Drainage Report
Sunnyside Nursery

PFN:

for

Steven & Pauline Smith
3915 Sunnyside Blvd
Marysville, WA 98270

SITE LOCATION:
6331 40th St NE
Marysville, WA 98270
TPN: 29050300106100,
2905030010600,
29050300101200

Prepared by:
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Job No: 21-0819
January 2022

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1. INTRODUCTION

This document is intended to provide the engineering information necessary to support the permits required to clear the violation on this property. A large amount of gravel parking has been added to these subject parcels in the recent past without the required permits.

The improvements for this project will require the construction of stormwater facilities to provide flow control and treatment for the recently constructed gravel surfaces. All new impervious and pervious surfaces from the on-site improvements will be collected and conveyed to the proposed detention system.

The USDA Web Soil Survey indicates that this site is underlain by Tokul gravelly medial loam, which generally consists of fine sandy loam with a depth to restrictive layer of approximately 20 to 39 inches below grade.

The site is located at 6331 40th St NE in the City of Marysville, and in Section 3, Township 29N, Range 5E, Willamette Meridian. See Figure 1 - Vicinity Map.

A. DRAINAGE INFORMATION SUMMARY FORM

Project: **Sunnyside Nursery**
PFN:

Engineer: **Omega Engineering, Inc.**
2707 Wetmore Ave
Everett, WA 98201
Attention: Joseph Smeby, P.E.

Total site area: **2.16 acres**
Offsite area: **0.0 acres**
Project area: **0.62 acres**

Applicant: **Steven Smith**
3915 Sunnyside Blvd
Marysville, WA 98270

Drainage Basin Information	**Basin A**
On-site Developed Area	0.62 acres
Off-site Improved Area	0.0 acres
Types of storage proposed on site	Bioretention/Detention Pond
Approximate total storage volume	12,223 cf
Soil Types	Type C Soils
Basin Data	
Existing Basin	
2-year	0.17 cfs
50-year	0.61 cfs
Developed Basin (Pond Discharge)	
2-year	0.067 cfs
50-year	0.20 cfs

2. EXISTING SITE CONDITIONS

The site is located at 6331 40th St NE, in the City of Marysville, and in Section 3, Township 29N, Range 5E, Willamette Meridian. See Figure 1 - Vicinity Map.

Land use around the site is primarily single-family homes. The parcel associated with this project currently contains a large gravel parking lot, a lawn/hog fuel open area, and a paper-fill wetland along the northern property line.

The project area consists of three rectangular parcels. The grades within the project site are mild, with slopes averaging approximately 5 percent. The only vegetation found on the existing property is within the wetland area on the north side of the existing split rail fence, which will not be disturbed for this project.

A site visit was conducted on September 30, 2021. The weather was very rainy with temperatures in the 50's. Due to the extreme nature of the storm event, some surface water was seen pooling in the low, northwestern portion of the parking lot where the new bioretention area will be installed.

The USDA Web Soil Survey was used to find that Tokul gravelly medial loam is present in this area, which generally consists of fine sandy loam with a depth to restrictive layer of 20 to 39 inches below grade.

This project proposes to construct stormwater facilities to manage runoff from all of the gravel parking surfaces on site. The stormwater facilities include a bioretention cell, biofiltration swale and detention pond (see Section 5 for a detailed description).

3. DEVELOPED SITE CONDITIONS

The site currently consists of approximately 50,000 sf (1.15 acres) of gravel surfacing. A large portion of this was recently installed without the required permits, and the property owner received a violation from the City of Marysville. To clear this violation, a drainage design must be prepared to mitigate for ALL gravel surfaces on the site. The runoff from these surfaces will be collected and conveyed to a detention pond.

Based on the fact that this project triggers Flow Control and native soils in this area are known to have very poor infiltration characteristics, infiltration is infeasible for this project. A bioretention cell and bio-filtration swale will be used to treat the runoff (See Section 5D), and everything will drain to a proposed detention pond that has been designed to meet the flow control requirement. Soil amendments will be utilized for disturbed pervious areas.

4. OFFSITE ANALYSIS

DEFINE STUDY AREA:

UPSTREAM ANALYSIS

From observations made during the field visit and the topographic survey, the 1-acre residential property to the west drains to a low point at our northwestern property corner where runoff is conveyed east through an 8-inch pipe to outfall into the paper-fill wetland on-site. Because the proposed flow control system for this project will be hydraulically connected to this existing wetland in which a small amount of storage will be achieved, this up-stream tributary area of approximately 1-acre was included in the existing and developed basins when sizing the drainage facilities. No other significant off-site areas appear to drain toward the project site.

DOWNSTREAM ANALYSIS

Runoff from this parcel drains in a generally northern/northwestern direction. The vast majority of the runoff from the gravel surfacing on site currently drains into the on-site wetland, either directly or via the aforementioned 8-inch pipe that picks up runoff in the northwestern corner of the site. Runoff flows gradually in an eastern direction through the wetland and is discharged via a 12-inch pipe that flows east. Runoff flow approximately 120 feet east in this pipe where it discharges into a creek just off-site near the northeastern property corner. Runoff in this creek flows approximately 250 feet in a northeastern direction where it flows into the large off-site wetland. Runoff in this wetland flows very gradually, uninterrupted in a northwestern direction for ¼ mile at which point the downstream analysis was concluded.

REVIEW AVAILABLE INFORMATION:

The Snohomish County GIS Map was reviewed to find that a large wetland complex exists off-site to the northwest. The buffer of this wetland extends slightly onto our property as shown on the plans.

FIELD INSPECTION:

Some water pooling in the low part of the parking lot was observed during the site visit during a very large storm event. Pooling is unlikely to occur once the drainage improvements have been constructed.

DESCRIPTION OF DRAINAGE SYSTEM AND ANY EXISTING OR PREDICTED PROBLEMS:

The downstream systems for this project appear in good condition. The systems consist of engineered pipe conveyance systems, channel and wetland flow. Since this project will provide flow control assuming a forested existing condition and the current site is almost entirely gravel, the runoff flow rates and durations will be significantly lower than the current runoff conditions for the site.

5. STORMWATER CONTROL PLAN

A. Site Hydrology Analysis

Pre-Developed Site Hydrology

The existing site drains to the north/northwest. The majority of the site currently drains into the wetland that outfalls east and into the creek near the northeastern property corner.

Developed Site Hydrology

For the developed site hydrology, all the impervious surfaces will be collected and treated/detained on-site. Rather than cutting off all of the gravel surface runoff that currently drains to the wetland and sending it directly to the new detention pond, a creative design has been shaped to maintain the hydrology of the wetland while still meeting the flow control and runoff treatment requirements of the 2014 DOE Stormwater Management Manual for Western Washington. In summation, the wetland will be hydraulically connected to the proposed bioretention cell and detention pond so that treated runoff from the bioretention cell will flow through the wetland, and the wetland outlet will be modified to discharge to the detention pond. That way, along with the approximately 1-acre of off-site tributary area that drains into this wetland, a large portion of the existing gravel surface area on site will still drain to the wetland. To meet the treatment requirement, a bio-filtration swale will be constructed between the parking lot and the wetland, cutting off approximately 0.45 acres of gravel that currently drains to the wetland.

The detention pond will tightline to the north and connect to the existing 12-inch line that outfalls to the creek, maintaining the downstream runoff path.

B. PERFORMANCE STANDARDS

The proposed water quality and detention systems designed for the new improvements under violation have been sized using the WWMH2012 software as required in the DOE 2012 manual with 2014 revisions.

C. FLOW CONTROL SYSTEM

The future fully developed site drainage design will utilize a detention pond, bioretention cell and bio-filtration swale to meet both the flow control and water quality requirements. The following provides the input information for WWHM2012 along with the required pond size for this project. The following table summarizes the land cover and areas tributary to the pond.

DEVELOPED BASINS				
	Impervious area (sf)	Impervious area (ac)	Pervious area (sf)	Pervious area (ac)
Lawn (off-site)			43,500	1.0
Pond (Wetland)	8,700	0.20	0	0
Parking	50,000	1.15	0	0
Roads			0	0
Sidewalks			0	0
Total	58,700	1.35	43,500	1.0

As noted previously, the existing wetland will be incorporated into the flow control design and utilized for some storage in large storm events when the detention pond becomes overwhelmed and has to back up into the wetland. Therefore, the 1-acre of off-site tributary area was included in the calculations, because it will continue to flow through the proposed system.

Appendix A contains WWHM2012 printouts for all the different calculations necessary for this design. There will be the flow control calcs along with the water quality sizing and conveyance calcs.

D. WATER QUALITY SYSTEM

Public online soil data and the presence of a wetland on-site indicate that the underlying soils have very poor infiltrative characteristics. So, within the approved options for water quality treatment are bioretention cells and bio-filtration swales.

A large portion of the gravel area on site currently drains toward the low spot in the northwestern area of the parking lot where standing water was observed during the site visit. A bioretention cell shall be constructed, approximately 120 feet long along the low, northern edge of this parking area that will collect runoff from approximately 0.7 acres of gravel parking. Per the SWMMWW, runoff treatment is achieved when at least 91 percent of the total runoff profile flows through the filter system. The WWHM results indicate a total "percent through underdrain" of 93.33 percent, exceeding the 91 percent threshold. Runoff is treated by flowing through 18-inches of bioretention soil media, and is collected in the underdrain that sends the treated runoff into the wetland and eventually into the detention pond.

