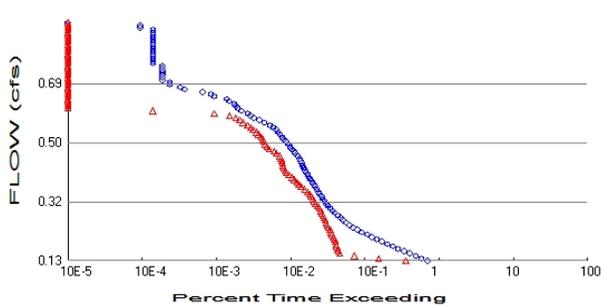
Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault-N POC	<input type="checkbox"/>	2221.14			<input type="checkbox"/>	0.00			
Total Volume Infiltrated		2221.14	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2

Total Pervious Area: 7.06
 Total Impervious Area: 0

Mitigated Landuse Totals for POC #2

Total Pervious Area: 2.829
 Total Impervious Area: 4.831

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	Flow(cfs)
2 year	0.26098
5 year	0.417348
10 year	0.541773
25 year	0.72421
50 year	0.879395
100 year	1.051932

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	Flow(cfs)
2 year	0.123807
5 year	0.173729
10 year	0.213634
25 year	0.272666
50 year	0.323468
100 year	0.380633

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	Predeveloped	Mitigated
1949	0.290	0.109
1950	0.295	0.126
1951	0.250	0.105
1952	0.203	0.099
1953	0.165	0.097
1954	1.032	0.118
1955	0.313	0.147
1956	0.273	0.147
1957	0.379	0.134
1958	0.330	0.114
1959	0.257	0.120

1960	0.249	0.124
1961	0.518	0.138
1962	0.251	0.102
1963	0.423	0.109
1964	0.333	0.090
1965	0.206	0.125
1966	0.121	0.102
1967	0.245	0.106
1968	0.299	0.128
1969	0.966	0.113
1970	0.170	0.108
1971	0.321	0.237
1972	0.198	0.113
1973	0.195	0.126
1974	0.528	0.119
1975	0.202	0.096
1976	0.212	0.115
1977	0.153	0.102
1978	0.178	0.101
1979	0.591	0.107
1980	0.277	0.100
1981	0.174	0.101
1982	0.226	0.132
1983	0.479	0.108
1984	0.233	0.241
1985	0.311	0.141
1986	0.698	0.419
1987	0.316	0.312
1988	0.164	0.132
1989	0.210	0.094
1990	0.221	0.132
1991	0.228	0.124
1992	0.173	0.129
1993	0.166	0.091
1994	0.158	0.124
1995	0.231	0.141
1996	0.436	0.138
1997	0.866	0.608
1998	0.145	0.106
1999	0.189	0.125
2000	0.164	0.141
2001	0.057	0.081
2002	0.215	0.131
2003	0.169	0.117
2004	0.284	0.139
2005	0.197	0.120
2006	0.681	0.140
2007	0.503	0.130
2008	0.584	0.410
2009	0.178	0.123

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	1.0324	0.6081
2	0.9661	0.4190
3	0.8659	0.4098
4	0.6983	0.3117

5	0.6812	0.2408
6	0.5913	0.2373
7	0.5842	0.1470
8	0.5280	0.1468
9	0.5177	0.1411
10	0.5032	0.1409
11	0.4794	0.1407
12	0.4365	0.1396
13	0.4225	0.1386
14	0.3789	0.1378
15	0.3330	0.1376
16	0.3296	0.1344
17	0.3213	0.1325
18	0.3158	0.1323
19	0.3127	0.1318
20	0.3109	0.1306
21	0.2985	0.1304
22	0.2949	0.1287
23	0.2904	0.1279
24	0.2836	0.1257
25	0.2769	0.1255
26	0.2734	0.1254
27	0.2574	0.1251
28	0.2505	0.1243
29	0.2496	0.1243
30	0.2494	0.1238
31	0.2448	0.1226
32	0.2329	0.1198
33	0.2315	0.1198
34	0.2276	0.1194
35	0.2259	0.1182
36	0.2210	0.1174
37	0.2152	0.1148
38	0.2121	0.1140
39	0.2102	0.1132
40	0.2059	0.1126
41	0.2030	0.1092
42	0.2019	0.1088
43	0.1983	0.1080
44	0.1975	0.1080
45	0.1954	0.1067
46	0.1888	0.1062
47	0.1784	0.1062
48	0.1779	0.1054
49	0.1742	0.1025
50	0.1735	0.1019
51	0.1704	0.1017
52	0.1687	0.1010
53	0.1660	0.1010
54	0.1647	0.1002
55	0.1642	0.0994
56	0.1635	0.0972
57	0.1579	0.0959
58	0.1530	0.0937
59	0.1446	0.0906
60	0.1208	0.0904
61	0.0569	0.0807

