



civil & structural
engineering & planning

DRAINAGE REPORT

Centennial Park Parking Improvements

67th Ave and 172nd Street NE
Arlington, WA 98223



CG Project No.: 23069.20

04/18/2023

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Section I – Project Overview

Section I Summary

Overview

Existing Condition

Developed Condition

Vicinity Map

Aerial Photograph

Overview

The proposed project consists of the development of an additional parking lot to an existing 9-acre multi-family development which was recently constructed. The project will fill an existing wetland and add 96 parking spaces. The project parcel is located at the northeast corner of 67th Ave and 172nd St NE in Arlington (TPN: 31052300300800) and has an area of 8.81 acres. The total site disturbed area is approximately 0.79 ac.

The project will comply with the 2019 Stormwater Management Manual for Western Washington (herein referred to as the SWMMWW). The project must address Minimum Requirements #1-9 of the SWMMWW.

The site is within the Mixed-Use NC-Neighborhood Commercial zone. Surrounding areas include RLMD-Low to Moderate Density Residential to the north and east, GI- General Industrial to the west, and GC-General Commercial to the southwest. The site is at the southern border of the City of Arlington.

Existing Condition

The site totals 0.79 ac and is undeveloped and partially a Category IV wetland. There is a ditch running southeast to northwest through the site with a drainage culvert inlet at the northwest corner of the site. In general, the site slopes moderately towards the drainage ditch. Per the NRCS Web Soil Survey, site soils consist of Norma loam on the west two-thirds of the site and Everett very gravelly sandy loam on the east third of the site.

Developed Condition

Most of the project parcel has been developed under Phase I and II of this project. The remaining undisturbed wetland area will be developed in the proposed condition. A parking lot with 96 spaces will be constructed. Site stormwater will be routed to a rain garden with an underdrain which overflows to a detention pipe system. The project adds approximately 24,437 sf (0.56 ac) of new asphalt. Specific areas for purposes of stormwater design are listed in Section IV.

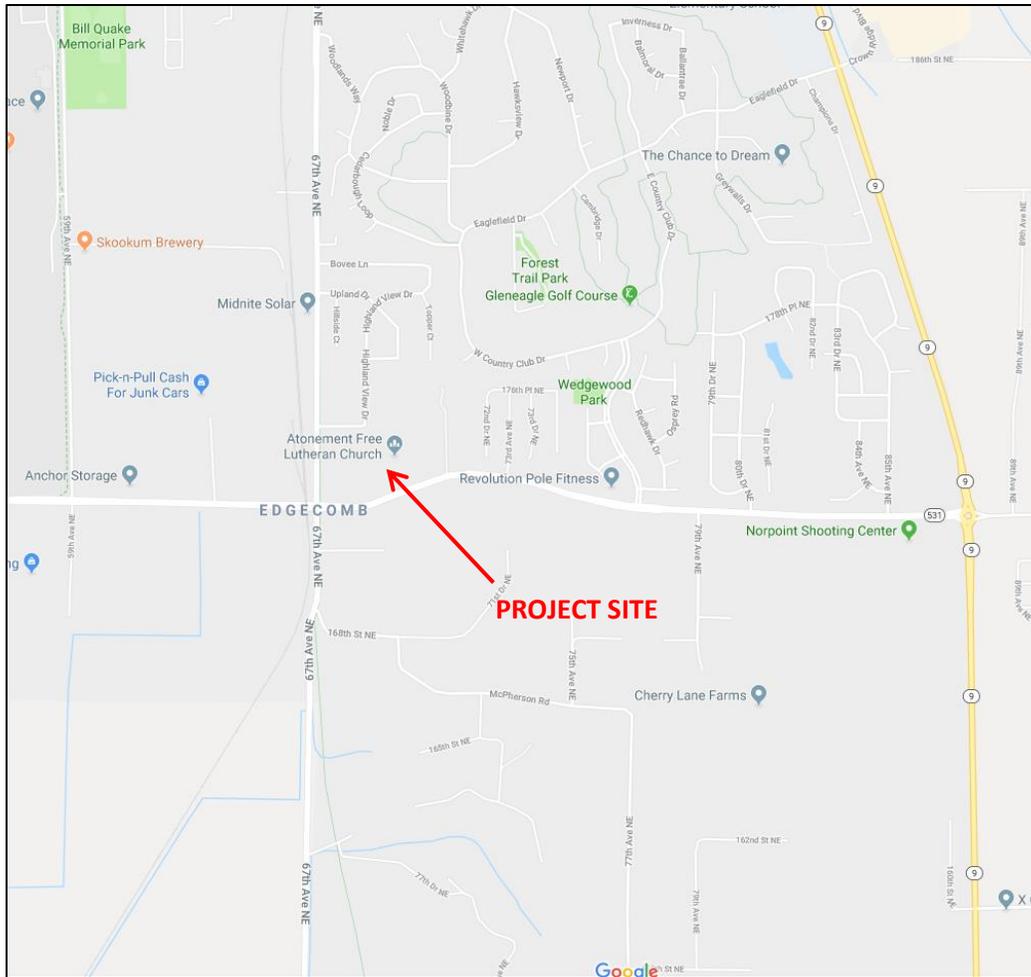


Figure I-1 Vicinity Map

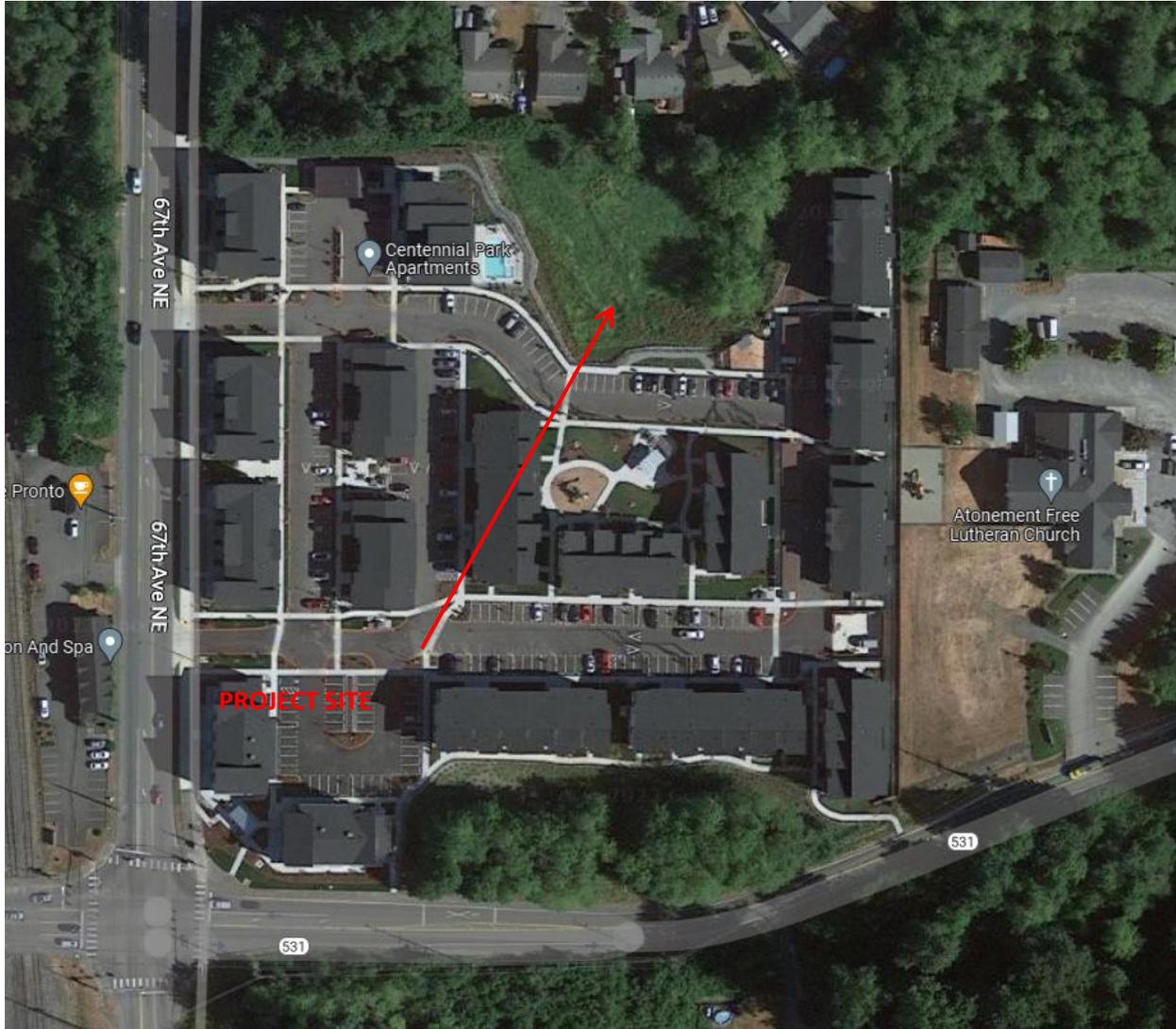


Figure I-2 Aerial Photograph

Section II – Minimum Requirements

Section II Summary

Narrative

Stormwater requirements were determined from the 2019 SWMMWW. This report is based on the steps recommended in Chapter 3 of Volume I in the SWMMWW. The project will comply with Minimum Requirements #1-9.

Minimum Requirement #1: Preparation of Stormwater Site Plans: The stormwater site plan consists of this report and the civil drawings and is prepared in accordance with Chapter 3 of Volume 1 of the SWMMWW.

Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP): The SWPPP shall include a narrative and drawings. The SWPPP narrative shall include documentation that addresses the 13 elements of Construction Stormwater Pollution Prevention. See Section V and the civil drawings. A Construction Stormwater General Permit is not required because land disturbance will be under an acre.

Minimum Requirement #3: Source Control of Pollution: Source control BMPs during construction are described in Section IV. For this site we have looked at the pool for compliance with 2019 SWMMWW S433.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls: Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down-gradient properties. All projects shall submit an off-site qualitative analysis. A qualitative analysis of the upstream and downstream system entering the site is presented in Section III.

Minimum Requirement #5: On-Site Stormwater Management: Per Table 2.5.1 from the SWMMWW, new development projects on any parcel inside the Urban Growth Area that trigger Minimum Requirements #1 through #9 must demonstrate compliance with the Low Impact Development Performance Standard and BMP T5.13; or use On-Site Stormwater Management BMPs from List #2. The project proposes to use BMPs from list #2 using bioretention and BMP T5.13. See Section IV.

Minimum Requirement #6: Runoff Treatment: This requirement applies to the new plus replaced hard surfaces and the converted vegetation areas. Runoff treatment is required because the project adds more than 5,000 sf of pollution-generating hard surface. See Section IV.

Minimum Requirement #7: Flow Control: Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The project will meet the flow control duration standard using a combination of bioretention and detention pipes. See Section IV.

Minimum Requirement #8: Wetlands Protection: There is an existing Category IV wetland on site which will be filled in order to accommodate the proposed parking area. Refer to the ecologist report provided in Section VI.

Minimum Requirement #9: Operation and Maintenance: An Operation and Maintenance Manual that is consistent with the provisions in Volume V of the SWMMWW is required for proposed Stormwater Treatment and Flow Control BMPs/facilities. The party (or parties) responsible for maintenance and operation shall be identified in the operation and maintenance manual. For private facilities, a copy of the Operation and Maintenance Manual shall be retained on-site or within reasonable access to the site and shall be transferred with the property to the new owner. For public facilities, a copy of the operation and maintenance manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection. Please see Section VIII.

Section III – Off-Site Analysis

Section III Summary

Task 1 – Define and map the study area

Task 2 – Review all available information of the study area

Task 3 – Field inspect the area

Task 4 - Describe the drainage system, and its existing and predicted problems

Task 1 – Define and map the study area

Development projects that discharge stormwater off-site shall submit an off-site analysis report that assesses the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project and that proposes appropriate mitigation of those impacts. An initial qualitative analysis shall extend downstream for the entire flow path from the project site to the receiving water or up to one mile, whichever is less.

Runoff from the new site areas will flow to a bioretention pond with an underdrain and overflow connection to a detention pipe system. The system will overflow to an existing drainage inlet at the northwest corner of the site. The overflow paths will be studied in this section.

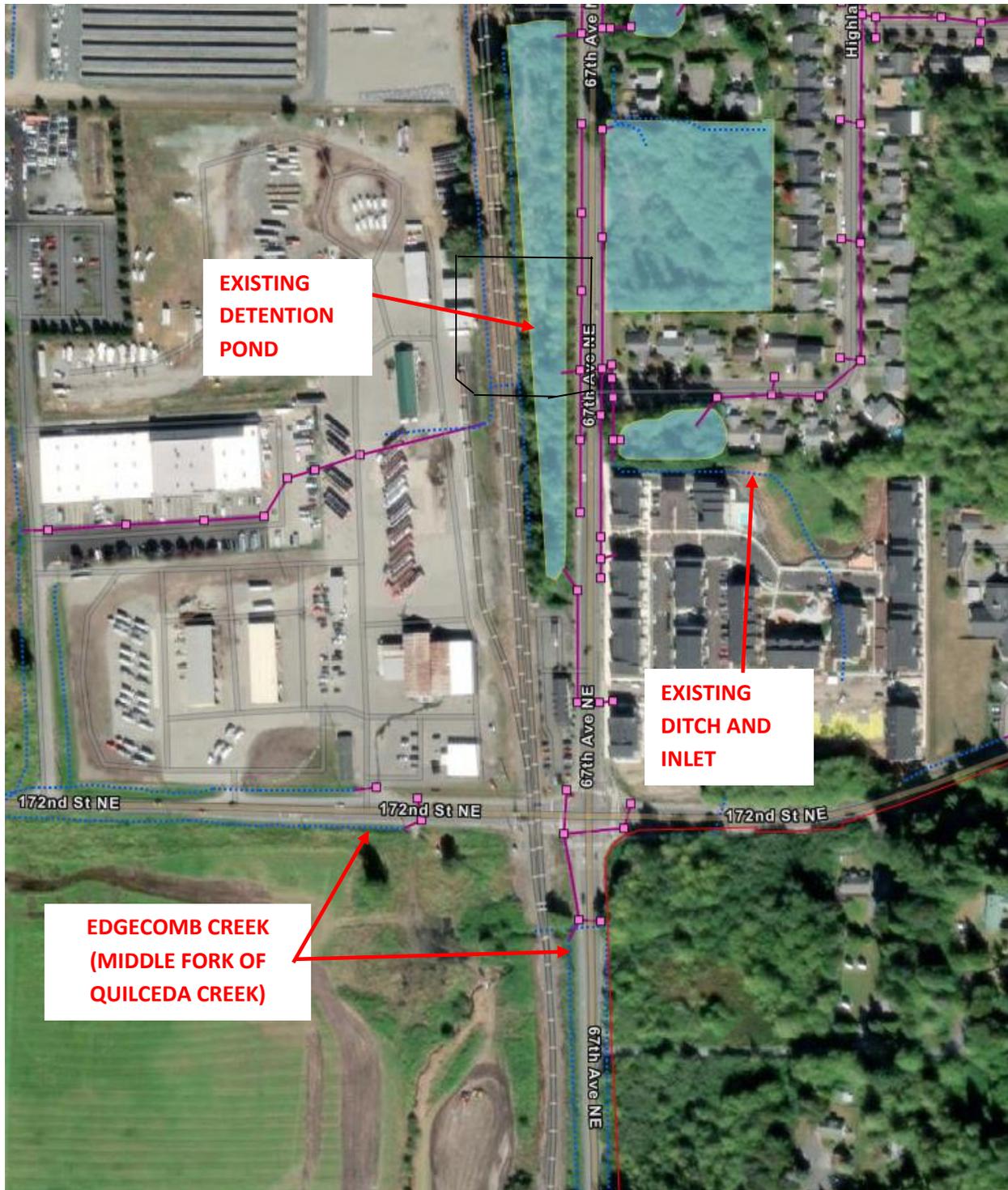


Figure III-1 Study Area from Stormwater Infrastructure Map of City of Arlington.