Treatment of the eastern portion of the parking area (approximately 0.45 acres) that currently drains directly into the wetland will take place in a continuous inflow biofiltration swale (BMP T9.30). This biofiltration swale has been sized per Vol V, Section 9.4 of the 2014 DOE SWMMWW and determined to meet the treatment requirements with a bottom width of 2 feet, longitudinal slope of 0.75% and length of 180 feet (see Appendix A for Bioswale Sizing spreadsheets)

Therefore, all PGHS runoff is treated using a combination of bioretention and biofiltration techniques.

E. CONVEYANCE SYSTEM ANALYSIS

The proposed stormwater conveyance lines between the wetland and detention pond will be 12-inch and maintain minimum longitudinal slopes of 0.5%. Stormwater mains are typically of this size and minimum slope, so these proposed stormwater conveyance pipes will have more than enough capacity to convey the 100-year flows without any backwater conditions.

A 4-inch PVC line will be used to convey the runoff from the bioretention underdrain to the existing 8-inch line that discharges to the wetland. The hydrology model indicates that the bioretention underdrain will never convey more than 0.01 cfs, and a 4-inch pvc pipe can convey up to 0.18 cfs at 0.5 percent slope.

6. SWPPP NARRATIVE

The intent of this section is to provide the information necessary to support the engineering plans to implement a design that will; reduce, eliminate or prevent the discharge of stormwater pollutants, meet or exceed the water quality and sediment management standards for the City and State, and prevent adverse impacts to the receiving waters for this project. Note: this narrative is intended to support the SWPPP that is included with the Drainage Plans also a part of this submittal package to the City.

A. SITE GRADING/EROSION CONTROL RISK ASSESSMENT

Area proposed to be cleared/worked:	0.62 acres
Average slope for the site:	5% (Area of Disturbance Only)
Erosion Hazard of Soil	Slight
Critical Areas downslope	Yes
Site is upstream of an ESA Stream	No

Based on the above information and the fact that significant areas of vegetation can be retained along the perimeter of the area of disturbance, and that if site conditions warrant, additional BMP's can be implemented as corrective measures the Risk Category for this site is **Low Risk.**

B. SWPPP Minimum Elements

1: Preserve Vegetation and Mark Clearing Limits
The first step in the construction process is for the contractor to flag or fence the limits of clearing/disturbance prior to any other construction activity. The engineering plans locate and provide the square footages for the areas of grading, clearing, impervious surfaces and un-disturbed areas on the proposed site. Existing vegetation can be preserved around the perimeter of the site during the initial construction phases on this project. Approximately 90% of the entire site will be cleared or disturbed for this project. The existing paper-fill wetland shall not be disturbed.

2: Establish Construction Access
The SWPPP calls for the proposed construction entrance to be installed as the second step after the staking of clearing limits. A gravel driveway entrance to the site existing in the current conditions and shall be used as the construction entrance. At this time winter work is expected during the wet season.

3: Control Flow Rates
The site will be graded and the runoff from the construction site will be directed toward the stormwater facilities with the control structures for this project. This system will be constructed to aid in the removal of sediment within the runoff as well as meter out the release of the runoff from the site.

4: Install Sediment Controls
This site SWPPP proposes to construct/maintain gravel entrances, vegetative buffer, silt fencing or a brush barrier if necessary, interceptor swales, sediment vault and retention of the existing vegetation that will provide a vegetated strip between the cleared areas and most property lines. The construction of these features should be completed before the clearing and grading of the site. Mulch will also be used on the exposed soil as necessary to limit erosion.

5: Stabilize Soils
The "Construction Sequence" calls for the stabilization of soils that remain unworked for certain lengths of time based on the time of year. Stabilization techniques may include but not limited to mulching, plastic sheeting or hydroseeding, notes have been added to the plan regarding protection for the stockpile area if necessary. Stockpile areas have been identified on the SWPPP and are setback a minimum of 25-feet from any down slope property line.

6: Protect Slopes
All disturbed slopes on site during construction are required to be protected with mulch or other means as specified in the construction sequence. No concentrated runoff or significant amounts of sheet flow will be directed to new cut or fill slopes during construction.

7: Protect Drain Inlets
All existing catch basins adjacent to this project and immediately downstream will be protected with inlet protection.

8: Stabilize Channels and Outlets
All new biofiltration swale and bioretention cell will be vegetated to prevent erosion.

9: Control Pollutants
No outside chemicals are expected to be necessary for the construction of this project. All vehicles working on and around the site would need to meet the State requirements for emissions. Vehicle fueling locations will be used to limit the potential impacts from any spills and concrete washout areas will also be provided well away from the detention pond.

10: Control DeWatering
DeWatering may be necessary during construction of this detention pond. Existing vegetation retained on site would be available to spread any water from construction for filtration and disposal. In addition, the bioretention area with underdrain can be constructed first and dewatering runoff discharged to it to help mitigate.

11: Maintain BMPs
The construction supervisor will be responsible for maintaining all BMPs during construction and working with the City to relocate or add BMPs as necessary as site conditions change.

12: Manage the Project
It will be the responsibility of the Contractor and Developer to manage this project and coordinate with the City Inspector and Engineer.

Inspection and Monitoring:
Site inspections shall be done by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have skills to first assess the site conditions and construction activities that could impact the quality of stormwater, and second assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP:
The construction SWPPP shall be retained on-site or within reasonable access to the site. The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven days following inspection.

13: Protect On-Site Stormwater Management BMPs for Runoff from Hard Surfaces
The bioretention cell and biofiltration swale shall be constructed once the major site construction has been completed and those areas protected during construction to prevent compaction.

7. PROJECT OVERVIEW

This project proposes to construct stormwater facilities to mitigate for approximately 50,000 square feet of gravel parking that has caused a violation from the City. In addition, All of this gravel impervious surface runoff will be treated and detained using a combination of bioretention, biofiltration and a detention pond. No land conversion will take place for this project other than converting some gravel and lawn areas to stormwater facilities.

The site grades for this project are mild and average 5% in the project area. Site grading will be necessary to build the stormwater facilities and re-grade part of the parking lot.

VICINITY MAP
SCALE 1" = 2000'

FIG. 1

OMEGA
ENGINEERING, INC.
2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958

VICINITY MAP
SUNNYSIDE NURSERY

DATE	JOB NO.	SCALE	SHEET
1/27/22	21-0819	1" = 2000'	1 OF 1

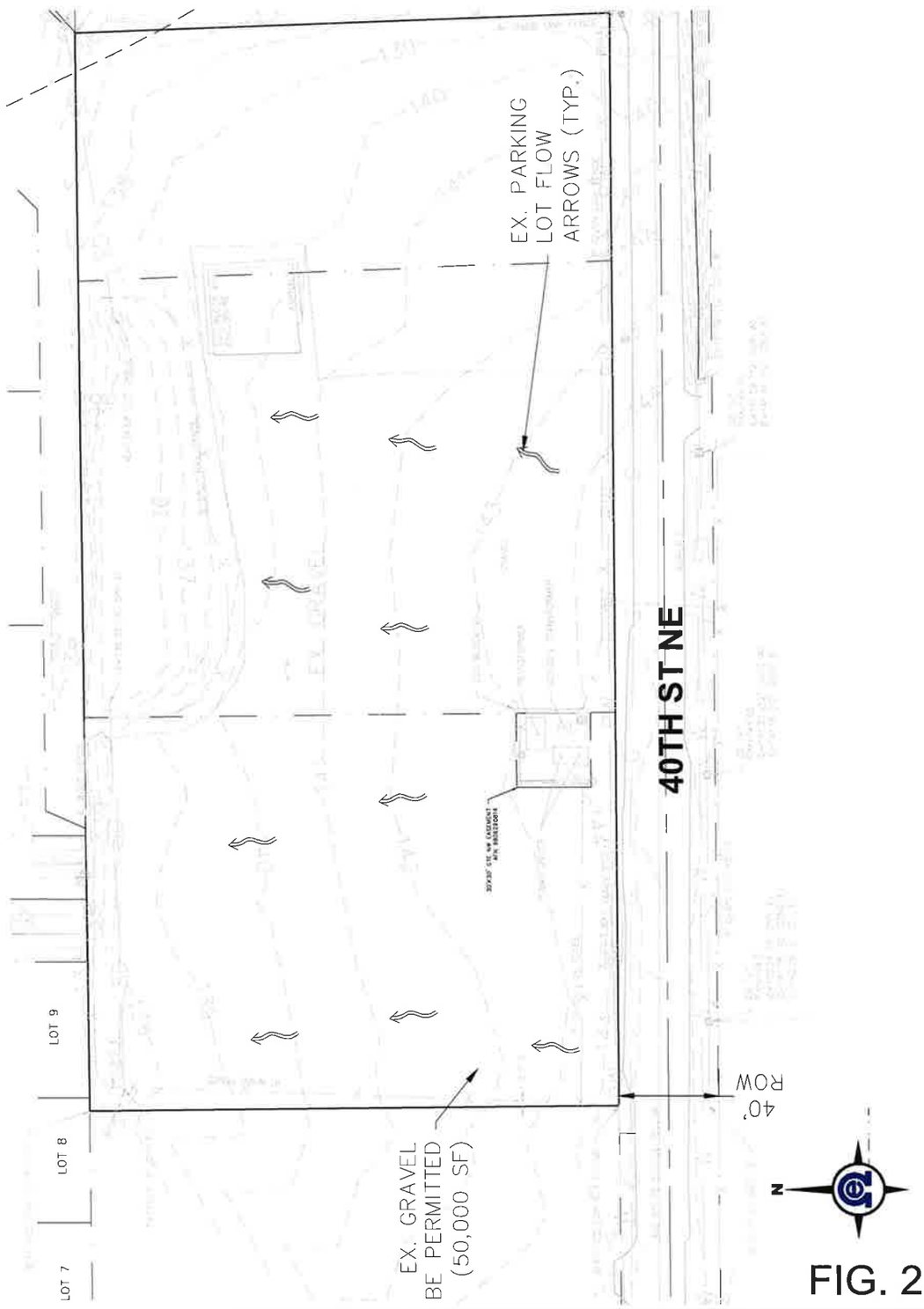


FIG. 2

OMEGA
ENGINEERING, INC.
2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958