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1305	14940	7548	50	Pass
0.1381	12365	3292	26	Pass
0.1456	10359	1544	14	Pass
0.1532	8583	978	11	Pass
0.1607	7270	932	12	Pass
0.1683	5987	909	15	Pass
0.1759	5101	890	17	Pass
0.1834	4297	870	20	Pass
0.1910	3589	852	23	Pass
0.1986	3104	832	26	Pass
0.2061	2637	805	30	Pass
0.2137	2282	779	34	Pass
0.2213	1931	754	39	Pass
0.2288	1671	724	43	Pass
0.2364	1473	684	46	Pass
0.2440	1324	660	49	Pass
0.2515	1183	639	54	Pass
0.2591	1077	621	57	Pass
0.2667	1004	603	60	Pass
0.2742	921	582	63	Pass
0.2818	847	565	66	Pass
0.2893	783	540	68	Pass
0.2969	723	521	72	Pass
0.3045	674	493	73	Pass
0.3120	635	458	72	Pass
0.3196	612	442	72	Pass
0.3272	583	423	72	Pass
0.3347	553	405	73	Pass
0.3423	519	385	74	Pass
0.3499	500	361	72	Pass
0.3574	481	332	69	Pass
0.3650	457	295	64	Pass
0.3726	437	276	63	Pass
0.3801	416	259	62	Pass
0.3877	397	240	60	Pass
0.3953	382	224	58	Pass
0.4028	364	203	55	Pass
0.4104	348	186	53	Pass
0.4179	337	179	53	Pass
0.4255	324	172	53	Pass
0.4331	312	168	53	Pass
0.4406	299	166	55	Pass
0.4482	288	163	56	Pass
0.4558	278	159	57	Pass
0.4633	265	154	58	Pass
0.4709	246	137	55	Pass
0.4785	236	128	54	Pass
0.4860	221	110	49	Pass
0.4936	210	102	48	Pass
0.5012	197	98	49	Pass
0.5087	187	93	49	Pass
0.5163	174	90	51	Pass
0.5239	164	86	52	Pass

0.5314	153	79	51	Pass
0.5390	146	74	50	Pass
0.5465	135	67	49	Pass
0.5541	125	62	49	Pass
0.5617	112	56	50	Pass
0.5692	94	49	52	Pass
0.5768	80	44	55	Pass
0.5844	68	39	57	Pass
0.5919	62	32	51	Pass
0.5995	56	20	35	Pass
0.6071	46	3	6	Pass
0.6146	41	0	0	Pass
0.6222	39	0	0	Pass
0.6298	37	0	0	Pass
0.6373	32	0	0	Pass
0.6449	30	0	0	Pass
0.6525	20	0	0	Pass
0.6600	18	0	0	Pass
0.6676	14	0	0	Pass
0.6751	8	0	0	Pass
0.6827	7	0	0	Pass
0.6903	5	0	0	Pass
0.6978	5	0	0	Pass
0.7054	4	0	0	Pass
0.7130	4	0	0	Pass
0.7205	4	0	0	Pass
0.7281	4	0	0	Pass
0.7357	4	0	0	Pass
0.7432	4	0	0	Pass
0.7508	4	0	0	Pass
0.7584	3	0	0	Pass
0.7659	3	0	0	Pass
0.7735	3	0	0	Pass
0.7811	3	0	0	Pass
0.7886	3	0	0	Pass
0.7962	3	0	0	Pass
0.8037	3	0	0	Pass
0.8113	3	0	0	Pass
0.8189	3	0	0	Pass
0.8264	3	0	0	Pass
0.8340	3	0	0	Pass
0.8416	3	0	0	Pass
0.8491	3	0	0	Pass
0.8567	3	0	0	Pass
0.8643	3	0	0	Pass
0.8718	2	0	0	Pass
0.8794	2	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault-S POC	<input type="checkbox"/>	1059.18			<input type="checkbox"/>	0.00			
Total Volume Infiltrated		1059.18	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

