Stormwater Site Plan (SSP) Report

Tacoma Subaru MOD Facility

Prepared For

SDEV23-0202

Project Location

3812 S Tacoma Way

Tacoma, WA 98409

0220131004

Stormwater Site Plan Prepared By

Name	Organization	Contact Telephone Number	Email Address
Daniel Hendrickson	Hendrickson Engineering PLLC	253.514.2413	dan@hendricksoncc.com

Date Prepared

10/5/2023

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Notes for Preparer:

When completing the Stormwater Site Plan Report provide all required information in the textbox forms under each section and delete any sections from the report and appendices that are not applicable to the proposed project. Further information and guidance on the information required can be found in the comment bubbles to the right of each section. Once the report has been completed delete all comment bubbles and grey highlighted instructions, select the References tab and update the Table of Contents, and input the figure/table numbers and names in List of Figures and List of Tables under the contents page above.

1. Project Information

A. Project Contacts

See Title Page for Stormwater Site Plan Development Team

B. Property Owner

Name	Organization	Mailing Address	Contact Telephone Number	Email Address
(Insert Name)	Micky LLC	C/o Tacoma Subaru, PO Box 111270, Tacoma, WA 98411	253.468.2346	todd@toddwardllc.com

C. Applicant (if different than Property Owner)

Name	Organization	Mailing Address	Contact Telephone Number	Email Address
(Insert Name)	(Insert Name)	(Insert Address)	(Insert Phone Number)	(Insert Email Address)

D. Associated Permits

i) Associated City of Tacoma Permit Number(s)

SDEV23-0202

ii) Other Federal, State, or Local Associated Permit Types and Numbers

N/A

E. Vesting

i) City of Tacoma Stormwater Management Manual Edition Used

N/A

ii) If using a manual other than the most current version, provide vesting justification:

N/A

2. Project Overview

A. Provide a brief description of the proposed project.

This report accompanies the civil plans being submitted to the City of Tacoma for the construction of a new modification building at the Tacoma Subaru property on South Tacoma Way. Proposed improvements include the demolition of three existing buildings and associated appurtenances. After the new building is constructed, the surrounding asphalt lot will be regraded and repaved. Water quality and flow control storm improvements will be constructed, as well as associated landscaping and striping improvements. A site development permit through the City of Tacoma is required for this work.

The site is located at 3812 South Tacoma Way. See Vicinity Map in Appendix D, Exhibit D-1. The project site is located on tac parcel number 0220131004 and is approximately 44,200 square feet (1.015 AC) in area. Minor improvements will also take place on tax parcels 022131050 and 0220131135. The parcels are located in Section 13, Township 20, Range 02, Quarter 14.

3. Existing Project Site Conditions

A. Answer the following questions, provide additional description, and provide figures (if necessary) to describe the existing site conditions.

i) Describe in one or two sentences the existing project site use:

The existing project site is used as a used car sales lot. There are multiple small sales structures located on the project site. The project site is mostly covered by existing impervious surfaces.

ii) Describe in words or show on a figure the stormwater runoff patterns (natural and artificial) and the points where stormwater enters and exits the project site.

All stormwater runoff in the existing condition utilizes sheet flow conveyance to the east over the existing parking lot area. There are two existing catch basins located onsite near the east property boundary. These catch basins collect and convey all onsite stormwater into the City of Tacoma Stormwater Drainage System located within South Tacoma Way.

iii) Answer the following questions to help describe the existing site conditions. If Answer is Yes, include an associated figure(s) that shows location. Answers must be based upon site reconnaissance and readily available mapping data. See SWMM – Volume 2, Chapter 3 for resources.

Questions	**Answer**	**Data Source(s)**
Are groundwater protection areas located on the project site or within 500 feet of the project site?	☒Yes ☐No ☐Unknown	Tacoma DART Map
Are wetlands and/or their buffers located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are steep slopes located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are floodplains located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	FEMA Map 53053C0301E
Are streams located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are creeks located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are ravines located on the project site or within 500 feet of the project site?	☐Yes	Tacoma DART Map

	☒No ☐Unknown	
Are springs located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are any other sensitive areas or critical areas located on the project site or within 500 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are any structures located on the project site?	☒Yes ☐No ☐Unknown	Tacoma DART Map
Are any fuel tanks or other storage tanks (above or below-ground) located on the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are any groundwater wells located on the project site or within 100 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are any septic systems located on the project site or within 100 feet of the project site?	☐Yes ☒No ☐Unknown	
Are any Superfund sites located on the project site or within 100 feet of the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map
Are any Flood Hazard Areas located on the project site or within 100 feet of the project site?	☐Yes ☒No ☐Unknown	FEMA Map 53053C0301E
Is the project located in the South Tacoma Groundwater Protection District?	☒Yes ☐No ☐Unknown	Tacoma DART Map
Are any public or private easements located on the project site?	☐Yes ☒No ☐Unknown	Tacoma DART Map

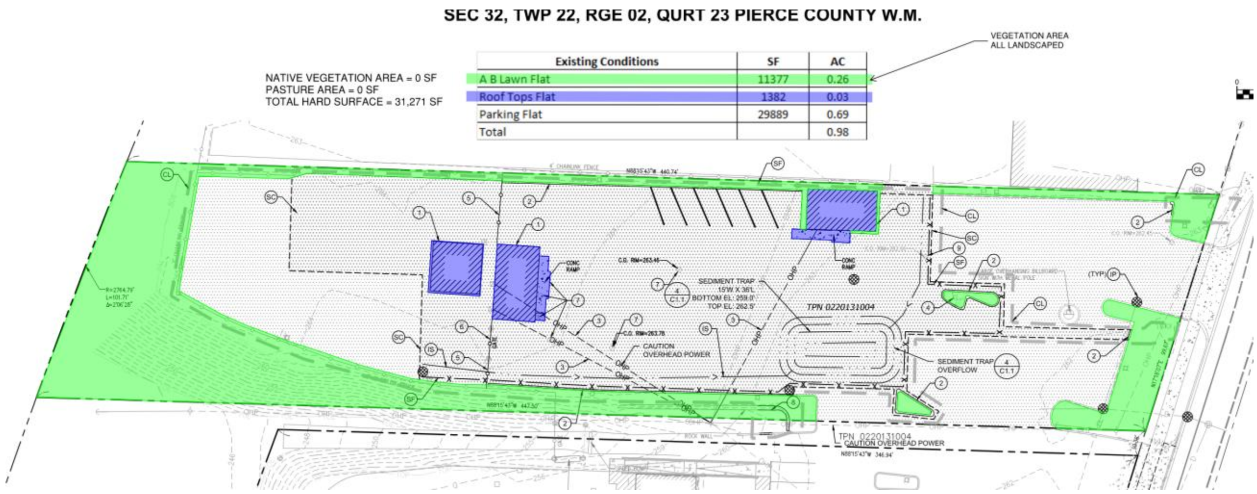
iv) Additional Information

N/A

B. Existing Project Site Condition Basin Map

i) Provide an existing conditions basin map

Existing Conditions Map A-1



Existing Conditions	SF	AC
A B Lawn Flat	11377	0.26
Roof Tops Flat	1382	0.03
Parking Flat	29889	0.69
Total		0.98

C. Downstream Flowpath – Existing Condition

Downstream Flow Path A-2

4. Proposed Project Site Conditions

A. Describe in words and provide figure(s) to describe the proposed project site conditions.

i) Describe in one or two sentences the proposed project site use:

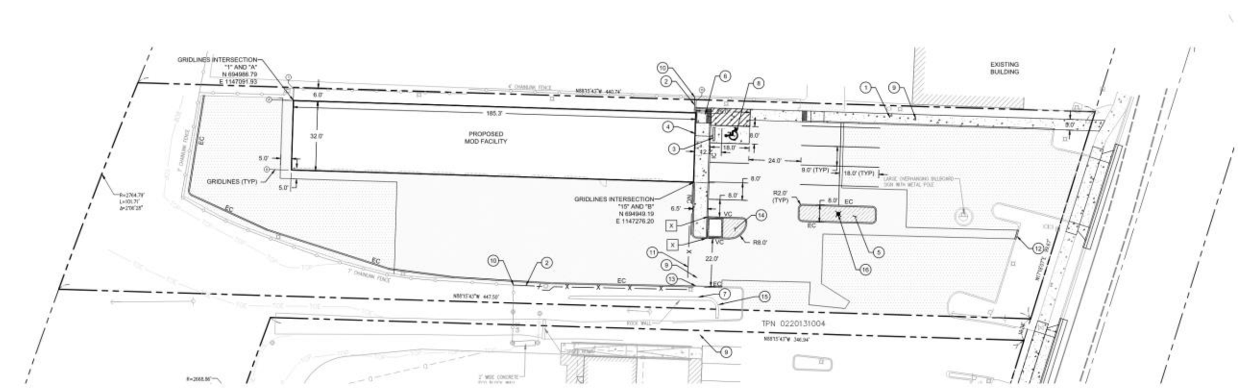
The proposed project site will develop the existing site with a new 5,000 SF MOD Facility for Tacoma Subaru. This facility shall be used to detail and modify cars.

ii) Describe in words or show on a figure the stormwater runoff patterns (natural and artificial) and the points where stormwater enters and exits the project site.

Stormwater runoff in the proposed condition shall be collected and conveyed to the onsite infiltration facility. This facility shall be centrally located on the property. All hard surfaces on the west side of the site as well as centrally located shall be collected and conveyed to this system. All areas located on the east portion of the project site shall be conveyed to the east and discharged into the existing stormwater system.

iii) Provide a figure showing:
- the proposed improvements (buildings, sidewalks, parking lots, utilities, etc.),
- fuel tanks (above and below ground) that are proposed or will remain in place, proposed groundwater wells on the project site
- proposed septic systems
- proposed public and private easements

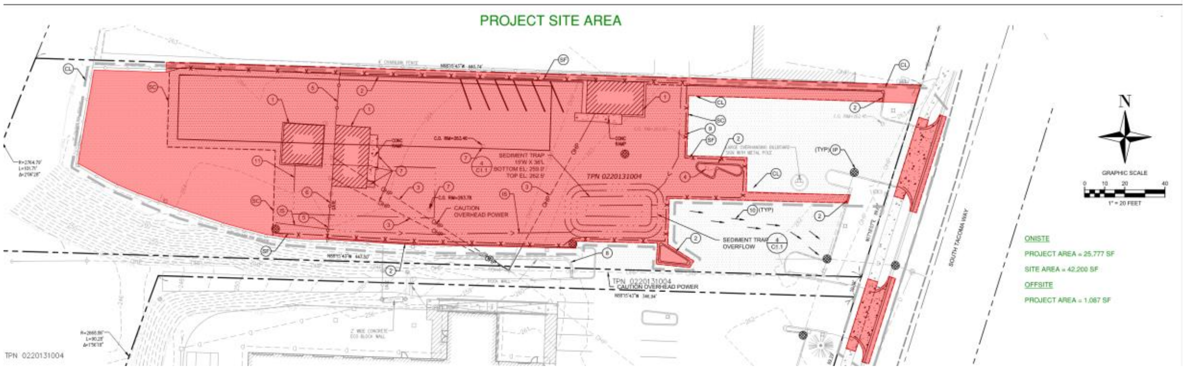
Developed Conditions Map A-3

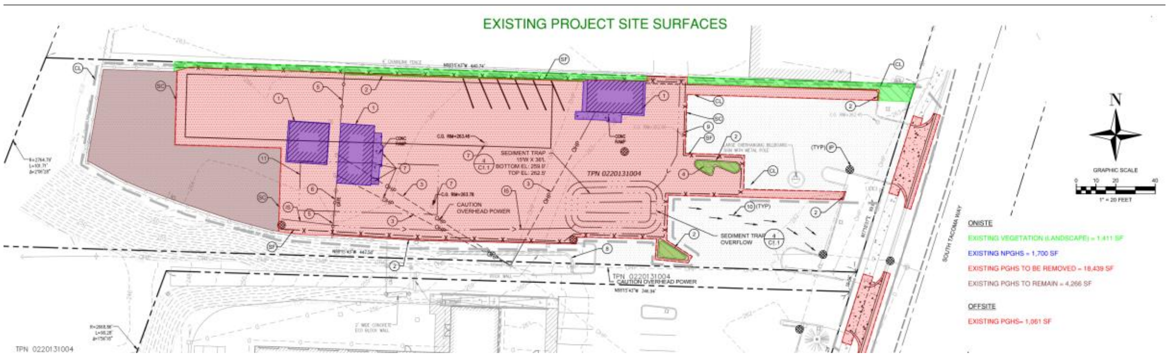


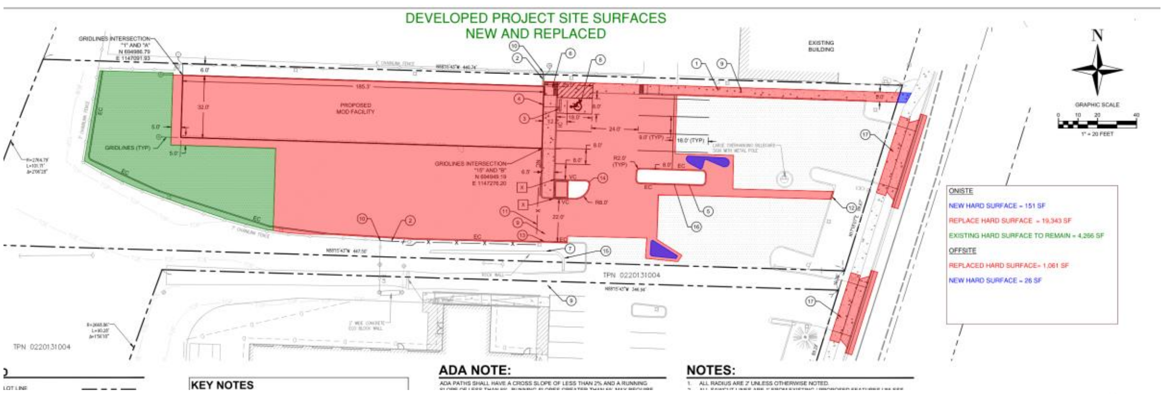
iv) Additional Information
N/A

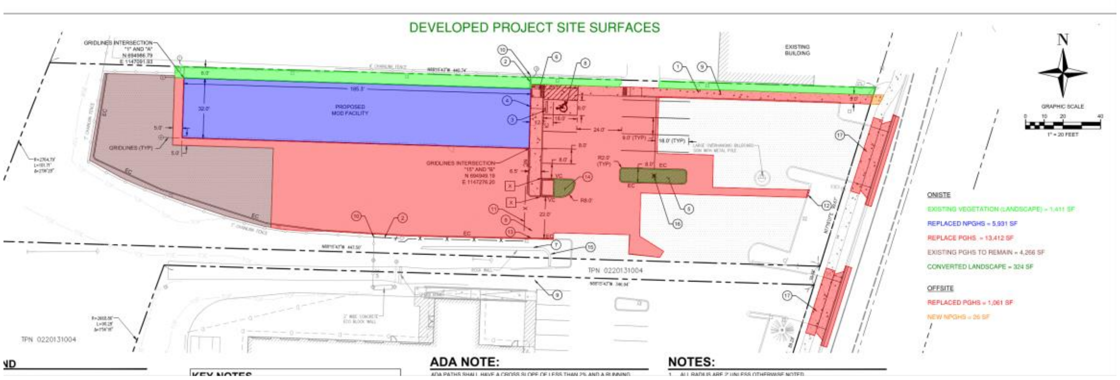
B. Proposed Project Site Condition Basin Map

Proposed Conditions Maps A-4









C. Downstream Flowpath – Proposed Condition

The downstream flow path in the proposed condition is not changed by the proposed development.

5. Minimum Requirement Determination

A. Table 1 - Project Thresholds

Table Notes - Do Not Copy Into SSP	Surface Type	Onsite	Offsite	Total	Project Notes
See Glossary - Project Site	Total Project Site Area (ft^2)	25777	1087	26864	
See Glossary - Site	Total Site Area (ft^2)	44200	1087	45287	
				0	
See Glossary - Hard Surface	Existing Hard Surface Area (ft^2)	24366	1061	25427	
See Glossary - Native Vegetation	Existing Native Vegetation Area (ft^2)	0	0	0	
See Glossary - Vegetation	Existing Vegetation Area (ft^2)	1411	0	1411	
See Glossary - Lawn/Landscaped	Existing Lawn/Landscaped Area (ft^2)	1411	26	1437	
See Glossary - Pasture	Existing Pasture Area (ft^2)	0	0	0	
Equals E5/E2 * 100. <35% is considered new development; equal to or greater than 35% is redevelopment	Existing Hard Surface Coverage (%)	0.945261279	0.976080957		
See Glossary - New Hard Surface and Pollution Generating Hard Surface If>5,000 and E33<50%, MR#6 and MR#9 applies to new PGHS only and this is amount of PGHS that requires treatment.	New Pollution Generating Hard Surface Area (ft^2)	151	0	151	
See Glossary - New Hard Surface. This will be all other new hard surfaces that are not PGHS.	New Non-Pollution Generating Hard Surface Area (ft^2)		26	26	
(E12+E13)	Total New Hard Surface Area (ft^2)	151	26	177	
See Glossary - Replaced Hard Surface and Pollution Generating Hard Surface	Replaced Pollution Generating Hard Surface Area (ft^2)	13412	1061	14473	
See Glossary - Replaced Hard Surface. This will be all other replaced hard surfaces that are not PGHS.	Replaced Non-Pollution Generating Hard Surface Area (ft^2)	5931	0	5931	
(E15+E16)	Total Replaced Hard Surface Area (ft^2)	19343	1061	20404	
(E14+E17) >2,000 - Review MR #1-5 >5,000 - Review MR#1-9	Total of New Plus Replaced Hard Surface Area (ft^2)	19494	1087	20581	
(E12+E15) >5,000 and B29>50%, MR#6 and MR#9 applies to new and replaced PGHS and this is amount of PGHS that requires treatment.	Total of New Plus Replaced Pollution Generating Hard Surface Area (ft^2)	13563	1061	14624	
See Glossary - Vegetation, Lawn Area, and Landscaped Areas If >32,670 - Review MR#1-#9	Amount of Vegetation Converted to Lawn/Landscaped Area (ft^2)	0	0	0	
See Glossary - Native Vegetation and Pasture If >108,900 - Review MR#1-#9	Amount of Native Vegetation Converted to Pasture (ft^2)	0	0	0	
(E18+E20+E21) The total hard surface and converted vegetation areas that require compliance with MRs if B29>50%. Typically the amount of area requiring flow control if flow control is required.	Total of New Plus Replaced Hard Surfaces and Converted Vegetation Areas (ft^2)	19494	1087	20581	
(E14+E20+E21) The total hard surface and converted vegetation areas that require compliance with MRs if E29<50%. Typically the amount of area requiring flow control if flow control is required.	Total of New Hard Surfaces and Converted Vegetation Areas (ft^2)	151	26	177	
See Glossary - Hard Surface and Vegetation	Amount of Existing Hard Surface Converted to Vegetation (ft^2)	324	0	324	
See Glossary - Native Vegetation	Amount of Native Vegetation to Remain (ft^2)	0	0	0	
See Glossary - Vegetation	Amount of Existing Vegetation to Remain (ft^2)	1237	0	1237	
See Glossary - Existing Hard Surface	Amount of Existing Hard Surface to Remain (ft^2)	4266	0	4266	
See Glossary - Lawn/Landscaped Areas	Amount of Existing Lawn/Landscaped to Remain (ft^2)	1237	0	1237	
See Glossary - Pasture	Amount of Existing Pasture to Remain (ft^2)	0	0	0	
See Glossary - Land Disturbing Activities If >7,000 - Review MR#1-5	Amount of Land Disturbing Activity (ft^2)	25777	1087	26864	
Construction Cost Estimates of proposed improvements and building improvements - including interior improvements.	Value of Proposed Improvements ($)	450000	20,000	470000	
Per Pierce County Auditor	Assessed value of Existing Project Site Improvements ($)	1018800	20,000	1038800	
(E31/E32 * 100) If >50%: new hard surfaces, replaced hard surfaces, and converted vegetation areas shall be comply with MR#1-9 as applicable. If <50%: Only New Hard Surfaces and Converted Vegetation Areas Comply with MR#1-9 as applicable.	Proposed Improvements Compared to Existing Project Site Improvements (%)	0.441696113	1	0.452445129	

B. Table 2- Receiving Waterbody Table

Foss Waterway

C. Table 3 – Minimum Requirements Required

MR #1-5, 6 and 9

D. Cumulative Impacts

i. Cumulative Impacts

To the best of our knowledge this table is not relevant to the proposed project.

E. Flowcharts

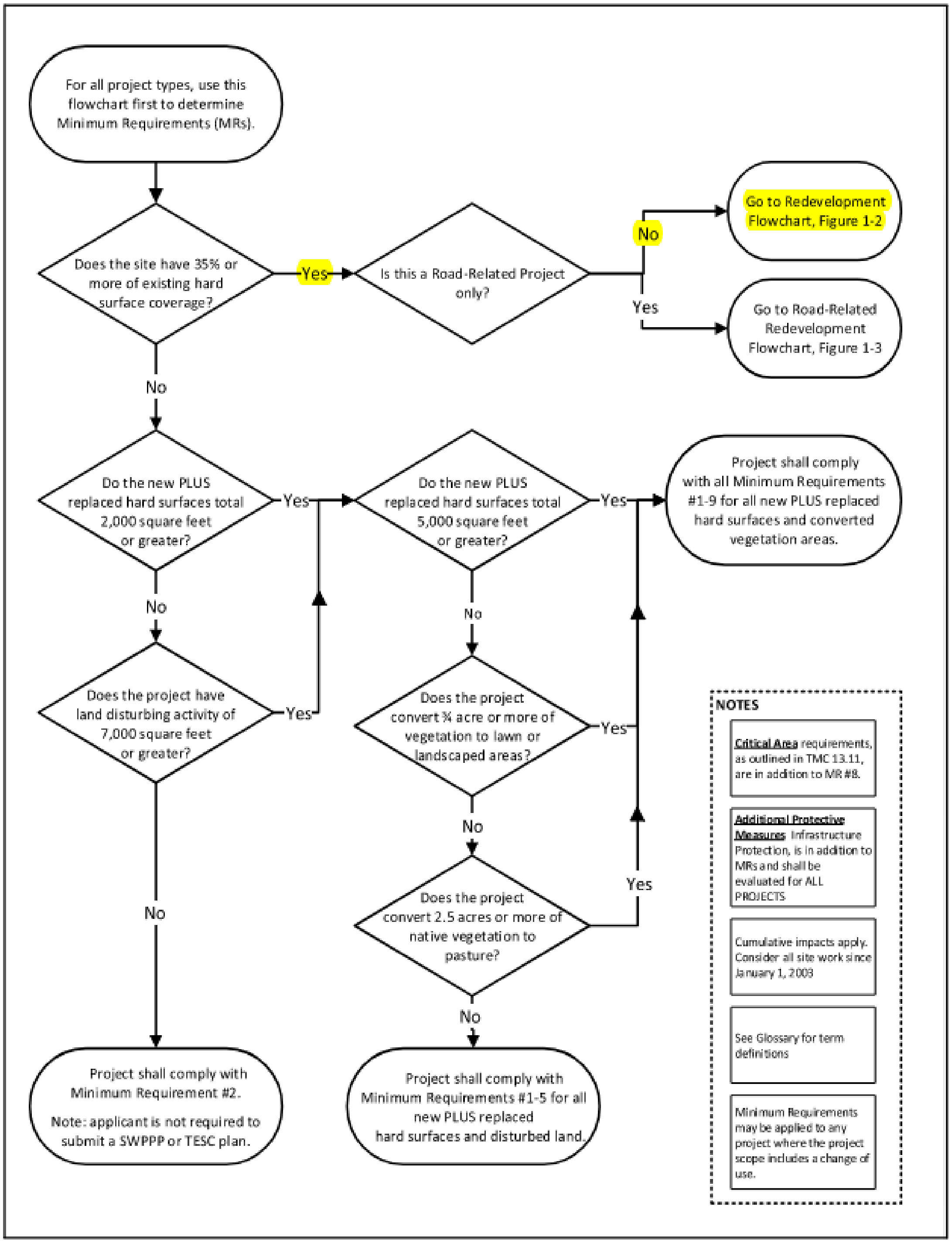


Figure 1 - 1: All Projects and New Development Flowchart

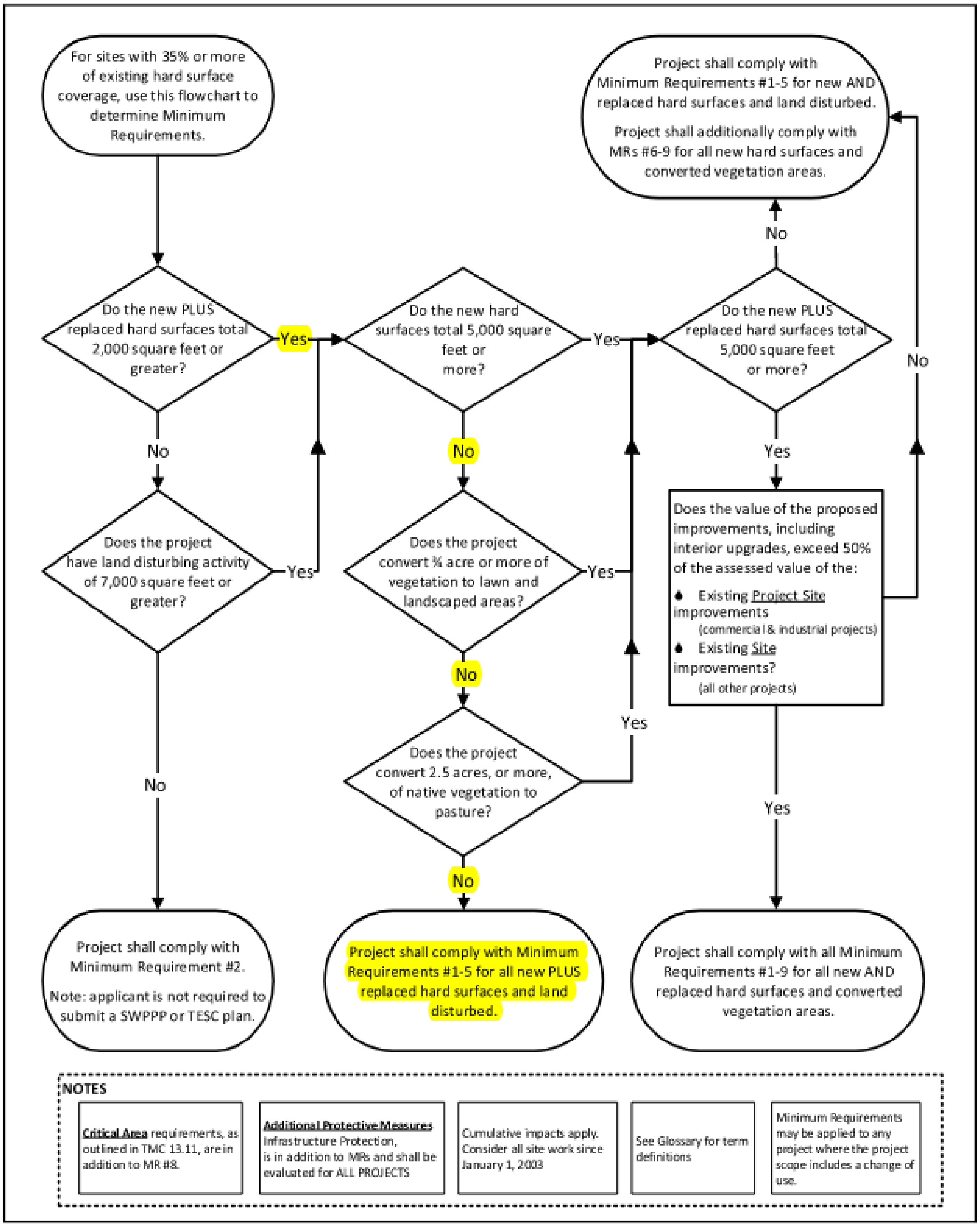


Figure 1 - 2: Redevelopment Flowchart

6. Discussion of Minimum Requirements

A. Minimum Requirement #1 – Preparation of a Stormwater Site Plan

This Stormwater Site Plan Report and the Tacoma Subaru Mod Facility Civil Drawings are being used to meet Minimum Requirement #1.

Description of Site Appropriate Development Principles

Where practicable, projects shall use the following site appropriate development principles. Put a checkmark next to the principles that will be used for the project. Project design is not required to be changed in order to accommodate site appropriate development principles, but where feasible, these principles must be used. If none of the site development principles are feasible, place a checkmark next to that box below.

☒ Minimization of land disturbance by fitting development to the natural terrain.

☒ Minimization of land disturbance by confining construction to the smallest area feasible and away from critical areas.

☒ Preservation of natural vegetation.

☐ Locating impervious surfaces over less permeable soils.

☒ Clustering buildings.

☐ Minimizing impervious surfaces.

☐ Site appropriate development principles are not practicable because of project design.

B. Minimum Requirement #2 – Construction Stormwater Pollution Prevention Plan

The Construction Stormwater Pollution Prevention Plan is available as a stand-alone document as part of the Permit submittal.

C. Minimum Requirement #3 – Source Control

i. Description of Final Site Use

The developed site shall be used to detail and modify vehicles. As well as store vehicles in the parking lot area as in the existing condition.

ii. Source Control BMPs

BMP S102: Formation of a Pollution Prevention team
BMP S103: Preventative Maintenance/Good Housekeeping
BMP S104: Spill Prevention and Cleanup
BMP S105: Employee Training
BMP S106: Inspections
BMP S107: Record Keeping
BMP S108: Washing Best Management Practices for All Activities
BMP S109: Cleaning or Washing of Tools, Equipment, and Machinery
BMP S114: Loading and Unloading Areas for Liquid and Solid Material
BMP S121: Parking and Storage for Vehicles and Equipment
BMP S127: Building Repair, Remodeling, and Construction
BMP S128: Roof and Building Drains
BMP S129: Roof Vents
BMP S134: De-Icing and Anti-Icing Operations for Streets and Highways
BMP S135: Streets
S139: Stormwater System Maintenance
BMP S140: Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots
BMP S142: Soil Erosion and Sediment Control at Commercial and Industrial Sites
BMP S143: Landscaping and Lawn/Vegetation Management
BMP S162: Proper Disposal

D. Minimum Requirement #4 – Preserving Drainage Patterns and Outfalls

i. Description of Drainage Patterns and Outfalls

In the existing condition stormwater runoff utilizes sheet flow dispersion to the east. Stormwater is then collected within the onsite stormwater drainage system and conveyed to the The of Tacoma stormwater drainage system. From here stormwater is conveyed northeast and discharged into the Foss Waterway. Based on onsite soils, before development it is likely that stormwater was infiltrated into the existing soils.

ii. Description of Concentrated and/or Increased Volume or Flowrate and Mitigation

In the mitigated condition stormwater runoff form the proposed developments shall be collected into the proposed stormwater drainage system and conveyed to the proposed infiltration trench located onsite. By doing so, stormwater flow rates leaving the site are greatly reduced as the new infiltration facility has been sized to infiltrate 100% of stormwater runoff produced by the proposed improvements.

E. Minimum Requirement #5 – Onsite Stormwater Management

This project will utilize: LID

The proposed project shall meet the LID Performance standard by utilizing BMP L602 Full Infiltration (Using the Stormtech Chamber systems) as well and BMP L613 Post-Construction Soil

Quality and Depth. Please see the attached WWHM calculations. In order to meet the LID performance standard a portion of the existing hard surface to remain shall be directed towards the infiltration facility while some of the replace hard surface shall be bypassed. Please see the Basin Maps above for reference to these areas.

The stormwater infiltration system has been designed using a native design infiltration ate of 0.50 in/hr. This rate is conservative compared to the 10 to 2 in/hr called out within the Geotechnical report. The reason for using this conservative infiltration rate is that this project is requesting a modification from the infiltration rate testing standards per the COT. Testing the native infiltration rate onsite presents many challenges as the location of the proposed infiltration facility is encumbered by existing building and utilities. The site is currently being utilized by the owner as a car sales lot and there is limited room to perform the required testing.

It is our opinion that using this conservative infiltration rate should be acceptable for this project.

F. Minimum Requirement #6 – Stormwater Treatment

i. Description of Compliance Need

Treatment for this project site is required based on the site located and proposed infiltration facility. The site shall utilize a modular wetland facility to meet Basic treatment requirements onsite.

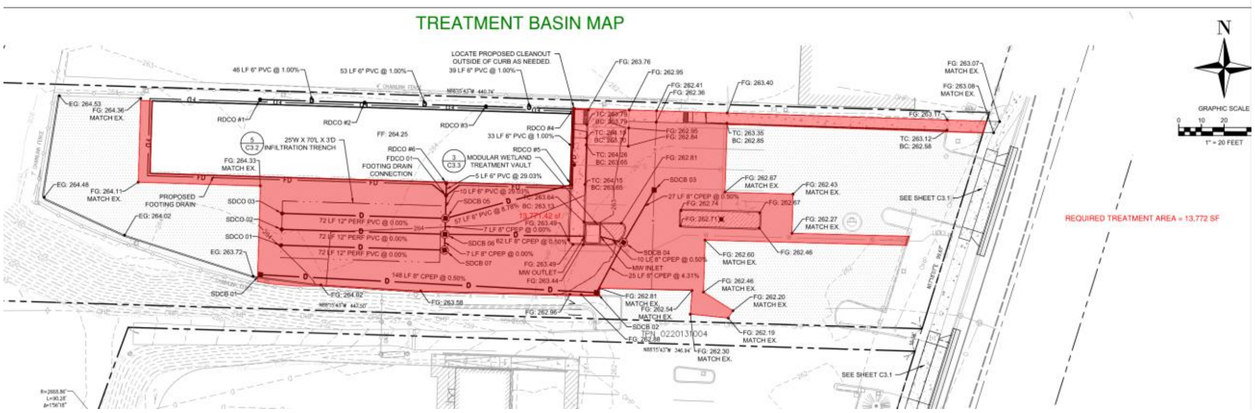
ii. Compliance Mechanism(s)

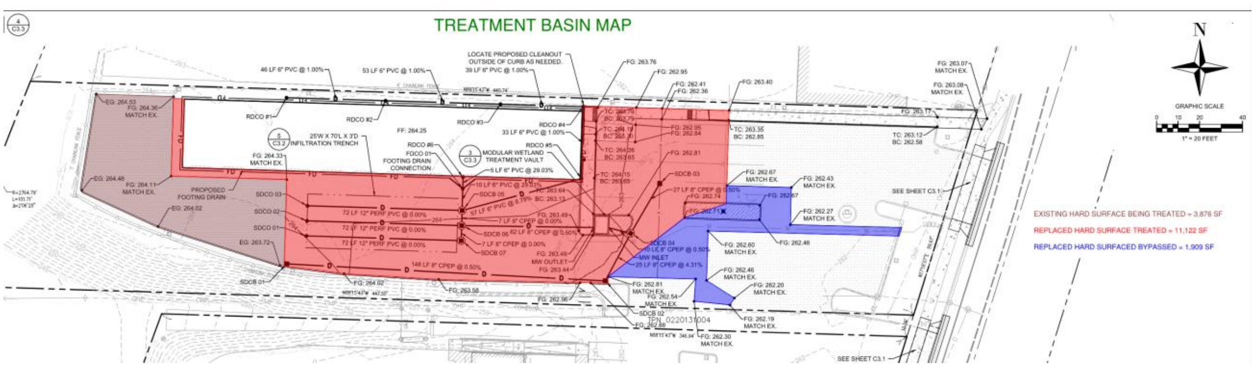
a. Treatment type required

The site is located within the Groundwater Protection area of Tacoma and therefore is required to meet Basic Treatment Requirements.

b. Stormwater treatment basin map

Treatment Basin Map





c. State the BMP(s) being used.

Modular Wetland MWS-L-6-8-V-UG

G. Minimum Requirement #7 – Flow Control

i. <u>Description of Compliance Need</u>

This project is not required to meet MR #7, However by meeting the LID Performance Standard MR #7 is achieved.

H. Minimum Requirement #8 – Wetlands Protection

To the best of our knowledge there are no known wetlands located on or near the proposed project site.

I. Minimum Requirement #9 – Operation and Maintenance

The Operation and Maintenance Manual is available as a stand-alone document as part of the Permit submittal.

7. Additional Protective Measure – Infrastructure Protection

A. Description of Compliance Need

Infrastructure protection measures and calculation should not be required for this project as the existing volume of runoff leaving the project site is being reduced. Therefore, existing City infrastructure should benefit from the proposed project.

8. Conveyance System Design

A. Include all information necessary to show how the conveyance system was designed.

Conveyance of this drainage system will consist of 6-inch downspout lines, 8-inch lines in the parking area, and 4-inch for the footing drains. The parking area contributing to the parking storm system totals 16,700 square feet (0.383 acre). Using the rational method with an asphalt (c=0.9) land cover and a minimum time of concentration, 25-year storm (I=2.81 iph), this would produce a runoff of 0.97 cfs. An 8-inch plastic pipe at 0.75 percent grade has a full flow capacity of 1.02 cfs.

The maximum amount of roof going to the roof collector is just over half the building, 5,930 square feet (0.134 acre). With the same rational method inputs as above, this produces a runoff of 0.34 cfs. A 6-inch plastic pipe at 50 percent capacity sloping at 1 percent grade has a flow capacity of 0.36 cfs.

Both the roof downspout collector and the parking lot pipes will be adequate to convey the 25-year storm flows.

A full backwater analysis for this size of project should not be required. The proposed development will utilize 3 new catch basins. Each contributing area to these catch basins are less than a quarter acre which is industry standard for Type 1 catch basin collection areas. Utilizing the Mannings equation to demonstrate pipe depth is a conservative approach for such a small system. Further the WWHM model has been utilized to show 100% infiltration of stormwater runoff being collected by the proposed conveyance system.

Tacoma Subaru MOD

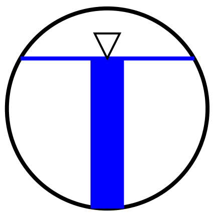
4.13.2013

Results

Flow, Q (See notes)	1.0264	cfs
Velocity, v	3.6188	ft/sec
Velocity head, h_v	0.0620	m H2O
Flow area	0.2836	ft^2
Wetted perimeter	1.4032	ft
Hydraulic radius	0.2021	ft
Top width, T	0.5802	ft
Froude number, F	0.91	
Average shear stress (tractive force), tau	0.0631	psf

Inputs

Pipe diameter, d_0	.67	ft
Manning roughness, n	0.01	
Pressure slope (possibly ? equal to pipe slope), S_0	.005	rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	75	%



Tacoma Subaru MOD

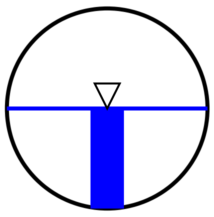
4.13.2013

Inputs

Pipe diameter, d_0	.5	ft
Manning roughness, n	0.01	
Pressure slope (possibly ? equal to pipe slope), S_0	.01	rise/run
Percent of (or ratio to) full depth (100% or 1 if flowing full)	50	%

Results

Flow, Q (See notes)	0.3647	cfs
Velocity, v	3.7148	ft/sec
Velocity head, h_v	0.0654	m H2O
Flow area	0.0982	ft^2
Wetted perimeter	0.7854	ft
Hydraulic radius	0.1250	ft
Top width, T	0.5000	ft
Froude number, F	1.48	
Average shear stress (tractive force), tau	0.0780	psf



Appendices

A. Soils Report

The Soils Report is available as a stand-alone document as part of the Permit submittal. It is titled: Tacoma Subaru Addition, Associated Earth Sciences Incorporated, March 12, 2018

associated earth sciences incorporated

Subsurface Exploration and Geotechnical Engineering Evaluation

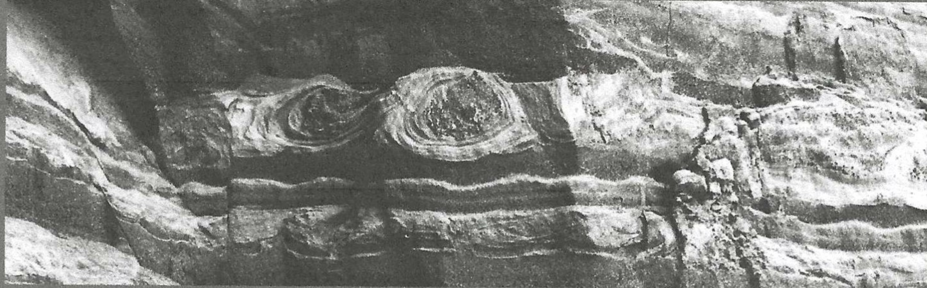
TACOMA SUBARU ADDITION

Tacoma, Washington

Prepared For:

BRUCE TITUS AUTOMOTIVE GROUP

Project No. 170536E001
March 12, 2018



Associated Earth Sciences, Inc.
911 5th Avenue
Kirkland, WA 98033
P (425) 827 7701
F (425) 827 5424

associated earth sciences incorporated

March 12, 2018
Project No. 170536E001

Bruce Titus Automotive Group
6221 Tacoma Mall Boulevard
Tacoma, Washington 98409

Attention: Todd Ward, Owner's Representative

Subject: Subsurface Exploration and Geotechnical Engineering Evaluation
Tacoma Subaru Addition
3838 South Tacoma Way
Tacoma, Washington

Dear Mr. Ward:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this report describing our subsurface exploration and geotechnical engineering evaluation concerning the planned Tacoma Subaru building addition in Tacoma, Washington. Our services were completed in general accordance with our proposal dated September 26, 2017, and were authorized by the owner's signature on September 29, 2017.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington

James M. Brisbine, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer

JMB/ld
170536E001-3
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SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

TACOMA SUBARU ADDITION

Tacoma, Washington

Prepared for:
Bruce Titus Automotive Group
6221 Tacoma Mall Boulevard
Tacoma, Washington 98409

Prepared by:
Associated Earth Sciences, Inc.
1552 Commerce Street, Suite 102
Tacoma, Washington 98402
253-722-2992
Fax: 253-722-2993

March 12, 2018
Project No. 170536E001

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1.0 PROJECT AND SITE DESCRIPTION

The project site consists of an existing automobile dealership located in South Tacoma, as shown on the attached "Vicinity Map" (Figure 1). This facility occupies three contiguous parcels that are visually delineated by a Sound Transit railroad on the west, by South Tacoma Way on the east, and by commercial properties on the north and south. The combined parcels form a roughly rectangular shape that measures approximately 450 feet by 600 feet overall and encompasses about 3.7 acres. Presently, the site is occupied by a main sales and service building, along with several ancillary structures. The remainder of the site is mostly covered with asphaltic pavement. Our attached "Site and Exploration Plan" (Figure 2) illustrates certain site boundaries and existing features.

Development plans call for constructing a new automotive parts and service building addition on the site. According to a conceptual layout plan prepared by Feltus Hawkins Design, this new addition will be located immediately north of the main building. It will be a single-story, at-grade or split-level structure, likely imposing relatively low foundation and floor loads. Most of the existing asphaltic pavement will remain in place. Figure 2 shows the proposed building addition in context with existing features. We understand that stormwater runoff will be infiltrated onsite if soil conditions are found to be suitable; if not, then runoff will be conveyed to the municipal drainage system.

2.0 PURPOSE AND SCOPE

Associated Earth Sciences, Inc. (AESI) performed this study to characterize subsurface conditions below the site, such that we can derive geotechnical conclusions and recommendations concerning the proposed improvements. Our scope of work included the following tasks.

- Reviewed topographic maps, geologic maps, site layout drawings, aerial photos, survey plans, and other available information pertaining to the site vicinity.
- Performed a visual surface reconnaissance of the site and immediate surroundings.
- Advanced four exploration borings (designated EB-1 through EB-4) to a maximum depth of about 26½ feet, at strategic locations across the site.
- Installed one groundwater monitoring well (designated EB-2w) to a depth of about 20 feet in a selected borehole.
- Visually classified all soil samples obtained from our explorations.
- Conducted one laboratory grain-size (sieve) test on a representative sample of the on-site soils.

- Analyzed all research, field, and laboratory data in context with the proposed site improvements.
- Prepared this report summarizing our geotechnical findings, conclusions, and recommendations.

Figure 2 shows the locations of all subsurface explorations with respect to existing and proposed site features. Appendix A contains our exploration logs, and Appendix B contains our laboratory testing data.

3.0 FIELD EXPLORATION PROCEDURES

We explored subsurface conditions at the site on October 27, 2017. The number, locations, and depths of our explorations were completed within the constraints of surface access, utility conflicts, and project budgets. Our exploration procedures are described below. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. Soil contact depths shown on the logs should be regarded as only an approximation; the actual changes between sediment types are often gradational and/or undulating.

The conclusions and recommendations presented in this report are based, in part, on conditions encountered by our explorations completed for this study. Due to the nature of subsurface exploratory work, it is necessary to interpolate and extrapolate soil conditions between and beyond the field explorations. Differing subsurface conditions could be present outside the area of the explorations due to the random nature of deposition and the alteration of topography by past grading activities. The nature and extent of any variations between the field explorations might not become fully evident until construction begins. If variations are observed at that time, it could be necessary to modify specific conclusions or recommendations in this report.

3.1 Exploration Borings

All exploration borings were performed by Holocene Drilling, Inc., working under subcontract to AESI. Each boring was completed by advancing an 8-inch outside-diameter, hollow-stem auger with a truck-mounted drill rig. During the drilling process, disturbed but representative soil samples were obtained at 2½- or 5-foot-depth intervals using the Standard Penetration Test (SPT) procedure in accordance with the *American Society for Testing and Materials* (ASTM) specification D-1586. After completion of drilling, each borehole was backfilled with bentonite chips, and the surface was patched with concrete.

The SPT testing and sampling procedure consists of driving a standard, 2-inch outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches represents the Standard Penetration Resistance (also known as the "N-value"). If a total of 50 blows is reached within one 6-inch interval, the N-value is recorded as 50 blows for the corresponding number of inches of penetration. The N-value provides a measure of the relative density of granular soils or the relative consistency of cohesive soils. Higher N-values correspond to a denser or stiffer soil. Our measured N-values are plotted on the exploration boring logs presented in Appendix A.

All exploration borings were continuously observed and logged by an AESI geologist. The materials obtained from the split-barrel sampler were classified in the field, and representative portions were placed in watertight containers. These soil samples were then transported to our office for further visual classification and/or laboratory testing. The soil descriptions shown on our exploration logs are generally based on a combination of factors, such as N-values, drilling action, field observations, and laboratory test results.

3.2 Monitoring Wells

Our groundwater monitoring well was installed by Holocene Drilling, Inc. in conjunction with our exploration borings. This well consists of a 2-inch-diameter plastic casing with a finely slotted screen near the bottom to allow water inflow. The annular space around the well screen was backfilled with clean sand, and the upper portion of annulus was sealed with bentonite chips and concrete. A flush-mounted steel monument was placed over the top of the wellhead for protection. The as-built well configuration is illustrated on the boring logs in Appendix A. Following installation, an AESI representative developed the well by adding several well-volumes of water. We also installed an electronic data-logger in the well casing to allow for continuous monitoring of future groundwater levels.

4.0 SITE CONDITIONS

The following text sections describe current site conditions, including development features, regional and local topography, regional geology, local soils, and local groundwater. Our sources of information include topographic and geologic maps published by the U.S. Geological Survey (USGS), a site survey map prepared by Apex Engineers, and aerial photographs published by Google Earth.

4.1 Development Features

Presently, the eastern part of the site is occupied by a single-story, high-bay, concrete-walled, main building, as well as several small, single-story, ancillary buildings. Asphalt-paved driveways and parking lots cover the remainder of the site. The proposed building addition footprint overlies an existing ancillary building and part of an existing parking lot. The foundation of the main building appears to be adequately supported; we did not observe any obvious indications of settlement, such as cracking, tilting, or warping in the exterior walls.

The existing asphaltic pavements appear to be in fair to good condition. We observed several large cracks directly north of the existing main building (in the vicinity of borings EB-2 and EB-3), but other areas of pavement were generally free of cracks. Our exploration borings revealed about 2 to 2½ inches of asphalt concrete pavement covering the parking lots, underlain by a crushed gravel base course of 3 to 4 inches.

4.2 Regional and Local Topography

The project site is located on the western edge of a broad glacial terrace, and immediately east of the "Nalley Valley" topographic trough. Regional surface grades across this terrace are flat to slightly undulating, with a gradual slope downward from east to west. Surface elevations range from about 235 feet within the trough, to 260 feet or more on the terrace. Existing grades across the proposed building footprint reflect this regional gradient; surface elevations rise approximately from 257 to 261 feet in a west-to-east direction.

4.3 Regional Geology

The draft USGS *Geologic Map of the Tacoma South Quadrangle, Pierce County, Washington* (1:24,000 scale) indicates that the project site and adjacent areas are underlain by Vashon-age recessional outwash sediments. These sediments normally comprise a loose to medium dense, well-sorted mixture of sands, gravels, and/or cobbles, with a total thickness ranging from several feet to several tens of feet. Recessional outwash is typically underlain by dense to very dense, glacial lodgement till, and the geologic map shows Vashon-age lodgement till exposed on the hill located east of the site. The recessional outwash at this site is believed to have scoured into older glacial deposits during ice recession and, as such, directly overlies Vashon-age advance outwash (Esperance Sand). These sand deposits are slightly older than the Vashon lodgement till and were deposited as deltaic deposits into a proglacial (ice-dammed) lake occupying the Puget Lowland during glacial advances.

4.4 Local Soils

Our subsurface explorations confirmed the presence of glacially deposited recessional outwash below the site, as shown on the regional geology map. We also encountered surficial fill soils in one borehole. These various soils are discussed below, and the exploration logs contained in Appendix A provide additional information concerning observed soil conditions.

Surficial Fill: Boring EB-2 disclosed approximately 7 feet of fill soils underlying the southwestern corner of the proposed building footprint. These fill soils consisted of brown, medium to coarse sandy gravel to gravelly medium to coarse sand with a trace of silt. They were likely reworked or placed here during past site grading activities.

Recessional Outwash: Below the pavement and/or surficial fill, all four of our borings revealed native recessional outwash comprising a mixture of loose to dense sands, gravelly sands, and sandy gravels. A few soil samples also included small quantities of silt. This outwash deposit ranged from about 5 to 11 feet thick at our boring locations.

Advance Outwash: Underlying the recessional outwash, at a depth of about 7½ to 12½ feet below existing grades, all four of our exploration borings encountered dense, subtly to distinctly stratified sands with varying amounts of silt and scattered gravel dropstones. We interpret this deposit to be Vashon-age advance outwash deltaic deposits (locally known as Esperance Sand). The advance outwash extended beyond our maximum exploration depth of 26½ feet, and it has been observed to have a total thickness ranging from several tens of feet to a few hundred feet in the Puget Sound region.

4.5 Local Groundwater

At the time of drilling (October 27, 2017), none of our exploration borings encountered groundwater within their maximum termination depth (26½ feet). Subsequent checks of our on-site monitoring well EB-2w in November, December, and January also found dry conditions to a depth of 20 feet or more. Groundwater levels typically rise during the wet season and fluctuate over long periods of time due to changes in precipitation patterns, on-site and off-site development, and other factors. However, it is difficult to predict whether the seasonal high water level will rise to the elevation of our monitoring well. For this reason, AESI will be monitoring on-site groundwater levels throughout the 2017-18 wet season by means of an electronic data-logger.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our surface reconnaissance, subsurface explorations, and document research, we conclude that the proposed site improvements are feasible from a geotechnical standpoint, contingent on proper design implementation and construction practices. Our geotechnical conclusions and recommendations concerning general considerations, site preparation, foundations, slab-on-grade floors, retaining walls, pavements, and structural fill are presented herein.

Specification Codes: The following reference documents are cited for specification purposes within subsequent report sections.

- ASTM: Refers to the latest manual published by the *American Society for Testing and Materials* (ASTM).
- WSDOT: Refers to the 2016 edition of *Standard Specifications for Road, Bridge, and Municipal Construction* published by the Washington State Department of Transportation (WSDOT).

5.1 General Considerations

We offer the following comments, conclusions, and recommendations concerning general geotechnical design issues affecting the overall project.

Geological Hazards: Our evaluation did not reveal any geological hazards associated with steep slopes, erosion zones, landslide zones, or abandoned landfills in the site vicinity. In addition, we infer that the dense advance outwash sediments and other glacially overridden soil deposits underlying the site represent a negligible hazard with respect to seismically induced liquefaction. Earthquake activity is obviously a widespread hazard throughout Western Washington, but the risk of associated shaking and ground rupture does not appear to be any higher at this site than elsewhere in the region. Consequently, the proposed site improvements are not constrained by any prevailing geological hazards, in our opinion.

Foundation Support: Our subsurface explorations encountered loose to medium dense recessional outwash (gravelly sands and sandy gravels) underlying the proposed building addition footprint at fairly shallow depths. In our opinion, these native outwash soils are suitable for supporting the new addition on conventional spread footings, although some degree of subgrade improvement will be needed below all footings, and localized remedial measures will be needed in areas of uncontrolled fill soils.

Closure Pours: Because some gradual settlement of the new addition is inevitable, differential settlements will occur relative to the existing main building. This differential settlement will be most apparent at the contact line between the existing and new structures. To minimize the adverse effects of such differential settlement, we recommend that any closure pours connecting the existing and new structures be delayed as long as practical in the construction process.

Drainage Considerations: Due to the coarse-grained soil conditions and absence of observed shallow groundwater levels at the site, surface and near-surface seepage water will tend to percolate downward rather than collecting near or below on-site structures. Therefore, we infer that conventional perimeter foundation drains will not be needed around the new building addition. The use of such drains can be considered optional at the discretion of the project civil engineer and/or architect. Nonetheless, final site grades should be sloped so that surface water flows away from the building rather than ponding near the foundation walls.

Earthwork Scheduling: Our explorations indicate that the on-site soils generally have a high sand and gravel content and a low silt content. These native soils tend to be relatively insensitive to changes in moisture content and can be used during a variety of weather conditions. As such, earthwork does not necessarily need to be scheduled for the dry season. It should be noted, however, that the native outwash might contain localized silty zones that become difficult to use during wet weather.

Seismic Site Class: The 2015 *International Building Code* (IBC) assigns a seismic Site Class on the basis of geological conditions prevailing within a depth of 100 feet below the local ground surface. Although our subsurface explorations did not extend to such a depth, we infer from shallower soil observations and from available geologic maps that the subsurface conditions correspond to Site Class "D" as defined by the IBC.

Infiltration Potential: The native recessional outwash and advance outwash deposits underlying the site appear to be favorable receptor soils for stormwater infiltration, due to their relatively high permeability. Also, on-site groundwater levels were observed to be fairly low (more than 27½ feet below existing grades) at the time of this study. We therefore conclude that the use of an infiltration trench or other shallow system would be feasible for on-site stormwater disposal, as long as the wintertime groundwater table remains sufficiently low to provide an adequate thickness of unsaturated soil below the infiltration subgrade. AESI will be monitoring on-site groundwater levels throughout the 2017-18 wet-season in order to further assess this feasibility.

Infiltration Rates: Although our scope of work did not include field infiltration testing as needed to establish a design value for an on-site infiltration system, we are able to derive tentatively estimated values on the basis of our soil texture observations, laboratory sieve test, and local experience. For preliminary system sizing purposes, a design rate in the range of 2 to 10 inches per hour can be assumed, with the faster rates generally corresponding to a shallow system and the slower rates generally corresponding to a deeper system. Prior to final design, one or more field infiltration tests should be performed at the planned system location and depth.

5.2 Site Preparation

Preparation of the project site will involve tasks such as temporary drainage, stripping, cutting, erosion control, and subgrade compaction. The paragraphs below present our geotechnical comments and recommendations concerning these various site issues.

Site Demolition: We anticipate that initial site preparation will involve demolition or removal of all existing features located within the new building footprint. We recommend that any underground foundation elements or abandoned utilities be removed as part of this work. Removal of any underground storage tanks, if present, would require special environmental oversight; AESI is available to assist with such a task upon request.

Well Decommissioning: Our field exploration program for this project included the installation of a ground water monitoring well. This well can be used by the future construction contractor to measure on-site ground water levels before and during earthwork, if desired. Once the well is no longer needed, it should be decommissioned by a licensed well driller in accordance with *Washington Administrative Code* (WAC) 173-160. We recommend that all decommissioning activities be included in the contractor's scope of work.

Temporary Drainage: Any sources of surface or near-surface water that could potentially enter the construction zones should be intercepted and diverted before stripping and excavating activities begin. We tentatively anticipate that a system of temporary swales, berms, or curbs placed around the construction zone will adequately intercept most off-site surface water runoff. Because the selection of an appropriate drainage system will depend on the actual water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding temporary drainage details are best made in the field at the time of construction.

Clearing and Stripping: After surface and near-surface water sources have been controlled, the construction zone should be cleared and stripped of all existing sod, topsoil, pavements, and other surface features. Our exploration borings disclosed about 2 to 2½ inches of asphaltic pavement in the new building footprint. However, the actual thicknesses could vary considerably from one location to another.

Weather Considerations: The native outwash soils do not appear to be especially sensitive to moisture changes and wet weather. However, they can become saturated and difficult to use during periods of heavy precipitation. During the summer months, sprinkling will likely be needed to moisture-condition soils for compaction purposes and dust control.

Erosion Control Measures: Because stripped surfaces and soil stockpiles are typically a source of runoff sediments, they should be given particular attention. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion. Similarly, soil stockpiles and cut slopes should be covered with plastic sheeting for erosion protection. We also recommend that silt fences, berms, and/or swales be maintained around stripped areas and stockpiles in order to capture runoff water and thereby reduce the downslope sediment transport. Stripped areas should be revegetated as soon as possible, also reducing the potential for erosion.

5.3 Spread Footings

In our opinion, conventional spread footings could be used for supporting the new building addition if general subgrade improvements and localized remediation are performed where needed. We offer the following comments and recommendations concerning design and construction of spread footings.

Footing Depths and Widths: For frost and erosion protection, the bottoms of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bottoms of interior footings need bear only 12 inches below the surrounding slab or crawl-space level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 18 and 24 inches wide, respectively. It should be noted, however, that greater depths or widths might be needed for other reasons, as determined by the project structural engineer.

Bearing Provisions: We recommend that all footings gain support from the native, loose to medium dense, recessional outwash soils underlying the site. Suitable bearing soils were observed at a shallow depth in most explored locations. After the footing excavations have been completed, we recommend that the exposed subgrade soils be compacted to a uniformly firm and unyielding condition using a vibratory roller or hydraulic oscillator ("hoe-packer"). Where localized zones of uncontrolled fill soils are observed in the subgrade (such as at the location of EB-2), these materials should be overexcavated and then be recompacted or replaced with granular fill. Regardless of type, all fill should be compacted to a density of at least 95 percent of the maximum dry density (per ASTM D-1557).

Bearing Capacities: Based on the bearing provisions described above, we recommend that all footings be designed for the following maximum allowable bearing capacities. These values are stated in pounds per square foot (psf), and they incorporate static and transient (wind or seismic) safety factors of at least 2.0 and 1.5, respectively. Due to the thickness of the recessional outwash deposit, it does not appear economically practical to achieve higher bearing capacities for this project.

Static Allowable Bearing Capacity:	3,000 psf
Transient Allowable Bearing Capacity:	4,000 psf

Footing Setbacks: For stability purposes, footings should not be placed near steep slopes or steps in the bearing soils. We specifically recommend keeping all footings at least 3 feet behind any slopes, and also behind a 0.75H:1V (Horizontal:Vertical) line extending upward from the toe of any retaining walls. Furthermore, utility trenches, footing trenches, and other excavations should not encroach on a 1.0H:1V influence line extending downward from any existing footing. If the new building location requires localized excavations very close to any existing footings, proper underpinning or shoring should be provided. Upon request, we can supply specific underpinning or shoring recommendations for specific situations at the site.

Footing Settlements: We estimate that total post-construction settlements of properly designed footings bearing on a properly prepared subgrade will not exceed 1 inch. Differential settlements between new foundation elements over horizontal spans on the order of 50 feet could approach ¾ inch. In all cases, these settlements would be reduced if the actual design bearing pressures are lower than our recommended maximum allowable pressures.

Footing and Stemwall Backfill: To provide erosion protection and lateral load resistance, we recommend that backfill be placed on both sides of the footings and stemwalls after the concrete has cured. Either on-site or imported granular soils can be used for this purpose. All footing and stemwall backfill soil should be compacted to a uniform density of at least 90 percent (based on ASTM D-1557).

Lateral Resistance: Footings and stemwalls that have been properly backfilled as described above will resist lateral loads by means of both passive earth pressure and base friction. We recommend using the following allowable values. These earth pressures are stated in pounds per cubic foot (pcf), and they incorporate static and transient (wind or seismic) safety factors of at least 1.5 and 1.1, respectively. Allowable base friction, which includes a safety factor of 1.5, can be combined with the respective passive pressure to resist static and transient loads.

Allowable Static Passive Pressure:	300 pcf
Allowable Transient Passive Pressure:	400 pcf
Base Friction Coefficient:	0.35

Subgrade Verification and Construction Monitoring: Footings should never be cast atop loose, soft, organic, or frozen soil, slough, debris, uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by an AESI representative before any concrete is placed. Furthermore, all subgrade remediation work should be continuously monitored and/or tested by an AESI representative.

5.4 Slab-On-Grade Floors

Because floor slabs typically carry a light load in comparison to building foundations, they allow more latitude concerning support options. We offer the following comments and recommendations for slab-on-grade floors.

Floor Sections: A conventional slab-on-grade floor section typically comprises a reinforced concrete slab over a vapor retarder over an aggregate base course over a granular subbase course. Assuming that the slab has a conventional thickness on the order of 4 inches and is subjected to typical loads, we recommend the following underslab layers (top to bottom) and minimum thicknesses for floors in the new building addition.

Vapor Retarder:	10 mils
Base Course:	4 inches

Subgrade Preparation: After the floor footprint has been excavated as needed to accommodate the above-recommended floor section, the exposed subgrade should be compacted to a firm and unyielding condition using a heavy vibratory roller. Any localized zones of soft, organic-rich, or saturated soils revealed during compaction should be overexcavated and replaced with granular structural fill.

Base Course: The base course serves as both a capillary break layer and a leveling layer for the floor slab. Ideally, the base course would consist of clean, uniform, well-rounded gravel, such as pea gravel, $^5/_8$-inch washed rock, or $^7/_8$-inch washed rock. It would also be acceptable to use a washed, angular gravel or crushed rock for this purpose. In all cases, the base course should be lightly compacted with a static roller or vibratory sled to create a firm, smooth surface.

Vapor Retarder: A vapor retarder consists of heavy-duty plastic sheeting that is placed between the base course and floor slab. In our opinion, a vapor retarder provides a significant benefit by reducing the amount of ground moisture that penetrates the floor slab. We recommend that a vapor retarder be installed beneath all floor areas that will be covered by carpet, wood, tile, or any other moisture-sensitive materials. The vapor retarder should be selected on the basis of allowable vapor transmission rates for the planned floor finish materials, and should be installed in strict accordance with the manufacturer's guidelines.

Floor Settlements: If the subgrade and underslab layers are properly constructed, we estimate that total post-construction static settlements of the slab-on-grade floor will not exceed ¾ inch under conventional loading conditions. Differential settlements across the length or width of the floor could approach one-half of the actual total settlement.

Subgrade Verification and Construction Monitoring: Floor slab sections should never be placed atop loose, soft, organic-rich, or frozen soil, slough, debris, or surfaces covered by standing water. We recommend that an AESI representative be allowed to monitor all floor slab construction to verify suitable conditions. Our monitoring services would include probings of subgrade soils, observation and testing of underslab fill layers, and a check of layer thicknesses.

5.5 Backfilled Retaining Walls

We anticipate that backfilled concrete retaining walls might be used to accommodate grade changes in certain interior and/or exterior site locations. Furthermore, any subsurface vault walls should also be designed as backfilled retaining walls. Our design and construction recommendations for new backfilled retaining walls are presented below.

Wall Foundations: To avoid excessive differential settlement of any new retaining walls, they should be supported on firm, non-organic native soils in accordance with our recommendations presented in the "Spread Footings" section of this report. The allowable static and transient bearing capacities presented in that text section would apply to the wall footings.

Static Lateral Earth Pressures: Yielding (cantilever) walls that are allowed to deflect more than 0.005 times the wall height should be designed to withstand an appropriate static *active* lateral earth pressure. Non-yielding (restrained) walls that are allowed to deflect less than 0.005 times the wall height should be designed to withstand an appropriate static *at-rest* lateral earth pressure. These pressures act over the entire back of the wall and vary with the backslope inclination. For retaining walls with a level or 2H:1V backslope and well-drained conditions, we recommend using the following values, which are given in pcf of equivalent fluid pressure.

Static Active Earth Pressure with Level Backslope:	35 pcf
Static Active Earth Pressure with 2H:1V Backslope:	50 pcf
Static At-Rest Earth Pressure with Level Backslope:	55 pcf
Static At-Rest Earth Pressure with 2H:1V Backslope:	80 pcf

Static Lateral Surcharge Pressures: Any backslope load located within a 0.75H:1V line projected upward from the wall base will apply a lateral surcharge on the wall. Possible sources of surcharge loading include parking lots, traffic lanes, and structure footings. These surcharge pressures act over the portion of wall adjacent to the load source. For distributed vertical loads, active and at-rest static lateral surcharge pressures can be approximated by multiplying the vertical pressure "Q" (in psf) by the appropriate coefficient shown below. We recommend using a vertical pressure of 250 psf to model traffic and parking loads behind the wall.

Static Active Surcharge Pressure:	0.30(Q) psf
Static At-Rest Surcharge Pressure:	0.45(Q) psf

Seismic Lateral Surcharge Pressures: The total static pressures acting on a wall should be increased to account for seismic surcharge loadings resulting from lateral earthquake motions. These surcharge pressures act over the entire back of the wall and vary with the backslope inclination, the seismic acceleration, and the wall height. For retaining walls with a level backslope, active and at-rest seismic lateral surcharge pressures can be approximated by multiplying the wall height "H" (in feet) by the appropriate coefficient shown below.

Seismic Active Surcharge Pressure:	8(H) psf
Seismic At-Rest Surcharge Pressure:	12(H) psf

Curtain Drains: A curtain drain is a vertical layer of drainage material placed against the back of a wall to dissipate hydrostatic pressures. We recommend that a curtain of washed gravel be used behind all walls. This curtain drain should extend outward at least 12 inches from the wall and should extend upward nearly to the ground surface. The backslope directly above this drain should be capped with asphalt or concrete or a layer of low-permeability soil.

Heel Drains: A heel drain is a horizontal drainage element placed behind the rearward projection (heel) of a wall foundation to collect water from the curtain drain. We recommend that a heel drain be included behind the subject wall. The heel drain should comprise a 4-inch-diameter perforated pipe surrounded by at least 6 inches of washed gravel, all wrapped with filter fabric (such as Mirafi 140N). The drainpipe should then be connected to a tightline discharge pipe that routes water to an appropriate location.

Backfill Soil: We recommend that all backfill placed behind the curtain drain consist of granular structural fill. Non-organic, sandy and gravelly portions of the on-site soils would be suitable for this purpose. Other suitable materials include imported, well-graded sand and gravel mixtures, such as "Ballast" per WSDOT 9-03.9(1) or "Gravel Borrow" per WSDOT 9-03.14. It would also be acceptable to reuse on-site soils having a maximum particle size of 4 inches and a low fines content. If the backfill soil contains more than 10 percent fines, a layer of filter fabric (such as Mirafi 140N) should be placed between the curtain drain and backfill.

Backfill Compaction: Because soil compactors place significant lateral pressures on walls, we recommend that only small, hand-operated compaction equipment be used within 3 feet of a wall. Also, the soil within 3 feet should be compacted to a density as close as possible to 90 percent of the maximum dry density (based on ASTM D-1557). A greater degree of compaction closely behind the wall would increase the lateral earth pressure, whereas a lesser degree of compaction might lead to excessive post-construction settlements. Structural backfill placed more than 3 feet behind the wall should be compacted to a density of at least 95 percent.

Construction Monitoring: We recommend that an AESI representative be allowed to monitor all retaining wall construction. Our monitoring services would include verification of foundation systems, observation of drainage components, and testing of backfill compaction.

5.6 Conventional Pavement Sections

We understand that conventional flexible (asphalt concrete) pavements might be used in the new car parking areas and driveways, whereas rigid (cement concrete) pavement might be used for certain other locations. The following comments and recommendations are given for pavement design and construction purposes.

Soil Design Values: Soil conditions can be defined by a California Bearing Ratio (CBR), which quantitatively predicts the effects of wheel loads imposed on a saturated subgrade. Although our scope of work did not include a CBR test on the surficial site soils, we infer from our observations and limited textural testing that a CBR value on the order of 4 to 8 would likely be appropriate for pavement design purposes.

Traffic Design Values: Traffic conditions can be defined by a Traffic Index (TI), which quantifies the combined effects of projected car and truck traffic. Although no specific traffic data was available at the time of our analysis, we estimate that a TI of 3.0 to 4.0 would likely be appropriate for the car parking areas. A higher TI of about 5.0 to 6.0 appears appropriate for driveways and other areas that are occasionally or periodically subjected to delivery trucks and other heavy vehicles.

Flexible Pavement Sections: A flexible pavement section typically comprises an asphalt concrete pavement (ACP) over a crushed aggregate base (CAB) over a granular subbase (GSB). Our recommended minimum thicknesses for flexible pavement sections, which are based on the aforementioned design values and a 20-year lifespan, are shown below.

Car Parking Lots

Asphalt Concrete Pavement (ACP):	3 inches
Crushed Aggregate Base Course (CAB):	4 inches

Access Driveways

Asphalt Concrete Pavement (ACP):	4 inches
Crushed Aggregate Base Course (CAB):	4 inches
Granular Subbase Course (GSB):	6 inches

Rigid Pavement Sections: A rigid pavement section typically comprises a cement concrete pavement (CCP) over a CAB over a GSB. We recommend the following minimum thicknesses for a rigid pavement section that is subjected to occasional delivery trucks. Pavements and slabs that are subjected to frequent truck traffic or to other heavy structural loads would require a special design.

Access Driveways

Cement Concrete Pavement (CCP):	7 inches
Crushed Aggregate Base Course (CAB):	4 inches

Subgrade Preparation: All pavement subgrades should be compacted to a firm and unyielding condition before any pavement layers are placed. We recommend using a heavy vibratory-drum roller for granular (sand and gravel) subgrades, and a heavy static-drum roller for cohesive (silt and clay) subgrades. The resulting subgrade condition should then be verified by proof-rolling with a loaded dump truck or other heavy construction vehicle, in the presence of an AESI representative. Any localized zones of soft, organic-rich, or debris-laden soils disclosed during the proof-rolling test should be overexcavated and replaced with compacted structural fill.

Granular Subbase: A subbase course helps to provide more-uniform structural support for a pavement section bearing on a variable subgrade. For the subbase course, we recommend using an imported, well-graded sand and gravel, such as "Ballast" per WSDOT 9-03.9(1) or "Gravel Borrow" per WSDOT 9-03.14. Other acceptable options include 1¼-inch crushed rock and crushed recycled concrete. It would also be acceptable to reuse on-site soils having a maximum particle size of 3 inches. In all cases, the subbase should be vibratory-compacted to achieve a uniform density of at least 95 percent (based on ASTM D-1557).

Crushed Aggregate Base: We recommend that all CAB material conform to the criteria for "Crushed Surfacing Base Course" per WSDOT 9-03.9(3). In the interest of using recycled materials from on-site or off-site sources, it would be acceptable to substitute up to 20 percent of the CAB with crushed recycled concrete, provided that the final mixture meets the same grain-size criteria as the aforementioned WSDOT material. Regardless of composition, all CAB material should be compacted to a minimum density of 95 percent based on the modified Proctor maximum dry density (per ASTM D-1557).

Asphalt Concrete Pavement: We recommend that the ACP aggregate gradation conform to the control points for a ½-inch mix (per WSDOT 9-03.8(6)) and that the binder conform to Performance Grade 58-22 criteria (per WSDOT 9-02.1(4)). We also recommend that the ACP be compacted to a target average density of 92 percent, with no individual locations compacted to less than 90 percent nor more than 96 percent, based on the Rice theoretical maximum density for that material (per ASTM D-2041).

Cement Concrete Pavement: We recommend that the CCP consist of Portland cement concrete with a minimum compressive strength of 4,000 pounds per square inch (psi) and a minimum rupture modulus of 500. We also recommend that the concrete be reinforced with a welded wire mesh, such as W2-6x6, positioned at a one-third depth within the CCP layer.

Pavement Life and Maintenance: It should be realized that conventional asphaltic pavements are not maintenance-free. The foregoing pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Furthermore, a 20-year pavement life typically assumes that an overlay will be placed after about 10 years. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to "alligator" cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

5.7 Structural Fill

The term *structural fill* refers to any materials placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the fines content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum.

Structural Fill Materials: For general use, a well-graded mixture of sand and gravel with a low fines content (commonly called "gravel borrow" or "pit-run") provides an economical structural fill material. For specialized applications, it may be necessary to use a highly processed material such as crushed rock, quarry spalls, clean sand, granulithic gravel, pea gravel, drain rock, controlled-density fill (CDF), or lean-mix concrete (LMC). Recycled asphalt or concrete, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter, debris, environmental contaminants, or individual particles greater than about 6 inches in diameter.

On-Site Soils: We expect that moderate quantities of on-site soils will be generated by the building and utility excavations and other grading activities. Most of the on-site soils will likely consist of native sandy gravels and gravelly sands, with variable amounts of cobbles. In our opinion, these native soils can likely be reused as structural fill if segregated from any cobbles larger than about 4 inches. Localized zones of silty soils might be present and would be difficult to reuse during the wet season or during isolated periods of rainy weather.

Fill Placement and Compaction: Structural fill materials should be placed in horizontal lifts not exceeding about 12 inches in loose thickness. Unless stated otherwise in this report, we recommend that each lift then be thoroughly compacted with a mechanical compactor to a uniform density of at least 95 percent, based on the modified Proctor maximum dry density (per ASTM D-1557). Compaction is not necessary for certain structural fill materials, such as pea gravel, drain rock, quarry spalls, CDF, and LMC.

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with our various recommendations for site preparation. The condition of all subgrades should be verified by an AESI representative before soil or concrete placement begins. Also, fill soil compaction should be verified by means of in-place density testing, hand-probing, proof-rolling, or other appropriate methods performed during fill placement so that the adequacy of soil compaction efforts may be evaluated as earthwork progresses.

6.0 CLOSURE

AESI has prepared this report for the exclusive use of our client and their agents, for specific application to this project. Within the limitations of scope and schedule, our services have been performed in accordance with generally accepted local geotechnical engineering practices in effect at the time our report was prepared. No other warranty, express or implied, is made.

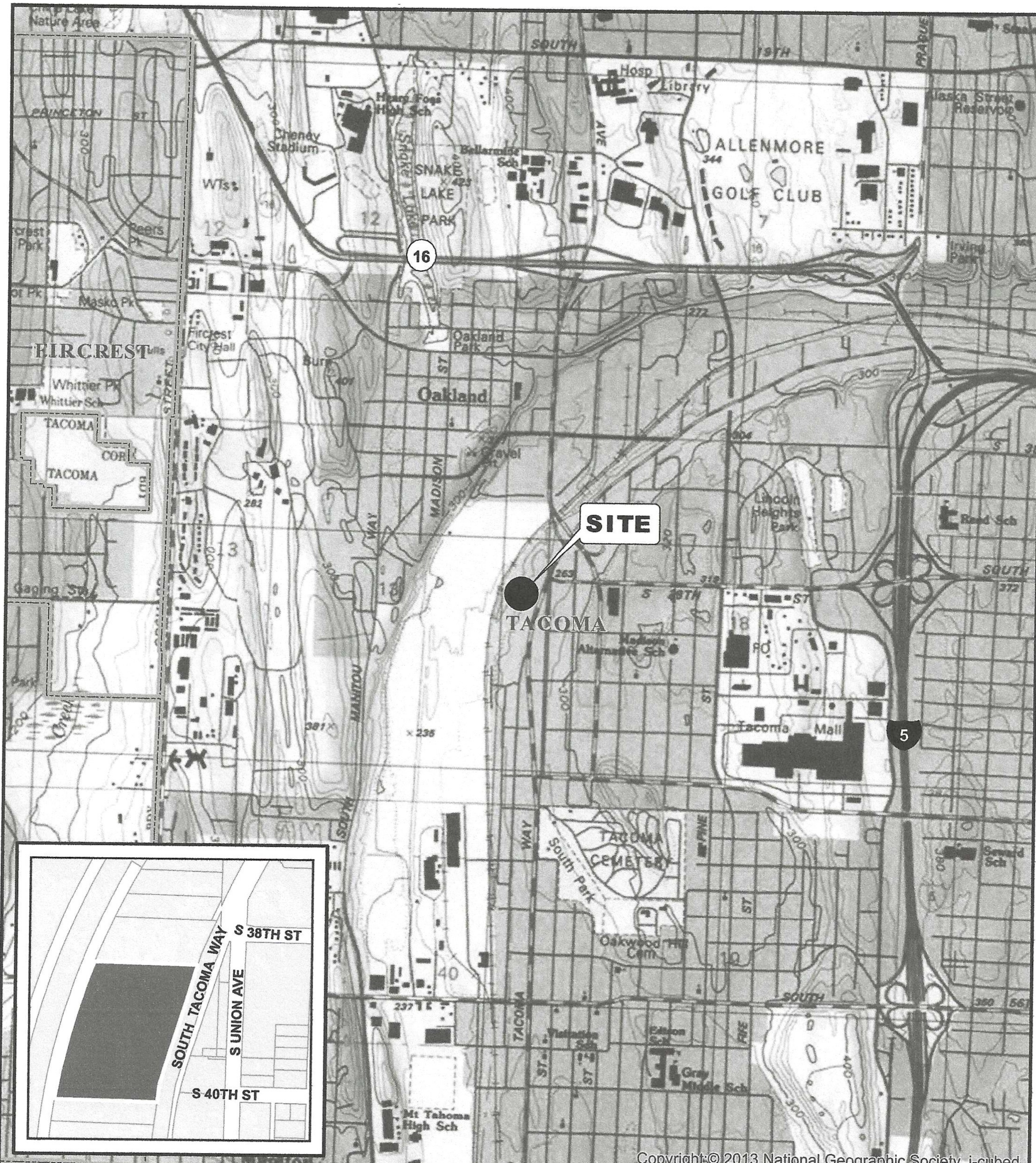
We appreciate the opportunity to be of continued service to you on this project. Should you have any questions regarding this report or other geotechnical aspects of the project, please call us at your earliest convenience.

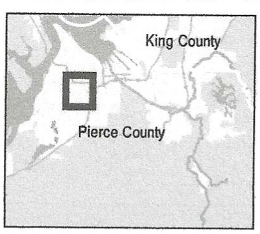
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington

3/14/18

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

James M. Brisbine, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer





Document Path: G:\GIS_Projects\aTemplates\aVM_Template\VM_MXD\170536E001 F1 VM_TSubaru.mxd

DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRAPHIC MAPS
PIERCE CO: STREETS, CITY LIMITS, PARCELS 02/17

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 1000 2000
FEET

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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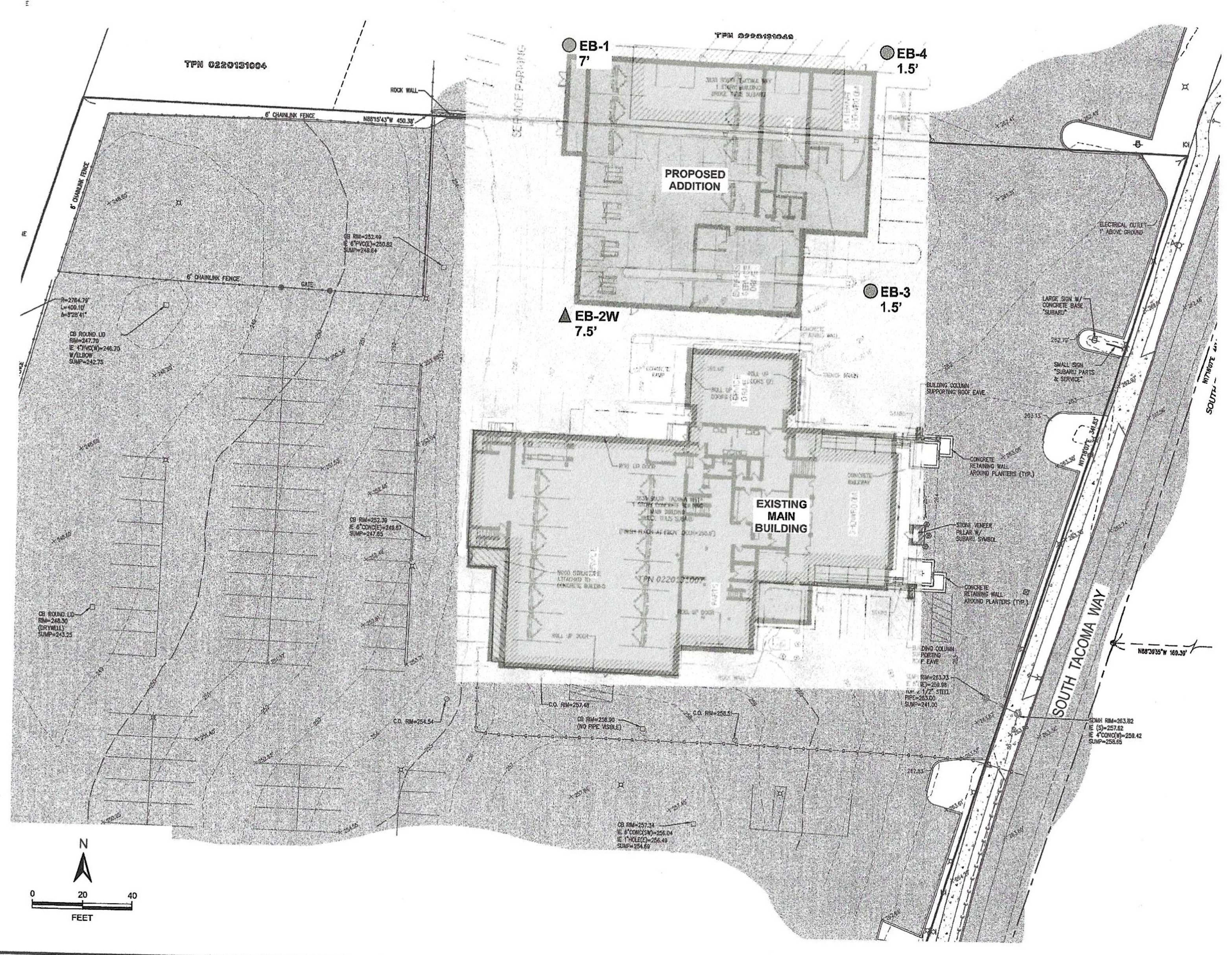
VICINITY MAP

TACOMA SUBARU ADDITION
TACOMA, WASHINGTON

PROJ NO.	DATE:	FIGURE:
170536E001	11/17	1



LEGEND:

● EB — EXPLORATION BORING WITH DEPTH (FT) OF NATIVE BEARING HORIZON BELOW EXISTING GROUND SURFACE

▲ EB — MONITORING WELL WITH DEPTH (FT) OF NATIVE BEARING HORIZON BELOW EXISTING GROUND SURFACE

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: APEX ENGINEERING, TACOMA SUBARU TOPOGRAPHIC SURVEY, SHEET 1 OF 1, DATED 7/3/2017 FELTUS HAWKINS DESIGN, TACOMA SUBARU PROPOSED SITE PLAN, SHEET 4 OF 7, DATED 5/18/2017

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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SITE AND EXPLORATION PLAN

TACOMA SUBARU ADDITION
TACOMA, WASHINGTON

PROJ NO.	DATE:	FIGURE:
170536E001	11/17	2

170536 Tacoma Subaru Addition \ 170536E001 F2 S-E.cdr

APPENDIX A

Field Exploration Logs

Major Division	Subdivision	Fines	Symbol	Description
Coarse-Grained Soils - More than 50%(1) Retained on No. 200 Sieve	Gravels - More than 50%(1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines(5)	**GW**	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines(5)	**GM**	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50%(1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines(5)	**SW**	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines(5)	**SM**	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%(1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		**ML**	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		**MH**	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			**PT**	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT(2) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50
	Consistency	**SPT(2) blows/foot**
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

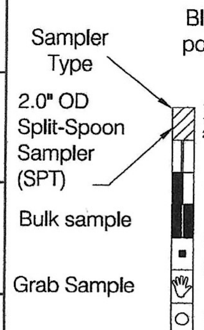
(3) Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

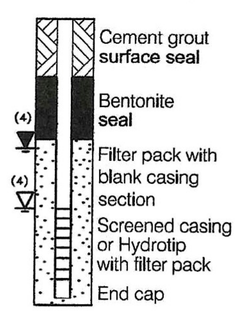
Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols



Sampler Type Description

3.0" OD Split-Spoon Sampler
3.25" OD Split-Spoon Ring Sampler
3.0" OD Thin-Wall Tube Sampler (including Shelby tube)
Portion not recovered



(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

(4) Depth of ground water
▼ ATD = At time of drilling
▽ Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

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EXPLORATION LOG KEY

FIGURE A1

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Exploration Log

Project Number	Exploration Number	Sheet
170536E001	EB-1	1 of 1

Project Name: Tacoma Subaru Addition
Location: Tacoma
Driller/Equipment: Holocene Drilling, Inc. / HSA / Truck
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): 258
Datum: NGVD 29
Date Start/Finish: 10/27/17,10/27/17
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Asphalt - 2 inches					
				Crushed Rock Base Course - 3 inches					
				Vashon Recessional Outwash					
		S-1		Dry, brown, fine to medium sandy, GRAVEL, trace silt (GP).			2 3 2	▲5	
5		S-2		Dry, brown, fine to medium SAND, trace to some gravel (SP).			3 3 2	▲5	
				Driller notes gravel.					
10				No recovery. Driller notes cobble obstruction; blowcounts overstated.			50/6"	▲50/6"	
				Vashon Advance Outwash					
				No recovery due to cobble obstruction. Driller notes gravelly sand in auger; blowcount overstated (SP).			50/3"	▲50/3"	
15				First pass: No recovery due to obstruction. Repeated: No recovery due to obstruction. Blowcount overstated.			50/1"	▲50/1"	
		S-3		Moved auger hole 2 feet north to redrill. No recovery due to obstruction. Sample S-3 auger represents 10 to 20 feet interval; blowcount overstated.			50/2"	▲50/2"	
				Dry; Refusal using Modified California Sampler.					
20				Bottom of exploration boring at 20 feet No groundwater encountered.					
25									

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample

M - Moisture
Water Level ()
Water Level at time of drilling (ATD)

Logged by: JDD
Approved by: JHS

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Exploration Log

Project Number	Exploration Number	Sheet
170536E001	EB-3	1 of 1

Project Name	Tacoma Subaru Addition	Ground Surface Elevation (ft)	260.5
Location	Tacoma	Datum	NGVD 29
Driller/Equipment	Holocene Drilling, Inc. / HSA / Truck	Date Start/Finish	10/27/17,10/27/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
		Asphalt - 2.5 inches		
		Crushed Rock Base Course - 4 inches		
		Vashon Recessional Outwash		
		Visually noted: Dry, gray, sandy, fine GRAVEL, trace silt in auger (GP).		
	S-1	Moist, brown to gray, fine sandy, GRAVEL, some coarse sand, trace silt; few fractured clasts (GP).	9 12 13	25
5	S-2	Moist, brown to gray, medium to coarse sandy, GRAVEL, trace fine sand; slightly stratified; fractured clasts (GP). Grades upwards to gravelly, medium to coarse SAND, trace fine sand; mid to upper delta facies (SP).	8 21 18	39
		Vashon Advance Outwash		
10	S-3	Moist to very moist, brownish gray, silty, fine SAND to fine sandy, SILT, some medium sand, with beds (2 to 4 inches thick) of trace silt; middle to lower delta facies (SP-SM).	13 16 20	36
15	S-4	Moist, light gray, fine to medium SAND; stratified and subtly graded; with beds of fine SAND, trace silt or silty, fine SAND, contains a few dropstones (SP/SM).	13 16 20	36
20	S-5	Moist to very moist, brownish gray, fine SAND, some coarse sand grades to fine SAND, trace silt; subtly reverse graded beds (SP).	9 20 26	46
25	S-6	Moist, gray, fine to medium SAND; subtly bedded, grades to fine SAND, some silt; thin to thick beds (SP).	13 20 21	41
		Bottom of exploration boring at 26.5 feet No groundwater encountered.		

Other column headings: S T, Graphic Symbol, Well Completion, Water Level, Other Tests. Blows/Foot scale: 10 20 30 40

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDD
Approved by: JHS

Exploration Log

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Project Number	Exploration Number	Sheet
170536E001	EB-4	1 of 1

Project Name	Tacoma Subaru Addition	Ground Surface Elevation (ft)	261
Location	Tacoma	Datum	NGVD 29
Driller/Equipment	Holocene Drilling, Inc. / HSA / Truck	Date Start/Finish	10/27/17,10/27/17
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	ST	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot	Other Tests
			Asphalt - 2 inches					
			Crushed Rock Base Course - 3 inches					
			Vashon Recessional Outwash					
	Grab	S-1	Dry brown, fine gravelly, SAND, some silt (SP/SM).					
		S-2	Moist, brown, medium sandy, GRAVEL (GP).			4 6 15	21	
5		S-3	Moist, brown, gravelly, medium to coarse SAND, trace fine sand; subtly graded; some fractured gravel (SP).			7 9 10	19	
			Vashon Advance Outwash					
10		S-4	Moist, gray to slightly mottled, fine to medium SAND, trace gravel; few thin beds of coarse sand (SP).			9 18 16	34	
15		S-5	Moist, gray, fine SAND, some medium sand; some beds have trace silt; a thin bed (~2 inches thick) of gravelly, medium to coarse SAND in bottom of sample; subtly graded; gravel fractured (SP).			13 17 21	28	
20		S-6	Moist, gray, fine SAND, beds of medium SAND and beds of fine SAND, some silt; subtly bedded/graded (SP).			12 17 21	38	
25		S-7				10 15 20	35	
			Bottom of exploration boring at 26.5 feet No groundwater encountered.					

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDD
Approved by: JHS

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Exploration Log

Project Number	Exploration Number	Sheet
170536E001	EB-2W	1 of 1

Project Name: Tacoma Subaru Addition
Location: Tacoma
Driller/Equipment: Holocene Drilling, Inc. / HSA / Truck
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): 257
Datum: NGVD 29
Date Start/Finish: 10/27/17,10/27/17
Hole Diameter (in): 8 inches

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Asphalt - 2 inches** *Flush mount monument*		
		Crushed Rock Base Course - 3 inches		
		Fill		
	S-1	Moist, brown, medium to coarse sandy, GRAVEL; slightly stratified; fractured clasts (GP).	7 15 8	23
5	S-2	Moist, brown, gravelly, medium to coarse SAND, trace silt; few fractured clasts (SP).	4 4 3	7
		Vashon Recessional Outwash		
10	S-3	Moist, gray, gravelly, medium SAND, some coarse sand grades to gravelly, medium to coarse SAND; few fractured clasts (SP). Grades to gravelly in auger.	9 8 7	15
		Vashon Advance Outwash		
		Refusal at 15 feet due to gravel obstruction; cobble caught in auger. Moved 4 feet north. Sample S-4 and blowcounts from new drill hole.		
15	S-4	Moist, gray, fine SAND, trace coarse sand, trace gravel (dropstones) (SP).	14 20 24	44
20	S-5	Moist, gray, fine to medium SAND, trace coarse sand, trace silt (SP). *Slip cap*	10 13 17	30
25	S-6	Moist, brownish gray, fine SAND, trace coarse sand (SP).	13 16 17	33
		Bottom of exploration boring at 26.5 feet. No groundwater encountered.		

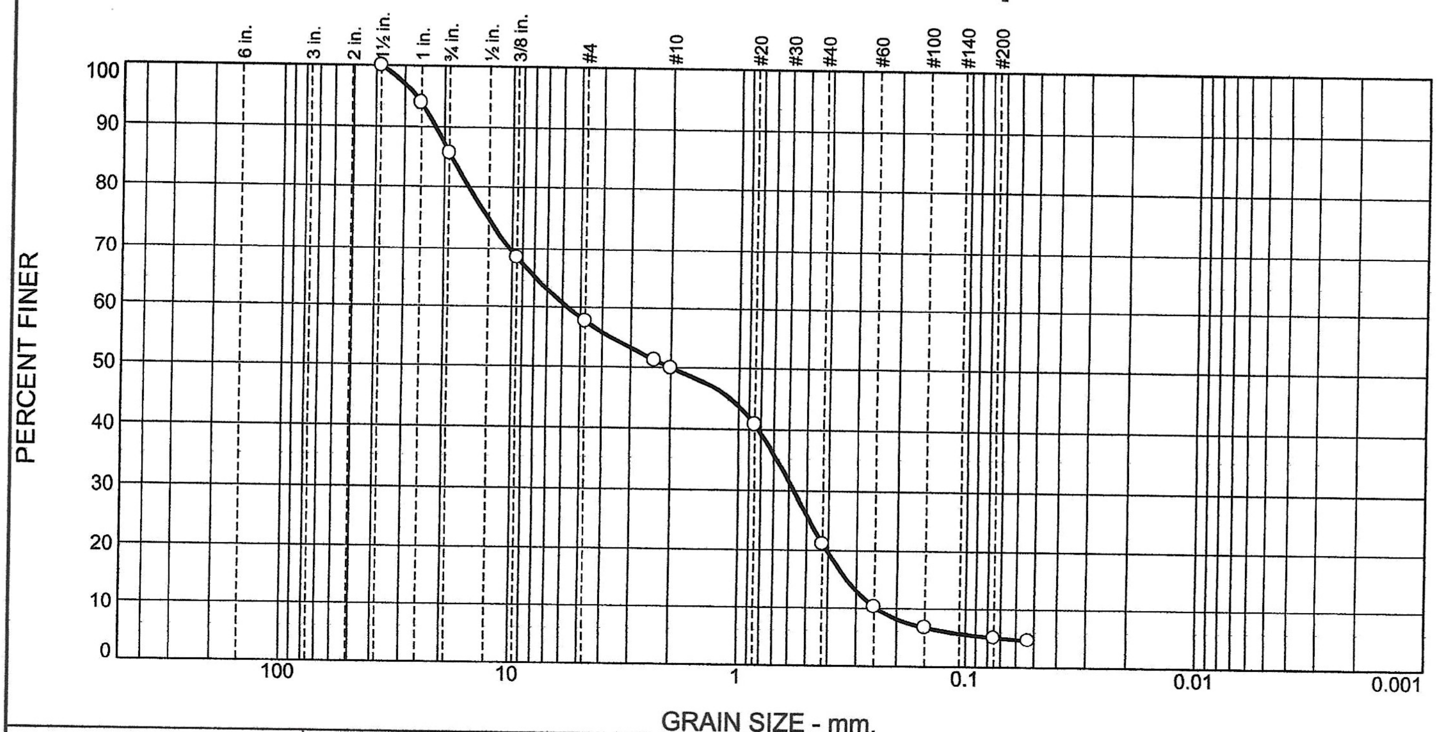
Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JDD
Approved by: JHS

APPENDIX B

Laboratory Testing Data

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.3	28.1	7.7	28.8	16.0	5.1	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	93.9		
.75	85.7		
.375	68.5		
#4	57.6		
#8	51.2		
#10	49.9		
#20	40.8		
#40	21.1		
#60	10.3		
#100	6.8		
#200	5.1		
#270	4.7		

* (no specification provided)

Material Description

very gravelly, SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-a

Coefficients

D_{90}= 21.9472 D_{85}= 18.6090 D_{60}= 5.7284
D_{50}= 2.0152 D_{30}= 0.5721 D_{15}= 0.3309
D_{10}= 0.2446 C_u= 23.42 C_c= 0.23

Remarks

Collected by: JDD

Date Received: 11-2-2017 **Date Tested:** 11-3-2017

Tested By: BN

Checked By: JB

Title:

Location: Onsite
Sample Number: EB-4 **Depth:** 1.0'-2.5' **Date Sampled:** 10-27-2017

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Client:
Project: Tacoma Subaru
Project No: 170536 E001 **Figure**

B. Stormwater Treatment Calculations

MWS-L-6-8-V

Required treatment flow rate = 0.138 cfs = 61.94 gpm

MWS-L-6-8 vault treatment capacity = 0.138 cfs = 61.94 gpm at 3.2 ft operating hydraulic grade line (HGL)

MWS-L-6-8 wetland perimeter = P = 18.8 ft x 1 media cages = 18.8 ft

WetlandMedia surface area = operating HGL x wetland perimeter

WetlandMedia surface area = 3.2 ft x 18.8 ft = 60.16 ft^2

WetlandMedia Loading Rate = 61.94 gpm / 1.03 ft2 = 1.03 gpm/ft^2

FLOW-BASED SIZING

Discharge Equation: Q = vA

<u>Solve for the pre treatment loading rate:</u>

Q = 0.138 cfs = 61.94 gpm

Pretreatment surface area = 25.6 ft^2 per cartridge

$$v\ pretreatment = Q/A = \frac{61.94\ gpm}{25.6\ ft^2\ x\ 1.5\ cartridges} = 1.61\ gpm/ft^2$$

<u>Solve for the required HGL:</u>

Q = 1 cfs = 60.16 gpm

v = WetlandMedia loading rate = 1.03 gpm/ft^2

A = wetland perimeter x height = P x h

Solve for height, h:

$$h = Q / (v * P) = \frac{61.94\ gpm}{1.03 \times 18.8} = 3.2\ ft$$

The HGL within the MWS unit needs to be 3.2 ft in order to treat 0.138 cfs

MWS ORIFICE SIZING

Q = vA; Q = treatment flow rate; v = cd √(2gh); A= $\pi D^2/4$

Treatment HGL, h = 3.2 ft

Discharge coefficient, c_d

Coefficient of velocity, c_v = 0.98

Coefficient of contraction for the orifice, c_c = 0.62

$c_d = c_v \times c_c$ = 0.61

This unit has 1 underdrain outlet, so cd = 1 x 0.61 = 0.61

Rewrite to solve for the diameter of the orifice:

$$A = \frac{Q}{V} rewrite \rightarrow \frac{\pi D^2}{4} = \frac{Q}{c_d\sqrt{2gh}}$$

$$D = \sqrt{\frac{4Q}{\pi C_d\sqrt{2gh}}};$$

Q = 0.138 cfs, h= 3.2 ft, cd= 0.61 , g = 32.17 ft/s^2

$$D = \sqrt{\left(\frac{4 \times 0.138}{\pi \times 0.61 \times \sqrt{(2 \times 32.17 \times 3.2)}}\right.} = 0.141684\ ft = 1.7\ inches$$

The diameter of the orifice needs to be 1.7 inches in order to produce a head of 3.2 ft in the MWS unit

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	2220033QUALIT20230831
Site Name:	
Site Address:	
City:	
Report Date:	8/31/2023
Gage:	40 IN WEST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2021/10/18
Version:	4.2.18

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
A B, Pasture, Flat	0.34
Pervious Total	0.34
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.34

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

TREATMENT

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.34
Impervious Total	0.34
Basin Total	0.34

Element Flows To:

Surface	Interflow	Groundwater

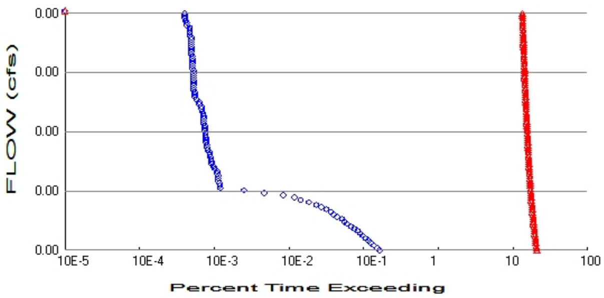
Routing Elements

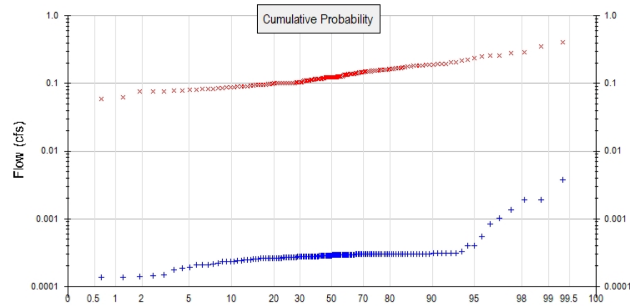
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	0.34
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	0
Total Impervious Area:	0.34

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.000274
5 year	0.000394
10 year	0.000496
25 year	0.000654
50 year	0.000797
100 year	0.000963

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.123933
5 year	0.165993
10 year	0.19651
25 year	0.23822
50 year	0.271655
100 year	0.30718

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.000	0.147
1903	0.000	0.162
1904	0.000	0.183
1905	0.000	0.083
1906	0.000	0.090
1907	0.000	0.123
1908	0.000	0.101
1909	0.000	0.125
1910	0.000	0.119
1911	0.000	0.134

1912	0.004	0.221
1913	0.000	0.097
1914	0.000	0.408
1915	0.000	0.084
1916	0.000	0.155
1917	0.000	0.058
1918	0.000	0.125
1919	0.000	0.078
1920	0.000	0.103
1921	0.000	0.087
1922	0.000	0.136
1923	0.000	0.094
1924	0.000	0.174
1925	0.000	0.076
1926	0.000	0.143
1927	0.000	0.122
1928	0.000	0.089
1929	0.000	0.177
1930	0.000	0.183
1931	0.000	0.090
1932	0.000	0.097
1933	0.000	0.096
1934	0.001	0.155
1935	0.000	0.080
1936	0.000	0.116
1937	0.000	0.155
1938	0.000	0.085
1939	0.000	0.101
1940	0.000	0.187
1941	0.000	0.203
1942	0.000	0.138
1943	0.000	0.136
1944	0.000	0.196
1945	0.000	0.148
1946	0.000	0.115
1947	0.000	0.090
1948	0.000	0.125
1949	0.000	0.191
1950	0.000	0.110
1951	0.000	0.166
1952	0.000	0.184
1953	0.000	0.169
1954	0.000	0.101
1955	0.000	0.096
1956	0.000	0.094
1957	0.000	0.100
1958	0.002	0.124
1959	0.000	0.124
1960	0.000	0.102
1961	0.000	0.280
1962	0.000	0.122
1963	0.000	0.089
1964	0.000	0.260
1965	0.000	0.117
1966	0.000	0.098
1967	0.000	0.137
1968	0.000	0.116
1969	0.000	0.104

1970	0.000	0.117
1971	0.000	0.114
1972	0.000	0.354
1973	0.000	0.218
1974	0.000	0.159
1975	0.000	0.163
1976	0.000	0.175
1977	0.000	0.077
1978	0.000	0.127
1979	0.000	0.138
1980	0.000	0.133
1981	0.000	0.129
1982	0.000	0.102
1983	0.000	0.137
1984	0.000	0.135
1985	0.000	0.155
1986	0.000	0.079
1987	0.000	0.128
1988	0.000	0.083
1989	0.000	0.077
1990	0.000	0.101
1991	0.000	0.151
1992	0.000	0.144
1993	0.000	0.160
1994	0.000	0.111
1995	0.000	0.086
1996	0.001	0.115
1997	0.000	0.104
1998	0.000	0.123
1999	0.000	0.142
2000	0.000	0.116
2001	0.000	0.094
2002	0.000	0.170
2003	0.000	0.104
2004	0.000	0.148
2005	0.001	0.291
2006	0.000	0.134
2007	0.000	0.150
2008	0.000	0.124
2009	0.000	0.095
2010	0.000	0.120
2011	0.000	0.124
2012	0.000	0.118
2013	0.000	0.110
2014	0.000	0.110
2015	0.000	0.181
2016	0.000	0.113
2017	0.000	0.180
2018	0.001	0.109
2019	0.000	0.161
2020	0.000	0.131
2021	0.000	0.111
2022	0.000	0.187
2023	0.000	0.234
2024	0.000	0.249
2025	0.000	0.123
2026	0.000	0.148
2027	0.000	0.148

2028	0.000	0.059
2029	0.000	0.095
2030	0.000	0.195
2031	0.000	0.062
2032	0.000	0.101
2033	0.000	0.128
2034	0.000	0.100
2035	0.000	0.123
2036	0.000	0.101
2037	0.000	0.135
2038	0.000	0.127
2039	0.000	0.260
2040	0.000	0.101
2041	0.000	0.128
2042	0.000	0.147
2043	0.000	0.162
2044	0.000	0.112
2045	0.000	0.089
2046	0.000	0.100
2047	0.000	0.123
2048	0.000	0.102
2049	0.000	0.151
2050	0.000	0.114
2051	0.000	0.158
2052	0.000	0.123
2053	0.000	0.103
2054	0.000	0.205
2055	0.000	0.116
2056	0.000	0.161
2057	0.000	0.080
2058	0.000	0.153
2059	0.002	0.194

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0038	0.4078
2	0.0019	0.3536
3	0.0019	0.2909
4	0.0013	0.2796
5	0.0010	0.2601
6	0.0008	0.2596
7	0.0005	0.2494
8	0.0004	0.2338
9	0.0004	0.2209
10	0.0003	0.2179
11	0.0003	0.2048
12	0.0003	0.2032
13	0.0003	0.1962
14	0.0003	0.1949
15	0.0003	0.1942
16	0.0003	0.1907
17	0.0003	0.1869
18	0.0003	0.1869
19	0.0003	0.1838
20	0.0003	0.1833
21	0.0003	0.1830
22	0.0003	0.1811

23	0.0003	0.1803
24	0.0003	0.1766
25	0.0003	0.1745
26	0.0003	0.1739
27	0.0003	0.1705
28	0.0003	0.1689
29	0.0003	0.1664
30	0.0003	0.1633
31	0.0003	0.1625
32	0.0003	0.1616
33	0.0003	0.1611
34	0.0003	0.1606
35	0.0003	0.1602
36	0.0003	0.1589
37	0.0003	0.1583
38	0.0003	0.1555
39	0.0003	0.1553
40	0.0003	0.1551
41	0.0003	0.1549
42	0.0003	0.1530
43	0.0003	0.1510
44	0.0003	0.1505
45	0.0003	0.1500
46	0.0003	0.1484
47	0.0003	0.1483
48	0.0003	0.1482
49	0.0003	0.1481
50	0.0003	0.1467
51	0.0003	0.1466
52	0.0003	0.1435
53	0.0003	0.1433
54	0.0003	0.1421
55	0.0003	0.1384
56	0.0003	0.1379
57	0.0003	0.1372
58	0.0003	0.1366
59	0.0003	0.1363
60	0.0003	0.1362
61	0.0003	0.1355
62	0.0003	0.1353
63	0.0003	0.1344
64	0.0003	0.1342
65	0.0003	0.1331
66	0.0003	0.1312
67	0.0003	0.1286
68	0.0003	0.1284
69	0.0003	0.1279
70	0.0003	0.1276
71	0.0003	0.1274
72	0.0003	0.1266
73	0.0003	0.1250
74	0.0003	0.1250
75	0.0003	0.1245
76	0.0003	0.1244
77	0.0003	0.1243
78	0.0003	0.1240
79	0.0003	0.1238
80	0.0003	0.1234

81	0.0003	0.1231
82	0.0003	0.1231
83	0.0003	0.1230
84	0.0003	0.1230
85	0.0003	0.1225
86	0.0003	0.1219
87	0.0003	0.1217
88	0.0003	0.1204
89	0.0003	0.1193
90	0.0003	0.1183
91	0.0003	0.1171
92	0.0003	0.1169
93	0.0003	0.1162
94	0.0003	0.1161
95	0.0003	0.1161
96	0.0003	0.1156
97	0.0003	0.1152
98	0.0003	0.1150
99	0.0003	0.1144
100	0.0003	0.1136
101	0.0003	0.1130
102	0.0003	0.1120
103	0.0003	0.1111
104	0.0003	0.1109
105	0.0003	0.1105
106	0.0003	0.1104
107	0.0003	0.1098
108	0.0003	0.1085
109	0.0003	0.1042
110	0.0003	0.1041
111	0.0003	0.1037
112	0.0003	0.1029
113	0.0003	0.1026
114	0.0003	0.1022
115	0.0003	0.1019
116	0.0003	0.1018
117	0.0003	0.1015
118	0.0003	0.1014
119	0.0003	0.1014
120	0.0003	0.1010
121	0.0003	0.1009
122	0.0003	0.1009
123	0.0003	0.1007
124	0.0003	0.1005
125	0.0003	0.1002
126	0.0003	0.1002
127	0.0003	0.0981
128	0.0003	0.0975
129	0.0003	0.0973
130	0.0003	0.0959
131	0.0003	0.0958
132	0.0003	0.0954
133	0.0003	0.0946
134	0.0003	0.0943
135	0.0003	0.0936
136	0.0002	0.0936
137	0.0002	0.0904
138	0.0002	0.0904

139	0.0002	0.0904
140	0.0002	0.0893
141	0.0002	0.0888
142	0.0002	0.0885
143	0.0002	0.0871
144	0.0002	0.0861
145	0.0002	0.0846
146	0.0002	0.0840
147	0.0002	0.0827
148	0.0002	0.0827
149	0.0002	0.0804
150	0.0002	0.0797
151	0.0002	0.0789
152	0.0002	0.0784
153	0.0001	0.0771
154	0.0001	0.0766
155	0.0001	0.0760
156	0.0001	0.0615
157	0.0001	0.0586
158	0.0001	0.0581

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0001	9014	1153441	12796	Fail
0.0001	8354	1142361	13674	Fail
0.0002	7534	1130727	15008	Fail
0.0002	6853	1119093	16329	Fail
0.0002	6371	1109675	17417	Fail
0.0002	5900	1099149	18629	Fail
0.0002	5432	1089177	20051	Fail
0.0002	5045	1080866	21424	Fail
0.0002	4620	1072002	23203	Fail
0.0002	4140	1063138	25679	Fail
0.0002	3733	1055936	28286	Fail
0.0002	3353	1047626	31244	Fail
0.0002	3055	1039870	34038	Fail
0.0002	2831	1033222	36496	Fail
0.0002	2424	1026020	42327	Fail
0.0002	2171	1018818	46928	Fail
0.0002	2004	1012724	50535	Fail
0.0003	1759	1006076	57195	Fail
0.0003	1516	999428	65925	Fail
0.0003	1290	993887	77045	Fail
0.0003	1017	987793	97128	Fail
0.0003	792	977821	123462	Fail
0.0003	650	972835	149666	Fail
0.0003	459	967295	210739	Fail
0.0003	260	961755	369905	Fail
0.0003	138	956769	693310	Fail
0.0003	67	951783	1420571	Fail
0.0003	66	946243	1433701	Fail
0.0003	65	942365	1449792	Fail
0.0003	62	937379	1511901	Fail
0.0003	62	932393	1503859	Fail
0.0003	62	928515	1497604	Fail
0.0004	61	923529	1513981	Fail
0.0004	60	919097	1531828	Fail
0.0004	57	915219	1605647	Fail
0.0004	54	910787	1686642	Fail
0.0004	51	906354	1777164	Fail
0.0004	51	903030	1770647	Fail
0.0004	50	898598	1797196	Fail
0.0004	49	894720	1825959	Fail
0.0004	48	891396	1857075	Fail
0.0004	47	887518	1888336	Fail
0.0004	45	883640	1963644	Fail
0.0004	44	880316	2000718	Fail
0.0004	44	876438	1991904	Fail
0.0004	43	873114	2030497	Fail
0.0004	43	869790	2022767	Fail
0.0005	43	866466	2015037	Fail
0.0005	42	863142	2055100	Fail
0.0005	42	859818	2047185	Fail
0.0005	41	856494	2089009	Fail
0.0005	41	853170	2080902	Fail
0.0005	41	850400	2074146	Fail
0.0005	40	847076	2117690	Fail

0.0005	40	844306	2110765	Fail
0.0005	40	841536	2103840	Fail
0.0005	40	838212	2095530	Fail
0.0005	39	835442	2142158	Fail
0.0005	38	832672	2191242	Fail
0.0005	37	829902	2242978	Fail
0.0005	37	827132	2235491	Fail
0.0005	35	824362	2355320	Fail
0.0006	35	821591	2347402	Fail
0.0006	32	818821	2558815	Fail
0.0006	30	816605	2722016	Fail
0.0006	30	813835	2712783	Fail
0.0006	30	811065	2703550	Fail
0.0006	29	808849	2789134	Fail
0.0006	29	806079	2779582	Fail
0.0006	29	803309	2770031	Fail
0.0006	29	801093	2762389	Fail
0.0006	29	798877	2754748	Fail
0.0006	29	796107	2745196	Fail
0.0006	29	793891	2737555	Fail
0.0006	29	791675	2729913	Fail
0.0006	29	788905	2720362	Fail
0.0006	28	787243	2811582	Fail
0.0007	28	784473	2801689	Fail
0.0007	28	782257	2793775	Fail
0.0007	28	780595	2787839	Fail
0.0007	28	777825	2777946	Fail
0.0007	28	775609	2770032	Fail
0.0007	27	773947	2866470	Fail
0.0007	27	771731	2858262	Fail
0.0007	27	769515	2850055	Fail
0.0007	27	767299	2841848	Fail
0.0007	27	765083	2833640	Fail
0.0007	27	762867	2825433	Fail
0.0007	27	761205	2819277	Fail
0.0007	27	759543	2813122	Fail
0.0007	26	757327	2912796	Fail
0.0007	26	755665	2906403	Fail
0.0008	26	753449	2897880	Fail
0.0008	26	751233	2889357	Fail
0.0008	24	749571	3123212	Fail
0.0008	24	747355	3113979	Fail
0.0008	23	745693	3242143	Fail
0.0008	22	744031	3381959	Fail
0.0008	22	741815	3371886	Fail
0.0008	22	740153	3364331	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:	0.0389 acre-feet
On-line facility target flow:	0.0527 cfs.
Adjusted for 15 min:	0.0527 cfs.
Off-line facility target flow:	0.0305 cfs.
Adjusted for 15 min:	0.0305 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
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

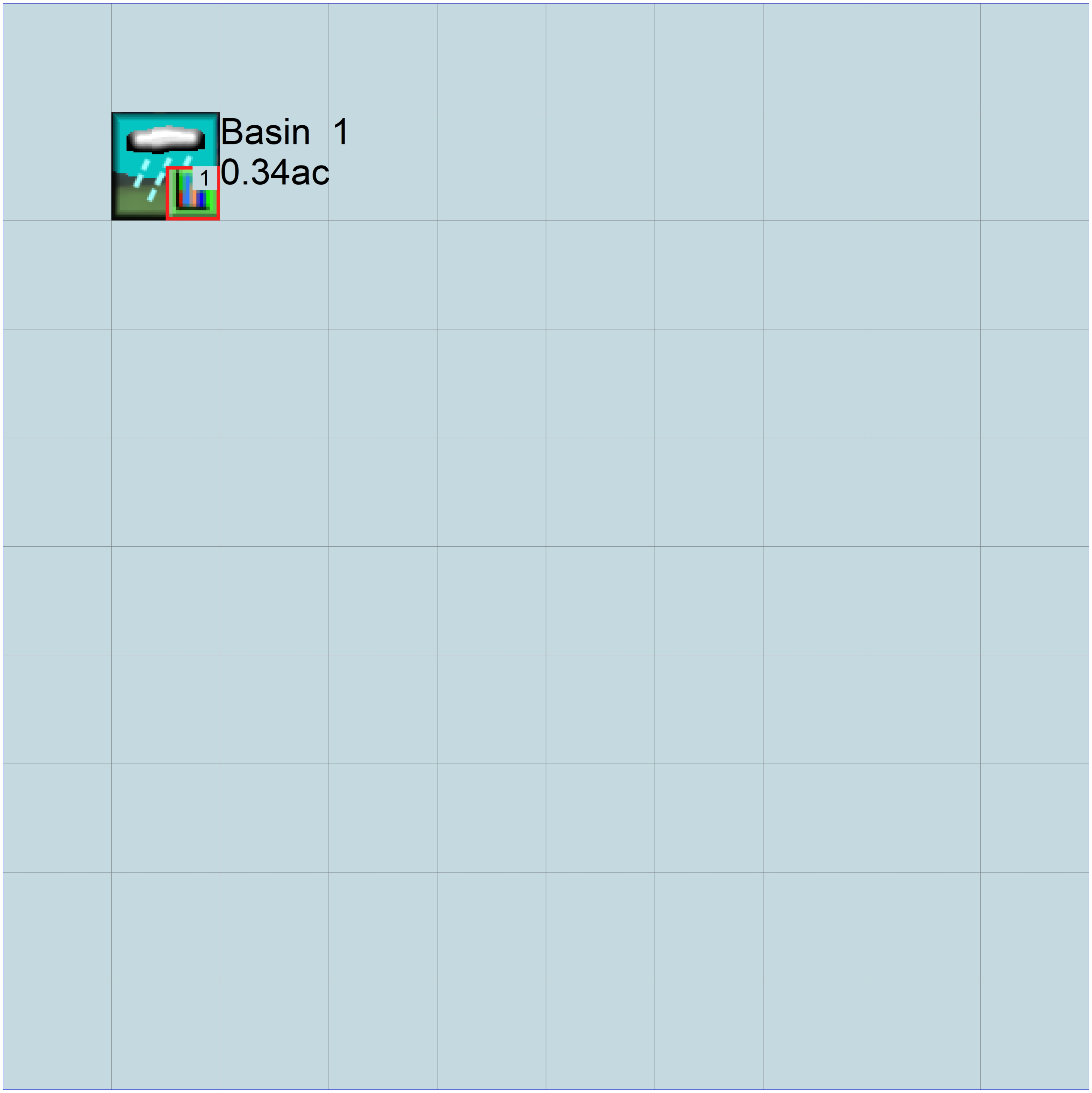
PERLND Changes

No PERLND changes have been made.

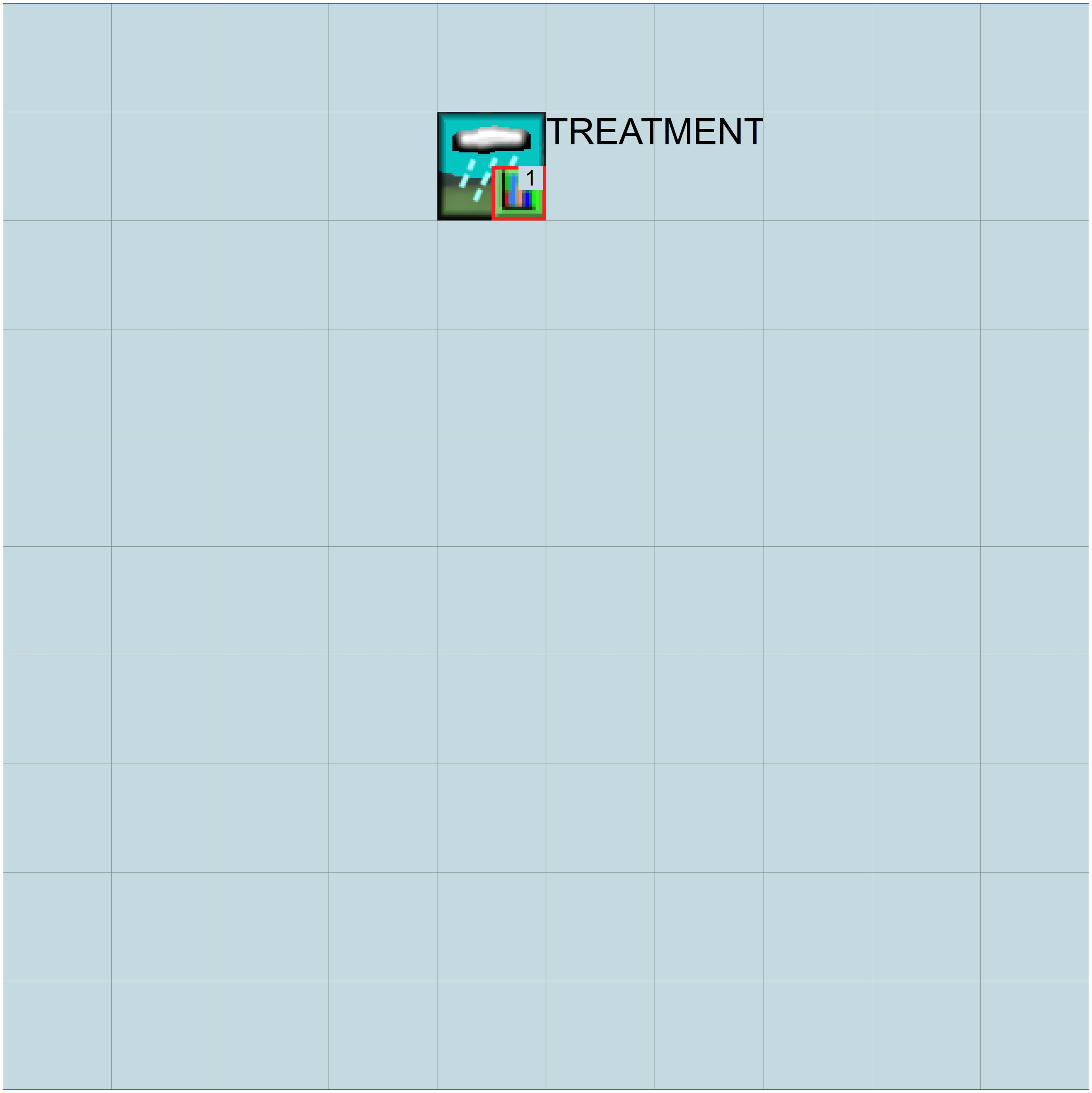
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   2220033QUALIT20230831.wdm
MESSU      25   Mit2220033QUALIT20230831.MES
           27   Mit2220033QUALIT20230831.L61
           28   Mit2220033QUALIT20230831.L62
           30   POC2220033QUALIT202308311.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        TREATMENT                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
  END GEN-INFO
  *** Section PWATER***

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

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

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
```

```
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
  END PWAT-PARM4

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

END PERLND

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

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
  END IWAT-STATE1

END IMPLND
```

```
SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
TREATMENT***
IMPLND   1                        0.34     COPY   501     15

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

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



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

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

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

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

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP
```

```
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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C. Flow Control Calculations

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: 20230926flowcontrol

Site Name:

Site Address:

City:

Report Date:	9/26/2023
Gage:	38 IN CENTRAL
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2023/03/31
Version:	4.2.19

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
A B, Lawn, Flat	0.26
Pervious Total	0.26
Impervious Land Use	acre
ROOF TOPS FLAT	0.03
PARKING FLAT	0.69
Impervious Total	0.72
Basin Total	0.98

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROOF TOPS FLAT	0.13
PARKING FLAT	0.38
Impervious Total	0.51
Basin Total	0.51

Basin 2

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
A B, Lawn, Flat	0.27
Pervious Total	0.27
Impervious Land Use	acre
SIDEWALKS FLAT	0.01
PARKING FLAT	0.19
Impervious Total	0.2
Basin Total	0.47

Routing Elements
Predeveloped Routing

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	74.00 ft.
Bottom Width:	25.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	1
Pour Space of material for first layer:	0.4
Material thickness of second layer:	3.75
Pour Space of material for second layer:	0.68
Material thickness of third layer:	0.75
Pour Space of material for third layer:	0.4
Infiltration On	
Infiltration rate:	0.5
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	205.262
Total Volume Through Riser (ac-ft.):	0.01
Total Volume Through Facility (ac-ft.):	205.272
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure
Riser Height: 5.5 ft.
Riser Diameter: 12 in.
Element Flows To:
Outlet 1 Outlet 2

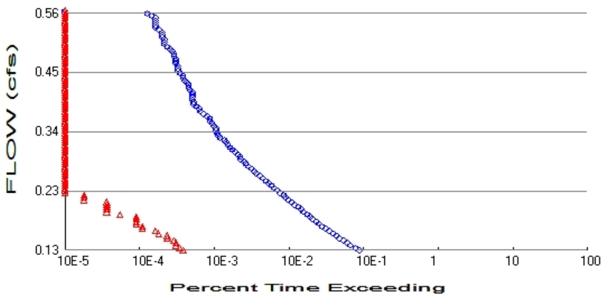
Gravel Trench Bed Hydraulic Table

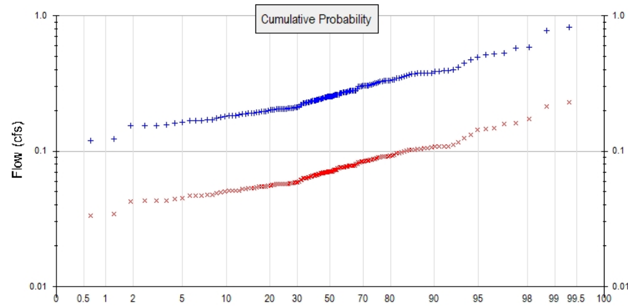
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.042	0.000	0.000	0.000
0.0611	0.042	0.001	0.000	0.021
0.1222	0.042	0.002	0.000	0.021
0.1833	0.042	0.003	0.000	0.021
0.2444	0.042	0.004	0.000	0.021
0.3056	0.042	0.005	0.000	0.021
0.3667	0.042	0.006	0.000	0.021
0.4278	0.042	0.007	0.000	0.021
0.4889	0.042	0.008	0.000	0.021
0.5500	0.042	0.009	0.000	0.021
0.6111	0.042	0.010	0.000	0.021
0.6722	0.042	0.011	0.000	0.021
0.7333	0.042	0.012	0.000	0.021
0.7944	0.042	0.013	0.000	0.021
0.8556	0.042	0.014	0.000	0.021
0.9167	0.042	0.015	0.000	0.021
0.9778	0.042	0.016	0.000	0.021
1.0389	0.042	0.018	0.000	0.021
1.1000	0.042	0.020	0.000	0.021
1.1611	0.042	0.021	0.000	0.021
1.2222	0.042	0.023	0.000	0.021
1.2833	0.042	0.025	0.000	0.021
1.3444	0.042	0.027	0.000	0.021
1.4056	0.042	0.029	0.000	0.021

1.4667	0.042	0.030	0.000	0.021
1.5278	0.042	0.032	0.000	0.021
1.5889	0.042	0.034	0.000	0.021
1.6500	0.042	0.036	0.000	0.021
1.7111	0.042	0.037	0.000	0.021
1.7722	0.042	0.039	0.000	0.021
1.8333	0.042	0.041	0.000	0.021
1.8944	0.042	0.043	0.000	0.021
1.9556	0.042	0.044	0.000	0.021
2.0167	0.042	0.046	0.000	0.021
2.0778	0.042	0.048	0.000	0.021
2.1389	0.042	0.050	0.000	0.021
2.2000	0.042	0.051	0.000	0.021
2.2611	0.042	0.053	0.000	0.021
2.3222	0.042	0.055	0.000	0.021
2.3833	0.042	0.057	0.000	0.021
2.4444	0.042	0.059	0.000	0.021
2.5056	0.042	0.060	0.000	0.021
2.5667	0.042	0.062	0.000	0.021
2.6278	0.042	0.064	0.000	0.021
2.6889	0.042	0.066	0.000	0.021
2.7500	0.042	0.067	0.000	0.021
2.8111	0.042	0.069	0.000	0.021
2.8722	0.042	0.071	0.000	0.021
2.9333	0.042	0.073	0.000	0.021
2.9944	0.042	0.074	0.000	0.021
3.0556	0.042	0.076	0.000	0.021
3.1167	0.042	0.078	0.000	0.021
3.1778	0.042	0.080	0.000	0.021
3.2389	0.042	0.081	0.000	0.021
3.3000	0.042	0.083	0.000	0.021
3.3611	0.042	0.085	0.000	0.021
3.4222	0.042	0.087	0.000	0.021
3.4833	0.042	0.089	0.000	0.021
3.5444	0.042	0.090	0.000	0.021
3.6056	0.042	0.092	0.000	0.021
3.6667	0.042	0.094	0.000	0.021
3.7278	0.042	0.096	0.000	0.021
3.7889	0.042	0.097	0.000	0.021
3.8500	0.042	0.099	0.000	0.021
3.9111	0.042	0.101	0.000	0.021
3.9722	0.042	0.103	0.000	0.021
4.0333	0.042	0.104	0.000	0.021
4.0944	0.042	0.106	0.000	0.021
4.1556	0.042	0.108	0.000	0.021
4.2167	0.042	0.110	0.000	0.021
4.2778	0.042	0.111	0.000	0.021
4.3389	0.042	0.113	0.000	0.021
4.4000	0.042	0.115	0.000	0.021
4.4611	0.042	0.117	0.000	0.021
4.5222	0.042	0.119	0.000	0.021
4.5833	0.042	0.120	0.000	0.021
4.6444	0.042	0.122	0.000	0.021
4.7056	0.042	0.124	0.000	0.021
4.7667	0.042	0.125	0.000	0.021
4.8278	0.042	0.126	0.000	0.021
4.8889	0.042	0.127	0.000	0.021
4.9500	0.042	0.128	0.000	0.021

5.0111	0.042	0.129	0.000	0.021
5.0722	0.042	0.130	0.000	0.021
5.1333	0.042	0.131	0.000	0.021
5.1944	0.042	0.132	0.000	0.021
5.2556	0.042	0.133	0.000	0.021
5.3167	0.042	0.134	0.000	0.021
5.3778	0.042	0.135	0.000	0.021
5.4389	0.042	0.136	0.000	0.021
5.5000	0.042	0.137	0.000	0.021

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.26
Total Impervious Area: 0.72

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.27
Total Impervious Area: 0.71

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.25272
5 year	0.339512
10 year	0.402633
25 year	0.489066
50 year	0.558467
100 year	0.632301

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.070521
5 year	0.095034
10 year	0.112904
25 year	0.137421
50 year	0.157141
100 year	0.178148

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.298	0.083
1903	0.331	0.092
1904	0.374	0.104
1905	0.168	0.047
1906	0.188	0.052
1907	0.251	0.070
1908	0.206	0.057
1909	0.255	0.071
1910	0.243	0.068
1911	0.273	0.076

1912	0.494	0.173
1913	0.197	0.055
1914	0.828	0.230
1915	0.170	0.047
1916	0.318	0.088
1917	0.120	0.033
1918	0.255	0.071
1919	0.156	0.043
1920	0.207	0.058
1921	0.178	0.049
1922	0.279	0.078
1923	0.195	0.054
1924	0.367	0.102
1925	0.154	0.043
1926	0.299	0.083
1927	0.244	0.068
1928	0.181	0.050
1929	0.361	0.100
1930	0.378	0.105
1931	0.182	0.051
1932	0.197	0.055
1933	0.195	0.054
1934	0.317	0.088
1935	0.168	0.047
1936	0.235	0.065
1937	0.349	0.097
1938	0.171	0.047
1939	0.215	0.060
1940	0.379	0.105
1941	0.374	0.104
1942	0.282	0.078
1943	0.279	0.077
1944	0.401	0.111
1945	0.304	0.084
1946	0.236	0.065
1947	0.184	0.051
1948	0.253	0.070
1949	0.391	0.109
1950	0.221	0.061
1951	0.334	0.093
1952	0.378	0.108
1953	0.348	0.098
1954	0.205	0.057
1955	0.191	0.053
1956	0.188	0.052
1957	0.204	0.057
1958	0.256	0.076
1959	0.260	0.078
1960	0.201	0.056
1961	0.573	0.159
1962	0.246	0.068
1963	0.183	0.051
1964	0.531	0.148
1965	0.239	0.069
1966	0.199	0.055
1967	0.279	0.078
1968	0.235	0.065
1969	0.212	0.059

1970	0.241	0.067
1971	0.234	0.065
1972	0.773	0.215
1973	0.449	0.125
1974	0.325	0.090
1975	0.336	0.094
1976	0.358	0.099
1977	0.154	0.043
1978	0.267	0.080
1979	0.272	0.076
1980	0.268	0.075
1981	0.253	0.070
1982	0.206	0.057
1983	0.279	0.078
1984	0.277	0.077
1985	0.316	0.088
1986	0.160	0.045
1987	0.282	0.078
1988	0.168	0.047
1989	0.154	0.043
1990	0.203	0.056
1991	0.303	0.084
1992	0.288	0.080
1993	0.329	0.092
1994	0.225	0.063
1995	0.175	0.049
1996	0.236	0.066
1997	0.210	0.058
1998	0.250	0.069
1999	0.272	0.076
2000	0.239	0.066
2001	0.192	0.053
2002	0.348	0.097
2003	0.203	0.056
2004	0.305	0.085
2005	0.582	0.162
2006	0.273	0.076
2007	0.305	0.085
2008	0.252	0.070
2009	0.192	0.053
2010	0.247	0.069
2011	0.260	0.072
2012	0.241	0.067
2013	0.227	0.063
2014	0.220	0.061
2015	0.369	0.103
2016	0.231	0.064
2017	0.370	0.103
2018	0.231	0.072
2019	0.328	0.091
2020	0.269	0.075
2021	0.227	0.063
2022	0.385	0.107
2023	0.476	0.132
2024	0.511	0.144
2025	0.248	0.069
2026	0.272	0.076
2027	0.304	0.084

2028	0.119	0.033
2029	0.195	0.055
2030	0.391	0.109
2031	0.123	0.034
2032	0.208	0.058
2033	0.261	0.073
2034	0.205	0.057
2035	0.252	0.070
2036	0.204	0.057
2037	0.275	0.076
2038	0.261	0.072
2039	0.524	0.146
2040	0.205	0.057
2041	0.260	0.072
2042	0.300	0.083
2043	0.332	0.092
2044	0.228	0.063
2045	0.185	0.051
2046	0.205	0.057
2047	0.253	0.070
2048	0.209	0.058
2049	0.309	0.086
2050	0.230	0.064
2051	0.325	0.090
2052	0.248	0.069
2053	0.211	0.059
2054	0.418	0.116
2055	0.256	0.071
2056	0.330	0.092
2057	0.163	0.045
2058	0.311	0.086
2059	0.388	0.108

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8280	0.2300
2	0.7730	0.2148
3	0.5820	0.1733
4	0.5733	0.1618
5	0.5310	0.1593
6	0.5241	0.1476
7	0.5114	0.1456
8	0.4938	0.1440
9	0.4759	0.1322
10	0.4489	0.1247
11	0.4183	0.1162
12	0.4008	0.1113
13	0.3909	0.1086
14	0.3906	0.1085
15	0.3879	0.1078
16	0.3852	0.1077
17	0.3788	0.1070
18	0.3782	0.1052
19	0.3778	0.1049
20	0.3744	0.1040
21	0.3743	0.1040
22	0.3702	0.1028

23	0.3692	0.1026
24	0.3674	0.1020
25	0.3609	0.1003
26	0.3576	0.0993
27	0.3493	0.0976
28	0.3481	0.0970
29	0.3480	0.0969
30	0.3360	0.0939
31	0.3343	0.0929
32	0.3322	0.0923
33	0.3307	0.0919
34	0.3304	0.0918
35	0.3294	0.0915
36	0.3284	0.0914
37	0.3249	0.0903
38	0.3246	0.0902
39	0.3177	0.0882
40	0.3166	0.0879
41	0.3157	0.0877
42	0.3110	0.0864
43	0.3093	0.0859
44	0.3054	0.0848
45	0.3045	0.0846
46	0.3038	0.0844
47	0.3035	0.0843
48	0.3032	0.0842
49	0.3003	0.0834
50	0.2993	0.0831
51	0.2984	0.0829
52	0.2883	0.0801
53	0.2815	0.0801
54	0.2815	0.0782
55	0.2793	0.0782
56	0.2792	0.0781
57	0.2791	0.0780
58	0.2788	0.0776
59	0.2775	0.0775
60	0.2749	0.0774
61	0.2731	0.0771
62	0.2730	0.0764
63	0.2722	0.0762
64	0.2721	0.0759
65	0.2720	0.0758
66	0.2688	0.0757
67	0.2684	0.0756
68	0.2668	0.0756
69	0.2615	0.0748
70	0.2608	0.0746
71	0.2603	0.0727
72	0.2597	0.0725
73	0.2595	0.0723
74	0.2561	0.0722
75	0.2559	0.0715
76	0.2548	0.0711
77	0.2545	0.0709
78	0.2529	0.0708
79	0.2529	0.0704
80	0.2526	0.0703

81	0.2519	0.0702
82	0.2517	0.0700
83	0.2511	0.0699
84	0.2501	0.0697
85	0.2481	0.0695
86	0.2479	0.0694
87	0.2467	0.0690
88	0.2465	0.0690
89	0.2438	0.0687
90	0.2434	0.0685
91	0.2413	0.0677
92	0.2408	0.0676
93	0.2391	0.0671
94	0.2389	0.0669
95	0.2357	0.0664
96	0.2355	0.0660
97	0.2353	0.0655
98	0.2349	0.0654
99	0.2340	0.0652
100	0.2313	0.0652
101	0.2307	0.0641
102	0.2304	0.0640
103	0.2282	0.0634
104	0.2271	0.0631
105	0.2266	0.0629
106	0.2254	0.0627
107	0.2210	0.0614
108	0.2196	0.0610
109	0.2149	0.0598
110	0.2122	0.0589
111	0.2107	0.0585
112	0.2105	0.0585
113	0.2085	0.0580
114	0.2081	0.0578
115	0.2071	0.0575
116	0.2064	0.0573
117	0.2058	0.0572
118	0.2054	0.0571
119	0.2051	0.0570
120	0.2048	0.0570
121	0.2047	0.0569
122	0.2044	0.0569
123	0.2038	0.0567
124	0.2030	0.0564
125	0.2029	0.0564
126	0.2009	0.0558
127	0.1992	0.0553
128	0.1973	0.0549
129	0.1965	0.0546
130	0.1955	0.0546
131	0.1949	0.0544
132	0.1946	0.0541
133	0.1921	0.0534
134	0.1916	0.0532
135	0.1911	0.0532
136	0.1883	0.0523
137	0.1879	0.0523
138	0.1847	0.0513

139	0.1840	0.0512
140	0.1832	0.0509
141	0.1822	0.0507
142	0.1808	0.0502
143	0.1776	0.0494
144	0.1752	0.0487
145	0.1707	0.0474
146	0.1698	0.0472
147	0.1680	0.0468
148	0.1679	0.0467
149	0.1679	0.0466
150	0.1625	0.0452
151	0.1603	0.0445
152	0.1556	0.0432
153	0.1536	0.0428
154	0.1536	0.0427
155	0.1535	0.0427
156	0.1230	0.0343
157	0.1200	0.0334
158	0.1189	0.0331

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1264	4808	21	0	Pass
0.1307	4305	19	0	Pass
0.1351	3715	17	0	Pass
0.1395	3312	17	0	Pass
0.1438	2971	16	0	Pass
0.1482	2624	13	0	Pass
0.1525	2388	13	0	Pass
0.1569	2149	10	0	Pass
0.1613	1921	9	0	Pass
0.1656	1733	6	0	Pass
0.1700	1523	6	0	Pass
0.1744	1400	5	0	Pass
0.1787	1283	5	0	Pass
0.1831	1137	5	0	Pass
0.1875	1050	5	0	Pass
0.1918	970	3	0	Pass
0.1962	866	2	0	Pass
0.2006	800	2	0	Pass
0.2049	740	2	0	Pass
0.2093	654	2	0	Pass
0.2137	602	2	0	Pass
0.2180	543	1	0	Pass
0.2224	501	1	0	Pass
0.2267	473	1	0	Pass
0.2311	419	0	0	Pass
0.2355	391	0	0	Pass
0.2398	354	0	0	Pass
0.2442	322	0	0	Pass
0.2486	296	0	0	Pass
0.2529	270	0	0	Pass
0.2573	247	0	0	Pass
0.2617	222	0	0	Pass
0.2660	204	0	0	Pass
0.2704	189	0	0	Pass
0.2748	177	0	0	Pass
0.2791	158	0	0	Pass
0.2835	145	0	0	Pass
0.2879	137	0	0	Pass
0.2922	125	0	0	Pass
0.2966	122	0	0	Pass
0.3009	115	0	0	Pass
0.3053	104	0	0	Pass
0.3097	96	0	0	Pass
0.3140	90	0	0	Pass
0.3184	84	0	0	Pass
0.3228	80	0	0	Pass
0.3271	76	0	0	Pass
0.3315	66	0	0	Pass
0.3359	63	0	0	Pass
0.3402	61	0	0	Pass
0.3446	59	0	0	Pass
0.3490	58	0	0	Pass
0.3533	55	0	0	Pass

0.3577	52	0	0	Pass
0.3621	48	0	0	Pass
0.3664	48	0	0	Pass
0.3708	44	0	0	Pass
0.3751	40	0	0	Pass
0.3795	36	0	0	Pass
0.3839	35	0	0	Pass
0.3882	32	0	0	Pass
0.3926	29	0	0	Pass
0.3970	29	0	0	Pass
0.4013	28	0	0	Pass
0.4057	28	0	0	Pass
0.4101	28	0	0	Pass
0.4144	28	0	0	Pass
0.4188	26	0	0	Pass
0.4232	25	0	0	Pass
0.4275	25	0	0	Pass
0.4319	24	0	0	Pass
0.4363	22	0	0	Pass
0.4406	21	0	0	Pass
0.4450	21	0	0	Pass
0.4493	19	0	0	Pass
0.4537	18	0	0	Pass
0.4581	18	0	0	Pass
0.4624	18	0	0	Pass
0.4668	17	0	0	Pass
0.4712	17	0	0	Pass
0.4755	17	0	0	Pass
0.4799	16	0	0	Pass
0.4843	16	0	0	Pass
0.4886	15	0	0	Pass
0.4930	14	0	0	Pass
0.4974	13	0	0	Pass
0.5017	12	0	0	Pass
0.5061	12	0	0	Pass
0.5105	12	0	0	Pass
0.5148	11	0	0	Pass
0.5192	11	0	0	Pass
0.5235	11	0	0	Pass
0.5279	10	0	0	Pass
0.5323	9	0	0	Pass
0.5366	9	0	0	Pass
0.5410	9	0	0	Pass
0.5454	9	0	0	Pass
0.5497	9	0	0	Pass
0.5541	8	0	0	Pass
0.5585	7	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Gravel Trench Bed 1 POC	☐	186.80			☐	100.00			
Total Volume Infiltrated		186.80	0.00	0.00		100.00	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.

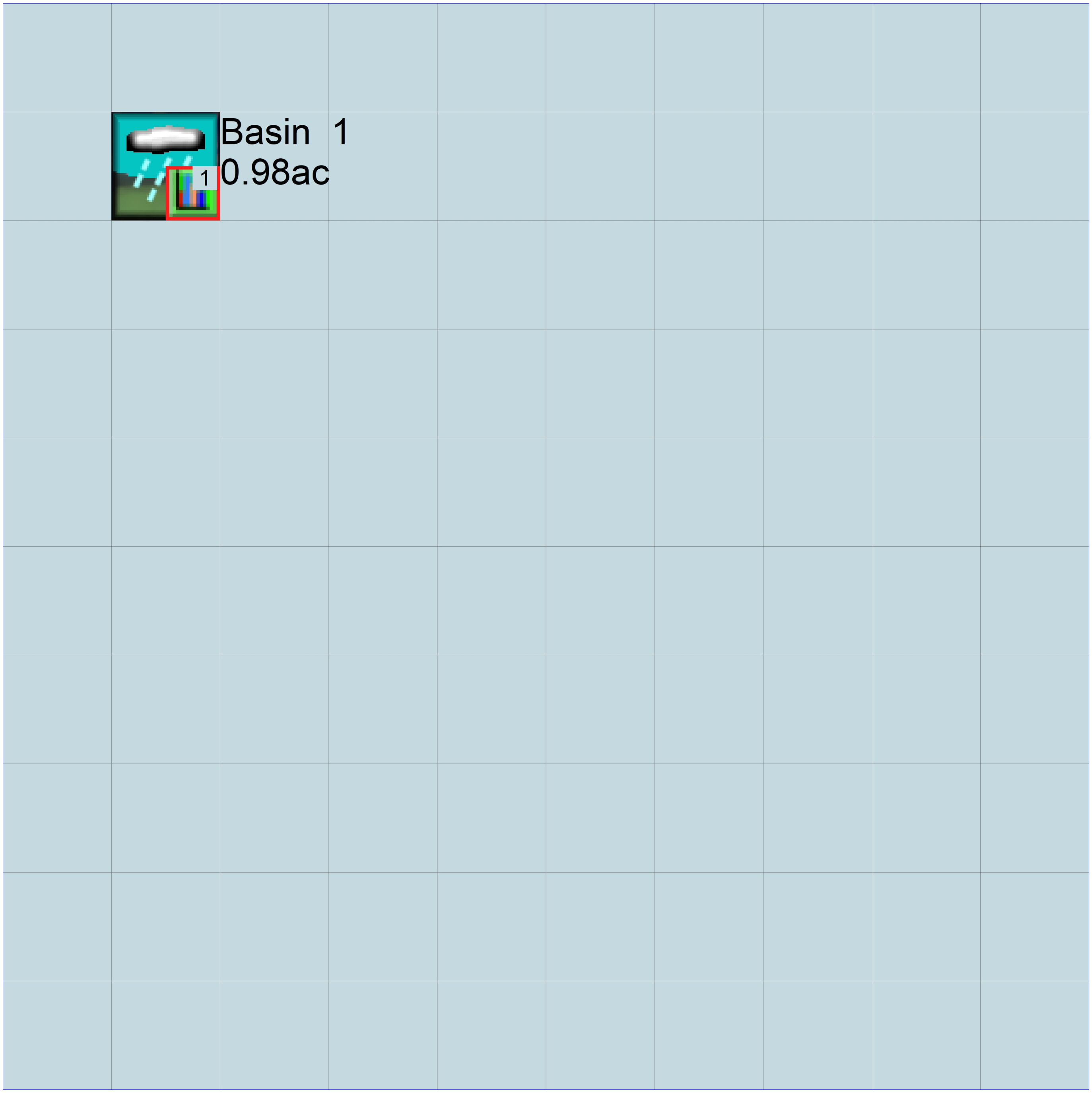
PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   20230926flowcontrol.wdm
MESSU      25   Pre20230926flowcontrol.MES
           27   Pre20230926flowcontrol.L61
           28   Pre20230926flowcontrol.L62
           30   POC20230926flowcontrol1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       7
      IMPLND       4
      IMPLND      11
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out           ***
    7     A/B, Lawn, Flat          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    7         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
```

```
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    7         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    7              0         5       0.8       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7            0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    7              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out           ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
   11         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         0    0    4    0    0    4    1    9
   11         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
   11         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
   11            400      0.01       0.1       0.1
```

```
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4             0         0
   11             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4             0         0
   11             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   7                        0.26     COPY   501     12
PERLND   7                        0.26     COPY   501     13
IMPLND   4                        0.03     COPY   501     15
IMPLND  11                        0.69     COPY   501     15

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

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



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

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

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

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

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
```

```
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                           ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   20230926flowcontrol.wdm
MESSU      25   Mit20230926flowcontrol.MES
           27   Mit20230926flowcontrol.L61
           28   Mit20230926flowcontrol.L62
           30   POC20230926flowcontrol1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       4
      IMPLND      11
      PERLND       7
      IMPLND       8
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Gravel Trench Bed 1         MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                         in  out           ***
    7     A/B, Lawn, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    7         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    7         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    7            0         5       0.8       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7            0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                   ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7            0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    7            0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out          ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
   11         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   *********
    4         0    0    4    0    0    4    1    9
   11         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
```

```
   11         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
   11            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
   11              0         0
    8              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
   11              0         0
    8              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
IMPLND   4                        0.13     RCHRES   1      5
IMPLND  11                        0.38     RCHRES   1      5
Basin  2***
PERLND   7                        0.27     COPY   501     12
PERLND   7                        0.27     COPY   601     12
PERLND   7                        0.27     COPY   501     13
PERLND   7                        0.27     COPY   601     13
IMPLND   8                        0.01     COPY   501     15
IMPLND   8                        0.01     COPY   601     15
IMPLND  11                        0.19     COPY   501     15
IMPLND  11                        0.19     COPY   601     15

******Routing******
IMPLND   4                        0.13     COPY     1     15
IMPLND  11                        0.38     COPY     1     15
RCHRES   1                           1     COPY   501     17
END SCHEMATIC

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



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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
    1     Gravel Trench Be-006    2    1    1    1   28    0    1
  END GEN-INFO
```

```
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1        1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1        4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                     ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)    (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.042470  0.000000  0.000000  0.000000
  0.061111  0.042470  0.001038  0.000000  0.021412
  0.122222  0.042470  0.002076  0.000000  0.021412
  0.183333  0.042470  0.003114  0.000000  0.021412
  0.244444  0.042470  0.004153  0.000000  0.021412
  0.305556  0.042470  0.005191  0.000000  0.021412
  0.366667  0.042470  0.006229  0.000000  0.021412
  0.427778  0.042470  0.007267  0.000000  0.021412
  0.488889  0.042470  0.008305  0.000000  0.021412
  0.550000  0.042470  0.009343  0.000000  0.021412
  0.611111  0.042470  0.010382  0.000000  0.021412
  0.672222  0.042470  0.011420  0.000000  0.021412
  0.733333  0.042470  0.012458  0.000000  0.021412
  0.794444  0.042470  0.013496  0.000000  0.021412
  0.855556  0.042470  0.014534  0.000000  0.021412
  0.916667  0.042470  0.015572  0.000000  0.021412
  0.977778  0.042470  0.016611  0.000000  0.021412
  1.038889  0.042470  0.018375  0.000000  0.021412
  1.100000  0.042470  0.020140  0.000000  0.021412
  1.161111  0.042470  0.021905  0.000000  0.021412
  1.222222  0.042470  0.023670  0.000000  0.021412
  1.283333  0.042470  0.025435  0.000000  0.021412
  1.344444  0.042470  0.027200  0.000000  0.021412
  1.405556  0.042470  0.028965  0.000000  0.021412
  1.466667  0.042470  0.030730  0.000000  0.021412
  1.527778  0.042470  0.032494  0.000000  0.021412
  1.588889  0.042470  0.034259  0.000000  0.021412
```

```
  1.650000  0.042470  0.036024  0.000000  0.021412
  1.711111  0.042470  0.037789  0.000000  0.021412
  1.772222  0.042470  0.039554  0.000000  0.021412
  1.833333  0.042470  0.041319  0.000000  0.021412
  1.894444  0.042470  0.043084  0.000000  0.021412
  1.955556  0.042470  0.044848  0.000000  0.021412
  2.016667  0.042470  0.046613  0.000000  0.021412
  2.077778  0.042470  0.048378  0.000000  0.021412
  2.138889  0.042470  0.050143  0.000000  0.021412
  2.200000  0.042470  0.051908  0.000000  0.021412
  2.261111  0.042470  0.053673  0.000000  0.021412
  2.322222  0.042470  0.055438  0.000000  0.021412
  2.383333  0.042470  0.057203  0.000000  0.021412
  2.444444  0.042470  0.058967  0.000000  0.021412
  2.505556  0.042470  0.060732  0.000000  0.021412
  2.566667  0.042470  0.062497  0.000000  0.021412
  2.627778  0.042470  0.064262  0.000000  0.021412
  2.688889  0.042470  0.066027  0.000000  0.021412
  2.750000  0.042470  0.067792  0.000000  0.021412
  2.811111  0.042470  0.069557  0.000000  0.021412
  2.872222  0.042470  0.071322  0.000000  0.021412
  2.933333  0.042470  0.073086  0.000000  0.021412
  2.994444  0.042470  0.074851  0.000000  0.021412
  3.055556  0.042470  0.076616  0.000000  0.021412
  3.116667  0.042470  0.078381  0.000000  0.021412
  3.177778  0.042470  0.080146  0.000000  0.021412
  3.238889  0.042470  0.081911  0.000000  0.021412
  3.300000  0.042470  0.083676  0.000000  0.021412
  3.361111  0.042470  0.085441  0.000000  0.021412
  3.422222  0.042470  0.087205  0.000000  0.021412
  3.483333  0.042470  0.088970  0.000000  0.021412
  3.544444  0.042470  0.090735  0.000000  0.021412
  3.605556  0.042470  0.092500  0.000000  0.021412
  3.666667  0.042470  0.094265  0.000000  0.021412
  3.727778  0.042470  0.096030  0.000000  0.021412
  3.788889  0.042470  0.097795  0.000000  0.021412
  3.850000  0.042470  0.099559  0.000000  0.021412
  3.911111  0.042470  0.101324  0.000000  0.021412
  3.972222  0.042470  0.103089  0.000000  0.021412
  4.033333  0.042470  0.104854  0.000000  0.021412
  4.094444  0.042470  0.106619  0.000000  0.021412
  4.155556  0.042470  0.108384  0.000000  0.021412
  4.216667  0.042470  0.110149  0.000000  0.021412
  4.277778  0.042470  0.111914  0.000000  0.021412
  4.338889  0.042470  0.113678  0.000000  0.021412
  4.400000  0.042470  0.115443  0.000000  0.021412
  4.461111  0.042470  0.117208  0.000000  0.021412
  4.522222  0.042470  0.118973  0.000000  0.021412
  4.583333  0.042470  0.120738  0.000000  0.021412
  4.644444  0.042470  0.122503  0.000000  0.021412
  4.705556  0.042470  0.124268  0.000000  0.021412
  4.766667  0.042470  0.125306  0.000000  0.021412
  4.827778  0.042470  0.126344  0.000000  0.021412
  4.888889  0.042470  0.127382  0.000000  0.021412
  4.950000  0.042470  0.128420  0.000000  0.021412
  5.011111  0.042470  0.129458  0.000000  0.021412
  5.072222  0.042470  0.130497  0.000000  0.021412
  5.133333  0.042470  0.131535  0.000000  0.021412
  5.194444  0.042470  0.132573  0.000000  0.021412
  5.255556  0.042470  0.133611  0.000000  0.021412
  5.316667  0.042470  0.134649  0.000000  0.021412
  5.377778  0.042470  0.135687  0.000000  0.021412
  5.438889  0.042470  0.136726  0.000000  0.021412
  5.500000  0.042470  0.137764  0.000000  0.021412
  5.561111  0.042470  0.140359  0.159997  0.021412
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
```

```
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1               PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1               IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1               PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1               IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   1 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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D. Emerging Technology Use Level Designations

Basic, Enhanced and Phosphorus Treatment

November 2022

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) ENHANCED AND PHOSPHORUS TREATMENT

For

Contech Engineered Solutions, LLC (Contech) Modular Wetlands Linear

Ecology's Decision

Based on Modular Wetland Systems, Inc, application submissions, including the Technical Evaluation Report, dated April 1, 2014, Ecology hereby issues the following use level designation:

1. General Use Level Designation (GULD) for the Modular Wetlands Linear Stormwater Treatment System for Basic, Phosphorus, and Enhanced treatment
   - Sized at a hydraulic loading rate of:
     - 1 gallon per minute (gpm) per square foot (sq ft) of Wetland Cell Surface Area
     - Prefilter box (approved at either 22 inches or 33 inches tall)
       - 3.0 gpm/sq ft of prefilter box surface area for moderate pollutant loading rates (low to medium density residential basins).
       - 2.1 gpm/sq ft of prefilter box surface area for high pollutant loading rates (commercial and industrial basins).
2. Ecology approves the Modular Wetlands Linear Stormwater Treatment System units for Basic, Phosphorus, and Enhanced treatment at the hydraulic loading rate listed above. Designers shall calculate the water quality design flow rates using the following procedures:
   - Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute water quality treatment design flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology- approved continuous runoff model.

- Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute water quality treatment design flow rate as calculated using one of the three methods described in Chapter 2.7.6 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
- Entire State: For treatment installed downstream of detention, the water quality treatment design flow rate is the full 2-year release rate of the detention facility.

3. These use level designations have no expiration date but may be amended or revoked by Ecology, and are subject to the conditions specified below.

Ecology's Conditions of Use

Applicants shall comply with the following conditions:

1) Design, assemble, install, operate, and maintain the Modular Wetlands Linear Stormwater Treatment System units, in accordance with Contech's. applicable manuals and documents and the Ecology Decision.
2) Each site plan must undergo Contech review and approval before site installation. This ensures that site grading and slope are appropriate for use of a Modular Wetlands Linear Stormwater Treatment System unit.
3) Modular Wetlands Linear Stormwater Treatment System media shall conform to the specifications submitted to and approved by Ecology.
4) The applicant tested the Modular Wetlands Linear Stormwater Treatment System with an external bypass weir. This weir limited the depth of water flowing through the media, and therefore the active treatment area, to below the root zone of the plants. This GULD applies to Modular Wetlands Linear Stormwater Treatment Systems whether plants are included in the final product or not.
5) Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of stormwater treatment technology.
   - Typically, Contech designs Modular Wetland systems for a target prefilter media life of 6 to 12 months.
   - Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
   - Owners/operators must inspect Modular Wetland systems for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You must conduct inspections monthly during the wet season, and every other month during the dry season (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to the SWMMEW, the wet

season in eastern Washington is October 1 to June 30). After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.
- When inspections are performed, the following findings typically serve as maintenance triggers:
    - Standing water remains in the vault between rain events, or
    - Bypass occurs during storms smaller than the design storm.
    - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
    - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)

6) Discharges from the Modular Wetlands Linear Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.

Applicant: Contech Engineered Solutions, LLC

Applicant's Address: 11815 NE Glenn Widing Dr.
Portland, OR 97220

Application Documents:

Original Application for Conditional Use Level Designation, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., January 2011

Quality Assurance Project Plan: Modular Wetland System – Linear Treatment System Performance Monitoring Project, draft, January 2011

Revised Application for Conditional Use Level Designation, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., May 2011

Memorandum: Modular Wetland System-Linear GULD Application Supplementary Data, April 2014

Technical Evaluation Report: Modular Wetland System Stormwater Treatment System Performance Monitoring, April 2014

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, and Phosphorus treatment device in accordance with Ecology's Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE) January 2011 Revision.

Applicant's Performance Claims:

- The Modular Wetlands Linear is capable of removing a minimum of 80-percent of TSS from stormwater with influent concentrations between 100 and 200 mg/L.
- The Modular Wetlands Linear is capable of removing a minimum of 50-percent of total phosphorus from stormwater with influent concentrations between 0.1 and 0.5 mg/L.
- The Modular Wetlands Linear is capable of removing a minimum 30-percent of dissolved copper from stormwater with influent concentrations between 0.005 and 0.020 mg/L.
- The Modular Wetlands Linear is capable of removing a minimum 60-percent of dissolved zinc from stormwater with influent concentrations between 0.02 and 0.30 mg/L.

Ecology's Recommendations:

- Contech has shown Ecology, through laboratory and field-testing, that the Modular Wetlands Linear Stormwater Treatment System filter system is capable of attaining Ecology's Basic, Phosphorus, and Enhanced treatment goals.

Findings of Fact:

<u>Laboratory Testing</u>

The Modular Wetlands Linear Stormwater Treatment System has the:

- Capability to remove 99 percent of total suspended solids (using Sil-Co-Sil 106) in a quarter-scale model with influent concentrations of 270 mg/L.
- Capability to remove 91 percent of total suspended solids (using Sil-Co-Sil 106) in laboratory conditions with influent concentrations of 84.6 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 93 percent of dissolved Copper in a quarter-scale model with influent concentrations of 0.757 mg/L.
- Capability to remove 79 percent of dissolved Copper in laboratory conditions with influent concentrations of 0.567 mg/L at a flow rate of 3.0 gpm per square foot of media.

- Capability to remove 80.5-percent of dissolved Zinc in a quarter-scale model with influent concentrations of 0.95 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 78-percent of dissolved Zinc in laboratory conditions with influent concentrations of 0.75 mg/L at a flow rate of 3.0 gpm per square foot of media.

Field Testing

- Modular Wetland Systems, Inc. conducted monitoring of an MWS-Linear (Model # MWS-L-4-13) from April 2012 through May 2013, at a transportation maintenance facility in Portland, Oregon. The manufacturer collected flow-weighted composite samples of the system's influent and effluent during 28 separate storm events. The system treated approximately 75 percent of the runoff from 53.5 inches of rainfall during the monitoring period. The applicant sized the system at 1 gpm/sq ft. (wetland media) and 3gpm/sq ft. (prefilter).
- Influent TSS concentrations for qualifying sampled storm events ranged from 20 to 339 mg/L. Average TSS removal for influent concentrations greater than 100 mg/L (n=7) averaged 85 percent. For influent concentrations in the range of 20-100 mg/L (n=18), the upper 95 percent confidence interval about the mean effluent concentration was 12.8 mg/L.
- Total phosphorus removal for 17 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 65 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 58 percent.
- The lower 95 percent confidence limit of the mean percent removal was 60.5 percent for dissolved zinc for influent concentrations in the range of 0.02 to 0.3 mg/L (n=11). The lower 95 percent confidence limit of the mean percent removal was 32.5 percent for dissolved copper for influent concentrations in the range of 0.005 to 0.02 mg/L (n=14) at flow rates up to 28 gpm (design flow rate 41 gpm). Laboratory test data augmented the data set, showing dissolved copper removal at the design flow rate of 41 gpm (93 percent reduction in influent dissolved copper of 0.757 mg/L).

Issues to be addressed by the Company:

1. Contech should collect maintenance and inspection data for the first year on all installations in the Northwest in order to assess standard maintenance requirements for various land uses in the region. Contech should use these data to establish required maintenance cycles.
2. Contech should collect pre-treatment chamber sediment depth data for the first year of operation for all installations in the Northwest. Contech will use these data to create a correlation between sediment depth and pre-filter clogging.

Technology Description:
Download at https://www.conteches.com/modular-wetlands

Contact Information:

Applicant: Jeremiah Lehman
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11815 NE Glenn Widing Dr.
Portland, OR 97220
Jeremiah.Lehman@ContechES.com

Applicant website: http://www.conteches.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 870-0983
douglas.howie@ecy.wa.gov

Revision History

Date	**Revision**
June 2011	Original use-level-designation document
September 2012	Revised dates for TER and expiration
January 2013	Modified Design Storm Description, added Revision Table, added maintenance discussion, modified format in accordance with Ecology standard
December 2013	Updated name of Applicant
April 2014	Approved GULD designation for Basic, Phosphorus, and Enhanced treatment
December 2015	Updated GULD to document the acceptance of MWS – Linear Modular Wetland installations with or without the inclusion of plants
July 2017	Revised Manufacturer Contact Information (name, address, and email)
December 2019	Revised Manufacturer Contact Address
July 2021	Added additional prefilter sized at 33 inches
August 2021	Changed “Prefilter” to “Prefilter box”
November 2022	Changed Contacts to Contech ES

Table Notes - Do Not Copy Into SSP	Surface Type	Onsite	Offsite	Total	Project Notes
See Glossary - Project Site	Total Project Site Area (ft^2)	25777	1087	26864	
See Glossary - Site	Total Site Area (ft^2)	44200	1087	45287	
				0	
See Glossary - Hard Surface	Existing Hard Surface Area (ft^2)	24366	1061	25427	
See Glossary - Native Vegetation	Existing Native Vegetation Area (ft^2)	0	0	0	
See Glossary - Vegetation	Existing Vegetation Area (ft^2)	1411	0	1411	
See Glossary - Lawn/Landscaped	Existing Lawn/Landscaped Area (ft^2)	1411	26	1437	
See Glossary - Pasture	Existing Pasture Area (ft^2)	0	0	0	
Equals E5/E2 * 100. <35% is considered new development; equal to or greater than 35% is redevelopment	Existing Hard Surface Coverage (%)	0.945261279	0.976080957		
See Glossary - New Hard Surface and Pollution Generating Hard Surface If>5,000 and E33<50%, MR#6 and MR#9 applies to new PGHS only and this is amount of PGHS that requires treatment.	New Pollution Generating Hard Surface Area (ft^2)	151	0	151	
See Glossary - New Hard Surface. This will be all other new hard surfaces that are not PGHS.	New Non-Pollution Generating Hard Surface Area (ft^2)		26	26	
(E12+E13)	Total New Hard Surface Area (ft^2)	151	26	177	
See Glossary - Replaced Hard Surface and Pollution Generating Hard Surface	Replaced Pollution Generating Hard Surface Area (ft^2)	13412	1061	14473	
See Glossary - Replaced Hard Surface. This will be all other replaced hard surfaces that are not PGHS.	Replaced Non-Pollution Generating Hard Surface Area (ft^2)	5931	0	5931	
(E15+E16)	Total Replaced Hard Surface Area (ft^2)	19343	1061	20404	
(E14+E17) >2,000 - Review MR #1-5 >5,000 - Review MR#1-9	Total of New Plus Replaced Hard Surface Area (ft^2)	19494	1087	20581	
(E12+E15) >5,000 and B29>50%, MR#6 and MR#9 applies to new and replaced PGHS and this is amount of PGHS that requires treatment.	Total of New Plus Replaced Pollution Generating Hard Surface Area (ft^2)	13563	1061	14624	
See Glossary - Vegetation, Lawn Area, and Landscaped Areas If >32,670 - Review MR#1-#9	Amount of Vegetation Converted to Lawn/Landscaped Area (ft^2)	0	0	0	
See Glossary - Native Vegetation and Pasture If >108,900 - Review MR#1-#9	Amount of Native Vegetation Converted to Pasture (ft^2)	0	0	0	
(E18+E20+E21) The total hard surface and converted vegetation areas that require compliance with MRs if B29>50%. Typically the amount of area requiring flow control if flow control is required.	Total of New Plus Replaced Hard Surfaces and Converted Vegetation Areas (ft^2)	19494	1087	20581	
(E14+E20+E21) The total hard surface and converted vegetation areas that require compliance with MRs if E29<50%. Typically the amount of area requiring flow control if flow control is required.	Total of New Hard Surfaces and Converted Vegetation Areas (ft^2)	151	26	177	
See Glossary - Hard Surface and Vegetation	Amount of Existing Hard Surface Converted to Vegetation (ft^2)	324	0	324	
See Glossary - Native Vegetation	Amount of Native Vegetation to Remain (ft^2)	0	0	0	
See Glossary - Vegetation	Amount of Existing Vegetation to Remain (ft^2)	1237	0	1237	
See Glossary - Existing Hard Surface	Amount of Existing Hard Surface to Remain (ft^2)	4266	0	4266	
See Glossary - Lawn/Landscaped Areas	Amount of Existing Lawn/Landscaped to Remain (ft^2)	1237	0	1237	
See Glossary - Pasture	Amount of Existing Pasture to Remain (ft^2)	0	0	0	
See Glossary - Land Disturbing Activities If >7,000 - Review MR#1-5	Amount of Land Disturbing Activity (ft^2)	25777	1087	26864	
Construction Cost Estimates of proposed improvements and building improvements - including interior improvements.	Value of Proposed Improvements ($)	450000	20,000	470000	
Per Pierce County Auditor	Assessed value of Existing Project Site Improvements ($)	1018800	20,000	1038800	
(E31/E32 * 100) If >50%: new hard surfaces, replaced hard surfaces, and converted vegetation areas shall be comply with MR#1-9 as applicable. If <50%: Only New Hard Surfaces and Converted Vegetation Areas Comply with MR#1-9 as applicable.	Proposed Improvements Compared to Existing Project Site Improvements (%)	0.441696113	1	0.452445129	

PROJECT SITE AREA

ONISTE

PROJECT AREA = 25,777 SF

SITE AREA = 42,200 SF

OFFSITE

PROJECT AREA = 1,087 SF

LEGEND

SC	NEAT SAWCUT LINE	
SF	FILTER FABRIC FENCE	5 / C1.1
CL	CLEARING LIMITS	
IP	INLET SEDIMENT PROTECTION	1 / C1.1
IS	INTERCEPTOR SWALE	2 / C1.1
	EXISTING PAVEMENT REMOVAL	
	EXISTING PAVEMENT TO REMAIN	
	EXISTING CONCRETE REMOVAL	
	EXISTING CONCRETE TO REMAIN	

KEY NOTES

1	REMOVE EXISTING BUILDING AND ALL ASSOCIATED APPURTENANCES.
2	REMOVE EXISTING CURB
3	EXISTING OVERHEAD POWER LINES TO BE REMOVED BY TACOMA POWER OR LICENSED PURVEYOR.
4	REMOVED EXISTING LIGHT POLE TO BE RELOCATED.
5	REMOVE EXISTING FENCE
6	REMOVE EXISTING GATE
7	REMOVE EXISTING UTILITY AND ASSOCIATED APPURTENANCES TO MAXIMUM EXTENT NEEDED FOR CONSTRUCTION.
8	REMOVE PORTION OF EXISTING ROCK WALL TO BE REPLACED WITH CONCRETE STAIRS AND RETAINING STRUCTURES. SEE SHEET C2.0
9	PROTECT EXISTING UTILITY TO REMAIN
10	SEDIMENT TRAP OVERFLOW RUNOFF FLOW PATH. RUNOFF SHALL DISCHARGE INTO COT STOMRWATER SYSTEM. INLET PROTECTION TO BE PROVIDED AND MAINTAINED AT ALL TIME.
11	PROPOSED LOCATION OF THE INFITRATION FACILITY. THIS FACILITY SHALL BE PROTECTED ONSITE USING HIGH VISIBILITY ORANGE FENCING. THE FENCING SHALL BE LOCATED AROUND THE PERIMETER OF THE FACILITY UNTIL CONSTRUCTION OF THE FACILITY IS COMPLETED. HEAVY MACHINERY SHALL NOT BE PERMITTED TO DRIVE IN THIS LOCATION DURING THE DURATION OF CONSTRUCTION.

CONSTRUCTION SEQUENCE

1. ARRANGE AND ATTEND A PRE-CONSTRUCTION MEETING WITH CITY OF TACOMA.
2. STAKE / FLAG CLEARING AND CONSTRUCTION LIMITS.
3. CONSTRUCT ALL TEMPORARY EROSION CONTROL BMP'S ACCORDING TO THE TESC PLAN. INSTALL INLET SEDIMENT PROTECTION EXISTING CATCH BASINS.
4. INSTALL CONSTRUCTION ENTRANCE AS NEEDED.
5. INSPECTION NUMBER 1. EROSION CONTROL.
6. DEMOLISH EXISTING SITE FEATURES.
7. MAINTAIN EROSION CONTROL MEASURES IN ACCORDANCE TO CITY OF TACOMA STANDARDS AND MANUFACTURER'S RECOMMENDATIONS.
8. INSPECTION NUMBER 2. COMPLETION OF DEMOLITION AND CLEARING.
9. ROUGH GRADE SITE.
10. CONSTRUCT SANITARY, STORM, AND WATER SYSTEMS AND INSTALL INLET SEDIMENT PROTECTION TO NEW CATCH BASINS.SANITARY SEWER AND WATER ARE UNDER SEPARATE PERMITS AND COVER.
11. APPLY EROSION CONTROL MULCH AND SEEDING, STRAW MULCH OR EQUAL TO AREAS THAT WILL NOT BE BROUGHT TO FINAL GRADE OR PERMANENTLY VEGETATED WITHIN 7 DAYS OF EXPOSURE. DURING THE DRY SEASON, AND 2 DAYS OF EXPOSURE DURING THE WET SEASON (OCTOBER 1 - APRIL 30).
12. RELOCATE EROSION CONTROL MEASURES OR INSTALL NEW MEASURES SO THAT AS THE SITE CONDITIONS CHANGE, THE EROSION AND SEDIMENT CONTROL IS ALWAYS IN ACCORDANCE TO THE CITY SWPPP MINIMUM REQUIREMENTS.
13. FINAL GRADE SITE AND INSTALL FINAL SURFACE TREATMENTS. ENSURE THAT SURFACE WATER IS POSITIVELY DIRECTED TOWARD PROPOSED STORM COLLECTION FACILITIES.
14. INSPECTION NUMBER 3. COMPLETION OF EXCAVATION, FILL AND EARTHWORK.
15. FINE GRADE PAVED AREA, POUR CURB & GUTTERS, AND PAVE ROADS.
16. REMOVE REMAINING TEMPORARY EROSION CONTROL ITEMS ONCE SITE HAD BEEN STABILIZED AND UPON APPROVAL FROM PIERCE COUNTY.
17. COMPLETE FINAL LANDSCAPING.
18. INSPECTION NUMBER 4. COMPLETION OF PROJECT.

DEMOLITION GENERAL NOTES

1. CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT ALL UTILITIES HAVE BEEN DISCONNECTED PRIOR TO COMMENCING DEMOLITION.
2. REFER TO ELECTRICAL DRAWINGS FOR SITE ELECTRICAL DEMOLITION/RELOCATION.
3. SIDE SEWER CONNECTIONS SHALL BE MAINTAINED.
4. CONTRACTOR SHALL MINIMIZE DUST GENERATION ONSITE BY SPRINKLING THE SITE WITH WATER UNTIL A SURFACE IS WET. SEE BMP C140.
5. REFER TO SWPPP FOR ADDITIONAL INFORMATION REGARDING EROSION CONTROL MEASURES.
6. CONTRACTOR SHALL STAGE DEMOLITION AND CONSTRUCTION IN SUCH MANNER AS TO ALWAYS MAINTAIN A ROUTE FOR THE CONVEYANCE OF STORMWATER FROM THE EXISTING SITE AND AREA UPSTREAM OF THE CONSTRUCTION AREA.
7. INSTALL CONSTRUCTION FENCING TO SECURE SITE.

CUT/FILL NOTES

CUT SLOPES

SLOPES SHALL NOT BE STEEPER THAN 2 HORIZONTAL TO 1 VERTICAL, OR AS RECOMENDED BY A SOILS ENGINEER.

THE CATCH POINT OF THE TOP OF THE SLOPE SHALL BE SET BACK FROM THE SITE BOUNDARY LINE IN ACCORDANCE WITH THE FOLLOWING TABLE, UNLESS A RETAINING WALL IS DESIGNED BY THE ENGINEER AND CONSTRUCTED FOR THE PROJECT.

CUT DEPTH	SET BACK DISTANCE
UNDER 5 FEET	2 FEET
5 - 20 FEET	HEIGHT/2
OVER 20 FEET	10 FEET

FILL STANDARDS

FILL LOCATION

SLOPES SHALL NOT BE STEEPER THAN SOILS ENGINEER RECOMMENDATIONS. FILL SITES MUST BE APPROVED BY THE ENGINEER AS SUITABLE LOCATIONS FOR THE PROPOSED FILL.

PREPARATION OF GROUND

THE GROUND SURFACE FOR FILLS OVER FIVE FEET IN HEIGHT SHALL BE PREPARED BY REMOVING VEGETATION, NONCOMPLIANT FILL, TOPSOIL, AND OTHER UNSUITABLE MATERIALS; SCARIFYING TO PROVIDE A BOND WITH THE NEW FILL; AND, WHERE EXISTING SLOPES ARE STEEPER THAN 5 HORIZONTAL TO 1 VERTICAL, BY BENCHING INTO COMPETENT MATERIAL AS DETERMINED BY THE ENGINEER. THE BENCH UNDER THE TOE OF A FILL ON A SLOPE STEEPER THAN 5 HORIZONTAL TO 1 VERTICAL SHALL BE AT LEAST 10 FEET WIDE, OR AS RECOMMENDED BY A SOILS ENGINEER.

SETBACK FROM PROPERTY LINES

THE TOE OR CATCH POINT OF FILL SLOPES SHALL BE SET BACK FROM THE SITE BOUNDARY LINE IN ACCORDANCE WITH THE FOLLOWING TABLE, UNLESS A RETAINING WALL IS DESIGNED BY THE ENGINEER AND CONSTRUCTED FOR THE PROJECT.

FILL DEPTH	SET BACK DISTANCE
UNDER 5 FEET	2 FEET
5 - 40 FEET	HEIGHT/2
OVER 40 FEET	20 FEET

TOPOGRAPHIC NOTE

THE EXISTING CULTURAL AND TOPOGRAPHIC DATA SHOWN ON THESE DRAWINGS HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, HENDRICKSON ENGINEERING PLLC CANNOT ENSURE ACCURACY AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THAT INFORMATION OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO THESE DRAWINGS AS A RESULT.

TESC NOTES

1. PROVIDE TEMPORARY EROSION CONTROL MEASURES AS SHOWN ON PLANS. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING AND ADJUSTING EROSION CONTROL FACILITIES AS SITE CONDITIONS CHANGE REFER TO T.E.S.C. NOTES AND DETAILS ON SHEET C2.1.
2. CONTRACTOR SHALL DESIGNATE A WASHINGTON STATE CERTIFIED EROSION AND SEDIMENT CONTROL LEAD (CESCL) WHO WILL BE ON-SITE OR ON CALL AT ALL TIMES. THE EROSION CONTROL LEAD SHALL HAVE THE AUTHORITY TO IMPLEMENT THE STORMWATER POLLUTION PREVENTION PLAN BASED ON SITE CONDITIONS THEREIN IF THE METHODS INDICATED FOR EROSION AND SEDIMENT CONTROL ARE NOT ADEQUATE, THE CESCL SHALL IMPLEMENT ADDITIONAL METHODS AS REQUIRED.
3. CONTRACTOR SHALL IMPLEMENT AND CHANGE EROSION CONTROL MEASURES AS NECESSITATED BY CONSTRUCTION ACTIVITIES.
4. CONTRACTOR SHALL MAINTAIN BMP C150: MATERIALS ON HAND, ON-SITE IN AN AREA EASILY ACCESSIBLE. REFER TO SWPPP FOR BMP DESCRIPTION AND INFORMATION.
5. CONTRACTOR TO FOLLOW BMP C153: MATERIAL DELIVERY, STORAGE AND CONTAINMENT IN THE STORAGE OF HAZARDOUS MATERIALS ONSITE.REFER TO SWPPP FOR BMP DESCRIPTION AND INFORMATION.
6. THIS TESC PLAN SHALL BE USED IN CONJUNCTION WITH THE CONSTRUCTION SWPPP AND MAY BE MODIFIED AS SITE CONDITIONS CHANGE BY THE CESCL.
7. SWEEP ADJACENT STREETS DAILY, AS REQUIRED BY THE CITY OF TACOMA INSPECTOR AND AT COMPLETIONS OF PROJECT. SEDIMENT TRACKED ONTO CITY STREETS MUST BE SWEPT IMMEDIATELY.
8. PROVIDED PLASTIC, STRAW, OR OTHER APPROPRIATE BMP ON DISTURBED SOILS NOT BEING WORKED FOR SHORT PERIODS OF TIME DURING THE DRY SEASON. REFER TO THE CSWPPP FOR STABILIZATION REQUIREMENTS DURING THE WET SEASON AND FOR EXTENDED TIME PERIODS.
9. MAINTAIN EXISTING PAVEMENT FOR CONSTRUCTION STAGING AND LAY DOWN AS LONG AS FEASIBLE. SWEEP AS NECESSARY TO PREVENT DEBRIS AND SEDIMENT FROM ENTERING STORM SYSTEM.
10. THE PROPOSED STORM SYSTEM CAN BE USED TO COLLECT AND CONVEY STORMWATER DURING CONSTRUCTION. CONSTRUCTION STORMWATER SHALL NOT BE RELEASED WITHOUT TREATMENT TO APPROPRIATE TURBIDITY LEVELS. STORM SYSTEM SHALL BE CLEANED PRIOR TO ACCEPTANCE.

WET WEATHER NOTE

SITE SOILS ARE CONSIDERED TO BE MOISTURE SENSITIVE AND CANNOT BE ADEQUATELY COMPACTED DURING WET WEATHER CONDITIONS. CONTRACTOR MAY NEED TO REMOVE EXCESSIVELY SATURATED SOILS OR PROVIDED COVER METHODS IF CONSTRUCTION DURING WET WEATHER. REFER TO GEO-TECHNICAL REPORT.

CESCL NOTE

A CERTIFIED EROSION AND SEDIMENT CONTROL LEAD (CESCL), OR CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL IS REQUIRED FOR THE PROJECT. THE NAMED PERSON OR FIRM SHALL BE ON SITE OR ON-CALL AT ALL TIMES.
CONTACT: MR. CALEB HILGER
PHONE: 253.584.4766

EMERGENCY CONTACT

A 24-HOUR EMERGENCY CONTACT IS REQUIRED FOR THIS PROJECT.
CONTACT: MR. CALEB HILGER
ADDRESS: 10905 25TH AVE E, TACOMA WA 98445
PHONE: 253.584.4766

BASIS OF BEARING

HELD SOUTH 88°42'01" EAST BETWEEN CITY OF TACOMA CONTROL MONUMENTS #1220 AND #1033

HORIZONTAL DATUM

WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
N 695117.01
E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

BENCHMARK 3760

DESC "X" ON SE BOLT OF STREET LIGHT POLE AT THE SE CORNER OF THE INTERSECTION OF S 38TH STREET AND SOUTH TACOMA WAY.
ELEV: 263.28'

Know what's below. Call before you dig.

HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

NOTICE
ALTERATION OF THIS DOCUMENT SHALL INVALIDATE THE PROFESSIONAL SEAL AND SIGNATURE. PUBLICATION OF THIS DOCUMENT DOES NOT DEROGATE FROM RESERVED OWNERSHIP RIGHTS IN IT. THIS DOCUMENT IS FOR USE ONLY FOR THE PROJECT IDENTIFIED IN THE TITLE BLOCK AND IS NOT TO BE USED FOR REPAIR, REMODEL OR ADDITION TO THAT PROJECT OR FOR ANY OTHER PROJECT.

Tacoma

NO	REVISION	DATE	APPD

FINAL CONSTRUCTION CHECKED
BY
DATE
FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED	CHECKED
DJH	DJH
DRAWN	PROJECT NAME
DJH	TACOMA SUBARU MOD FACILITY

DRAWING NAME: TESC PLAN

DANIEL J. HENDRICKSON, STATE OF WASHINGTON, PROFESSIONAL ENGINEER, 8/18/2023

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SITE AND BUILDING DIVISION

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202

SHEET NO. C1.0

SHEET 2 OF 12

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-TESC.dwg

EXISTING PROJECT SITE SURFACES

LEGEND

SC	NEAT SAWCUT LINE
SF	FILTER FABRIC FENCE (5/C1.1)
CL	CLEARING LIMITS
IP	INLET SEDIMENT PROTECTION (1/C1.1, 2/C1.1)
IS	INTERCEPTOR SWALE
	EXISTING PAVEMENT REMOVAL
	EXISTING PAVEMENT TO REMAIN
	EXISTING CONCRETE REMOVAL
	EXISTING CONCRETE TO REMAIN

KEY NOTES

1	REMOVE EXISTING BUILDING AND ALL ASSOCIATED APPURTENANCES.
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4. CONTRACTOR SHALL MINIMIZE DUST GENERATION ONSITE BY SPRINKLING THE SITE WITH WATER UNTIL A SURFACE IS WET. SEE BMP C140.
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CUT DEPTH	SET BACK DISTANCE
UNDER 5 FEET	2 FEET
5 - 20 FEET	HEIGHT/2
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FILL STANDARDS
FILL LOCATION
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PHONE: 253.584.4766

EMERGENCY CONTACT

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CONTACT: MR. CALEB HILGER
ADDRESS: 10905 25TH AVE E, TACOMA WA 98445
PHONE: 253.584.4766

BASIS OF BEARING

HELD SOUTH 88°42'01" EAST BETWEEN CITY OF TACOMA CONTROL MONUMENTS #1220 AND #1033

HORIZONTAL DATUM

WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
N 695117.01
E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

BENCHMARK 3760

DESC "X" ON SE BOLT OF STREET LIGHT POLE AT THE SE CORNER OF THE INTERSECTION OF S 38TH STREET AND SOUTH TACOMA WAY.
ELEV: 263.28'

Know what's below. Call before you dig.

HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

REVISION | DATE | APPD

FINAL CONSTRUCTION CHECKED | BY | DATE | FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED DJH	CHECKED DJH
DRAWN DJH	PROJECT NAME TACOMA SUBARU MOD FACILITY
DRAWING NAME TESC PLAN	

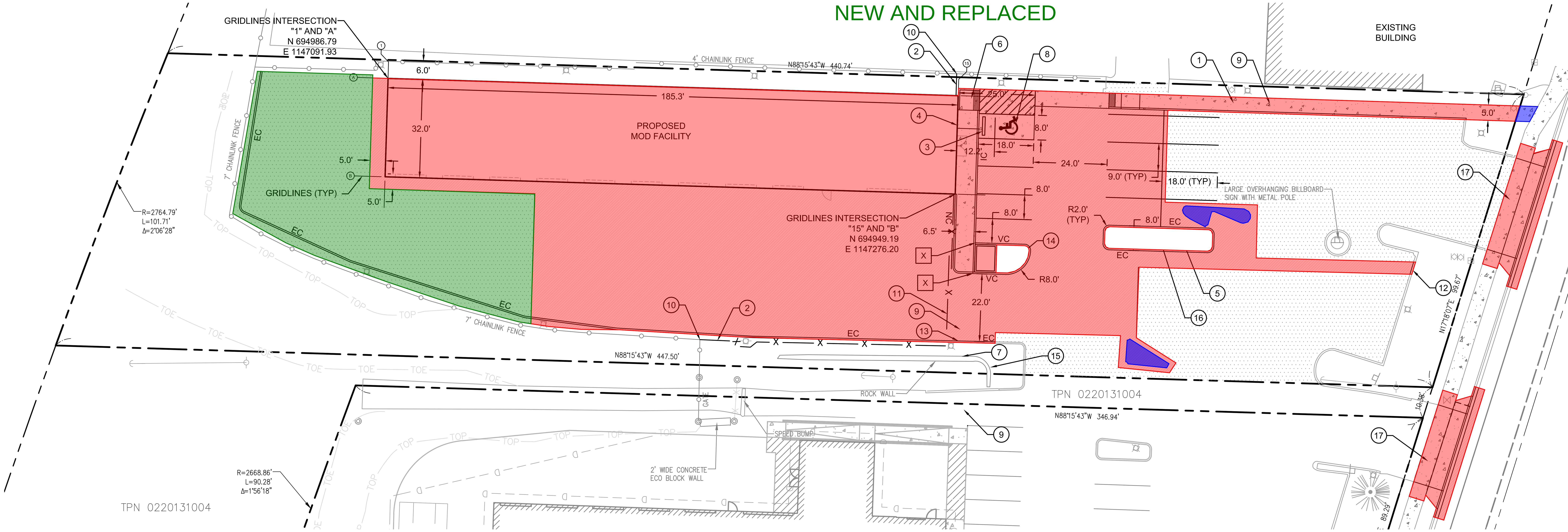
CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SITE AND BUILDING DIVISION

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202
SHEET NO. C1.0
SHEET 2 OF 12

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-TESC.dwg

DEVELOPED PROJECT SITE SURFACES
NEW AND REPLACED



ONISTE

NEW HARD SURFACE = 151 SF

REPLACE HARD SURFACE = 19,343 SF

EXISTING HARD SURFACE TO REMAIN = 4,266 SF

OFFSITE

REPLACED HARD SURFACE= 1,061 SF

NEW HARD SURFACE = 26 SF

LEGEND

EXISTING LOT LINE		
PROPERTY SETBACK		
EASEMENT LINE		
PROPOSED BUILDING OUTLINE		
6' CHAINLINK FENCE	X	2 C2.2
PROPOSED ASPHALT		5 C2.1
PROPOSED CONCRETE		6 C2.1
ADA ACCESSIBLE PARKING STALL		8 C2.1
INTEGRAL CURB	IC	2 C2.1
EXTRUDED CURB	EC	3 C2.1
VERTICAL CURB	VC	4 C2.1
NO CURB	NC	
CHANGE OF CURB TYPE	X	

KEY NOTES

1	PROVIDE 5' WIDE ADA PATH TO ROW.	
2	INSTALL 6' CHAINLINK FENCE	
3	INSTALL WHEEL STOP. FACE OF WHEEL STOP SHALL BE 24" FROM FACE OF CURB.	1 C2.1
4	INSTALL ADA PARKING W/ VAN SIGN. STALL SIGN SHALL NOT OBSTRUCT WALKWAY. SIGN MAY BE MOUNTED TO BUILDING.	7 C2.1
5	PROVIDE 12" OF TOPSOIL- INSTALL GROUND COVER PRUNUS LAUROCERASUS 'MT VERNON' 2 GAL @ 3' O.C (PER BMP L613)	
6	PROVIDED TYPE B PARALLEL CURB RAMP PER WSDOT STANDARD PLAN F-40.12-03	1 C2.2, 3 C2.2
7	CONCRETE STEPS AND METAL HANDRAILS ON BOTH SIDES OF STAIRS. ADDITIONAL RETAINING MAY BE NEEDED ON BOTH SIDES OF THE NEW STAIR CASE. CONTRACTOR TO SELECT RETAINING STRUCTURE MATERIAL DURING CONSTRUCTION. ADDITIONAL RETAINING TO BE COORDINATED WITH OWNER AND ENGINEER. ADDITIONAL RETAINING SHALL NOT EXCEED 4 FEET IN TOTAL HEIGHT. IF ADDITIONAL RETAINING OF OVER 4 FEET IS REQUIRED, A STRUCTURAL ENGINEER SHALL DESIGN THE ADDITIONAL RETAINING STRUCTURE.	5 C2.2
8	ACCESSIBLE PARKING SYMBOL	
9	PROVIDE 4" WHITE STRIPING AT 45° AND 2' O.C.	4 C2.2
10	CONNECT TO EXISTING CHAINLIKE FENCE	
11	PROVIDE 24' WIDE ROLL GATE. CONTRACTOR TO COORDINATE SPECIFICATIONS AND GATE MANUFACTURER WITH OWNER. GATE OPERATIONAL SPACE AND OPENING TO BE FIELD VERIFIED PRIOR TO INSTALLATION.	6 C2.2
12	MATCH EXISTING CURB TYPE	
13	PROVIDE ½" CONCRETE LIP TO DIRECT FLOW TOWARDS PROPOSED CATCH BASIN.	
14	PROVIDE 12" OF TOPSOIL- INSTALL FLOWERING PERENNIAL PLANTINGS @ 18" O.C.-COORDINATE PLANT PALATE WITH OWNER PRIOR TO INSTALLATION. (PER COT BMP L613)	
15	EXISTING ROCK WALL TO BE RECONSTRUCTED. CONTRACTOR TO FIELD VERIFY WALL HEIGHT NOT TO EXCEED 4 FEET. CONTRACTOR TO RECONSTRUCT WALL AS NEEDED TO CONSTRUCT STRAIRS.	
16	RELOCATED STREET LIGHTING	
17	DRIVEWAY ACCESS PER COT STANDARD DETAIL SU-7A	

ADA NOTE:

ADA PATHS SHALL HAVE A CROSS SLOPE OF LESS THAN 2% AND A RUNNING SLOPE OF LESS THAN 5%. RUNNING SLOPES GREATER THAN 5% MAY REQUIRE ADDITIONAL FEATURES TO MEET ADA REQUIREMENTS

EXTRUDED CURB NOTE

EXTRUDED CURB IS CONSTRUCTED WITH A BOTTOM WIDTH OF 10". EXTRUDED CURB IS SHOWN ON THE DRAWINGS AT 6". AN ADDITIONAL 6" OF HMA SHOULD BE CONSTRUCTED ON THE BACKSIDE OF AREAS WITH PROPOSED EXTRUDED CURB TO TAKE INTO ACCOUNT THE ADDITIONAL 4" BOTTOM WIDTH AND 2" HMA APRON ON THE BACKSIDE OF THE CURB.

NOTES:

1. ALL RADIUS ARE 2' UNLESS OTHERWISE NOTED.
2. ALL SAWCUT LINES ARE 1' FROM EXISTING / PROPOSED FEATURES UNLESS OTHERWISE NOTED.
3. ALL PARKING STALL ARE 9' WIDE BY 18' LONG UNLESS OTHERWISE NOTED.

TOPOGRAPHIC NOTE

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BASIS OF BEARING

HELD SOUTH 88°42'01" EAST BETWEEN CITY OF TACOMA CONTROL MONUMENTS #1220 AND #1033

HORIZONTAL DATUM

WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
N 695117.01
E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

BENCHMARK 3760

DESC "X" ON SE BOLT OF STREET LIGHT POLE AT THE SE CORNER OF THE INTERSECTION OF S 38TH STREET AND SOUTH TACOMA WAY.
ELEV: 263.28'

---

811 Know what's below. Call before you dig.

HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

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Tacoma

NO	REVISION	DATE	APPD

FINAL CONSTRUCTION CHECKED
BY
DATE
FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED DJH	CHECKED DJH
DRAWN DJH	PROJECT NAME TACOMA SUBARU MOD FACILITY
DRAWING NAME SITE PLAN	

DANIEL J. HENDRICKSON STATE OF WASHINGTON 8/18/2023

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SITE AND BUILDING DIVISION

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202
SHEET NO. C2.0
SHEET 3 OF 12

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-SITE.dwg

DEVELOPED PROJECT SITE SURFACES

LEGEND

EXISTING LOT LINE		
PROPERTY SETBACK		
EASEMENT LINE		
PROPOSED BUILDING OUTLINE		
6' CHAINLINK FENCE	X	2 / C2.2
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NO CURB	NC	
CHANGE OF CURB TYPE	X	

KEY NOTES

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BASIS OF BEARING

HELD SOUTH 88°42'01" EAST BETWEEN CITY OF TACOMA CONTROL MONUMENTS #1220 AND #1033

HORIZONTAL DATUM

WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
N 695117.01
E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

BENCHMARK 3760

DESC "X" ON SE BOLT OF STREET LIGHT POLE AT THE SE CORNER OF THE INTERSECTION OF S 38TH STREET AND SOUTH TACOMA WAY.
ELEV: 263.28'

Know what's below. Call before you dig.

HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

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Tacoma

NO	REVISION	DATE	APP'D

FINAL CONSTRUCTION CHECKED
BY
DATE
FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED: DJH	CHECKED: DJH
DRAWN: DJH	PROJECT NAME: TACOMA SUBARU MOD FACILITY
DRAWING NAME: SITE PLAN	

DANIEL J. HENDRICKSON, STATE OF WASHINGTON, 62023358, REGISTERED PROFESSIONAL ENGINEER, 8/18/2023

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SITE AND BUILDING DIVISION

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202
SHEET NO. C2.0
SHEET 3 OF 12

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-SITE.dwg

ALL DISTURBED AREA TO BE COMPOST SOIL AMENDED PER CITY OF TACOMA BMP L613 (4/C3.3)

LEGEND

TYPE 1 CATCH BASIN	■	1/C3.3
TYPE 2 MANHOLE	◉	2/C3.3
ROOF DRAIN CLEANOUT	•	1/C3.2
PROPOSED STORM DRAIN PIPE	—•—	
PROPOSED ROOF DRAIN PIPE	—RD—	3/C3.2
FOOTING DRAIN	—FD—	2/C3.2
EXISTING MINOR CONTOUR	- - -XXX- - -	
EXISTING MAJOR CONTOUR	— —XXX— —	
PROPOSED MINOR CONTOUR	——XXX——	
PROPOSED MAJOR CONTOUR	——XXX——	
VALLEY FLOWLINE	—— v ——	

EARTHWORK QUANTITIES

CUT = 37 CU. YDS
FILL = 120 CU. YDS
NET = 83 CU. YDS (FILL)
NOTE:
THE ABOVE QUANTITIES ARE ESTIMATES ONLY INTENDED FOR THE PERMITTING PROCESS. DO NOT USE FOR BID PURPOSES. THE QUANTITIES DO NOT HAVE STRIPPING, COMPACTION, OR CUT OR FILL ADJUSTMENT FACTORS APPLIED TO THEM, NOR DO THEY ACCOUNT FOR ROADWAY SECTION.

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WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

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E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

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ELEV: 263.28'

DRAINAGE NOTE

1. ALL CATCH BASINS SHALL HAVE VANED GRATES UNLESS OTHERWISE NOTED.
2. PIPE COVER SHALL BE A MINIMUM OF 2' FOR CPEP AND 1' FOR DUCTILE IRON.
3. ALL ROOF DRAINS TO BE RIGID PVC UNLESS OTHERWISE NOTED.
4. PIPE BEDDING AND BACKFILL SHALL BE PER DETAIL. (4/C3.2)
5. ALL STORM PIPES SHALL BE CPEP UNLESS OTHERWISE NOTED. CPEP PIPES SHALL BE ADS N-12 OR APPROVED EQUAL.
6. PROPOSED PIPE LENGTHS AND HORIZONTAL CONTROL ARE PROVIDED TO CENTER OF STRUCTURE UNLESS OTHERWISE NOTED.
7. ALL ELEVATIONS ARE TO FINISHED GRADE UNLESS OTHERWISE NOTED.
8. ALL STORM PIPES SHALL BE CLEANED BEFORE FINAL ACCEPTANCE.
9. CONTRACTOR TO CLEAN EXISTING STORM CATCH BASINS. REMOVE EXISTING LIQUIDS AND ANY ACCUMULATED SEDIMENT; DISPOSE OF AT AN APPROVED OFFSITE LOCATION AND PROVIDE COUNTY INSPECTOR WITH A COPY OF THE BILL OF LADING.
10. MATERIALS FOR THE STORM DRAINAGE SYSTEM SHALL BE IN ACCORDANCE WITH THE 2021 CITY OF TACOMA STORMWATER MANAGEMENT MANUAL.
11. ALL CATCH BASINS, INLETS, ETC SHALL BE MARKED WITH THE APPROVED COT CURB MARKERS / STENCILS. STENCILS ARE AVAILABLE FOR BOTH PRIVATE AND PUBLIC PROJECTS AS NEEDED.

STORM STRUCTURE TABLE

STRUCTURE NAME	STRUCTURE DETAILS
FDCO 01 CO N 694945.13 E 1147221.51	RIM = 259.79 IE = 258.44 (6" N) IE = 258.44 (6" S) IE = 261.00 (4" NE) IE = 261.00 (4" NW)
MW INLET Null Structure N 694926.95 E 1147289.53 (3/C3.3)	IE = 259.21 (8" E)
MW OUTLET Null Structure N 694927.13 E 1147282.53 (3/C3.3)	IE = 255.81 (8" W)
RDCO #1 CO N 694987.35 E 1147139.55	RIM = 263.96 IE = 262.25 (6" E)
RDCO #2 CO N 694985.95 E 1147185.61	RIM = 264.36 IE = 261.79 (6" W) IE = 261.79 (6" E)
RDCO #3 CO N 694984.33 E 1147239.08	RIM = 264.32 IE = 261.26 (6" W) IE = 261.26 (6" E)
RDCO #4 CO N 694983.15 E 1147277.73	RIM = 263.95 IE = 260.87 (6" W) IE = 260.87 (6" S)
RDCO #5 CO N 694949.84 E 1147276.72	RIM = 264.23 IE = 260.54 (6" N) IE = 260.54 (6" W)
RDCO #6 CO N 694950.51 E 1147221.66	RIM = 264.27 IE = 260.00 (6" S)
SDCB 01 TYPE 1 N 694910.21 E 1147139.69	RIM = 263.75 IE = 261.08 (8" E)

STORM STRUCTURE TABLE

STRUCTURE NAME	STRUCTURE DETAILS
SDCB 02 TYPE 1 N 694902.33 E 1147287.79	RIM = 262.81 IE = 260.34 (8" NE) IE = 260.34 (8" W)
SDCB 03 TYPE 1 N 694947.55 E 1147313.18	RIM = 262.06 IE = 259.39 (8" SW)
SDCB 04 48" TYPE 2 N 694924.38 E 1147299.67	RIM = 262.89 IE = 259.26 (8" W) IE = 259.26 (8" NE) IE = 259.26 (8" SW)
SDCB 05 48" TYPE 2 N 694935.02 E 1147221.24	RIM = 264.06 IE = 255.50 (8" S) IE = 255.50 (12" W) IE = 255.50 (6" E) IE = 255.50 (6" N)
SDCB 06 48" TYPE 2 N 694928.02 E 1147221.02	RIM = 263.95 IE = 255.50 (8" S) IE = 255.50 (8" N) IE = 255.50 (12" W) IE = 255.50 (8" E)
SDCB 07 48" TYPE 2 N 694921.02 E 1147220.81	RIM = 263.85 IE = 255.50 (8" N) IE = 255.50 (12" W)
SDCO 01 CO N 694923.21 E 1147148.84	RIM = 264.04 IE = 255.50 (12" E)
SDCO 02 CO N 694930.18 E 1147149.06	RIM = 264.23 IE = 255.50 (12" E)
SDCO 03 CO N 694937.20 E 1147149.27	RIM = 264.22 IE = 255.50 (12" E)

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HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

Tacoma

NO	REVISION	DATE	APPD

FINAL CONSTRUCTION CHECKED
BY
DATE
FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED: DJH	CHECKED: DJH
DRAWN: DJH	PROJECT NAME: TACOMA SUBARU MOD FACILITY

DRAWING NAME: GRADING AND DRAINAGE PLAN

DANIEL J. HENDRICKSON, STATE OF WASHINGTON, 60123358, REGISTERED PROFESSIONAL ENGINEER, 8/18/2023

SITE AND BUILDING DIVISION

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202

SHEET NO. C3.0

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-GRAD.dwg

ALL DISTURBED AREA TO BE COMPOST SOIL AMENDED PER CITY OF TACOMA BMP L613 (4 / C3.3)

TREATMENT BASIN MAP

LEGEND

TYPE 1 CATCH BASIN	■	1 / C3.3
TYPE 2 MANHOLE	◙	2 / C3.3
ROOF DRAIN CLEANOUT	•	1 / C3.2
PROPOSED STORM DRAIN PIPE	—D—	
PROPOSED ROOF DRAIN PIPE	—RD—	3 / C3.2
FOOTING DRAIN	—FD—	2 / C3.2
EXISTING MINOR CONTOUR	---XXX---	
EXISTING MAJOR CONTOUR	—XXX—	
PROPOSED MINOR CONTOUR	—XXX—	
PROPOSED MAJOR CONTOUR	—XXX—	
VALLEY FLOWLINE	—v—	

EARTHWORK QUANTITIES

CUT = 37 CU. YDS
FILL = 120 CU. YDS
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BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
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RDCO #3 CO N 694984.33 E 1147239.08	RIM = 264.32 IE = 261.26 (6" W) IE = 261.26 (6" E)
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RDCO #5 CO N 694949.84 E 1147276.72	RIM = 264.23 IE = 260.54 (6" N) IE = 260.54 (6" W)
RDCO #6 CO N 694950.51 E 1147221.66	RIM = 264.27 IE = 260.00 (6" S)
SDCB 01 TYPE 1 N 694910.21 E 1147139.69	RIM = 263.75 IE = 261.08 (8" E)

STORM STRUCTURE TABLE

STRUCTURE NAME	STRUCTURE DETAILS
SDCB 02 TYPE 1 N 694902.33 E 1147287.79	RIM = 262.81 IE = 260.34 (8" NE) IE = 260.34 (8" W)
SDCB 03 TYPE 1 N 694947.55 E 1147313.18	RIM = 262.06 IE = 259.39 (8" SW)
SDCB 04 48" TYPE 2 N 694924.38 E 1147299.67	RIM = 262.89 IE = 259.26 (8" W) IE = 259.26 (8" NE) IE = 259.26 (8" SW)
SDCB 05 48" TYPE 2 N 694935.02 E 1147221.24	RIM = 264.06 IE = 255.50 (8" S) IE = 255.50 (12" W) IE = 255.50 (6" E) IE = 255.50 (6" N)
SDCB 06 48" TYPE 2 N 694928.02 E 1147221.02	RIM = 263.95 IE = 255.50 (8" S) IE = 255.50 (8" N) IE = 255.50 (12" W) IE = 255.50 (8" E)
SDCB 07 48" TYPE 2 N 694921.02 E 1147220.81	RIM = 263.85 IE = 255.50 (8" N) IE = 255.50 (12" W)
SDCO 01 CO N 694923.21 E 1147148.84	RIM = 264.04 IE = 255.50 (12" E)
SDCO 02 CO N 694930.18 E 1147149.06	RIM = 264.23 IE = 255.50 (12" E)
SDCO 03 CO N 694937.20 E 1147149.27	RIM = 264.22 IE = 255.50 (12" E)

Know what's below. Call before you dig.

HENDRICKSON ENGINEERING
6909 FORD DR NW, GIG HARBOR, WA 98335 TEL: 253.514.2413

NOTICE
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Tacoma

NO	REVISION	DATE	APPD

FINAL CONSTRUCTION CHECKED
BY
DATE
FIELD BOOKS

DATE	SCALE
8.18.2023	N/A
DESIGNED: DJH	CHECKED: DJH
DRAWN: DJH	PROJECT NAME: TACOMA SUBARU MOD FACILITY

DRAWING NAME: GRADING AND DRAINAGE PLAN

DANIEL J. HENDRICKSON, STATE OF WASHINGTON, 53356, REGISTERED PROFESSIONAL ENGINEER, 8/18/2023

CITY OF TACOMA
DEPARTMENT OF PUBLIC WORKS
SITE AND BUILDING DIVISION

TACOMA SUBARU MOD FACILITY
3812 SOUTH TACOMA WAY, TACOMA, WA 98409
SITE DEVELOPMENT PERMIT SET

SDEV23-0202
SHEET NO. C3.0
SHEET 7 OF 12

DATE: August 30, 2023 FILENAME: C:\Users\dhend\Hendrickson Const Co Dropbox\Daniel Hendrickson\Hendrickson Engineering\Projects\2022\2220033 (Tacoma Subaru Addition)\CAD\2220033-SH-GRAD.dwg

ALL DISTURBED AREA TO BE COMPOST SOIL AMENDED PER CITY OF TACOMA BMP L613 (4 / C3.3)

TREATMENT BASIN MAP

LEGEND

TYPE 1 CATCH BASIN (1 / C3.3)	■
TYPE 2 MANHOLE (2 / C3.3)	◙
ROOF DRAIN CLEANOUT (1 / C3.2)	•
PROPOSED STORM DRAIN PIPE	—D—
PROPOSED ROOF DRAIN PIPE (3 / C3.2)	—RD—
FOOTING DRAIN (2 / C3.2)	—FD—
EXISTING MINOR CONTOUR	---XXX---
EXISTING MAJOR CONTOUR	---XXX---
PROPOSED MINOR CONTOUR	—XXX—
PROPOSED MAJOR CONTOUR	—XXX—
VALLEY FLOWLINE	—v—

EARTHWORK QUANTITIES

CUT = 37 CU. YDS
FILL = 120 CU. YDS
NET = 83 CU. YDS (FILL)
NOTE:
THE ABOVE QUANTITIES ARE ESTIMATES ONLY INTENDED FOR THE PERMITTING PROCESS. DO NOT USE FOR BID PURPOSES. THE QUANTITIES DO NOT HAVE STRIPPING, COMPACTION, OR CUT OR FILL ADJUSTMENT FACTORS APPLIED TO THEM, NOR DO THEY ACCOUNT FOR ROADWAY SECTION.

TOPOGRAPHIC NOTE

THE EXISTING CULTURAL AND TOPOGRAPHIC DATA SHOWN ON THESE DRAWINGS HAS BEEN PREPARED, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS INFORMATION IS BELIEVED TO BE RELIABLE, HENDRICKSON ENGINEERING PLLC CANNOT ENSURE ACCURACY AND THUS IS NOT RESPONSIBLE FOR THE ACCURACY OF THAT INFORMATION OR FOR ANY ERRORS OR OMISSIONS WHICH MAY HAVE BEEN INCORPORATED INTO THESE DRAWINGS AS A RESULT.

BASIS OF BEARING

HELD SOUTH 88°42'01" EAST BETWEEN CITY OF TACOMA CONTROL MONUMENTS #1220 AND #1033

HORIZONTAL DATUM

WASHINGTON STATE PLAN COORDINATE SYSTEM, SOUTH ZONE (NAD 83/91)

BASED ON TIES CITY OFTACOMA MONUMENTS #34, 1033, 1219 AND 1220.

COT MONUMENT #1220
N 695117.01
E 1147556.43
FOUND 3" BRASS DISK W/PUNCH ON SURFACE AT INTX. OF S. 38TH ST. AND UNION AVE.

VERTICAL DATUM

CITY OF TACOMA NGVD 29

BENCHMARK 3760

DESC "X" ON SE BOLT OF STREET LIGHT POLE AT THE SE CORNER OF THE INTERSECTION OF S 38TH STREET AND SOUTH TACOMA WAY.
ELEV: 263.28'

DRAINAGE NOTE

1. ALL CATCH BASINS SHALL HAVE VANED GRATES UNLESS OTHERWISE NOTED.
2. PIPE COVER SHALL BE A MINIMUM OF 2' FOR CPEP AND 1' FOR DUCTILE IRON.
3. ALL ROOF DRAINS TO BE RIGID PVC UNLESS OTHERWISE NOTED.
4. PIPE BEDDING AND BACKFILL SHALL BE PER DETAIL. (4 / C3.2)
5. ALL STORM PIPES SHALL BE CPEP UNLESS OTHERWISE NOTED. CPEP PIPES SHALL BE ADS N-12 OR APPROVED EQUAL.
6. PROPOSED PIPE LENGTHS AND HORIZONTAL CONTROL ARE PROVIDED TO CENTER OF STRUCTURE UNLESS OTHERWISE NOTED.
7. ALL ELEVATIONS ARE TO FINISHED GRADE UNLESS OTHERWISE NOTED.
8. ALL STORM PIPES SHALL BE CLEANED BEFORE FINAL ACCEPTANCE.
9. CONTRACTOR TO CLEAN EXISTING STORM CATCH BASINS. REMOVE EXISTING LIQUIDS AND ANY ACCUMULATED SEDIMENT; DISPOSE OF AT AN APPROVED OFFSITE LOCATION AND PROVIDE COUNTY INSPECTOR WITH A COPY OF THE BILL OF LADING.
10. MATERIALS FOR THE STORM DRAINAGE SYSTEM SHALL BE IN ACCORDANCE WITH THE 2021 CITY OF TACOMA STORMWATER MANAGEMENT MANUAL.
11. ALL CATCH BASINS, INLETS, ETC SHALL BE MARKED WITH THE APPROVED COT CURB MARKERS / STENCILS. STENCILS ARE AVAILABLE FOR BOTH PRIVATE AND PUBLIC PROJECTS AS NEEDED.

STORM STRUCTURE TABLE

STRUCTURE NAME	STRUCTURE DETAILS
FDCO 01 CO N 694945.13 E 1147221.51	RIM = 259.79 IE = 258.44 (6" N) IE = 258.44 (6" S) IE = 261.00 (4" NE) IE = 261.00 (4" NW)
MW INLET Null Structure N 694926.95 E 1147289.53 (3 / C3.3)	IE = 259.21 (8" E)
MW OUTLET Null Structure N 694927.13 E 1147282.53 (3 / C3.3)	IE = 255.81 (8" W)
RDCO #1 CO N 694987.35 E 1147139.55	RIM = 263.96 IE = 262.25 (6" E)
RDCO #2 CO N 694985.95 E 1147185.61	RIM = 264.36 IE = 261.79 (6" W) IE = 261.79 (6" E)
RDCO #3 CO N 694984.33 E 1147239.08	RIM = 264.32 IE = 261.26 (6" W) IE = 261.26 (6" E)
RDCO #4 CO N 694983.15 E 1147277.73	RIM = 263.95 IE = 260.87 (6" W) IE = 260.87 (6" S)
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