EXISTING BASIN MAP
SUNNYSIDE NURSERY

DATE	JOB NO.	SCALE	SHEET
1/27/22	21-0819	1" = 60'	1 OF 1

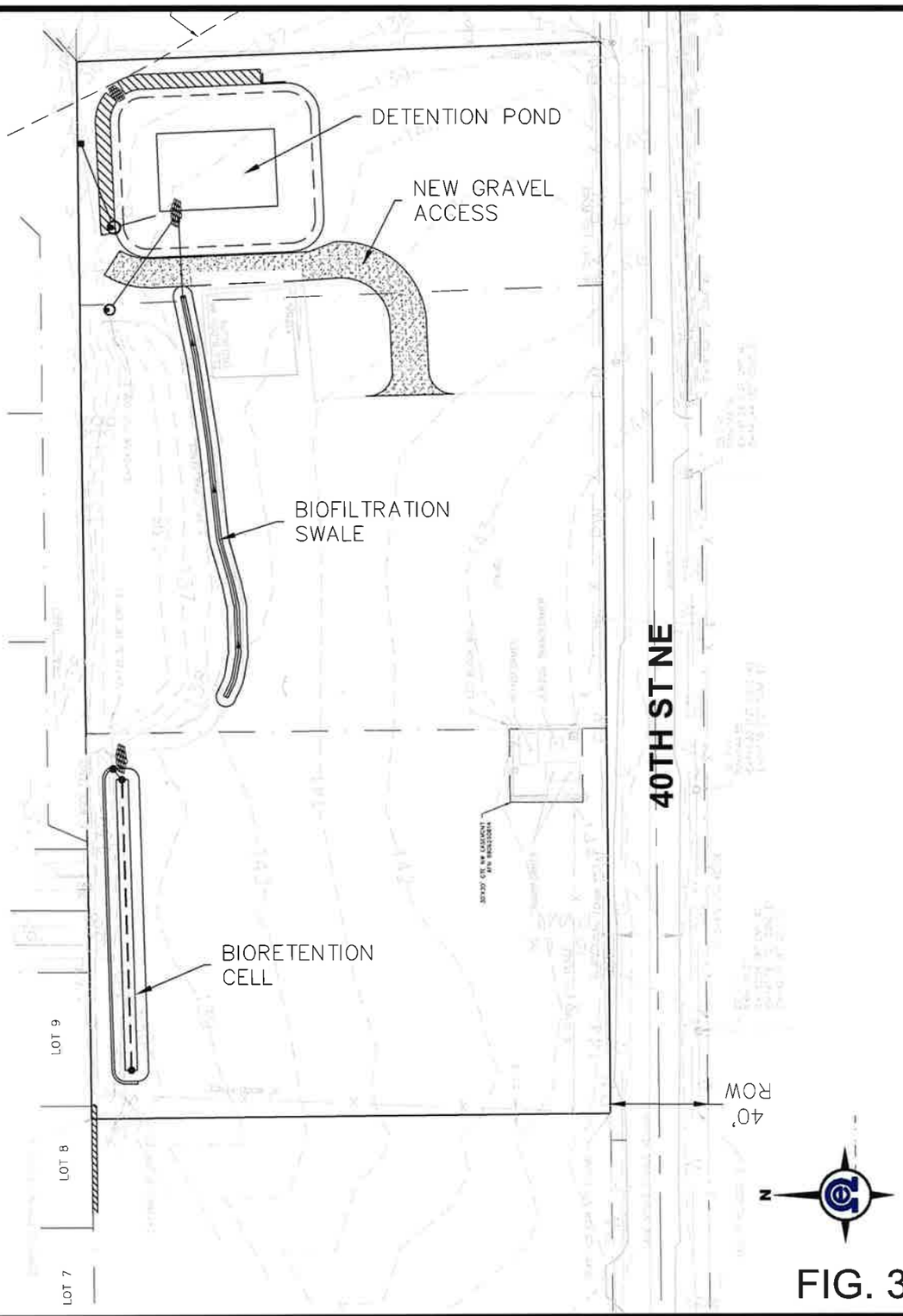


FIG. 3

OMEGA
ENGINEERING, INC.
2707 WETMORE AVE.
Everett, WA 98201
(o)425.387.3820 (f) 425.259.1958

DEVELOPED BASIN MAP
SUNNYSIDE NURSERY

DATE	JOB NO.	SCALE	SHEET
1/27/22	21-0819	1" = 60'	1 OF 1

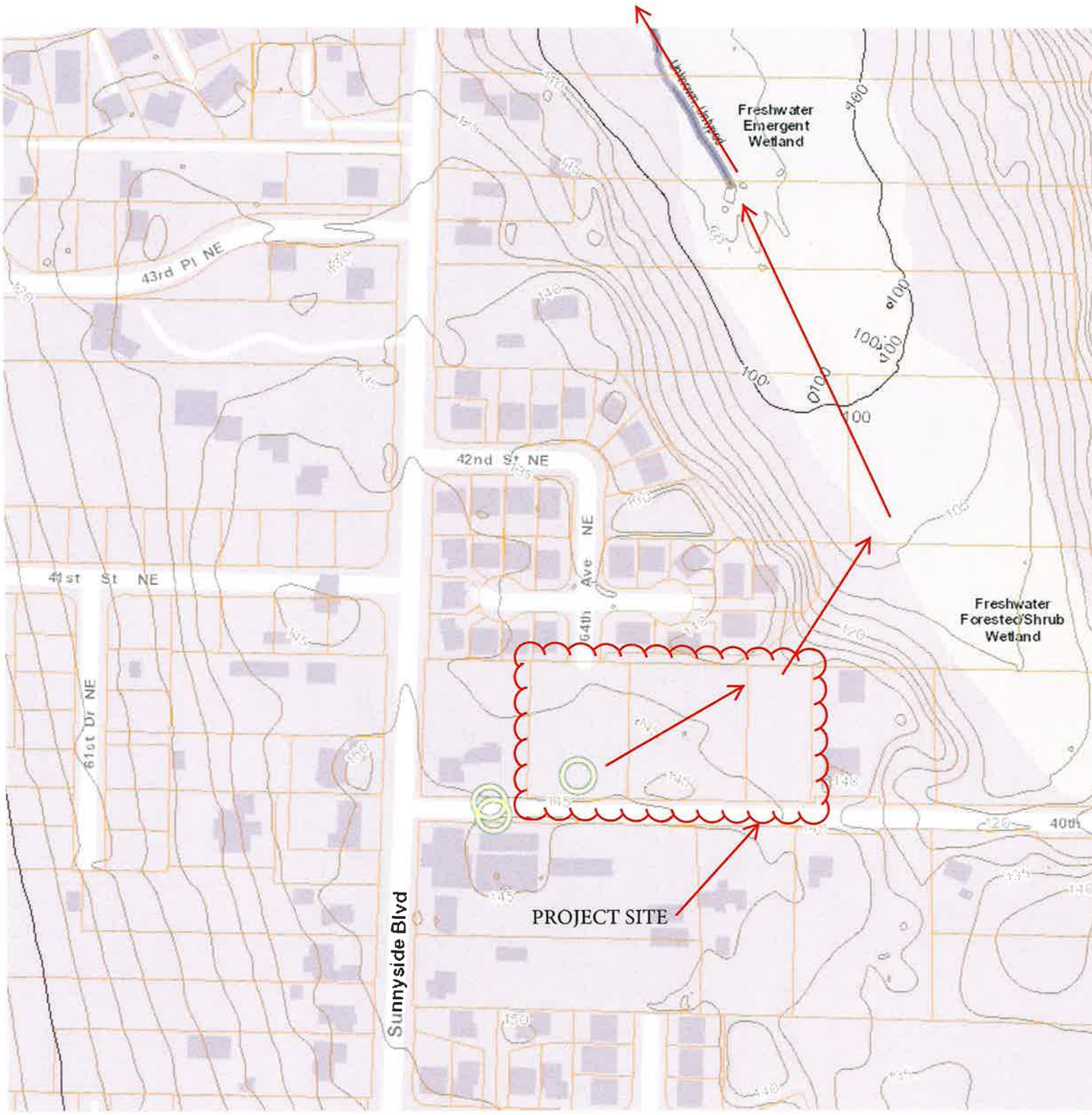

Freshwater
Emergent
Wetland
43rd Pl NE
42nd St NE
41st St NE
64th Ave NE
61st Dr NE
Freshwater
Forested/Shrub
Wetland
PROJECT SITE
Sunnyside Blvd

FIG. 4

APPENDIX A

STORMWATER CALCULATIONS

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Hybrid Pond
Site Name:	
Site Address:	
City:	
Report Date:	1/21/2022
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	1.15
C, Lawn, Flat	1
Pervious Total	2.15