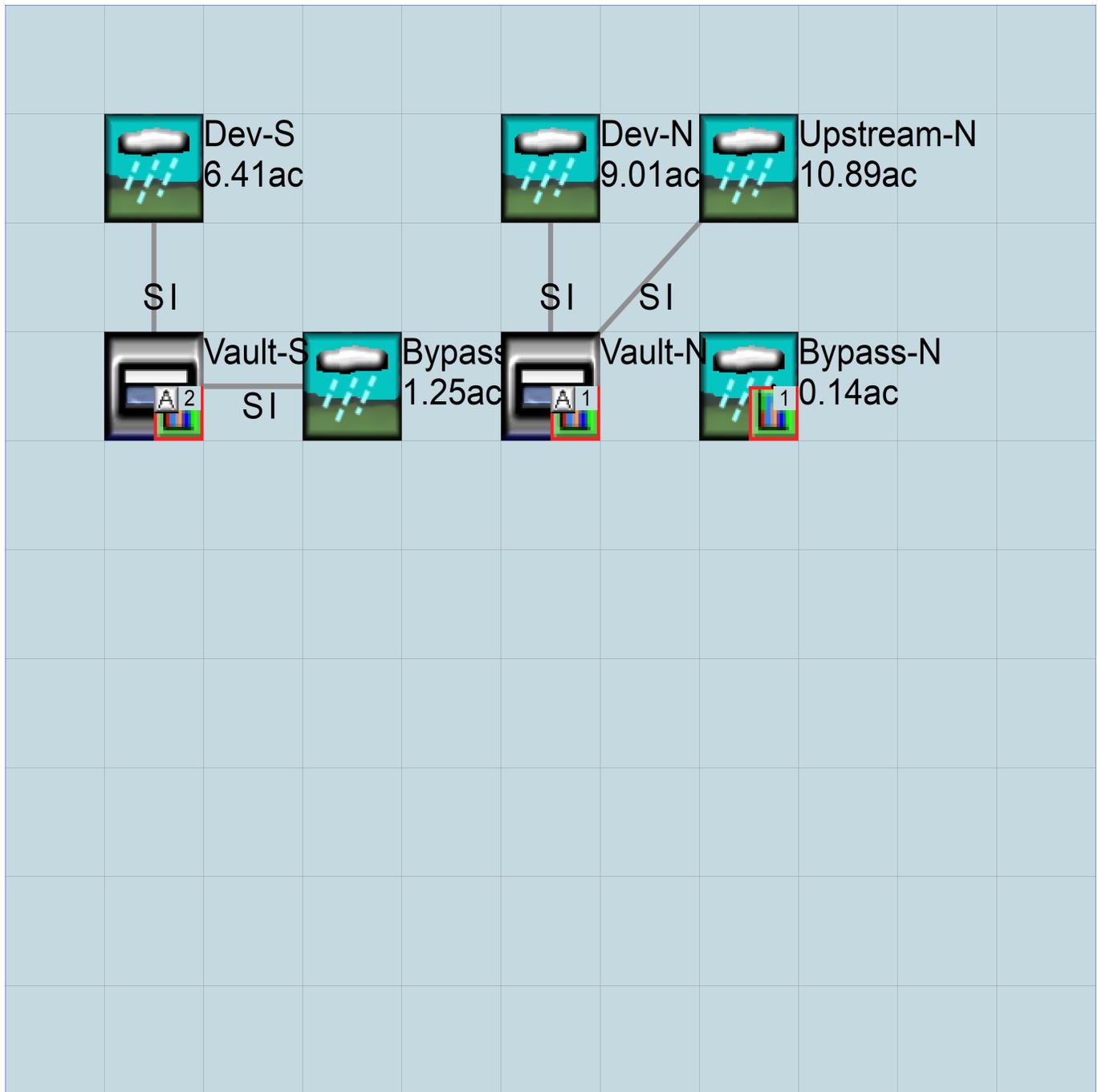
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

