

SITE2022-01  
#8571

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CITY OF MONROE

# Riverside Station Apartments

## Drainage Report

### **Applicant**

Riverside Station LLC  
397 North Madison Street  
Monroe, WA 98272  
(425) 327-5928  
[support@emandatarecovery.com](mailto:support@emandatarecovery.com)  
Contact: Mr. Emanuel Popa

### **Engineer**

Valor Civil Engineering, PLLC  
1009 North 9<sup>th</sup> Street  
Tacoma, WA 98403  
(253) 861-7741  
[valorcivilengineering@hotmail.com](mailto:valorcivilengineering@hotmail.com)  
Contact: Frank Marescalco, PE

### **Contractor**

Not yet selected

20 July 2022. No corrections or revisions requested, however see comment on page 9 of this PDF and sheet 7 of the preliminary site plan civils. There may be changes regarding overflow provisions. T. Gathmann

### **Project Engineer's Certification**

I hereby state that this drainage control plan for this project has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers.

This report has been prepared for review by the City of Monroe in accordance with the Department of Ecology's 2019 Stormwater Management Manual for Western Washington.



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## **Section 1: Proposed Project Overview**

This drainage report has been prepared as a component of a stormwater site plan submitted to support the application for permits to redevelop an existing site in Monroe into mixed use apartments. The project area consists of what is currently made up of two separate tax parcels. The address for the site is approximately 135 South Ann Street, Monroe, WA 98272. The parcel numbers corresponding to the current property are 27070600300900 and 27070600301000.

According to the City's records, the project area is zoned Downtown Commercial and it is part of the East Downtown Neighborhood Plan overlay area. The survey completed for the property indicates an overall property area of 0.78 acre. The project area also includes adjacent areas within public right-of-way in South Ann Street and Simons Road.

This project proposes to clear the site of existing buildings and improvements and construct a new building. The building will have ground-level commercial and storage space with some accessible living units. The upper levels will all be individual living units. Site improvements consist of surface parking and tenant amenities. The project will have pedestrian and vehicular connections to both adjacent rights-of-way. The project also improves Simons Road and South Ann Street.

### ***Project Thresholds***

The proposed project will create new and replaced hard surfaces on private property and within adjacent right-of-way. The entire project site area is within a single threshold discharge area. Table 1 shows a summary of project thresholds.

Based on the thresholds shown in Table 1, it appears that a full stormwater site plan is required.

### ***Minimum Requirements***

The existing property is developed with over 35 percent hard surface coverage. Therefore, the proposed project is classified as redevelopment and the determination of applicability of minimum requirements will be made using Figure I-3.2 of the Manual (See Figure A-1). According to Figure I-3.2, all minimum requirements apply to the new and replaced hard surfaces and the converted vegetation areas. The project has no converted vegetation areas.

The following narrative demonstrates how the project complies with each of the applicable minimum requirements.

#### ***Minimum Requirement #1 – Preparation of Stormwater Site Plan***

This document and its accompanying attachments satisfy this requirement.

**Table 1: Project Threshold Summary**

Description	Area (ft <sup>2</sup> )		
	On-Site	ROW	Total
<i>Existing</i>			
Non-Pollution-Generating Hard Surface	5,141	161	5,302
Pollution-Generating Hard Surface	7,815	5,325	13,140
Lawn and Landscape	21,086	3,417	24,503
Vegetated Area (Cleared and forested)	0	0	0
Total Project/Lot Area	34,042	8,903	42,945
<i>Developed</i>			
New Hard Surface	1,261	879	2,140
New PGHS <sup>1</sup>	6,402	0	6,402
Replaced Hard Surface	12,956	5,486	18,442
Replaced PGHS	7,815	4,107	11,922
New + Replaced Hard Surface	26,095	6,365	32,460
New + Replaced PGHS	14,217	4,107	18,324
Existing Hard Surface Converted to Vegetation	0	0	0
Land Disturbed	34,042	8,903	42,945
New Lawn/Landscape	0 <sup>2</sup>	0 <sup>2</sup>	0 <sup>2</sup>
Native Vegetation to Pasture	0	0	0
Existing Hard Surface to Remain Unaltered	0	0	0

1. Pollution-generating hard surface
2. All existing pervious surfaces are already lawn/landscape. There is no native vegetation.

*Minimum Requirement #2 – Construction Stormwater Pollution Prevention*

The attached Construction Stormwater Pollution Prevention Plan document and the project plans satisfy this requirement.

*Minimum Requirement #3 – Source Control of Pollution*

The proposed project would generate potential stormwater pollutants typical of normal single-family residential land use. The commercial use component is not expected to have a significant impact on source control measures in use at the site. Nonetheless, there may be some source control BMPs of commercial nature that apply to the site. These include:

- BMP S411: Lawn/landscape vegetation management
- BMP S427: Storage of liquid, food waste, or dangerous waste containers

These source control BMPs are attached to the separate Operation and Maintenance Manual document.

*Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls*

The proposed project would not alter any existing drainage systems or flow paths. The prevailing topography of the property will not be changed.

### *Minimum Requirement #5 – On-Site Stormwater Management*

According to Figure I-3.3 of the Manual (see Figure A-2), this project is required to either use BMPs from List #2 or satisfy the Low-Impact Development (LID) Performance Standard. The project site soils support infiltration, so the project has chosen to use the LID Performance Standard. Calculations showing that the project meets the standard are included in Appendix D.

### *Minimum Requirement #6 – Runoff Treatment*

This project generates more than 5,000 square feet of new and replaced pollution-generating hard surfaces. Therefore, it is obligated to meet requirements for basic water quality. The project satisfies this requirement through the use of the following systems:

- Bioretention for on-site surfaces
- Proprietary filter catch basin for South Ann Street improvements
- Open-top infiltration trench with sand filter pre-treatment for Simons Road

The selection of basic water quality treatment devices for surfaces within the right-of-way was completed in close coordination with City of Monroe staff to ensure that the selected public facilities would be good candidates for long-term maintenance efforts on the City's part.

### *Minimum Requirement #7 – Flow Control*

The proposed project generates more than 5,000 square feet of new and replaced hard surfaces and therefore must examine the three thresholds which trigger flow control.

- **The project generates 10,000 square feet or more of effective hard surface**  
Because almost all of the project's hard surfaces are fully infiltrated, the project does not meet this threshold. Only about 438 square feet of replaced hard surface within the right-of-way is effective hard surface.
- **The project converts  $\frac{3}{4}$  of an acre or more of native vegetation to lawn/landscape, or the project converts 2.5 acres or more of native vegetation to pasture**  
Since the site has no native vegetation, pasture, or non-native vegetation, the project has no converted vegetation areas of any kind. Even if it did, all of the runoff from the project's soft surfaces is collected and infiltrated.
- **The project creates more than a 0.15 cubic feet per second (cfs) increase in the peak 100-year flow rate through a combination of pervious and impervious surfaces.**  
The site was modeled in its post-development condition for all target hard surfaces and their proposed mitigation. The change in the 100-year peak flow rate when compared to the project site existing condition was found to be a

reduction of approximately 0.304 cfs. Modeling is included in Appendix E to show how this result was calculated.

We wish to note specifically that the Manual allows the mitigated condition of the site to be compared to either the pre-project condition of the site or the condition of the site as it existed at the time that the local jurisdiction first adopted flow control requirements for the purposes of this calculation. Therefore, the reviewer will find the pre-development modeling condition to differ from the LID Analysis, which requires that the mitigated site be compared to forested conditions. Figure A-5 shows how these conditions were determined.

Based on the lengthy foregoing analysis, the project is not required to meet flow control standards. Since the pre-project site condition for flow control is outwash forest, the project does not meet flow control standards despite being fully infiltrated. This is because outwash forest has virtually no runoff which is a difficult standard to meet.

#### *Minimum Requirement #8 – Wetlands Protection*

The project is not known to discharge directly or indirectly to a wetland.

#### *Minimum Requirement #9 – Operation and Maintenance*

The separate, stand-alone Operation and Maintenance document satisfies this requirement.

### ***Proposed Stormwater Facilities and Best Management Practices***

The LID Performance Standard is met through the use of the following infiltration systems:

- On-site building roof is piped directly to an infiltration trench
- On-site surface drainage is directed to a bioretention cell which infiltrates the water quality event. Larger events are routed through the bioretention overflow to the on-site infiltration trench for larger events.
- South Ann Street runoff is directed to an infiltration trench preceded by basic water quality filter unit.
- Simons Road runoff is directed to an open-top infiltration trench with sand filter pre-treatment.

## **Section 2: Existing Conditions**

The property is currently developed with a single-family home and several outbuildings. The use of the property is not clear. It appears to have been in use most recently as some kind of storage yard for building materials. There are large canopies and paved areas on the property that serve as storage for what appears to be, for lack of a better term, junk.

The project area has direct access to South Ann Street, a paved City street. The north lot has frontage along Simons Road but there is no frequently used access to this street, although there are two driveways and a gate.

There do not appear to be any steep slopes, wetland areas, or other surface encumbrances on or near the site. Although we do not have access to records to confirm, we suspect that the site is located within an aquifer recharge area simply because it is located on well drained soils within a quarter-mile of Woods Creek and Skykomish River.

There are some existing large trees on the property, but nothing that could be construed as native vegetation for stormwater purposes. Land cover appears to be heavily impacted lawn/landscape where the site has not been paved over or built out.

Topography at the site is essentially flat. According to the survey, the site relief is less than two feet in any direction and the topography undulates between high and low areas without any apparent drainage. While there are some areas of known standing water in the right-of-way, there are not any areas of standing water at the site to our knowledge.

There are no obvious signs of historical flooding or erosion. According to maps obtained from the FEMA Flood Map Service Center, the project area is not located within an area of significant flooding concern. The Woods Creek floodplain is located somewhat near the site to the southeast, but the project site itself is buffered from this area by adjacent development. Approximate base flood elevation appears to be on the order of 10 to 15 feet lower than the site.

### **Section 3: Soils Investigation and Characteristics**

According to the USDA Natural Resources Conservation Service's Web Soil Survey, the soils in the project area are Sultan silt loam. The Washington Geologic Information Portal maps the area as continental glacial outwash gravels, which would not be consistent with silt loam.

On-site reconnaissance was performed by Quality Geo NW in February 2021. The study consisted of excavating three test pits across the property to a maximum depth of 12 feet and observing soils. The explorations confirmed that the soils are generally well drained outwash gravel. The geotechnical engineer noted that the southern part of the site appears to have been subjected to heavily compacted undocumented fill in the past, and those areas are not suitable for infiltration without further investigation and potential amendments.

Infiltration rates were calculated using the soil grain size analysis method since the soils are not considered to be glacially consolidated. In summary, shallow infiltration features can use a rate of 5 inches per hour and deeper facilities can use a rate of 10 inches per hour. A complete soils report is available in Appendix E.

### **Section 4: Wells and Septic Systems**

To the best of our knowledge, there are no wells or septic systems on the property. We are unaware of any wells in the immediate project vicinity.

## Section 5: Fuel Tanks

No fuel tanks are known to exist on the site and none are proposed for this project.