Impervious Land Use	acre
POND	0.2
Impervious Total	0.2
Basin Total	2.35

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Off-site Lawn

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	1
Pervious Total	1
Impervious Land Use	acre
POND	0.2
Impervious Total	0.2
Basin Total	1.2

Element Flows To:

Surface	Interflow	Groundwater
Wetland	Wetland	

West Parking

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
PARKING FLAT	0.7
Impervious Total	0.7
Basin Total	0.7

Element Flows To:

Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

East Parking

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
PARKING FLAT	0.45
Impervious Total	0.45
Basin Total	0.45

Element Flows To:

Surface	Interflow	Groundwater
Detention Pond	Detention Pond	

Routing Elements
Predeveloped Routing

Mitigated Routing

Wetland

Bottom Length: 130.00 ft.
Bottom Width: 20.00 ft.
Depth: 3 ft.
Volume at riser head: 0.1692 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 3 To 1
Side slope 3: 5 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 2 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 0.55 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2
Detention Pond

Pond Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
135.00	0.059	0.000	0.000	0.000
135.03	0.060	0.002	0.001	0.000
135.07	0.061	0.004	0.002	0.000
135.10	0.062	0.006	0.002	0.000
135.13	0.062	0.008	0.003	0.000
135.17	0.063	0.010	0.003	0.000
135.20	0.064	0.012	0.003	0.000
135.23	0.065	0.014	0.004	0.000
135.27	0.066	0.016	0.004	0.000
135.30	0.066	0.019	0.004	0.000
135.33	0.067	0.021	0.004	0.000
135.37	0.068	0.023	0.005	0.000
135.40	0.069	0.025	0.005	0.000
135.43	0.070	0.028	0.005	0.000
135.47	0.070	0.030	0.005	0.000
135.50	0.071	0.032	0.005	0.000
135.53	0.072	0.035	0.006	0.000
135.57	0.073	0.037	0.006	0.000
135.60	0.074	0.040	0.006	0.000
135.63	0.075	0.042	0.006	0.000
135.67	0.075	0.045	0.006	0.000
135.70	0.076	0.047	0.006	0.000
135.73	0.077	0.050	0.007	0.000
135.77	0.078	0.052	0.007	0.000
135.80	0.079	0.055	0.007	0.000
135.83	0.080	0.058	0.007	0.000
135.87	0.080	0.060	0.007	0.000
135.90	0.081	0.063	0.007	0.000
135.93	0.082	0.066	0.007	0.000
135.97	0.083	0.069	0.008	0.000
136.00	0.084	0.071	0.008	0.000
136.03	0.085	0.074	0.008	0.000
136.07	0.086	0.077	0.008	0.000
136.10	0.086	0.080	0.008	0.000
136.13	0.087	0.083	0.008	0.000

136.17	0.088	0.086	0.008	0.000
136.20	0.089	0.089	0.009	0.000
136.23	0.090	0.092	0.009	0.000
136.27	0.091	0.095	0.009	0.000
136.30	0.092	0.098	0.009	0.000
136.33	0.092	0.101	0.009	0.000
136.37	0.093	0.104	0.009	0.000
136.40	0.094	0.107	0.009	0.000
136.43	0.095	0.110	0.009	0.000
136.47	0.096	0.114	0.009	0.000
136.50	0.097	0.117	0.010	0.000
136.53	0.098	0.120	0.010	0.000
136.57	0.099	0.123	0.010	0.000
136.60	0.100	0.127	0.010	0.000
136.63	0.100	0.130	0.010	0.000
136.67	0.101	0.133	0.010	0.000
136.70	0.102	0.137	0.010	0.000
136.73	0.103	0.140	0.010	0.000
136.77	0.104	0.144	0.010	0.000
136.80	0.105	0.147	0.011	0.000
136.83	0.106	0.151	0.011	0.000
136.87	0.107	0.154	0.011	0.000
136.90	0.108	0.158	0.011	0.000
136.93	0.109	0.161	0.011	0.000
136.97	0.109	0.165	0.011	0.000
137.00	0.110	0.169	0.011	0.000
137.03	0.111	0.172	0.076	0.000
137.07	0.112	0.176	0.194	0.000
137.10	0.113	0.180	0.345	0.000
137.13	0.114	0.184	0.521	0.000
137.17	0.115	0.188	0.715	0.000
137.20	0.116	0.192	0.919	0.000
137.23	0.117	0.195	1.127	0.000
137.27	0.118	0.199	1.330	0.000
137.30	0.119	0.203	1.522	0.000
137.33	0.120	0.207	1.696	0.000
137.37	0.121	0.211	1.847	0.000
137.40	0.122	0.215	1.972	0.000
137.43	0.122	0.219	2.072	0.000
137.47	0.123	0.224	2.151	0.000
137.50	0.124	0.228	2.240	0.000
137.53	0.125	0.232	2.313	0.000
137.57	0.126	0.236	2.384	0.000
137.60	0.127	0.240	2.452	0.000
137.63	0.128	0.245	2.519	0.000
137.67	0.129	0.249	2.585	0.000
137.70	0.130	0.253	2.648	0.000
137.73	0.131	0.258	2.710	0.000
137.77	0.132	0.262	2.771	0.000
137.80	0.133	0.266	2.830	0.000
137.83	0.134	0.271	2.889	0.000
137.87	0.135	0.275	2.946	0.000
137.90	0.136	0.280	3.002	0.000
137.93	0.137	0.284	3.056	0.000
137.97	0.138	0.289	3.110	0.000
138.00	0.139	0.294	3.163	0.000
138.03	0.140	0.298	3.216	0.000

Bioretention 1

Bottom Length:	120.00 ft.
Bottom Width:	4.00 ft.
Material thickness of first layer:	1.5
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	0
Material type for second layer:	Sand
Material thickness of third layer:	0
Material type for third layer:	GRAVEL
Underdrain used	
Underdrain Diameter (feet):	0.33
Orifice Diameter (in.):	0.5
Offset (in.):	0
Flow Through Underdrain (ac-ft.):	104.689
Total Outflow (ac-ft.):	112.174
Percent Through Underdrain:	93.33
Discharge Structure	
Riser Height:	1 ft.
Riser Diameter:	8 in.
Element Flows To:	
Outlet 1	Outlet 2
Wetland	

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
137.50	0.0385	0.0000	0.0000	0.0000
137.53	0.0382	0.0002	0.0000	0.0000
137.57	0.0375	0.0003	0.0000	0.0000
137.60	0.0369	0.0005	0.0000	0.0000
137.63	0.0363	0.0007	0.0000	0.0000
137.66	0.0356	0.0009	0.0006	0.0000
137.70	0.0350	0.0012	0.0009	0.0000
137.73	0.0343	0.0014	0.0013	0.0000
137.76	0.0337	0.0016	0.0018	0.0000
137.80	0.0331	0.0018	0.0024	0.0000
137.83	0.0325	0.0021	0.0031	0.0000
137.86	0.0318	0.0023	0.0039	0.0000
137.90	0.0312	0.0026	0.0043	0.0000
137.93	0.0306	0.0029	0.0044	0.0000
137.96	0.0300	0.0032	0.0046	0.0000
137.99	0.0293	0.0035	0.0048	0.0000
138.03	0.0287	0.0038	0.0049	0.0000
138.06	0.0281	0.0041	0.0051	0.0000
138.09	0.0275	0.0044	0.0052	0.0000
138.13	0.0269	0.0047	0.0054	0.0000
138.16	0.0263	0.0051	0.0055	0.0000
138.19	0.0257	0.0054	0.0056	0.0000
138.23	0.0251	0.0058	0.0058	0.0000
138.26	0.0244	0.0061	0.0059	0.0000
138.29	0.0238	0.0065	0.0060	0.0000
138.32	0.0232	0.0069	0.0062	0.0000
138.36	0.0226	0.0073	0.0063	0.0000
138.39	0.0220	0.0077	0.0064	0.0000
138.42	0.0214	0.0081	0.0065	0.0000
138.46	0.0209	0.0085	0.0066	0.0000
138.49	0.0203	0.0089	0.0067	0.0000

138.52	0.0197	0.0094	0.0069	0.0000
138.55	0.0191	0.0098	0.0070	0.0000
138.59	0.0185	0.0103	0.0071	0.0000
138.62	0.0179	0.0107	0.0072	0.0000
138.65	0.0173	0.0112	0.0073	0.0000
138.69	0.0167	0.0117	0.0074	0.0000
138.72	0.0162	0.0122	0.0075	0.0000
138.75	0.0156	0.0127	0.0076	0.0000
138.79	0.0150	0.0132	0.0077	0.0000
138.82	0.0144	0.0137	0.0078	0.0000
138.85	0.0139	0.0143	0.0079	0.0000
138.88	0.0133	0.0148	0.0080	0.0000
138.92	0.0127	0.0154	0.0081	0.0000
138.95	0.0121	0.0159	0.0082	0.0000
138.98	0.0116	0.0165	0.0083	0.0000
139.00	0.0110	0.0168	0.0107	0.0000