Figure III- 1 depicts the downstream flow path from the site. Existing drainage in 67th Ave NE flows north and outfalls into a large detention pond on the west side of the street. From there through a ditch and

culvert system and a piped system the stormwater outfalls into the Edgecomb Creek/Middle Fork Quilceda Creek which outfalls into the Possession Sound (Puget Sound).

Task 2 – Review all available information on the study area

There are no significant upstream flows contributing to the site. The project site is currently classified as wetland and has a ditch running through it. Per the survey, an existing 24" inlet is located at the northwest corner of the site. The surrounding development contains an infiltration system with overflows to the City mains on 67th Ave NE. Existing stormwater infrastructure in the adjacent streets was determined from the survey, field inspection and the City's online maps. The site is within the Edgecomb Creek/Quilceda Creek drainage basin which outlets to the Possession Sound.

Task 3 – Field inspect the study area

A site visit was conducted on May 29, 2019. The weather was warm and rain had not recently occurred.

The site visit occurred prior to development of the project parcel. At this point, the parcel has been developed, but the existing drainage culvert at the northwest corner of the site and the downstream system have remained as existing.

Task 4 – Describe the drainage system, and its existing and predicted problems

The existing drainage system is described in Task 2.

Site runoff will be mitigated with a bioretention planter overflowing to a detention pipe system. The detention pipe system will have a flow control structure which outfalls to an existing ditch with a 24" inlet at the northwest corner of the site. The inlet conveys stormwater west to the ROW, before flowing to a large detention pond. Outflows from the detention pond eventually reach the Edgecomb Creek. See Section IV and Appendix A for further description and calculations for the drainage system.



Figure III-3 From the project site facing the existing drainage ditch which eventually flows to 67th Ave.



Figure III-4 Looking east into the site from 67th Ave. Gravel path follows the approximate location of the 24" outlet culvert.



Figure III-5 Looking north on 67th Ave. Trees on the left side of picture border off site detention pond.

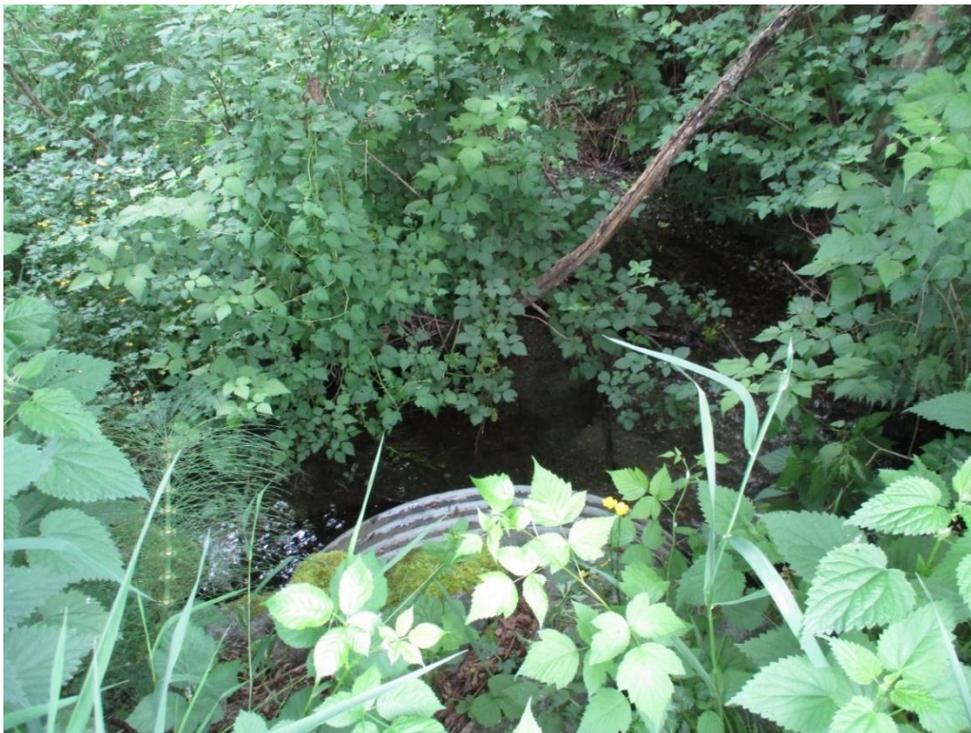


Figure III-6 Edgecomb Creek culvert on south side of SR 531. Shown here crossing under 67th Ave, south of intersection.

Section IV – Permanent Stormwater Control Plan

Section IV Summary

On-Site Stormwater Management

Runoff Treatment

Flow Control

Source Control

The developed site consists of a 0.79 ac portion of the northeast corner of the project parcel which was considered wetland during the initial development of the property. Stormwater from the site area will be managed with a bioretention planter which overflows to a detention system. The bioretention planter will meet Minimum Requirement #5 and #6 and the detention system will meet Minimum Requirement #7. The WWHM output of this system is included in Section VI. The areas included in the WWHM report are listed below.

Predeveloped:

Pervious Area

Forest, Mod, Sat:	15,511 sf (0.36 ac)
Forest, Mod, C:	18,935 sf (0.43 ac)
Total:	34,446 sf (0.79 ac)

Developed:

Area to Bioretention

Parking, Flat:	24,437 sf (0.56 ac)
Landscaping, Flat, C:	4,659 sf (0.11 ac)
Total:	29,096 sf (0.67 ac)

Area to bypass Bioretention

Pasture, Steep, C:	639 sf (0.01 ac)
Pasture, Flat, C:	4,711 sf (0.11 ac)
Total:	5,350 sf (0.12 ac)

On-Site Stormwater Management & Flow Control

The project must meet Minimum Requirement #5 & 7.

Per Table 2.5.1 from the SWMMWW, new development projects on any parcel inside the Urban Growth Area that trigger Minimum Requirements #1 through #9 must either use On-Site Stormwater Management BMPs from List #2 for all surfaces within each type of surface in List #2 or demonstrate compliance with the LID Performance Standard and BMP T5.13.

The project will use BMPs from List #2. BMPs are evaluated for feasibility below:

Lawn and landscaped areas:

1. Post-construction soil quality and depth in accordance with BMP T5.13 in Chapter 5 of Volume V of the SWMMWW will be used for all disturbed pervious areas.

Other Hard Surfaces:

1. Full Dispersion in accordance with BMP T5.30 is **infeasible** because there is no room on-site or enough forested area for a dispersion system.
2. Permeable Pavement in accordance with BMP T5.15 is **infeasible** as the geotechnical engineer does not recommend infiltration as there is dense soils and shallow groundwater.
3. Rain garden BMPs in accordance with Chapter 5 of Volume V is **feasible** and will be utilized for site areas. An underdrain will be used due to the non-infiltrating properties of the soil.

A detention system was designed downstream of the bioretention planter in order to meet the flow control standard. Refer to Appendix A for the WWHM output for the entire system.

Runoff Treatment

Runoff treatment is required for pollution-generating hard surfaces (PGHS). Per Chapter 2.1 of Volume V of the SWMMWW, enhanced treatment is required since the project is a multi-family residential project that discharges directly to fresh waters or conveyance systems tributary to fresh waters designed for aquatic life use. The project will use BMP T7.30 – Bioretention to provide runoff treatment. The bioretention planter was sized with WWHM to treat greater than 91% of the runoff volume. See Appendix A.

Section V – Construction Stormwater Pollution Prevention

Section V Summary

Narrative

Erosion control details are provided consistent with the 2019 SWMMWW. Erosion control plan sheets are provided in full size as a part of the civil drawing set.

A Construction Stormwater General Permit (CSGP) is not required through the Department of Ecology because land disturbing activities total less than one acre. A summary of the elements is provided below.

Element 1: Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction will be clearly marked before land-disturbing activities begin. Clearing limits will be to the extents of necessary land disturbance. The BMPs relevant to marking the clearing limits that will be applied for this project include:

High Visibility Plastic or Metal Fence (BMP C103)

Element 2: Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads. The existing drive aisle will be used for construction access.

Element 3: Control Flow Rates

Stormwater should not be directed to bioretention and detention facilities until the site has been stabilized. Protect Low Impact Development BMPs from compaction and sedimentation per Element 13.

Silt Fence (BMP C233)

Element 4: Install Sediment Controls

Stormwater must be filtered prior to leaving the construction site. A silt fence will be installed around the entire perimeter of the site.

If sediment controls are ineffective and turbid water is observed discharging from the site, additional energy dissipation BMPs and sediment control BMPs should be installed such as wattles. It may also be necessary to stabilize soils per Element 5 that are not being worked on. The specific BMPs to be used for controlling sediment on this project include:

Silt Fence (BMP C233)

Element 5: Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

Temporary and Permanent Seeding (BMP C120)
Mulching (BMP C121)
Nets and Blankets (BMP C122)
Plastic Covering (BMP C123)
Sodding (BMP C124)
Topsoiling/Composting (BMP C125)
Surface Roughening (BMP C130)
Dust Control (BMP C140)

Element 6: Protect Slopes

Exposed slopes shall be stabilized with BMPs found in Element 5.

Element 7: Protect Drain Inlets

Drain inlets near the site and those made operable on-site will be protected from sedimentation. Stormwater shall not enter the conveyance system without first being filtered or treated to remove sediment. Inlet protection devices shall be cleaned or removed and replaced when sediment has filled one-third of the available storage (or as specified by the manufacturer). The specific BMPs to be used for protecting drain inlets are:

Storm Drain Inlet Protection (BMP C220)

Element 8: Stabilize Channels and Outlets

All temporary on-site conveyance channels shall be designed, constructed, and stabilized to prevent erosion during construction. The specific BMPs to be used for are:

Channel Lining (BMP C202)

Outlet Protection (BMP C209)

Element 9: Control Pollutants

Design, install, implement, and maintain effective pollution prevention measures to minimize the discharge of pollutants. The suggested BMPs are:

Concrete Handling (BMP C151)

Saw Cutting and Surfacing Pollution Prevention (BMP C152)

Material Delivery, Storage and Containment (BMP C153)

Element 10: Control Dewatering

De-watering is not anticipated.

Element 11: Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to ensure continued performance of their intended function.

Element 12: Manage the Project

- Phase development projects to the maximum degree practicable and consider seasonal work limits.

- Inspection and monitoring – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with the Construction Stormwater General Permit or local plan approval authority.
- Maintain an Updated Construction SWPPP
 - This SWPPP shall be retained on-site or within reasonable access to the site.
 - The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
 - The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

Element 13: Protect Low Impact Development BMPs

A bioretention planter is proposed for the site. All heavy equipment should be kept off bioretention facilities that have been excavated to final grade to retain the existing properties of the soil. The proposed facility shall be protected from compaction during construction with orange protective fencing.

Section VI – Special Reports and/or Studies

Section VI Summary

Narrative

The following reports are included in this section:

1. Geotechnical Engineering Report by GeoEngineers, dated April 5, 2023.

Geotechnical Engineering Report

Centennial Park – Parking Lot Expansion
17327 67th Avenue NE
Arlington, Washington

for

Williams Investments LLC

April 5, 2023



Geotechnical Engineering Report

Centennial Park – Parking Lot Expansion
17327 67th Avenue NE
Arlington, Washington

for

Williams Investments LLC

April 5, 2023



554 West Bakerview Road
Bellingham, Washington 98226
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Geotechnical Engineering Report
Centennial Park – Parking Lot Expansion
17327 67th Avenue NE
Arlington, Washington

File No. 22450-002-01

April 5, 2023

Prepared for:

Williams Investments LLC
2513 Colby Avenue
Everett, Washington 98203

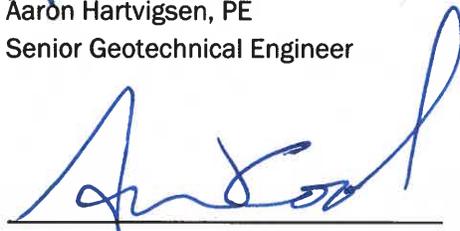
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Figure 2. Site and Exploration Plan

APPENDICES

Appendix A. Field Exploration and Laboratory Testing

Figure A-1 – Key to Exploration Logs

Figures A-2 through A-6 – Logs of Hand Augers

Figures A-7 through A-11 – DCPT Logs

Figure A-12 – Sieve Analysis Results

Appendix B. Report Limitations and Guidelines for Use

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Centennial Park – Parking Lot Expansion project, located at 17327 67th Avenue NE in Arlington, Washington. This approximately 1.45 acre area identified as the “site” is an existing Category IV wetland that will be filled to support the proposed parking lot expansion (96 spaces). The general location of the site is shown in the Vicinity Map, Figure 1.

We understand the proposed development will consist of the addition of a paved surface parking lot to service the existing development. The project will require up to 8 feet of new fill within the wetland area to achieve desired site grades. Stormwater is planned to be managed by use of rain gardens and detention pipes. Short concrete retaining walls are planned for grade transitions. The site conditions are shown in the Site and Exploration Plan, Figure 2.

Geotechnical investigation and reporting have been requested by the civil engineer, CG Engineering. This request included site investigation and recommendations for the required earthwork, pavement, and stormwater management. This proposal is based on correspondence with CG Engineering, a review of project documents, our familiarity with the area, and our experience on similar projects.

The purpose of our geotechnical engineering services was to explore subsurface conditions at the site as a basis for developing geotechnical recommendations for the proposed parking lot development. The scope of our services included completing five hand auger investigations and five dynamic cone penetrometer tests (DCPTs), performing engineering analyses, and preparing this report. The scope of work is described in our proposal for the project dated February 1, 2023.

2.0 SITE CONDITIONS

2.1. Surface Conditions

The site is located just northeast of the intersection of 67th Avenue NE and 172nd Street NE within the Centennial Park Apartments in Arlington, Washington. This approximately 1.45 acre area identified as the “site” is an existing Category IV wetland that will be filled to support the proposed parking lot expansion (96 spaces). The site is bounded by 76th Avenue NE to the west, State Route (SR) 531 to the south, a church to the east and a residential neighborhood to the north. Based on a brief review of nearby available geotechnical information, the subsurface conditions at the site consist of existing fill overlying alluvium and sandy glacial outwash soils extending to significant depth.