## Section 6: Subbasin Description

The subject property is located within a highland plains area that sits above a valley for Woods Creek to the southeast. The area is generally very flat. It is not clear whether the area's flatness is naturally occurring or a result of previous development efforts. The project is located within an older area of Monroe that could have been cleared and flattened as part of major construction efforts when it was first developed. The consistency of the soils found at depth suggests that the area is probably naturally fairly flat.

There is most likely no significant run-on anywhere to the property. It is possible that some areas immediately surrounding the property to the east and south could have small amounts of contributing surface area. These limited pervious areas are shown on Figure A-7 as contributing to the on-site bioretention feature. Runoff from the property, if any, would tend to gather in the local low point on the southeast side of the intersection of Simons Road and South Ann Street. This low point has standing water after significant storm events, but it is likely that the majority of the drainage is from the roads themselves.. The water infiltrates into the underlying soils following rain. There is no other obvious, well defined drainage path away from the site.

See Section 9 for a complete downstream analysis.

## Section 7: Floodplain Analysis

According to maps obtained from the FEMA Flood Map Service Center, the project area is not located within an area of significant flooding concern. A map from the FEMA service is included in Appendix A as Figure A-3. The map shows a 100-year floodplain to the southeast associated with Woods Creek.

## Section 8: Aesthetic Considerations for Facilities

No aesthetic themes beyond the typical and customary have been considered for this project.

## Section 9: Facility Sizing and Downstream Analysis

### *Facility Sizing*

There are several infiltration facilities in the project area. Each facility was designed using recommendations for infiltration rates from the geotechnical engineer. The systems were designed using continuous runoff simulation modeling. Sizing was done to achieve 100 percent infiltration of all runoff expected to reach the facilities. The connection between the trench in South Ann Street and the main drainage line in South Ann Street is for emergency overflows only and is expected to see flows only when the storm event exceeds the 100-year return interval.

See comment on civils. Might be best to deal with rare, major events in a different way.

## ***Equivalent Areas***

Due to the topography of the project area, some of the runoff from the project's actual impacts escape the proposed stormwater management facilities. These areas include small portions of South Ann Street pavement on the west side of the crown of the road and the receiving curb ramp on the northeast side of the corner of the intersection of Simons Road and South Ann Street. It would not be practical to capture and treat or infiltrate the runoff from these surfaces because it would require the construction of a totally new facilities outside of the project site area. The total area bypassed is about 438 square feet, which is a very small percentage of the project's total area. These areas are best shown in Figure A-6.

The surfaces in South Ann Street itself are considered pollution-generating and are subject to basic water quality mitigation. Technically these areas are not subject to flow control because the project itself is not subject to flow control, even after accounting for the hydrologic effect of their bypass. But it is not necessary to perform complicated modeling to show that the project still meets its obligation to mitigate impacts.

In the case of both water quality and flow control, the project's proposed facilities accept runoff from large existing areas of impervious surfaces that are beyond the project impacts. These areas are best seen on Figures A-6 and A-7. These "off-site" areas contribute drainage to the project's infiltration and treatment facilities because their runoff naturally enters the project area. These areas include the east half of South Ann Street north of the catch basin installed by River's Edge to the south, and the area of Simons Road that drains to the shoulder adjacent to the project site on the south side of the street.

By capturing these areas for treatment and flow control, the project actually manages more runoff than it is obligated to by code, even after accounting for the loss of the runoff from the bypassed surfaces. Figure A-6 shows how this area swap is applied to the flow control part of the code. Figure A-7 shows how the analysis applies to the water quality part of the code. In summary:

- The project bypasses a total of 438 square feet of hard surfaces subject to infiltration management, but it collects runoff from 4,488 square feet of existing off-site hard surfaces that it is not obligated to collect by code. Therefore, the project exceeds its flow control obligation by the difference, 4,050 square feet.
- The project bypasses a total of 383 square feet of pollution-generating hard surfaces subject to basic water quality requirements, but it collects and treats runoff from 3,099 square feet of off-site PGHS. Therefore, the project exceeds its water quality obligation by 2,716 square feet.

The modeling included in Appendix D is meant to show the project in its actual, built condition in which the project's facilities accept run-on from upstream/upslope property. The analysis shows that the facilities are sized properly to account for this additional load while still meeting the various performance requirements.

### ***Downstream Flow Path***

The downstream flow path for the site is not well defined because of the topography of the area and the well drained soils. Drainage from the site and surrounding areas tends to gather in low points and infiltrate following storms. The standing water is not present for long enough to motivate property owners in the area to do anything to improve drainage.

However, if the soils were totally impervious and the drainage were allowed to simply build up to the point where it finally reached a natural overflow location, this location would be to the south of the project site in South Ann Street. At some point, the water would reach the City's drainage system. Once within the drainage system, flows would be conveyed south by the main line directly to Woods Creek. Once within Woods Creek, the flows would travel south and west until reaching Skykomish River. The ¼ mile downstream point is within the Woods Creek drainage course, approximately 1/3 of the distance from the pipe outfall to the Skykomish River.

A map of the downstream flow path is included as Figure A-5.

### **Section 10: Utilities**

The property has access to public water, sewer, and drainage utilities within South Ann Street. There is also public water within Simons Road. Natural gas is located within South Ann Street. Overhead power is available from several locations around the site.

### **Section 11: Covenants, Dedications, and Easements**

The property owner will be responsible for the maintenance of on-site stormwater management facilities. A separate Operation and Maintenance document has been prepared and included with this submittal.

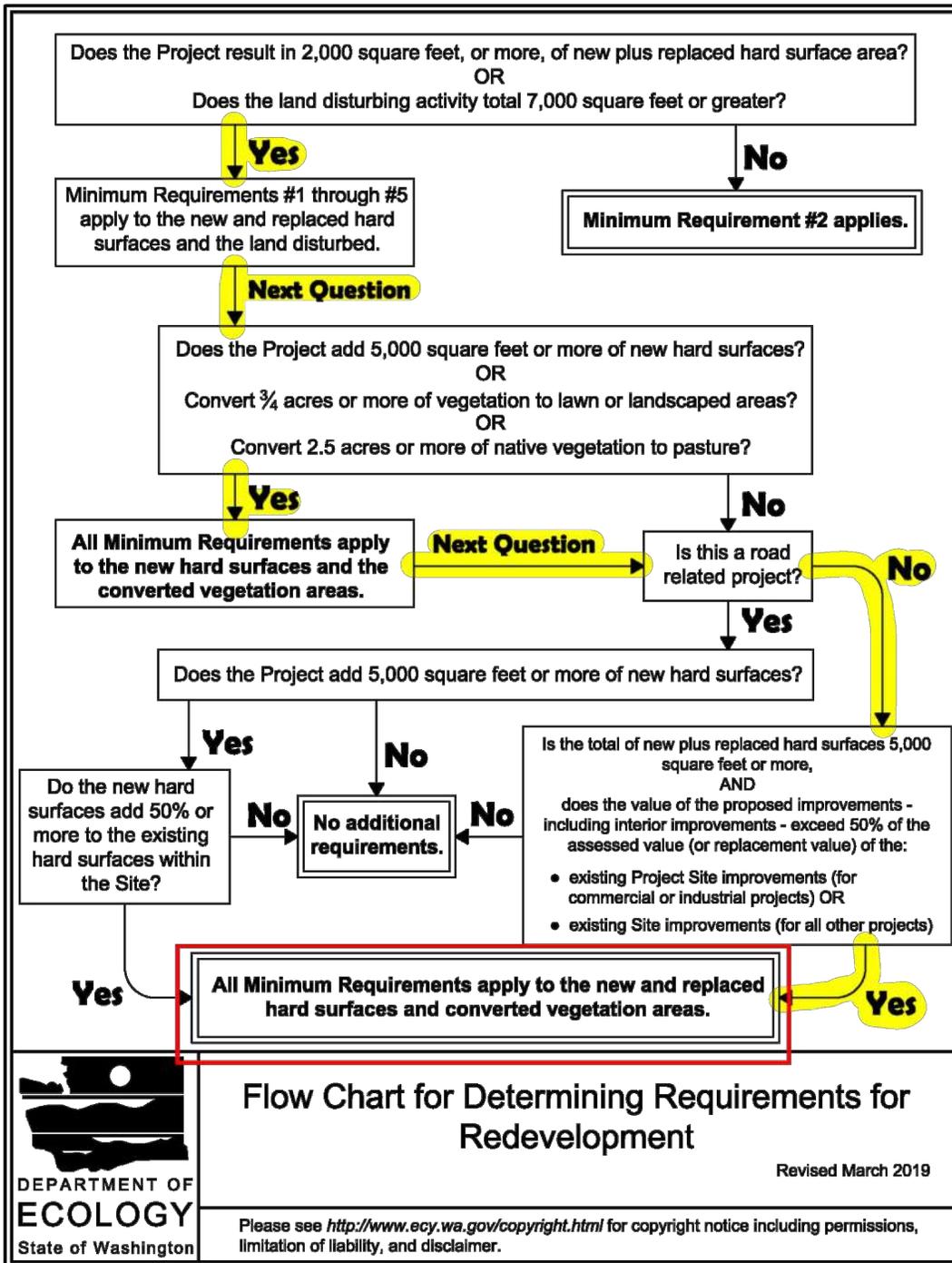
### **Section 12: Other Permits or Conditions Placed on Project**

No other permits or conditions are known to apply to this project.