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	To Amended(cfs)	Infilt(cfs)
1.5000	0.0385	0.0168	0.0000	0.1333	0.0000
1.5330	0.0391	0.0181	0.0000	0.1333	0.0000
1.5659	0.0398	0.0194	0.0000	0.1392	0.0000
1.5989	0.0404	0.0207	0.0000	0.1421	0.0000
1.6319	0.0411	0.0220	0.0000	0.1451	0.0000
1.6648	0.0417	0.0234	0.0000	0.1480	0.0000
1.6978	0.0424	0.0248	0.0000	0.1509	0.0000
1.7308	0.0431	0.0262	0.0000	0.1538	0.0000
1.7637	0.0437	0.0276	0.0000	0.1568	0.0000
1.7967	0.0444	0.0291	0.0000	0.1597	0.0000
1.8297	0.0450	0.0305	0.0000	0.1626	0.0000
1.8626	0.0457	0.0320	0.0000	0.1656	0.0000
1.8956	0.0464	0.0335	0.0000	0.1685	0.0000
1.9286	0.0470	0.0351	0.0000	0.1714	0.0000
1.9615	0.0477	0.0366	0.0000	0.1744	0.0000
1.9945	0.0484	0.0382	0.0000	0.1773	0.0000
2.0275	0.0490	0.0398	0.0000	0.1802	0.0000
2.0604	0.0497	0.0415	0.0000	0.1832	0.0000
2.0934	0.0504	0.0431	0.0000	0.1861	0.0000
2.1264	0.0511	0.0448	0.0000	0.1890	0.0000
2.1593	0.0518	0.0465	0.0000	0.1919	0.0000
2.1923	0.0524	0.0482	0.0000	0.1949	0.0000
2.2253	0.0531	0.0499	0.0000	0.1978	0.0000
2.2582	0.0538	0.0517	0.0000	0.2007	0.0000
2.2912	0.0545	0.0535	0.0000	0.2037	0.0000
2.3242	0.0552	0.0553	0.0000	0.2066	0.0000
2.3571	0.0559	0.0571	0.0000	0.2095	0.0000
2.3901	0.0566	0.0590	0.0000	0.2125	0.0000
2.4231	0.0573	0.0609	0.0000	0.2154	0.0000
2.4560	0.0580	0.0628	0.0000	0.2183	0.0000
2.4890	0.0587	0.0647	0.0000	0.2212	0.0000
2.5220	0.0594	0.0666	0.0230	0.2222	0.0000
2.5549	0.0601	0.0686	0.0908	0.2222	0.0000
2.5879	0.0608	0.0706	0.1820	0.2222	0.0000
2.6209	0.0615	0.0726	0.2875	0.2222	0.0000
2.6538	0.0622	0.0746	0.3989	0.2222	0.0000
2.6868	0.0629	0.0767	0.5072	0.2222	0.0000
2.7198	0.0636	0.0788	0.6044	0.2222	0.0000
2.7527	0.0643	0.0809	0.6839	0.2222	0.0000

2.7857	0.0650	0.0830	0.7429	0.2222	0.0000
2.8187	0.0657	0.0852	0.7843	0.2222	0.0000
2.8516	0.0664	0.0874	0.8301	0.2222	0.0000
2.8846	0.0672	0.0896	0.8681	0.2222	0.0000
2.9176	0.0679	0.0918	0.9046	0.2222	0.0000
2.9505	0.0686	0.0940	0.9396	0.2222	0.0000
2.9835	0.0693	0.0963	0.9734	0.2222	0.0000
3.0000	0.0697	0.0975	1.0060	0.2222	0.0000

Surface retention 1

Element Flows To:

Outlet 1	Outlet 2
Wetland	Bioretention 1

Detention Pond

Bottom Length: 50.00 ft.
Bottom Width: 35.00 ft.
Depth: 4.85 ft.
Volume at riser head: 0.2806 acre-feet.
Side slope 1: 3.5 To 1
Side slope 2: 3.5 To 1
Side slope 3: 3.5 To 1
Side slope 4: 3.5 To 1
Discharge Structure
Riser Height: 3.85 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.047 ft.
Notch Height: 0.950 ft.
Orifice 1 Diameter: 1.51 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

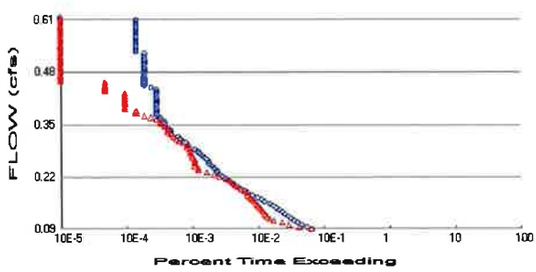
Pond Hydraulic Table

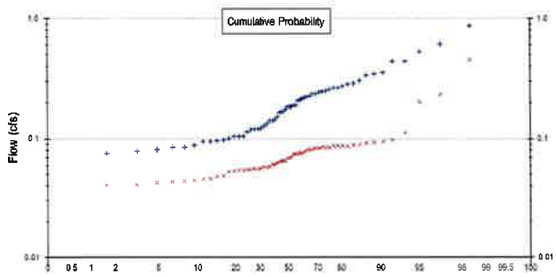
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
133.00	0.040	0.000	0.000	0.000
133.05	0.040	0.002	0.014	0.000
133.11	0.041	0.004	0.020	0.000
133.16	0.042	0.006	0.024	0.000
133.22	0.043	0.009	0.028	0.000
133.27	0.043	0.011	0.032	0.000
133.32	0.044	0.013	0.035	0.000
133.38	0.045	0.016	0.038	0.000
133.43	0.046	0.018	0.040	0.000
133.49	0.047	0.021	0.043	0.000
133.54	0.047	0.023	0.045	0.000
133.59	0.048	0.026	0.047	0.000
133.65	0.049	0.028	0.049	0.000
133.70	0.050	0.031	0.051	0.000
133.75	0.051	0.034	0.053	0.000
133.81	0.052	0.037	0.055	0.000
133.86	0.052	0.040	0.057	0.000
133.92	0.053	0.042	0.059	0.000
133.97	0.054	0.045	0.060	0.000
134.02	0.055	0.048	0.062	0.000
134.08	0.056	0.051	0.064	0.000
134.13	0.057	0.054	0.065	0.000
134.19	0.057	0.057	0.067	0.000
134.24	0.058	0.061	0.068	0.000
134.29	0.059	0.064	0.070	0.000
134.35	0.060	0.067	0.071	0.000
134.40	0.061	0.070	0.073	0.000
134.46	0.062	0.074	0.074	0.000
134.51	0.063	0.077	0.076	0.000
134.56	0.064	0.080	0.077	0.000
134.62	0.065	0.084	0.078	0.000
134.67	0.066	0.087	0.080	0.000
134.72	0.067	0.091	0.081	0.000
134.78	0.068	0.095	0.082	0.000

134.83	0.069	0.098	0.083	0.000
134.89	0.069	0.102	0.085	0.000
134.94	0.070	0.106	0.086	0.000
134.99	0.071	0.110	0.087	0.000
135.05	0.072	0.114	0.088	0.000
135.10	0.073	0.118	0.089	0.000
135.16	0.074	0.122	0.090	0.000
135.21	0.075	0.126	0.092	0.000
135.26	0.076	0.130	0.093	0.000
135.32	0.077	0.134	0.094	0.000
135.37	0.078	0.138	0.095	0.000
135.43	0.079	0.142	0.096	0.000
135.48	0.080	0.147	0.097	0.000
135.53	0.082	0.151	0.098	0.000
135.59	0.083	0.156	0.099	0.000
135.64	0.084	0.160	0.100	0.000
135.69	0.085	0.165	0.101	0.000
135.75	0.086	0.169	0.102	0.000
135.80	0.087	0.174	0.103	0.000
135.86	0.088	0.179	0.104	0.000
135.91	0.089	0.184	0.105	0.000
135.96	0.090	0.188	0.109	0.000
136.02	0.091	0.193	0.113	0.000
136.07	0.092	0.198	0.119	0.000
136.13	0.093	0.203	0.125	0.000
136.18	0.095	0.208	0.132	0.000
136.23	0.096	0.214	0.139	0.000
136.29	0.097	0.219	0.146	0.000
136.34	0.098	0.224	0.154	0.000
136.40	0.099	0.229	0.162	0.000
136.45	0.100	0.235	0.171	0.000
136.50	0.101	0.240	0.179	0.000
136.56	0.103	0.246	0.188	0.000
136.61	0.104	0.251	0.197	0.000
136.66	0.105	0.257	0.206	0.000
136.72	0.106	0.263	0.215	0.000
136.77	0.107	0.268	0.224	0.000
136.83	0.108	0.274	0.234	0.000
136.88	0.110	0.280	0.321	0.000
136.93	0.111	0.286	0.625	0.000
136.99	0.112	0.292	1.050	0.000
137.04	0.113	0.298	1.560	0.000
137.10	0.115	0.304	2.131	0.000
137.15	0.116	0.311	2.737	0.000
137.20	0.117	0.317	3.354	0.000
137.26	0.118	0.323	3.955	0.000
137.31	0.120	0.330	4.516	0.000
137.37	0.121	0.336	5.016	0.000
137.42	0.122	0.343	5.441	0.000
137.47	0.123	0.349	5.782	0.000
137.53	0.125	0.356	6.046	0.000
137.58	0.126	0.363	6.253	0.000
137.63	0.127	0.370	6.526	0.000
137.69	0.128	0.377	6.739	0.000
137.74	0.130	0.384	6.945	0.000
137.80	0.131	0.391	7.145	0.000
137.85	0.132	0.398	7.339	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 2.15
Total Impervious Area: 0.2

Mitigated Landuse Totals for POC #1
Total Pervious Area: 1
Total Impervious Area: 1.35