2.2. Geology

We reviewed a U.S. Geological Survey (USGS) map for the project area, “Geologic map of the Arlington West 7.5 minute quadrangle, Snohomish County, Washington” by Minard (1985). Soil deposits in the site area are mapped as recessional outwash deposits of the Marysville Sand Member. Also mapped at near the site are older alluvium, transitional beds, and advance outwash (to the east). The sand, gravel, silt, and clay associated with the Marysville Sand Member were deposited by meltwater from the stagnating and receding Vashon Stade glacier and are typically medium dense/stiff. Most of the north-south trending valley in the vicinity of the site is covered with a thin layer, approximately 30 feet thick, of the recessional deposits.

Geologic descriptions of the area are consistent with the subsurface conditions observed in our shallow hand explorations and nearby deeper explorations.

2.3. Subsurface Explorations

Subsurface soil and groundwater conditions at the site were explored by completing five hand augers (HA-1 through HA-5) excavated to depths of 4 to 4½ feet below ground surface (bgs) with a shovel and a 3-inch-diameter hand auger, and five DCPTs (DCPT-1 through DCPT-5) using Triggs® Wildcat DCPT equipment. The explorations were completed on February 23, 2023 by a GeoEngineers, Inc. (GeoEngineers) staff. The approximate locations of the explorations are shown in Figure 2. Details of the field exploration program, laboratory testing, and the exploration logs are presented in Appendix A.

2.4. Subsurface Conditions

2.4.1. Soil Conditions

Subsurface soil conditions generally consisted of organic topsoil of variable thickness overlying native alluvial soils and outwash sand and gravel. Surficial soils at our exploration locations consisted of highly organic topsoil.

- **Topsoil** – Topsoil was observed in all of the hand augers. This unit generally consisted of very loose brown silty sand or soft brown silt with clay and organic matter. The moisture content varied from 39 to 424 percent, which indicates a peat-like topsoil layer for portions of this unit. This layer was typically 1- to 2-feet thick, and 3-feet thick in HA-2.
- **Alluvium** – Below the topsoil layer the alluvium consisted of very soft to soft gray and brown sandy silt in HA-1 and HA-2 and very loose to loose silty sand and/or sand with silt HA-3 through HA-5, with scattered organics in this unit. The alluvium was encountered to the depths explored of 4 feet before reaching practical refusal due to groundwater and caving.
- **Recessional Outwash** – The hand augers were not able to advance into this layer due to shallow groundwater and caving conditions of overlying alluvium. Deeper explorations from previous development nearby indicate that this layer extends to at least 50 feet below grade. The density profile observed in our DCPT's indicated a medium dense sand layer at depths of 4 to 6 feet below existing grade which is interpreted to be the recessional outwash unit.

2.5. Groundwater Conditions

Groundwater was observed on the date of our hand auger explorations at depths ranging from 1 to 2.5 feet bgs. Groundwater conditions should be expected to vary as a function of season, precipitation, and other factors.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The site is underlain by highly organic topsoil, alluvium, and recessional outwash at depth. It is our opinion the site is suitable for the proposed development provided that remedial excavation is incorporated into the site development to mitigate the topsoil layer prior to aerial fill placement. Below-grade detention facilities and low-height site retaining walls may be constructed with earthwork considerations presented in this report.

3.1. Earthwork Considerations

In the area to be filled, we recommend that the existing upper 2 to 3 feet of soils that consist of highly organic topsoil should be removed prior to placement of fill. If not removed, these soils will contribute to a relatively high degree of long-term post construction settlement. The majority of the alluvial soils may remain in place. In some isolated areas with higher organic content, it may be necessary to overexcavate and replace with structural fill.

The exposed subgrade soils will not support construction equipment. We recommend the use of lightweight tracked equipment for removal of topsoil and placement of structural fill material until an adequate thickness is achieved as a working surface.

3.1.1. Subgrade Stabilization

The area is currently a wetland with very loose and soft soil that will be difficult to place initial fill lifts unless stabilized. We recommend that the fill be constructed with a base layer of permeable ballast a minimum of 12 inches thick. We recommend a geotextile fabric for separation be used between the native alluvial soil and the permeable ballast.

3.1.2. Fill Induced Settlement

As discussed, an aerial fill ranging from 4 to 8 feet thick is required to achieve the planned site grades. Placement of fill will result in settlement of the alluvial soils even after removal of the organic topsoil layer. We evaluated the settlement potential of the alluvial silt and sand using the computer program Settle3 from Rocscience Inc. (version 5.018). The estimated settlement is anticipated to be $\frac{3}{4}$ inch or less. The settlement in the alluvial soils is anticipated to occur rapidly, within 2 to 3 weeks of fill placement. Final grading could be delayed for this time period to allow the settlement to occur before paving.

3.2. Stormwater Infiltration Considerations

Based on infiltration infeasibility discussed below, we understand that the project will be designed with rain gardens for stormwater quality and detention pipes for storage.

The Washington Department of Ecology's (Ecology's) 2019 *Stormwater Management Manual for Western Washington* (2019 SMMWW) provides guidelines for determining infiltration rates for stormwater systems and allows for the use of grain size analyses as a substitute for pilot infiltration tests (PITs) on site with soils unconsolidated by glacial advance. The 2019 SMMWW states that the preferred stormwater management techniques include infiltration, dispersion, and retainage of stormwater runoff as part of site development "to the extent feasible without causing flooding or erosion impacts." The Ecology Stormwater Manual describes how the feasibility can be evaluated when site conditions are appropriate, and also provides infeasibility criteria for each best management practice (BMP).

The 2019 Ecology Manual allows for some infeasibility criteria which may be "cited as reasons for a finding of infeasibility without further justification." Such criteria which are applicable to the proposed project include:

- "Where the minimum vertical separation of 1 foot to the seasonal high water table, bedrock, or other impervious layer would not be achieved..." for drainage areas with less than 10,000 square feet of impervious surface.

- “Where the minimum vertical separation of 3 feet to the seasonal high water table, bedrock, or other impervious layer would not be achieved...” for drainage areas exceeding 10,000 square feet of impervious surface and $\frac{3}{4}$ acres of pervious surfaces. It is our opinion that this condition applies to the proposed development.

Based on groundwater separation guidelines for infiltration systems presented in the 2019 SMMWW, the very shallow seasonal high groundwater, relatively low permeability of the fine-grained soils, as well as the general subsurface variability, it is our opinion that site conditions preclude the use of infiltration systems for stormwater management for this specific portion of the development.

3.3. CMP Storm Detention Pipe Design

As currently proposed, the stormwater detention is planned to consist of a series of connected 4- to 6-foot-diameter corrugated metal pipe (CMP) structures. The detention structure is planned to be founded with an invert at approximately Elevation 137 to 138 feet. Based on the results of our site explorations and review of nearby information, we anticipate that base of the culvert will bear in native alluvial soils. We recommend that subgrade soils be prepared as described in Section 3.3.1 of this report.

Backfill material around the culvert should be free of rocks larger than 3-inches diameter and backfill should proceed up equally on both sides of the pipe to avoid unbalanced loading on either side of the pipe.

3.3.1. Subgrade Preparation and Foundation Support

The results of our explorations indicate that soft/loose alluvial soils will likely be encountered at the proposed culvert subgrade elevation. We recommend that any soil disturbed during excavation at the foundation subgrade be thoroughly compacted to a firm condition or removed. The subgrade should be prepared to a uniformly firm surface and should be shaped to fit the pipe bottom before placement. Backfill should also be carefully tamped under the pipe haunches as recommended by the manufacturer. We expect that dewatering of perched groundwater may be required to stabilize the base of the excavation prior to compaction.

To provide uniform support, we recommend that the detention pipes bear on a minimum of 12 inches of foundation material consisting of crushed surface base course (CSBC) meeting criteria in section 9-03.9(3) of the Washington State Department of Transportation (WSDOT) Standard Specifications. For additional protection, a woven geotextile fabric for stabilization with a 200-pound tensile strength in accordance with ASTM International (ASTM) D 4632 (Mirafi HP270 or equivalent) should be placed over the native alluvial subgrade prior to placing the foundation material, especially if the subgrade is wet at the time of construction. We recommend that the condition of the pipe subgrade be observed by a representative of GeoEngineers to confirm that work is completed in accordance with our recommendations and that the subsurface conditions are as expected and provide recommendations for additional overexcavation, if necessary, based on conditions encountered during construction.

3.3.2. Buoyancy and Uplift

The below-grade pipes may extend below the groundwater level; therefore, buoyancy and uplift is a consideration and hydrostatic pressures should be considered up to Elevation 140 feet unless drainage provisions are provided. Resistance to uplift can be developed by the dead weight of the structure and backfill soil with unit weight of 120 pounds per cubic foot (pcf) above the groundwater table and 60 pcf below the groundwater table. In addition to the above means of resisting uplift, the structure may be anchored or ballasted to resist uplift.

Buoyancy and uplift can be controlled to some extent by installing a gravity relief drain at the desired design elevation that outfalls to the site discharge. This relief drain will limit the level that groundwater can rise in the vicinity of the below-grade pipe structures.

3.4. Site Retaining Walls

Low-height conventional cast-in-place walls may be necessary for retaining structures for grade separation at the site. Retaining wall design recommendations are provided in the following sections.

3.4.1. Shallow Foundation Design

The small cast-in-place walls will be supported on traditional shallow foundations. We anticipate that they will be lightly loaded.

3.4.1.1. Footing Subgrade Preparation

We recommend the footings bear on a minimum of 2 feet of structural fill. The structural fill described later in this report should be compacted to 95 percent of the maximum dry density (MDD) in accordance with ASTM D 1557. The overexcavation should extend 1 foot beyond the edges of the footings or a minimum lateral distance equivalent to one-half the depth below the footings, whichever is greater.

We suggest the excavations for the footings be accomplished with a smooth bucket to minimize subgrade disturbance. Any soft or disturbed material should be removed from the excavation or compacted to a dense condition. The fill subgrade soils will be susceptible to disturbance when wet. We recommend that we observe the subgrade and compaction of the subgrade to confirm suitable bearing conditions are present before fill placement.

3.4.1.2. Footing Design

Isolated or continuous spread footings founded on the minimum thickness of compacted structural fill as described above will provide adequate support for the proposed retaining walls. A maximum allowable soil bearing pressure of 1,500 pounds per square foot (psf) for dead plus live loads can be used for design. The allowable soil bearing pressure may be increased by up to one-third for wind or seismic loads.

3.4.1.3. Settlement

We estimate that the total settlement of spread footings founded on compacted structural fill prepared in accordance with our recommendations will be less than 3/4-inch with differential settlement limited to less than 1/2-inch over 50 feet. The settlement will occur rapidly as loads are applied.

3.4.2. Lateral Earth Pressures

The lateral soil pressures acting on conventional cast-in-place subsurface walls will depend on the nature, density, and configuration of the soil behind the wall and the amount of lateral wall movement which can occur as backfill is placed.

For walls that are free to yield at the top at least 0.1 percent of the height of the wall, soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing. Assuming that the walls are backfilled and drainage is provided as outlined in the following paragraphs, we recommend that yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 35 pcf (triangular distribution), while non-yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 55 pcf (triangular distribution). For seismic loading conditions, a rectangular earth pressure equal

to 7H psf, where H is the height of the wall, should be added to the active/at-rest pressures presented above. Traffic surcharges can be approximated by increasing the wall height (H) by 2 feet. Other surcharge loading should be applied as appropriate. GeoEngineers can assist in developing recommendations for other surcharge loading, as necessary.

Lateral resistance for conventional cast in place walls can be provided by frictional resistance along the base of the wall and passive resistance in front of the wall as previously below in the “Shallow Foundations” section of this report.

The above soil pressures assume that wall drains will be installed to prevent the buildup of hydrostatic pressure behind the walls, as discussed below.

3.4.3. Lateral Resistance

Lateral loads (e.g., wind and seismic) on the structure can be resisted by a combination of passive earth pressures on buried foundation elements, and frictional resistance, which can develop on the base of slabs or footings.

The passive resistance on the face of embedded foundation elements may be computed using an equivalent fluid density of 135 pcf for structural fill, which assumes a saturated condition. We recommend an allowable frictional resistance be computed using a coefficient of friction of 0.42 applied to vertical dead-load forces. The above values include a factor of safety of about 1.5.

3.5. Pavement Recommendations

3.5.1. Subgrade Preparation

We recommend the subgrade and subbase soils in new pavement areas be prepared and evaluated as described in Section 3.7. All pavement areas should be supported on at least 2 feet of structural fill compacted to at least 95 percent of the MDD. Prior to placing the 2-foot-thick structural fill layer, if the exposed subgrade soils are excessively loose or soft, it may be necessary to excavate localized areas and replace them with structural fill. Pavement subgrade conditions should be observed during construction and prior to placing the subbase materials in order to evaluate the presence of unsuitable subgrade soils and the need for over-excavation.

3.5.2. New Hot Mix Asphalt Pavement

In light-duty pavement areas (e.g., automobile parking), we recommend a pavement section consisting of at least 3 inches of ½-inch hot mix asphalt (HMA) (PG 58-22) per WSDOT Sections 5-04 and 9-03, over 4 inches of densely compacted crushed rock base course per WSDOT Section 9-03.9(3). Alternatively, the site development may follow the City of Arlington typical roadway standards, which consist of 3 inches of Class B asphalt over 4 inches of asphalt-treated base (ATB) over 6 inches of crushed rock base course as shown in the City of Arlington standard detail R-020. The base course and upper 24 inches of subgrade soils should be compacted to at least 95 percent of the MDD per ASTM D 1557. The pavement subgrade soils which will consist of imported structural fill should be compacted with a heavy smooth-drum vibratory roller to specified compaction per Section 3.6.3 below.

The pavement sections recommended above are based on our experience. Thicker asphalt sections may be needed based on the actual traffic data, truck loads, and intended use. All paved and landscaped areas should be graded so surface drainage is directed to appropriate catch basins.

3.6. Earthwork

Based on the subsurface soil conditions encountered in the explorations, we anticipate the soils at the site may be excavated using conventional construction equipment. The materials we encountered include topsoil, and soft/loose silty and sandy alluvium. The underlying glacial soils in the area commonly contain cobbles and boulders that may be encountered during deeper excavation. Accordingly, the contractor should be prepared to deal with cobbles and boulders.

Ideally, earthwork should be undertaken during extended periods of dry weather (June through September) when the surficial soils will be less susceptible to disturbance and provide better support for construction equipment. If possible, deeper excavations should be completed at times of the year when groundwater levels are deeper to reduce the amount of temporary dewatering required. Dry weather construction will help reduce earthwork costs.

3.6.1. Clearing and Site Preparation

Areas to be developed or graded should be cleared of surface and subsurface deleterious matter, including any debris, shrubs, trees and associated stumps and roots. Graded areas should be stripped of organic soils. Based on our observations, stripping depths on the order of 24 inches will be needed to remove organic topsoil and root mass materials in most areas but could range up to 3 feet. Deeper zones of organic soils should be expected in areas of dense vegetation or where large tree bulbs are located. We expect that the excavated topsoil and onsite native soils will be excavated and removed offsite.