# Appendix A: Figures and Maps

*Attached*

**Figure I-3.2: Flow Chart for Determining Requirements for Redevelopment**



RIVERSIDE STATION APARTMENTS  
 135 SOUTH ANN STREET  
 MONROE, WA 98272  
 TPNS 2707060030-0900/ -1000



**Valor Civil Engineering, PLLC**  
 Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

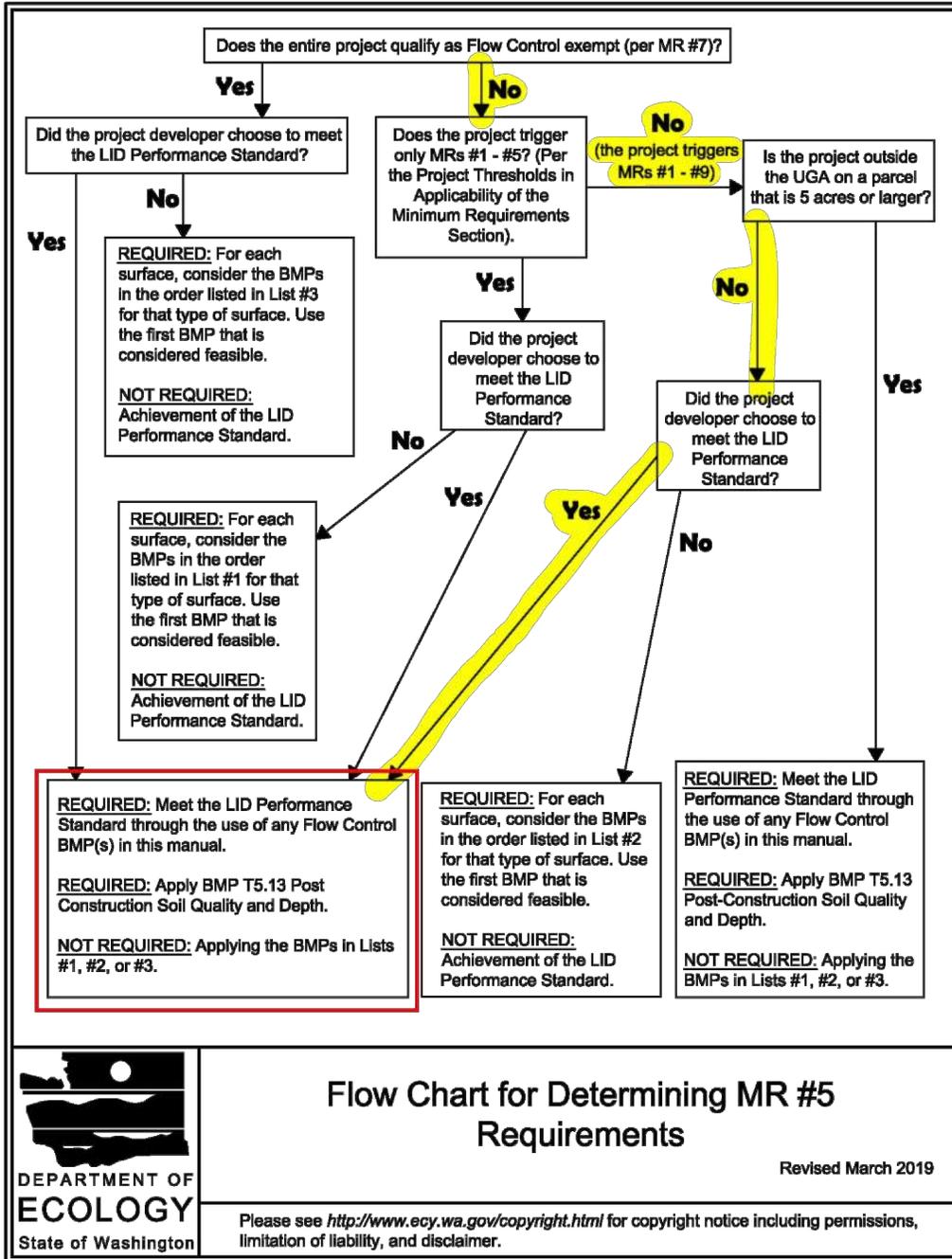
STORMWATER SITE PLAN  
 DETERMINATION OF MINIMUM  
 REQUIREMENTS

PROJECT NO: 2021-126      DATE: DECEMBER 22, 2021

FIGURE  
A-1

PAGE  
A-2

Figure I-3.3: Flow Chart for Determining MR #5 Requirements



RIVERSIDE STATION APARTMENTS  
 135 SOUTH ANN STREET  
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**Valor Civil Engineering, PLLC**  
 Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

STORMWATER SITE PLAN  
 MINIMUM REQUIREMENT #5

PROJECT NO: 2021-126      DATE: DECEMBER 22, 2021

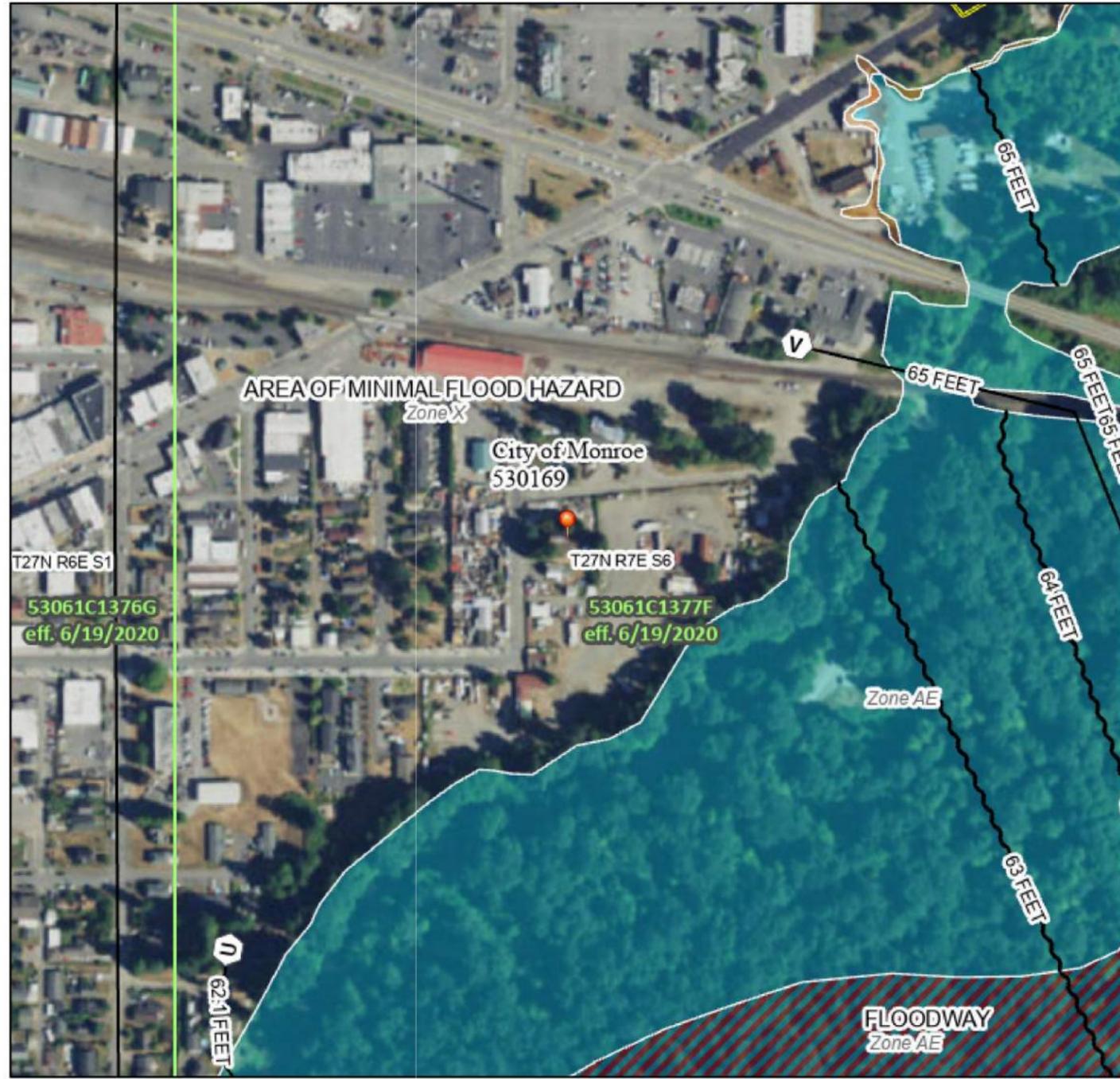
FIGURE  
A-2

PAGE  
A-3

# National Flood Hazard Layer FIRMette



121°58'13"W 47°51'33"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000  
 Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020  
 121°57'36"W 47°51'8"N

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

- |                                    |   |
|------------------------------------|---|
| <b>SPECIAL FLOOD HAZARD AREAS</b>  | <ul style="list-style-type: none"> <li>Without Base Flood Elevation (BFE)<br/>Zone A, V, A99</li> <li>With BFE or Depth Zone AE, AO, AH, VE, AR</li> <li>Regulatory Floodway</li> </ul>   |
| <b>OTHER AREAS OF FLOOD HAZARD</b> | <ul style="list-style-type: none"> <li>0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X</li> <li>Future Conditions 1% Annual Chance Flood Hazard Zone X</li> <li>Area with Reduced Flood Risk due to Levee. See Notes. Zone X</li> <li>Area with Flood Risk due to Levee Zone D</li> </ul> |
| <b>OTHER AREAS</b>                 | <ul style="list-style-type: none"> <li>NO SCREEN Area of Minimal Flood Hazard Zone X</li> <li>Effective LOMRs</li> <li>Area of Undetermined Flood Hazard Zone D</li> </ul>  |
| <b>GENERAL STRUCTURES</b>          | <ul style="list-style-type: none"> <li>Channel, Culvert, or Storm Sewer</li> <li>Levee, Dike, or Floodwall</li> </ul>   |
| <b>OTHER FEATURES</b>              | <ul style="list-style-type: none"> <li>20.2 Cross Sections with 1% Annual Chance Water Surface Elevation</li> <li>17.5 Coastal Transect</li> <li>Base Flood Elevation Line (BFE)</li> <li>Limit of Study</li> <li>Jurisdiction Boundary</li> <li>Coastal Transect Baseline</li> <li>Profile Baseline</li> <li>Hydrographic Feature</li> </ul>   |
| <b>MAP PANELS</b>                  | <ul style="list-style-type: none"> <li>Digital Data Available</li> <li>No Digital Data Available</li> <li>Unmapped</li> </ul> <p>The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.</p>   |

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/22/2021 at 4:04 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