RUN

GLOBAL

WVHM4 model simulation
START 1948 10 01 END 2009 09 30
RUN INTERP OUTPUT LEVEL 3 0
RESUME 0 RUN 1 UNIT SYSTEM 1
END GLOBAL

FILES

```
<File> <Un#> <-----File Name----->***  
<-ID-> ***  
WDM 26 Garibaldi_Combined_210303.wdm  
MESSU 25 PreGaribaldi_Combined_210303.MES  
27 PreGaribaldi_Combined_210303.L61  
28 PreGaribaldi_Combined_210303.L62  
31 POCGaribaldi_Combined_2103032.dat  
30 POCGaribaldi_Combined_2103031.dat
```

END FILES

OPN SEQUENCE

INGRP INDELT 00:15
PERLND 11
PERLND 14
IMPLND 2
COPY 502
COPY 501
DISPLY 2
DISPLY 1

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INFO1

#	-	#	<-----Title----->	***TRAN	PIVL	DIG1	FIL1	PYR	DIG2	FIL2	YRND
2			Predev-S	MAX				1	2	31	9
1			Predev-N	MAX				1	2	30	9

END DISPLY-INFO1

END DISPLY

COPY

TIMESERIES

#	-	#	NPT	NMN	***
1			1	1	
502			1	1	
501			1	1	

END TIMESERIES

END COPY

GENER

OPCODE

OPCD ***

END OPCODE

PARM

K ***

END PARM

END GENER

PERLND

GEN-INFO

<PLS >	<-----Name----->	NBLKS	Unit-systems	Printer	***	
#	-	#	User	t-series	Engl Metr	***
			in	out		***

11	C, Forest, Mod	1	1	1	1	27	0
14	C, Pasture, Mod	1	1	1	1	27	0

END GEN-INFO

*** Section PWATER***

ACTIVITY

<PLS >	***** Active Sections *****														
#	-	#	ATMP	SNOW	PWAT	SED	PST	PWG	PQAL	MSTL	PEST	NITR	PHOS	TRAC	***
11			0	0	1	0	0	0	0	0	0	0	0	0	

14 0 0 1 0 0 0 0 0 0 0 0 0 0
END ACTIVITY

PRINT-INFO

<PLS > ***** Print-flags ***** PIVL PYR
- # ATMP SNOW PWAT SED PST PWG PQAL MSTL PEST NITR PHOS TRAC *****
11 0 0 4 0 0 0 0 0 0 0 0 0 1 9
14 0 0 4 0 0 0 0 0 0 0 0 0 1 9
END PRINT-INFO

PWAT-PARM1

<PLS > PWATER variable monthly parameter value flags ***
- # CSNO RTOP UZFG VCS VUZ VMN VIFW VIRC VLE INFC HWT ***
11 0 0 0 0 0 0 0 0 0 0 0
14 0 0 0 0 0 0 0 0 0 0 0
END PWAT-PARM1

PWAT-PARM2

<PLS > PWATER input info: Part 2 ***
- # ***FOREST LZSN INFILT LSUR SLSUR KVARY AGWRC
11 0 4.5 0.08 400 0.1 0.5 0.996
14 0 4.5 0.06 400 0.1 0.5 0.996
END PWAT-PARM2

PWAT-PARM3

<PLS > PWATER input info: Part 3 ***
- # ***PETMAX PETMIN INFEXP INFILD DEEPFR BASETP AGWETP
11 0 0 2 2 0 0 0
14 0 0 2 2 0 0 0
END PWAT-PARM3

PWAT-PARM4

<PLS > PWATER input info: Part 4 ***
- # CEPSC UZSN NSUR INTFW IRC LZETP ***
11 0.2 0.5 0.35 6 0.5 0.7
14 0.15 0.4 0.3 6 0.5 0.4
END PWAT-PARM4

PWAT-STATE1

<PLS > *** Initial conditions at start of simulation
ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
- # *** CEPS SURS UZS IFWS LZS AGWS GWVS
11 0 0 0 0 2.5 1 0
14 0 0 0 0 2.5 1 0
END PWAT-STATE1