3.6.2. Subgrade Preparation

Prior to placing new fills or pavement base course materials, subgrade areas for pavements should be evaluated to locate any soft or pumping soils. Native subgrade soils after stripping will likely not be suitable for a proof roll. We recommend the exposed subgrade areas be probed and evaluated by an engineer from our firm to determine the extent of any remaining soft unsuitable soils. If soft or pumping soils are observed, they should be removed and replaced with structural fill.

We recommend that the subgrade be compacted to the extent possible without causing undue weaving or pumping of the subgrade soils, or any loose/disturbed soil be removed. Subgrade disturbance or deterioration could occur if the subgrade is wet and cannot be dried. If the subgrade deteriorates during compaction, it may become necessary to modify the compaction criteria or methods.

3.6.3. Structural Fill

All newly placed fill should meet the criteria for structural fill presented below. The suitability of soil for use as structural fill depends on its gradation and moisture content.

3.6.3.1. Materials

Materials used to construct the surface parking and drive aisle areas, or to backfill utility trenches are classified as structural fill for the purpose of this report. Structural fill material quality varies depending upon its use as described below:

- A non-woven geotextile fabric such as Mirafi 140N, or other as approved by GeoEngineers, should be placed between the native alluvial subgrade and the permeable ballast.

- Structural fill placed as the permeable ballast drainage layer below the remainder of the fill should conform to Section 9-03.9(2) of the most recent WSDOT Standard Specifications.
- Structural fill placed to construct parking and roadway areas and to backfill utility trenches should consist of Imported Gravel Borrow as described in Section 9-03.14(1) of the most recent WSDOT Standard Specifications, with the additional restriction that the fines content be limited to no more than 5 percent.
- Structural fill placed as crushed surfacing base course below pavements or as support of the detention pipe structures should conform to Section 9-03.9 (3) of the most recent WSDOT Standard Specifications.

3.6.3.2. Reuse of On-site Soils

The near surface on-site soils consist of topsoil and upper silty sand or sandy silt alluvial soils. The topsoil should be stripped and removed from all areas where improvements are planned. The project consists of a fill with very little excavation of onsite soils with exception of the topsoil layers. Therefore, we do not expect large quantities of excavated materials will be generated for reuse. Site soils are not suitable for reuse as structural fill. For planning and budgeting purposes, we recommend that the project include imported gravel borrow for use as structural fill where other specific materials are not specified.

3.6.3.3. Fill Placement and Compaction

Structural fill should be compacted at moisture contents that are within 3 percent of the optimum moisture content as determined by ASTM Test Method D 1557 (Modified Proctor). The optimum moisture content varies with gradation and should be evaluated during construction. Fill material that is not near the optimum moisture content should be moisture conditioned prior to compaction.

Fill and backfill material should be placed in uniform, horizontal lifts, and compacted with appropriate equipment. The appropriate lift thickness will vary depending on the material and compaction equipment used. Fill material should be compacted in accordance with Table 1, below. It is the contractor’s responsibility to select appropriate compaction equipment and place the material in lifts that are thin enough to meet these criteria. However, in no case should the loose lift thickness exceed 18 inches.

TABLE 1. COMPACTION CRITERIA

Fill Type	Compaction Requirements		
	Percent Maximum Dry Density Determined by ASTM Test Method D 1557 at ± 3% of Optimum Moisture		
	0 to 2 Feet Below Subgrade	> 2 Feet Below Subgrade	Pipe Zone
Imported Granular, maximum particle size < 1¼ inch	95	92	----
Imported Granular (Permeable Ballast)	n/a (proof-roll)	n/a (proof-roll)	----
Retaining Wall Backfill*	92	92	----
Nonstructural Zones	90	90	90
Trench Backfill	95	90	90

Note:

* Measures should be taken to prevent overcompaction of the backfill behind retaining walls. We recommend placing the zone of backfill located within 5 feet of the wall in lifts not exceeding about 6 inches in loose thickness and compacting this zone with hand-operated equipment such as a vibrating plate compactor and a jumping jack.

A representative from GeoEngineers should evaluate compaction of each lift of fill. Compaction should be evaluated by compaction testing unless other methods are proposed for oversized materials and are approved by GeoEngineers during construction. These other methods typically involve procedural placement and compaction specifications together with verifying requirements such as proof-rolling.

3.6.4. Weather Considerations

Disturbance of near surface soils should be expected, especially if earthwork is completed during periods of wet weather. During dry weather the soils will: (1) be less susceptible to disturbance; (2) provide better support for construction equipment; and (3) be more likely to meet the required compaction criteria.

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather may occur during any month of the year. For earthwork activities during wet weather, we recommend that the following steps be taken:

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of moderate to heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps, and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent that these soils become wet or unstable.
- The contractor should cover all soil stockpiles that will be used as structural fill with plastic sheeting.

3.7. Excavations

The stability of open cut slopes is a function of soil type, groundwater seepage, slope inclination, slope height and nearby surface loads. The use of inadequately designed open cuts could impact the stability of adjacent work areas, existing utilities, and endanger personnel. The contractor performing the work has the primary responsibility for protection of workmen and adjacent improvements. In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and groundwater conditions. Therefore, the contractor should have the primary responsibility for deciding whether or not to use open cut slopes for much of the excavations rather than some form of temporary excavation support, and for establishing the safe inclination of the cut slope. Acceptable slope inclinations for utilities and ancillary excavations should be determined during construction. Because of the diversity of construction techniques and available shoring systems, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. Temporary cut slopes and shoring must comply with the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring."

Because the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. The contractor should take all necessary steps to ensure the safety of the workers near the slopes.

3.7.1. Temporary Cut Slopes

For planning purposes, temporary unsupported cut slopes more than 4 feet high and completed above the groundwater level may be inclined at 1.5H:1V (horizontal to vertical). These slopes may need to be flattened by the contractor if significant caving/sloughing or groundwater seepage occurs. Deeper excavations near or below the water table may require dewatering and/or shoring to maintain safe working conditions. For open cuts at the site, we recommend that:

- No traffic, construction equipment, stockpiles, or building supplies be allowed at the top of the cut slopes within a distance of at least 5 feet from the top of the cut;
- The excavation does not encroach on a 1H:1V influence line projected down from the edges of nearby or planned foundation elements;
- Exposed soil along the slope be protected from surface erosion using waterproof tarps, plastic sheeting, or flash coating with shotcrete;
- Construction activities be scheduled so that the length of time the temporary cut is left open is reduced to the extent practicable;
- Erosion control measures be implemented as appropriate such that runoff from the site is reduced to the extent practicable;
- Surface water be diverted away from the excavation; and
- The general condition of the slopes be observed periodically by GeoEngineers to confirm adequate stability.

3.7.2. Temporary Dewatering

Excavations which extend below the groundwater level will require temporary dewatering. Dewatering via open pumping is therefore likely to be needed, as well as keeping excavations as shallow as possible below the groundwater table.

To the extent possible, the design should consider limiting the required excavations below the groundwater level and planned excavations should be completed during periods of lower groundwater levels. The Contractor should be made responsible for design, installation and operation of a suitable dewatering system to accommodate deeper excavations, which may require a series of dewatering wells or vacuum wellpoints to lower the groundwater below the base of the excavation during construction.

3.7.3. Utility Trenches

Trench excavation, pipe bedding, and trench backfilling should be completed using the general procedures described in the most recent WSDOT Standard Specifications or other suitable procedures specified by the project civil engineer. The recessional outwash and upper sand soils encountered at the site are generally of low corrosivity based on our experience in the Puget Sound area.

Utility trench backfill should consist of structural fill and should be placed in loose lifts not exceeding 12 inches in thickness when using heavy compaction equipment, or 6 inches when using light-weight hand operated compaction equipment. The actual thickness will be dependent on the structural fill material used, and the type and size of compaction equipment. Each lift should be conditioned to within 2 percent of the soils optimum moisture content and compacted to the specified density before placing subsequent lifts. The backfill should be compacted in accordance with the criteria discussed above.

3.7.4. Sedimentation and Erosion Control

In our opinion, the erosion potential of the on-site soils is low to moderate. Construction activities, including stripping and grading, will expose soils to the erosion effects of wind and water. The amount and potential impacts of erosion are partly related to the time of year that construction actually occurs. Wet weather construction will increase the amount and extent of erosion and potential sedimentation.

Erosion and sedimentation control measures may be implemented by using a combination of interceptor swales, straw bale barriers, silt fences and straw mulch for temporary erosion protection of exposed soils. All disturbed areas should be finish graded and seeded as soon as practicable to reduce the risk of erosion. Erosion and sedimentation control measures should be installed and maintained in accordance with the requirements of the City of Arlington.

4.0 LIMITATIONS

We have prepared this report for use by Williams Investments LLC, and other members of the design team for consideration in preliminary design of the proposed Centennial Park – Parking Lot Expansion development project in Arlington, Washington.

Within the limitation of scope, schedule and budget, our services have been executed in accordance with generally accepted geotechnical practices in the area at the time the report was prepared. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to the Appendix C, “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

5.0 REFERENCES

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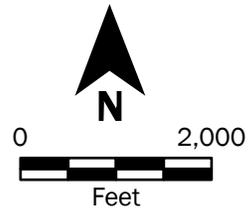
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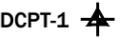
Vicinity Map	
Centennial Park Parking Expansion Arlington, Washington	
GEOENGINEERS	Figure 1

Source(s):
• ESRI

Coordinate System: NAD 1983 UTM Zone 10N

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

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- Legend**
-  Site Boundary
 -  DCPT-1  Hand Auger and Dynamic Cone Penetration Test by GeoEngineers, 2023

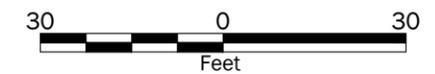


Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Basemap survey by ORCA Land Surveying 3/15/2023.

Projection: WA State Plane, North Zone, NAD83, US Foot



Site and Exploration Plan	
Centennial Park Parking Expansion Arlington, Washington	
	Figure 2

APPENDIX A
Field Exploration and Laboratory Testing

APPENDIX A

FIELD EXPLORATION AND LABORATORY TESTING

Hand Auger Explorations

Subsurface conditions at the site were explored by completing five hand auger explorations (HA-1 through HA-5) at the site on February 23, 2023. Handhole explorations were completed to a maximum depth of about 4 feet below the existing surface. The approximate locations of the explorations are shown in the Site and Exploration Plan, Figure 2. The locations of the explorations were determined by hand-held global positioning system (GPS); therefore, the locations shown in the figures should be considered approximate.

Disturbed soils samples were obtained from the cuttings of the hand auger. The samples were placed in plastic bags to maintain the moisture content and transported back to our laboratory for analysis and testing.

The explorations were continuously monitored by a staff geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration. Soils encountered in hand auger explorations were classified visually in general accordance with ASTM International (ASTM) D-2488-90, which is described in Figure A-1. An explanation of the symbols for the hand augers is also shown in Figure A-1.

The logs of the hand auger explorations are presented in Figures A-2 through A-6. The exploration logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. It also indicates the depths at which these soils or their characteristics change, although the change might actually be gradual. If the change occurred between samples, it was interpreted.

Dynamic Cone Penetrometer Testing

Dynamic cone penetration tests (DCPTs) were also completed at hand exploration locations (DCPT-1 through DCPT-5). The test records blow counts for 10-centimeter (cm) intervals from a 35-pound hammer falling a height of 15 inches. The blow counts can then be corrected to obtain equivalent Standard Penetration Test (SPT) blow counts. The logs of the DCPT soundings are presented in Figures A-7 through A-11. The DCPT explorations were completed to depths of 10 feet bgs. The exploration logs are based on empirical relationships developed by Triggs Technologies, Inc.

Laboratory Testing

Soil samples obtained from the hand auger explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of moisture content determination, percent fines, and grain size distribution. The tests were performed in general accordance with ASTM test methods or other applicable procedures.

Moisture Content Testing

The natural moisture contents of selected soil samples obtained from the explorations were determined in general accordance with ASTM D 2216 test procedures. The results from the moisture content determinations are displayed in the column labeled “Moisture Content (%)” adjacent to the corresponding samples on the summary logs.

Percent Passing U.S. No. 200 Sieve

Selected samples were “washed” through the U.S. No. 200 mesh sieve to determine the relative percentage of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted in general accordance with ASTM D 1140. The results from the percent fines determinations are displayed in the column labeled “Fines Content (%)” adjacent to the corresponding samples on the summary exploration logs.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, classified in general accordance with the Unified Soil Classification System (USCS), and are presented in Figure A-12.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS <small>(LITTLE OR NO FINES)</small>		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES <small>(APPRECIABLE AMOUNT OF FINES)</small>		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		SANDS WITH FINES <small>(APPRECIABLE AMOUNT OF FINES)</small>		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS <small>(LITTLE OR NO FINES)</small>		SW	WELL-GRADED SANDS, GRAVELLY SANDS
		SANDS WITH FINES <small>(APPRECIABLE AMOUNT OF FINES)</small>		SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES <small>(APPRECIABLE AMOUNT OF FINES)</small>		SM	SILTY SANDS, SAND - SILT MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
		LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		LIQUID LIMIT LESS THAN 50		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
		LIQUID LIMIT GREATER THAN 50		CH	INORGANIC CLAYS OF HIGH PLASTICITY
		LIQUID LIMIT GREATER THAN 50		OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

Sampler Symbol Descriptions

	2.4-inch I.D. split barrel / Dames & Moore (D&M)
	Standard Penetration Test (SPT)
	Shelby tube
	Piston
	Direct-Push
	Bulk or grab
	Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTIONS
GRAPH	LETTER	
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact



Measured groundwater level in exploration, well, or piezometer



Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point lead test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

Key to Exploration Logs



Figure A-1

Date Excavated	2/23/2022	Total Depth (ft)	4.5	Logged By	PU	Excavator	N/A	See "Remarks" section for groundwater observed	
				Checked By	AJH	Equipment	Hand Auger	Caving not observed	
Surface Elevation (ft) Vertical Datum	137 NAVD88		Easting (X) Northing (Y)	1321685 423504		Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)		

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
136	1	1 MC			TS	Brown silty sand with clay, rootlets and straw with mixed organic matter (very loose, moist) (topsoil) Becomes wet	55		Slow groundwater seepage observed at 1 foot
135	2				ML	Gray sandy silt (very soft, wet) (alluvium)			
134	3	2 SF					40	56	
133	4	3 SF			SM	Gray silty fine to coarse sand (very loose to loose, wet)	24	30	

Notes: See Figure A-1 for explanation of symbols.
The depths on the hand-augered boring logs are based on an average of measurements across the hand-auger and should be considered accurate to 1/2 foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Topographic Survey.