Valor Civil Engineering, PLLC

Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

RIVERSIDE STATION APARTMENTS  
 135 SOUTH ANN STREET  
 MONROE, WA 98272  
 TPNS 2707060030-0900/ -1000

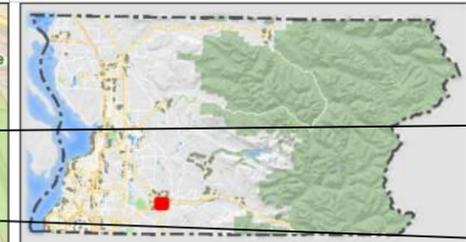
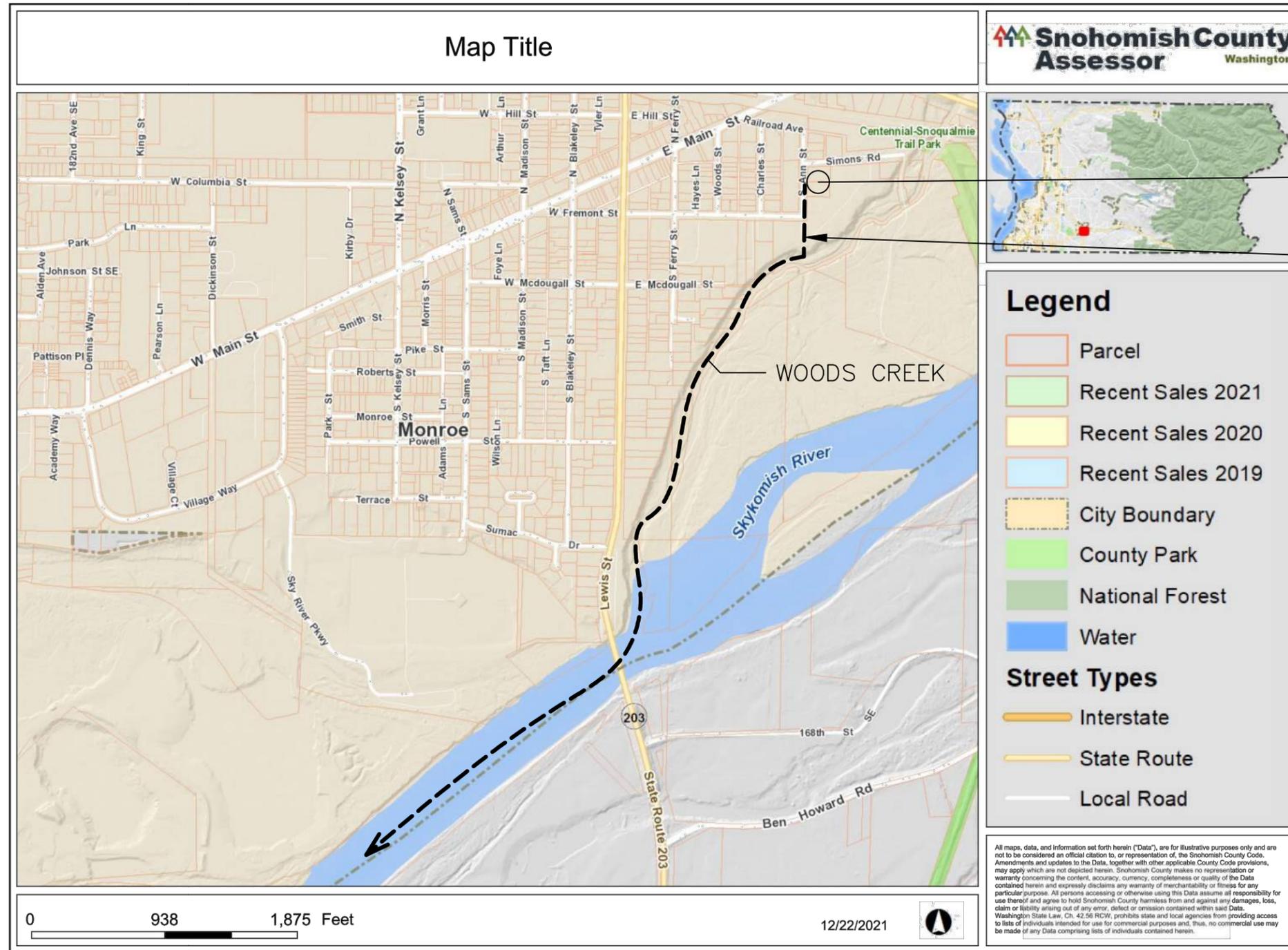
STORMWATER SITE PLAN  
 FEMA MAP

PROJECT NO: 2021-126

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FIGURE A-3

PAGE A-4



PROJECT SITE

DOWNSTREAM FLOW PATH

 **Valor Civil Engineering, PLLC**  
 Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

**RIVERSIDE STATION APARTMENTS**  
 135 SOUTH ANN STREET  
 MONROE, WA 98272  
 TPNS 2707060030-0900/ -1000

**STORMWATER SITE PLAN**  
**DOWNSTREAM FLOW PATH**

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FIGURE  
A-4

PAGE  
A-5

PRE-DEVELOPED BASIN SUMMARY		
LEGEND/COLOR	DESCRIPTION	AREA (FT <sup>2</sup> )
	ROOF AND SIDEWALK AREAS (NON-PGHS)	5,302
	POLLUTION-GENERATING HARD SURFACES	13,140
	LAWN AND LANDSCAPE AREAS	24,558
	TOTAL PROJECT SITE AREA	43,000

NOTE: THE ENTIRE PROJECT SITE AREA IS WITHIN A SINGLE THRESHOLD DISCHARGE AREA.




**Valor Civil Engineering, PLLC**  
 Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

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 135 SOUTH ANN STREET  
 MONROE, WA 98272  
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STORMWATER SITE PLAN  
 PRE-DEVELOPMENT CONDITIONS

PROJECT NO: 2021-126      DATE: DECEMBER 22, 2021

FIGURE A-5  
 PAGE A-6

DEVELOPED BASIN SUMMARY			
LEGEND/COLOR	DESCRIPTION	AREA (FT <sup>2</sup> )	MODELING NOTES
	SIDEWALKS AND NON-DRIVING SURFACES	3,917	THESE AREAS ARE TRIBUTARY TO EITHER THE ROAD INFILTRATION SYSTEM OR THE PRIVATE INFILTRATION SYSTEM.
	POLLUTION-GENERATING HARD SURFACES	18,324	
	BUILDING ROOF AREA	9,781	
	PROJECT SURFACES THAT BYPASS FLOW CONTROL	438	THESE AREAS BYPASS FLOW CONTROL BECAUSE OF TOPOGRAPHY, SEE EQUIVALENT AREAS NOTES BELOW AND FIG A-7
	OFF-SITE AREAS CAPTURED BY PROJECT FLOW CONTROL	4,488	THESE ARE EXISTING SURFACES BEYOND THE SCOPE OF THE PROJECT THAT ARE CAPTURED BY PROJECT FLOW CONTROL FACILITIES
	AMENDED SOILS (POLLUTION-GENERATING PERVIOUS SURFACES)	10,540	MODELED AS OUTWASH PASTURE. ALL OF THE PERVIOUS SURFACES FOR THE PROJECT ARE TRIBUTARY TO INFILTRATION FEATURES.
	TOTAL PROJECT SITE AREA	43,000	BASED ON ACTUAL PROJECT IMPACTS

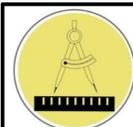
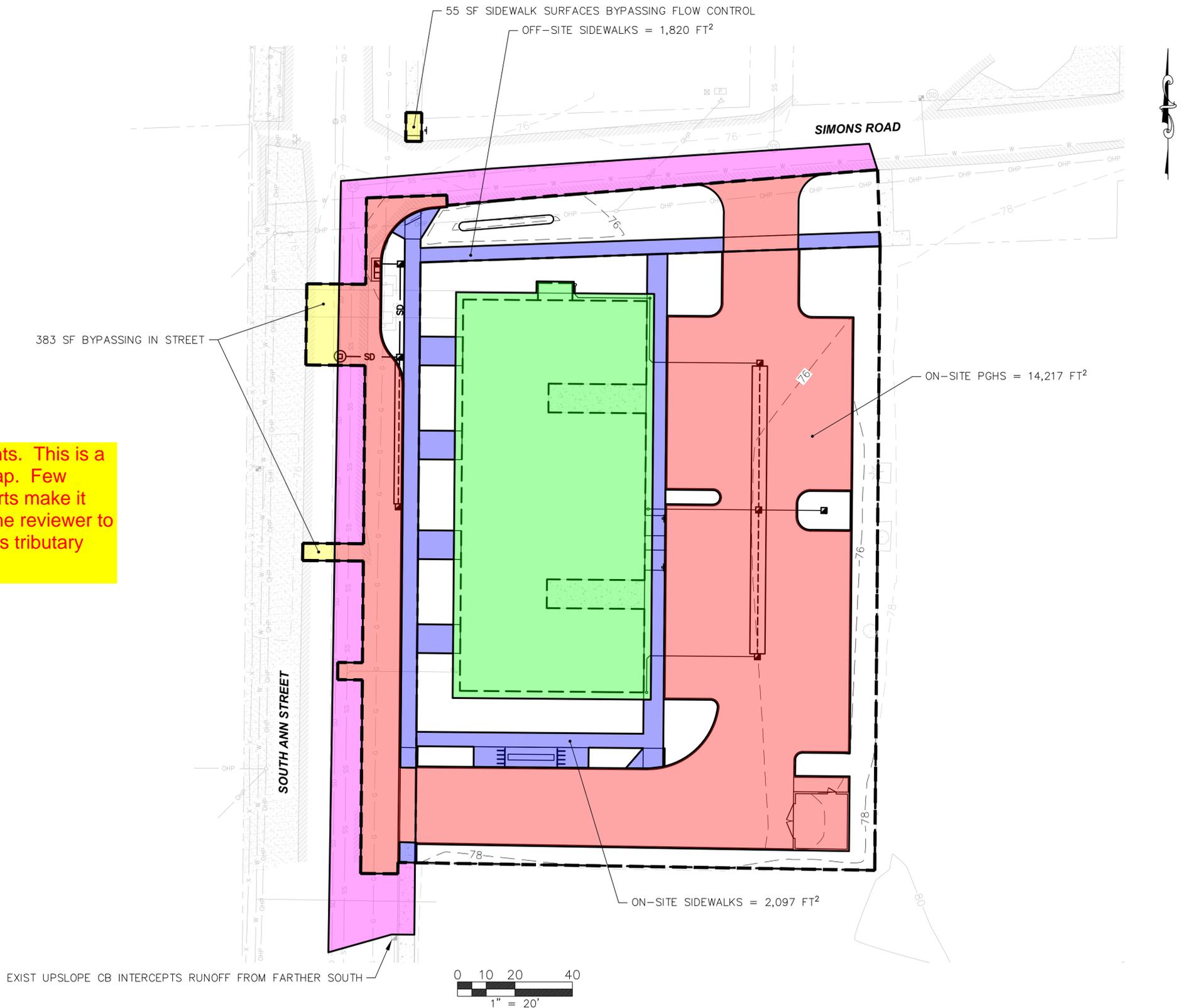
**NOTES**

1. THE ENTIRE PROJECT SITE AREA IS WITHIN A SINGLE THRESHOLD DISCHARGE AREA.
2. SOME OF THE PROJECT PERVIOUS SURFACES ARE TRIBUTARY TO INFILTRATION SYSTEMS. SEE FIGURE A-7.

**EQUIVALENT AREAS ANALYSIS**

1. TOTAL AREA OF HARD SURFACES THAT BYPASS FLOW CONTROL DUE TO TOPOGRAPHY  
438 FT<sup>2</sup>
  2. TOTAL AREA OF EXISTING HARD SURFACES THAT ARE MITIGATED BY PROJECT DUE TO TOPOGRAPHY  
4,488 FT<sup>2</sup>
- THEREFORE, THE PROJECT MITIGATES 4,050 FT<sup>2</sup> MORE THAN IT IS OBLIGATED TO MITIGATE BY CODE.