END PERLND

IMPLND

GEN-INFO

<PLS ><-----Name-----> Unit-systems Printer ***
- # User t-series Engl Metr ***
in out ***
2 ROADS/MOD 1 1 1 27 0
END GEN-INFO
*** Section IWATER***

ACTIVITY

<PLS > ***** Active Sections *****
- # ATMP SNOW IWAT SLD IWG IQAL ***
2 0 0 1 0 0 0
END ACTIVITY

PRINT-INFO

<ILS > ***** Print-flags ***** PIVL PYR
- # ATMP SNOW IWAT SLD IWG IQAL *****
2 0 0 4 0 0 0 1 9
END PRINT-INFO

IWAT-PARM1

<PLS > IWATER variable monthly parameter value flags ***

```
# - # CSNO RTOP VRS VNN RTLI ***
2 0 0 0 0 0
END IWAT-PARM1
```

```
IWAT-PARM2
<PLS > IWATER input info: Part 2 ***
# - # *** LSUR SLSUR NSUR RETSC
2 400 0.05 0.1 0.08
END IWAT-PARM2
```

```
IWAT-PARM3
<PLS > IWATER input info: Part 3 ***
# - # ***PETMAX PETMIN
2 0 0
END IWAT-PARM3
```

```
IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
# - # *** RETS SURS
2 0 0
END IWAT-STATE1
```

END IMPLND

```
SCHEMATIC
<-Source-> <--Area--> <-Target-> MBLK ***
<Name> # <-factor-> <Name> # Tbl# ***
Predev-S***
PERLND 11 7.06 COPY 502 12
PERLND 11 7.06 COPY 502 13
Predev-N***
PERLND 11 9.781 COPY 501 12
PERLND 11 9.781 COPY 501 13
Predev-Upstream***
PERLND 14 9 COPY 501 12
PERLND 14 9 COPY 501 13
IMPLND 2 1.89 COPY 501 15
```

```
*****Routing*****
END SCHEMATIC
```

```
NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # #<-factor->strg <Name> # # <Name> # # ***
COPY 502 OUTPUT MEAN 1 1 48.4 DISPLY 2 INPUT TIMSER 1
COPY 501 OUTPUT MEAN 1 1 48.4 DISPLY 1 INPUT TIMSER 1
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # #<-factor->strg <Name> # # <Name> # # ***
END NETWORK
```

```
RCHRES
GEN-INFO
RCHRES Name Nexits Unit Systems Printer ***
# - #<-----><----> User T-series Engl Metr LKFG ***
in out ***
END GEN-INFO
*** Section RCHRES***
```

```
ACTIVITY
<PLS > ***** Active Sections *****
# - # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
END ACTIVITY
```

```
PRINT-INFO
<PLS > ***** Print-flags ***** PIVL PYR
# - # HYDR ADCA CONS HEAT SED GQL OXRX NUTR PLNK PHCB PIVL PYR *****
END PRINT-INFO
```