Log of Hand Auger HA-1



Project: Centennial Park Parking Expansion
Project Location: Arlington, Washington
Project Number: 22450-002-01

Figure A-2
Sheet 1 of 1

Date: 4/5/23 Path: \\GEOENGINEERS.COM\WAN\PROJECTS\22\22450002\GINT\2245000201.GPJ DBLlibrary\Library\GEOENGINEERS_DF_STD_US_JUNE_2017\GLB\GEB_TESTPIT_IP_GEOTEC_MF

Date Excavated	2/23/2022	Total Depth (ft)	4.5	Logged By	PU	Excavator	N/A	See "Remarks" section for groundwater observed	
				Checked By	AJH	Equipment	Hand Auger	Caving not observed	
Surface Elevation (ft) Vertical Datum	138 NAVD88		Easting (X) Northing (Y)	1321775 423504		Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)		

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
137	1			[Cross-hatched pattern]	TS	Brown silty sand with clay, rootlets and straw with mixed organic matter (very loose, moist) (topsoil)			
136	2		1 MC	[Horizontal dashed pattern]	ML/OL	Dark brown organic sandy silt (very soft, wet)	204		Slow groundwater seepage observed at 1 foot
135	3			[Horizontal dashed pattern]	ML	Gray sandy silt (soft, wet) (alluvium)			
134	4		2 MC	[Horizontal dashed pattern]			82		

Notes: See Figure A-1 for explanation of symbols.
The depths on the hand-augered boring logs are based on an average of measurements across the hand-auger and should be considered accurate to 1/2 foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Topographic Survey.

Log of Hand Auger HA-2



Project: Centennial Park Parking Expansion
Project Location: Arlington, Washington
Project Number: 22450-002-01

Date: 4/5/23 Path: \\GEOENGINEERS.COM\WAN\PROJECTS\22\22450002\GINT\2245000201.GPJ DBL\Library\Library\GEOENGINEERS_DF_STD_US_JUNE_2017\GLB\GEB_TEST\PTT_IP_GEOTEC_MF

Date Excavated	2/23/2022	Total Depth (ft)	4	Logged By	PU	Excavator	N/A	See "Remarks" section for groundwater observed	
		Checked By	AJH	Equipment	Hand Auger			Caving not observed	
Surface Elevation (ft) Vertical Datum	142 NAVD88	Easting (X) Northing (Y)	1321861 423502	Coordinate System Horizontal Datum	WA State Plane North NAD83 (feet)				

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
141	1	MC			TS	Brown silty sand with clay, rootlets and straw with mixed organic matter (very loose, moist) (topsoil)	57		
140	2	SN			SP-SM	Gray fine to coarse sand with silt and gravel (very loose, moist) (alluvium) Becomes wet	17	5	Slow groundwater seepage observed at 2½ feet
139	3	SN			SM	Dark brown silty fine to medium sand with organics (very loose to loose, wet)	66	22	
138	4								

Notes: See Figure A-1 for explanation of symbols.
The depths on the hand-augered boring logs are based on an average of measurements across the hand-auger and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Topographic Survey.

Log of Hand Auger HA-3



Project: Centennial Park Parking Expansion
Project Location: Arlington, Washington
Project Number: 22450-002-01

Date: 4/5/23 Path: \\GEOENGINEERS.COM\WAN\PROJECTS\22_22450002\GINT\22450002\GINT\22450002\01.GPJ DBL\Library\Library\GEOENGINEERS_DF_STD_US_JUNE_2017\GLB_GEB_TESTPIT_IP_GEOtec_38F

Date Excavated	2/23/2022	Total Depth (ft)	4	Logged By	PU	Excavator	N/A	See "Remarks" section for groundwater observed	
				Checked By	AJH	Equipment	Hand Auger	Caving not observed	
Surface Elevation (ft)	138		Easting (X)	1321716		Coordinate System	WA State Plane North		
Vertical Datum	NAVD88		Northing (Y)	423428		Horizontal Datum	NAD83 (feet)		

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
137	1		MC		TS	Brown sandy silt with clay, grass, rootlets, roots and straw with mixed organic matter (very loose, moist) (topsoil)	39		
136	2		MS		SM	Gray silty fine to medium sand (very loose, moist) (alluvium) Becomes wet	29	29	Slow groundwater seepage observed at 1½ feet
135	3				SP-SM	Gray fine to coarse sand with silt (very loose, wet)			
134	4						22	6	

Notes: See Figure A-1 for explanation of symbols.
The depths on the hand-augered boring logs are based on an average of measurements across the hand-auger and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Topographic Survey.

Log of Hand Auger HA-4



Project: Centennial Park Parking Expansion
Project Location: Arlington, Washington
Project Number: 22450-002-01

Date: 4/5/23 Path: \\GEOENGINEERS.COM\WAN\PROJECTS\22\22450002\GINT\22450002\GINT\22450002\01.GPJ DBL\Library\Library\GEOENGINEERS_DF_STD_US_JUNE_2017\GLB_GEB_TESTPIT_IP_GEOTEC_MF

Date Excavated	2/23/2022	Total Depth (ft)	4	Logged By	PU	Excavator	N/A	See "Remarks" section for groundwater observed	
				Checked By	AJH	Equipment	Hand Auger	Caving not observed	
Surface Elevation (ft)	140		Easting (X)	1321835		Coordinate System	WA State Plane North		
Vertical Datum	NAVD88		Northing (Y)	423428		Horizontal Datum	NAD83 (feet)		

Elevation (feet)	Depth (feet)	SAMPLE		Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
		Testing Sample	Sample Name Testing						
139	1		MC		TS	Brown organic silty sand with clay, rootlets and straw with mixed organic matter (very loose, moist) (topsoil)	424		
138	2				SM	Gray silty sand (very loose to loose, wet) (alluvium)			Slow groundwater seepage observed at 2 feet
137	3				SM				
136	4				SM		62	36	

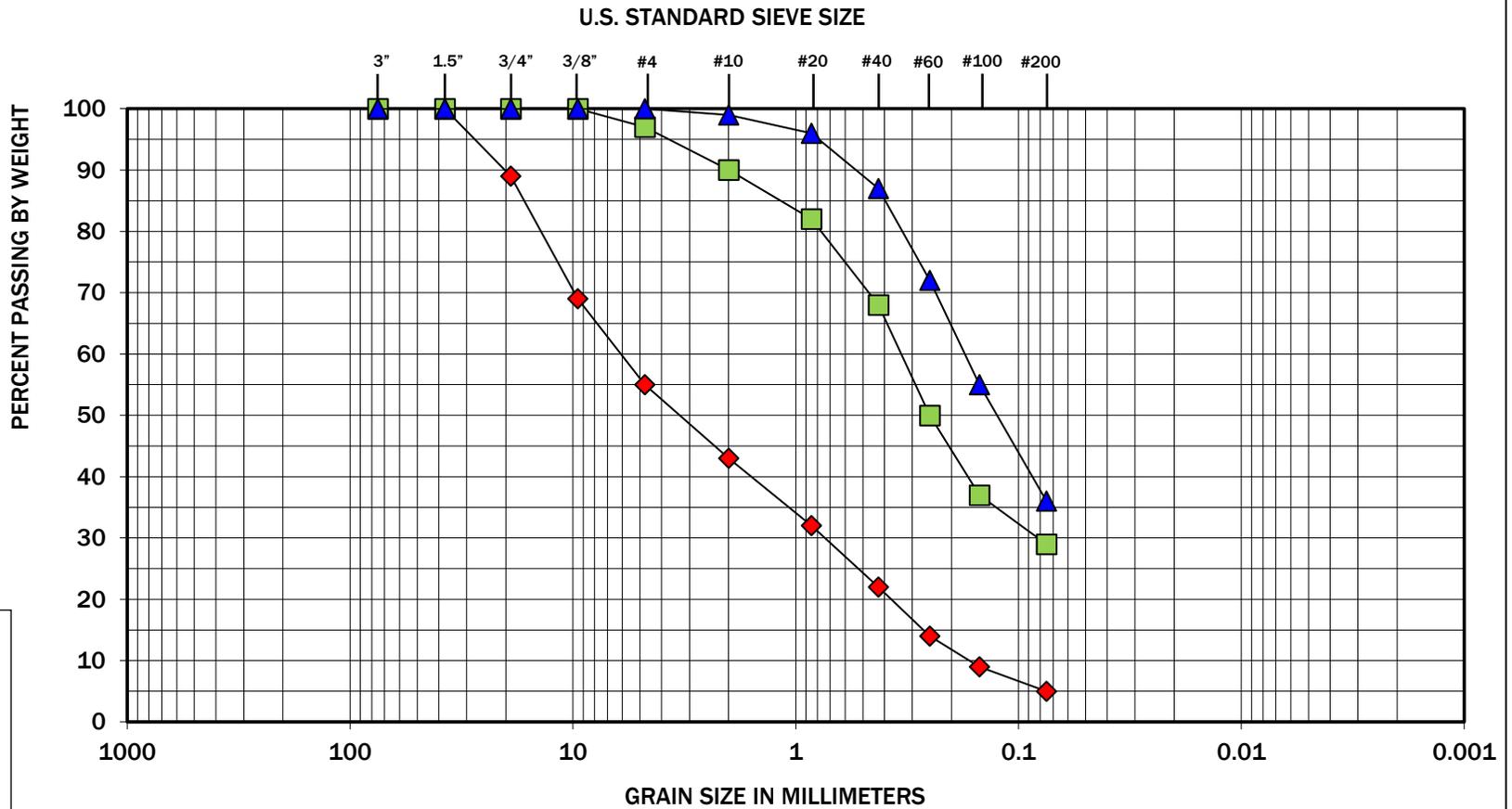
Notes: See Figure A-1 for explanation of symbols.
 The depths on the hand-augered boring logs are based on an average of measurements across the hand-auger and should be considered accurate to 1/2 foot.
 Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Topographic Survey.

Log of Hand Auger HA-5



Project: Centennial Park Parking Expansion
 Project Location: Arlington, Washington
 Project Number: 22450-002-01

Date: 4/5/23 Path: \\GEOENGINEERS.COM\WAN\PROJECTS\22\22450002\GINT\22450002\GINT\22450002\01\GPI\DBLibrary\Library\GEOENGINEERS_DF_STD_US_JUNE_2017\GLB\GEB_TESTPIT_IP_GEOTEC_MF



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	HA-3	2	17	Sand with silt and gravel (SP-SM)
■	HA-4	2	29	Silty sand (SM)
▲	HA-5	3.5	62	Silty sand (SM)

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The grain size analysis results were obtained in general accordance with ASTM D 6913. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

GEOENGINEERS
 Centennial Park Parking Expansion
 Arlington, Washington
Sieve Analysis Results
Figure A-12

APPENDIX B
Report Limitations and Guidelines for Use

APPENDIX B REPORT LIMITATIONS AND GUIDELINES FOR USE¹

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory “limitations” provisions in its reports. Please confer with GeoEngineers if you need to know more how these “Report Limitations and Guidelines for Use” apply to your project or site.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Williams Investments LLC and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our agreement with Williams Investments LLC dated and authorized on February 1, 2023 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed Centennial Park – Parking Lot Expansion project in Arlington, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;

¹ Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org

- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

The recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these “Report Limitations and Guidelines for Use.” When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Topsoil

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

Biological Pollutants

GeoEngineers’ Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

Section VII – Other Permits

Section VII Summary

Narrative

Below is a list of other required permits:

- Nationwide Permit (404) – US Army Corps of Engineers. Submitted November 11, 2022, and is awaiting Agency review and approval.
- Water Quality Certification (401) Washington State Department of Ecology. Submitted December 16, 2022, and is awaiting Agency review and approval.
- Civil construction permit.
- Zoning permit.
- Building permit for site retaining walls.
- Carport permits will be deferred submittals.

Section VIII – Operation and Maintenance Manual

Section VIII Summary

Narrative

The Operation and Maintenance Manual is a standalone document that will be given to the property manager following the construction of the project. The contractor will be responsible for the maintenance and operation of all stormwater structures and BMPs requiring maintenance during construction and, after construction, responsibility will pass to the property management company. The manual shall be kept in the offices of the proposed buildings. Upon request by the City, it shall be made available for their inspection. It is generally expected that few to none of these defects will be present upon the yearly inspection of each facility.

**Centennial Park Parking Improvements
67th Ave and 172nd Street NE
Arlington, WA 98223**

OPERATION AND MAINTENANCE MANUAL

Date: April 2023



250 4th Avenue South, Suite 200
Edmonds, WA 98020
ph. 425.778.8500 | f. 425.778.5536
www.cgeengineering.com

Operation and Maintenance Manual

This Operation and Maintenance Manual has been created for Centennial Park Parking Improvements, located at 67th Ave and 172nd Street NE Arlington, WA 98223. The proposed stormwater management system consists of catch basins, and conveyance pipes that collect runoff from parking, and new landscaping, and route them to a combined bioretention/detention system.

Included in this Operation and Maintenance Manual is an 11" x 17" grading and drainage plan sheet showing the locations of the drainage system. Please note that this map is generated during the design phase and may not reflect all changes made in permitting and construction. CG Engineering may be contacted for an updated copy of this map once the as-built drawings are completed for the site. Maintenance sheets from the 2019 Stormwater Management Manual for Western Washington are included for the following facilities:

Catch Basins: Concrete structures with steel grates that collect stormwater runoff from the site and act as junctions for storm conveyance pipes. See "No. 5" for maintenance.

Bioretention Planter: Engineered facilities that treat stormwater by passing it through a specified soil profile, and either retain or detain the treated stormwater for flow attenuation.

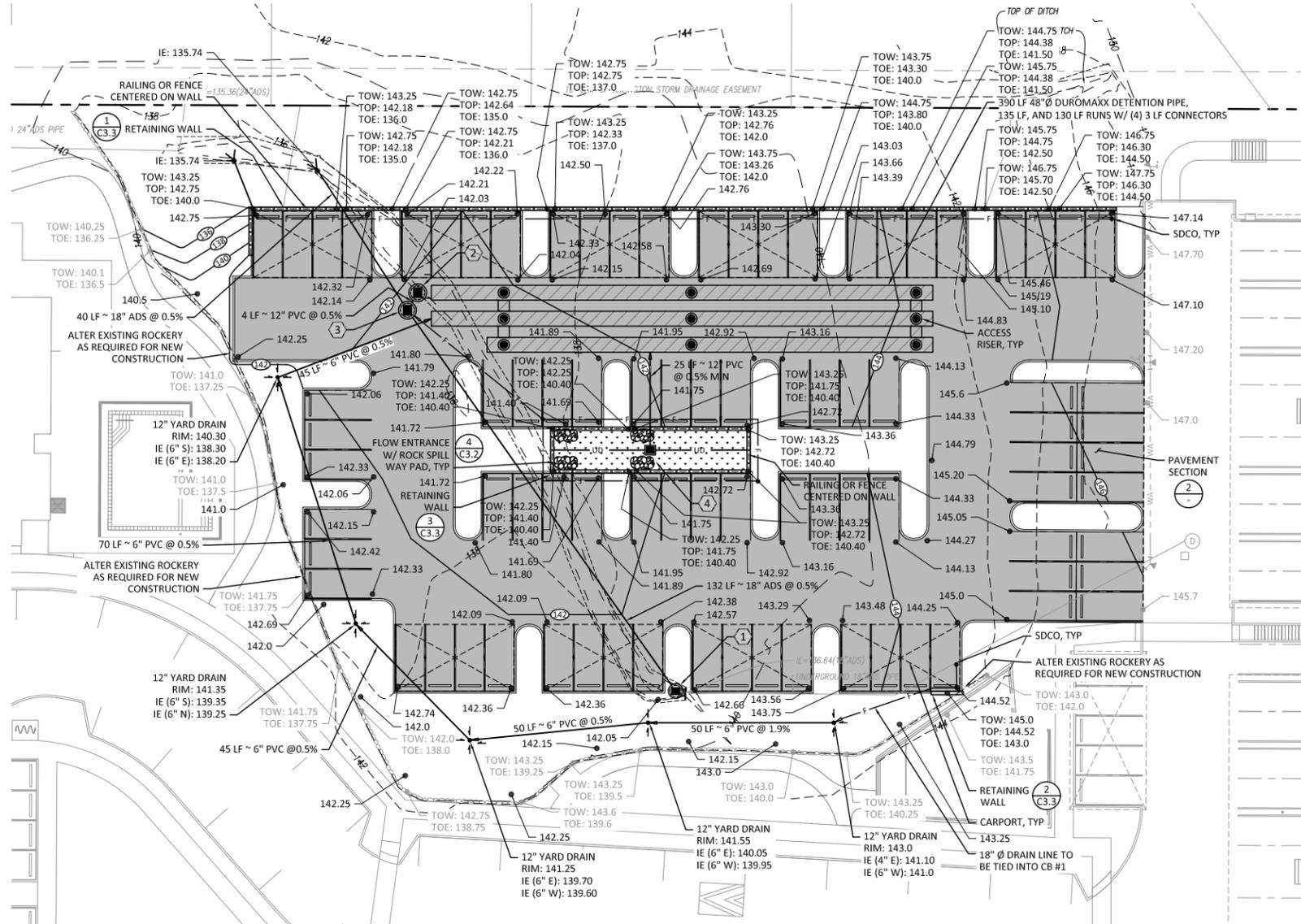
Detention Facility: An above or below ground facility, such as a pond or tank, that temporarily stores stormwater runoff and subsequently releases it at a slower rate than it is collected by the drainage facility system. There is little or no infiltration of stored stormwater.