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.173146
5 year	0.281598
10 year	0.368994
25 year	0.49842
50 year	0.609458
100 year	0.733741

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.066993
5 year	0.097871
10 year	0.123348
25 year	0.162068
50 year	0.196211
100 year	0.2354

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.237	0.056
1950	0.273	0.075
1951	0.135	0.055
1952	0.169	0.044
1953	0.186	0.043
1954	0.439	0.065
1955	0.266	0.092
1956	0.119	0.083
1957	0.265	0.076
1958	0.526	0.061

1959	0.142	0.056
1960	0.191	0.069
1961	0.873	0.087
1962	0.168	0.049
1963	0.344	0.057
1964	0.141	0.048
1965	0.076	0.071
1966	0.085	0.053
1967	0.186	0.054
1968	0.185	0.070
1969	0.614	0.059
1970	0.128	0.065
1971	0.224	0.084
1972	0.306	0.055
1973	0.207	0.063
1974	0.249	0.078
1975	0.227	0.045
1976	0.122	0.054
1977	0.085	0.046
1978	0.098	0.055
1979	0.357	0.058
1980	0.151	0.046
1981	0.115	0.041
1982	0.105	0.095
1983	0.220	0.061
1984	0.145	0.094
1985	0.215	0.085
1986	0.335	0.232
1987	0.176	0.113
1988	0.122	0.087
1989	0.211	0.041
1990	0.101	0.085
1991	0.095	0.065
1992	0.167	0.075
1993	0.106	0.045
1994	0.088	0.081
1995	0.095	0.088
1996	0.234	0.090
1997	0.442	0.453
1998	0.243	0.058
1999	0.097	0.083
2000	0.245	0.088
2001	0.068	0.038
2002	0.082	0.085
2003	0.080	0.066
2004	0.282	0.089
2005	0.106	0.076
2006	0.289	0.098
2007	0.256	0.080
2008	0.191	0.202
2009	0.123	0.076

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8726	0.4533
2	0.6142	0.2319
3	0.5264	0.2020

4	0.4417	0.1131
5	0.4391	0.0978
6	0.3572	0.0955
7	0.3438	0.0942
8	0.3349	0.0924
9	0.3061	0.0904
10	0.2889	0.0889
11	0.2821	0.0879
12	0.2728	0.0878
13	0.2658	0.0875
14	0.2647	0.0874
15	0.2559	0.0854
16	0.2488	0.0851
17	0.2454	0.0850
18	0.2428	0.0843
19	0.2369	0.0833
20	0.2345	0.0829
21	0.2272	0.0810
22	0.2241	0.0805
23	0.2199	0.0781
24	0.2150	0.0763
25	0.2105	0.0762
26	0.2065	0.0756
27	0.1915	0.0752
28	0.1910	0.0751
29	0.1859	0.0706
30	0.1856	0.0700
31	0.1855	0.0689
32	0.1756	0.0662
33	0.1691	0.0654
34	0.1679	0.0650
35	0.1665	0.0649
36	0.1511	0.0633
37	0.1451	0.0611
38	0.1419	0.0610
39	0.1412	0.0590
40	0.1347	0.0583
41	0.1283	0.0578
42	0.1229	0.0573
43	0.1218	0.0564
44	0.1216	0.0562
45	0.1188	0.0553
46	0.1150	0.0551
47	0.1059	0.0548
48	0.1055	0.0544
49	0.1048	0.0541
50	0.1011	0.0529
51	0.0980	0.0486
52	0.0971	0.0480
53	0.0955	0.0464
54	0.0954	0.0462
55	0.0883	0.0449
56	0.0850	0.0445
57	0.0847	0.0438
58	0.0818	0.0428
59	0.0796	0.0411
60	0.0762	0.0410
61	0.0676	0.0380

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0866	1361	1356	99	Pass
0.0919	1143	891	77	Pass
0.0971	960	614	63	Pass
0.1024	831	483	58	Pass
0.1077	743	361	48	Pass
0.1130	670	314	46	Pass
0.1183	601	285	47	Pass
0.1235	539	265	49	Pass
0.1288	485	252	51	Pass
0.1341	436	236	54	Pass
0.1394	393	223	56	Pass
0.1447	353	209	59	Pass
0.1500	315	198	62	Pass
0.1552	264	184	69	Pass
0.1605	235	169	71	Pass
0.1658	204	159	77	Pass
0.1711	172	148	86	Pass
0.1764	146	139	95	Pass
0.1816	133	127	95	Pass
0.1869	115	115	100	Pass
0.1922	100	104	104	Pass
0.1975	88	94	106	Pass
0.2028	83	85	102	Pass
0.2081	73	79	108	Pass
0.2133	66	69	104	Pass
0.2186	61	55	90	Pass
0.2239	55	45	81	Pass
0.2292	50	35	70	Pass
0.2345	50	26	52	Pass
0.2397	45	26	57	Pass
0.2450	43	23	53	Pass
0.2503	38	23	60	Pass
0.2556	37	23	62	Pass
0.2609	35	23	65	Pass
0.2661	32	21	65	Pass
0.2714	31	21	67	Pass
0.2767	27	20	74	Pass
0.2820	26	20	76	Pass
0.2873	23	19	82	Pass
0.2926	19	18	94	Pass
0.2978	18	18	100	Pass
0.3031	17	15	88	Pass
0.3084	15	13	86	Pass
0.3137	14	12	85	Pass
0.3190	13	11	84	Pass
0.3242	10	10	100	Pass
0.3295	10	9	90	Pass
0.3348	10	9	90	Pass
0.3401	9	9	100	Pass
0.3454	8	8	100	Pass
0.3507	8	7	87	Pass
0.3559	8	7	87	Pass
0.3612	7	6	85	Pass

0.3665	7	5	71	Pass
0.3718	6	4	66	Pass
0.3771	6	3	50	Pass
0.3823	6	3	50	Pass
0.3876	6	2	33	Pass
0.3929	6	2	33	Pass
0.3982	6	2	33	Pass
0.4035	6	2	33	Pass
0.4088	6	2	33	Pass
0.4140	6	2	33	Pass
0.4193	6	2	33	Pass
0.4246	6	2	33	Pass
0.4299	6	1	16	Pass
0.4352	6	1	16	Pass
0.4404	5	1	20	Pass
0.4457	4	1	25	Pass
0.4510	4	1	25	Pass
0.4563	4	0	0	Pass
0.4616	4	0	0	Pass
0.4669	4	0	0	Pass
0.4721	4	0	0	Pass
0.4774	4	0	0	Pass
0.4827	4	0	0	Pass
0.4880	4	0	0	Pass
0.4933	4	0	0	Pass
0.4985	4	0	0	Pass
0.5038	4	0	0	Pass
0.5091	4	0	0	Pass
0.5144	4	0	0	Pass
0.5197	4	0	0	Pass
0.5250	4	0	0	Pass
0.5302	3	0	0	Pass
0.5355	3	0	0	Pass
0.5408	3	0	0	Pass
0.5461	3	0	0	Pass
0.5514	3	0	0	Pass
0.5566	3	0	0	Pass
0.5619	3	0	0	Pass
0.5672	3	0	0	Pass
0.5725	3	0	0	Pass
0.5778	3	0	0	Pass
0.5830	3	0	0	Pass
0.5883	3	0	0	Pass
0.5936	3	0	0	Pass
0.5989	3	0	0	Pass
0.6042	3	0	0	Pass
0.6095	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.0432 acre-feet
On-line facility target flow:	0.0682 cfs.
Adjusted for 15 min:	0.0682 cfs.
Off-line facility target flow:	0.0386 cfs.
Adjusted for 15 min:	0.0386 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
Detention Pond POC	☐	263.09			☐	0.00			
Wetland	☐	199.35			☐	0.00			
retention 1	☐	102.08			☐	0.00			
Total Volume Infiltrated		564.51	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 = Passed

Model Default Modifications

Total of 0 changes have been made.

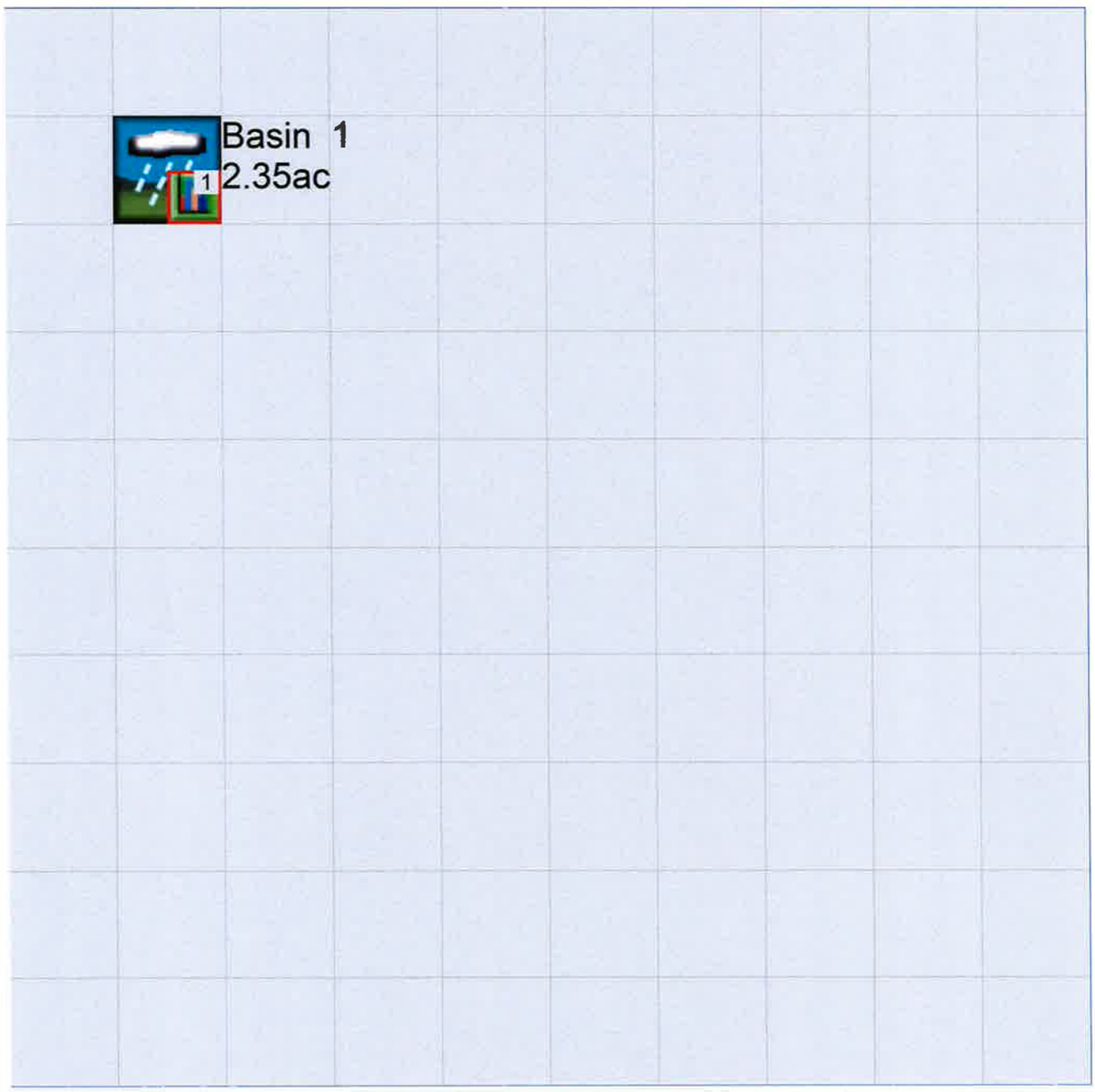
PERLND Changes

No PERLND changes have been made.

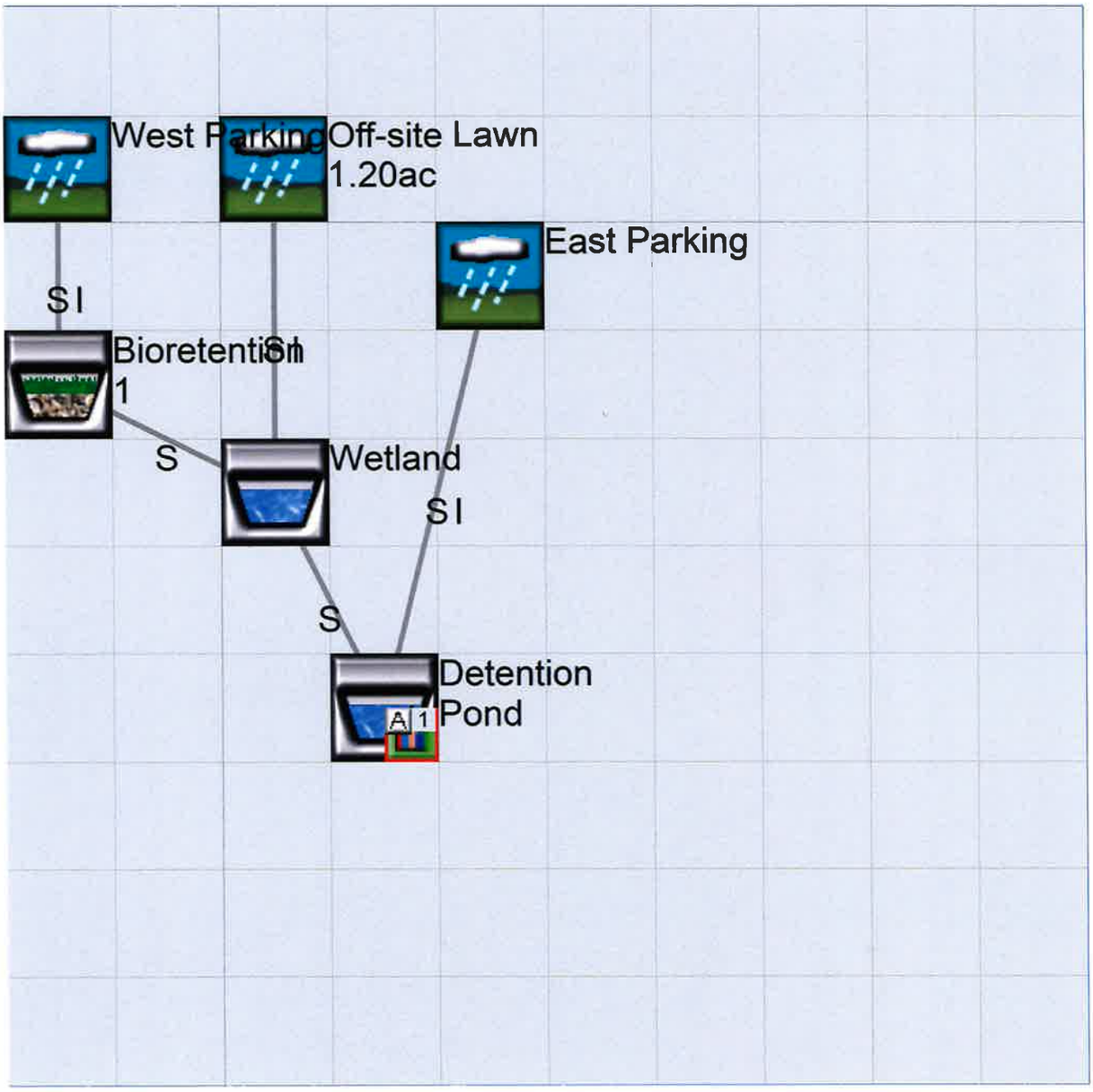
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



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WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Bioswale WQ Flowrate
Site Name:	
Site Address:	
City:	
Report Date:	1/19/2022
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	0.43
Pervious Total	0.43
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.43

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
PARKING FLAT	0.43
Impervious Total	0.43
Basin Total	0.43

Element Flows To:

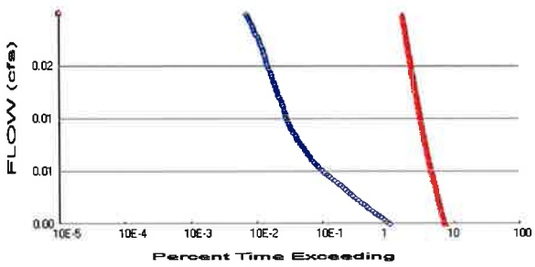
Surface	Interflow	Groundwater

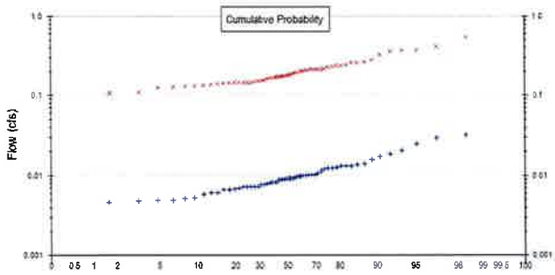
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.43
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0
Total Impervious Area: 0.43

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.009218
5 year	0.013643
10 year	0.016673
25 year	0.020581
50 year	0.023538
100 year	0.026526

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.18258
5 year	0.247024
10 year	0.294149
25 year	0.358963
50 year	0.411206
100 year	0.466958

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.005	0.187
1950	0.010	0.218
1951	0.008	0.214
1952	0.007	0.171
1953	0.005	0.225
1954	0.020	0.279
1955	0.014	0.213
1956	0.012	0.096
1957	0.014	0.164
1958	0.009	0.413

1959	0.010	0.170
1960	0.009	0.161
1961	0.009	0.538
1962	0.008	0.208
1963	0.010	0.235
1964	0.008	0.128
1965	0.009	0.149
1966	0.005	0.151
1967	0.011	0.366
1968	0.013	0.195
1969	0.010	0.366
1970	0.007	0.145
1971	0.010	0.204
1972	0.009	0.260
1973	0.007	0.214
1974	0.013	0.264
1975	0.007	0.204
1976	0.007	0.142
1977	0.006	0.144
1978	0.007	0.109
1979	0.013	0.240
1980	0.008	0.140
1981	0.007	0.144
1982	0.009	0.146
1983	0.012	0.193
1984	0.009	0.180
1985	0.012	0.259
1986	0.029	0.237
1987	0.013	0.212
1988	0.007	0.170
1989	0.006	0.176
1990	0.010	0.134
1991	0.010	0.175
1992	0.008	0.168
1993	0.005	0.132
1994	0.005	0.144
1995	0.010	0.135
1996	0.017	0.193
1997	0.032	0.206
1998	0.006	0.233
1999	0.009	0.108
2000	0.005	0.365
2001	0.002	0.132
2002	0.009	0.126
2003	0.007	0.170
2004	0.011	0.323
2005	0.008	0.152
2006	0.018	0.183
2007	0.016	0.181
2008	0.025	0.143
2009	0.008	0.154

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0322	0.5377
2	0.0295	0.4127
3	0.0247	0.3660

4	0.0204	0.3659
5	0.0182	0.3651
6	0.0169	0.3231
7	0.0155	0.2793
8	0.0138	0.2639
9	0.0136	0.2599
10	0.0132	0.2592
11	0.0131	0.2401
12	0.0130	0.2368
13	0.0126	0.2349
14	0.0123	0.2331
15	0.0122	0.2248
16	0.0120	0.2178
17	0.0112	0.2141
18	0.0107	0.2136
19	0.0102	0.2131
20	0.0101	0.2122
21	0.0101	0.2083
22	0.0099	0.2064
23	0.0099	0.2042
24	0.0097	0.2039
25	0.0096	0.1947
26	0.0095	0.1934
27	0.0093	0.1928
28	0.0092	0.1870
29	0.0092	0.1826
30	0.0091	0.1809
31	0.0091	0.1799
32	0.0090	0.1765
33	0.0089	0.1752
34	0.0088	0.1713
35	0.0087	0.1704
36	0.0082	0.1703
37	0.0081	0.1697
38	0.0081	0.1677
39	0.0080	0.1641
40	0.0078	0.1610
41	0.0077	0.1540
42	0.0077	0.1515
43	0.0073	0.1505
44	0.0072	0.1492
45	0.0072	0.1459
46	0.0072	0.1449
47	0.0072	0.1444
48	0.0069	0.1442
49	0.0068	0.1436
50	0.0066	0.1428
51	0.0066	0.1423
52	0.0061	0.1401
53	0.0061	0.1348
54	0.0058	0.1341
55	0.0054	0.1316
56	0.0052	0.1316
57	0.0051	0.1279
58	0.0050	0.1262
59	0.0049	0.1094
60	0.0047	0.1076
61	0.0016	0.0965

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0046	22629	157721	696	Fail
0.0048	20523	153721	749	Fail
0.0050	18576	150042	807	Fail
0.0052	16801	146813	873	Fail
0.0054	15150	143818	949	Fail
0.0056	13700	140974	1029	Fail
0.0058	12457	138300	1110	Fail
0.0059	11293	135712	1201	Fail
0.0061	10237	133252	1301	Fail
0.0063	9302	130835	1406	Fail
0.0065	8451	128418	1519	Fail
0.0067	7676	126173	1643	Fail
0.0069	6936	123969	1787	Fail
0.0071	6312	121745	1928	Fail
0.0073	5773	119542	2070	Fail
0.0075	5281	117382	2222	Fail
0.0077	4851	115350	2377	Fail
0.0079	4438	113318	2553	Fail
0.0081	4092	111307	2720	Fail
0.0082	3700	109275	2953	Fail
0.0084	3373	107243	3179	Fail
0.0086	3050	105340	3453	Fail
0.0088	2748	103393	3762	Fail
0.0090	2505	101490	4051	Fail
0.0092	2299	99565	4330	Fail
0.0094	2106	97704	4639	Fail
0.0096	1949	95907	4920	Fail
0.0098	1820	94153	5173	Fail
0.0100	1698	92571	5451	Fail
0.0102	1582	90988	5751	Fail
0.0103	1483	89512	6035	Fail
0.0105	1400	88122	6294	Fail
0.0107	1331	86774	6519	Fail
0.0109	1264	85470	6761	Fail
0.0111	1201	84186	7009	Fail
0.0113	1138	82903	7284	Fail
0.0115	1081	81662	7554	Fail
0.0117	1025	80507	7854	Fail
0.0119	956	79352	8300	Fail
0.0121	915	78262	8553	Fail
0.0123	879	77085	8769	Fail
0.0124	847	75973	8969	Fail
0.0126	810	74882	9244	Fail
0.0128	767	73749	9615	Fail
0.0130	731	72679	9942	Fail
0.0132	700	71717	10245	Fail
0.0134	676	70690	10457	Fail
0.0136	655	69770	10651	Fail
0.0138	639	68808	10768	Fail
0.0140	620	67867	10946	Fail
0.0142	605	66990	11072	Fail
0.0144	587	66091	11259	Fail
0.0146	573	65236	11384	Fail
0.0147	560	64380	11496	Fail

0.0149	551	63503	11525	Fail
0.0151	539	62691	11630	Fail
0.0153	523	61921	11839	Fail
0.0155	512	61129	11939	Fail
0.0157	497	60274	12127	Fail
0.0159	473	59504	12580	Fail
0.0161	457	58734	12852	Fail
0.0163	448	57921	12928	Fail
0.0165	438	57236	13067	Fail
0.0167	427	56509	13233	Fail
0.0168	417	55761	13371	Fail
0.0170	402	55055	13695	Fail
0.0172	396	54349	13724	Fail
0.0174	385	53686	13944	Fail
0.0176	374	52980	14165	Fail
0.0178	362	52317	14452	Fail
0.0180	355	51633	14544	Fail
0.0182	349	50927	14592	Fail
0.0184	338	50306	14883	Fail
0.0186	329	49708	15108	Fail
0.0188	320	49109	15346	Fail
0.0189	310	48531	15655	Fail
0.0191	306	47890	15650	Fail
0.0193	300	47312	15770	Fail
0.0195	296	46713	15781	Fail
0.0197	288	46114	16011	Fail
0.0199	283	45515	16083	Fail
0.0201	276	44938	16281	Fail
0.0203	270	44382	16437	Fail
0.0205	260	43847	16864	Fail
0.0207	253	43312	17119	Fail
0.0209	245	42756	17451	Fail
0.0211	239	42221	17665	Fail
0.0212	234	41730	17833	Fail
0.0214	227	41195	18147	Fail
0.0216	215	40660	18911	Fail
0.0218	205	40211	19615	Fail
0.0220	200	39740	19870	Fail
0.0222	195	39270	20138	Fail
0.0224	188	38821	20649	Fail
0.0226	184	38329	20830	Fail
0.0228	176	37858	21510	Fail
0.0230	170	37388	21992	Fail
0.0232	165	36938	22386	Fail
0.0233	159	36532	22976	Fail
0.0235	152	36126	23767	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

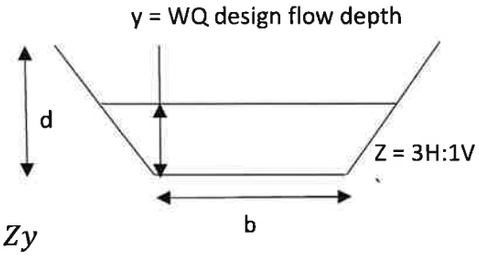
On-line facility volume:	0.0432 acre-feet
On-line facility target flow:	0.0682 cfs.
Adjusted for 15 min:	0.0682 cfs.
Off-line facility target flow:	0.0386 cfs.
Adjusted for 15 min:	0.0386 cfs.

Sunnyside Nursery

Continuous Inflow Biofiltration Swale Sizing (BMP T9.30)

Step 1: Solve for bottom width (b) at water quality design flow depth (y)

WQ Flow Rate (Q)	0.07	cfs (from WWHM)
n	0.24	(mowed infrequently)
y	0.3334	ft
Slope (s)	0.0075	ft/ft
Z	3	
b =	**1.04**	**ft**



Formula: $b = \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$

Minimum width b = 2 ft.

Design width b = 2.0 ft

Step 2: Check that flow velocity (V) at this bottom width (b) is less than 1 ft/s

Flow Area (A) = 1.00 ft^2

Formula: $A_{trapezoid} = by + zy^2$

Flow Velocity (V) =	0.07	ft/s < 1

Formula: $V = Q/A$

Step 3: Calculate minimum required bioswale length (L)

$$L = 60Vt$$

where: t = hydraulic residence time

t = 18 minutes (minimum) for continuous inflow

L = 75.6 ft

*Minimum bioswale length per code = 100 ft

Design length L = 170 ft

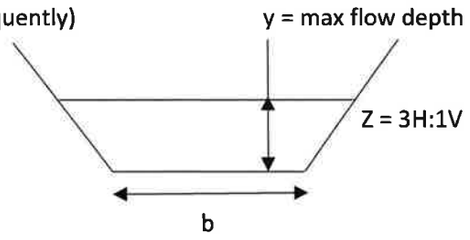
Step 4: Define final Biofiltration Swale dimensions

bottom width (b) =	2 ft
Lenth (L) =	170 ft
longitudinal slope (S) =	0.0075 ft/ft

Sunnyside Nursery - Bioswale Max. Capacity Check

Peak 100-Yr Flow to Bioswale (from WWHM) = **0.47 cfs**

n	0.24	(mowed infrequently)
y	**0.500**	ft
b	2.0	ft
Z	3.0	ft/ft
A	1.75	sf
Hyd Rad (R)	4.000	ft
S	0.0075	ft/ft



Qmax	**2.37 cfs**	**>> 0.47 cfs**

Formula= (1.49/n)*A*R^(2/3)*S^(1/2)

*Therefore, this biofiltration swale has more than enough capacity to convey the 100-year storm flow event without overflowing.

APPENDIX B

USDA WEB SOIL SURVEY DATA

Soil Map—Snohomish County Area, Washington

Map Scale: 1:736 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 35 70 140 210

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 23, Aug 31, 2021

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	2.4	100.0%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	0.0	0.0%
Totals for Area of Interest		**2.4**	**100.0%**