**My compliments. This is a very useful map. Few drainage reports make it this easy for the reviewer to see the various tributary areas.**



**Valor Civil Engineering, PLLC**

Phone: (253) 861-7741  
valorcivilengineering@hotmail.com

RIVERSIDE STATION APARTMENTS  
135 SOUTH ANN STREET  
MONROE, WA 98272  
TPNS 2707060030-0900/ -1000

STORMWATER SITE PLAN  
POST-DEVELOPMENT CONDITIONS

PROJECT NO: 2021-126

DATE: DECEMBER 22, 2021

FIGURE  
A-6

PAGE  
A-7

WATER QUALITY BASIN LEGENED		
LEGEND/COLOR	DESCRIPTION	NOTES
	HARD SURFACES THAT ARE BEYOND THE PROJECT BOUNDARIES BUT TRIBUTARY TO THE TREATMENT AND INFILTRATION SYSTEMS	
	HARD SURFACES WHICH ARE WITHIN THE PROJECT BOUNDARIES AND TRIBUTARY TO THE TREATMENT AND INFILTRATION SYSTEMS	
	POLLUTION-GENERATING HARD SURFACES WHICH ARE PART OF THE PROJECT AREA BUT BYPASS WATER QUALITY DEVICES DUE TO TOPOGRAPHY	SEE EQUIVALENT AREAS ANALYSIS BELOW
	AMENDED SOILS TRIBUTARY TO THE TREATMENT AND INFILTRATION SYSTEMS	MODELED AS OUTWASH PASTURE
	WATER QUALITY BASIN OUTLINE	

**MODELING RESULTS**

- ON-LINE WATER QUALITY FLOW RATE FOR CONTECH SYSTEM IN SOUTH ANN STREET  
 0.034 CFS = 15.2 GPM  
 REQUIRED NUMBER OF CARTRIDGES:  
 15.2 GPM/7.5 GPM/CARTRIDGE = 2.03 CARTRIDGES -> USE 2 CARTRIDGES
- TOTAL PERCENTAGE OF INFLUENT RUNOFF INFILTRATED BY BIORETENTION: 92.70  
 NOTE: OVERFLOW IS TRIBUTARY TO ON-SITE INFILTRATION TRENCH.
- TOTAL PERCENTAGE OF INFLUENT RUNOFF INFILTRATED IN SIMONS ROAD: 100

**EQUIVALENT AREAS ANALYSIS**

- TOTAL AREA OF PROJECT POLLUTION-GENERATING HARD SURFACES THAT BYPASS WATER QUALITY DEVICES DUE TO TOPOGRAPHY  
 383 FT<sup>2</sup>
- TOTAL AREA OF EXISTING OFF-SITE POLLUTION-GENERATING HARD SURFACES THAT ARE MITIGATED BY PROJECT DUE TO TOPOGRAPHY  
 3,099 FT<sup>2</sup>  
 THEREFORE, THE PROJECT MITIGATES 2,716 FT<sup>2</sup> MORE THAN IT IS OBLIGATED TO MITIGATE BY CODE.

RECEIVING CURB RAMP IS NOT PART OF WATER QUALITY ANALYSIS BECAUSE IT IS NOT POLLUTION-GENERATING HARD SURFACE AND IT IS NOT TRIBUTARY TO A WATER QUALITY SYSTEM

SIMONS ROAD OPEN-TOP TRENCH W/ SAND FILTER 30'L x 3'W x 2'D

SIMONS ROAD TRENCH BASIN  
 TOTAL AREA = 5,656 FT<sup>2</sup>  
 IMPERVIOUS = 1,353 FT<sup>2</sup>  
 AMENDED SOILS = 4,303 FT<sup>2</sup>

STORMFILTER CATCH BASIN 2 CARTRIDGES

TOTAL AREA OF PROJECT PGHS BYPASSING WATER QUALITY DEVICES = 383 FT<sup>2</sup>

EMERGENCY OVERFLOW FOR SOUTH ANN STREET INFILTRATION SYSTEM

SOUTH ANN STREET BASIN  
 TOTAL AREA = 10,384 FT<sup>2</sup>  
 TOTAL HARD SURFACES WITHIN PROJECT BOUNDARIES = 5,224 FT<sup>2</sup>  
 TOTAL OFF-SITE HARD SURFACES TRIBUTARY TO BASIN = 3,099 FT<sup>2</sup>  
 AMENDED SOILS = 2,061 FT<sup>2</sup>

SOUTH ANN STREET TRENCH 50'L x 3'W x 3'D

BUILDING ROOF IS NOT TRIBUTARY TO ANY WATER QUALITY SYSTEM

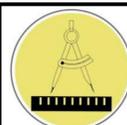
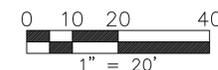
BIORETENTION BASIN  
 TOTAL AREA = 23,174 FT<sup>2</sup>  
 IMPERVIOUS = 15,673 FT<sup>2</sup>  
 AMENDED SOILS = 7,502 FT<sup>2</sup>

BIORETENTION CELL AREA = 240 FT<sup>2</sup>

PRIVATE TRENCH SERVES BIORETENTION OVERFLOW AND ROOF 100'L x 5.25'W x 3.5'D

SOUTH ANN STREET

SIMONS ROAD



**Valor Civil Engineering, PLLC**

Phone: (253) 861-7741  
 valorcivilengineering@hotmail.com

RIVERSIDE STATION APARTMENTS  
 135 SOUTH ANN STREET  
 MONROE, WA 98272  
 TPNS 2707060030-0900/ -1000

STORMWATER SITE PLAN  
 WATER QUALITY SIZING EXHIBIT

PROJECT NO: 2021-126

DATE: DECEMBER 21, 2021

FIGURE  
 A-7

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 A-8

## **Appendix B: Project Plans**

Project plans are provided as a separate, attached document.

## **Appendix C: Construction SWPPP**

The Construction Stormwater Pollution Prevention Plan is provided as a separate, attached document. Temporary erosion and sediment control drawings are part of the project plans under Appendix B.

# Appendix D: Calculations

*Attached*

---

# MGS FLOOD PROJECT REPORT

This model is for actual conditions, including off-site areas that are captured, and shows that the project meets LID and 100 percent infiltration for target surfaces. Also shows sizing for StormFilter and bioretention cell.

Program Version: MGSFlood 4.55  
Program License Number: 202010013  
Project Simulation Performed on: 12/22/2021 12:33 AM  
Report Generation Date: 12/22/2021 12:33 AM

---

Input File Name: 2021-126 MGS Flood Modeling.fld  
Project Name: Riverside Station  
Analysis Title:  
Comments:

---

## PRECIPITATION INPUT

---

Computational Time Step (Minutes): 15

Extended Precipitation Time Series Selected  
Climatic Region Number: 18

Full Period of Record Available used for Routing  
Precipitation Station : 96005205 Puget East 52 in\_5min 10/01/1939-10/01/2097  
Evaporation Station : 961052 Puget East 52 in MAP  
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1  
HSPF Parameter Region Name : USGS Default

\*\*\*\*\* Default HSPF Parameters Used (Not Modified by User) \*\*\*\*\*

## \*\*\*\*\* WATERSHED DEFINITION \*\*\*\*\*

### Predevelopment/Post Development Tributary Area Summary

	Predeveloped	Post Developed
Total Subbasin Area (acres)	1.143	1.137
Area of Links that Include Precip/Evap (acres)	0.000	0.006
Total (acres)	1.143	1.143

## -----SCENARIO: PREDEVELOPED

Number of Subbasins: 1

----- Subbasin : Subbasin 1 -----  
-----Area (Acres) -----  
Outwash Forest 1.143  
-----  
Subbasin Total 1.143

← assumed all forested  
for purposes of LID  
standard

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 4

----- Subbasin : South Ann Street Basin -----  
-----Area (Acres) -----  
Till Pasture 0.047  
Impervious 0.191  
-----  
Subbasin Total 0.238

----- Subbasin : Bioretention Basin -----  
-----Area (Acres) -----  
Till Pasture 0.172  
Impervious 0.360  
-----  
Subbasin Total 0.532

----- Subbasin : Roof -----  
-----Area (Acres) -----  
Impervious 0.225  
-----  
Subbasin Total 0.225

----- Subbasin : Simons Street Basin -----  
-----Area (Acres) -----  
Till Pasture 0.051  
Impervious 0.091  
-----  
Subbasin Total 0.142

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Links: 0

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: POSTDEVELOPED

Number of Links: 6

-----  
**Link Name: POC**  
Link Type: Copy  
Downstream Link: None

-----  
**Link Name: Parking Area Bio Cell**

Link Type: Ecology Bioretention Facility  
Downstream Link Name: Main Trench

Floor Elevation (ft) : 100.00  
Riser Crest Elevation (ft) : 101.00  
Storage Depth (ft) : 1.00  
Bottom Length (ft) : 24.0  
Bottom Width (ft) : 10.0  
Bottom Slope (ft/ft) : 0.000  
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00  
Bottom Area (sq-ft) : 240.  
Area at Riser Crest El (sq-ft) : 240.  
(acres) : 0.006  
Volume at Riser Crest (cu-ft) : 240.  
(ac-ft) : 0.006

Infiltration on Bottom and Sideslopes Selected

Soil Properties

Layer No	Soil Name	Thickness (ft)
1	SMMWW 12 in/hr (Ecol	1.500
2	SMMWW 12 in/hr (Ecol	0.000
3	GRAVEL	0.000

KSat Safety Factor: 4.0  
Native Soil Infiltration Rate (in/hr) : 5.00

Underdrain Not Present

Riser Geometry

Riser Structure Type : Circular  
Riser Diameter (in) : 6.00  
Common Length (ft) : 0.000  
Riser Crest Elevation : 101.00 ft

Hydraulic Structure Geometry

Number of Devices: 0

-----  
**Link Name: Main Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 100.00  
Trench Width (ft) : 5.25  
Trench Depth (ft) : 3.50  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

-----  
**Link Name: Ann Street WQ Statistics**

Link Type: Copy  
Downstream Link Name: S Ann St Trench

-----  
**Link Name: S Ann St Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 51.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 3.00  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

-----  
**Link Name: Simons Road Ditch**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench at Toe of Embankment  
Trench Length (ft) : 35.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 2.00  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

\*\*\*\*\***FLOOD FREQUENCY AND DURATION STATISTICS**\*\*\*\*\*

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1  
Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 4  
Number of Links: 6

\*\*\*\*\* **Subbasin: South Ann Street Basin** \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs)      Flood Peak (cfs)

=====  
2-Year      8.330E-02

5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Subbasin: Bioretention Basin \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.162
5-Year	0.209
10-Year	0.252
25-Year	0.309
50-Year	0.414
100-Year	0.506
200-Year	0.508
500-Year	0.508

\*\*\*\*\* Subbasin: Roof \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	9.463E-02
5-Year	0.122
10-Year	0.142
25-Year	0.172
50-Year	0.211
100-Year	0.264
200-Year	0.267
500-Year	0.270

\*\*\*\*\* Subbasin: Simons Street Basin \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.133E-02
5-Year	5.336E-02
10-Year	6.404E-02
25-Year	7.889E-02
50-Year	0.108
100-Year	0.132
200-Year	0.132
500-Year	0.132

\*\*\*\*\* Link: POC

\*\*\*\*\* Link Inflow

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	1.152E-05
5-Year	1.995E-05
10-Year	2.676E-05
25-Year	1.217E-03
50-Year	9.470E-02
100-Year	0.192
200-Year	0.253
500-Year	0.334

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link Inflow

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.162
5-Year	0.209
10-Year	0.252
25-Year	0.309
50-Year	0.414
100-Year	0.506
200-Year	0.508
500-Year	0.508

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link Outflow 1

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.130
5-Year	0.178
10-Year	0.209
25-Year	0.271
50-Year	0.317
100-Year	0.417
200-Year	0.444
500-Year	0.477

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link WSEL

Stats

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	101.057
1.11-Year	101.062
1.25-Year	101.069
2.00-Year	101.086
3.33-Year	101.101
5-Year	101.108
10-Year	101.122
25-Year	101.155
50-Year	101.180
100-Year	101.283

\*\*\*\*\* Link: Main Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.219
5-Year	0.293
10-Year	0.339
25-Year	0.415
50-Year	0.467
100-Year	0.680
200-Year	0.706
500-Year	0.735

\*\*\*\*\* Link: Main Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.688E-06
5-Year	7.360E-06
10-Year	9.421E-06
25-Year	1.523E-05
50-Year	2.579E-02
100-Year	8.816E-02
200-Year	0.172
500-Year	0.285