Vegetation Management: Landscaping can include grading, soil transfer, vegetation removal, pesticide and fertilizer applications, and watering. Stormwater contaminants include toxic organic compounds, heavy metals, oils, total suspended solids, coliform bacteria, fertilizers, and pesticides.

Facilities shall be inspected for defects listed in the following facility sheets. Most maintenance tasks are generally reactionary to a defect being found, rather than a matter of constant upkeep. It is generally expected that few to none of these defects will be present upon the yearly inspection of each facility. The facility sheets list the potential conditions warranting maintenance and the expected result following any maintenance. Several engineer's notes for specific tasks are provided within the facility sheets. **Unless otherwise noted on the facility sheets the maintenance tasks should be performed on an "as needed" basis:**

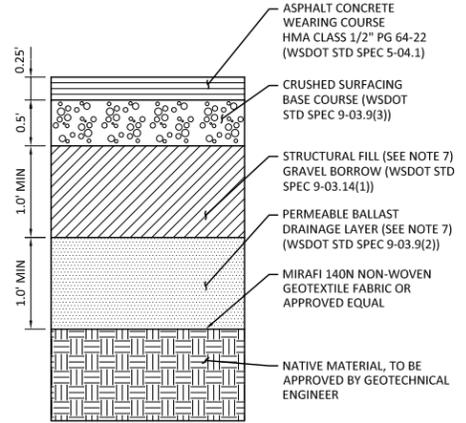
- (a) When the described defect is visible to whomever performs the yearly inspection,
- (b) Should any defect become apparent between inspections.

SW 1/4, SW 1/4, SECTION 23, TOWNSHIP 31 NORTH, RANGE 3 EAST, W.M.



CATCH BASIN SCHEDULE

- ① 54" Ø TYPE II W/ SOLID LID
RIM: 143.16
IE: 136.64 (18" E)
IE: 136.64 (18" NW)
- ② 54" Ø TYPE II W/ SOLID LID
RIM: 141.95
IE: 136.0 (36" E)
IE: 136.0 (12" SW)
FLOW CONTROL STRUCTURE
- ③ 54" Ø TYPE II W/ SOLID LID
RIM: 141.95
IE: 135.98 (18" SE)
IE: 135.98 (18" NW)
IE: 135.98 (12" NE)
- ④ TYPE I CB
RIM: 141.40 (RAIN GARDEN OVERFLOW)
IE: 138.50 (6" PERF PVC E & W)
IE: 138.50 (12" N)



1 GRADING AND DRAINAGE PLAN

2 TYPICAL PAVEMENT SECTION

SCALE: 1" = 20'

SCALE: 1" = 1'-0"

GRADING AND DRAINAGE PLAN NOTES:

1. SOILS REPORT
REPORT NUMBER: 22450-002-01
PREPARED BY: GEOENGINEERS
DATED: APRIL 5, 2023
2. ALL DISTURBED AREAS ON AND OFF-SITE SHALL BE COMPOST- AMENDED PER THE REQUIREMENTS OF BMP T5.13 IN THE STORMWATER MANUAL VOLUME V, CHAPTER 11.
3. TOW REFERS TO THE TOP OF THE CONCRETE WALL. TOP AND TOE REFER TO FINISHED GRADE AT THE TOP AND BOTTOM OF THE WALLS, RESPECTIVELY.
4. A TYPE II CATCH BASIN IS REQUIRED WHENEVER RIM TO INVERT EXCEEDS 5'.
5. A MINIMUM OF 2' OF COVER IS REQUIRED FOR ALL PIPES LOCATED UNDER DRIVEABLE SURFACES AND 1' OF COVER UNDER LANDSCAPE SURFACES.
6. NEW/REPLACED IMPERVIOUS SURFACE: 24,437 SF. RUNOFF ROUTED TO BIORETENTION/DETENTION SYSTEM THROUGH SHEET FLOW.
7. CONTRACTOR SHALL PROVIDE FOOTING AND PAVEMENT SUBSTRATE PREPARATION, FILL, COMPACTION, AND DRAINAGE PER GEOTECHNICAL REPORT. GEOTECHNICAL ENGINEER SHALL OBSERVE EXCAVATED SOIL CONDITIONS DURING CONSTRUCTION (AND GROUNDWATER CONDITIONS) AS REQUIRED, AND PROVIDE ADDITIONAL RECOMMENDATIONS IF NECESSARY BASED ON ACTUAL SITE CONDITIONS.

PAVING LEGEND	
	NEW ASPHALT/UTILITY SAWCUT
	OVERLAY EXISTING ASPHALT
	NEW CONCRETE

GRADING QUANTITIES	
TOTAL EXCAVATION (CUT) -	2,600 CU YDS TOTAL
EMBANKMENT (FILL) -	7,000 CU YDS
TOTAL	9,600 CU YDS

THE QUANTITIES SHOWN ABOVE ARE FOR THE PERMIT PROCESS ONLY. THESE VALUES ARE APPROXIMATE. DO NOT USE FOR BIDDING, PAYMENT, OR ESTIMATING PURPOSES.

ENGINEERING
250 4TH AVE. S., SUITE 200
EDMONDS, WASHINGTON 98020
PHONE (425) 778-8500
FAX (425) 778-5536

PROFESSIONAL ENGINEER
04/18/23

MARK	DATE	DESCRIPTION
	04/18/23	PERMIT SUBMITTAL

DESIGN:	JPU
DRAWN:	ATD
CHECK:	JPU
JOB NO:	23069.20
DATE:	04/18/23

CENTENNIAL PARK PARKING ADDITION
17327 67TH AVE NE
ARLINGTON, WA 98223
GRADING AND DRAINAGE
PLAN AND DETAILS

SHEET:

C3.1

can cause air pollution include grain dust, sawdust, coal, gravel, crushed rock, cement, and boiler fly ash. Air emissions can contaminate stormwater. The objective of this BMP is to reduce the stormwater pollutants caused by dust generation and control.

Pollutant Control Approach: Prevent dust generation and emissions where feasible, regularly clean-up dust that can contaminate stormwater, and convey dust contaminated stormwater to proper treatment.

Applicable BMPs:

- Clean, as needed, powder material handling equipment and vehicles.
- Regularly sweep dust accumulation areas that can contaminate stormwater. Conduct sweeping using vacuum filter equipment to minimize dust generation and to ensure optimal dust removal.
- Use dust filtration/collection systems such as baghouse filters, cyclone separators, etc. to control vented dust emissions that could contaminate stormwater. Control of zinc dusts in rubber production is one example.
- Maintain on-site controls to prevent vehicle track-out.
- Maintain dust collection devices on a regular basis.

Recommended BMPs:

- In manufacturing operations, train employees to handle powders carefully to prevent generation of dust.
- Use water spray to flush dust accumulations to sanitary sewers where allowed by the local sewer authority or to other appropriate treatment system.
- Use approved dust suppressants such as those listed in *Methods for Dust Control* ([Ecology, 2016b](#)). Application of some products may not be appropriate in close proximity to receiving waters or conveyances close to receiving waters. For more information check with Ecology or the local jurisdiction.

Recommended Treatment BMPs

Install sedimentation basins, wet ponds, wet vaults, catch basin filters, vegetated filter strips, or equivalent sediment removal BMPs.

S411 BMPs for Landscaping and Lawn / Vegetation Management

Description of Pollutant Sources: Landscaping can include grading, soil transfer, vegetation planting, and vegetation removal. Examples include weed control on golf course lawns, access roads, and utility corridors and during landscaping; and residential lawn/plant care. Proper management of vegetation can minimize excess nutrients and pesticides.

Pollutant Control Approach: Maintain appropriate vegetation to control erosion and the discharge of stormwater pollutants. Prevent debris contamination of stormwater. Where practicable, grow plant species appropriate for the site, or adjust the soil properties of the site to grow desired plant species.

Applicable BMPs:

- Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
- Select the right plants for the planting location based on proposed use, available maintenance, soil conditions, sun exposure, water availability, height, sight factors, and space available.
- Ensure that plants selected for planting are not on the noxious weed list. For example, butterfly bush often gets planted as an ornamental but is actually on the noxious weed list.

The Washington State Noxious Weed List can be found at the following webpage:

<https://www.nwcb.wa.gov/printable-noxious-weed-list>

- Do not dispose of collected vegetation into waterways or storm sewer systems.
- Do not blow vegetation or other debris into the drainage system.
- Dispose of collected vegetation such as grass clippings, leaves, sticks by composting or recycling.
- Remove, bag, and dispose of class A & B noxious weeds in the garbage immediately.
- Do not compost noxious weeds as it may lead to spreading through seed or fragment if the composting process is not hot enough.
- Use manual and/or mechanical methods of vegetation removal (pincer-type weeding tools, flame weeders, or hot water weeders as appropriate) rather than applying herbicides, where practical.
- Use at least an eight-inch "topsoil" layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium.
 - Organic matter is the least water-soluble form of nutrients that can be added to the soil. Composted organic matter generally releases only between 2 and 10 percent of its total nitrogen annually, and this release corresponds closely to the plant growth cycle. Return natural plant debris and mulch to the soil, to continue recycling nutrients indefinitely.
- Select the appropriate turfgrass mixture for the climate and soil type.
 - Certain tall fescues and rye grasses resist insect attack because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects.

- The fungus causes no known adverse effects to the host plant or to humans.
 - Tall fescues and rye grasses do not repel root-feeding lawn pests such as Crane Fly larvae.
 - Tall fescues and rye grasses are toxic to ruminants such as cattle and sheep
- Endophytic grasses are commercially available; use them in areas such as parks or golf courses where grazing does not occur.
- Local agricultural or gardening resources such as Washington State University Extension office can offer advice on which types of grass are best suited to the area and soil type.
- Use the following seeding and planting BMPs, or equivalent BMPs, to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates: [BMP C120: Temporary and Permanent Seeding](#), [BMP C121: Mulching](#), [BMP C123: Plastic Covering](#), and [BMP C124: Sodding](#).
- Adjusting the soil properties of the subject site can assist in selection of desired plant species. Consult a soil restoration specialist for site-specific conditions.

Recommended Additional BMPs:

- Conduct mulch-mowing whenever practicable.
- Use native plants in landscaping. Native plants do not require extensive fertilizer or pesticide applications. Native plants may also require less watering.
- Use mulch or other erosion control measures on soils exposed for more than one week during the dry season (May 1 to September 30) or two days during the rainy season (October 1 to April 30).
- Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages deeper root systems and drought-resistant plants.
- Apply an annual topdressing application of 3/8" compost. Amending existing landscapes and turf systems by increasing the percent organic matter and depth of topsoil can:
 - Substantially improve the permeability of the soil.
 - Increase the disease and drought resistance of the vegetation.
 - Reduces the demand for fertilizers and pesticides.
- Disinfect gardening tools after pruning diseased plants to prevent the spread of disease.
- Prune trees and shrubs in a manner appropriate for each species.
- If specific plants have a high mortality rate, assess the cause and replace with another more appropriate species.
- When working around and below mature trees, follow the most current American National Standards Institute (ANSI) ANSI A300 standards (see

http://www.tcia.org/TCIA/BUSINESS/ANSI_A300_Standards_/TCIA/BUSINESS/A300_Standards/A300_Standards.aspx?hkey=202ff566-4364-4686-b7c1-2a365af59669) and International Society of Arboriculture BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil).

- Monitor tree support systems (stakes, guys, etc.).
 - Repair and adjust as needed to provide support and prevent tree damage.
 - Remove tree supports after one growing season or maximum of 1 year.
 - Backfill stake holes after removal.
- When continued, regular pruning (more than one time during the growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location.
- Make reasonable attempts to remove and dispose of class C noxious weeds.
- Re-seed bare turf areas until the vegetation fully covers the ground surface.
- Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions.
- Plant and protect trees per [BMP T5.16: Tree Retention and Tree Planting](#).
- Aerate lawns regularly in areas of heavy use where the soil tends to become compacted. Conduct aeration while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than ¾-inch deep.
- Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally mowing only 1/3 of the grass blade height will prevent stressing the turf.
 - Mowing is a stress-creating activity for turfgrass.
 - Grass decreases its productivity when mowed too short and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone and more reliant on outside means such as pesticides, fertilizers, and irrigation to remain healthy.

Additional BMP Information:

- King County's *Best Management Practices for Golf Course Development and Operation* ([King County, 1993](#)) has additional BMPs for Turfgrass Maintenance and Operation.
- King County, Seattle Public Utilities, and the Saving Water Partnership have created the following natural lawn and garden care resources that include guidance on building healthy soil with compost and mulch, selecting appropriate plants, watering, using alternatives to pesticides, and implementing natural lawn care techniques.

- *Natural Yard Care - Five steps to make your piece of the planet a healthier place to live* ([King County and SPU, 2008](#))
 - *The Natural Lawn & Garden Series: Smart Watering* ([Saving Water Partnership, 2006](#))
 - *Natural Lawn Care for Western Washington* ([Saving Water Partnership, 2007](#))
 - *The Natural Lawn & Garden Series: Growing Healthy Soil; Choosing the Right Plants; and Natural Pest, Weed and Disease Control* ([Saving Water Partnership, 2012](#))
- The International Society of Arboriculture (ISA) is a group that promotes the professional practice of arboriculture and fosters a greater worldwide awareness of the benefits of trees through research, technology, and education. ISA standards used for managing trees, shrubs, and other woody plants are the American National Standards Institute (ANSI) A300 standards. The ANSI A300 standards are voluntary industry consensus standards developed by the Tree Care Industry Association (TCIA) and written by the Accredited Standards Committee (ASC). The ANSI standards can be found on the ISA website: www.isa-arbor.com/education/publications/index.aspx
 - Washington State University's *Gardening in Washington State* website at <http://gardening.wsu.edu> contains Washington State specific information about vegetation management based on the type of landscape.
 - See the *Pacific Northwest Plant Disease Management Handbook* ([Pscheidt and Ocamb, 2016](#)) for information on disease recognition and for additional resources.

~~S425 BMPs for Soil Erosion and Sediment Control at Industrial Sites~~

Description of Pollutant Sources: Industrial activities on soil areas; exposed and disturbed soils; steep grading; etc. can be sources of sediments that can contaminate stormwater runoff.

Pollutant Control Approach: Limit the exposure of erodible soil, stabilize, or cover erodible soil where necessary to prevent erosion, and/or provide treatment for stormwater contaminated with TSS caused by eroded soil.

~~Applicable BMPs:~~

- Limit the exposure of erodible soil
- Stabilize entrances/exits to prevent track-out. See [BMP C105: Stabilized Construction Access](#).
- Stabilize or cover erodible soil to prevent erosion. Cover practice options include:
 - Use vegetative cover such as grass, trees, shrubs, on erodible soil areas.
 - Cover exposed areas with mats such as clear plastic, jute, synthetic fiber. See [BMP C122: Nets and Blankets](#) and [BMP C123: Plastic Covering](#).

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
		(A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
Storage Area	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
Catch Basins	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.4: Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
Overflow Pipe	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)
Catch Basin	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.5: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Top slab is free of holes and cracks. Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regouted and secure at basin wall.
	Settlement/ Mis-alignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe/joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	No pollution present.
	Catch Basin Cover	Cover Not in Place Locking Mechanism Not Working Cover Difficult to Remove	Cover/grate is in place, meets design standards, and is secured Mechanism opens with proper tools. Cover can be removed by one maintenance person.
	Ladder	Ladder Rungs Unsafe	Ladder meets design standards and allows maintenance person safe access.
	Metal Grates (If Applicable)	Grate opening Unsafe Trash and Debris Damaged or Missing	Grate opening meets design standards. Grate free of trash and debris. Grate is in place, meets the design standards, and is installed and aligned with the flow path.

Table V-A.17: Maintenance Standards - Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed	
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.	
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.	
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.	
	Oil Accumulation	Oil accumulation that exceeds 1/4-inch at the water surface.	Oil is extracted from vault using vacuuming methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.	
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.	
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.	
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.	
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.	
	Access Ladder Damaged	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.		Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
		Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.		Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-A.18: Maintenance Standards - Catch Basin Inserts

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

Table V-A.19: Maintenance Standards - Media Filter Drain (MFD)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with street flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean to spread flows evenly over entire embankment width.

Table V-A.21: Maintenance Standards - Bioretention Facilities

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	<ul style="list-style-type: none"> Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	<ul style="list-style-type: none"> Eradicate rodents (see "Pest control") Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	<ul style="list-style-type: none"> Repair/ seal cracks Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	<ul style="list-style-type: none"> Remove excess sediment Replace any vegetation damaged or destroyed by sediment accumulation and removal Mulch newly planted vegetation Identify and control the sediment source (if feasible) If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
			Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	<p>Determine cause and resolve in the following order:</p> <ol style="list-style-type: none"> 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil mix	As needed		Bioretention soil mix protection is needed when performing maintenance requiring entrance into the facility footprint	<ul style="list-style-type: none"> • Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	<ul style="list-style-type: none"> • Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	<ul style="list-style-type: none"> • Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
Overflow	A		Bar screen damaged or missing	Repair/replace
Underdrain pipe	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	<ul style="list-style-type: none"> Plant roots, sediment or debris reducing capacity of underdrain Prolonged surface ponding (see "Ponded water") 	<ul style="list-style-type: none"> Jet clean or rotary cut debris/roots from underdrain(s) If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	<ul style="list-style-type: none"> Determine cause of poor vegetation growth and correct condition Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the <i>LID Technical Guidance Manual for Puget Sound</i>, (Himman and Wulkm, 2012). Confirm that plant selection is appropriate for site growing conditions Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	<ul style="list-style-type: none"> Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants Disinfect gardening tools after pruning to prevent the spread of disease See the <i>Pacific Northwest Plant Disease Management Handbook (Pscheidt and Ocamb, 2016)</i> for information on disease recognition and for additional resources Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
	All pruning seasons (timing varies by species)		Pruning as needed	<ul style="list-style-type: none"> Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
Trees and shrubs	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	<ul style="list-style-type: none"> Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. Remove trees and shrubs, if necessary.
	Fall and Spring		Standing dead vegetation is present	<ul style="list-style-type: none"> Remove standing dead vegetation Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. Determine cause of dead vegetation and address issue, if possible

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	<ul style="list-style-type: none"> When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	<ul style="list-style-type: none"> Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	<ul style="list-style-type: none"> Maintain appropriate height for sight clearance When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. Remove or transplant if continual safety hazard Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	<ul style="list-style-type: none"> Leave dry foliage for winter interest Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	<ul style="list-style-type: none"> Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring Clean, rake, and comb grasses when they become too tall Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March - October; preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	<ul style="list-style-type: none"> By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately Reasonable attempts must be made to remove and dispose of class C noxious weeds It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions Apply mulch after weed removal (see "Mulch")
Weeds		M (March - October;	Weeds are present	<ul style="list-style-type: none"> Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Excessive vegetation		preceding seed dispersal)		<p>appropriate</p> <ul style="list-style-type: none"> Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
		Once in early to mid-May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	<ul style="list-style-type: none"> Edge or trim groundcovers and shrubs at facility edge Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	<ul style="list-style-type: none"> Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) Remove plants that are weak, broken or not true to form; replace in-kind Thin grass or plants impacting facility function without leaving visual holes or bare soil areas Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	<ul style="list-style-type: none"> Supplement mulch with hand tools to a depth of 2 to 3 inches Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	<ul style="list-style-type: none"> 10 to 15 gallons per tree 3 to 5 gallons per shrub 2 gallons water per square foot for groundcover areas Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> Pulse water to enhance soil absorption, when feasible

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method, each pass increases soil absorption and allows more water to infiltrate prior to runoff Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	<ul style="list-style-type: none"> 10 to 15 gallons per tree 3 to 5 gallons per shrub 2 gallons water per square foot for groundcover areas Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> Pulse water to enhance soil absorption, when feasible Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method, each pass increases soil absorption and allows more water to infiltrate prior to runoff <ul style="list-style-type: none"> Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear Water during drought conditions or more often if necessary to maintain plant cover
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	<ul style="list-style-type: none"> Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. Use of pesticides or <i>Bacillus thuringiensis israelensis</i> (Bti) may be considered only as a temporary measure while addressing the standing water cause. If overflow to a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	<ul style="list-style-type: none"> Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) Place predator decoys Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) Remove pet waste regularly For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	<ul style="list-style-type: none"> Reduce hiding places for pests by removing diseased and dead plants For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM

Table V-A-21: Maintenance Standards - Bioretention Facilities (continued)

Maintenance Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	vegetation management			protocols)

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

a Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM - Integrated Pest Management
ISA - International Society of Arboriculture

Table V-A-22: Maintenance Standards - Permeable Pavement

Component	Recommended Frequency a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				
Permeable Pavements, all	A, S		Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving	<ul style="list-style-type: none"> Clean deposited soil or other materials from permeable pavement or other adjacent surfacing Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) Mulch and/or plant all exposed soils that may erode to pavement surface
				<p>Clean surface debris from pavement surface using one or a combination of the following methods:</p> <ul style="list-style-type: none"> Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) Vacuum/sweep permeable paving installation using: <ul style="list-style-type: none"> Walk-behind vacuum (sidewalks) High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ShopVac or brush brooms (small areas) Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.
Porous asphalt or pervious concrete	A or B		None (routine maintenance)	<ul style="list-style-type: none"> Review the overall performance of the facility. (note that small clogged areas may not reduce overall performance of facility) Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 7,000 square feet. If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods:

Appendix A – WWHM Reports

Appendix A Summary

Narrative

WWHM Report

This Appendix provides the WWHM report for the design of the combined bioretention and detention facility.

**WWHM2012
PROJECT REPORT**

Project Name: Centennial Park Parking Lot RG + Det 04.03.23
Site Name:
Site Address:
City :
Report Date: 4/18/2023
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 1.20
Version Date: 2019/09/13
Version : 4.2.17

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

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Basin 1
Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Forest, Mod	.43
SAT, Forest, Mod	.36
Pervious Total	0.79
<u>Impervious Land Use</u>	<u>acre</u>
Impervious Total	0
Basin Total	0.79

Element Flows To:

Surface	Interflow	Groundwater
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MITIGATED LAND USE

Name : To Rain Garden
Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	.11
Pervious Total	0.11
<u>Impervious Land Use</u>	<u>acre</u>
PARKING FLAT	0.56
Impervious Total	0.56
Basin Total	0.67

Element Flows To:		
Surface	Interflow	Groundwater
Surface retention 1	Surface retention 1	

Name : Not to RG
Bypass: No

GroundWater: No

<u>Pervious Land Use</u>	<u>acre</u>
C, Pasture, Flat	.11
C, Pasture, Steep	.01
Pervious Total	0.12
<u>Impervious Land Use</u>	<u>acre</u>
Impervious Total	0
Basin Total	0.12

Element Flows To:		
Surface	Interflow	Groundwater
Tank 1	Tank 1	

Name : Bioretention 1
Bottom Length: 50.00 ft.
Bottom Width: 15.00 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
Material thickness of second layer: 0
Material type for second layer: Sand
Material thickness of third layer: 0
Material type for third layer: GRAVEL

Underdrain used

Underdrain Diameter (feet): 0.5
Orifice Diameter (in.): 2
Offset (in.): 0
Flow Through Underdrain (ac-ft.): 92.699
Total Outflow (ac-ft.): 92.821
Percent Through Underdrain: 99.87

Discharge Structure

Riser Height: 1 ft.
Riser Diameter: 12 in.

Element Flows To:

Outlet 1 Outlet 2
Tank 1

Bioretention 1 Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0172	0.0000	0.0000	0.0000
0.0385	0.0172	0.0003	0.0000	0.0000
0.0769	0.0172	0.0005	0.0000	0.0000
0.1154	0.0172	0.0008	0.0000	0.0000
0.1538	0.0172	0.0010	0.0001	0.0000
0.1923	0.0172	0.0013	0.0006	0.0000
0.2308	0.0172	0.0016	0.0010	0.0000
0.2692	0.0172	0.0018	0.0015	0.0000
0.3077	0.0172	0.0021	0.0020	0.0000
0.3462	0.0172	0.0024	0.0027	0.0000
0.3846	0.0172	0.0026	0.0035	0.0000
0.4231	0.0172	0.0029	0.0045	0.0000
0.4615	0.0172	0.0031	0.0055	0.0000
0.5000	0.0172	0.0034	0.0067	0.0000
0.5385	0.0172	0.0037	0.0081	0.0000
0.5769	0.0172	0.0039	0.0096	0.0000
0.6154	0.0172	0.0042	0.0113	0.0000
0.6538	0.0172	0.0044	0.0131	0.0000
0.6923	0.0172	0.0047	0.0151	0.0000
0.7308	0.0172	0.0050	0.0173	0.0000
0.7692	0.0172	0.0052	0.0196	0.0000
0.8077	0.0172	0.0055	0.0222	0.0000
0.8462	0.0172	0.0058	0.0249	0.0000
0.8846	0.0172	0.0060	0.0278	0.0000
0.9231	0.0172	0.0063	0.0309	0.0000
0.9615	0.0172	0.0065	0.0342	0.0000
1.0000	0.0172	0.0068	0.0377	0.0000
1.0385	0.0172	0.0071	0.0414	0.0000
1.0769	0.0172	0.0073	0.0453	0.0000
1.1154	0.0172	0.0076	0.0494	0.0000
1.1538	0.0172	0.0078	0.0537	0.0000
1.1923	0.0172	0.0081	0.0583	0.0000
1.2308	0.0172	0.0084	0.0631	0.0000
1.2692	0.0172	0.0086	0.0681	0.0000
1.3077	0.0172	0.0089	0.0733	0.0000
1.3462	0.0172	0.0092	0.0788	0.0000
1.3846	0.0172	0.0094	0.0845	0.0000

1.4231	0.0172	0.0097	0.0904	0.0000
1.4615	0.0172	0.0099	0.0965	0.0000
1.5000	0.0172	0.0102	0.1716	0.0000

Surface retention 1 Hydraulic Table

<u>Stage (feet)</u>	<u>Area (ac.)</u>	<u>Volume (ac-ft.)</u>	<u>Discharge (cfs)</u>	<u>To Amended (cfs)</u>	<u>Wetted Surface</u>
1.5000	0.0172	0.0102	0.0000	0.1042	0.0000
1.5385	0.0172	0.0109	0.0000	0.1042	0.0000
1.5769	0.0172	0.0115	0.0000	0.1095	0.0000
1.6154	0.0172	0.0122	0.0000	0.1122	0.0000
1.6538	0.0172	0.0129	0.0000	0.1149	0.0000
1.6923	0.0172	0.0135	0.0000	0.1175	0.0000
1.7308	0.0172	0.0142	0.0000	0.1202	0.0000
1.7692	0.0172	0.0148	0.0000	0.1229	0.0000
1.8077	0.0172	0.0155	0.0000	0.1255	0.0000
1.8462	0.0172	0.0162	0.0000	0.1282	0.0000
1.8846	0.0172	0.0168	0.0000	0.1309	0.0000
1.9231	0.0172	0.0175	0.0000	0.1335	0.0000
1.9615	0.0172	0.0181	0.0000	0.1362	0.0000
2.0000	0.0172	0.0188	0.0000	0.1389	0.0000
2.0385	0.0172	0.0195	0.0000	0.1416	0.0000
2.0769	0.0172	0.0201	0.0000	0.1442	0.0000
2.1154	0.0172	0.0208	0.0000	0.1469	0.0000
2.1538	0.0172	0.0215	0.0000	0.1496	0.0000
2.1923	0.0172	0.0221	0.0000	0.1522	0.0000
2.2308	0.0172	0.0228	0.0000	0.1549	0.0000
2.2692	0.0172	0.0234	0.0000	0.1576	0.0000
2.3077	0.0172	0.0241	0.0000	0.1603	0.0000
2.3462	0.0172	0.0248	0.0000	0.1629	0.0000
2.3846	0.0172	0.0254	0.0000	0.1656	0.0000
2.4231	0.0172	0.0261	0.0000	0.1683	0.0000
2.4615	0.0172	0.0268	0.0000	0.1709	0.0000
2.5000	0.0172	0.0274	0.0000	0.1736	0.0000
2.5385	0.0172	0.0281	0.0800	0.1736	0.0000
2.5769	0.0172	0.0287	0.2257	0.1736	0.0000
2.6154	0.0172	0.0294	0.4122	0.1736	0.0000
2.6538	0.0172	0.0301	0.6273	0.1736	0.0000
2.6923	0.0172	0.0307	0.8600	0.1736	0.0000
2.7308	0.0172	0.0314	1.0991	0.1736	0.0000
2.7692	0.0172	0.0321	1.3333	0.1736	0.0000
2.8077	0.0172	0.0327	1.5516	0.1736	0.0000
2.8462	0.0172	0.0334	1.7445	0.1736	0.0000
2.8846	0.0172	0.0340	1.9054	0.1736	0.0000
2.9231	0.0172	0.0347	2.0318	0.1736	0.0000
2.9615	0.0172	0.0354	2.1274	0.1736	0.0000
3.0000	0.0172	0.0360	2.2271	0.1736	0.0000
3.0385	0.0172	0.0367	2.3112	0.1736	0.0000
3.0769	0.0172	0.0374	2.3923	0.1736	0.0000
3.1154	0.0172	0.0380	2.4708	0.1736	0.0000
3.1538	0.0172	0.0387	2.5468	0.1736	0.0000
3.1923	0.0172	0.0393	2.6207	0.1736	0.0000
3.2308	0.0172	0.0400	2.6925	0.1736	0.0000
3.2692	0.0172	0.0407	2.7624	0.1736	0.0000
3.3077	0.0172	0.0413	2.8306	0.1736	0.0000
3.3462	0.0172	0.0420	2.8972	0.1736	0.0000
3.3846	0.0172	0.0427	2.9624	0.1736	0.0000
3.4231	0.0172	0.0433	3.0261	0.1736	0.0000

3.4615	0.0172	0.0440	3.0885	0.1736	0.0000
3.5000	0.0172	0.0446	3.1496	0.1736	0.0000
3.5000	0.0172	0.0446	3.2096	0.1736	0.0000

Name : Surface retention 1

Element Flows To:

Outlet 1	Outlet 2
Tank 1	Bioretention 1

Name : Tank 1

Tank Name: Tank 1

Dimensions

Depth: 4 ft.
Tank Type : Circular
Diameter : 4 ft.
Length : 390 ft.

Discharge Structure

Riser Height: 3.95 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 1.05 in. **Elevation:** 0.5 ft.
Orifice 2 Diameter: 1.23 in. **Elevation:** 2.5 ft.

Element Flows To:

Outlet 1	Outlet 2
-----------------	-----------------

Tank Hydraulic Table

<u>Stage(feet)</u>	<u>Area(ac.)</u>	<u>Volume(ac-ft.)</u>	<u>Discharge(cfs)</u>	<u>Infilt(cfs)</u>
0.0000	0.000	0.000	0.000	0.000
0.0444	0.007	0.000	0.000	0.000
0.0889	0.010	0.000	0.000	0.000
0.1333	0.012	0.001	0.000	0.000
0.1778	0.014	0.001	0.000	0.000
0.2222	0.016	0.002	0.000	0.000
0.2667	0.017	0.003	0.000	0.000
0.3111	0.019	0.004	0.000	0.000
0.3556	0.020	0.004	0.000	0.000
0.4000	0.021	0.005	0.000	0.000
0.4444	0.022	0.006	0.000	0.000
0.4889	0.023	0.007	0.000	0.000
0.5333	0.024	0.008	0.005	0.000
0.5778	0.025	0.010	0.008	0.000
0.6222	0.026	0.011	0.010	0.000
0.6667	0.026	0.012	0.012	0.000
0.7111	0.027	0.013	0.013	0.000
0.7556	0.028	0.014	0.015	0.000
0.8000	0.028	0.016	0.016	0.000
0.8444	0.029	0.017	0.017	0.000
0.8889	0.029	0.018	0.018	0.000

0.9333	0.030	0.020	0.019	0.000
0.9778	0.030	0.021	0.020	0.000
1.0222	0.031	0.022	0.021	0.000
1.0667	0.031	0.024	0.022	0.000
1.1111	0.032	0.025	0.023	0.000
1.1556	0.032	0.026	0.024	0.000
1.2000	0.032	0.028	0.025	0.000
1.2444	0.033	0.029	0.025	0.000
1.2889	0.033	0.031	0.026	0.000
1.3333	0.033	0.032	0.027	0.000
1.3778	0.034	0.034	0.028	0.000
1.4222	0.034	0.035	0.028	0.000
1.4667	0.034	0.037	0.029	0.000
1.5111	0.034	0.038	0.030	0.000
1.5556	0.034	0.040	0.030	0.000
1.6000	0.035	0.042	0.031	0.000
1.6444	0.035	0.043	0.032	0.000
1.6889	0.035	0.045	0.032	0.000
1.7333	0.035	0.046	0.033	0.000
1.7778	0.035	0.048	0.033	0.000
1.8222	0.035	0.049	0.034	0.000
1.8667	0.035	0.051	0.035	0.000
1.9111	0.035	0.053	0.035	0.000
1.9556	0.035	0.054	0.036	0.000
2.0000	0.035	0.056	0.036	0.000
2.0444	0.035	0.057	0.037	0.000
2.0889	0.035	0.059	0.037	0.000
2.1333	0.035	0.061	0.038	0.000
2.1778	0.035	0.062	0.038	0.000
2.2222	0.035	0.064	0.039	0.000
2.2667	0.035	0.065	0.039	0.000
2.3111	0.035	0.067	0.040	0.000
2.3556	0.035	0.068	0.040	0.000
2.4000	0.035	0.070	0.041	0.000
2.4444	0.034	0.072	0.041	0.000
2.4889	0.034	0.073	0.042	0.000
2.5333	0.034	0.075	0.050	0.000
2.5778	0.034	0.076	0.054	0.000
2.6222	0.034	0.078	0.057	0.000
2.6667	0.033	0.079	0.060	0.000
2.7111	0.033	0.081	0.063	0.000
2.7556	0.033	0.082	0.065	0.000
2.8000	0.032	0.084	0.067	0.000
2.8444	0.032	0.085	0.069	0.000
2.8889	0.032	0.087	0.071	0.000
2.9333	0.031	0.088	0.073	0.000
2.9778	0.031	0.089	0.075	0.000
3.0222	0.030	0.091	0.077	0.000
3.0667	0.030	0.092	0.078	0.000
3.1111	0.029	0.093	0.080	0.000
3.1556	0.029	0.095	0.082	0.000
3.2000	0.028	0.096	0.083	0.000
3.2444	0.028	0.097	0.085	0.000
3.2889	0.027	0.099	0.086	0.000
3.3333	0.026	0.100	0.087	0.000
3.3778	0.026	0.101	0.089	0.000
3.4222	0.025	0.102	0.090	0.000

3.4667	0.024	0.103	0.091	0.000
3.5111	0.023	0.104	0.093	0.000
3.5556	0.022	0.105	0.094	0.000
3.6000	0.021	0.106	0.095	0.000
3.6444	0.020	0.107	0.097	0.000
3.6889	0.019	0.108	0.098	0.000
3.7333	0.017	0.109	0.099	0.000
3.7778	0.016	0.110	0.100	0.000
3.8222	0.014	0.110	0.101	0.000
3.8667	0.012	0.111	0.102	0.000
3.9111	0.010	0.111	0.104	0.000
3.9556	0.007	0.112	0.109	0.000
4.0000	0.000	0.112	0.224	0.000
4.0444	0.000	0.000	0.413	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
 Total Pervious Area:0.79
 Total Impervious Area:0

Mitigated Landuse Totals for POC #1
 Total Pervious Area:0.23
 Total Impervious Area:0.56

Flow Frequency Return Periods for Predeveloped. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.080814
5 year	0.118358
10 year	0.143242
25 year	0.174443
50 year	0.197436
100 year	0.220187

Flow Frequency Return Periods for Mitigated. POC #1

<u>Return Period</u>	<u>Flow(cfs)</u>
2 year	0.041616
5 year	0.054729
10 year	0.064495
25 year	0.078117
50 year	0.089237
100 year	0.101228

Stream Protection Duration

Annual Peaks for Predeveloped and Mitigated. POC #1

<u>Year</u>	<u>Predeveloped</u>	<u>Mitigated</u>
1949	0.020	0.039

1950	0.066	0.040
1951	0.065	0.039
1952	0.046	0.033
1953	0.039	0.031
1954	0.197	0.038
1955	0.138	0.051
1956	0.077	0.042
1957	0.148	0.063
1958	0.100	0.041
1959	0.076	0.040
1960	0.107	0.058
1961	0.127	0.054
1962	0.090	0.039
1963	0.138	0.040
1964	0.078	0.038
1965	0.061	0.037
1966	0.049	0.032
1967	0.087	0.040
1968	0.072	0.075
1969	0.122	0.038
1970	0.063	0.033
1971	0.100	0.040
1972	0.127	0.040
1973	0.097	0.033
1974	0.119	0.035
1975	0.109	0.035
1976	0.064	0.047
1977	0.060	0.038
1978	0.065	0.031
1979	0.182	0.069
1980	0.050	0.037
1981	0.071	0.037
1982	0.070	0.079
1983	0.116	0.039
1984	0.089	0.043
1985	0.117	0.063
1986	0.180	0.135
1987	0.076	0.073
1988	0.049	0.040
1989	0.059	0.029
1990	0.032	0.038
1991	0.061	0.040
1992	0.068	0.034
1993	0.061	0.037
1994	0.049	0.038
1995	0.051	0.039
1996	0.145	0.072

Stream Protection Duration

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1968	0.1345
2	0.1819	0.0794
3	0.1799	0.0750
4	0.1480	0.0730
5	0.1453	0.0722

6	0.1379	0.0691
7	0.1379	0.0634
8	0.1272	0.0627
9	0.1272	0.0576
10	0.1224	0.0542
11	0.1191	0.0509
12	0.1171	0.0466
13	0.1158	0.0427
14	0.1094	0.0418
15	0.1066	0.0406
16	0.1005	0.0404
17	0.1001	0.0404
18	0.0968	0.0404
19	0.0898	0.0402
20	0.0893	0.0401
21	0.0866	0.0398
22	0.0784	0.0396
23	0.0765	0.0396
24	0.0762	0.0395
25	0.0757	0.0393
26	0.0720	0.0391
27	0.0707	0.0389
28	0.0696	0.0385
29	0.0681	0.0384
30	0.0658	0.0383
31	0.0651	0.0382
32	0.0646	0.0378
33	0.0639	0.0377
34	0.0630	0.0375
35	0.0608	0.0371
36	0.0607	0.0368
37	0.0606	0.0367
38	0.0601	0.0365
39	0.0588	0.0353
40	0.0507	0.0349
41	0.0503	0.0337
42	0.0493	0.0334
43	0.0493	0.0331
44	0.0489	0.0326
45	0.0460	0.0325
46	0.0391	0.0315
47	0.0316	0.0307
48	0.0205	0.0294

Stream Protection Duration

POC #1

The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0404	1042	766	73	Pass
0.0420	915	480	52	Pass
0.0436	824	428	51	Pass
0.0452	754	412	54	Pass
0.0468	696	391	56	Pass

0.0483	631	381	60	Pass
0.0499	575	364	63	Pass
0.0515	522	351	67	Pass
0.0531	477	328	68	Pass
0.0547	443	303	68	Pass
0.0563	407	288	70	Pass
0.0579	376	267	71	Pass
0.0594	337	246	72	Pass
0.0610	305	228	74	Pass
0.0626	281	206	73	Pass
0.0642	254	187	73	Pass
0.0658	227	172	75	Pass
0.0674	211	156	73	Pass
0.0690	197	138	70	Pass
0.0705	181	122	67	Pass
0.0721	167	102	61	Pass
0.0737	158	86	54	Pass
0.0753	149	76	51	Pass
0.0769	143	70	48	Pass
0.0785	137	64	46	Pass
0.0801	129	56	43	Pass
0.0816	121	53	43	Pass
0.0832	108	51	47	Pass
0.0848	98	49	50	Pass
0.0864	93	46	49	Pass
0.0880	85	44	51	Pass
0.0896	82	40	48	Pass
0.0912	75	37	49	Pass
0.0928	70	35	50	Pass
0.0943	61	32	52	Pass
0.0959	57	29	50	Pass
0.0975	53	27	50	Pass
0.0991	51	24	47	Pass
0.1007	48	22	45	Pass
0.1023	45	19	42	Pass
0.1039	40	17	42	Pass
0.1054	39	17	43	Pass
0.1070	38	16	42	Pass
0.1086	38	16	42	Pass
0.1102	35	15	42	Pass
0.1118	35	15	42	Pass
0.1134	32	15	46	Pass
0.1150	28	15	53	Pass
0.1165	27	15	55	Pass
0.1181	26	14	53	Pass
0.1197	23	14	60	Pass
0.1213	23	14	60	Pass
0.1229	20	14	70	Pass
0.1245	20	14	70	Pass
0.1261	19	14	73	Pass
0.1276	16	14	87	Pass
0.1292	16	13	81	Pass
0.1308	16	11	68	Pass
0.1324	16	6	37	Pass
0.1340	16	3	18	Pass
0.1356	15	0	0	Pass
0.1372	15	0	0	Pass

0.1387	13	0	0	Pass
0.1403	13	0	0	Pass
0.1419	13	0	0	Pass
0.1435	13	0	0	Pass
0.1451	12	0	0	Pass
0.1467	9	0	0	Pass
0.1483	7	0	0	Pass
0.1499	6	0	0	Pass
0.1514	5	0	0	Pass
0.1530	5	0	0	Pass
0.1546	5	0	0	Pass
0.1562	5	0	0	Pass
0.1578	5	0	0	Pass
0.1594	5	0	0	Pass
0.1610	5	0	0	Pass
0.1625	5	0	0	Pass
0.1641	5	0	0	Pass
0.1657	5	0	0	Pass
0.1673	5	0	0	Pass
0.1689	4	0	0	Pass
0.1705	4	0	0	Pass
0.1721	3	0	0	Pass
0.1736	3	0	0	Pass
0.1752	3	0	0	Pass
0.1768	3	0	0	Pass
0.1784	3	0	0	Pass
0.1800	2	0	0	Pass
0.1816	2	0	0	Pass
0.1832	1	0	0	Pass
0.1847	1	0	0	Pass
0.1863	1	0	0	Pass
0.1879	1	0	0	Pass
0.1895	1	0	0	Pass
0.1911	1	0	0	Pass
0.1927	1	0	0	Pass
0.1943	1	0	0	Pass
0.1958	1	0	0	Pass
0.1974	0	0	0	Pass

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	Total Volume	Volume	Infiltration	Cumulative
Percent	Water Quality	Percent	Through	Volume	Volume
Volume		Treatment?	Facility	(ac-ft.)	Infiltration
Infiltrated	Treated	(ac-ft)	(ac-ft)		Credit

Tank 1 POC	N	116.32			N
0.00					
retention 1	N	108.07			N
0.00					
Total Volume Infiltrated		224.39	0.00	0.00	
0.00	0%	No Treat. Credit			0.00
Compliance with LID Standard 8					
Duration Analysis Result = Failed					

PerlnD and Implnd Changes

No changes have been made.

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