Mitigated UCI File

Predeveloped HSPF Message File

Mitigated HSPF Message File

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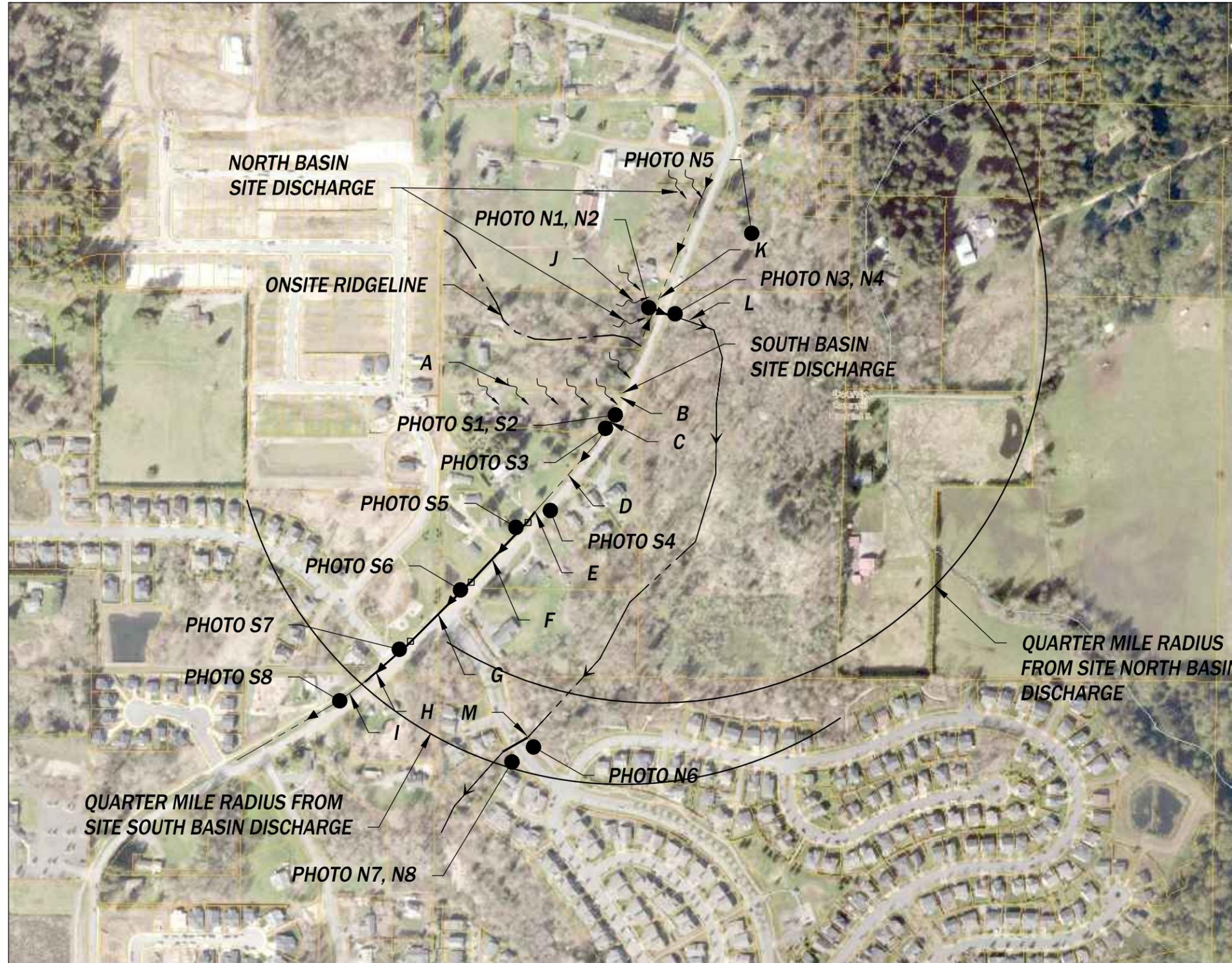
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APPENDIX C

CONVEYANCE CALCULATIONS
(TO BE PROVIDED WITH FINAL ENGINEERING)

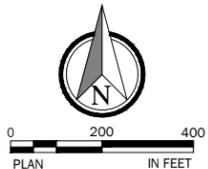
APPENDIX D

DOWNSTREAM ANALYSIS



P:\projects\00541802\00541802\Reports\TRV181205\CAD\Appendix D_Downstream Analysis Map.dwg
 3/4/2021 12:57 PM CASEY TORRES

C|P|H
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 Landscape Architecture • Land Use Consulting
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 Wenatchee, WA 98801 • (509) 293-7331
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NOTE:
 1. THE AERIAL MAP AND PIPE SYSTEM INFORMATION SHOWN ON THIS MAP IS FROM THE PUBLIC WEB PORTAL FOR INTERACTIVE MAPPING PROVIDED BY SNOHOMISH COUNTY. IT IS INTENDED FOR A VISUAL OF THE OFFSITE ANALYSIS PURPOSES ONLY AND DOES NOT REFLECT SURVEY ACCURACY FOR ANY OTHER PURPOSE.

- DOWNSTREAM PIPE
- DOWNSTREAM CB
- DOWNSTREAM DITCH
- STREAM/WETLAND
- SHEET FLOW

DOWNSTREAM ANALYSIS MAP



Photo N1, left: Looking north, sheet flow from site's north basin flows easterly to ditch along west frontage of Chain Lake Road right-of-way and converges to a single natural discharge point as shown in photo.