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\* Link Inflow

Frequency Stats

Flood Frequency Data(cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	8.330E-02
5-Year	0.106

10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\* Link Outflow 1

Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	8.330E-02
5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	8.330E-02
5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	5.767E-06
5-Year	8.968E-06
10-Year	1.166E-05
25-Year	1.453E-05
50-Year	3.419E-02
100-Year	0.126
200-Year	0.134
500-Year	0.141

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs) Flood Peak (cfs)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.133E-02
5-Year	5.336E-02
10-Year	6.404E-02
25-Year	7.889E-02
50-Year	0.108
100-Year	0.132
200-Year	0.132
500-Year	0.132

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs) Flood Peak (cfs)

Tr (yrs)	Flood Peak (cfs)
2-Year	2.485E-06
5-Year	4.644E-06
10-Year	6.735E-06
25-Year	1.188E-03
50-Year	1.528E-02
100-Year	6.416E-02
200-Year	6.960E-02
500-Year	7.542E-02

\*\*\*\*\***Groundwater Recharge Summary**\*\*\*\*\*

Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: Subbasin 1	467.229
<b>Total:</b>	<b>467.229</b>

Total Post Developed Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: South Ann Street Bas	9.884
Subbasin: Bioretention Basin	36.171
Subbasin: Roof	0.000
Subbasin: Simons Street Basin	10.725
Link: POC	0.000
Link: Parking Area Bio Cel	247.175
Link: Main Trench	163.567
Link: Ann Street WQ Statis	0.000
Link: S Ann St Trench	128.499

Link: Simons Road Ditch 68.807

Total: 664.828

**Total Predevelopment Recharge is Less than Post Developed  
Average Recharge Per Year, (Number of Years= 158)  
Predeveloped: 2.957 ac-ft/year, Post Developed: 4.208 ac-ft/year**

\*\*\*\*\*Water Quality Facility Data \*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Links: 6

\*\*\*\*\* Link: POC \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 0.02  
Inflow Volume Including PPT-Evap (ac-ft): 0.02  
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.02  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

\*\*\*\*\* Link: Parking Area Bio Cell \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 264.31  
Inflow Volume Including PPT-Evap (ac-ft): 266.65  
Total Runoff Infiltrated (ac-ft): 247.17, 92.70%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 26.87  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 92.70%

Over 91 percent, so the water quality standard is met. The rest goes through overflow to infiltration trench.

\*\*\*\*\* Link: Main Trench \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 163.57  
Inflow Volume Including PPT-Evap (ac-ft): 163.57  
Total Runoff Infiltrated (ac-ft): 163.57, 100.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.01  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\*

15-Minute Timestep, Water Quality Treatment Design Discharge  
On-line Design Discharge Rate (91% Exceedance): 0.034 cfs  
Off-line Design Discharge Rate (91% Exceedance): 0.019 cfs

← Rate used to size StormFilter system

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 128.50  
Inflow Volume Including PPT-Evap (ac-ft): 128.50  
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 128.50  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 128.50  
Inflow Volume Including PPT-Evap (ac-ft): 128.50  
Total Runoff Infiltrated (ac-ft): 128.50, 100.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.01  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 68.81  
Inflow Volume Including PPT-Evap (ac-ft): 68.81  
Total Runoff Infiltrated (ac-ft): 68.81, 100.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.00  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\***Compliance Point Results**\*\*\*\*\*

Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: POC

\*\*\* **Point of Compliance Flow Frequency Data** \*\*\*

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	9.127E-04	2-Year	0.000
5-Year	1.986E-03	5-Year	0.000

10-Year	4.439E-03	10-Year	0.000
25-Year	1.663E-02	25-Year	1.217E-03
50-Year	2.669E-02	50-Year	9.470E-02
100-Year	3.616E-02	100-Year	0.192
200-Year	3.726E-02	200-Year	0.253
500-Year	3.839E-02	500-Year	0.334

\*\* Record too Short to Compute Peak Discharge for These Recurrence Intervals

**\*\*\*\* Flow Duration Performance \*\*\*\***

Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%):	-99.8%	PASS
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%):	-99.4%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	99999.0%	FAIL
Percent Excursion from Q2 to Q50 (Must be less than 50%):	17.4%	PASS

Not required to meet

-----  
**FLOW DURATION DESIGN CRITERIA: FAIL**  
 -----

**\*\*\*\* LID Duration Performance \*\*\*\***

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	-100.0%	PASS
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	-99.8%	PASS

-----  
**MEETS ALL LID DURATION DESIGN CRITERIA: PASS**  
 -----



---

# MGS FLOOD PROJECT REPORT

This modeling is for comparing the pre- and post-development conditions to determine whether project exceeds the 0.15-cfs rule for flow control.

**Program Version: MGSFlood 4.55**  
**Program License Number: 202010013**  
**Project Simulation Performed on: 12/22/2021 12:28 AM**  
**Report Generation Date: 12/22/2021 12:28 AM**

---

Input File Name: 2021-126 MGS Flood Modeling 0.15 cfs rule.fld  
Project Name: Riverside Station  
Analysis Title:  
Comments:

---

## PRECIPITATION INPUT

---

Computational Time Step (Minutes): 15

Extended Precipitation Time Series Selected  
Climatic Region Number: 18

Full Period of Record Available used for Routing  
Precipitation Station : 96005205 Puget East 52 in\_5min 10/01/1939-10/01/2097  
Evaporation Station : 961052 Puget East 52 in MAP  
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1  
HSPF Parameter Region Name : USGS Default

\*\*\*\*\* Default HSPF Parameters Used (Not Modified by User) \*\*\*\*\*

\*\*\*\*\* **WATERSHED DEFINITION** \*\*\*\*\*

### Predevelopment/Post Development Tributary Area Summary

	Predeveloped	Post Developed
Total Subbasin Area (acres)	0.986	1.137
Area of Links that Include Precip/Evap (acres)	0.000	0.006
Total (acres)	0.986	1.143

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Subbasin 1 -----  
-----Area (Acres) -----  
Outwash Grass 0.563  
Impervious 0.423  
-----  
Subbasin Total 0.986

Existing conditions  
are allowed for this  
calculation



-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 4

----- Subbasin : South Ann Street Basin -----  
-----Area (Acres) -----  
Till Pasture 0.047  
Impervious 0.191  
-----  
Subbasin Total 0.238

----- Subbasin : Bioretention Basin -----  
-----Area (Acres) -----  
Till Pasture 0.172  
Impervious 0.360  
-----  
Subbasin Total 0.532

----- Subbasin : Roof -----  
-----Area (Acres) -----  
Impervious 0.225  
-----  
Subbasin Total 0.225

----- Subbasin : Simons Street Basin -----  
-----Area (Acres) -----  
Till Pasture 0.051  
Impervious 0.091  
-----  
Subbasin Total 0.142

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Links: 0

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: POSTDEVELOPED

Number of Links: 6

-----  
**Link Name: POC**  
Link Type: Copy  
Downstream Link: None  
-----

**Link Name: Parking Area Bio Cell**

Link Type: Ecology Bioretention Facility  
Downstream Link Name: Main Trench

Floor Elevation (ft) : 100.00  
Riser Crest Elevation (ft) : 101.00  
Storage Depth (ft) : 1.00  
Bottom Length (ft) : 24.0  
Bottom Width (ft) : 10.0  
Bottom Slope (ft/ft) : 0.000  
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00  
Bottom Area (sq-ft) : 240.  
Area at Riser Crest El (sq-ft) : 240.  
(acres) : 0.006  
Volume at Riser Crest (cu-ft) : 240.  
(ac-ft) : 0.006

Infiltration on Bottom and Sideslopes Selected

Soil Properties

Layer No	Soil Name	Thickness (ft)
1	SMMWW 12 in/hr (Ecol	1.500
2	SMMWW 12 in/hr (Ecol	0.000
3	GRAVEL	0.000

KSat Safety Factor: 4.0  
Native Soil Infiltration Rate (in/hr) : 5.00

Underdrain Not Present

Riser Geometry  
Riser Structure Type : Circular  
Riser Diameter (in) : 6.00  
Common Length (ft) : 0.000  
Riser Crest Elevation : 101.00 ft

Hydraulic Structure Geometry

Number of Devices: 0

-----  
**Link Name: Main Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 100.00  
Trench Width (ft) : 5.25  
Trench Depth (ft) : 3.50  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

-----  
**Link Name: Ann Street WQ Statistics**  
Link Type: Copy  
Downstream Link Name: S Ann St Trench

-----  
**Link Name: S Ann St Trench**  
Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 51.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 3.00  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

-----  
**Link Name: Simons Road Ditch**  
Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench at Toe of Embankment  
Trench Length (ft) : 30.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 2.00  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 10.00

\*\*\*\*\*FLOOD FREQUENCY AND DURATION STATISTICS\*\*\*\*\*

-----**SCENARIO: PREDEVELOPED**  
Number of Subbasins: 1  
Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**  
Number of Subbasins: 4  
Number of Links: 6

\*\*\*\*\* Subbasin: South Ann Street Basin \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs) Flood Peak (cfs)

=====

2-Year	8.330E-02
5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Subbasin: Bioretention Basin \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs)      Flood Peak (cfs)

=====	
2-Year	0.162
5-Year	0.209
10-Year	0.252
25-Year	0.309
50-Year	0.414
100-Year	0.506
200-Year	0.508
500-Year	0.508

\*\*\*\*\* Subbasin: Roof \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs)      Flood Peak (cfs)

=====	
2-Year	9.463E-02
5-Year	0.122
10-Year	0.142
25-Year	0.172
50-Year	0.211
100-Year	0.264
200-Year	0.267
500-Year	0.270

\*\*\*\*\* Subbasin: Simons Street Basin \*\*\*\*\*

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs)      Flood Peak (cfs)

=====	
2-Year	4.133E-02
5-Year	5.336E-02
10-Year	6.404E-02
25-Year	7.889E-02
50-Year	0.108
100-Year	0.132
200-Year	0.132
500-Year	0.132

\*\*\*\*\* Link: POC

\*\*\*\*\* Link Inflow

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	1.284E-05
5-Year	2.163E-05
10-Year	2.877E-05
25-Year	1.422E-02
50-Year	0.103
100-Year	0.200
200-Year	0.261
500-Year	0.342

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link Inflow

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.162
5-Year	0.209
10-Year	0.252
25-Year	0.309
50-Year	0.414
100-Year	0.506
200-Year	0.508
500-Year	0.508

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link Outflow 1

Frequency Stats

Flood Frequency Data(cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.130
5-Year	0.178
10-Year	0.209
25-Year	0.271
50-Year	0.317
100-Year	0.417
200-Year	0.444
500-Year	0.477

\*\*\*\*\* Link: Parking Area Bio Cell

\*\*\*\*\* Link WSEL

Stats

WSEL Frequency Data(ft)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	101.057
1.11-Year	101.062
1.25-Year	101.069
2.00-Year	101.086
3.33-Year	101.101
5-Year	101.108
10-Year	101.122
25-Year	101.155
50-Year	101.180
100-Year	101.283

\*\*\*\*\* Link: Main Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	0.219
5-Year	0.293
10-Year	0.339
25-Year	0.415
50-Year	0.467
100-Year	0.680
200-Year	0.706
500-Year	0.735

\*\*\*\*\* Link: Main Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.688E-06
5-Year	7.360E-06
10-Year	9.421E-06
25-Year	1.523E-05
50-Year	2.579E-02
100-Year	8.816E-02
200-Year	0.172
500-Year	0.285

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\* Link Inflow

Frequency Stats  
 Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs)	Flood Peak (cfs)
2-Year	8.330E-02

5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\* Link Outflow 1

Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

```
=====
```

2-Year	8.330E-02
5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

```
=====
```

2-Year	8.330E-02
5-Year	0.106
10-Year	0.129
25-Year	0.155
50-Year	0.200
100-Year	0.247
200-Year	0.249
500-Year	0.250

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

```
=====
```

2-Year	5.767E-06
5-Year	8.968E-06
10-Year	1.166E-05
25-Year	1.453E-05
50-Year	3.419E-02
100-Year	0.126
200-Year	0.134
500-Year	0.141

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs) Flood Peak (cfs)

Tr (yrs)	Flood Peak (cfs)
2-Year	4.133E-02
5-Year	5.336E-02
10-Year	6.404E-02
25-Year	7.889E-02
50-Year	0.108
100-Year	0.132
200-Year	0.132
500-Year	0.132

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data(cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs) Flood Peak (cfs)

Tr (yrs)	Flood Peak (cfs)
2-Year	3.794E-06
5-Year	6.317E-06
10-Year	8.688E-06
25-Year	1.420E-02
50-Year	2.588E-02
100-Year	7.225E-02
200-Year	7.776E-02
500-Year	8.368E-02

\*\*\*\*\*Groundwater Recharge Summary\*\*\*\*\*

Recharge is computed as input to Perlnd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: Subbasin 1	269.810
<b>Total:</b>	<b>269.810</b>

Total Post Developed Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: South Ann Street Bas	9.884
Subbasin: Bioretention Basin	36.171
Subbasin: Roof	0.000
Subbasin: Simons Street Basin	10.725
Link: POC	0.000
Link: Parking Area Bio Cel	247.175
Link: Main Trench	163.567
Link: Ann Street WQ Statis	0.000

Link: S Ann St Trench 128.499  
Link: Simons Road Ditch 68.807

---

Total: 664.828

**Total Predevelopment Recharge is Less than Post Developed  
Average Recharge Per Year, (Number of Years= 158)  
Predeveloped: 1.708 ac-ft/year, Post Developed: 4.208 ac-ft/year**

\*\*\*\*\*Water Quality Facility Data \*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Links: 6

\*\*\*\*\* Link: POC \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 0.03  
Inflow Volume Including PPT-Evap (ac-ft): 0.03  
Total Runoff Infiltrated (ac-ft): 0.00, 0.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.03  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

\*\*\*\*\* Link: Parking Area Bio Cell \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 264.31  
Inflow Volume Including PPT-Evap (ac-ft): 266.65  
Total Runoff Infiltrated (ac-ft): 247.17, 92.70%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 26.87  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 92.70%

\*\*\*\*\* Link: Main Trench \*\*\*\*\*

Infiltration/Filtration Statistics-----  
Inflow Volume (ac-ft): 163.57  
Inflow Volume Including PPT-Evap (ac-ft): 163.57  
Total Runoff Infiltrated (ac-ft): 163.57, 100.00%  
Total Runoff Filtered (ac-ft): 0.00, 0.00%  
Primary Outflow To Downstream System (ac-ft): 0.01  
Secondary Outflow To Downstream System (ac-ft): 0.00  
Volume Lost to ET (ac-ft): 0.00  
Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* Link: Ann Street WQ Statistics

\*\*\*\*\*

Infiltration/Filtration Statistics-----  
 Inflow Volume (ac-ft): 128.50  
 Inflow Volume Including PPT-Evap (ac-ft): 128.50  
 Total Runoff Infiltrated (ac-ft): 0.00, 0.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 128.50  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

\*\*\*\*\* Link: S Ann St Trench \*\*\*\*\*

Infiltration/Filtration Statistics-----  
 Inflow Volume (ac-ft): 128.50  
 Inflow Volume Including PPT-Evap (ac-ft): 128.50  
 Total Runoff Infiltrated (ac-ft): 128.50, 100.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 0.01  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* Link: Simons Road Ditch \*\*\*\*\*

Infiltration/Filtration Statistics-----  
 Inflow Volume (ac-ft): 68.81  
 Inflow Volume Including PPT-Evap (ac-ft): 68.81  
 Total Runoff Infiltrated (ac-ft): 68.81, 100.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 0.01  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\***Compliance Point Results**\*\*\*\*\*

Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: POC

\*\*\* **Point of Compliance Flow Frequency Data** \*\*\*

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.191	2-Year	0.000
5-Year	0.253	5-Year	0.000
10-Year	0.301	10-Year	0.000
25-Year	0.375	25-Year	1.422E-02
50-Year	0.446	50-Year	0.103
100-Year	0.504	100-Year	0.200

Mitigated site shows a decrease of 0.304 cfs at the 100-year peak flow.

200-Year	0.507	200-Year	0.261
500-Year	0.508	500-Year	0.342

\*\* Record too Short to Compute Peak Discharge for These Recurrence Intervals

**\*\*\*\* Flow Duration Performance \*\*\*\***

Excursion at Predeveloped 50%Q2 (Must be Less Than or Equal to 0%):	-99.9%	PASS
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than or Equal to 0%):	-98.8%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-92.3%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

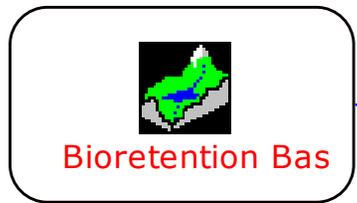
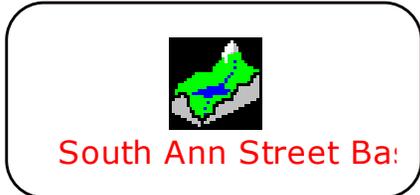
-----  
MEETS ALL FLOW DURATION DESIGN CRITERIA: PASS  
-----

Irrelevant for this  
calculation - see  
the other set of  
calcs

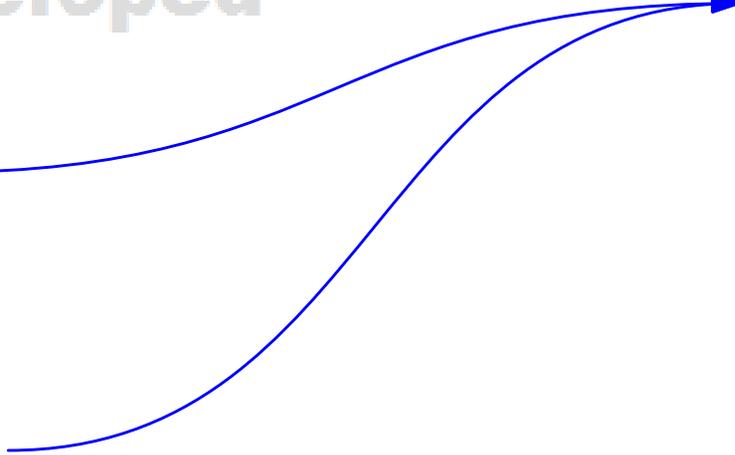
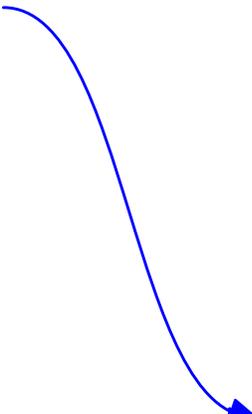
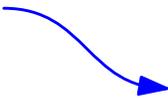
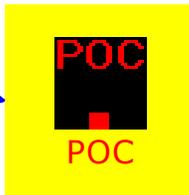
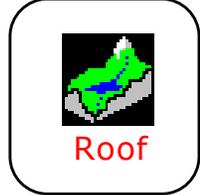
**\*\*\*\* LID Duration Performance \*\*\*\***

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	-100.0%	PASS
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	-99.9%	PASS

-----  
MEETS ALL LID DURATION DESIGN CRITERIA: PASS  
-----

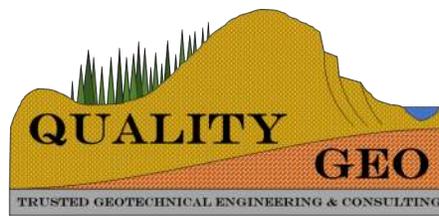


Postdeveloped



# Appendix E: Soils Report

*Attached*



2/26/2021

**The Iris Group**

Nick Taylor  
420 Golf Club Rd Ste 200  
Lacey, WA 98503

**Subject: Popa Apartments – Targeted Infiltration Investigation**  
135 South Ann St, Monroe, WA  
QG Project No.: QG21-015

Dear Mr. Taylor:

At your request, Quality Geo, PLLC (QG) has completed a limited evaluation of the existing shallow site soils within the subject area proposed for stormwater infiltration. We understand the general permeability of the soil is in question. We also understand a geotechnical evaluation is requested to meet the requirements of the local Stormwater Management Manual (SWMM). Our goal has been to determine the general feasibility of infiltration within the existing site soils.

***GEOLOGIC LITERATURE REVIEW***

The Washington Geologic Information Portal (WGIP) maintained by the Department of Natural Resources Division of Geology and Earth Resources provides 1:100,000-scale geologic mapping of the region. The subject site is mapped as glacial outwash gravel (Qgod).

***SITE INVESTIGATION METHODOLOGY***

Site exploration activities were performed on 2/9/2021. Exploration locations were marked in the field by a QG Project Geologist with respect to the provided map and cleared for public conductible utilities. Our exploration location was selected by an QG Project Geologist prior to field work to provide safest access to relevant soil conditions. The geologist directed the advancement of 3 excavated test pits (TP). The test pits were advanced within the vicinity of the anticipated development footprint areas, to a maximum depth of up to 12 feet below present grade in general accordance with the specified contract depth.

During explorations QG logged each soil horizon we encountered, and field classified them in accordance with the Unified Soil Classification System (USCS). Representative soil samples were collected from each unit, identified according to boring location and depth, placed in plastic bags to protect against moisture loss, and were transported to the soil laboratory for supplemental

classification and other tests.

A site map with exploration locations is included in Appendix A. Complete Pierce County format test pit logs are provided in Appendix B of this report. Results of laboratory tests are presented in Appendix C.

### ***SURFACE OBSERVATION***

The site is currently developed with a small outdoor storage facility to the north and two single-family homes spread over the rest of the property. Topography is generally flat, near the same elevation as the adjacent roadway. Apartment buildings surround the property to the east and south, with commercial/industrial properties to the north and west. What appears to have been a historic garage seems to have been located near the southeast corner, which has since been demolished with the building footprint filled in.

### ***SOIL & WATER CONDITIONS***

Site soils were generally consistent across the property. Beneath sod, shallow soil units were identified as a horizon of weathered outwash gravel with some silt and sand, extending as deep as 4 feet below present grade. Beneath the weathered cover soils, an unweathered horizon of outwash sand/gravel was present, extending from 4 feet to beyond 12 feet below present grade.