Photo N2, below: Looking southerly, a close-up photo of a 12" PVC pipe culvert in great condition conveys runoff 44 LF southeasterly where runoff daylights into vegetated stream.





Photo N3, above: Runoff is conveyed through 12" PVC pipe in great condition and extends 4.7' from grade to wetland area where runoff daylights and discharges to open channel flow. Photo taken approximately 90 feet downstream.

Photo N4, right: Runoff is conveyed along an open channel at this location within a wetland area and continues downstream in densely-vegetated conditions. The downstream path could not be followed further due to private property restrictions and impenetrable vegetation. However, from the topography of the area it is believed that the runoff continues southeast as open channel flow and stream-like conveyance beyond the quarter (0.25) mile downstream threshold.





Photo N5, above: Photo taken approx. 230 LF outside the downstream path of conveyance. Runoff continues downstream within the densely-vegetated wetland area and likely turns southerly.

Photo N6, below: Photo taken past the quarter (0.25) mile threshold at approximately 1,700 feet downstream, runoff reaches a culvert downstream in densely-vegetated wetland area and enters a likely functional culvert with no visible potential problems.





Photo N7, left: Runoff is conveyed through culvert not visible from level 1 downstream analysis and no potential problems are visible. This photo was taken beyond the quarter (0.25) mile downstream threshold.

Photo N8, right: Photo taken approximately 1,750 feet downstream, runoff daylight at end of existing culvert with no visible existing problems nor potential problems evident and continues downstream beyond the quarter (0.25) mile downstream threshold where a series of wetland areas and culverts convey surface water to the Skykomish river as part of the Snohomish river watershed.





Photo S1, above: Looking north at the southeast corner of the site, runoff sheet flows southerly from on-site topographic ridge and easterly to vegetated ditch along Chain Lake Road right-of-way. The site is developed and comprised of pasture, single family homes, and outlying structures.



Photo S2, right: Looking southerly, runoff continues downstream in right-of-way ditch and enters 12" concrete culvert 64 feet from site.



Photo S3, left: Looking north, ditch continues southerly and flow through 12” concrete culvert shown in Photo #2 and daylight 22 LF south, 82 feet from site.



Photo S4, left: Looking south, a buried culvert of unidentified material conveys runoff in ditch under second driveway. Photo taken approximately 532 feet downstream.

Photo S5, right: Looking north, 12" PVC pipe ends at open grate catch basin approximately 554 feet downstream, which conveys runoff in ditch under second driveway.



Photo S6, left: Looking north, 12" PVC pipe ends at open grate catch basin approximately 823 feet downstream, which conveys runoff in existing storm drainage infrastructure.



Photo S7, left: Looking north, 12” PVC pipe ends at open grate catch basin approximately 1,152 feet downstream, which conveys runoff in existing storm drainage infrastructure.

Photo 8, right: Looking north, 12” PVC pipe daylights approximately 1344 feet downstream, beyond the 1,320 feet (1/4 mile) threshold, which ends the South Basin downstream analysis. Runoff continues downstream in ditch to Woods Creek, to the Skykomish River as part of the Snohomish River watershed.



APPENDIX E

OPERATIONS AND MAINTENANCE MANUAL

V-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 V-4.5.2(1) Maintenance Standards - 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	Any evidence of oil,	No contaminants or pol-

**Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems
(Tanks/Vaults) (continued)**

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	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 (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(5) Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	<p>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%.</p> <p>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.</p> <p>Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.</p> <p>Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).</p>	<p>No Trash or debris located immediately in front of catch basin or on grate opening.</p> <p>No trash or debris in the catch basin.</p> <p>Inlet and outlet pipes free of trash or debris.</p> <p>No dead animals or vegetation present within the catch basin.</p>
	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 is sit-

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
		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	ting 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. 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.	Basin replaced or repaired to design standards. Pipe is regouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
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	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into	Mechanism opens with

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Working	frame have less than 1/2 inch of thread.	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.

Table V-4.5.2(6) Maintenance Standards - 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 are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks) (continued)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Bars.	Bars are missing or entire barrier missing. Bars are loose and rust is causing 50% deterioration to any part of barrier.	inch. Bars in place according to design. Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-4.5.2(7) Maintenance Standards - 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.

**Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters
(continued)**

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	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).

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

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