Within the southern portions of the site, the uncontrolled fill from past demolition appeared very compact. These soils were in a generally dense condition, and presented as a mix of demolition rubble and intermixed gravel. The fill extended as deep as 4 feet. Beneath these shallow soils was a very dense version of the lower native gravel unit, with some sand, and cobbles up to 12-inch diameter.

No groundwater was encountered within any of our explorations.

### ***DISCUSSION & RECOMMENDATIONS***

QG understands design of on-site stormwater controls are pending the results of this study to confirm design parameters and interpreted depths to restrictive soil features.

#### ***Infiltration Feasibility***

During test pit excavations for general site investigation, QG additionally collected representative samples of native soil deposits among potential infiltration strata and depths. We understand the project will be subject to infiltration design based on the Washington Department of Ecology Stormwater Management Manual for Western Washington (DoE SMMWW). For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve and hydrometer tests for stormwater design characterization and rate

determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

$$(1) \quad \log_{10}(K_{sat}) = -1.57 + 1.90 \cdot D_{10} + 0.015 \cdot D_{60} - 0.013 \cdot D_{90} - 2.08 \cdot f_f$$

Corrected Ksat values presented below are a product of the initial Ksat and correction factor CFT. For a generalized site-wide design situation, we have applied a site variability factor of CFv = 0.7 along with typical values of CFt = 0.4 (for the Grain Size Method) and CFm = 0.9 (assuming standard influent control).

$$(2) \quad CFT = CF_v \times CF_t \times CF_m = 0.7 \times 0.4 \times 0.9 = 0.25$$

Results were cross-referenced with test pit logs to determine the validity and suitability of unique materials as an infiltration receptor. Additional reductions were applied, based on our professional judgement and knowledge of local soil types.

**Table 1. Results Of Massmann Analysis**

TP #	Sample Depth (BPG)	Unit Extent (ft)	Soil Type	D10	D60	D90	Fines (%)	Ksat (in/hr)	Approved Ksat (in/hr)	Cation Exchange Capacity (meq/100g)	Organic Content %
1	2.0	0 to ~4	GW-GC	0.103	8.677	21.436	8.4	28.44	5.0	9.0	2.7
1	4.0	~4 to 12+	SP	0.130	1.387	12.303	3.3	41.75	10.0	3.5	1.2

Considering most of the southern portions of the site are overly compacted, we consider it unwise to attempt any infiltration methods south of the existing southern house. See the map in Appendix A for clarification. In-ground infiltration structures are required to maintain a minimum separation from restrictive soil & perched water features. Available well logs indicate the potential for ground water as shallow as 15 feet below grade. The required separation appears generally achievable across the site. We recommend inground stormwater galleries, drywells, etc, penetrate at least 5 feet below present grade, but no deeper than 10 feet, in order to maintain the required separation. At this time, QG does not recommend mounding analysis due to the generally suitable site conditions.

Beneath sod and cover soils, the lower existing outwash soils were observed to generally exhibit slightly reduced fines content and minimal oxidation patterns. For in-ground stormwater gallery and drywells infiltrating within the underlying clean gravel unit at or below 4 feet in depth, we recommend a maximum design rate of up to 10.0 inches/hour be considered for undisturbed native soils.

Alternatives to in ground infiltration include the use of rain gardens, bio-swales, or pervious pavement, which can be considered at the discretion of the designer and client depending on final development needs and constraints. For these shallow features **within the overriding weathered gravel unit less than 4 feet in depth, we recommend a maximum design rate of up to 5.0 inches/hour** be considered for these native soils.

QG recommends the facility designer review these results and stated assumptions per reference literature to ensure applicability with the proposed development, level of anticipated controls, and long- term maintenance plan. The designer may make reasonable adjustments to correction factors and the resulting design values based on these criteria to ensure design and operational intent is met. We recommend that we be contacted if substantial changes to rate determination are considered.

### ***DRYWELL FILL MATERIALS***

QG typically recommends stormwater infiltration galleries & drywells have their effective storage area filled with clean granular material with a porosity between 35 & 40%. Material conforming to WSDOT Standard Specification 9-03.12(5) - *Gravel Backfill for Drywells* (or an approved alternative) may be used for this purpose. The storage material shall be separated on all sides from surrounding native soils and fill soils above by a layer of nonwoven permeable fabric. Gravel may be vibratory compacted in place to allow for maximum packing of the grains and prevent settlement. Conventional compaction methods will not typically reduce the porosity below 35%. Over compaction or use of a jumping jack may fracture the aggregate and result in decreased porosity. The contractor shall take care to not contaminate the fill with other soils. Conventional nuclear density testing does not typically work for verifying clean aggregate compaction, and therefore shall be visually evaluated for adequate compaction when inspection is required.

### ***TREATMENT POTENTIAL***

Depending on stormwater and runoff sources, some stormwater features, such as rain gardens or pervious pavements may require treatment. Stormwater facilities utilizing native soils as treatment media typically require Cation Exchange Capacities (CEC) of greater than 5 milliequivalents per 100grams (meq/100g) and organic contents greater than 1% (this may vary depending on local code). Native soils at likely shallow treatment depths no greater than 4 feet in depth were found to have a Cation Exchange Capacity and an organic content that meet these required minimums.

***CLOSING REMARKS:***

We trust this letter satisfies your project needs currently and greatly thank you for the opportunity to be of service. QG wishes you the best while completing the project.

Respectfully Submitted,

**Quality Geo, PLLC**



2/26/2021

**LUKE PRESTON MCCANN**

**Luke Preston McCann, L.G.**  
**Principal Geologist**

### LIMITATIONS

Upon acceptance and use of this report, and its interpretations and recommendations, the user shall agree to indemnify and hold harmless QG, including its owners, employees and subcontractors, from any adverse effects resulting from development and occupation of the subject site. Ultimately, it is the owner's choice to develop and live in such an area of possible geohazards (which exist in perpetuity across the earth in one form or another), and therefore the future consequences, both anticipated and unknown, are solely the responsibility of the owner. By using this report for development of the subject property, the owner must accept and understand that it is not possible to fully anticipate all inherent risks of development. The recommendations provided above are intended to reduce (but may not eliminate) such risks.

This report does not represent a construction specification or plan and shall not be used or referenced as such. The information included in this report shall be considered supplemental to the requirements contained in the project plans & specifications and shall be read in conjunction with the above referenced information. The selected recommendations presented in this report are intended to inform only the specific corresponding subjects. All other requirements of the above-mentioned items remain valid, unless otherwise specified.

Recommendations contained in this report are based on our understanding of the proposed development and construction activities, field observations and explorations, and laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, or If the scope of the proposed construction changes from that described in this report, QG shall be notified immediately in order to review and provide supplemental recommendations.

The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this report assume that an adequate program of tests and observations will be conducted by a WABO approved special inspection firm during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the Client and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. It is the Client's responsibility to ensure that the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. Note that if another firm assumes Geotechnical Engineer of Record responsibilities, they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation.

Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required. Based on the intended use of the report, QG may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the Client or anyone else will release QG from any liability resulting from the use of this report. The Client, the design consultants, and any unauthorized party, agree to defend, indemnify, and hold harmless QG from any claim or liability associated with such unauthorized use or non-compliance. We recommend that QG be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. We assume no responsibility for misinterpretation of our recommendations.

Appendix A. Site Map



Quality Geo,  
PLLC

Site Map  
Popa Apts

Source: Google Imagery 2021  
Scale & Locations are approx.  
Not for Construction

Figure 1

Appendix B. Laboratory Results

**Materials Testing & Consulting, Inc.**

Geotechnical Engineering • Special Inspection • Materials Testing • Environmental Consulting



**Sieve Report**

<b>Project:</b> Quality Geo - 2021 <b>Project #:</b> 21S019 <b>Client:</b> Quality Geo PLLC <b>Source:</b> TP-1 @ 2' (Popa) <b>Sample#:</b> S21-0197		<b>Date Received:</b> February 10, 2021 <b>Date Sampled:</b> February 10, 2021 <b>Sampled By:</b> Client <b>Date Tested:</b> February 15, 2021 <b>Tested By:</b> S. Bennett		<b>ASTM D-2487 Unified Soils Classification System</b> GW-GC, Well-graded Gravel with Silty Clay and Sand <b>Sample Color:</b> Brown																																																																																																																																																																																																	
<b>ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821</b>																																																																																																																																																																																																					
<b>Specifications</b> No Specs Sample Meets Specs ? N/A		D <sub>15</sub> = 0.045 mm D <sub>30</sub> = 0.103 mm D <sub>60</sub> = 0.206 mm D <sub>100</sub> = 1.390 mm D <sub>200</sub> = 5.230 mm D <sub>425</sub> = 8.677 mm D <sub>850</sub> = 21.436 mm Dust Ratio = 35.93		% Gravel = 51.4% % Sand = 40.2% % Silt & Clay = 8.4% Liquid Limit = n/a Plasticity Index = n/a Sand Equivalent = n/a Fracture %, 1 Face = n/a Fracture %, 2+ Faces = n/a		Coeff. of Curvature, C <sub>c</sub> = 2.16 Coeff. of Uniformity, C <sub>u</sub> = 84.09 Fineness Modulus = 4.86 Plastic Limit = n/a Moisture %, as sampled = n/a Req'd Sand Equivalent = Req'd Fracture %, 1 Face = Req'd Fracture %, 2+ Faces =																																																																																																																																																																																															
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All results apply only to actual location and materials tested. As a natural protection to clients, the public and ourselves, all reports are submitted as the confidential property of clients, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval.

Comments: \_\_\_\_\_

Reviewed by: egab-hable





<b>MATERIALS TESTING</b>	Date Received: 2/18/2021
777 CHRYSLER DR	Grower: 20S2019 QUALITY GEO2021
Burlington, WA 98233	Field: TP-1 AT 2FT POPA
Laboratory #: S21-01119	Sampled By: PO#MTC-21-1013
	Customer Account #:
	Customer Sample ID:

Soil Test Results				
Cation Exchange	CEC	meq/100g	9.0	pH 1:1
				E.C. 1:1 m.mhos/cm
				Est Sat Paste E.C. m.mhos/cm
				Effervescence
				<u>Lbs/Acre</u>
				Ammonium - N mg/kg
				Organic Matter W.B. % ENR:

Other Tests:

Organic Matter (LOI 360) 2.7 %:



<b>MATERIALS TESTING</b>	Date Received: 2/18/2021
777 CHRYSLER DR	Grower: 20S2019 QUALITY GEO2021
Burlington, WA 98233	Field: TP-1 AT 4FT POPA
Laboratory #: S21-01120	Sampled By: PO#MTC-21-1013
	Customer Account #:
	Customer Sample ID:

Soil Test Results				
Cation Exchange	CEC	meq/100g	3.5	pH 1:1
				E.C. 1:1 m.mhos/cm
				Est Sat Paste E.C. m.mhos/cm
				Effervescence
				<u>Lbs/Acre</u>
				Ammonium - N mg/kg
				Organic Matter W.B. % ENR:

Other Tests:

Organic Matter (LOI 360) 1.2 %: