Preliminary Drainage Control Plan

Hogum Bay Commercial
Lacey, WA

Prepared For:
Golden Nugget Investment Group, LLC
9632 6th Way SE
Lacey, WA

Prepared By:
LDC, Inc.
321 Cleveland Ave SE
Tumwater, WA 98501
425.806.1869

February 2024

LDC | Surveying Engineering Planning

Drainage Report

Project Information

Project:	**Hogum Bay Commercial**
Prepared for:	**Golden Nugget Investment Group, LLC** 9632 6th Way SE Lacey, WA 98513 Contact Name: Antony Chung Contact Phone:

Reviewing Agency

Jurisdiction:	City of Lacey

Project Representative

Prepared by:	**LDC, Inc.** 321 Cleveland Ave SE Tumwater, WA 98501 425.806.1869 ldccorp.com
Contact:	Tyrell Bradly, PE
Project Reference:	C22-130 Path: P:\Civil\2022\C22-130 Hogum Bay Commercial\Data Engineer\Drainage Report\Working Report\2024-xxxx Stormwater Site Plan.docx

PROJECT ENGINEER'S CERTIFICATION

I hereby certify that this Drainage Control Plan for the Hogum Bay Commercial project has been prepared by me or under my supervision and meets the minimum standards of care and expertise which is usual and customary in this community for professional engineers. I understand that the City of Lacey does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

Kyle Herrera, Design Engineer
KHerrera@LDCCorp.com
(360) 634-2080

Date

Tyrell Bradley, PE
TBradley@LDCCorp.com
(360) 634-2066

Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

DRAINAGE CONTROL PLAN ATTACHMENTS

1. PROPOSED PROJECT DESCRIPTION

The following report was prepared for the Hogum Bay Commercial project in Lacey, WA. This report was prepared to comply with the minimum technical standards and requirements that are set forth in the City of Lacey 2022 *Stormwater Design Manual (SDM).*

Project Proponent:	Golden Nugget Investment Group, LLC
Parcel Numbers:	11811120800
Total Parcel Area:	4.70 Acres
Current Zoning:	HPBD-C Hawks Prairie Business District
Required Permits:	Grading, Utility, Paving, Building, etc.
Site Address:	2405 Hogum Bay Rd NE, Lacey WA
Section, Township, Range:	Section 11, Township 18 N, Range 1 W

The proposed Hogum Bay Commercial project is located on one parcel that contains a total of 4.7 acres. The site is bounded by Marvin Road NE to the west, commercial buildings to the north, and Hogum Bay Road NE to the east. The site is the only parcel undeveloped in a surrounding heavily commercial area. The proposed construction includes 2 hotels, as well as parking stalls, utilities, and stormwater improvements disturbing approximately 4.07 acres. Specifically, the proposed site improvements/construction activities for this project include the following:

- Site preparation, grading, and erosion control activities
- Construction of 2 hotel buildings
- Construction of interior circulation roadways
- Construction of parking stalls and sidewalks
- Construction/installation of on-site water quality and flow control facilities
- Extension of available utilities (i.e., water, sewer, etc.)

A site vicinity map of the proposed project location, an Existing and Proposed Basin Map, and a worksheet for determining the number of Core Requirements for this project has been prepared and is enclosed herein as **Appendix 2**. Core requirements 1-9 are required for this project. Table 1 in section 4 of this report describes the land use of the project.

1.1 SUMMARY OF COMPLIANCE ON-SITE

The stormwater design complies with the 9 core requirements as follows:

Core Requirement #1 – Preparation of Stormwater Site Plans – This summary is contained within the Drainage Report.

Core Requirement #2 – Construction Stormwater Pollution Prevention – A pollution prevention plan has been included within the drainage control plan as **Attachment No. 1** which describes the 13 required elements. Further, an erosion control plan has been prepared and is part of the engineering plan set. The contractor may need to amend and update these plans as part of development and/or management of the SWPPP. The contractor will be responsible for preparing the full SWPPP which shall comply with all of the required elements and the Washington Department of Ecology requirements for coverage under the NPDES Construction Stormwater General Permit.

Core Requirement #3 – Source Control of Pollution – All source control BMPs have been evaluated for feasibility and are identified in the Maintenance and Source Control Manual.

Core Requirement #4 – Preservation of Natural Drainage Systems and Outfalls – Currently, the majority of stormwater runoff generated on the project parcel infiltrates on-site. Stormwater runoff from the western portion of the site sheet flows to a low spot where it then fully infiltrates. Runoff generated on the eastern portion of the site sheet flows to the south and fully infiltrates. The majority of the stormwater runoff generated from the proposed development will follow existing flow paths by infiltrating fully on-site. Runoff from the western portion of the site will be collected, treated, and conveyed to the proposed western infiltration trench where it will infiltrate fully as it does today. Runoff from the eastern portion of the site will be collected, treated, and conveyed to the proposed eastern infiltration trench where it will also fully infiltrate. Runoff from the southern portion of site will continue to sheet flow down the hill and enter the existing pond to the south where it will fully infiltrate. See Section 4 of this report for more information.

Core Requirement #5 – On-site Stormwater Management, including Easements and Setbacks– In accordance with Core Requirement #7, this project is not flow control exempt. Using Figure 2.3: Flow Chart for Determining Core Requirement #5 Requirements, the proposed project is a new development triggering core requirement #1-9 located in the UGA, therefore the project shall employ the On-Site Stormwater Management BMPs in accordance with the Low Impact Performance Standard or List #2. The project will demonstrate compliance with List #2, see below.

Lawn and Landscaped Areas:

- Per Chapter 7 Section 7.4.1, the 2022 SDM, Post Construction Soil Quality and Depth will be utilized to the maximum extent practicable. See landscape plans for details.

Roofs:

- **Full Dispersion (Chapter 7, Section 7.4.2) or Downspout Infiltration (Chapter 7, Section 7.4.10):** Full dispersion is not feasible for this project site. Full dispersion requires that the site protects at least 65% of the site in a forest or native condition. For this reason alone this BMP is not feasible. In addition, the existing topography and the surrounding development does not allow for the required native vegetation paths. Downspout infiltration is feasible for the proposed project, however due to the variation in the on-site soils throughout the parcel it is safer to localize the majority of the roof runoff to the proposed infiltration system. The native soils within the eastern and western portions of the site are the most viable for infiltration and therefore these are the proposed locations for the infiltration facilities. The stormwater runoff from the roof area of the two buildings on-site will be tightlined directly to the proposed downspout infiltration trenches for both Basins 1 and 2.

Other Hard Surfaces:

- **Full Dispersion (Chapter 7, Section 7.4.2):** Full dispersion is not feasible for this project site for the reasons mentioned above.
- **Permeable Pavement (Chapter 7, Section 7.4.6):** The proposed pollution generating impervious surfaces require treatment prior to infiltration, therefore the proposed roadways cannot be permeable. Additionally, the soils vary across the site and would not be safe for the design of permeable pavement. Due to these things, permeable pavement is infeasible.
- **Bioretention (Chapter 7, Section 7.4.4):** Bioretention is not feasible for the proposed project due to the development of the site and lack of available space to provide a sufficient pond facility and meet setback requirements.
- **Sheet Flow Dispersion (Chapter 7, Section 7.4.2) or Concentrated Flow Dispersion (Chapter 7, Section 7.4.2):** Sheet flow dispersion and concentrated flow dispersion are not feasible for the proposed development due to lack of available vegetated surfaces within the site.
- Infiltration trenches (BMP T7.20) are feasible for the proposed development due to the infiltrative capacity of the native soils and the sufficient separation from the groundwater level. The proposed trenches will be used to meet requirements #5 and 7 for the stormwater runoff generated from the on-site drive aisles and parking stalls. See Section 4 of this report for more information.

Core Requirement #6 – Runoff Treatment – Per this requirement, a treatment facility was chosen for this project based on the step-by-step selection process in Section 8.2.1 of the 2022 SDM. See Section 4 of this report for this process. Phosphorous treatment is not required for the project area. The project is considered a commercial development but does not discharge to a water body designated for aquatic life nor does it infiltrate within the 1-year time-of-travel zone for a wellhead protection area. Therefore, enhanced treatment is not required for the proposed development and basic treatment will be provided. Basic treatment will be provided by two GULD-approved mechanical treatment devices located near the infiltration facilities in Basins 1 and 2. The treatment BMP was sized to treat all of the stormwater runoff conveyed to it. After treatment, the stormwater runoff will be conveyed via a storm pipe to an infiltration trench within each basin. See Section 4 of this report for more information.

Core Requirement #7 – Flow Control – This requirement will be met through the use of infiltration within the on-site infiltration trenches. Almost all of the stormwater runoff within the parcel will be collected and conveyed to one of the two infiltration trench facilities. These facilities will infiltrate 100% of the runoff that is conveyed to them. See Section 4 of this report for more information.

Core Requirement #8 – Wetlands Protection – There are no wetlands on the project site nor does the project site does currently discharge into a wetland.

Core Requirement #9 – Operation and Maintenance – A Maintenance and Source Control Manual will be completed and included herein as **Attachment No. 2** at the time of civil permit submittal.

2. EXISTING CONDITIONS DESCRIPTION

2.1 EXISTING ON-SITE CONDITIONS

The subject site is +/- 4.70 acres in size. Topography within the property generally slopes to the northeast at approximately 2-12%. The parcel is currently undeveloped with approximately 85% forested land cover and the remaining area pasture/grass. There are no known current drainage flow control facilities on the site. See the figures below.

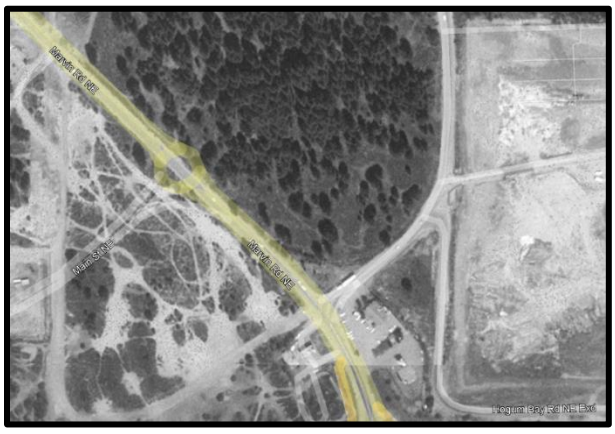


Figure 1: Existing Conditions (1990)

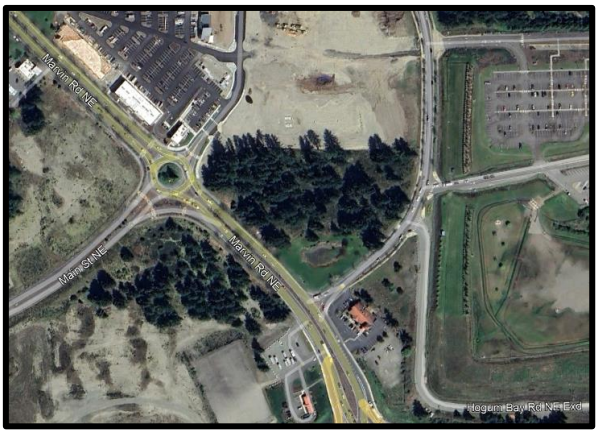


Figure 2: Existing Conditions (2024)

2.2 CRITICAL AREAS

Flood Zones: The project parcel is located with Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 53067C0185F According to the FIRM Map the project parcel is located within Zone X. Zone X is determined to be an area of minimal flood hazard. See **Appendix 2** for the FIRM Map.

Critical Aquifer Recharge Areas (CARA): According to Figure 8B.2 of the SDM, the proposed project is located within a Critical Aquifer Recharge Area Category I.

2.2.1 On-Site Soils Information

A full geotechnical report was provided by Quality Geo NW on September 1, 2023. The on-site geotechnical investigation was conducted on August 3, 2023, and included three test pits across the project site to a maximum depth of 10 feet. The on-site soil samples revealed sand and gravelly soils with minimal fines content beneath the topsoil. The on-site soil sampling confirmed the USDA soil classification of Spanaway gravelly sandy loam. Soil samples excavated from test pits 1 and 3, the western and eastern portions of the site respectively, were used to characterize the local infiltration conditions. Laboratory results were interpreted to recommend a design infiltration rate in accordance with the City of Lacey 2022 Stormwater Design Manual. As a result of the on-site and laboratory testing, a design infiltration rate of 20.0 inches/hour was recommended for in-ground infiltration facilities. This design infiltration rate was used in the preliminary sizing and design of the proposed on-site stormwater facilities. For more information see **Appendix 2** for the soils reports and groundwater information.

3. VICINITY ANALYSIS AND SUBBASIN DESCRIPTION

There are no known flooding or bank overtopping problems, and no steep slopes are located near the project site. The project site is located within the Category I Critical Aquifer Recharge Area. The project is not located within a wellhead protection area. There are no known fuel tanks on-site.

3.1 QUALITATIVE UPSTREAM ANALYSIS

The adjacent roadways area either curbed or equipped with a drainage ditch, therefore the roadway runoff does not enter the site. The parcels to the north are developed and contain their own stormwater systems therefore on-site run-on is minimal to none.

3.2 QUALITATIVE/QUANTITATIVE DOWNSTREAM ANALYSIS

Currently, the majority of the stormwater runoff generated on-site fully infiltrates on-site. Runoff generated in the southern portion of the project site sheet flows south and enters the existing pond where it infiltrates off-site. Roughly 0.96-acres of the existing site currently drains off-site to the existing pond located to the south. After construction, the majority of the stormwater runoff generated by the developed site will be collected, treated, and infiltrated on-site. Only 0.21-acres of the stormwater runoff generated by the pervious surfaces on the southern portion of the site will continue to sheet flow downhill into the existing pond to the south, reducing the offsite runoff by approximately 75%. Overall, the stormwater runoff from the site is anticipated to decrease with the construction of this project and the downstream conveyance system will be improved.

4. FLOW CONTROL AND WATER QUALITY FACILITY SIZING

4.1 SUMMARY SECTION

Following Figure 2.1 (See **Appendix 3**), this project classifies as a new development that triggers all of the core requirements. The site does not have 35% or more of existing impervious coverage, and the project will add more than 5,000 S.F. of new impervious surfaces. See **Appendix 1** for the proposed stormwater facility locations and details as well as the basin maps. See Tables 1 and 2 below for the existing and proposed land type designations.

Table 1: Existing Land Type Designations

LAND TYPE DESIGNATIONS	AREA (ACRES)	% OF TOTAL AREA
Total Parcel Area	**4.70**	**100**
EXISTING		
Basin 1	**3.11**	**66.2**
Impervious	0.00	0.0
Pervious	3.11	66.2
Basin 2	**0.96**	**20.4**
Impervious	0.00	0.0
Pervious	0.96	20.4
Basin 3 (Undisturbed)	**0.63**	**13.4**
Impervious	0.00	0.0
Pervious	0.63	13.4

Table 2. Proposed Land Type Designations

LAND TYPE DESIGNATIONS	AREA (ACRES)	% OF TOTAL AREA
Total Parcel Area	**4.70**	**100**
PROPOSED		
Basin 1	**2.47**	**52.6**
Roof	0.25	5.3
Concrete	0.08	1.7
Asphalt	1.60	34.0
Pervious	0.54	11.5
Basin 2	**1.39**	**29.6**
Roof	0.49	10.4
Concrete	0.17	3.6
Asphalt	0.47	10.0
Pervious	0.26	5.5
Basin 3 (Undisturbed)	**0.63**	**13.4**
Impervious	0.00	0.0
Pervious	0.63	13.4
Basin 4	**0.21**	**4.5**
Impervious	0.00	0.0
Pervious	0.21	4.5

4.1.1 Performance Standards and Goals

Following Figure 2.1 – Flow Chart for Determining Requirements for New Development, the project site triggers the use of Core Requirements #1-9. All of the stormwater runoff from the disturbed area of the project parcel will be collected, treated, and infiltrated on-site. On-site basic treatment will be provided for this project through the use of manufactured treatment devices which have been approved for the General Use Level Designation (GULD).

4.1.2 Flow Control System

Flow control is required for the proposed development and will be provided through the use of infiltration facilities. WWHM2012 was used to size the infiltration facilities within Basin 1 and 2. The drainage plan with the infiltration trench facility locations has been included as **Drainage Control Plan Appendix 1**. See **Appendix 3** for the WWHM reports.

- Basin 1: The majority of the stormwater runoff from the proposed commercial development will be collected and conveyed to the proposed infiltration trench facility. The infiltration trench facility has been sized to infiltrate 100% of the stormwater runoff generated from the Basin 1 area with a bottom area of 3,200 s.f. and a depth of 4 feet with 2 feet of ground cover for a total depth of 6 feet. A design infiltration rate of 20 inches/hour was used to size the facility as recommended by the geotechnical report. Additionally, the estimated maximum groundwater elevation is approximately 24 feet below ground surface (bgs). With a total depth of 6 feet to the bottom of the proposed facility, a mounding analysis is not required.

- Basin 2: The stormwater runoff generated from the proposed Basin 2 will be collected and conveyed to the proposed infiltration trench facility in the northern portion of the parking lot. The infiltration trench has been sized to infiltrate 100% of the stormwater runoff generated in Basin 2 with a bottom area of 1,840 s.f. and a depth of 4 feet and 2 feet of groundcover for a total depth of 6 feet. A design infiltration rate of 20 inches/hour was used to size the facility as recommended by the geotechnical report. The bottom of the proposed infiltration trench facility is 6 feet bgs while the estimated maximum groundwater elevation is 24 feet bgs, therefore a mounding analysis is not required for the proposed facility.
- Basin 3: This Basin will remain undisturbed throughout the development of the project and the stormwater generated will continue to infiltrate on-site.
- Basin 4: The stormwater runoff generated within Basin 4 will continue to sheet flow south and into the off-site pond located to the south where it will infiltrate as it does today.

4.1.3 Water Quality System

Per Minimum Requirement #6, basic treatment is required for all on-site pollution-generating impervious surfaces for the proposed development. The basic treatment requirement has been selected in accordance with Figure 8.1 of the 2022 SDM. Basic treatment will be provided through the use of two mechanical treatment devices that will precede the infiltration facilities. The proposed treatment systems have been approved for the General Use Level Designation (GULD) from the Department of Ecology and will be sized using the Western Washington Hydrology Model (WWHM 2012) at the time of civil permit submittal. Per Chapter 8 Section 8.4 of the 2022 SDM, for treatment systems preceding detention BMPs, the systems are required to treat the flow rate at or below 91% of the runoff volume as estimated by WWHM 2012. It is assumed that the stormwater runoff from the sidewalk areas and internal landscape islands will flow across the asphalt parking areas, and therefore will be included in the treatment facility sizing. The project site is divided into two treatment basins. See Table 2 below for an area breakdown per treatment basin.

Table 3: Land Type Designations for Proposed Treatment Areas

LAND TYPE DESIGNATIONS	AREA (ACRES)	% OF TOTAL AREA
Total Requiring Treatment	**2.17**	**46.2**
Basin 1	**1.67**	**35.5**
Asphalt	1.60	34.0
Concrete	0.07	1.5
Landscaping	0.10	2.1
Basin 2	**0.50**	**10.6**
Asphalt	0.47	10.0
Concrete	0.03	0.6
Landscaping	0.09	1.9

The drainage plan with the locations of the stormwater facilities has been included as **Drainage Control Plan Attachment No. 1**.

5. AESTHETIC CONSIDERATIONS FOR FACILITIES

All of the stormwater facilities will be designed in such a way that they will provide necessary treatment and flow control, but also provide eye appeal to the residents. The infiltration and treatment facilities will

be located underground beneath the parking lots and will not impair the visual aesthetics of the developed site.

6. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

All stormwater conveyance systems will be sized to convey the 24-hour 25-year storm within the pipe. All proposed stormwater pipes are a minimum of 12" at a minimum slope of 0.5% while the proposed roof drain lines are a minimum 6" at a minimum slope of 0.5%. Additionally, a 12" diameter pipe at a minimum slope of 0.5% has a maximum discharge of 3.27 cfs. The maximum 24-hour 25-year storm that will run through the proposed conveyance system is 1.67 cfs. Therefore, the proposed conveyance system has sufficient capacity for the proposed flows. See **Appendix 3** for the conveyance calculations.

7. COVENANTS, DEDICATIONS, EASEMENTS

It is the City of Lacey's policy that the property owner(s) shall maintain their stormwater drainage facilities. Thus, the Golden Nugget Investment Group, LLC will be responsible for maintaining and insuring that all installed drainage facilities are functioning in accordance with their design purposes. The Bradley Park Homeowner's Association will keep a copy of the maintenance plan at the project site. The Maintenance and Source Control Manual is a standalone document that will be submitted separately at the time of civil permit submittal. The Establishment of Maintenance Covenant will be completed and included herein as **Attachment 5** at the time of civil permit submittal.

It is important to note that only slow release fertilizers shall be applied for the life of the development at a maximum amount of 4 lbs of nitrate as Nitrogen annually and no more than 1 lb. per application for every 1,000 square feet of turf grass. Only fertilizer formulas with a minimum of 50% water insoluble form of nitrogen are permitted for use. Approved water insoluble forms of nitrogen include sulfur and/or polymer coated fertilizers, Isobutylidene Diurea (IBDU), Methylene Urea and Ureaform, and organic fertilizers registered with Washington Department of Agriculture.

8. AGREEMENTS AND GUARANTEES

Maintenance and/or operational bonding or other appropriate financial guarantees are required for all projects to ensure construction and functionality of drainage facilities in compliance with applicable standards. These guarantees are to be consistent with the most recent edition of the City of Lacey Development Guidelines and Public Works Standards.

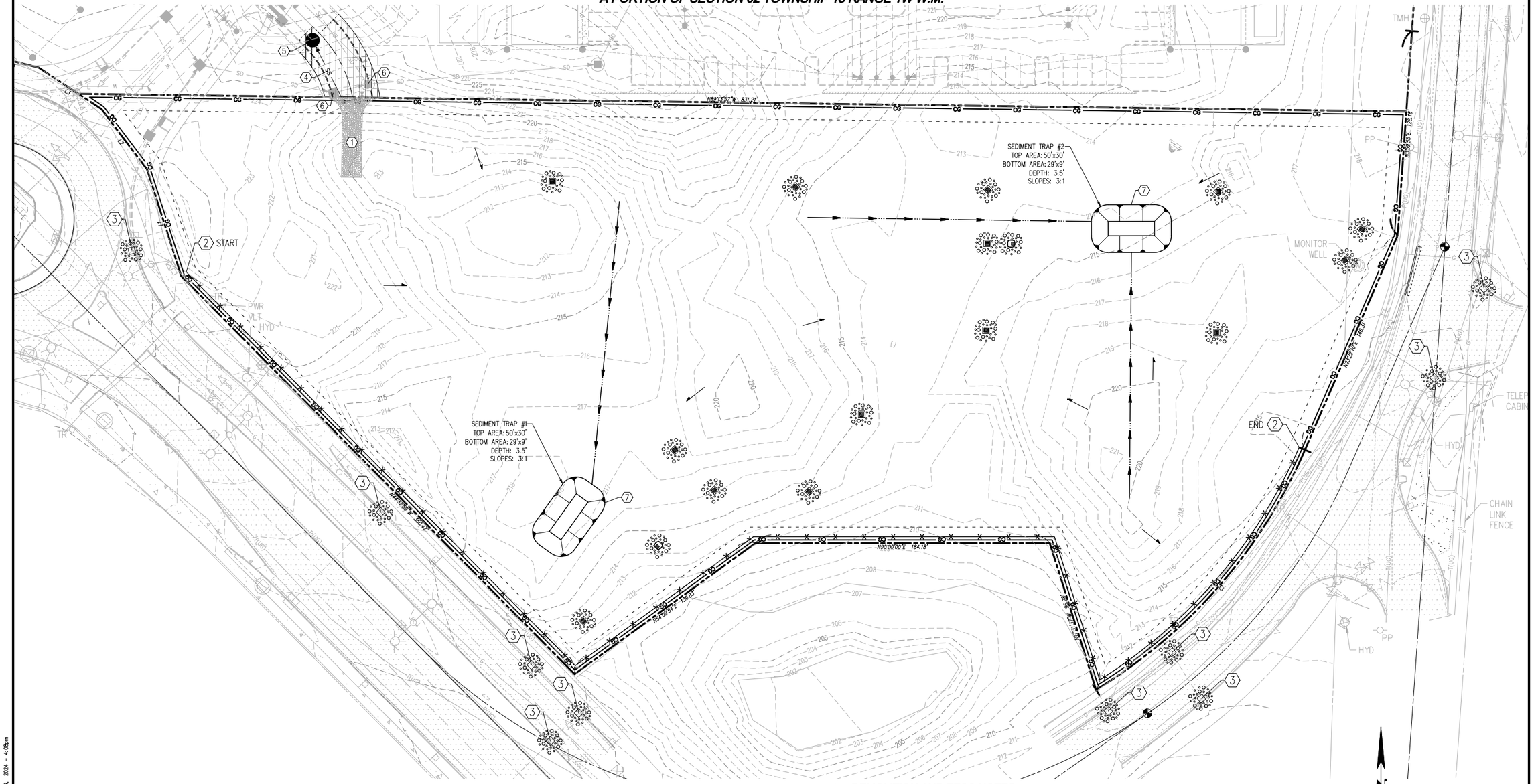
9. OTHER PERMITS OR CONDITIONS PLACED ON THE PROJECT

There are no other known required permits at this time.

END OF STORMWATER SITE PLAN

DRAINAGE CONTROL PLAN
APPENDIX 1
MAPS AND PLANS

A PORTION OF SECTION 02 TOWNSHIP 18 RANGE 1W W.M.



DEMOLITION AND TESC NOTES

1. STABILIZED CONSTRUCTION ENTRANCE
2. SILT FENCE
3. STORM DRAIN INLET PROTECTION
4. REMOVE EXISTING SEWER LINE
5. REMOVE EXISTING SEWER MANHOLE
6. PROTECT IN PLACE EXISTING STORM STRUCTURE
7. SEDIMENT TRAP

LEGEND

- CG — CLEARING LIMITS
- SILT FENCE
- TREE PROTECTION FENCE
- (1) STABILIZED CONSTRUCTION ENTRANCE
- STORM DRAIN INLET PROTECTION
- PRE DEVELOPMENT DRAINAGE PATTERN
- SAWCUT
- ASPHALT PAVEMENT REMOVAL
- CEMENT CONCRETE REMOVAL

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY MTN2COAST, LLC. LDC, INC (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

Drawing: P:\Civil\2022\c22-130 hogum bay commercial\Drawings\preliminary\C22130P-EC-PL.dwg Plotted: Feb 14, 2024 - 4:08pm

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC | Surveying Engineering Planning
Woodinville | Tumwater | Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 | www.LDCcorp.com | F 425.482.2893

GOLDEN NUGGET INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL

DEMOLITION AND TESC PLAN

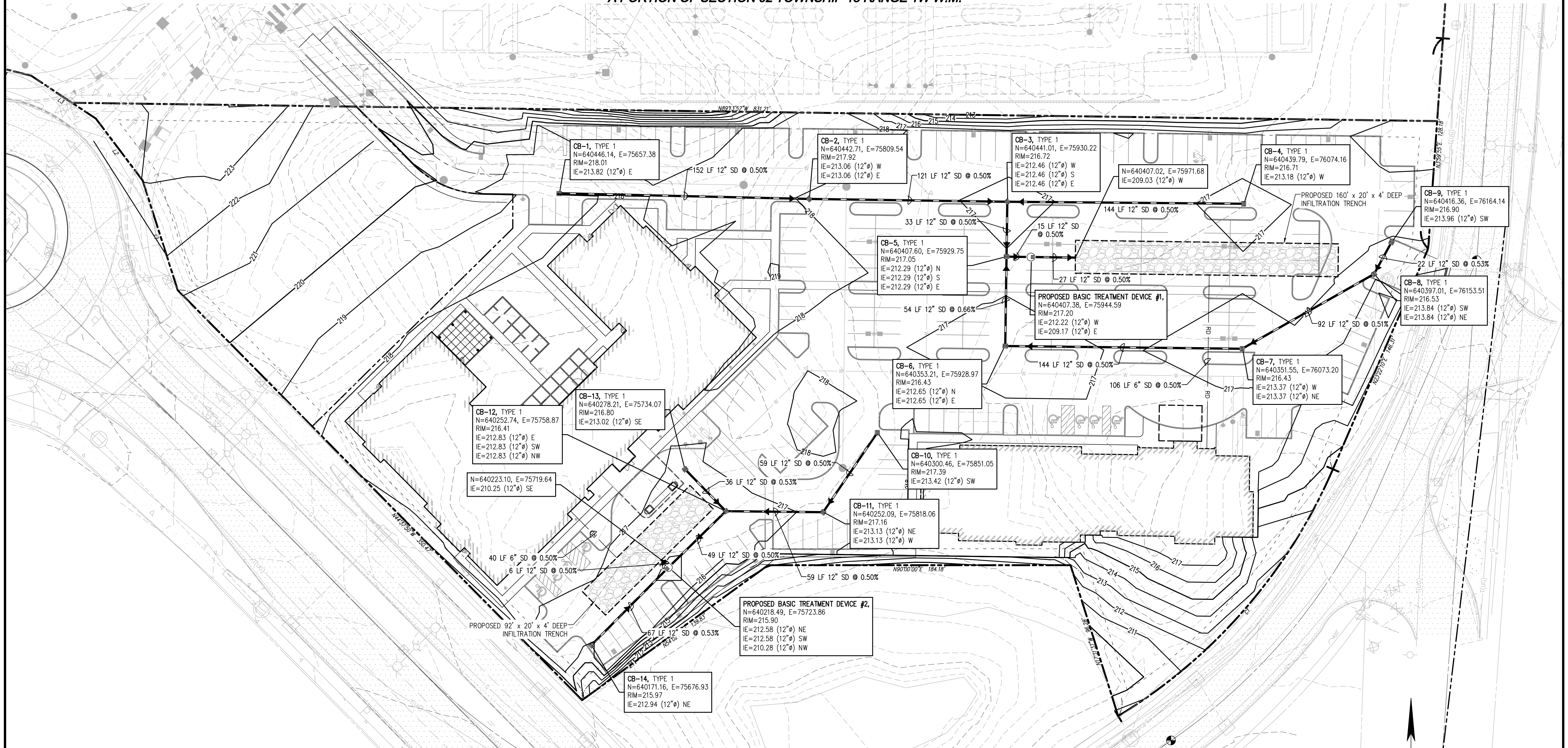
TYRELL E. BRAUN — STATE OF WASHINGTON — 51005 — REGISTERED PROFESSIONAL ENGINEER — 01-14-2024

JOB NUMBER:	C22130
DRAWING NAME:	C22130P-EC-PL
DESIGNER:	RW
DRAFTING BY:	AW
DATE:	FEBRUARY, 2024
SCALE:	AS SHOWN
JURISDICTION:	CITY OF LACEY

EC-01

SHEET 2 OF 6

A PORTION OF SECTION 02 TOWNSHIP 18 RANGE 1W W.M.



N

SCALE: 1" = 30'

30' 0 30' 60'

LEGEND

○	STORM DRAIN CLEANOUT
■	TYPE 1 CATCH BASIN WITH SOLID LID
	ASTM D3034 SDR35 PVC STORM PIPE, UNLESS OTHERWISE NOTED
	ASTM D3034 SDR35 PVC DRAIN LINE
XX	EXISTING CONTOURS
XX	PROPOSED CONTOURS

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY MTN2COAST, LLC. LDC, INC (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC | Surveying Engineering Planning
Woodinville | Tumwater | Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 www.LDCcorp.com F 425.482.2893

GOLDEN NUGGET INVESTMENT GROUP, LLC
HOGUM BAY COMMERCIAL
PRELIMINARY GRADING AND DRAINAGE PLAN

TYRELL E. BRAHAM, STATE OF WASHINGTON, 51055, REGISTERED PROFESSIONAL ENGINEER, 02-14-2024

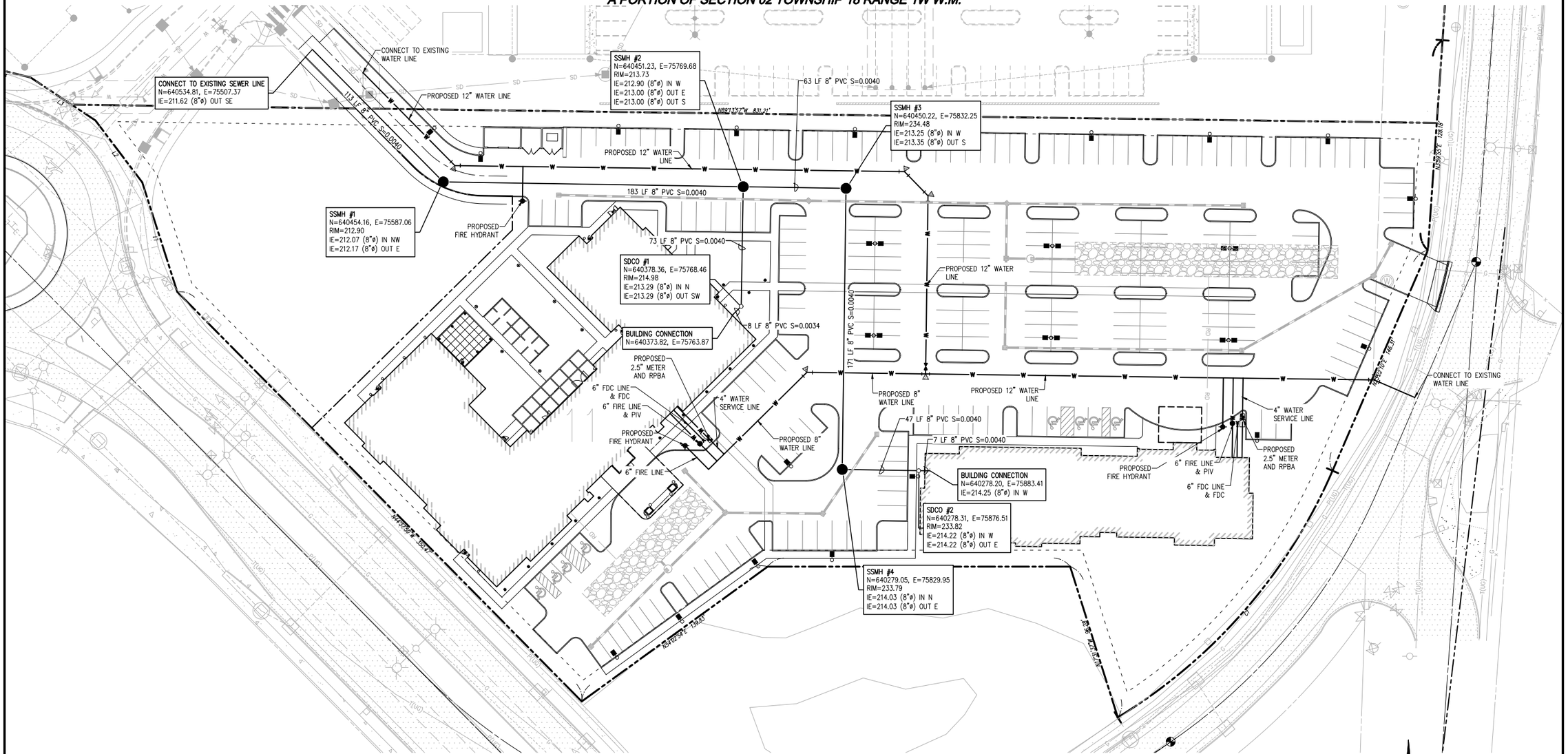
JOB NUMBER:	C22130
DRAWING NAME:	C22130P-CG-PL
DESIGNER:	RW
DRAFTING BY:	AW
DATE:	FEBRUARY, 2024
SCALE:	AS SHOWN
JURISDICTION:	CITY OF LACEY

CG-01

SHEET 4 OF 6

Drawing: P:\Civil\2022\c22-130 hogum bay commercial\Drawings\preliminary\C22130P-CG-PL.dwg Plotted: Feb 14, 2024 - 4:08pm

A PORTION OF SECTION 02 TOWNSHIP 18 RANGE 1W W.M.



LEGEND

- AWWA C900 PVC DR14 WATER LINE
- POST INDICATOR VALVE
- FIRE DEPARTMENT CONNECTION (FDC)
- RPBA
- METER
- GATE VALVE
- THRUST BLOCKING
- FIRE HYDRANT
- WATER BEND FITTING
- DCDA — DOUBLE CHECK DETECTOR ASSEMBLY
- PROPOSED WATER EASEMENT
- PROPOSED SITE LIGHTING

N

SCALE: 1" = 30'

30' 0 30' 60'

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY MTN2COAST, LLC. LDC, INC (LAND DEVELOPMENT CONSULTANTS, INC.,) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC
Surveying
Engineering
Planning
Woodinville Tumwater Kent
Tumwater
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 www.LDCcorp.com F 425.482.2893

GOLDEN NUGGET INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL

WATER AND SANITARY SEWER PLAN

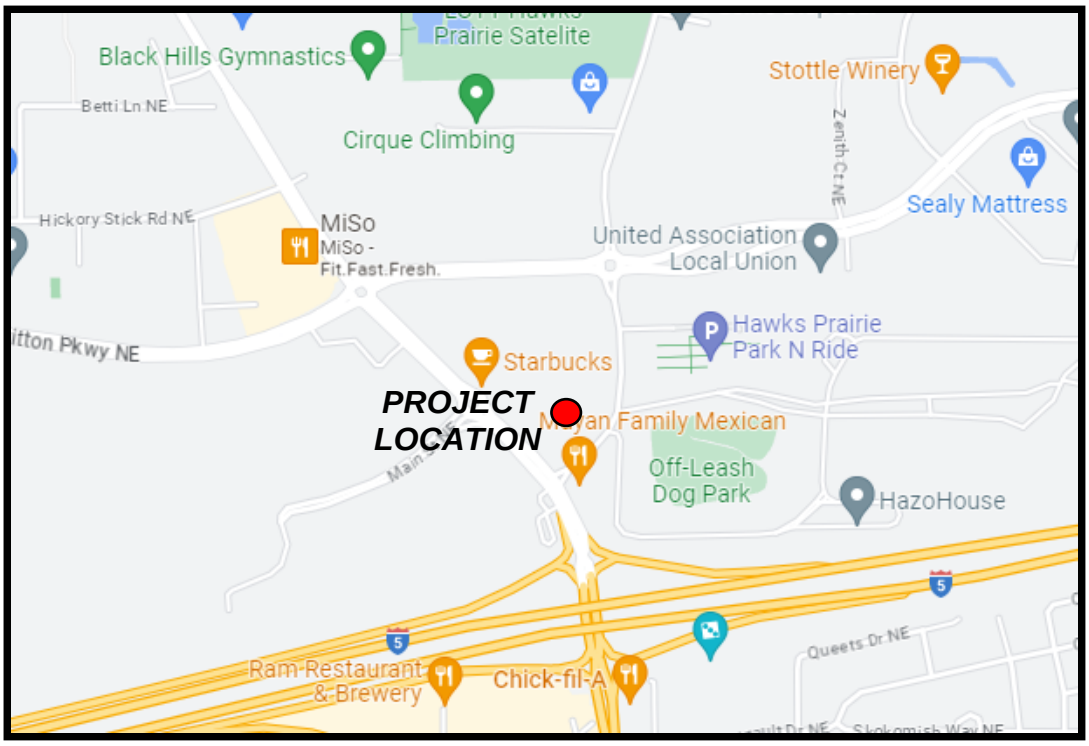
TYRELL E. BRAUN — STATE OF WASHINGTON — 51055 — REGISTERED PROFESSIONAL ENGINEER — 01-14-2024

JOB NUMBER:	C22130
DRAWING NAME:	C2130P-UT-PL
DESIGNER:	RW
DRAFTING BY:	AW
DATE:	FEBRUARY, 2024
SCALE:	AS SHOWN
JURISDICTION:	CITY OF LACEY

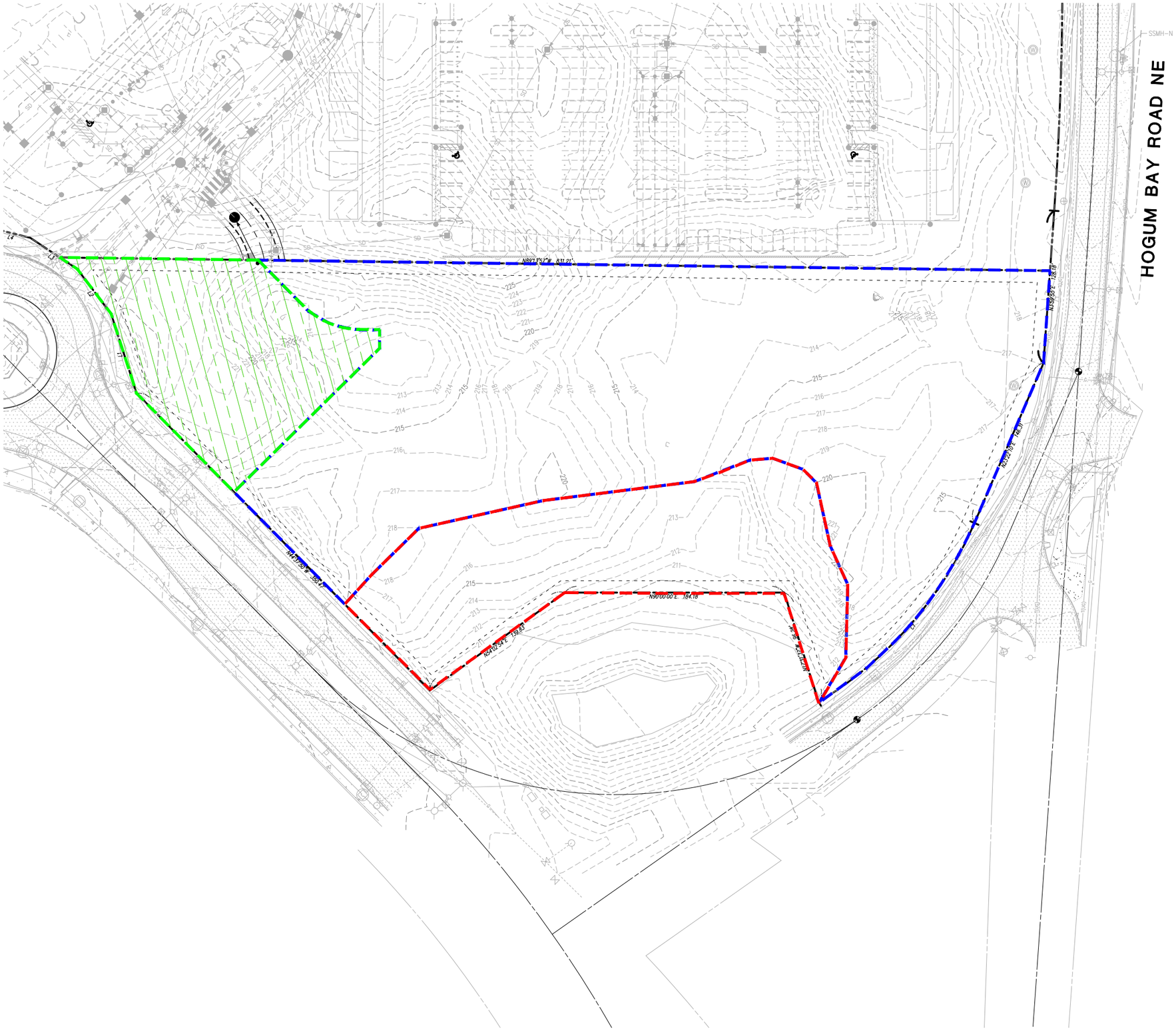
UT-01

SHEET 5 OF 6

Drawing: P:\Civil\2022\c22-130 hogum bay commercial\Drawings\preliminary\C22130P-UT-PL.dwg Plotted: Feb 14, 2024 - 4:08pm



321 Cleveland Avenue SE, Suite 209 • Tumwater, WA 98501 • ph: 425.806.1869 • fx: 425.482.2893 • www.LDCcorp.com



EXISTING BASIN 1 AREAS:

IMPERVIOUS AREA:	***0.00 ACRES***
PERVIOUS AREA:	***3.11 ACRES***
TOTAL:	***3.11 ACRES***

EXISTING BASIN 2 AREAS:

IMPERVIOUS AREA:	***0.00 ACRES***
PERVIOUS AREA:	***0.96 ACRES***
TOTAL:	***0.96 ACRES***

EXISTING BASIN 3 AREAS:

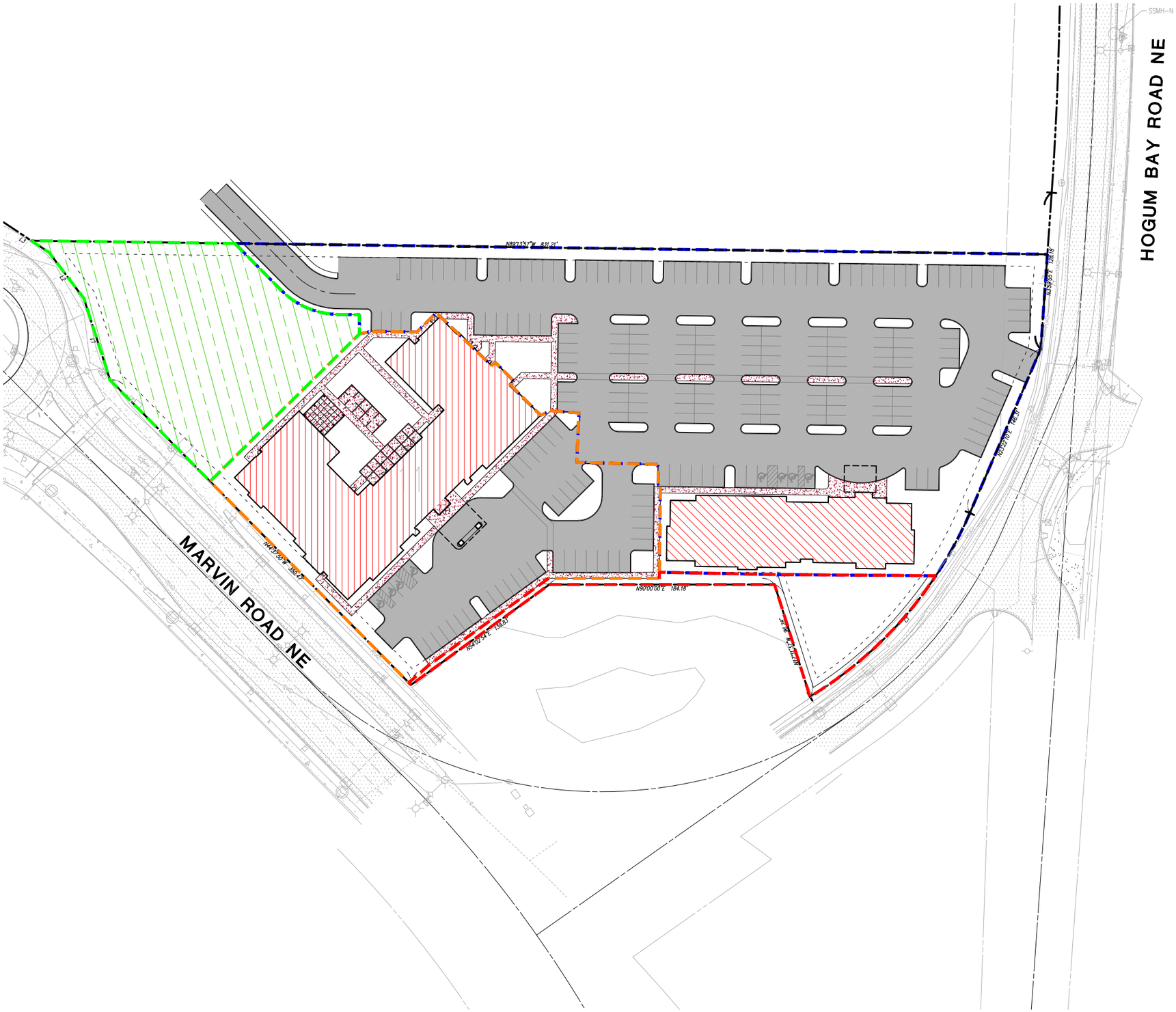
UNDISTURBED AREA:	***0.63 ACRES***
TOTAL:	***0.63 ACRES***

GOLDEN NUGGET INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL
EXISTING CONDITIONS MAP

LDC | Surveying Engineering Planning
Woodinville Tumwater Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 www.LDCcorp.com F 425.482.2893

ISSUE DATE: 02-12-2024



SCALE: 1" = 40'

40' 0 40' 80'

N

PROPOSED BASIN 1 AREAS:

ROOF AREA:	*0.25 ACRES*
CONCRETE AREA:	*0.08 ACRES*
ASPHALT AREA:	*1.60 ACRES*
PERVIOUS AREA:	*0.54 ACRES*
TOTAL:	*2.47 ACRES*

PROPOSED BASIN 2 AREAS:

ROOF AREA:	*0.49 ACRES*
CONCRETE AREA:	*0.17 ACRES*
ASPHALT AREA:	*0.47 ACRES*
PERVIOUS AREA:	*0.26 ACRES*
TOTAL:	*1.39 ACRES*

PROPOSED BASIN 3 AREAS:

UNDISTURBED AREA:	*0.63 ACRES*
TOTAL:	*0.63 ACRES*

PROPOSED BASIN 4 AREAS:

PERVIOUS AREA:	*0.21 ACRES*
TOTAL:	*0.21 ACRES*

GOLDEN NUGGER INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL
PROPOSED CONDITIONS MAP

LDC | Surveying Engineering Planning

Woodinville Tumwater Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501

T 425.806.1869 www.LDCcorp.com F 425.482.2893

ISSUE DATE: 02-12-2024

DRAINAGE CONTROL PLAN
APPENDIX 2
SUPPLEMENTAL REPORTS AND INFORMATION

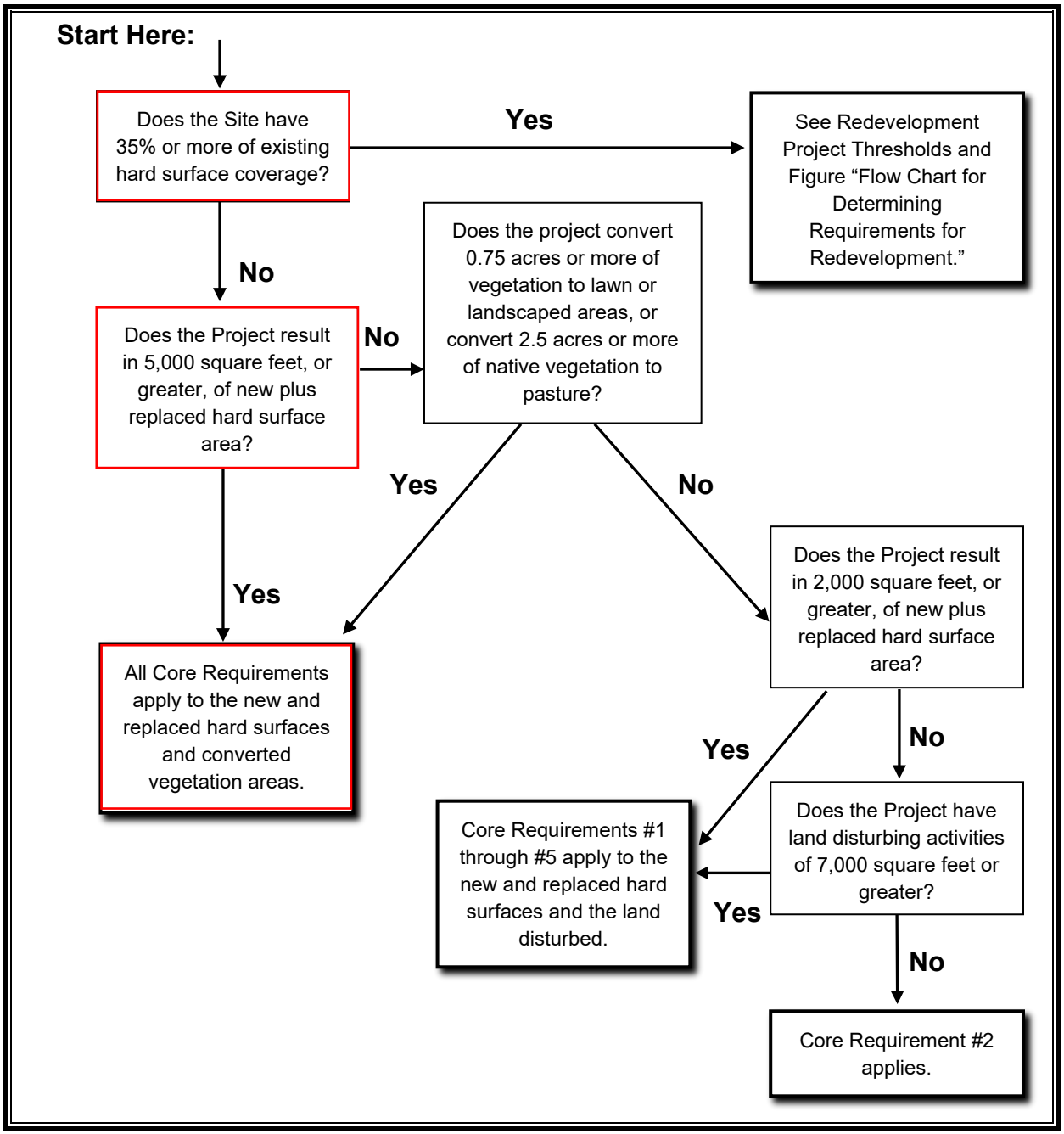


Figure 2.1. Flow Chart for Determining Requirements for New Development.

concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and developments must minimize their disruption of the natural hydrologic cycle in order to avoid significant natural resource degradation in lowland streams.

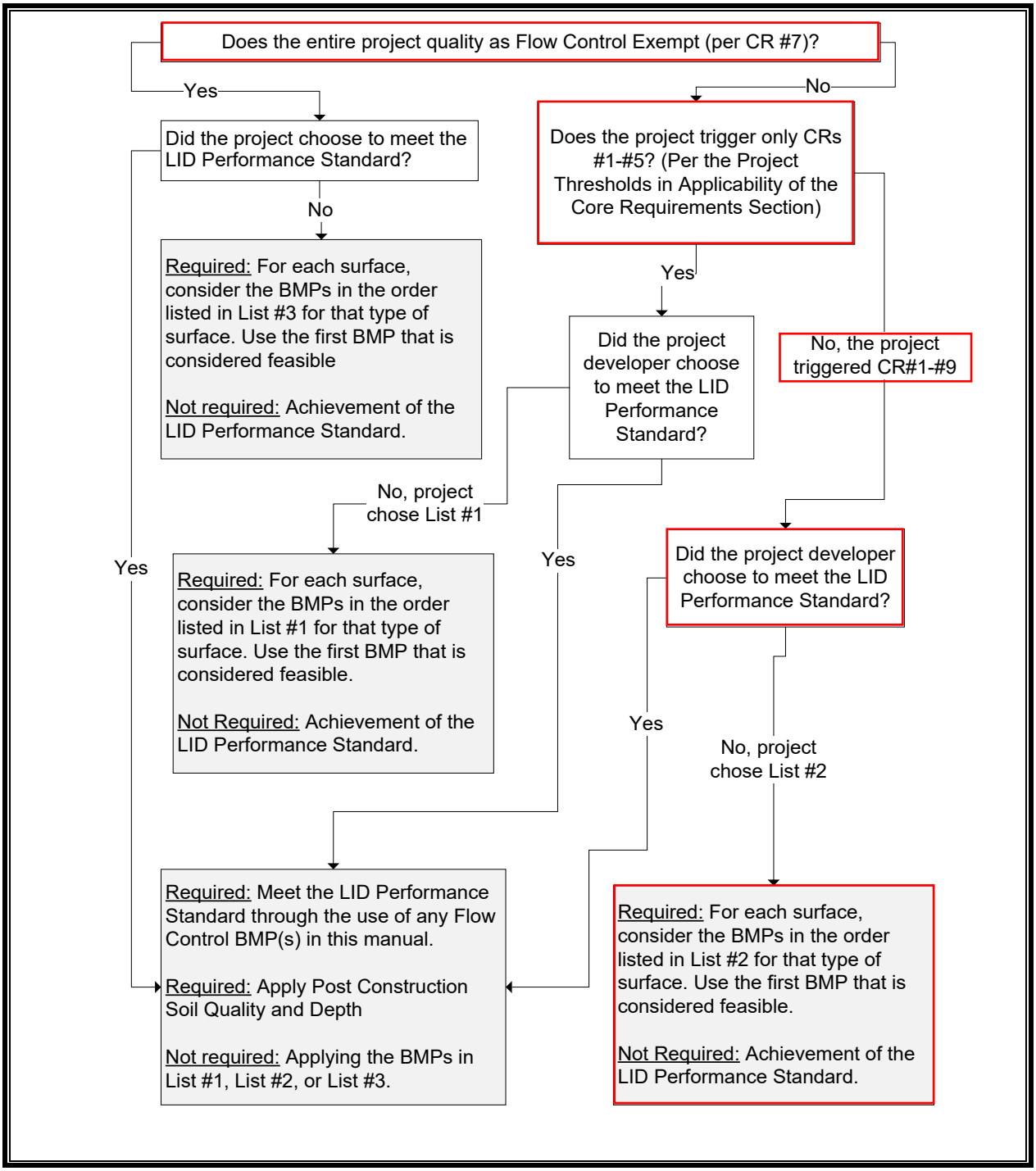


Figure 2.3. Flow Chart for Determining Core Requirement #5 Requirements.

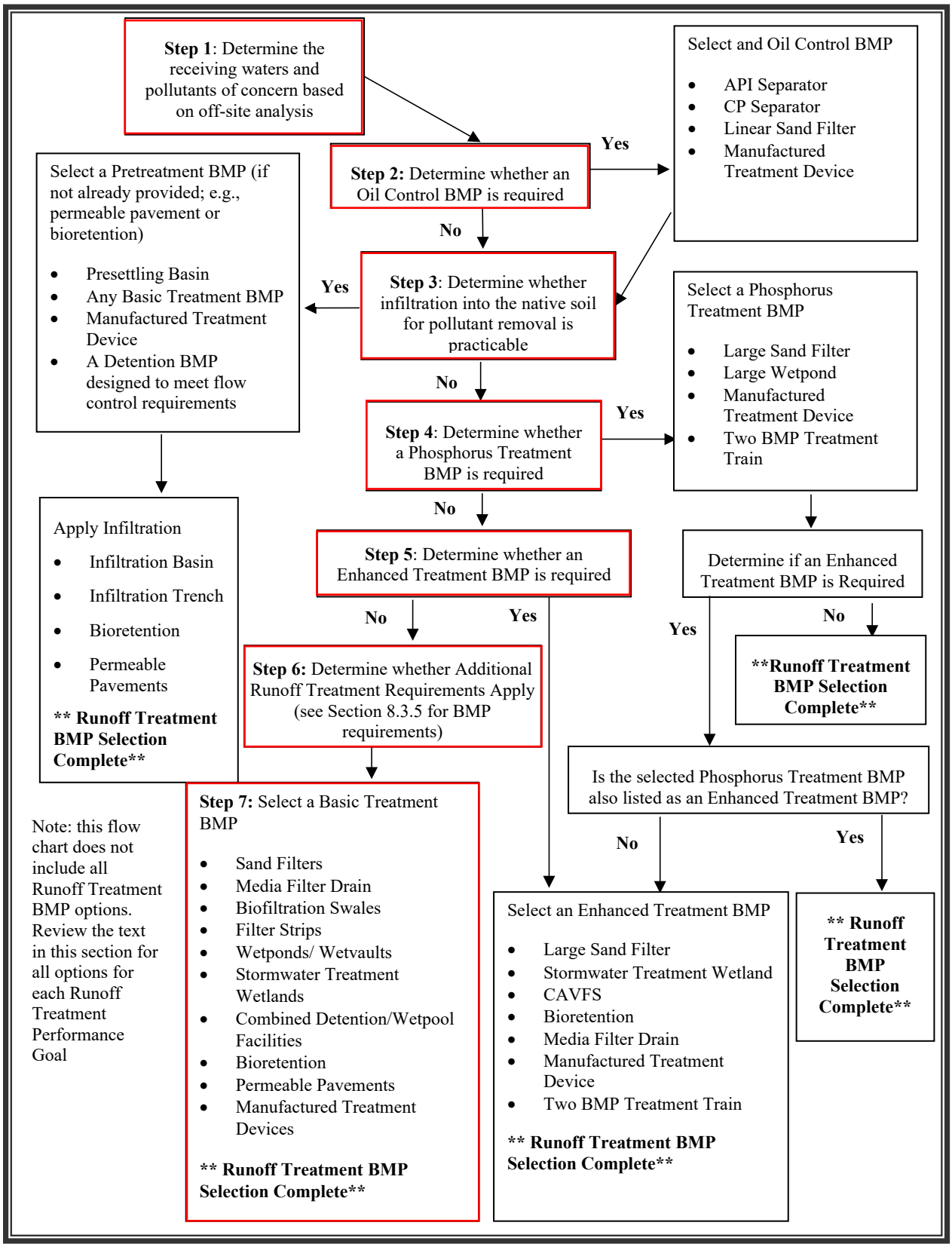


Figure 8.1. Runoff Treatment BMP Selection Flow Chart.

National Flood Hazard Layer FIRMette

FEMA

122°46'17"W 47°4'10"N

122°45'39"W 47°3'46"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN — Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 — Cross Sections with 1% Annual Chance
- 17.5 — Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/4/2023 at 3:14 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Critical Aquifer Recharge Area Map

Legend

- Critical Aquifer Recharge Areas
  - 1
  - 2
  - 3
- Parcel Boundaries
- Roads - Major
  - Major Roads
  - Ramp
  - I 5; US 101
- Roads (Large Scale)
- Railroads
- County Border

Scale 1: 8,112

0 350 700

Feet

Map Created Using GeoData Public Website

Published: 6/5/2023

Note:

THURSTON COUNTY
WASHINGTON
SINCE 1852

Thurston County GeoData Center

Wellhead Protection Area Map

Legend

- Wellhead Protection Areas
  - 6 Month
  - 1 Year
  - 2 Year
  - 3 Year
  - 5 Year
  - 10 Year
- Parcel Boundaries
- Roads - Major
  - Major Roads
  - Ramp
  - I 5; US 101
- Roads (Large Scale)
- Railroads
- County Border

Scale 1: 8,112

0 350 700

Feet

Map Created Using GeoData Public Website

Published: 6/5/2023

Note:

THURSTON COUNTY
WASHINGTON
SINCE 1852

Thurston County GeoData Center

9/1/2023

GSC Alliance Hotels LLC
Attn: Antony S. Chung
3801 Alderwood Mall Blvd
Lynnwood, WA 98036

Subject: **Homewood Suites - Geotechnical Consultation**
TPN: 11811120800, Marvin Rd NE & Hogum Bay Rd NE, Lacey, WA
Project Number: QG23-147

Dear Client,

At your request, Quality Geo NW, PLLC (QG) has completed a soils investigation of the above-referenced project. The investigation was performed in accordance with our proposal for professional services.

We would be pleased to continue our role as your geotechnical consultant of record during the project planning and construction phases, as local inspection firms have not been found to be as familiar or reliably experienced with geotechnical design. This may include soil subgrade inspections, periodic review of special inspection reports, or supplemental recommendations if changes occur during construction. We will happily meet with you at your convenience to discuss these and other additional *Time & Materials* services.

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

Respectfully Submitted,
Quality Geo NW, PLLC

Luke Preston McCann, L.E.G.
Owner + Principal

Ray Gean II
Staff Geologist/Project Manager

SOILS REPORT

HOMEWOOD SUITES GEOTECHNICAL CONSULTATION
TPN: 11811120800, MARVIN RD NE & HOGUM BAY RD NE
LACEY, WA

GSC Alliance Hotels LLC
Attn: Antony S. Chung
3801 Alderwood Mall Blvd
Lynnwood, WA 98036

Prepared by:

Audrey White, G.I.T.
Staff Geologist

Approved by:

State of Washington
Engineering Geologist
19110623
Licensed Geologist

9/1/2023

LUKE PRESTON MCCANN

Luke Preston McCann, L.E.G.
Principal Licensed Engineering Geologist

Quality Geo NW, PLLC
Geotechnical Investigation & Engineering Consultation
Phone: 360-878-9750 | Web: qualitygeonw.com
Mail: 4631 Whitman Ln SE, Ste D, Lacey, WA 98513

9/1/2023

QG Project # QG23-147

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the findings and recommendations of Quality Geo NW's (QG) soil investigation conducted in support of new site surface improvements.

1.1 PROJECT DESCRIPTION

QG understands the project entails new construction within a presently undeveloped parcel. QG has been contracted to perform a soils investigation of the proposed site to provide foundation, infiltration, and earthwork recommendations.

1.2 FIELD WORK

Site exploration activities were performed on 8/3/2023. Exploration locations were marked in the field by a QG Staff Geologist with respect to the provided map and cleared for public and private conductible utilities. Our exploration locations were selected by a QG Staff Geologist prior to fieldwork to provide safest access to relevant soil conditions. The geologist directed the advancement of 3 excavated test pits (TP). The test pits were advanced within the vicinity of the anticipated development footprint areas, to maximum depths of 10.0 feet below present grade (BPG) in general accordance with the specified contract depth.

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

QG advanced 1 Wildcat Dynamic Cone Penetrometer (DCP) tests at a representative location within the vicinity of the proposed development and as slope conditions permitted. The penetrometer test was terminated upon reaching the equipment's maximum practical extent. During penetrometer advancement, blow counts were recorded in 10-centimeter increments as a thirty-five-pound weight was dropped 15 inches. Blow counts were then converted to resistance (kg/cm2), standard penetration blow counts (N-values), and corresponding soil consistency, with complete results shown on the attached logs.

2.0 EXISTING SITE CONDITIONS

2.1 AREA GEOLOGY

QG reviewed available map publications to assess known geologic conditions and hazards present at the site location. The Washington Geologic Information Portal (WGIP), maintained by the Department of Natural Resources Division of Geology and Earth Resources, provides 1:24,000-scale geologic mapping of the region. The geology of the site location and vicinity consists of Vashon Stade till (Qgt). The deposits on site are described as "Unstratified and, in most exposures, highly compacted mixture of clay, silt, sand, and gravel deposited directly by glacier ice; gray where fresh and light yellowish brown where stained; unsorted and, in most exposures, of very low permeability; most commonly matrix-supported but may be clast-supported."

The WGIP Map also offers layers of mapped geohazard conditions within the state. According to the regional-scale interactive map, there are no mapped geohazards or recent deep seated landslide deposits to exist within the vicinity of the parcel. Available LiDAR imagery of the site did not reveal obvious or prominent landslide features within the site as well as within the vicinity.

The United States Department of Agriculture portal (USDA) provides a soil mapping of the region. The soils in the vicinity are mapped as Spanaway gravelly sandy loam (110), these are formed by outwash plains and terrace deposits. The parent material for these soils is volcanic ash over gravelly outwash. The soils are described as gravelly sandy loam from 0 to 15 inches, very gravelly loam from 15 to 20 inches, and extremely gravelly sand from 20 to 60+ inches. Depth to restrictive feature is more than 80 inches. Capacity of most limiting layer to transmit water (ksat), is listed as high (1.98 to 5.95 in/hr). Depth to water table is more than 80 inches.

2.2 SITE & SURFACE CONDITIONS

The parcel is irregularly shaped and had mild rolling topography, near the same elevation as the adjacent road. The site is vegetated with mature trees, shrubs, and grasses, and bordered by Marvin Road to the southwest, and Hogum Bay Road NE to the southeast. There is no surface water present on site. The parcel to the north of the site is currently in the process of development with active construction.

2.3 SOIL LOG

Site soil conditions were generally consistent across the property and within both test pits. Representative lab samples were taken from TP-1 and TP-3. A representative soil column from TP-3 is as follows:

- **0’ to 1.0’ – Topsoil:**

  An overriding layer of organic-rich topsoil ranging from 1.0 to 1.25 feet thick is present across the site. This soil is dark brown and dry, with cobbles measuring up to 6 inches in diameter, and no evidence of oxidation in the form of mottling.

- **1.0’ to 4.0’ – Poorly-Graded Gravel (GP)**

  Beneath the layer of topsoil is a layer of poorly graded gravel. This layer is grey to light tan in color and dry, with no organic content and cobbles up to 5 inches. This soil shows no evidence of oxidation in the form of mottling. In TP-2, this layer expends from 1.25 feet to 10.0 feet below grade, while it is not present in TP-1.

- **4.0’ to 10.0’+ – Poorly-Graded Sand with Gravel (SP)**
  In TP-3, the overriding GP layer grades into a similar layer of poorly-graded sand with gravel. This soil is also grey to light tan in color, with a very low organic content, cobbles to 5 inches, and no mottling. This layer is not present in TP-3, while it extends from 1.0 feet below grade to 10.0 feet in TP-1. No groundwater was encountered in any of the test pits advanced across the site.

2.4 SURFACE WATER AND GROUNDWATER CONDITIONS

No active surface water features are present on site. McAllister Creek of the Nisqually Wildlife Refuge Area is located approximately 1 mile to the east of the site. Based on well logs made publicly available by the WA Department of Ecology, the groundwater table is reported to exist at approximately 150 feet beneath the entire site.

QG’s scope of work did not include determination or monitoring of seasonal groundwater elevation variations, formal documentation of wet season site conditions, or conclusive measurement of groundwater elevations at depths past the extent feasible for explorations at the time of the field explorations.

3.0 GEOTECHNICAL RECOMMENDATIONS

3.1 SHALLOW FOUNDATION RECOMMENDATIONS

Assuming site preparation is completed as described below, we recommend the following:

- **Subgrade Preparation**

  QG recommends excavating and clearing any loose or organic cover soils, peat soils, uncontrolled fill, including the overriding layer of topsoil where necessary, from areas of proposed pavement construction, down to firm bearing conditions and benching the final bottom of subgrade elevation flat. Excavations should be performed with a smooth blade bucket to limit disturbance of subgrade soils. Vibratory compaction methods are suitable for densification of the non-organic native soils.

  After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade should be evaluated under the periodic guidance of a QG representative. Any areas that are identified as being soft or yielding during subgrade evaluation should be brought to the attention of the geotechnical engineer. Where over excavation is performed below a structure, the over excavation area should extend beyond the outside of the footing a distance equal to the depth of the over excavation below the footing. The over-excavated areas should be backfilled with properly compacted structural fill.

  The proposed buildings may utilize either stepped or continuous footings with slab-on-grade elements. For continuous footing elements, upon reaching bearing strata, we recommend benching foundation lines flat. Continuous perimeter and strip foundations may be stepped as needed to accommodate variations in final subgrade level. We also recommend maximum steps of 18 inches with spacing of at least 5 feet be constructed unless specified otherwise by the design engineer. Structural fill may then be placed as needed to reestablish final foundation grade.

- **Allowable Bearing Capacity:**

  Up to 1,500 pounds per square foot (psf) for foundations placed on compacted native soil or approved structural fill, placed in accordance with the recommendations of *Section 4.2*. Bearing capacities, at or below 1,500 psf may eliminate the need for additional inspection requirements if approved by the county. The allowable bearing capacity may be increased by 1/3 for transient loading due to wind and seismic events.

- **Minimum Footing Depth:**

  For a shallow perimeter and spread footing system, all exterior footings shall be embedded a minimum of 18 inches and all interior footings shall be embedded a minimum of 12 inches

below the lowest adjacent finished grade, but not less than the depth required by design. However, all footings must also penetrate to the prescribed bearing stratum cited above. Minimum depths are referenced per IBC requirements for frost protection; other design concerns may dictate greater values be applied.

- **Minimum Footing Width:**

  Footings should be proportioned to meet the stated bearing capacity and/or the IBC 2018 (or current) minimum requirements. For a shallow perimeter and spread footing system, continuous strip footings should be a minimum of 16 inches wide and interior or isolated column footings should be a minimum of 24 inches wide.

- **Estimated Settlements:**

  All concrete settles after placement. We estimate that the maximum settlements will be on the order of 0.5 inch, or less, with a differential settlement of ½ inch, or less, over 50 linear feet. Settlement is anticipated to occur soon after the load is applied during construction.

3.1.1 BUILDING SLAB ON GRADE FLOOR

QG anticipates that slab-on-grade floors are planned for the interior of the proposed building. Based on typical construction practices, we assume finished slab grade will be similar to or marginally above present grade for the below recommendations. If floor grades are planned to be substantially raised or lowered from existing grade, QG should be contacted to provide revised or alternative recommendations.

- **Capillary Break:**

  A capillary break will be helpful to maintain a dry slab floor and reduce the potential for floor damage resulting from shallow perched water inundation. To provide a capillary moisture break, a 6-inch thick, properly compacted granular mat consisting of open-graded, free-draining angular aggregate is recommended below floor slabs. To provide additional slab structural support, or to substitute for a structural fill base pad where specified, QG recommends the capillary break should consist of crushed rock all passing the 1-inch sieve and no more than 3 percent (by weight) passing the U.S. No. #4 sieve, compacted in accordance with *Section 4.2.2* of this report.

- **Vapor Barrier:**

  A vapor retarding membrane such as 10 mil polyethylene film should be placed beneath all floor slabs to prevent transmission of moisture where floor coverings may be affected. Care should be taken during construction not to puncture or damage the membrane. To protect the membrane, a layer of sand no more than 2 inches thick may be placed over the membrane if

desired. If excessive relict organic fill material is discovered at any location, additional sealant or more industrial gas barriers may be required to prevent off-gassing of decaying material from infiltrating the new structure. These measures shall be determined by the structural engineer to meet local code requirements as necessary.

- **Structural Design Considerations:**

  QG assumes the design and specifications of slabs will be assessed by the project design engineer. We suggest a minimum unreinforced concrete structural section of 4.0 inches be considered to help protect against cracking and localized settlement, especially where larger equipment or localized loads are anticipated. It is generally recommended that any floor slabs and annular exterior concrete paving subject to vehicular loading be designed to incorporate reinforcing. Additionally, some level of reinforcing, such as a wire mesh may be desirable to prolong slab life due to the overwhelming presence of such poor underlying soils. It should be noted that QG does not express any guarantee or warranty for proposed slab sections.

3.2 INFILTRATION RATE DETERMINATION

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

3.2.1 GRADATION ANALYSIS METHODS & RESULTS

During test pit excavations for general site investigation, QG additionally collected representative samples of native soil deposits among potential infiltration strata and depths from TP-1 and TP-3 to characterize the local infiltration conditions.

We understand the project will be subject to infiltration design based on the Washington Department of Ecology Stormwater Management Manual for Western Washington (DoE SMMWW). For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve and hydrometer tests for stormwater design characterization and rate determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below.

Laboratory results were interpreted to recommended design inputs in accordance with methods of the City of Lacey 2022 Stormwater Design Manual. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

(1) $\log10(Ksat) = -1.57 + 1.90*D10 + 0.015*D60 - 0.013*D90 - 2.08*ff$

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

(2) CFT = CFv x CFt x CFm = 0.7 x 0.4 x 0.9 = 0.25

Results were cross-referenced with test pit logs to determine the validity and suitability of unique materials as an infiltration receptor. Additional reduction factors were applied for practical rate determination based on our professional judgement.

Table 1. Results Of Massmann Analysis

TP #	Sample Depth *(BPG)*	Unit Extent *(ft)*	Soil Type	D10	D60	D90	Fines (%)	Ksat *(in/hr)*	Corrected Ksat *(in/hr)*	LT Design Infiltration Rate*(in/hr)*	Cation Exchange Capacity (meq/100g)	Organic Content %
1	3.0 ft	1.0ft to 10 ft	SP	0.50	6.85	24.71	3.4	174.69	43.67	**20.0**	4.0	1.7
3	2.5 ft	1.0ft to 10 ft	GP	1.9	9.0	32.75	1.5	1443.84	360.96	**20.0**	2.9	1.3

Beneath topsoil, the lower sand and gravelly soils were observed to generally exhibit minimal fines content and minimal oxidation patterns. In-ground infiltration structures are required to maintain a minimum 5-feet separation from restrictive soil & groundwater features.

For in-ground infiltration galleries, we recommend a maximum design rate of up to 20.0 inches/hour be considered. Available well logs did not indicate the potential for shallow ground water. The required separation appears generally achievable across the site. At this time, QG does not recommend mounding analysis due to the generally suitable site conditions.

Alternatives to in-ground infiltration include the use of rain gardens, bio-swales, or pervious pavement, which can be considered at the discretion of the designer and client depending on final development needs and constraints. for shallow infiltration features utilizing treatment media, we recommend a maximum design rate of up to 1.0 inch/hour be considered. This considers potential reductions from compaction during construction.

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

3.2.2 TREATMENT POTENTIAL

Depending on stormwater and runoff sources, some stormwater features, such as rain gardens or pervious pavements may require treatment. Stormwater facilities utilizing native soils as treatment media typically require Cation Exchange Capacities (CEC) of greater than 5 milliequivalents per 100grams (meq/100g) and organic contents greater than 1% (this may vary depending on local code). Soils across the site **do not** the minimum standards for treatment potential.

3.2.3 DRAINAGE RECOMMENDATIONS

QG recommends proper drainage controls for stormwater runoff during and after site development to protect the site. The ground surface adjacent to structures should be sloped to drain away at a 5% minimum to prevent ponding of water adjacent to them.

Foundations shall incorporate a wraparound footing drain composed of imported clean granular drain rock. There shall be a perforated drainpipe connected around the perimeter of the footing drain (within the rock) graded to gravity drain to an outfall pipe, to allow any accumulated water to be released to an approved drainage feature or location. The outfall point must be lower in elevation than the lowest point of possible water accumulation in the mat fill, so as to allow any captured water within the mat or crawlspace to completely drain away from the building footprint preventing standing water from accumulating.

QG recommends all stormwater catchments (new or existing) be tightlined (piped) away from structures to an existing catch basin, stormwater system, established channel, or approved outfall to be released using appropriate energy-dissipating features at the outfall to minimize point erosion. Roof and footing drains should be tightlined separately or should be gathered in an appropriately sized catch basin structure and redistributed collectively. If storm drains are incorporated for impervious flatworks (driveways, sidewalks, etc.) collected waters should also be discharged according to the above recommendations.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 EARTHWORK

4.1.1 GRADING & EXCAVATION

A grading plan was not available to QG at the time of this report. However, based on provided conceptual plans, this study assumes finished site grade will approximate current grade. Therefore, depths referred to in this report are considered roughly equivalent to final depths. Excavations can generally be performed with conventional earthmoving equipment such as bulldozers, scrapers, and excavators.

4.1.2 SUBGRADE EVALUATION & PREPARATION

After excavations have been completed to the planned subgrade elevations, but before placing fill or structural elements, the exposed subgrade should be evaluated under the part-time observation and guidance of a QG representative.

The special inspection firm should continuously evaluate all backfilling. Any areas that are identified as being soft or yielding during subgrade evaluation should be over excavated to a firm and unyielding condition or to the depth determined by the geotechnical engineer. Where over excavation is performed below a structure, the over excavation area should extend beyond the outside of the footing a distance equal to the depth of the over excavation below the footing. The over-excavated areas should be backfilled with properly compacted structural fill.

4.1.3 SITE PREPARATION, EROSION CONTROLL, WET WEATHER

Any silty or organic rich native soils may be moisture-sensitive and become soft and difficult to traverse with construction equipment when wet. During wet weather, the contractor should take measures to protect any exposed soil subgrades, limit construction traffic during earthwork activities, and limit machine use only to areas undergoing active preparation.

Once the geotechnical engineer has approved the subgrade, further measures should be implemented to prevent degradation or disturbance of the subgrade. These measures could include, but are not limited to, placing a layer of crushed rock or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tarp and keeping construction traffic off the subgrade. Once the subgrade has been approved, any disturbance because the subgrade was not protected should be repaired by the contractor at no cost to the owner.

During wet weather, earthen berms or other methods should be used to prevent runoff from draining into excavations. All runoffs should be collected and disposed of properly. Measures may

also be required to reduce the moisture content of on-site soils in the event of wet weather. These measures can include, but are not limited to, air drying and soil amendment, etc.

QG recommends earthwork activities take place during the summer dry season.

4.2 STRUCTURAL FILL MATERIALS AND COMPACTION

4.2.1 MATERIALS

All material placed below structures or pavement areas should be considered structural fill. Excavated native soils may be considered suitable for reuse as structural fill on a case-by-case basis. Imported material can also be used as structural fill. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials. Frozen soil is not suitable for use as structural fill. Fill material may not be placed on frozen soil.

Structural fill material shall be free of deleterious materials, have a maximum particle size of 4 inches, and be compactable to the required compaction level. Imported structural fill material should conform to the WSDOT manual Section 9-03.14(1) Gravel Borrow, or an approved alternative import material. Controlled-density fill (CDF) or lean mix concrete can be used as an alternative to structural fill materials, except in areas where free-draining materials are required or specified.

Imported materials utilized for trench back fill shall conform to Section 9-03.19, Trench Backfill, of the most recent edition (at the time of construction) of the State of Washington Department of Transportation *Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications)*. Imported materials utilize as grade fill beneath roads shall conform to WSDOT Section 9-03.10, Gravel Base.

Pipe bedding material should conform to the manufacturer's recommendations and be worked around the pipe to provide uniform support. Cobbles exposed in the bottom of utility excavations should be covered with pipe bedding or removed to avoid inducing concentrated stresses on the pipe.

Soils with fines content near or greater than 10% fines content may likely be moisture sensitive and become difficult to use during wet weather. Care should be taken by the earthwork contractor during grading to avoid contaminating stockpiled soils that are planned for reuse as structural fill with native organic materials.

The contractor should submit samples of each of the required earthwork materials to the materials testing lab for evaluation and approval prior to delivery to the site. The samples should be

submitted **at least 5 days prior to their delivery** and sufficiently in advance of the work to allow the contractor to identify alternative sources if the material proves unsatisfactory.

4.2.2 FILL PLACEMENT AND COMPACTION

For lateral and bearing support, structural fill placement below footings shall extend at minimum a distance past each edge of the base of the footing equal to the depth of structural fill placed below the footing [i.e. extending at least a 1H:1V past both the interior and the exterior of the concrete footing].

Prior to placement and compaction, structural fill should be moisture conditioned to within 3 percent of its optimum moisture content. Loose lifts of structural fill shall not exceed 12 inches in thickness. All structural fill shall be compacted to a firm and unyielding condition and to a minimum percent compaction based on its modified Proctor maximum dry density as determined per ASTM D1557. Structural fill placed beneath each of the following shall be compacted to the indicated percent compaction:

- Foundation and Floor Slab Subgrades: 95 Percent
- Pavement Subgrades & wall backfill (upper 2 feet): 95 Percent
- Pavement Subgrades & wall backfill (below 2 feet): 90 Percent
- Utility Trenches (upper 4 feet): 95 Percent
- Utility Trenches (below 4 feet): 90 Percent

A sufficient number of tests should be performed to verify compaction of each lift. The number of tests required will vary depending on the fill material, its moisture condition and the equipment being used. Initially, more frequent tests will be required while the contractor establishes the means and methods required to achieve proper compaction.

Jetting or flooding is not a substitute for mechanical compaction and should not be allowed.

4.3 TEMPORARY EXCAVATIONS AND TRENCHES

All excavations and trenches must comply with applicable local, state, and federal safety regulations. Construction site safety is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing soil type information solely as a service to our client for planning purposes. Under no circumstances should the information be interpreted to mean that QG is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred. The contractor shall be responsible for the safety of personnel working in utility trenches. Given that steep excavations in native soils may be prone to caving, we recommend all utility trenches, but particularly those greater than 4 feet in depth, be supported in

accordance with state and federal safety regulations. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed near the top of any excavation.

Temporary excavations and trenches should be protected from the elements by covering them with plastic sheeting or some other similar impermeable material. Sheeting sections should overlap by at least 12 inches and be tightly secured with sandbags, tires, staking, or other means to prevent wind from exposing the soils under the sheeting.

5.0 SPECIAL INSPECTION

The recommendations made in this report assume that an adequate program of tests and observations will be made throughout construction to verify compliance with these recommendations. Testing and observations performed during construction should include, but not necessarily be limited to, the following:

- Geotechnical plan review and engineering consultation as needed prior to construction phase,
- Observations and testing during site preparation, earthwork, structural fill, and pavement section placement,
- Consultation on temporary excavation cutslopes and shoring if needed,
- Consultation as necessary during construction.

QG recommends that we be retained for construction phase soils testing and periodic earthwork observation in accordance with the local code requirements. We also strongly recommend that QG be retained as the project Geotechnical Engineering Firm of Record (GER) during the construction of this project to perform periodic supplementary geotechnical observations and review the special inspectors reports during construction.

Our knowledge of the project site and the design recommendations contained herein will be of great benefit in the event that difficulties arise and either modifications or additional geotechnical engineering recommendations are required or desired. We can also, in a timely fashion observe the actual soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

We would be pleased to meet with you at your convenience to discuss the *Time & Materials* scope and cost for these services.

6.0 LIMITATIONS

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

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

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

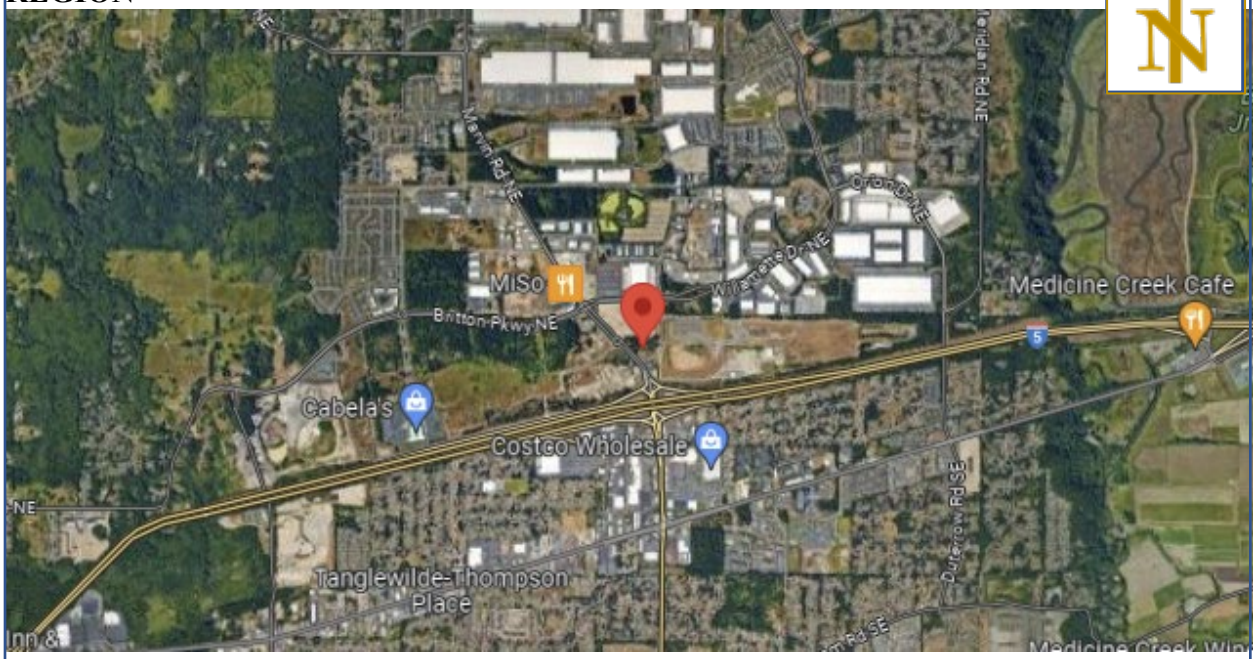
The findings of this study are limited by the level of scope applied. We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the subject region. No warranty, expressed or implied, is made. The recommendations provided in this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

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

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

Appendix A. Region & Vicinity Maps

REGION



VICINITY

Quality Geo NW, PLLC	**Site Region** Homewood Suites Geo	Source: Google Imagery, 2023 **Scale & Locations are approx.** **Not for Construction**	**Figure 1**

Appendix B. Exploration Map

Quality Geo NW, PLLC	**Site Map** Homewood Suites Geo	Source: Thurston Co. GIS, 2023 **Scale & Locations are approx.** **Not for Construction**	**Figure 2**

Appendix C. Exploration Logs

Test Pit Log TP-1

PROJECT NUMBER QG23-147
PROJECT NAME Homewood Geo
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 8/3/2023
DRILLING METHOD Excavator

BORING LOCATION Northwest Corner of parcel
SURFACE ELEVATION Existing
LOGGED BY AB, AW

COMMENTS

Depth (ft)	Samples	Is Analysed? (y/n)	Graphic Log	USCS	Material Description
0.5				TS	TOPSOIL Dark brown, dry, loose, high organic content, no mottling, sub-angular cobbles to 6 inches Gravel= 20% Sand= 70% Fines= 10%
1				SP	POORLY-GRADED SAND with GRAVEL Grey to light tan, dry, loose, no organic content, no mottling, rounded cobbles to 5 inches Gravel= 47% Sand= 49% Fines= 4%
1.5					
2					
2.5					
3	Sample@3.0ft	Y			
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10					Terminated at Contracted Depth No groundwater encountered

Quality Geo NW, PLLC - Ph: 360-878-9705, qualitygeonw.com, 4631 Whitman Lane SE, Ste D, Lacey, WA
produced by ESlog.ESdat.net on 30 Aug 2023

Page 1 of 1

Test Pit Log TP-2

PROJECT NUMBER QG23-147
PROJECT NAME Homewood Geo
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 8/3/2023
DRILLING METHOD Excavator

BORING LOCATION Center of Parcel
SURFACE ELEVATION Existing
LOGGED BY AB, AW

COMMENTS

Depth (ft)	Samples	Is Analysed? (y/n)	Graphic Log	USCS	Material Description
0.5				TS	TOPSOIL Dark brown, dry, loose, high organic content, no mottling, sub-angular cobbles to 6 inches Gravel= 20% Sand= 70% Fines= 10%
1					
1.5				GP	POORLY-GRADED GRAVEL Grey to light tan, dry, loose, no organic content, no mottling, rounded cobbles to 10 inches Gravel= 87% Sand= 11% Fines= 2%
2					
2.5					
3					
3.5					
4					
4.5					
5					
5.5					
6					
6.5					
7					
7.5					
8					
8.5					
9					
9.5					
10					Terminated at Contracted Depth No groundwater encountered

Test Pit Log TP-3

PROJECT NUMBER QG23-147
PROJECT NAME Homewood Geo
PROJECT LOCATION Lacey, WA

FIELD WORK DATE 8/3/2023
DRILLING METHOD Excavator

BORING LOCATION East Side of Parcel
SURFACE ELEVATION Existing
LOGGED BY AB, AW

COMMENTS

Depth (ft)	Samples	Is Analysed? (y/n)	Graphic Log	USCS	Material Description
0				TS	TOPSOIL Dark brown, dry, loose, high organic content, no mottling, sub-angular cobbles to 6 inches Gravel= 20% Sand= 70% Fines= 10%
1.5				GP	POORLY-GRADED GRAVEL Grey to light tan, dry, loose, no organic content, no mottling, rounded cobbles to 5 inches Gravel= 87% Sand= 11% Fines= 2%
2.5	Sample@2.5ft	Y			
4				SP	POORLY-GRADED SAND with GRAVEL Grey to light tan, dry, loose, no organic content, no mottling, rounded cobbles to 5 inches Gravel= 47% Sand= 49% Fines= 4%
10					Terminated at Contracted Depth No groundwater encountered

WILDCAT DYNAMIC CONE LOG

Quality Geo NW, PLLC
Geotechnical Consultants
Lacey, WA

PROJECT NUMBER: QG23-147
DATE STARTED: 08-03-2023
DATE COMPLETED: 08-03-2023

HOLE #: DCP-1
CREW: AB
PROJECT: Homewood Geo
ADDRESS: Marvin Rd NE & Hogum Bay Rd NE, Lacey, WA
LOCATION: Center of Parcel

SURFACE ELEVATION: Existing
WATER ON COMPLETION: No
HAMMER WEIGHT: 35 lbs.
CONE AREA: 10 sq. cm

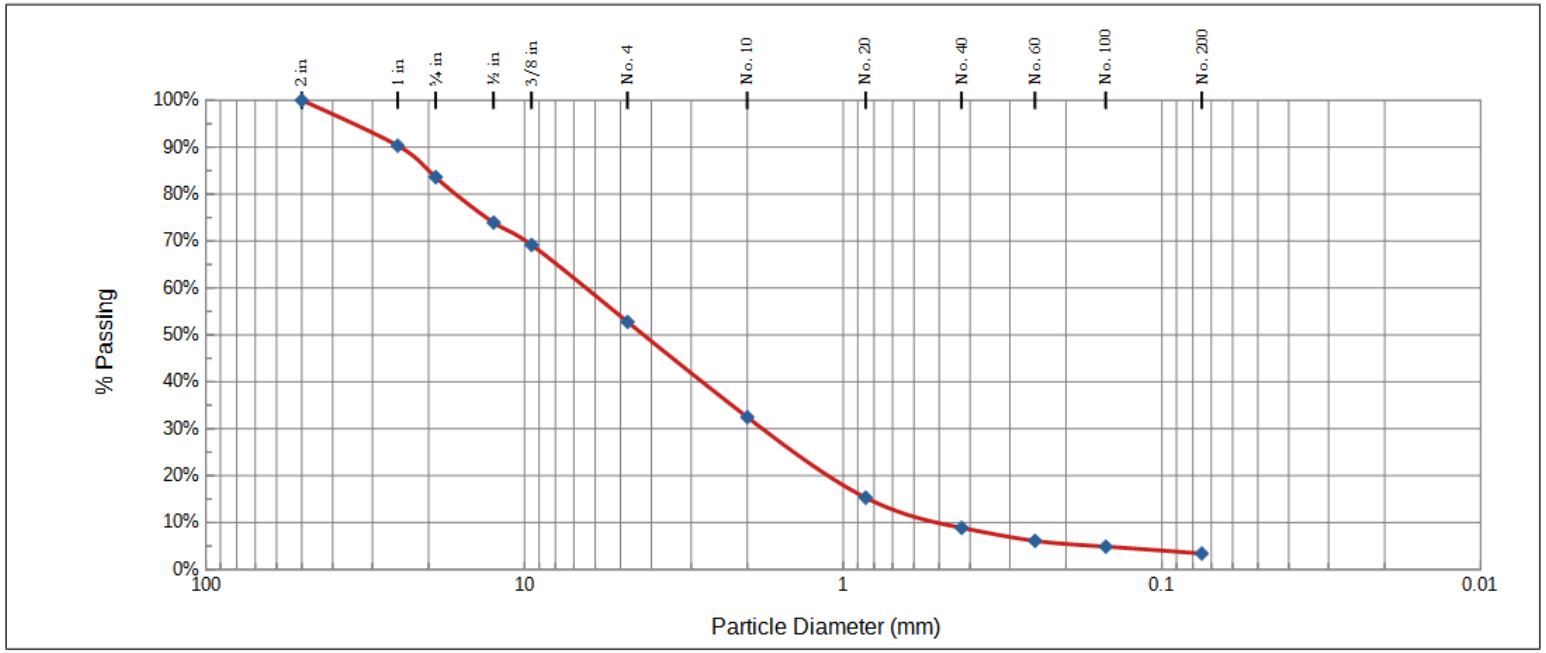
DEPTH	BLOWS PER 10 cm	RESISTANCE Kg/cm²	GRAPH OF CONE RESISTANCE 0 50 100 150	N'	TESTED CONSISTENCY NON-COHESIVE	TESTED CONSISTENCY COHESIVE
-	13	57.7	••••••••••••••••	16	MEDIUM DENSE	VERY STIFF
-	27	119.9	••••••••••••••••••••••••••••••••••	25+	DENSE	HARD
- 1 ft	23	102.1	••••••••••••••••••••••••••••	25+	MEDIUM DENSE	VERY STIFF
-	33	146.5	••	25+	DENSE	HARD
-	50	222.0	••	25+	VERY DENSE	HARD
- 2 ft						
-						
-						
- 3 ft						
- 1 m						
-						
- 4 ft						
-						
-						
- 5 ft						
-						
-						
- 6 ft						
-						
- 2 m						
- 7 ft						
-						
-						
- 8 ft						
-						
-						
- 9 ft						
-						
-						
- 3 m 10 ft						
-						
-						
-						
- 11 ft						
-						
-						
- 12 ft						
-						
-						
- 4 m 13 ft						

Appendix D. Laboratory Results

Project Name:	Homewood Geo
Project Number:	QG23-147
Date Collected:	08/03/23
Date Reported:	08/10/23
Boring ID:	TP-1
Boring Depth:	3ft

SAMPLE ID: TP-1@3ft

☑ Sieve Analysis | ☐ Wet Wash | ☐ Hydrometer | ☐ Atterberg Limits



USCS Scale	Coarse Gravel		Fine Gravel			Coarse Sand		Medium Sand		Fine Sand			(% of Fines Passing #200 Sieve) Hydrometer Method			Sand Total	Gravel Total
Sieve #	2"	1"	¾"	½"	3/8"	4	10	20	40	60	100	200	0.060	0.050	0.002		
Diameter, mm	50	25	19	12.5	9.5	4.75	2	0.85	0.425	0.25	0.15	0.075					
Retained	0.0%	9.7%	16.4%	26.1%	30.8%	47.2%	67.5%	84.7%	91.1%	93.9%	95.1%	96.6%	NA	NA	NA	**49.4%**	**47.2%**
Passing	100.0%	90.3%	83.6%	73.9%	69.2%	52.8%	32.5%	15.3%	8.9%	6.1%	4.9%	**3.4%**					

Graph Values

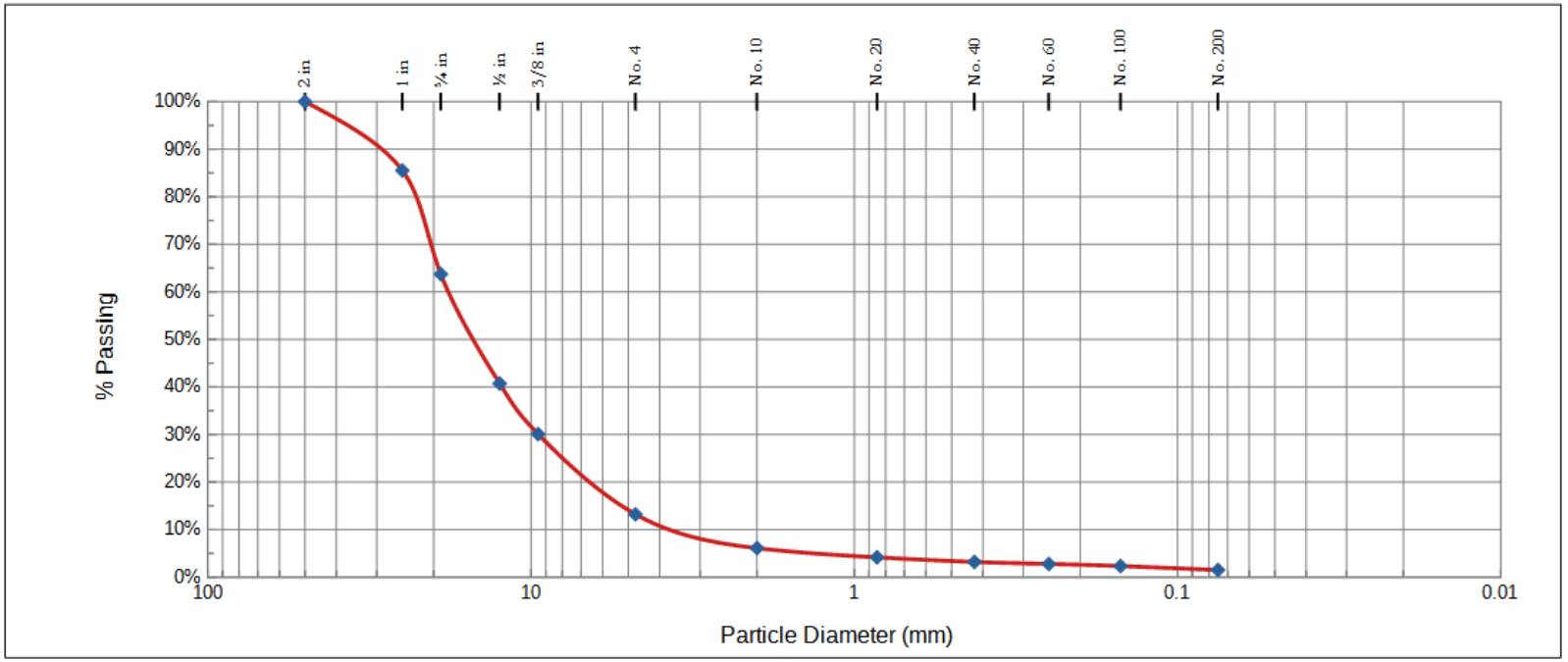
D90	24.71				
D60	6.85	**Coefficient of Uniformity:**	3.73	**CEC:**	4.0 meq/100g
D30	1.835	**Coefficient of Gradation:**	0.98	**OM (LOI 360):**	1.7 %
D10	0.500				

Unified Soil Classification System (USCS) Description	
SP	POORLY GRADED SAND with GRAVEL

SAMPLE ID: TP-3@2.5ft

☑ Sieve Analysis | ☐ Wet Wash | ☐ Hydrometer | ☐ Atterberg Limits

Project Name:	Homewood Geo
Project Number:	QG23-147
Date Collected:	08/03/23
Date Reported:	08/10/23
Boring ID:	TP-3
Boring Depth:	2.5ft



USCS Scale	Coarse Gravel		Fine Gravel			Coarse Sand		Medium Sand		Fine Sand			(% of Fines Passing #200 Sieve) Hydrometer Method			Sand Total	Gravel Total
Sieve #	2"	1"	¾"	½"	3/8"	4	10	20	40	60	100	200					
Diameter, mm	50	25	19	12.5	9.5	4.75	2	0.85	0.425	0.25	0.15	0.075	0.060	0.050	0.002		
Retained	0.0%	14.5%	36.3%	59.3%	69.9%	86.8%	93.9%	95.8%	96.8%	97.2%	97.7%	98.5%	NA	NA	NA	**11.7%**	**86.8%**
Passing	100.0%	85.5%	63.7%	40.7%	30.1%	13.2%	6.1%	4.2%	3.2%	2.8%	2.3%	**1.5%**					

Graph Values

D90	32.75				
D60	17.95	**Coefficient of Uniformity:**	1.89	**CEC:**	2.9 meq/100g
D30	9.478	**Coefficient of Gradation:**	1.43	**OM (LOI 360):**	1.3 %
D10	3.506				

Unified Soil Classification System (USCS) Description	
GP	POORLY GRADED GRAVEL

HYDROGEOLOGIC REPORT

Hogum Bay Commercial Site

Hogum Bay Road

Lacey, Washington

Prepared for:

Monte Square Enterprises

100 Brumfield Avenue
Montesano, Washington

Prepared by:

Amec Foster Wheeler
Environment & Infrastructure, Inc.
221 South 28th Street, Suite 102 Tacoma, Washington 98402
(425) 368-1000

March 30, 2018
Project No. PS17-19162-0

HYDROGELOGIC REPORT

Hogum Bay Commercial Site

Hogum Bay Road

Lacey, Washington

March 30, 2018
Project No. PS17-19162-0

Milan Radic, PE
Senior Engineer
milan.radic@amecfw.com

Henry W. Brenniman, LHG
Senior Geologist
henry.brenniman@amecfw.com

Reviewed by:
William J. Lockard, LEG
Senior Geologist
bill.lockard@amecfw.com

TABLE OF CONTENTS

TABLES

FIGURES

CHARTS

APPENDICES

HYDROGEOLOGIC REPORT

Hogum Bay Commercial Site
Hogum Bay Road
Lacey, Washington

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler), is pleased to submit this report describing our site hydrogeologic evaluation for the Hogum Bay Commercial Site located near the intersection of Hogum Bay Road NE and Marvin Road NE in Lacey, Washington ("the site"). The purpose of our evaluation was to derive conclusions and recommendations concerning infiltration rates for future detention ponds to be located on the site.

Our scope of work consisted of field explorations, laboratory testing, hydrogeologic review, and report preparation. We received written authorization for our evaluation on December 19, 2017. This report has been prepared for the exclusive use of Monte Square Enterprises (Monte Square) and their consultants for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The project site is an existing undeveloped wooded area located 200 feet north of the intersection of Hogum Bay Road NE and Marvin Road NE in Lacey, Washington, as shown on Figure 1. The site consists of a trapezoidal-shaped parcel comprising approximately 4.2 acres. The site is bounded by a City of Lacey infiltration pond and landscaping to the south, Hogum Bay Road NE to the east, Marvin Road NE to the west, and undeveloped wooded land to the north extending to where the north side of Main Street NE would intersect the undeveloped land. Figure 2 illustrates the existing site boundaries and adjacent existing features.

We understand that the new development will consist of an approximately 3,000-square-foot retail building, a gas station, and a hotel building with supporting infrastructure consisting of paved parking, driveway accesses, and landscaping. Stormwater runoff from the proposed development is currently planned to be infiltrated on site.

Prior to allowing Monte Square to infiltrate additional surface water into the subsurface within the site area, the City of Lacey is requesting Monte Square to provide hydrogeologic information showing that groundwater mounding will not occur atop the very dense glacial till soils underlying the site. The purpose of this hydrogeologic report is to provide hydrogeologic information to Monte Square's design

team to demonstrate that additional surface water infiltration will not cause groundwater mounding beneath the project site. The scope of this report was developed to meet the infiltration requirements as defined by the City of Lacey's Stormwater Design Manual ("Stormwater Manual"; City of Lacey, 2016).

The conclusions and recommendations in this report are based on our understanding of the currently proposed utilization of the project site, as derived from layout drawings, written information, and verbal information supplied to us by Monte Square. Consequently, if any changes are made in the currently proposed project, we may need to modify our conclusions and recommendations contained herein.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on December 21, 2017. Our exploration and testing program comprised the following elements:

- A visual surface reconnaissance of the site;
- Three borings (designated B-1 through B-3), advanced at strategic locations across the site;
- Installation of a groundwater observation well equipped with water level and atmospheric pressure transducers in one of the borings (B-2);
- Four grain size analyses and moisture content determinations performed on selected soil samples obtained from our borings; and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate locations, surface elevations, and termination depths of the three subsurface explorations performed for this investigation, and Figure 2 depicts the locations of these explorations. Section 2.1 summarizes the procedures used for boring explorations, and detailed descriptions of exploration methods are presented in Appendix A. Laboratory test results are included in Appendix B.

The specific number, locations, and depths of our explorations were selected by Amec Foster Wheeler relative to the existing and proposed site features, under the constraints of surface access, underground utility conflicts, and budget. We estimated the relative location of each exploration by measuring from existing features and scaling these measurements onto a topographic survey provided to us by Monte Square. We then estimated their elevations by interpolating between contour lines shown on the topographic survey. Consequently, the data listed in Table 1 and the locations

depicted on Figure 2 should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

Table 1 Exploration Locations, Elevations, and Depths

Exploration	Relative Location	Surface Elevation (feet)	Termination Depth (feet)
B-1	West-central area of site	222	26.5
B-2	South-central area of site	212	26.3
B-3	East-central area of site	217	26.5

Elevation datum: Site topographic map by Barghausen Consulting Engineers, Inc., dated 07/31/07 (NAVD 88).

It should be noted that the explorations performed and used for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other locations could vary. Furthermore, the nature and extent of these variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify the conclusions and recommendations presented in this report to reflect the actual site conditions.

2.1 EXPLORATORY SOIL BORING PROCEDURES

Our exploratory borings were advanced with a hollow-stem auger, using a track-mounted drill rig operated by an independent drilling firm working under subcontract to Amec Foster Wheeler. A geologist from our firm continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to a preselected laboratory for further visual examination and testing. After each boring was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with soil or concrete (well monument installation).

Throughout the drilling operation, soil samples were obtained at 2.5- to 5-foot depth intervals by means of the standard penetration test (SPT) per ASTM D-1586. This testing and sampling procedure consists of driving a 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the standard penetration resistance, or "SPT blow count." If a total of 50 blows is struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting standard penetration resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils. For this project, a 3-inch-

diameter split-spoon sampler was used at times to improve the sample recovery due to the gravelly nature of the site soils, and the resulting blow counts were subsequently converted to SPT blow counts by means of energy correlations.

The boring logs presented in Appendix A describe the vertical sequence of soils and materials encountered in each boring, based primarily on our field classifications and supported by subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, as well as any laboratory tests performed on these soil samples. If groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the boring log. The logs also indicate the well screen interval if a well was installed in the boring. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted.

2.2 WELL INSTALLATION PROCEDURES

Boring B-2 was converted to a groundwater observation well after completion of the boring. The groundwater observation well consists of 2-inch-diameter polyvinyl chloride (PVC pipe), the lower 10 feet of which is finely slotted. The annular space around the slotted segment was backfilled with clean sand, and the upper portion of the annulus was sealed with bentonite chips and concrete. A flush-mounted monument was placed over the top of the wellhead for protection. The as-built configuration of the observation well is illustrated on the respective boring log in Appendix A. Barometric and groundwater monitoring pressure transducers were installed in the well on December 26, 2017, to monitor and record groundwater fluctuations versus time on an hourly basis.

3.0 SITE CONDITIONS

This section presents our observations, measurements, findings, and interpretations regarding utilities, surface, soil, and groundwater conditions at the project site.

3.1 UTILITIES CONDITIONS

No existing underground utilities are present at the project site. The existing underground utilities lie within the rights-of-way along Hogum Bay Road NE and Marvin Road NE adjacent to the east and west property boundaries. However, two existing electrical and cable boxes, Puget Sound Energy 10-foot by 10-foot and TCI 4-foot by 6-foot (non-plotable) extend from the Marvin Road NE right-of-way into the west margins of the project site (Figure 2). Also, one groundwater monitoring well in the

northeast corner of the property may be associated with the groundwater monitoring program for the Hawks Prairie Landfill.

3.2 SURFACE CONDITIONS

The site topography undulates across the site from west to east and from north to south. Near the northwestern corner of the site, topography along Marvin Road NE is relatively flat, sloping at 2.5 percent from elevation 224 feet to elevation 212 at the southwest corner of the site. Moving 250 feet east from Marvin Road NE the topography slopes down at 6 percent into a depression to an elevation of 212 feet before moderately rising at a slope of 12 percent to a north/south-trending ridge at an elevation of 220 feet roughly 100 feet east of the depression. At this north/south-trending ridge, the topography slopes down to the east to elevation 214 feet before rising to elevation 218 feet at the northeast corner of the site along Hogum Bay Road NE. Through the central and east-central areas of the site, there are topographic highs at elevations of 220 feet before sloping down at grades of 15 percent to roughly elevation 212 feet that rings the northern boundary of the infiltration pond to the south.

The project site is located within a heavily wooded and vegetated area consisting of secondary growth of conifers (Douglas-fir and western redcedar) with a few deciduous trees of maple and alder. Understory vegetation consists of wild grasses, scrub brush, ferns, blackberries, and Oregon grape. No visible surface water was present within the site boundaries at the time of the site exploration.

3.3 SOIL CONDITIONS

According to published geologic maps (Logan et al. 2003), soil and subsurface conditions in the site vicinity are characterized by recessional outwash deposits underlain by glacial till of Vashon age. The recessional outwash deposits are characterized by poorly to well graded sand and gravel with varying amounts of silt and clay. The glacial till deposits consist of very dense silty sand with gravel and clay.

In general, our on-site explorations revealed fairly uniform near-surface soil conditions and confirmed the mapped stratigraphy. The exploration borings encountered the following strata:

- Existing Fill: Two of our explorations, B-1 and B-3, drilled in the west-central and east-central areas of the project site, respectively, encountered fill soils. The fill soils in B-1 consisted of 2 feet of loose, yellowish brown sandy gravel with trace to some silt. The fill soils in B-3 consisted of roughly 6.5 feet of loose dark brown-brown sandy gravel with some silt and trace organics. These soils appear to be pseudo-topsoil deposits that were stripped from somewhere in the area and stockpiled here. It was difficult to determine if the soils between 6.5 and 9 feet below the ground surface in B-3 were fill or native recessional outwash deposits. These soils consisted of medium dense yellowish brown sandy gravel

with trace silt to some silt and scattered organic material at 8.7 feet that could be interpreted to be fill soils.

- Pseudo-Topsoil Deposits: Underlying the fill soils in boring B-1, drilled in the west-central area of the project site, we encountered pseudo-topsoil deposits. The thickness of these deposits was up to 3.5 feet. The deposits consist of loose to medium dense, blackish brown, sandy gravel with some silt and are considered to be a pseudo-topsoil mantling the underlying recessional outwash deposits. We have classified this soil as a pseudo-topsoil because of its high percentage of gravel and low percentage of organic-rich material compared to typical topsoil.

- Recessional Outwash (Qgo): All of our explorations encountered recessional outwash deposits at the surface (Boring B-2) or beneath the fill or pseudo-topsoil deposits (Borings B-1 and B-3). The recessional outwash deposits consisted of medium dense to dense sandy gravel with trace silt and cobbles extending from depths of 0 to 9 feet downward to depths of 12 to 20 feet below the ground surface. Beneath the sandy gravelly soils were medium dense to dense gravelly sand to depths of 21 and 24 feet below the ground surface in borings B-2 and B-3. Boring B-1 was terminated in this soil layer at 26.5 feet below the ground surface. Beneath the gravelly sand in borings B-2 and B-3 was dense to very dense sandy gravel. Boring B-3 was terminated in this soil layer at 26.5 feet. Boring B-2 encountered this layer from 21 to 25 feet below the ground surface.

- Glacial Till (Qvt): Exploration boring B-2 was drilled deep enough to encounter the glacial till soils. The glacial till soils were encountered at 25 feet below the ground surface and continued to the full depth of our boring of 26.3 feet. These soils generally consisted of very dense till that was wet. The glacial till is a mixture of clay, silt, sand, gravel, cobbles, and possibly boulders that has been over-ridden by continental glaciers. Over-consolidation of this well-graded soil created high shear strengths, low compressibility, and low permeability.

The boring logs in Appendix A provide a detailed description of the soil strata encountered in our subsurface explorations, and Table 2 summarizes the approximate thicknesses, depths, and elevations of selected soil layers.

Table 2 Approximate Thicknesses, Depths, and Elevations of Soil Layers Encountered in Explorations

Exploration	Thickness of Existing Fill (feet)	Thickness of Pseudo-Topsoil (feet)	Thickness of Recessional Outwash (feet)	Depth to top of Glacial Till (feet)	Elevation of top of Glacial Till (feet)
B-1	2	3.5	>21	NDE	NDE
B-2	N/E	N/E	25	25	187
B-3	6.5-9	N/E	>17.5	NDE	NDE

Elevation datum: Site topographic map by Barghausen Consulting Engineers, Inc., dated 07/31/07 (NAVD 88).
N/E = not encountered. NDE = not drilled deep enough.

A summary of geotechnical laboratory test results is presented in Table 3. We interpret sandy gravel and gravelly sand soils to be currently below or near their optimum moisture contents, and to be relatively insensitive to moisture content variations. However, the composite soil sample from boring B-2 (S-4 and S-5), consisting of silty sand with some gravel and silt fine sand seams, had a very high silt content of 34 percent. Soils with a fines content (silts and clays) of 15 percent or higher would be difficult to reuse as structural fill during the winter and spring months. The laboratory test sheets in Appendix B graphically present the test results, and Table 3 summarizes these results.

Table 3 Laboratory Test Results for On-site Soils

Soil Type and Source	Sample No / Depth (feet)	Moisture Content (percent)	Gravel Content (percent)	Sand Content (percent)	Silt/Clay Content (percent)
B-1 (Outwash)	Composite S-2/S-3, 7.5 to 11.5	4.2	74.9	23.1	2.0
B-2 (Outwash)	S-3, 10 to 11.5	3.5	53.5	37.6	8.9
B-2 (Outwash)	Composite S-4/S-5 12.5-16.5	8.5	23.7	34.3	42.0
B-3 (Outwash)	Composite S-3/S-4,10 to 14	4.1	77.3	20.8	1.9

3.4 GROUNDWATER CONDITIONS

At the time of drilling (December 2017), groundwater was encountered in borehole B-2 at a depth of 24 feet (measured on December 26, 2017) below the ground surface at an elevation of 188 feet. No groundwater was encountered in any of the other explorations. This groundwater is believed to be perched on top of the very dense glacial till soils. Because our explorations were performed during an extended period of wet weather, the observed groundwater conditions may closely represent the yearly high levels for the depths explored; somewhat lower levels may occur during the summer and fall months. At all times of the year, groundwater levels would likely fluctuate in response to precipitation patterns, off-site construction activities, and site utilization.

On December 26, 2017, we installed a pressure transduced in well B-2 to monitor groundwater fluctuations through the end of March 2018. The pressure transducer was installed at a depth of 23.5 feet below ground surface. A barometric pressure transducer was also installed in the borehole above groundwater level to compensate for barometric pressure changes during groundwater monitoring. The installed pressure transducer was programed to read and record the groundwater level on an hourly basis. We downloaded, manually checked, reviewed, and plotted groundwater levels on a monthly basis. In summary, groundwater fluctuated approximately 2 feet compared to the water level observed on the day of drilling. For the duration of the monitoring period, the groundwater

level stayed below elevation 188 feet. Chart 1 shows groundwater fluctuations between December 26, 2017, and March 29, 2018.

3.5 PRELIMINARY STORMWATER INFILTRATION ASSESSMENT

We understand that stormwater runoff generated on hardscaped areas of the proposed project development area will be infiltrated into new stormwater detention facilities, yet to be located. The infiltration system(s) has/have yet to be designed, and preliminary information obtained from this exploration program will be used to help site and design the proposed facilities.

3.5.1 Infiltrating Test Procedure

In situ infiltration testing was not performed at the project site at this time, as this investigation is being conducted to evaluate the feasibility of on-site stormwater infiltration and to develop preliminary infiltration recommendations. We relied on laboratory testing of representative samples obtained from our explorations within the project area to determine preliminary infiltration rates across the project site. The recessional outwash deposits were encountered in all of our explorations extending to depths ranging from 24 feet to greater than 26.5 feet below the ground surface and in most cases should be favorable for infiltrating surface stormwater runoff. Results of laboratory grain size analyses indicated the grain size distribution of recessional outwash sediments could vary at the proposed infiltration depth(s). Gravel content of the recessional outwash deposits tested ranged from 54 percent to 75 percent, while the fines content generally varied from 2 to 9 percent. Several silty sand seams were encountered in boring B-2 from 12 to 17 feet below the ground surface and had a fines content of 42 percent.

Amec Foster Wheeler used the City of Lacey 2016 Stormwater Design Manual Appendix Chapter 7A—Methods for Determining Design Infiltration Rates to estimate infiltration rates through the receptor soils (City of Lacey, 2016). For preliminary design, we used 7A.3 Method 2—Soil Grain Size Analysis Method.

Method 2 applies to project sites that are underlain by type A soils. Based on United States Department of Agriculture Natural Resource Conservation Service web soil survey mapping for Thurston County, Washington, the site is underlain by Spanaway gravelly sandy loam. According to the Interpretive Groups listed for the Spanaway Gravelly Loam, this soil unit is classified in the Hydrologic Soil Group A.

Equation (1) in Method 2 is used to estimate the initial saturated hydraulic conductivity (K_{sat}) in units of centimeters per second as follows:

$$\log10(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

where:

K_{sat} = Initial Saturated Hydraulic Conductivity
D_{10} = Grain Size in millimeters for 10 Percent Passing
D_{60} = Grain Size in millimeters for 60 Percent Passing
D_{90} = Grain Size in millimeters for 90 Percent Passing
f_{fines} = The Percent of Soil (by weight) that Passes U.S. Sieve #200

These parameters are obtained from the grain size distribution analyses of tested soil samples. The laboratory test results are included in Appendix B. The results for K_{sat} are provided in Table 4.

Table 4 Initial K_{sat} Values Using Method 2—Soil Grain Size Analysis

Boring	Sample	Depth (feet)	D_{10} (mm)	D_{60} (mm)	D_{90} (mm)	f_{fines}	$\log_{10}K_{sat}$	K_{sat} (cm/sec)	K_{sat} (in/hour)
B-1	S-2/S-3	7.5-11.5	1.30	18.0	25.0	0.02	0.80	6.359	>100
B-2	S-3	10.0-11.5	0.15	8.3	16.0	0.089	-1.55	0.028	40
B-2	S-4/S-5	12.5-16.5	0.01	0.30	20.0	0.42	-2.68	0.002	3
B-3	S-3/S-4	10.0-14.0	1.10	17.0	24.0	0.019	0.42	2.606	>100

$$K_{equiv} = \frac{d}{\sum \frac{d_i}{K_i}}$$

After determining the K_{sat} values based on this relationship for the different soil layers below the bottom of the proposed infiltration facility, the K_{equiv} values are calculated for each of the infiltration areas using the harmonic mean of the K_{sat} values determined for each soil layer beneath the bottom of the proposed infiltration area. According to the Stormwater Manual, the harmonic mean provides an appropriate effective hydraulic conductivity for flow that is perpendicular to the stratigraphic layers.

The effective hydraulic conductivity is calculated using Equation (2) under Method 2 in the *City of Lacey 2016 Stormwater Design Manual* as follows:

where:

K_{equiv} = Initial Satuirated Hydraulic Conductivity Determined Using Harmonic Mean
d_i = Thickness of Soil Layer i
K_i = Saturated Hydraulic Conductivity of Layer i

The results for K_{equiv} for each infiltration area are provided in Table 5.

Table 5 K_{equiv} Values for Each Boring Profile

Depth below ground surface (feet)	Boring B-1 K_i	d_i	d_i/K_i
6.5	9,013	6.5	0.001
14	50	7.5	0.150
21	35	7	0.200
28.5	13	7.5	0.577
		d	**$\Sigma\ d_i/K_i$**
		28.5	0.928
		K_{equiv} (in/hour)	**31**

Depth below ground surface (feet)	Boring B-2 K_i	d_i	d_i/K_i
7	9,013	7	0.001
12	40	5	0.125
17	3	5	1.667
21	35	4	0.086
24	13	3	0.230
		d	**$\Sigma\ d_i/K_i$**
		24	2.109
		K_{equiv} (in/hour)	**11**

Table 5 K_{equiv} Values for Each Boring Profile - Continued

Depth below ground surface (feet)	Boring B-3		
	K_i	d_i	d_i/K_i
2.5	40	2.5	0.063
13.5	3,758	11	0.003
17.5	50	4	0.060
20	40	2.5	0.063
22.5	13	2.5	0.19
		d	$\Sigma\ d_i/K_i$
		22.5	0.380
		K_{equiv} (in/hour)	57

According to Appendix 7A.2.1, Safety Factors for Field Measurements are incorporated into field testing procedures to obtain the design infiltration rate by the following equation:

$$I_{design} = I_{measured} \times F_{testing} \times F_{geometry} \times F_{plugging}$$

where:

I_{design} = Maximum Design Infiltration Rate
$I_{measured}$ = Stort Term (Measured) Infiltration Rate
$F_{testing}$ = Acsounts for Uncertanties in the Testing (0.4 fro Grain Size Method)
$F_{geometry}$ = Accounts for Uncertanties in the Facility Geometry (1.0 Assumed)
$F_{plugging}$ = Accounts for Sedimentation of Infiltration Media

For the project site, we assume the following safety factor values apply:

$F_{testing}$ = 0.4 (for lab testing)
$F_{geometry}$ = 1.0 (for infiltration trenches, where the value of $4D/W$ +0.05 is greater than 1.0)
$F_{plugging}$ = 0.9 (for medium sand)

where:

D = Depth from the bottom of the proposed facility to the maximum winter season water table or nearest impervious layer, whichever is less

W = Width of facility.

Table 6 summarizes preliminary design values obtained when applying these safety factors.

Table 6 $K_{sat\ design}$ Values for Each Boring Profile

Boring	K_{equiv} (in/hour)	$F_{testing}$	$F_{geometry}$	$F_{plugging}$	$K_{sat\ design}$ (in/hour)
B-1	31	0.4	1	0.9	**11**
B-2	11	0.4	1	0.9	**4**
B-3	57	0.4	1	0.9	**20**

In the description of Method 2, it is suggested that if the tested sample immediately below the pond bottom has a lower K_{sat} value than the $K_{equivalent}$ for that profile, the lower value should be used. In boring B-2 at 12 feet, the K_i value was determined to be 4 inches/hour. When applying the safety factors, the $K_{sat\ design}$ value would be as follows:

$K_{sat\ (in/hour)}$	$F_{testing}$	$F_{geometry}$	$F_{plugging}$	$K_{sat\ design}$ (in/hour)
4	0.4	1	0.9	**1**

Based on four samples collected below possible locations of infiltration ponds and tested for grain size analyses (for this study), as well as four additional samples tested for grain size distribution in the Spanaway gravely sandy loam (for a previous study to the north), this is the lowest computed value for K_{sat} by a factor of more than three. Based on this testing and observations made during drilling, we conclude that there are occasional discontinuous interbeds within the formation that may contain up to 40 percent fines and are near the base of the formation above the glacial till deposits. However, it is highly unlikely that a continuous layer would be encountered along the entire property as this silty sand was not encountered in borings B-1 and B-3. For this reason, we would conclude that a $K_{sat\ design}$ value of 10 inches per hour would be an appropriate value for design infiltration ponds at this time. It is recommended that once the locations of the infiltration ponds have been determined, the infiltration rates should be evaluated using 7A.1 Method 1. Field Testing Procedures (must incorporate safety factor).

Separation from groundwater: Groundwater was encountered and it is estimated to be at an elevation of approximately 188 to 190 feet. Wet soils were encountered in boring B-2 at depths of 21 to 24 feet below the existing ground surface. This depth to groundwater should provide adequate separation of at least 20 feet for any planned infiltration pond with a planned base elevation of 212 feet or higher.

3.5.2 Site Suitability Criteria

The Stormwater Manual outlines eight specific site suitability criteria for siting infiltration systems: (1) setback criteria; (2) groundwater protection areas; (3) high vehicle traffic areas; (4) soil infiltration/drawdown time; (5) depth to bedrock, water table, or impermeable layer; (6) soil physical and chemical suitability for treatment; (7) seepage analysis and control; and (8) cold climate and impact of roadway deicers. Through our exploration program we are able to provide information regarding soil infiltration/drawdown time and depth to water table and impermeable layer.

During drilling, soil samples were collected, and selected samples were tested in the laboratory for grain size distribution and moisture content determinations. The results are summarized in Table 4, and laboratory sheets are included in Appendix B.

4.0 RECOMMENDED ADDITIONAL SERVICES

This report was provided to evaluate on-site stormwater infiltration potential and to determine preliminary infiltration rates. We advanced three borings (designated B-1 through B-3) at strategic locations across the site primarily to evaluate hydrogeologic conditions. This information could be used for geotechnical site assessment and design on proposed structures. It should be noted that the explorations performed and used for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other locations could vary. Therefore, additional subsurface study will be required to supplement design. We recommend that Amec Foster Wheeler be retained to provide the following additional services:

- Review preliminary design documents and plans and perform additional site exploration consisting of test pit excavation to evaluate subsurface conditions within the footprint of proposed structures, parking lots, site access lanes, and infiltration facilities.
- Perform on-site pilot infiltration tests (PITs) for each required stormwater infiltration facility in accordance with the Stormwater Manual.
- Develop design recommendations, including recommendations for foundation design, retaining wall design, seismic design, pavement design, and stormwater infiltration facilities.
- Review design plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design.
- Attend a pre-construction conference with the design team and contractor to discuss important geotechnical-related construction issues.

- During construction, observe all exposed subgrades after completion of stripping and overexcavation to confirm that suitable soil conditions have been reached and to determine appropriate subgrade compaction methods.
- Monitor the placement of all structural fill and test the compaction of structural fill soils to verify their conformance with the construction specifications.

5.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations Amec Foster Wheeler performed and used for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Amec Foster Wheeler is available to provide geotechnical assessment, geotechnical recommendations, construction monitoring, soils testing, and other services throughout design and construction.

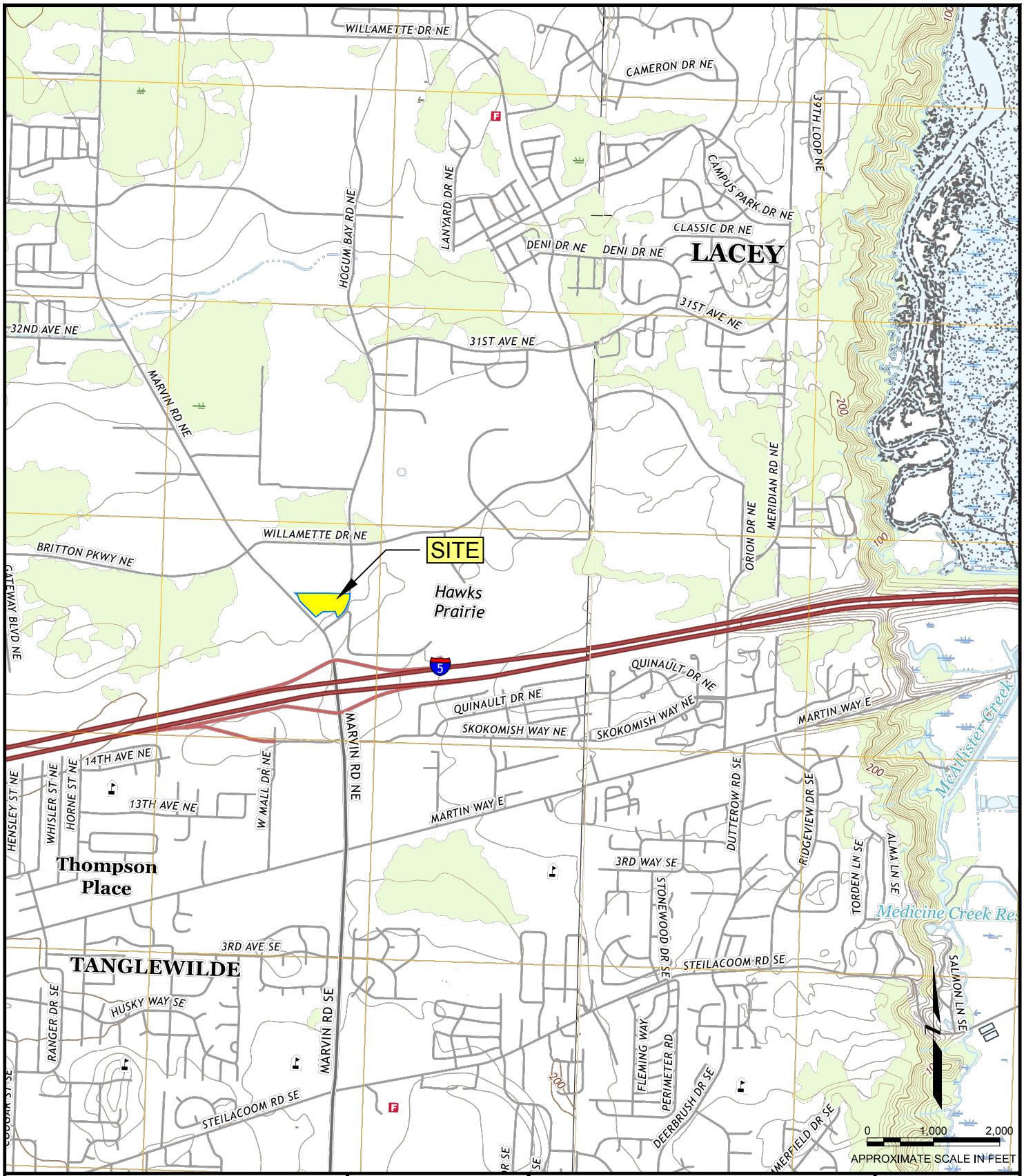
6.0 REFERENCES

City of Lacey, 2016. Stormwater Design Manual. Prepared by City of Lacey Department of Public Works, Water Resources Division. Effective Date: October 13, 2017.

Logan, R.L., Walsh, T.J., Schasse, H.W., and Polenz, M., 2003, Geologic Map of the Lacy 7.5-minute Quadrangle, Thurston County, Washington: Washington Division of Geology and Earth Resources, Open File Report 2003-9, scale 1:24,000

United States Department of Agriculture, Natural Resources Conservation Service. *Web Soil Survey*. (n.d.) Retrieved March 16, 2018, from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Figures



CLIENT
Monte Square Enterprises
100 Brumfield Avenue
Montesano, Washington 98563

Amec Foster Wheeler
Environment & Infrastructure, Inc.
221 South 28th Street, Suite 102
Tacoma, Washington 98402

amec foster wheeler

PROJECT
HOGUM BAY
COMMERCIAL SITE

TITLE
SITE LOCATION MAP

DATE
MARCH 2018

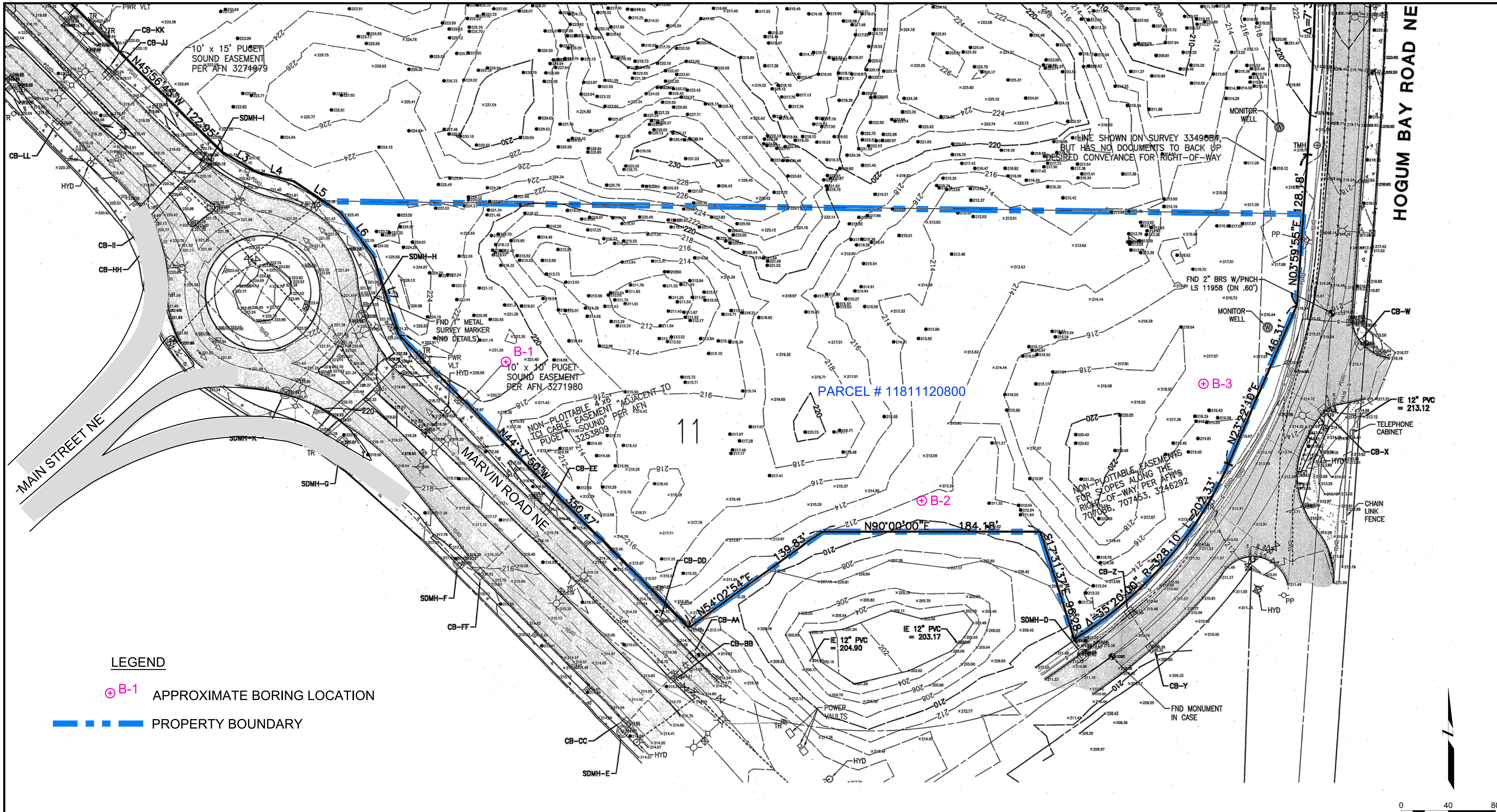
SCALE
AS SHOWN

PROJECT NO.
PS17-19162-0

FIGURE
1

DRAWN BY: APS CHECKED BY: HB

C:\Users\adam.stenberg\appdata\local\temp\AcPublish_4840\HogumBayCommercial_Site_010918.dwg - AFW_8x11_P - Jan. 09, 2018 1:16pm - adam.stenberg



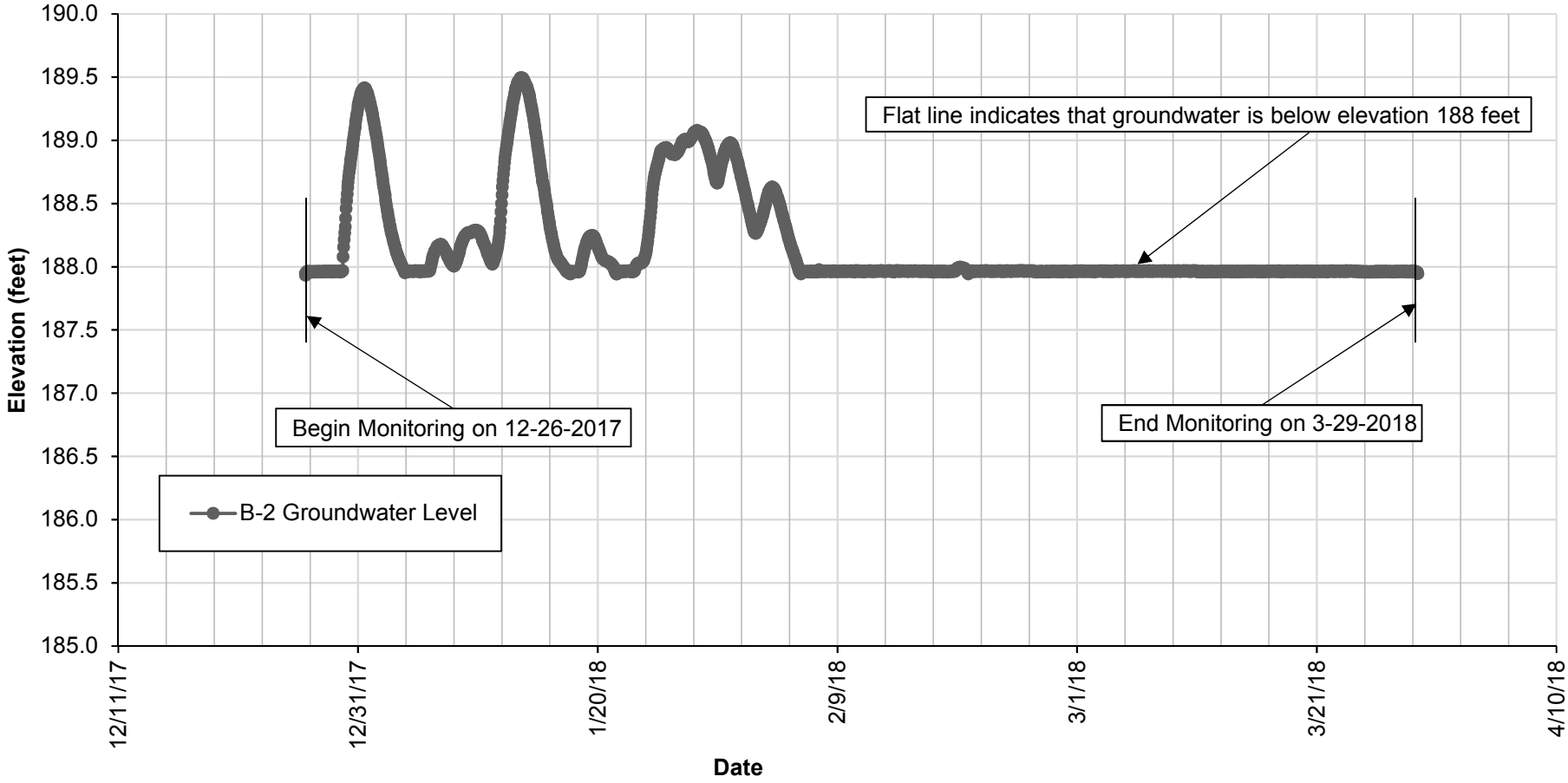
BASEMAP COURTESY OF BARGHAUSEN CONSULTING ENGINEERING, INC. (JULY, 2007)

CLIENT Monte Square Enterprises 100 Brumfield Avenue Montesano, Washington 98563	amec foster wheeler	PROJECT HOGUM BAY COMMERCIAL SITE	DATE MARCH 2018 SCALE AS SHOWN
Amec Foster Wheeler Environment & Infrastructure, Inc. 221 South 28th Street, Suite 102 Tacoma, Washington 98402		TITLE SITE AND EXPLORATION PLAN	PROJECT NO. PS17-19162-0 FIGURE 2

DRAWN BY: APS CHECKED BY: HB

C:\Users\adam.stenberg\appdata\local\temp\AcPublish_1500\HogumBayCommercial_Site_010918.dwg - AFW_11x17_L - Feb. 01, 2018 6:26pm - adam.stenberg

Charts



NOTES

1. Location and ground surface elevation of well B-2 is approximate and is assumed to be 212 feet. Groundwater monitoring data logger installed at elevation 188 feet.
2. Ground surface elevation is based on the topographic elevation presented on topographic survey, sheet 2 of 3, of the Barghausen Consulting Engineering, Inc. (July, 2007).

Monte Square Enterprises 100 Brumfield Avenue Montesano, Washington 98563	amec foster wheeler	HOGUM BAY COMMERCIAL SITE Lacey, Washington	DATE: MARCH 2018
			SCALE: NOT TO SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 221 South 28th Street, Suite 102 Tacoma, Washington 98402		OBSERVATION WELL B-2 MEASURED GROUNDWATER LEVELS	PROJECT NO.: PS17191620
			CHART: 1

Appendices

Appendix A

Subsurface Exploration Procedures and Results

APPENDIX A

SUBSURFACE EXPLORATION PROCEDURES AND RESULTS
Project No. PS17-19162-0

The following paragraphs describe procedures associated with the field explorations and field tests Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler), conducted for this project. Descriptive logs of our explorations are enclosed in this appendix.

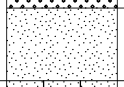
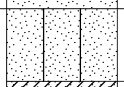
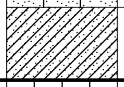
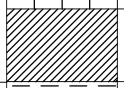
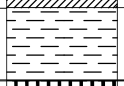
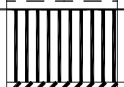
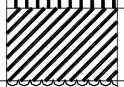
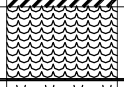
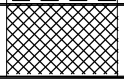
AUGER BORING PROCEDURES

Our exploratory borings were advanced with a hollow-stem auger, using a truck-mounted drill rig operated by an independent drilling firm working under subcontract to Amec Foster Wheeler. An engineering geologist from Amec Foster Wheeler continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to a laboratory for further visual examination and testing. After each boring was completed, the borehole was backfilled with a mixture of bentonite chips and soil cuttings, and the surface was patched with soil or concrete (well installation).

Throughout the drilling operation, soil samples were obtained at 2.5- or 5-foot depth intervals by means of the Standard Penetration Test (SPT) per ASTM D-1586. This testing and sampling procedure consists of driving a standard 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the standard penetration resistance, or "SPT blow count." If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting standard penetration resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily on our field classifications and supported by subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings, as well as the results of selected laboratory tests performed on these soil samples. If groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the boring log. Groundwater depth estimates are

typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted.

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE)	GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVELS (LESS THAN 5% FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (GREATER THAN 12% FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS (MORE THAN 50 OF COARSE FRACTION PASSING NO. 4 SIEVE)	CLEAN SANDS (LESS THAN 5% FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (GREATER THAN 12% FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)	INORGANIC		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		ORGANIC		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)	INORGANIC		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
		ORGANIC		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS
FILL SOILS				FILL (AF)	HUMAN ALTERED SOIL OR MODIFIED LAND

NOTES:

1. SOIL DESCRIPTIONS ARE BASED ON THE GENERAL APPROACH PRESENTED IN THE STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE), AS OUTLINED IN ASTM D 2488. WHERE LABORATORY INDEX TESTING HAS BEEN CONDUCTED, SOIL CLASSIFICATIONS ARE BASED ON THE STANDARD TEST METHOD FOR CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES, AS OUTLINED IN ASTM D 2487.

2. SOIL DESCRIPTION TERMINOLOGY IS BASED ON VISUAL ESTIMATES (IN THE ABSENCE OF LABORATORY TEST DATA) OF THE PERCENTAGES OF EACH SOIL TYPE AND IS DEFINED AS DESCRIBED BELOW:

3. DUAL SYMBOLS (E.G. SP-SM, OR GP-GM) ARE USED TO INDICATE A SOIL WITH AN ESTIMATED 5-12% FINES.

   PRIMARY CONSTITUENT: >50% - "GRAVEL", "SAND", "SILT", "CLAY", etc.
   SECONDARY CONSTITUENTS: >12% and ≤50% - "gravelly", "sandy", "silty", etc.
   ADDITIONAL CONSTITUENTS: >5% and ≤12% - "some gravel", "some sand", "some silt", etc.
   ≤5% - "trace gravel", "trace sand", "trace silt" etc. or not noted.

4. RELATIVE DENSITY OF SOIL IS BASED ON STANDARD TEST METHOD FOR PENETRATION TEST (SPT) AND SPLIT-BARREL SAMPLING OF SOILS ASTM D 1586 OR CORRELATIONS FOR OTHER SIMPLER TYPES AND METHODS FOR SPT SAMPLING, THE FOLLOWING BLOW COUNT CORRELATION APPLIES.

   A. RELATIVE DENSITY OF COARSE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
   VERY LOOSE: N = ≤4
   LOOSE: N = >4 AND ≤10
   MEDIUM DENSE: N = >10 AND ≤30
   DENSE: N = >30 AND ≤50
   VERY DENSE: N = >50

   B. RELATIVE CONSISTENCY OF FINE GRAINED SOILS (N = BLOWS/FOOT SPT METHOD)
   VERY SOFT: N = <2
   SOFT: N = ≥2 AND ≤4
   MEDIUM STIFF: N = >4 AND ≤8
   STIFF: N = >8 AND ≤15
   VERY STIFF: N = >15 AND ≤30

Amec Foster Wheeler
Environment & Infrastructure, Inc.
4020 Lake Washington Blvd. NE, Suite 200
Kirkland, Washington 98033

amec foster wheeler

SOIL CLASSIFICATION CHART / KEY

DATE: MARCH 2018
SCALE: NOT TO SCALE
PROJECT NO.: PS17-19162-0
FIGURE: A-1

DRAWN BY: JRS CHECKED BY: JD

PROJECT: *Hogum Bay Commercial Site* JOB No. *PS17-19162-0* BORING No. *B-1*

Location: W central area of site
Approximate ground surface elevation: ~222'

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Wild Grass over Loose, moist, yellowish brown, sandy GRAVEL with some silt (Fill) GP				N/E
	Loose, moist, blackish brown, sandy GRAVEL with some silt and trace organics (Pseudo Topsoil) GP-GM				
5	Loose, moist, yellowish brown, sandy GRAVEL with trace silt (Recessional Outwash) GW			S-1	
	Becomes medium dense			S-2	
10				S-3	
	Medium dense, moist, yellowish brown, gravelly SAND with trace silt (Recessional Outwash) SP			S-4	
15				S-5	
				S-6	
20	Medium dense, moist, yellowish brown SAND with some gravel and trace silt (Recessional Outwash) SP			S-7	
25				S-8	
30	Boring terminated at approximately 26.5 feet				

PENETRATION RESISTANCE
▲ Standard ##/## Blows over inches △ Other
Blows per foot
0 10 20 30 40 50

Standard penetration values: 7, 14, 14, 18, 17, 16, 11, 26

Page 1 of 1

TESTING: 2

0 20 40 60 80 100
Plastic Limit MOISTURE CONTENT Liquid Limit

LEGEND

- 2.00-inch OD split-spoon sampler
- No Recovery
- N/E No groundwater encountered
- Grain Size Analysis (% fines shown)

amec foster wheeler
4020 Lake Washington Blvd NE, Ste 200
Kirkland, WA 98033

Drilled by: *Holocene Drilling* Hammer Type: Automatic Date drilled: *December 21, 2017* Logged By: *HWB/EK*
Drilling Method: HSA

KIRKLAND_GEO_2017.GLB 2017 BORING_LOG FORMAT HOGUM BAY COMMERCIAL SITE.GPJ KIRKLAND_TEMPLATE_2017.GDT PRINTDATE 3/19/18

PROJECT: *Hogum Bay Commercial Site* JOB No. *PS17-19162-0* BORING No. *B-2*

Location: S central area of site
Approximate ground surface elevation: ~212'

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Wild grasses over Loose, damp, brown GRAVEL with some sand and trace silt (Recessional Outwash) GP				
5				S-1	
	Dense, moist, yellowish brown, sandy GRAVEL with some silt (Recessional Outwash) GP-GM			S-2	
10				S-3	
	Blow counts overstated due to gravel				
	Dense, moist, yellowish brown, gravelly, silty SAND (Recessional Outwash) SM; silty fine SAND seam from 13.2 to 13.5 feet			S-4	
15				S-5	
	Silty fine SAND seam from 16.0 to 16.5 feet				
	Very dense, moist to wet, yellowish brown, gravelly SAND with some silt (Recessional Outwash) SP-SM			S-6	
	Blow counts overstated due to gravel				
20				S-7	
	Very dense, wet to saturated, yellowish brown, sandy GRAVEL with some silt (Recessional Outwash) GP-GM				12/26/17
25				S-8	
	Very dense, wet, brown, silty, gravelly SAND (Glacial Till) SM				
	Unique DOE Well #PKC-276 Boring terminated at approximately 26.25 feet				
30					

PENETRATION RESISTANCE
▲ Standard ##/## Blows over inches △ Other
Blows per foot
0 10 20 30 40 50

S-1: 9
S-2: 30
S-3: 70
S-4: 35
S-5: 28
S-6: 60
S-7: 69
S-8: 50/3

TESTING: 9, 42

0 20 40 60 80 100
Plastic Limit MOISTURE CONTENT Liquid Limit

Page 1 of 1

LEGEND
- 2.00-inch OD split-spoon sampler
- Observed groundwater level
- Grain Size Analysis (% fines shown)

Observation well:
- Monument
- Bentonite Fill with PVC Pipe
- Groundwater Level
- Sand Fill with Slotted PVC Pipe
- Pipe Cap
- Slough at Bottom of Hole

amec foster wheeler
4020 Lake Washington Blvd NE, Ste 200
Kirkland, WA 98033

Drilled by: *Holocene Drilling* Hammer Type: Automatic Date drilled: *December 21, 2017* Logged By: *HWB*
Drilling Method: HSA

KIRKLAND_GEO_2017.GLB 2017 BORING_LOG FORMAT HOGUM BAY COMMERCIAL SITE.GPJ KIRKLAND_TEMPLATE_2017.GDT PRINTDATE 3/19/18

PROJECT: *Hogum Bay Commercial Site* JOB No. *PS17-19162-0* BORING No. *B-3*

Location: E central area of site
Approximate ground surface elevation: ~217'

DEPTH (feet)	Soil Description	USCS/USGS GRAPHICS	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Wild Grasses over Loose, moist, dark brown-brown, sandy GRAVEL with some silt and trace organics (Fill) GP-GM				N/E
5				S-1	
	Medium dense, moist, yellowish brown, sandy GRAVEL with trace to some silt (Fill/Recessional Outwash) GP-GM			S-2	
	Some reddish brown silty SAND at 8.7 feet (Fill?)				
10	Medium dense, moist, yellowish brown, sandy GRAVEL with trace silt (Recessional Outwash) GW			S-3	
				S-4	
15				S-5	
				S-6	
20	Medium dense, moist, yellowish brown, gravelly SAND with trace silt (Recessional Outwash) SP			S-7	
	Dense, moist, yellowish brown, sandy GRAVEL with trace silt (Recessional Outwash)				
25	Blow counts overstated due to gravel			S-8	
	Boring terminated at approximately 26.5 feet				
30					

PENETRATION RESISTANCE
Standard ▲ Blows over inches ## Other △
Blows per foot
0 10 20 30 40 50

Page 1 of 1

TESTING

S-1: 7
S-2: 17
S-3: 18
S-4: 10
S-5: 10
S-6: 12
S-7: 18
S-8: 57
Grain Size Analysis (% fines shown): 2

0 20 40 60 80 100
Plastic Limit — MOISTURE CONTENT — Liquid Limit

LEGEND

- 2.00-inch OD split-spoon sampler
- No Recovery
- N/E No groundwater encountered
- Grain Size Analysis (% fines shown)

amec foster wheeler
4020 Lake Washington Blvd NE, Ste 200
Kirkland, WA 98033

Drilled by: *Holocene Drilling* Hammer Type: Automatic Date drilled: *December 21, 2017* Logged By: *HWB/EK*
Drilling Method: HSA

KIRKLAND_GEO_2017.GLB 2017 BORING_LOG FORMAT HOGUM BAY COMMERCIAL SITE.GPJ KIRKLAND_TEMPLATE_2017.GDT PRINTDATE 3/19/18

Appendix B

Laboratory Testing Procedures and Results

APPENDIX B

LABORATORY TESTING PROCEDURES AND RESULTS
Project No. PS17-19162-0

The following paragraphs describe procedures associated with the laboratory tests conducted for this project. Graphical results of certain laboratory tests are enclosed in this appendix.

VISUAL CLASSIFICATION PROCEDURES

Visual soil classifications were conducted on all samples in the field and on selected samples in the laboratory. All soils were classified in general accordance with the Unified Soil Classification System, which includes color, relative moisture content, primary soil type (based on grain size), and accessory soil types. The resulting soil classifications are presented on the exploration logs in Appendix A.

MOISTURE CONTENT DETERMINATION PROCEDURES

Moisture content determinations were performed on representative samples to aid in identification and correlation of soil types. All determinations were made in general accordance with ASTM D-2216. The results of these tests are shown on the exploration logs contained in Appendix A.

GRAIN-SIZE ANALYSIS PROCEDURES

A grain-size analysis indicates the range of soil particle diameters included in a particular sample. Grain-size analyses were performed on representative samples in general accordance with ASTM D-422. The results of these tests are presented on the enclosed grain-size distribution graphs and were used in soil classifications shown on the exploration logs contained in Appendix A.

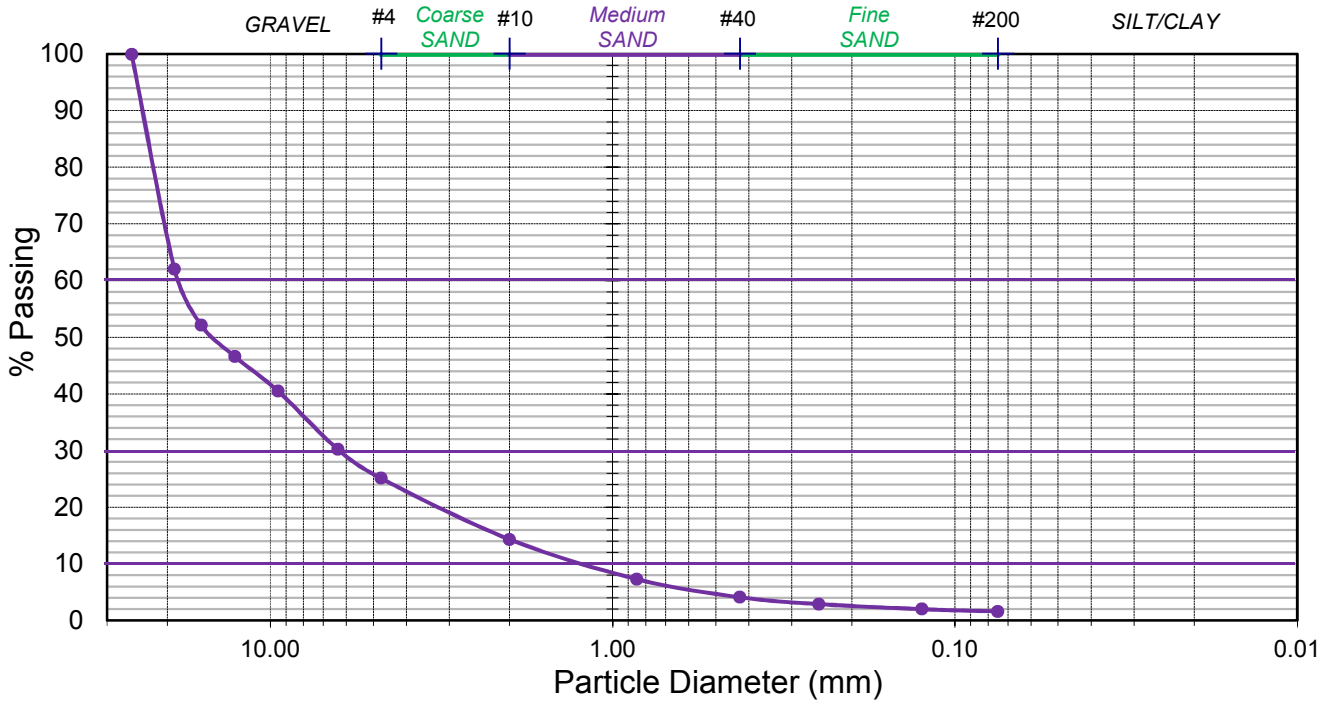
Sieve Analysis Data Sheet

ASTM D422

Project Name:	Hogum Bay Commercial Site	**Tested By:**	AMTEST	**Date:**	1/4/2018
Location:	Lacey, WA	**Checked By:**	AFW	**Date:**	1/18/2018
Test Pit No:	B-1, S-2/S-3	**Gnd Elev.:**	~222'	**Sample Depth:**	7.5' to 11.5'

USCS Soil Classification: **GW - Well graded GRAVEL with sand**

Sieve Number	Diameter (mm)	Soil Retained (%)	Soil Passing (%)	Particles
1"	25.4	0.1	99.9	Gravel
3/4"	19.05	37.9	62	
5/8"	15.9	9.9	52.1	
1/2"	12.7	5.5	46.6	
3/8"	9.5	6.1	40.5	
1/4"	6.35	10.3	30.2	
#4	4.75	5.1	25.1	
#10	2.0	10.8	14.3	Sand
#20	0.85	7	7.3	
#40	0.43	3.2	4.1	
#60	0.25	1.2	2.9	
#120	0.125	0.9	2	
#200	0.075	0.4	1.6	Fines
Pan	N/A	1.6	1.6	
	TOTAL:	100.0	0.0	



Grain Size Distribution Curve Results:

% Gravel:	74.9	**D_{10}:**	1.3	**C_u:**	13.8
% Sand:	23.1	**D_{30}:**	6.30	**C_c:**	1.7
% Fines:	2	**D_{60}:**	18		

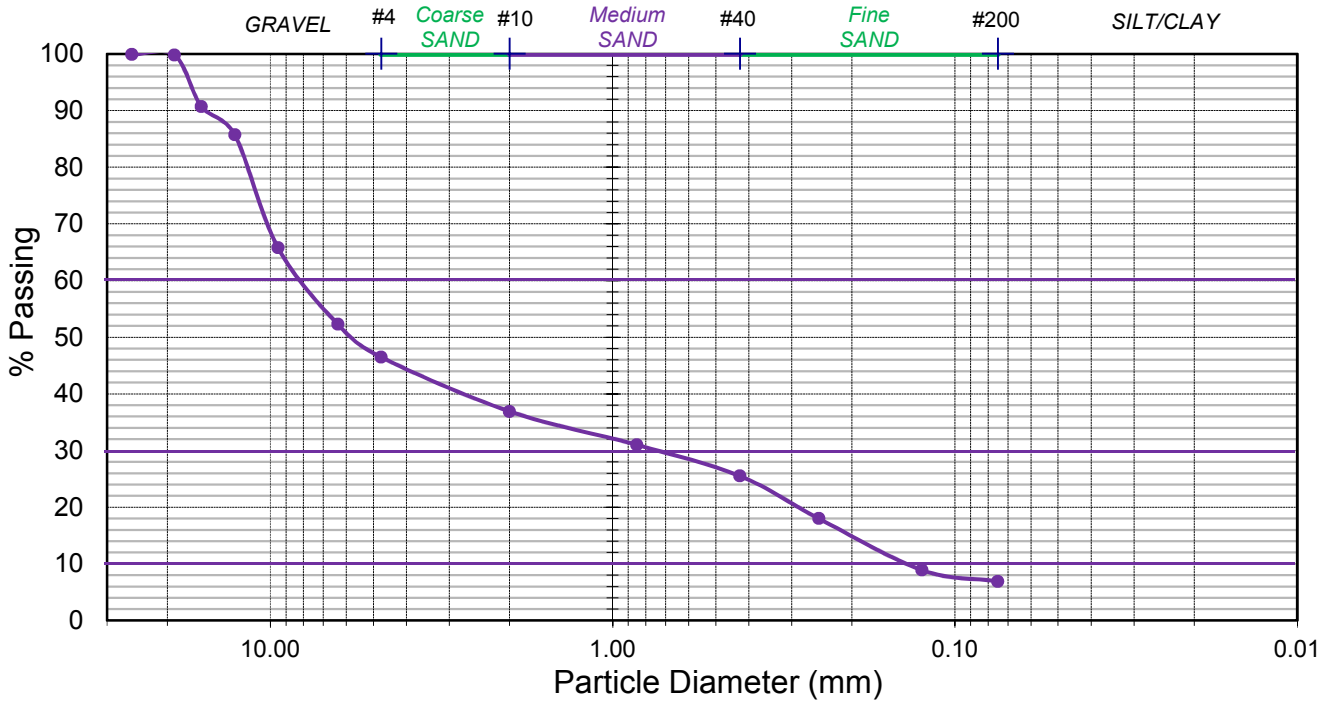
Sieve Analysis Data Sheet

ASTM D422

Project Name:	Hogum Bay Commercial Site	**Tested By:**	AMTEST	**Date:**	1/4/2018
Location:	Lacey, WA	**Checked By:**	AFW	**Date:**	1/18/2018
Test Pit No:	B-2, S-3	**Gnd Elev.:**	~212'	**Sample Depth:**	10' to 11.5'

USCS Soil Classification: **GW-GM - Well graded GRAVEL with sand and some silt**

Sieve Number	Diameter (mm)	Soil Retained (%)	Soil Passing (%)	Particles
1"	25.4	0.1	99.9	Gravel
3/4"	19.05	0.1	99.8	
5/8"	15.9	9.1	90.7	
1/2"	12.7	5	85.7	
3/8"	9.5	19.9	65.8	
1/4"	6.35	13.5	52.3	
#4	4.75	5.8	46.5	
#10	2.0	9.6	36.9	Sand
#20	0.85	5.9	31	
#40	0.43	5.5	25.5	
#60	0.25	7.5	18	
#120	0.125	9.1	8.9	
#200	0.075	2	6.9	Fines
Pan	N/A	6.9	6.9	
	TOTAL:	100.0	0.0	



Grain Size Distribution Curve Results:

% Gravel:	53.5	**D_{10}:**	0.15	**C_u:**	55.3
% Sand:	37.6	**D_{30}:**	0.70	**C_c:**	0.4
% Fines:	8.9	**D_{60}:**	8.3		

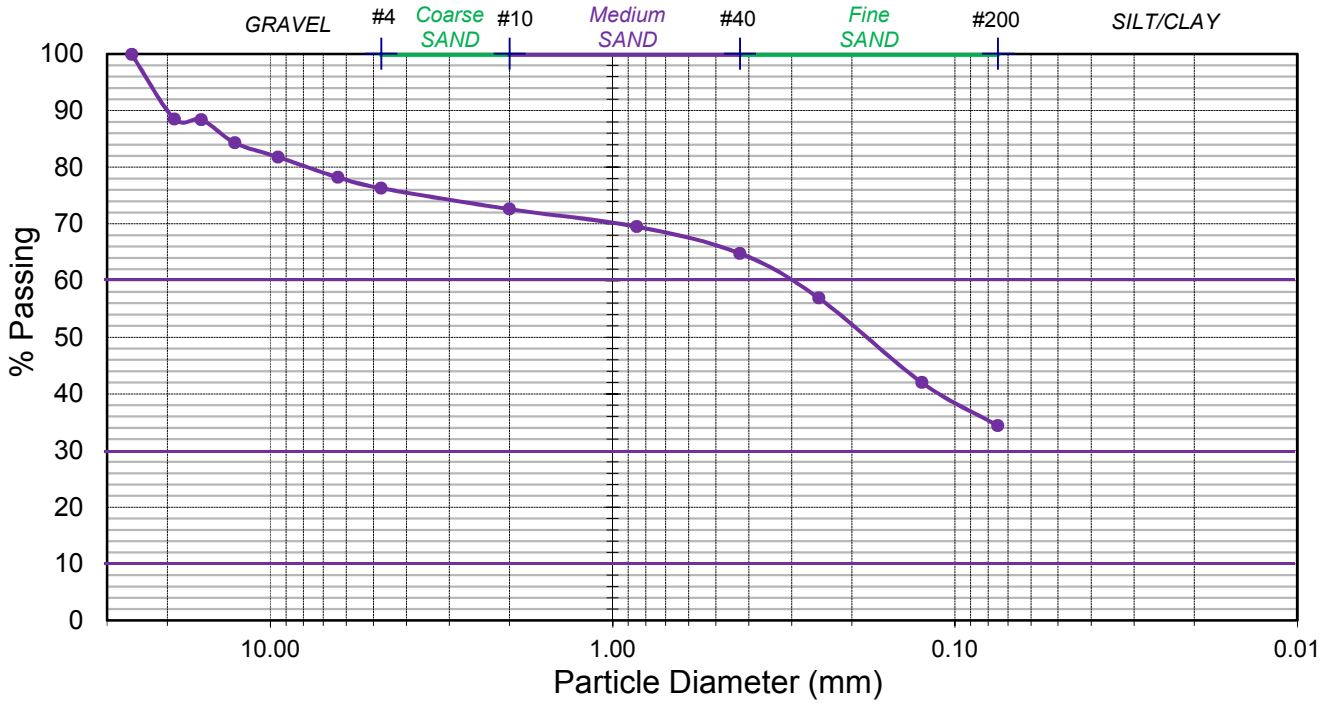
Sieve Analysis Data Sheet

ASTM D422

Project Name:	Hogum Bay Commercial Site	**Tested By:**	AMTEST	**Date:**	1/21/2018
Location:	Lacey, WA	**Checked By:**	AFW	**Date:**	1/23/2018
Test Pit No:	B-2, S-4 / S-5	**Gnd Elev.:**	~212'	**Sample Depth:**	12.5' to 16.5'

USCS Soil Classification: **SM - Silty SAND with gravel**

Sieve Number	Diameter (mm)	Soil Retained (%)	Soil Passing (%)	Particles
1"	25.4	0.1	99.9	
3/4"	19.05	11.4	88.5	
5/8"	15.9	0.1	88.4	
1/2"	12.7	4.1	84.3	**Gravel**
3/8"	9.5	2.5	81.8	
1/4"	6.35	3.6	78.2	
#4	4.75	1.9	76.3	
#10	2.0	3.7	72.6	
#20	0.85	3.1	69.5	
#40	0.43	4.7	64.8	**Sand**
#60	0.25	7.9	56.9	
#120	0.125	14.9	42	
#200	0.075	7.6	34.4	**Fines**
Pan	N/A	34.4	34.4	
	TOTAL:	100.0	0.0	



Grain Size Distribution Curve Results:

% Gravel:	23.7	**D_{10}:**	0.01	**C_u:**	30.0
% Sand:	34.3	**D_{30}:**	0.04	**C_c:**	0.5
% Fines:	42	**D_{60}:**	0.3		

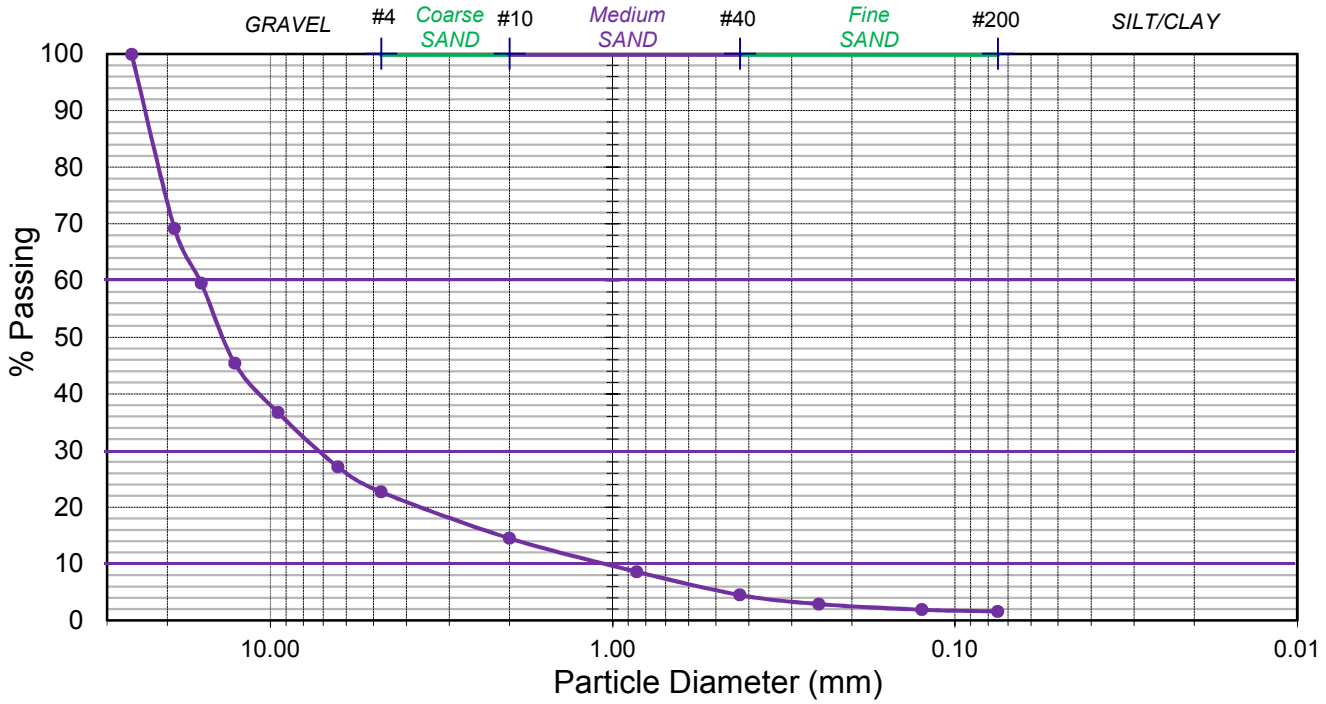
Sieve Analysis Data Sheet

ASTM D422

Project Name:	Hogum Bay Commercial Site	**Tested By:**	AMTEST	**Date:**	1/5/2018
Location:	Lacey, WA	**Checked By:**	AFW	**Date:**	1/18/2018
Test Pit No:	B-3, S-3/S-4	**Gnd Elev.:**	~217'	**Sample Depth:**	10' to 14'

USCS Soil Classification: **GW - Well graded GRAVEL with sand**

Sieve Number	Diameter (mm)	Soil Retained (%)	Soil Passing (%)	Particles
1"	25.4	0.1	99.9	Gravel
3/4"	19.05	30.7	69.2	
5/8"	15.9	9.7	59.5	
1/2"	12.7	14.1	45.4	
3/8"	9.5	8.7	36.7	
1/4"	6.35	9.6	27.1	
#4	4.75	4.4	22.7	
#10	2.0	8.2	14.5	Sand
#20	0.85	5.9	8.6	
#40	0.43	4.1	4.5	
#60	0.25	1.6	2.9	
#120	0.125	1	1.9	
#200	0.075	0.3	1.6	Fines
Pan	N/A	1.6	1.6	
	TOTAL:	100.0	0.0	



Grain Size Distribution Curve Results:

% Gravel:	77.3	**D_{10}:**	1.1	**C_u:**	15.5
% Sand:	20.8	**D_{30}:**	7.30	**C_c:**	2.8
% Fines:	1.9	**D_{60}:**	17		

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664

Professional Analytical Services

Jan 18 2018
AMEC E&I
4020 LAKE WASHINGTON BLVD NE
SUITE 200
KIRKLAND, WA 98033
Attention: MILAN RADIC

Dear MILAN RADIC:

Enclosed please find the analytical data for your HOGUM BAY COMMERCIAL SITE project.

The following is a cross correlation of client and laboratory identifications for your convenience.

CLIENT ID	MATRIX	AMTEST ID	TEST
B-1, S-2/S-3	Soil	18-A000015	Sieve Analysis, CONV, Sieve Analysis
B-2, S-3	Soil	18-A000016	Sieve Analysis, CONV, Sieve Analysis
B-3, S-3/S-4	Soil	18-A000017	Sieve Analysis, CONV, Sieve Analysis

Your samples were received on Tuesday, January 2, 2018. At the time of receipt, the samples were logged in and properly maintained prior to the subsequent analysis.

The analytical procedures used at AmTest are well documented and are typically derived from the protocols of the EPA, USDA, FDA or the Army Corps of Engineers.

Following the analytical data you will find the Quality Control (QC) results.

Please note that the detection limits that are listed in the body of the report refer to the Practical Quantitation Limits (PQL's), as opposed to the Method Detection Limits (MDL's).

If you should have any questions pertaining to the data package, please feel free to conact me.

Sincerely,

Aaron W. Young
Laboratory Manager

BACT = Bacteriological
CONV = Conventionals
MET = Metals
ORG = Organics
NUT=Nutrients
DEM=Demand
MIN=Minerals

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

AMEC E&I
4020 LAKE WASHINGTON BLVD NE
KIRKLAND, WA 98033
Attention: MILAN RADIC
Project Name: HOGUM BAY COMMERCIAL SITE
All results reported on a dry weight basis.

Date Received: 01/02/18
Date Reported: 1/18/18

AMTEST Identification Number **18-A000015**
Client Identification **B-1, S-2/S-3**
Sampling Date **12/21/17, 11:10**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Total Solids	95.8	%		0.1	SM 2540G	DP	01/04/18
% Moisture	4.2	%		0.1	Std Mthds. 2540 G	DP	01/04/18

Particle Size by Sieve Only

Sieve Number	Sieve Size	RESULT	UNITS	METHOD	ANALYST	DATE
1"	25.4 mm	< 0.1	% Retained	ASTM D422	DP	01/04/18
3/4"	19.05 mm	37.9	% Retained	ASTM D422	DP	01/04/18
5/8"	15.9 mm	9.90	% Retained	ASTM D422	DP	01/04/18
1/2"	12.7 mm	5.50	% Retained	ASTM D422	DP	01/04/18
3/8"	9.5 mm	6.10	% Retained	ASTM D422	DP	01/04/18
1/4"	6.35 mm	10.3	% Retained	ASTM D422	DP	01/04/18
#4	4.75 mm	5.10	% Retained	ASTM D422	DP	01/04/18
#10	2.0 mm	10.8	% Retained	ASTM D422	DP	01/04/18
#20	0.85 mm	7.00	% Retained	ASTM D422	DP	01/04/18
#40	0.425 mm	3.20	% Retained	ASTM D422	DP	01/04/18
#60	0.25 mm	1.20	% Retained	ASTM D422	DP	01/04/18
#120	0.125 mm	0.90	% Retained	ASTM D422	DP	01/04/18
#200	0.075 mm	0.40	% Retained	ASTM D422	DP	01/04/18

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

AMEC E&I
4020 LAKE WASHINGTON BLVD NE
KIRKLAND, WA 98033
Attention: MILAN RADIC
Project Name: HOGUM BAY COMMERCIAL SITE
All results reported on a dry weight basis.

Date Received: 01/02/18
Date Reported: 1/18/18

AMTEST Identification Number **18-A000016**
Client Identification **B-2, S-3**
Sampling Date **12/21/17, 09:10**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Total Solids	96.5	%		0.1	SM 2540G	DP	01/04/18
% Moisture	3.5	%		0.1	Std Mthds. 2540 G	DP	01/04/18

Particle Size by Sieve Only

Sieve Number	Sieve Size	RESULT	UNITS	METHOD	ANALYST	DATE
1"	25.4 mm	< 0.1	% Retained	ASTM D422	DP	01/04/18
3/4"	19.05 mm	< 0.1	% Retained	ASTM D422	DP	01/04/18
5/8"	15.9 mm	9.10	% Retained	ASTM D422	DP	01/04/18
1/2"	12.7 mm	5.00	% Retained	ASTM D422	DP	01/04/18
3/8"	9.5 mm	19.9	% Retained	ASTM D422	DP	01/04/18
1/4"	6.35 mm	13.5	% Retained	ASTM D422	DP	01/04/18
#4	4.75 mm	5.80	% Retained	ASTM D422	DP	01/04/18
#10	2.0 mm	9.60	% Retained	ASTM D422	DP	01/04/18
#20	0.85 mm	5.90	% Retained	ASTM D422	DP	01/04/18
#40	0.425 mm	5.50	% Retained	ASTM D422	DP	01/04/18
#60	0.25 mm	7.50	% Retained	ASTM D422	DP	01/04/18
#120	0.125 mm	9.10	% Retained	ASTM D422	DP	01/04/18
#200	0.075 mm	2.00	% Retained	ASTM D422	DP	01/04/18

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

AMEC E&I
4020 LAKE WASHINGTON BLVD NE
KIRKLAND, WA 98033
Attention: MILAN RADIC
Project Name: HOGUM BAY COMMERCIAL SITE
All results reported on a dry weight basis.

Date Received: 01/02/18
Date Reported: 1/18/18

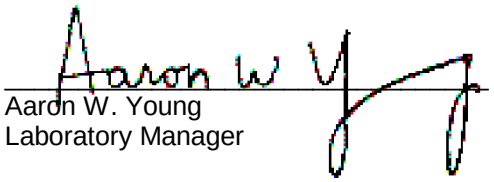
AMTEST Identification Number **18-A000017**
Client Identification **B-3, S-3/S-4**
Sampling Date **12/21/17, 12:30**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Total Solids	95.9	%		0.1	SM 2540G	DP	01/04/18
% Moisture	4.1	%		0.1	Std Mthds. 2540 G	DP	01/04/18

Particle Size by Sieve Only

Sieve Number	Sieve Size	RESULT	UNITS	METHOD	ANALYST	DATE
1"	25.4 mm	< 0.1	% Retained	ASTM D422	DP	01/05/18
3/4"	19.05 mm	30.7	% Retained	ASTM D422	DP	01/05/18
5/8"	15.9 mm	9.70	% Retained	ASTM D422	DP	01/05/18
1/2"	12.7 mm	14.1	% Retained	ASTM D422	DP	01/05/18
3/8"	9.5 mm	8.70	% Retained	ASTM D422	DP	01/05/18
1/4"	6.35 mm	9.60	% Retained	ASTM D422	DP	01/05/18
#4	4.75 mm	4.40	% Retained	ASTM D422	DP	01/05/18
#10	2.0 mm	8.20	% Retained	ASTM D422	DP	01/05/18
#20	0.85 mm	5.90	% Retained	ASTM D422	DP	01/05/18
#40	0.425 mm	4.10	% Retained	ASTM D422	DP	01/05/18
#60	0.25 mm	1.60	% Retained	ASTM D422	DP	01/05/18
#120	0.125 mm	1.00	% Retained	ASTM D422	DP	01/05/18
#200	0.075 mm	0.30	% Retained	ASTM D422	DP	01/05/18



Aaron W. Young
Laboratory Manager

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664

Professional Analytical Services

Feb 1 2018
AMEC Earth and Environmental
4020 LAKE WASHINGTON BLVD NE
SUITE 200
KIRKLAND, WA 98033
Attention: MILAN RADIC

Dear MILAN RADIC:

Enclosed please find the analytical data for your HOQUM BAY COMMERCIAL SITE project.

The following is a cross correlation of client and laboratory identifications for your convenience.

CLIENT ID	MATRIX	AMTEST ID	TEST
B-2 S-4	Soil	18-A001330	Sieve Analysis, CONV, Sieve Analysis

Your sample was received on Tuesday, January 23, 2018. At the time of receipt, the sample was logged in and properly maintained prior to the subsequent analysis.

The analytical procedures used at AmTest are well documented and are typically derived from the protocols of the EPA, USDA, FDA or the Army Corps of Engineers.

Following the analytical data you will find the Quality Control (QC) results.

Please note that the detection limits that are listed in the body of the report refer to the Practical Quantitation Limits (PQL's), as opposed to the Method Detection Limits (MDL's).

If you should have any questions pertaining to the data package, please feel free to conact me.

Sincerely,

Aaron W. Young
Laboratory Manager

cc: HENRY BRENNIMAN
Project #: PS17-19162-0

BACT = Bacteriological
CONV = Conventionals
MET = Metals
ORG = Organics
NUT=Nutrients
DEM=Demand
MIN=Minerals

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

AMEC Earth and Environmental
4020 LAKE WASHINGTON BLVD NE
KIRKLAND, WA 98033
Attention: MILAN RADIC
Project Name: HOQUM BAY COMMERCIAL SITE
Project #: PS17-19162-0
All results reported on a dry weight basis.

Date Received: 01/23/18
Date Reported: 2/ 1/18

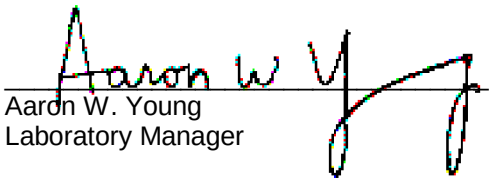
AMTEST Identification Number **18-A001330**
Client Identification **B-2 S-4**
Sampling Date **01/21/18, 09:10**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Total Solids	91.5	%		0.1	SM 2540G	DP	01/25/18
% Moisture	8.5	%		0.1	SM 2540G	DP	01/25/18

Particle Size by Sieve Only

Sieve Number	Sieve Size	RESULT	UNITS	METHOD	ANALYST	DATE
1"	25.4 mm	< 0.1	% Retained	ASTM D422	DP	01/25/18
3/4"	19.05 mm	11.4	% Retained	ASTM D422	DP	01/25/18
5/8"	15.9 mm	< 0.1	% Retained	ASTM D422	DP	01/25/18
1/2"	12.7 mm	4.10	% Retained	ASTM D422	DP	01/25/18
3/8"	9.5 mm	2.50	% Retained	ASTM D422	DP	01/25/18
1/4"	6.35 mm	3.60	% Retained	ASTM D422	DP	01/25/18
#4	4.75 mm	1.90	% Retained	ASTM D422	DP	01/25/18
#10	2.0 mm	3.70	% Retained	ASTM D422	DP	01/25/18
#20	0.85 mm	3.10	% Retained	ASTM D422	DP	01/25/18
#40	0.425 mm	4.70	% Retained	ASTM D422	DP	01/25/18
#60	0.25 mm	7.90	% Retained	ASTM D422	DP	01/25/18
#120	0.125 mm	14.9	% Retained	ASTM D422	DP	01/25/18
#200	0.075 mm	7.60	% Retained	ASTM D422	DP	01/25/18



Aaron W. Young
Laboratory Manager

CHAIN OF CUSTODY

LABORATORY TESTING PROGRAM

Amec Foster Wheeler Environment & Infrastructure, Inc.
4020 Lake Washington Blvd. NE-Suite 200 Tel (425) 368-1000
Kirkland, Washington 98033 Fax (425) 368-1001

amec foster wheeler

PROJECT: Hogum Bay Commercial Site
PROJECT NO.: 0517-19162-0
CLIENT: Monte Squares Enterprises
PROJECT MANAGER: Milan Radic
SAMPLER'S NAME (please print): HENRY BRENNIMAN
SAMPLER'S SIGNATURE: Henry W. Brenniman
PHONE #: 425-368-1000

ANALYSIS REQUESTED (circle, check box, or write preferred method in box)

SAMPLE I.D.	DEPTH	DATE	TIME	VISUAL CLASSIFICATION	MOISTURE CONTENT	SIEVE ANALYSIS	PROCTOR ☐MOD ☐STD	ORGANIC CONTENT	IN-SITU DENSITY	SPECIFIC GRAVITY	LA ABRASION	#200 WASH	TRIAXIAL UU	TRIAXIAL CU	CBR	SAND EQUIVALENT	SOUNDNESS	DIRECT SHEAR	HYDROMETER ANALYSIS	ATTERBERG LIMITS	CONSOLIDATION	UNCONFINED COMP.	OTHER	LAB ID NUMBER	COMMENTS
B30																									
B-2 S-4	12.5-14.0	1/22/17	9:10 AM		/	/																			[Composite
31 S-5	15.0-16.5		9:20 AM																						SAMPLE

SAMPLE RECEIPT	LABORATORY	TURNAROUND TIME	SPECIAL INSTRUCTIONS / ADDITIONAL COMMENTS
TOTAL # CONTAINERS	SHIPPING I.D. / AIRBILL #	☐ 8 HOUR ☐ 24 HOUR ☐ 1 WEEK ☐ 2 WEEK (standard) ☐ OTHER_____	
CONDITION OF CONTAINERS	CARRIER		
CONDITION OF SEALS	DOT DESIGNATION		

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME
1. Henry W. Brenniman	1/23/18	4:40			
2. L. Stoaks	1/23/18	4:40	ANTEST T=12.0		
3.					

PAGE 1 OF 1

DRAINAGE CONTROL PLAN
APPENDIX 3
DESIGN CALCULATIONS

WWHM2012

PROJECT REPORT

BASIN 1

FLOW CONTROL

General Model Information

WWHM2012 Project Name: Basin 1 Infiltration Trench

Site Name:	Hogum Bay Commercial
Site Address:	2405 Hogum Bay Rd NE
City:	
Report Date:	2/12/2024
Gage:	Fairgrounds (Kaiser)
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	2.47
Pervious Total	2.47
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.47

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.54
Pervious Total	0.54

Impervious Land Use	acre
ROADS FLAT	1.6
ROOF TOPS FLAT	0.25
SIDEWALKS FLAT	0.08
Impervious Total	1.93
Basin Total	2.47

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	160.00 ft.
Bottom Width:	20.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	20
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	390.979
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	390.979
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	3.5 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

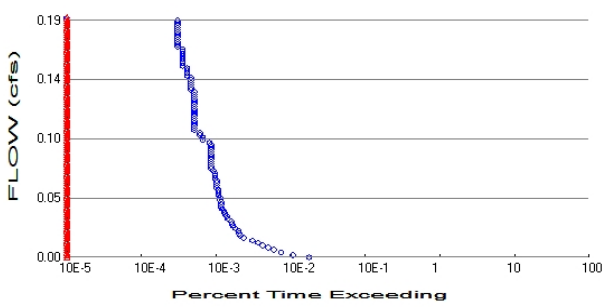
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.073	0.000	0.000	0.000
0.0444	0.073	0.001	0.000	1.481
0.0889	0.073	0.002	0.000	1.481
0.1333	0.073	0.003	0.000	1.481
0.1778	0.073	0.004	0.000	1.481
0.2222	0.073	0.005	0.000	1.481
0.2667	0.073	0.006	0.000	1.481
0.3111	0.073	0.007	0.000	1.481
0.3556	0.073	0.008	0.000	1.481
0.4000	0.073	0.009	0.000	1.481
0.4444	0.073	0.010	0.000	1.481
0.4889	0.073	0.011	0.000	1.481
0.5333	0.073	0.012	0.000	1.481
0.5778	0.073	0.014	0.000	1.481
0.6222	0.073	0.015	0.000	1.481
0.6667	0.073	0.016	0.000	1.481
0.7111	0.073	0.017	0.000	1.481
0.7556	0.073	0.018	0.000	1.481
0.8000	0.073	0.019	0.000	1.481
0.8444	0.073	0.020	0.000	1.481
0.8889	0.073	0.021	0.000	1.481
0.9333	0.073	0.022	0.000	1.481
0.9778	0.073	0.023	0.000	1.481

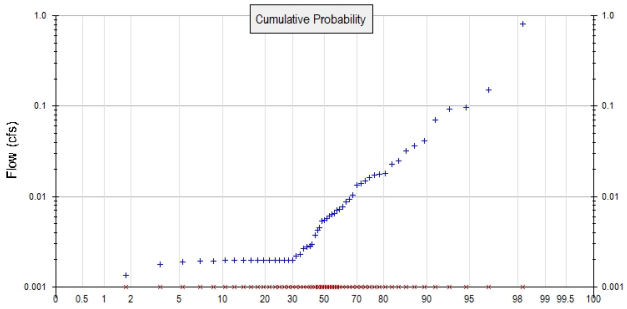
1.0222	0.073	0.024	0.000	1.481
1.0667	0.073	0.025	0.000	1.481
1.1111	0.073	0.026	0.000	1.481
1.1556	0.073	0.028	0.000	1.481
1.2000	0.073	0.029	0.000	1.481
1.2444	0.073	0.030	0.000	1.481
1.2889	0.073	0.031	0.000	1.481
1.3333	0.073	0.032	0.000	1.481
1.3778	0.073	0.033	0.000	1.481
1.4222	0.073	0.034	0.000	1.481
1.4667	0.073	0.035	0.000	1.481
1.5111	0.073	0.036	0.000	1.481
1.5556	0.073	0.037	0.000	1.481
1.6000	0.073	0.038	0.000	1.481
1.6444	0.073	0.039	0.000	1.481
1.6889	0.073	0.040	0.000	1.481
1.7333	0.073	0.042	0.000	1.481
1.7778	0.073	0.043	0.000	1.481
1.8222	0.073	0.044	0.000	1.481
1.8667	0.073	0.045	0.000	1.481
1.9111	0.073	0.046	0.000	1.481
1.9556	0.073	0.047	0.000	1.481
2.0000	0.073	0.048	0.000	1.481
2.0444	0.073	0.049	0.000	1.481
2.0889	0.073	0.050	0.000	1.481
2.1333	0.073	0.051	0.000	1.481
2.1778	0.073	0.052	0.000	1.481
2.2222	0.073	0.053	0.000	1.481
2.2667	0.073	0.054	0.000	1.481
2.3111	0.073	0.056	0.000	1.481
2.3556	0.073	0.057	0.000	1.481
2.4000	0.073	0.058	0.000	1.481
2.4444	0.073	0.059	0.000	1.481
2.4889	0.073	0.060	0.000	1.481
2.5333	0.073	0.061	0.000	1.481
2.5778	0.073	0.062	0.000	1.481
2.6222	0.073	0.063	0.000	1.481
2.6667	0.073	0.064	0.000	1.481
2.7111	0.073	0.065	0.000	1.481
2.7556	0.073	0.066	0.000	1.481
2.8000	0.073	0.067	0.000	1.481
2.8444	0.073	0.069	0.000	1.481
2.8889	0.073	0.070	0.000	1.481
2.9333	0.073	0.071	0.000	1.481
2.9778	0.073	0.072	0.000	1.481
3.0222	0.073	0.073	0.000	1.481
3.0667	0.073	0.074	0.000	1.481
3.1111	0.073	0.075	0.000	1.481
3.1556	0.073	0.076	0.000	1.481
3.2000	0.073	0.077	0.000	1.481
3.2444	0.073	0.078	0.000	1.481
3.2889	0.073	0.079	0.000	1.481
3.3333	0.073	0.080	0.000	1.481
3.3778	0.073	0.081	0.000	1.481
3.4222	0.073	0.083	0.000	1.481
3.4667	0.073	0.084	0.000	1.481
3.5111	0.073	0.085	0.012	1.481
3.5556	0.073	0.086	0.138	1.481

3.6000	0.073	0.087	0.333	1.481
3.6444	0.073	0.088	0.572	1.481
3.6889	0.073	0.089	0.838	1.481
3.7333	0.073	0.090	1.115	1.481
3.7778	0.073	0.091	1.383	1.481
3.8222	0.073	0.092	1.627	1.481
3.8667	0.073	0.093	1.834	1.481
3.9111	0.073	0.094	1.996	1.481
3.9556	0.073	0.095	2.114	1.481
4.0000	0.073	0.097	2.203	1.481

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 2.47
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.54
Total Impervious Area: 1.93

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.005666
5 year	0.019906
10 year	0.042276
25 year	0.101831
50 year	0.187518
100 year	0.334365

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.017	0.000
1957	0.004	0.000
1958	0.003	0.000
1959	0.006	0.000
1960	0.006	0.000
1961	0.008	0.000
1962	0.002	0.000
1963	0.098	0.000
1964	0.025	0.000
1965	0.009	0.000

1966	0.002	0.000
1967	0.007	0.000
1968	0.003	0.000
1969	0.003	0.000
1970	0.006	0.000
1971	0.037	0.000
1972	0.032	0.000
1973	0.002	0.000
1974	0.014	0.000
1975	0.003	0.000
1976	0.016	0.000
1977	0.002	0.000
1978	0.013	0.000
1979	0.002	0.000
1980	0.002	0.000
1981	0.041	0.000
1982	0.071	0.000
1983	0.004	0.000
1984	0.005	0.000
1985	0.002	0.000
1986	0.007	0.000
1987	0.015	0.000
1988	0.002	0.000
1989	0.002	0.000
1990	0.002	0.000
1991	0.152	0.000
1992	0.817	0.000
1993	0.093	0.000
1994	0.002	0.000
1995	0.006	0.000
1996	0.018	0.000
1997	0.010	0.000
1998	0.002	0.000
1999	0.002	0.000
2000	0.001	0.000
2001	0.001	0.000
2002	0.002	0.000
2003	0.018	0.000
2004	0.023	0.000
2005	0.002	0.000
2006	0.002	0.000
2007	0.002	0.000
2008	0.002	0.000
2009	0.004	0.000
2010	0.007	0.000
2011	0.009	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8167	0.0000
2	0.1519	0.0000
3	0.0975	0.0000
4	0.0928	0.0000
5	0.0706	0.0000
6	0.0411	0.0000
7	0.0366	0.0000
8	0.0322	0.0000

9	0.0246	0.0000
10	0.0227	0.0000
11	0.0181	0.0000
12	0.0177	0.0000
13	0.0171	0.0000
14	0.0161	0.0000
15	0.0150	0.0000
16	0.0140	0.0000
17	0.0133	0.0000
18	0.0103	0.0000
19	0.0094	0.0000
20	0.0087	0.0000
21	0.0077	0.0000
22	0.0073	0.0000
23	0.0070	0.0000
24	0.0065	0.0000
25	0.0063	0.0000
26	0.0061	0.0000
27	0.0057	0.0000
28	0.0055	0.0000
29	0.0053	0.0000
30	0.0045	0.0000
31	0.0043	0.0000
32	0.0038	0.0000
33	0.0029	0.0000
34	0.0028	0.0000
35	0.0028	0.0000
36	0.0027	0.0000
37	0.0023	0.0000
38	0.0022	0.0000
39	0.0020	0.0000
40	0.0020	0.0000
41	0.0020	0.0000
42	0.0020	0.0000
43	0.0020	0.0000
44	0.0020	0.0000
45	0.0020	0.0000
46	0.0020	0.0000
47	0.0020	0.0000
48	0.0020	0.0000
49	0.0019	0.0000
50	0.0019	0.0000
51	0.0019	0.0000
52	0.0019	0.0000
53	0.0019	0.0000
54	0.0018	0.0000
55	0.0013	0.0000
56	0.0013	0.0000

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0028	347	0	0	Pass
0.0047	210	0	0	Pass
0.0066	146	0	0	Pass
0.0084	115	0	0	Pass
0.0103	97	0	0	Pass
0.0122	83	0	0	Pass
0.0140	72	0	0	Pass
0.0159	60	0	0	Pass
0.0178	46	0	0	Pass
0.0196	41	0	0	Pass
0.0215	40	0	0	Pass
0.0234	39	0	0	Pass
0.0252	36	0	0	Pass
0.0271	33	0	0	Pass
0.0290	32	0	0	Pass
0.0308	31	0	0	Pass
0.0327	28	0	0	Pass
0.0345	27	0	0	Pass
0.0364	26	0	0	Pass
0.0383	25	0	0	Pass
0.0401	24	0	0	Pass
0.0420	23	0	0	Pass
0.0439	23	0	0	Pass
0.0457	23	0	0	Pass
0.0476	22	0	0	Pass
0.0495	22	0	0	Pass
0.0513	21	0	0	Pass
0.0532	21	0	0	Pass
0.0551	21	0	0	Pass
0.0569	20	0	0	Pass
0.0588	20	0	0	Pass
0.0607	20	0	0	Pass
0.0625	20	0	0	Pass
0.0644	19	0	0	Pass
0.0663	19	0	0	Pass
0.0681	19	0	0	Pass
0.0700	18	0	0	Pass
0.0719	17	0	0	Pass
0.0737	17	0	0	Pass
0.0756	17	0	0	Pass
0.0775	17	0	0	Pass
0.0793	17	0	0	Pass
0.0812	17	0	0	Pass
0.0830	17	0	0	Pass
0.0849	17	0	0	Pass
0.0868	17	0	0	Pass
0.0886	17	0	0	Pass
0.0905	17	0	0	Pass
0.0924	16	0	0	Pass
0.0942	13	0	0	Pass
0.0961	13	0	0	Pass
0.0980	12	0	0	Pass
0.0998	12	0	0	Pass

0.1017	10	0	0	Pass
0.1036	10	0	0	Pass
0.1054	10	0	0	Pass
0.1073	10	0	0	Pass
0.1092	10	0	0	Pass
0.1110	10	0	0	Pass
0.1129	10	0	0	Pass
0.1148	10	0	0	Pass
0.1166	10	0	0	Pass
0.1185	10	0	0	Pass
0.1204	10	0	0	Pass
0.1222	10	0	0	Pass
0.1241	10	0	0	Pass
0.1260	10	0	0	Pass
0.1278	10	0	0	Pass
0.1297	10	0	0	Pass
0.1316	10	0	0	Pass
0.1334	9	0	0	Pass
0.1353	9	0	0	Pass
0.1371	9	0	0	Pass
0.1390	9	0	0	Pass
0.1409	9	0	0	Pass
0.1427	9	0	0	Pass
0.1446	8	0	0	Pass
0.1465	8	0	0	Pass
0.1483	8	0	0	Pass
0.1502	8	0	0	Pass
0.1521	7	0	0	Pass
0.1539	7	0	0	Pass
0.1558	7	0	0	Pass
0.1577	7	0	0	Pass
0.1595	7	0	0	Pass
0.1614	7	0	0	Pass
0.1633	7	0	0	Pass
0.1651	7	0	0	Pass
0.1670	6	0	0	Pass
0.1689	6	0	0	Pass
0.1707	6	0	0	Pass
0.1726	6	0	0	Pass
0.1745	6	0	0	Pass
0.1763	6	0	0	Pass
0.1782	6	0	0	Pass
0.1801	6	0	0	Pass
0.1819	6	0	0	Pass
0.1838	6	0	0	Pass
0.1857	6	0	0	Pass
0.1875	6	0	0	Pass

Appendix
Predeveloped Schematic

Mitigated Schematic

Disclaimer

Legal Notice

This program and accompanying documentation are provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by End User. Clear Creek Solutions Inc. and the governmental licensee or sublicensees disclaim all warranties, either expressed or implied, including but not limited to implied warranties of program and accompanying documentation. In no event shall Clear Creek Solutions Inc. be liable for any damages whatsoever (including without limitation to damages for loss of business profits, loss of business information, business interruption, and the like) arising out of the use of, or inability to use this program even if Clear Creek Solutions Inc. or their authorized representatives have been advised of the possibility of such damages.

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

WWHM2012

PROJECT REPORT

BASIN 2

FLOW CONTROL

General Model Information

WWHM2012 Project Name: Basin 2 Infiltration Trench

Site Name:	Hogum Bay Commercial
Site Address:	2405 Hogum Bay Rd NE
City:	
Report Date:	2/13/2024
Gage:	Fairgrounds (Kaiser)
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	1.39
Pervious Total	1.39
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.39

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.26
Pervious Total	0.26

Impervious Land Use	acre
ROADS FLAT	0.47
ROOF TOPS FLAT	0.49
SIDEWALKS FLAT	0.17
Impervious Total	1.13
Basin Total	1.39

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	92.00 ft.
Bottom Width:	20.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.33
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	20
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	228.545
Total Volume Through Riser (ac-ft.):	0
Total Volume Through Facility (ac-ft.):	228.545
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	3.5 ft.
Riser Diameter:	12 in.
Element Flows To:	
Outlet 1	Outlet 2

Gravel Trench Bed Hydraulic Table

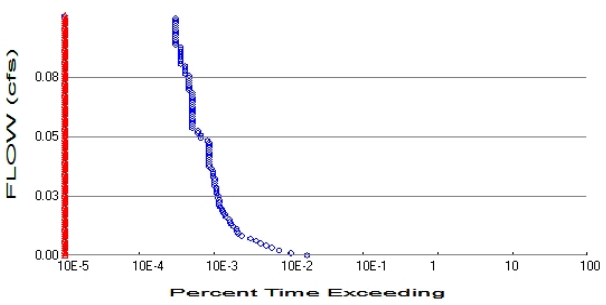
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.042	0.000	0.000	0.000
0.0444	0.042	0.000	0.000	0.851
0.0889	0.042	0.001	0.000	0.851
0.1333	0.042	0.001	0.000	0.851
0.1778	0.042	0.002	0.000	0.851
0.2222	0.042	0.003	0.000	0.851
0.2667	0.042	0.003	0.000	0.851
0.3111	0.042	0.004	0.000	0.851
0.3556	0.042	0.005	0.000	0.851
0.4000	0.042	0.005	0.000	0.851
0.4444	0.042	0.006	0.000	0.851
0.4889	0.042	0.006	0.000	0.851
0.5333	0.042	0.007	0.000	0.851
0.5778	0.042	0.008	0.000	0.851
0.6222	0.042	0.008	0.000	0.851
0.6667	0.042	0.009	0.000	0.851
0.7111	0.042	0.009	0.000	0.851
0.7556	0.042	0.010	0.000	0.851
0.8000	0.042	0.011	0.000	0.851
0.8444	0.042	0.011	0.000	0.851
0.8889	0.042	0.012	0.000	0.851
0.9333	0.042	0.013	0.000	0.851
0.9778	0.042	0.013	0.000	0.851

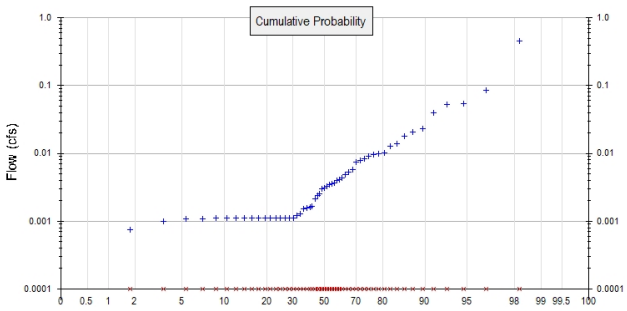
1.0222	0.042	0.014	0.000	0.851
1.0667	0.042	0.014	0.000	0.851
1.1111	0.042	0.015	0.000	0.851
1.1556	0.042	0.016	0.000	0.851
1.2000	0.042	0.016	0.000	0.851
1.2444	0.042	0.017	0.000	0.851
1.2889	0.042	0.018	0.000	0.851
1.3333	0.042	0.018	0.000	0.851
1.3778	0.042	0.019	0.000	0.851
1.4222	0.042	0.019	0.000	0.851
1.4667	0.042	0.020	0.000	0.851
1.5111	0.042	0.021	0.000	0.851
1.5556	0.042	0.021	0.000	0.851
1.6000	0.042	0.022	0.000	0.851
1.6444	0.042	0.022	0.000	0.851
1.6889	0.042	0.023	0.000	0.851
1.7333	0.042	0.024	0.000	0.851
1.7778	0.042	0.024	0.000	0.851
1.8222	0.042	0.025	0.000	0.851
1.8667	0.042	0.026	0.000	0.851
1.9111	0.042	0.026	0.000	0.851
1.9556	0.042	0.027	0.000	0.851
2.0000	0.042	0.027	0.000	0.851
2.0444	0.042	0.028	0.000	0.851
2.0889	0.042	0.029	0.000	0.851
2.1333	0.042	0.029	0.000	0.851
2.1778	0.042	0.030	0.000	0.851
2.2222	0.042	0.031	0.000	0.851
2.2667	0.042	0.031	0.000	0.851
2.3111	0.042	0.032	0.000	0.851
2.3556	0.042	0.032	0.000	0.851
2.4000	0.042	0.033	0.000	0.851
2.4444	0.042	0.034	0.000	0.851
2.4889	0.042	0.034	0.000	0.851
2.5333	0.042	0.035	0.000	0.851
2.5778	0.042	0.035	0.000	0.851
2.6222	0.042	0.036	0.000	0.851
2.6667	0.042	0.037	0.000	0.851
2.7111	0.042	0.037	0.000	0.851
2.7556	0.042	0.038	0.000	0.851
2.8000	0.042	0.039	0.000	0.851
2.8444	0.042	0.039	0.000	0.851
2.8889	0.042	0.040	0.000	0.851
2.9333	0.042	0.040	0.000	0.851
2.9778	0.042	0.041	0.000	0.851
3.0222	0.042	0.042	0.000	0.851
3.0667	0.042	0.042	0.000	0.851
3.1111	0.042	0.043	0.000	0.851
3.1556	0.042	0.044	0.000	0.851
3.2000	0.042	0.044	0.000	0.851
3.2444	0.042	0.045	0.000	0.851
3.2889	0.042	0.045	0.000	0.851
3.3333	0.042	0.046	0.000	0.851
3.3778	0.042	0.047	0.000	0.851
3.4222	0.042	0.047	0.000	0.851
3.4667	0.042	0.048	0.000	0.851
3.5111	0.042	0.048	0.012	0.851
3.5556	0.042	0.049	0.138	0.851

3.6000	0.042	0.050	0.333	0.851
3.6444	0.042	0.050	0.572	0.851
3.6889	0.042	0.051	0.838	0.851
3.7333	0.042	0.052	1.115	0.851
3.7778	0.042	0.052	1.383	0.851
3.8222	0.042	0.053	1.627	0.851
3.8667	0.042	0.053	1.834	0.851
3.9111	0.042	0.054	1.996	0.851
3.9556	0.042	0.055	2.114	0.851
4.0000	0.042	0.055	2.203	0.851

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.39
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.26
Total Impervious Area: 1.13

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.003188
5 year	0.011202
10 year	0.023791
25 year	0.057306
50 year	0.105526
100 year	0.188165

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1956	0.010	0.000
1957	0.002	0.000
1958	0.002	0.000
1959	0.003	0.000
1960	0.003	0.000
1961	0.004	0.000
1962	0.001	0.000
1963	0.055	0.000
1964	0.014	0.000
1965	0.005	0.000

1966	0.001	0.000
1967	0.004	0.000
1968	0.001	0.000
1969	0.002	0.000
1970	0.003	0.000
1971	0.021	0.000
1972	0.018	0.000
1973	0.001	0.000
1974	0.008	0.000
1975	0.002	0.000
1976	0.009	0.000
1977	0.001	0.000
1978	0.007	0.000
1979	0.001	0.000
1980	0.001	0.000
1981	0.023	0.000
1982	0.040	0.000
1983	0.002	0.000
1984	0.003	0.000
1985	0.001	0.000
1986	0.004	0.000
1987	0.008	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.085	0.000
1992	0.460	0.000
1993	0.052	0.000
1994	0.001	0.000
1995	0.004	0.000
1996	0.010	0.000
1997	0.006	0.000
1998	0.001	0.000
1999	0.001	0.000
2000	0.001	0.000
2001	0.001	0.000
2002	0.001	0.000
2003	0.010	0.000
2004	0.013	0.000
2005	0.001	0.000
2006	0.001	0.000
2007	0.001	0.000
2008	0.001	0.000
2009	0.003	0.000
2010	0.004	0.000
2011	0.005	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.4596	0.0000
2	0.0855	0.0000
3	0.0549	0.0000
4	0.0522	0.0000
5	0.0397	0.0000
6	0.0231	0.0000
7	0.0206	0.0000
8	0.0181	0.0000

9	0.0139	0.0000
10	0.0128	0.0000
11	0.0102	0.0000
12	0.0099	0.0000
13	0.0096	0.0000
14	0.0091	0.0000
15	0.0084	0.0000
16	0.0079	0.0000
17	0.0075	0.0000
18	0.0058	0.0000
19	0.0053	0.0000
20	0.0049	0.0000
21	0.0043	0.0000
22	0.0041	0.0000
23	0.0040	0.0000
24	0.0037	0.0000
25	0.0036	0.0000
26	0.0035	0.0000
27	0.0032	0.0000
28	0.0031	0.0000
29	0.0030	0.0000
30	0.0025	0.0000
31	0.0024	0.0000
32	0.0021	0.0000
33	0.0017	0.0000
34	0.0016	0.0000
35	0.0016	0.0000
36	0.0015	0.0000
37	0.0013	0.0000
38	0.0012	0.0000
39	0.0011	0.0000
40	0.0011	0.0000
41	0.0011	0.0000
42	0.0011	0.0000
43	0.0011	0.0000
44	0.0011	0.0000
45	0.0011	0.0000
46	0.0011	0.0000
47	0.0011	0.0000
48	0.0011	0.0000
49	0.0011	0.0000
50	0.0011	0.0000
51	0.0011	0.0000
52	0.0011	0.0000
53	0.0011	0.0000
54	0.0010	0.0000
55	0.0008	0.0000
56	0.0007	0.0000

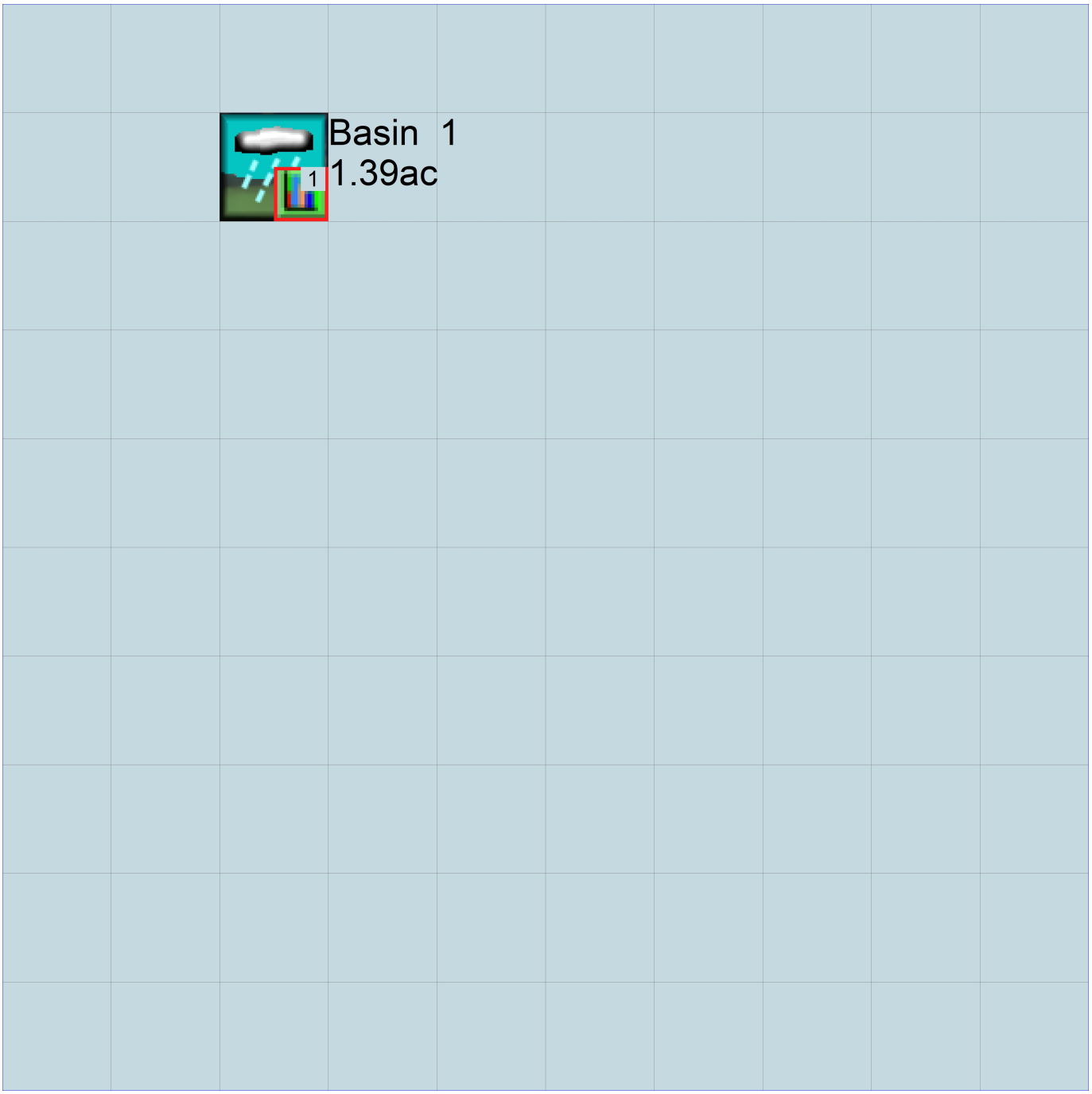
Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0016	347	0	0	Pass
0.0026	210	0	0	Pass
0.0037	146	0	0	Pass
0.0047	115	0	0	Pass
0.0058	97	0	0	Pass
0.0068	83	0	0	Pass
0.0079	72	0	0	Pass
0.0089	60	0	0	Pass
0.0100	46	0	0	Pass
0.0110	41	0	0	Pass
0.0121	40	0	0	Pass
0.0131	39	0	0	Pass
0.0142	36	0	0	Pass
0.0152	33	0	0	Pass
0.0163	32	0	0	Pass
0.0173	31	0	0	Pass
0.0184	28	0	0	Pass
0.0194	27	0	0	Pass
0.0205	26	0	0	Pass
0.0215	25	0	0	Pass
0.0226	24	0	0	Pass
0.0236	23	0	0	Pass
0.0247	23	0	0	Pass
0.0257	23	0	0	Pass
0.0268	22	0	0	Pass
0.0278	22	0	0	Pass
0.0289	21	0	0	Pass
0.0299	21	0	0	Pass
0.0310	21	0	0	Pass
0.0320	20	0	0	Pass
0.0331	20	0	0	Pass
0.0341	20	0	0	Pass
0.0352	20	0	0	Pass
0.0362	19	0	0	Pass
0.0373	19	0	0	Pass
0.0383	19	0	0	Pass
0.0394	18	0	0	Pass
0.0404	17	0	0	Pass
0.0415	17	0	0	Pass
0.0425	17	0	0	Pass
0.0436	17	0	0	Pass
0.0446	17	0	0	Pass
0.0457	17	0	0	Pass
0.0467	17	0	0	Pass
0.0478	17	0	0	Pass
0.0488	17	0	0	Pass
0.0499	17	0	0	Pass
0.0509	17	0	0	Pass
0.0520	16	0	0	Pass
0.0530	13	0	0	Pass
0.0541	13	0	0	Pass
0.0551	12	0	0	Pass
0.0562	12	0	0	Pass

0.0572	10	0	0	Pass
0.0583	10	0	0	Pass
0.0593	10	0	0	Pass
0.0604	10	0	0	Pass
0.0614	10	0	0	Pass
0.0625	10	0	0	Pass
0.0635	10	0	0	Pass
0.0646	10	0	0	Pass
0.0656	10	0	0	Pass
0.0667	10	0	0	Pass
0.0677	10	0	0	Pass
0.0688	10	0	0	Pass
0.0698	10	0	0	Pass
0.0709	10	0	0	Pass
0.0719	10	0	0	Pass
0.0730	10	0	0	Pass
0.0740	9	0	0	Pass
0.0751	9	0	0	Pass
0.0761	9	0	0	Pass
0.0772	9	0	0	Pass
0.0782	9	0	0	Pass
0.0793	9	0	0	Pass
0.0803	9	0	0	Pass
0.0814	8	0	0	Pass
0.0824	8	0	0	Pass
0.0835	8	0	0	Pass
0.0845	8	0	0	Pass
0.0856	7	0	0	Pass
0.0866	7	0	0	Pass
0.0877	7	0	0	Pass
0.0887	7	0	0	Pass
0.0898	7	0	0	Pass
0.0908	7	0	0	Pass
0.0919	7	0	0	Pass
0.0929	7	0	0	Pass
0.0940	6	0	0	Pass
0.0950	6	0	0	Pass
0.0961	6	0	0	Pass
0.0971	6	0	0	Pass
0.0982	6	0	0	Pass
0.0992	6	0	0	Pass
0.1003	6	0	0	Pass
0.1013	6	0	0	Pass
0.1024	6	0	0	Pass
0.1034	6	0	0	Pass
0.1045	6	0	0	Pass
0.1055	6	0	0	Pass

Appendix
Predeveloped Schematic



Mitigated Schematic

Disclaimer

Legal Notice

This program and accompanying documentation are provided 'as-is' without warranty of any kind. The entire risk regarding the performance and results of this program is assumed by End User. Clear Creek Solutions Inc. and the governmental licensee or sublicensees disclaim all warranties, either expressed or implied, including but not limited to implied warranties of program and accompanying documentation. In no event shall Clear Creek Solutions Inc. be liable for any damages whatsoever (including without limitation to damages for loss of business profits, loss of business information, business interruption, and the like) arising out of the use of, or inability to use this program even if Clear Creek Solutions Inc. or their authorized representatives have been advised of the possibility of such damages.

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

DRAINAGE CONTROL PLAN
APPENDIX 4
SOIL MANAGEMENT PLAN

NOT INCLUDED AT THIS TIME

DRAINAGE CONTROL PLAN
ATTACHMENT 1
CONSTRUCTION SWPPP REPORT

Construction Stormwater Pollution Prevention Plan (SWPPP)

Hogum Bay Commercial
Lacey, Washington

February 2024

LDC | Surveying Engineering Planning

Construction SWPPP

Project Information

Project:	**Hogum Bay Commercial**
Site Address:	2405 Hogum Bay Rd NE, Lacey, WA 98516
Owner/Applicant:	**Golden Nugget Investment Group, LLC** 9632 6th Way SE Lacey, WA 98513 Contact Name: Antony Chung Contact Phone:

Reviewing Agency

Jurisdiction:	City of Lacey

Project Representative

Prepared by:	**LDC, Inc.** 321 Cleveland Ave SE Tumwater, WA 98501 425.806.1869
Contact:	Tyrell Bradley, PE TBradley@LDCCorp.com
Project Reference:	C22-130

TABLE OF CONTENTS

TABLE OF CONTENTS

1. NARRATIVE

1.1 STORMWATER BMPS

The following explains and illustrates the measures to be taken on the site to control erosion and sedimentation problems. The SWPPP is a guideline to follow during construction to prevent erosion and sedimentation. Erosion control measures are not limited to those shown on the TESC plan and in this SWPPP. Measures shall be installed as necessary to meet the Department of Ecology's (DOE) and the City of Lacey's guidelines for stormwater pollution prevention and the requirements of the DOE National Pollutant Discharge Elimination System (NPDES) permit as applicable. Further, the SWPPP shall be updated by the contractor as required by the requirements of the DOE NPDES permit.

Total Disturbed Area: 4.70 acres

Property Use: HPBD-C Hawks Prairie Business District

Parcel Number: 11811120800

Section, Township, Range: Section 11, Township 18N, Range 1W, W.M.

1.1.1 *Element #1 –Mark Clearing Limits*

To protect adjacent properties and reduce the area of soil exposed, the limits of the construction will be clearly marked before land-disturbing activities begin. Where possible natural vegetation shall be preserved and the duff layer and native topsoil shall remain in place. The following BMP will be implemented where appropriate:

- BMP C101: Preserving Natural Vegetation
- BMP C103: High Visibility Plastic or Metal Fence

- BMP C233: Silt Fence

1.1.2 *Element #2 – Establish Construction Access*

Access points should be established to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site.

Construction access will be granted off of the northern access road. Areas used throughout the parcel for construction storage and parking will be moved throughout the parcel depending on the location of the construction being conducted.

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C106: Wheel Wash
- BMP C107: Construction Road/Parking Area Stabilization

1.1.3 *Element #3 – Control Flow Rates*

Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site. The following BMPs are applicable for this project. If the following BMPs are not shown on the construction plan set, the Owner and the Engineer reserves the right to direct the Contractor to install, construct, and/or implement said BMPs:

- BMP C235: Wattles

In general, discharge rates of stormwater from the site will be controlled where increases in impervious area or soil compaction during construction could lead to downstream erosion, or where necessary to meet local agency stormwater discharge requirements. Care will be taken throughout construction to protect the existing wetland from sediments, while protecting the hydrology as well.

1.1.4 *Element #4 – Install Sediment Controls*

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal BMP. Silt fence barriers shall be installed in accordance with BMP C233. In addition, the following BMP's will be implemented where appropriate:

- BMP C233: Silt Fence
- BMP C235: Wattles
- BMP C240: Sediment Trap
    - SA = 2 * Q_2/(0.00096) = 2 * 1.42/0.00096 = 2,955 S.F.
        - Two sediment traps at 1,478 S.F. each

In addition, sediment will be removed from paved areas in and adjacent to work areas manually or using mechanical sweepers, as needed, to minimize tracking of sediments on vehicle tires away from the site and to minimize wash off of sediments from adjacent streets in runoff.

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMP's (e.g. infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMP's, such as those used for infiltration or biofiltration; however, those BMP's designed to remove solids by settling (wet ponds or detention ponds) can be used. When permanent stormwater BMP's will be used to control sediment discharge, the structure will be protected from excessive sedimentation with adequate erosion and sediment control BMP's. Any accumulated sediment shall be removed after construction is complete and the permanent stormwater BMP will be restabilized with vegetation per applicable design requirements once the remainder of the site has been stabilized. Concentrated runoff is not anticipated for this project.

1.1.5 *Element #5 – Stabilize Soils*

All exposed and unworked soils shall be stabilized by application of effective BMP's, which protect the soil from the erosive forces of raindrop impact and flowing water and from wind erosion. From October 01 through April 30 of each calendar year, no construction shall be happening. From May 01 to September 30 of each calendar year, no soils shall remain exposed and unworked for more than seven (7) days. This condition applies to all on-site soils, whether at final grade or not. Additionally, except where approved chemical treatment, full dispersion, or infiltration is practiced, clearing, grading, and other soil disturbing activities are prohibited between November 1 and February 28.

In areas where construction activities have temporarily or permanently ceased, seeding and mulching shall be used in accordance with BMP's C120 and C121. Dust control shall be used as needed to prevent wind transport of dust from disturbed soil surfaces and in accordance with BMP C140.

In general, cut slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C124: Sodding
- BMP C125: Topsoiling
- BMP C140: Dust Control

1.1.6 *Element #6 – Protect Slopes*

Slopes shall be constructed in a manner that will minimize erosion. This shall include, but is not limited to: placing excavated material on the uphill side of trenches, collecting drainage at the top of slopes, etc. Slopes will be stabilized as indicated in Element #5 above. In addition, the following BMP's will be implemented where appropriate:

- BMP C130: Surface Roughening

- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels

1.1.7 *Element #7 – Protect Drain Inlets*

All storm drain inlets made operable during construction shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

- BMP C220: Storm Drain Inlet Protection

1.1.8 *Element #8 – Stabilize Channels and Outlets*

All temporary on-site conveyance channels shall be constructed and stabilized to prevent erosion. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent to streambanks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems. The following BMP's will be implemented where appropriate:

- BMP C202: Channel Lining

1.1.9 *Element #9 – Control Pollutants*

All pollutants, including waste materials, that occur on-site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle. Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations shall be followed for application rates and procedures. No pH-Modifying sources will be present on-site.

Two source control BMP's will apply to this project:

- Maintenance of Storm Drainage Facilities
- Street Sweeping

In addition, the following BMP's shall be implemented where appropriate:

- BMP C151: Concrete Handling

- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage and Containment
- BMP C154: Concrete Washout Area

1.1.10 *Element #10 – Control Dewatering*

Clean, non-turbid de-watering water, as determined by the Certified Professional in Erosion and Sediment Control, can be discharged to systems tributary to state surface waters, provided the de-watering flow does not cause erosion or flooding of receiving waters. These clean waters should not be routed through stormwater sediment ponds.

Highly turbid or otherwise contaminated de-watering water, such as from equipment operation shall be handled separately from stormwater at the site. Some disposal options, depending on site constraints, may include: 1) transport off-site in vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters, 2) on-site treatment using chemical treatment or other suitable treatment technologies such as Baker tanks or approved equal, or 3) sanitary sewer discharge with local sewer purveyor's approval if there is no other option.

1.1.11 *Element #11 – Maintain BMP's*

All temporary and permanent erosion and sediment control BMP's shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMP's specifications. Visual monitoring of the BMP's will be conducted per the inspection schedule in Section 6.

All temporary erosion and sediment control BMP's shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMP's are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMP's or vegetation shall be permanently stabilized.

- BMP C150: Materials on Hand
- BMP C160: Certified Erosion and Sediment Control Lead

1.1.12 *Element #12 – Manage the Project*

Erosion and sediment control BMP's for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.

- Thoroughly monitor site and maintain all ESC measures.

In addition, project management will incorporate the key components listed below:

Phasing

Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C162).

Inspection and Monitoring

All BMP's shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:

- Assess the site conditions and construction activities that could impact the quality of stormwater, and

- Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.

Whenever inspection and/or monitoring reveals that the BMP's identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMP's or design changes shall be implemented as soon as possible.

Maintaining an Updated 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 construction activities 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 BMP's designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

1.1.13 *Element #13 – Protect Low Impact Development BMPs*

All temporary and permanent erosion and sediment control BMP's shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repairs shall be completed in accordance with the practices, procedures, and materials for each respective BMP. This project will not construct any Low Impact Development BMPs or infiltration BMPs. The contractor shall refrain from compacting the existing soils surrounding the project site.

- BMP C233: Silt Fence

1.2 PROJECT DESCRIPTION

The project is located near the intersection of Hogum Bay Road NE and Marvin Road NE, Lacey Washington. See Vicinity Map below.

Figure 1) Vicinity Map

The proposed construction includes 2 hotels, as well as parking stalls, utilities, frontage and stormwater improvements disturbing approximately 4.07 acres of the parcel.

1.3 EXISTING SITE CONDITIONS

EXISTING DRAINAGE SYSTEM

There are no known current drainage flow control facilities on the site. Currently, it appears that the majority of the stormwater runoff sheet flows to the south and either infiltrates on-site or infiltrates in the existing pond to the south of the project parcel. The stormwater runoff generated from Hogum Bay Road NE and Marvin Road NE is currently collected and conveyed

via curb and gutter with catch basins and is ultimately treated and infiltrates in the pond located on the southern parcel.

EXISTING TOPOGRAPHY AND VEGETATION

Topography within the property generally slopes to the south at approximately 2-12%. The parcel is currently undeveloped with approximately 85% forested land cover and the remaining area pasture/grass.

1.4 ADJACENT AREAS

The site is bounded by Marvin Road NE to the west, Hogum Bay Road NE to the east, commercial buildings to the north and an infiltration pond to the south.

1.5 CRITICAL AREAS

Flood Zones: The project parcel is located with Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel No. 53067C0185F According to the FIRM Map the project parcel is located within Zone X. Zone X is determined to be an area of minimal flood hazard. See **Appendix 2** of the Drainage Control Plan for the FIRM Map.

Critical Aquifer Recharge Areas (CARA): According to Figure 8B.2 of the SDM, the proposed project is located within a Critical Aquifer Recharge Area Category I.

1.6 SOIL

A full geotechnical report was provided by Quality Geo NW on September 1, 2023. The on-site geotechnical investigation was conducted on August 3, 2023, and included three test pits across the project site to a maximum depth of 10 feet. The on-site soil samples revealed sand and gravelly soils with minimal fines content beneath the topsoil. The on-site soil sampling confirmed the USDA soil classification of Spanaway gravelly sandy loam. Soil samples excavated from test pits 1 and 3, the western and eastern portions of the site respectively, were used to characterize the local infiltration conditions. Laboratory results were interpreted to recommend a design infiltration rate in accordance with the City of Lacey 2022 Stormwater Design Manual. As a result of the on-site and laboratory testing, a design infiltration rate of 20.0 inches/hour was recommended for in-ground infiltration facilities. This design infiltration rate was used in the preliminary sizing and design of the proposed on-site stormwater facilities. For more information see **Appendix 2** of the Drainage Control Plan for the soils report and groundwater information.

1.7 POTENTIAL EROSION

Potential on-site erosion control problems are not anticipated at this time. The Certified Professional in Erosion and Sediment Control will be on-site or on-call during construction activities to identify any erosion control problems. If there is a problem, the Certified Professional in Erosion and Sediment Control will promptly authorize the Contractor to initiate corrective measures.

1.8 CONSTRUCTION PHASING

The BMP implementation schedule will be driven by the construction schedule. The key milestones for each segment are as follows:

- **04/01/2025:** Mobilize equipment on-site
- **04/01/2025:** Mobilize and store all erosion and sediment control (ESC) and soil stabilization products (store Materials On Hand BMP C150)
- **04/01/2025:** Install ESC measures include stormwater management facility if applicable
- **04/08/2025:** Begin implementing soil stabilization and sediment control BMPs throughout the site for the duration of the wet season. Implement Element #12 BMPs and manage site to minimize soil disturbance.
- **04/08/2025:** Site inspections and monitoring conducted weekly and for applicable rain events as detailed in Section 1.13 of this SWPPP
- **04/15/2025:** Begin clearing and grubbing
- **05/01/2025: Dry season starts**
- **10/15/2025: Wet season starts**
- **05/01/2026: Dry season starts**
- **10/15/2026: Wet season starts**
- **11/01/2026:** Construction end, full site cleanup and restoration

1.9 CONSTRUCTION SCHEDULE

Estimated Construction Start Date: April 2025

Estimated Construction End Date: November 2026

1.10 FINANCIAL/OWNERSHIP RESPONSIBILITIES

Golden Nugget Investment Group, LLC will be the owner of the site and will have full responsibility financially. If or when a new owner takes over the site, the new owner will have full financial responsibilities of the site.

1.11 ENGINEERING CALCULATIONS

The Western Washington Hydrology Model (WWHM 2012) was used to size the flow control facilities. These calculations have been provided in the Stormwater Site Plan **Appendix 3** prepared by LDC, Inc. dated February 2024.

1.12 POLLUTION PREVENTION TEAM

1.12.1 *Roles and Responsibilities*

The pollution prevention team consists of personnel responsible for implementation of the SWPPP, including the following:

- Certified Erosion and Sediment Control Lead – Primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Project Engineer – For projects with engineered structures only (sediment pond/traps, sand filters, etc.): site representative for the owner that is the project's supervising engineer responsible for inspections and issuing instructions and drawings to the contractor's site supervisor or representative.
- Emergency Owner Contact – Individual that is the site owner or representative of the site owner to contacted in the case of an emergency.
- Monitoring Personnel – Personnel responsible for conducting water quality monitoring; for most sites this person is also the CESCL.

1.12.2 *Team Members*

Title	Name (s)	Phone Number
Certified Erosion and Sedimentation Control Lead (CESCL)		
General Contractor		
Project Engineer	Tyrell Bradley – LDC, Inc.	425.806.1869
Emergency Owner Contact		
Emergency Ecology Contact	Southwest Regional Office	360.407.6300
Non-Emergency Ecology Contact	Carol Serdar	360.407.6269
Monitoring Personnel	See CESCL	

1.13 SITE INSPECTIONS AND MONITORING

Monitoring includes visual inspection, monitoring for water quality parameters of concern and documentation of the inspection and monitoring findings in a site log book. A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements
- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form and water quality monitoring forms included in this SWPPP include the required information for the site log book. This SWPPP may function as the site log book if desired, or the forms may be separated and included in a separate site log book. However, if separated, the site log book must be maintained on site or within reasonable access to the site and be made available upon request to Ecology or the local jurisdiction.

1.13.1 *Site Inspection*

All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. The inspector will be a CESCL per BMP C160. The name and contact information for the CESCL is provided in Section 1.12.2 of this SWPPP

Site inspection will occur in all areas disturbed by construction activities and at all potential stormwater discharge points. Stormwater will be examined for the presence of suspended sediment, turbidity, discoloration, and oily sheen.

The site inspector will evaluate and document the effectiveness of the installed BMPs and determine if it is necessary to repair or replace any of the BMPs to improve the quality of the stormwater discharges. All maintenance and repairs will be documented in the site log book or forms provided in this document. All new BMPs or design changes will be documented in the SWPPP as soon as possible.

1.13.2 *Site Inspection Frequency*

Site inspected will be conducted at least once a week and within 24 hours following any discharge from the site. For sites with temporary stabilization measures, the site inspection frequency will be reduced to once every month.

1.13.3 *Site Inspection Documentation*

The site inspector will record each site inspection using the site log inspection forms provided in Appendix C. The site inspection log forms may be separated from this SWPPP document, but will be maintained on site or within reasonable access to the site and be made available upon request to Ecology, the local jurisdiction and the Engineer.

1.14 STORMWATER QUALITY MONITORING

1.14.1 *Turbidity*

Turbidity sampling and monitoring will be conducted during the entire construction phase of the project. Samples will be collected weekly at the discharge point nearest the current phase of the project work. If there is no flow at the discharge point, the attempt to sample will be recorded in the site log book and reported to Ecology in the monthly Discharge Monitoring Report (DMR) as "No Discharge". Samples will be analyzed for turbidity using the Hach 2100Q Turbidimeter.

The key benchmark turbidity value is 25 nephelometric turbidity units (NTU) for the downstream receiving water body. If the 25 NTU benchmark is exceeded in any sample collected, the following steps will be conducted:

1. Ensure all BMPs specified in this SWPPP are installed and functioning as intended.

2. Assess whether additional BMPs should be implemented, and document modified BMPs in the SWPPP as necessary.

3. Sample discharge daily util the discharge is 25 NTU or lower.

If the turbidity exceeds 250 NTU at any time, the following steps will be conducted:

1. Notify ecology by phone within 24 hours of analysis (see Section 1.12.2 of this SWPPP for contact information).

2. Continue sampling daily until the discharge is 25 NTU or lower. Initiate additional treatment BMPs such as off-site treatment, infiltration, filtration and chemical treatment within 24 hours, and implement those additional treatment BMPs as soon as possible, but within a minimum of 7 days.

3. Describe inspection results and remedial actions taken in the site log book and in monthly discharge monitoring reports described in Section 1.15 of this SWPPP.

1.14.2 *pH*

Sampling and monitoring of pH occurs if significant concrete work (> 1,000 cubic yards throughout the life of the project) or use of engineered soils (e.g., cement-treated base) is anticipated. No significant concrete work or engineered soils is planned for this project; therefore , no pH testing will be conducted.

1.15 RECORDKEEPING

1.15.1 *Site Log Book*

A site log book will be maintained for all on-site construction activities and will include:

- A record of the implementation of the SWPPP and other permit requirements;

- Site inspections; and,
- Stormwater quality monitoring.

For convenience, the inspection form included in this SWPPP include the required information for the site log book.

1.15.2 *Records Retention*

Records of all monitoring information (site log book, inspection reports/checklists, etc.), this Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements will be retained during the life of the construction project and for a minimum of three years following the termination of permit coverage in accordance with permit condition S5.C.

1.15.3 *Access to Plans and Records*

All applicable documentation, including but not limited to the SWPPP, General Permit, Notice of Authorization letter, and Site Log Book will be retained on site or within reasonable access to the site and will be made immediately available upon request to Ecology or the local jurisdiction. A copy of this SWPPP will be provided to Ecology within 14 days of receipt of written request for the SWPPP from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the SWPPP or access to the SWPPP will be provided to the public when requested in writing in accordance with the general permit condition S5.G.

1.15.4 *Updating the SWPPP*

In accordance with conditions S3, S4.B, and S.B.3 of the General Permit, this SWPPP will be modified if the SWPPP is ineffective in eliminating of significantly minimizing pollutants in stormwater discharges from the site or there has been a change in design, construction, operation, or maintenance at the site that has a significant effect on the discharge, or potential for discharge, of pollutants to the waters of the State. The SWPPP will be modified within seven days of determination based on inspection(s) that additional or modified BMPs are necessary to correct problems identified, and an updated timeline for BMP implementation will be prepared.

1.16 REPORTING

1.16.1 *Notification of Noncompliance*

If any of the terms and conditions of this permit is not met, and it causes a threat to human health or the environment, the following steps will be taken in accordance with permit section S5.F:

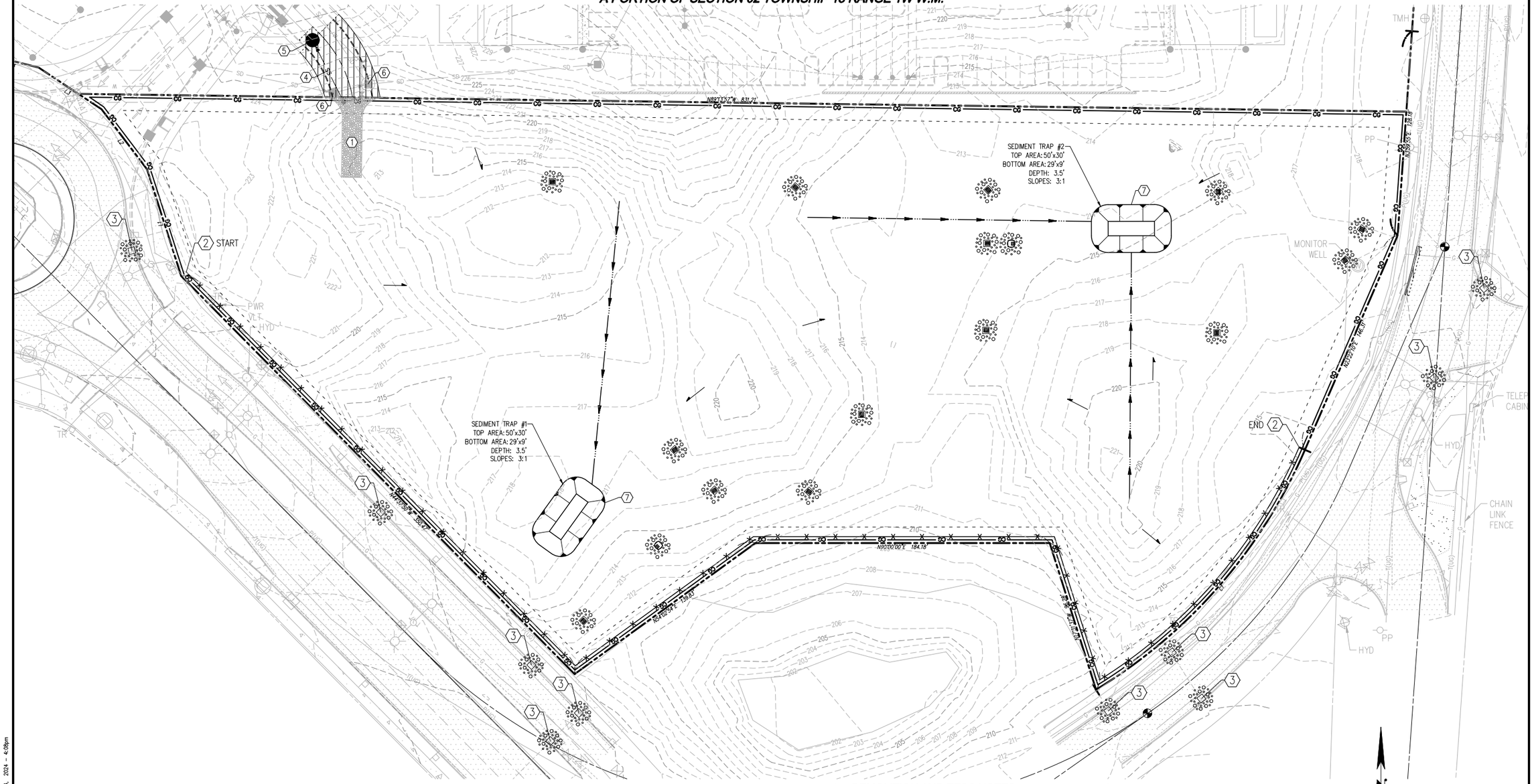
1. Ecology will be immediately notified of the failure to comply.
2. Immediate action will be taken to control the noncompliance issue and to correct the problem. If applicable, sampling and analysis of any noncompliance will be repeated

immediately and submitted to Ecology within five days of becoming aware of the violation.

3. A detailed report describing the noncompliance will be submitted to Ecology within five days, unless requested earlier by Ecology.

APPENDIX A
EROSION CONTROL AND GRADING PLANS

A PORTION OF SECTION 02 TOWNSHIP 18 RANGE 1W W.M.



DEMOLITION AND TESC NOTES

1. STABILIZED CONSTRUCTION ENTRANCE
2. SILT FENCE
3. STORM DRAIN INLET PROTECTION
4. REMOVE EXISTING SEWER LINE
5. REMOVE EXISTING SEWER MANHOLE
6. PROTECT IN PLACE EXISTING STORM STRUCTURE
7. SEDIMENT TRAP

LEGEND

- CG — CLEARING LIMITS
- SILT FENCE
- TREE PROTECTION FENCE
- (1) STABILIZED CONSTRUCTION ENTRANCE
- STORM DRAIN INLET PROTECTION
- PRE DEVELOPMENT DRAINAGE PATTERN
- SAWCUT
- ASPHALT PAVEMENT REMOVAL
- CEMENT CONCRETE REMOVAL

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY MTN2COAST, LLC. LDC, INC (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

Drawing: P:\Civil\2022\c22-130 hogum bay commercial\Drawings\preliminary\C22130P-EC-PL.dwg Plotted: Feb 14, 2024 - 4:08pm

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC | Surveying Engineering Planning
Woodinville | Tumwater | Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 | www.LDCcorp.com | F 425.482.2893

GOLDEN NUGGET INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL

DEMOLITION AND TESC PLAN

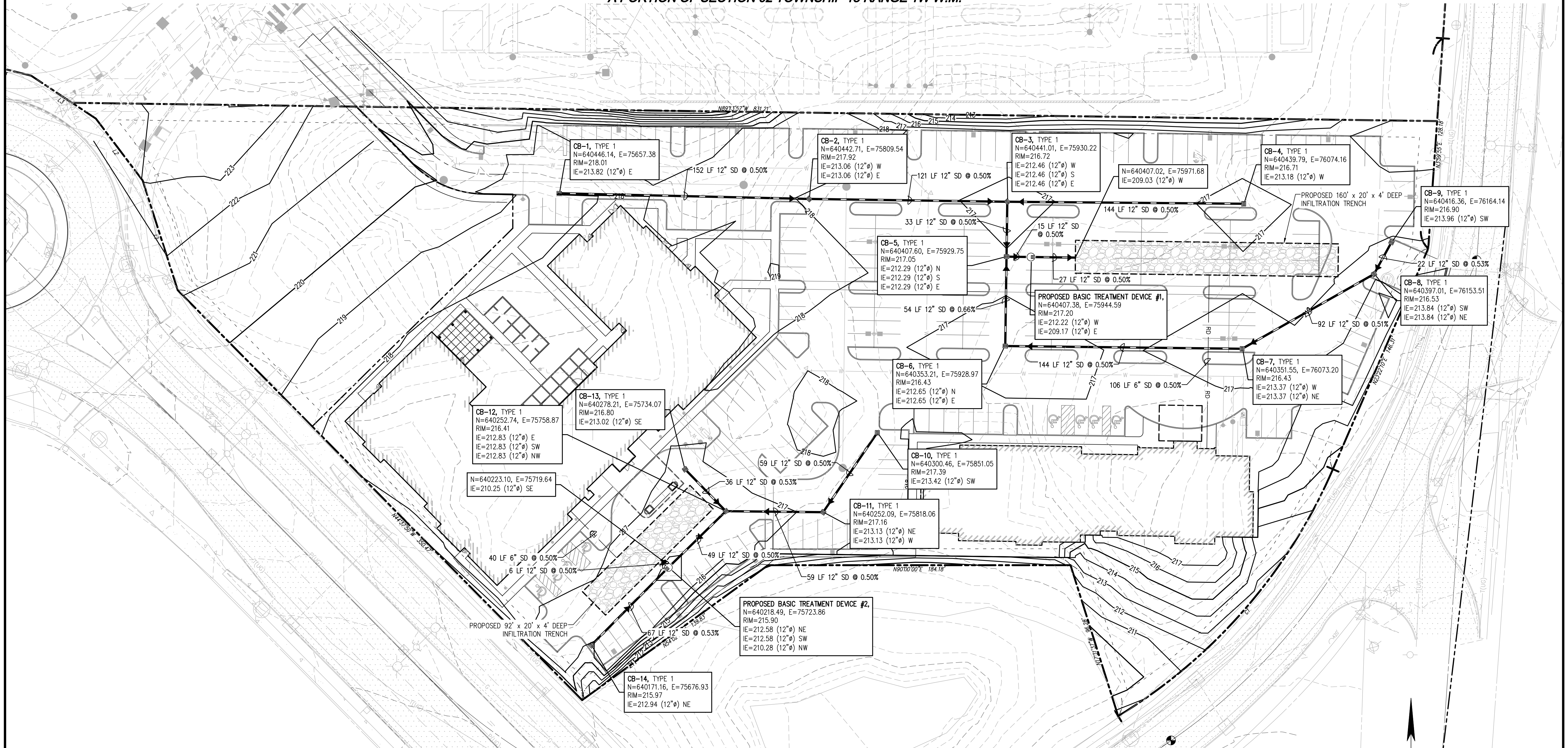
TYRELL E. BRAUN — STATE OF WASHINGTON — 51005 — REGISTERED PROFESSIONAL ENGINEER — 01-14-2024

JOB NUMBER:	C22130
DRAWING NAME:	C22130P-EC-PL
DESIGNER:	RW
DRAFTING BY:	AW
DATE:	FEBRUARY, 2024
SCALE:	AS SHOWN
JURISDICTION:	CITY OF LACEY

EC-01

SHEET 2 OF 6

A PORTION OF SECTION 02 TOWNSHIP 18 RANGE 1W W.M.



LEGEND

○	STORM DRAIN CLEANOUT
■	TYPE 1 CATCH BASIN WITH SOLID LID
——	ASTM D3034 SDR35 PVC STORM PIPE, UNLESS OTHERWISE NOTED
- - -	ASTM D3034 SDR35 PVC DRAIN LINE
—XX—	EXISTING CONTOURS
—XX—	PROPOSED CONTOURS

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

DISCLAIMER

TOPOGRAPHIC SURVEY INFORMATION CONTAINED ON THESE PLANS HAS BEEN PROVIDED BY MTN2COAST, LLC. LDC, INC (LAND DEVELOPMENT CONSULTANTS, INC.) ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

Call 2 Business Days Before You Dig
811 or 1-800-424-5555
Utilities Underground Location Center

Drawing: P:\Civil\2022\c22-130 hogum bay commercial\Drawings\preliminary\C22130P-CG-PL.dwg Plotted: Feb 14, 2024 - 4:08pm

REVISIONS

NO.	DATE	DESCRIPTION	BY

LDC | Surveying Engineering Planning
Woodinville · Tumwater · Kent
321 Cleveland Ave SE, #209
Tumwater, WA 98501
T 425.806.1869 www.LDCcorp.com F 425.482.2893

GOLDEN NUGGET INVESTMENT GROUP, LLC

HOGUM BAY COMMERCIAL

PRELIMINARY GRADING AND DRAINAGE PLAN

TYRELL E. BRABANT, STATE OF WASHINGTON, 51055, REGISTERED PROFESSIONAL ENGINEER, 02-14-2024

JOB NUMBER:	C22130
DRAWING NAME:	C22130P-CG-PL
DESIGNER:	RW
DRAFTING BY:	AW
DATE:	FEBRUARY, 2024
SCALE:	AS SHOWN
JURISDICTION:	CITY OF LACEY

CG-01

SHEET 4 OF 6

APPENDIX B
CONSTRUCTION BMPS

BMP C101: Preserving Natural Vegetation

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20 to 30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

- Natural vegetation must be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in forested areas.

- As required by the City or other agencies.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.

The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. City ordinances to save natural vegetation and trees should be reviewed.

- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- **Construction Equipment:** This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.

- **Grade Changes**: Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can typically tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less.

When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12 inches of the soil and cuts of only 2 to 3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of the plant.

- **Excavations:** Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:

  - Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint if roots will be exposed for more than 24 hours.

  - Backfill the trench as soon as possible.

  - Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, dogwood, red alder, western hemlock, western red cedar, and Douglas-fir do not readily adjust to changes in environment and special care should be taken to protect these trees.

- The windthrow hazard of Pacific silver fir and Pacific madrone is high, while that of western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.

- Cottonwoods, maples, and willows have water-seeking roots. These can cause trouble in sewer lines and infiltration fields. On the other hand, they thrive in high moisture conditions that other trees would not.

- Thinning operations in pure or mixed stands of grand fir, Pacific silver fir, noble fir, Sitka spruce, western red cedar, western hemlock, Pacific dogwood, and red alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

- Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

- If tree roots have been exposed or injured, prune cleanly with an appropriate pruning saw or loppers directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (e.g., fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C105: Stabilized Construction Access

Purpose

Stabilized construction accesses are established to reduce the amount of sediment transported onto paved roads by vehicles or equipment. This is done by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be entering or leaving a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction, provide stabilized construction accesses for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access, based on lot size and configuration.

Design and Installation Specifications

- See Figure 5.1 for details. Note: the 100 foot minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100 feet).

- Construct stabilized construction accesses with a 12-inch-thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. For single-family residential lots, pad may be reduced in length to fit site, to no less than 20 feet long, and in depth, to 6 inches thick with 4-inch to 6-inch quarry spalls, provided that performance standards are still met.

- Ecology's functionally equivalent technologies (i.e., FODS and Track Clean™ Construction Entrance Plates) are acceptable.

- Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

- A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

    - Grab Tensile Strength (ASTM D4751): 200 pounds per square inch (psi) minimum

    - Grab Tensile Elongation (ASTM D4632): 30 percent maximum

    - Mullen Burst Strength (ASTM D3786-80a): 400 psi minimum

    - AOS (ASTM D4751): 20 to 45 (U.S. standard sieve size)

- High-Visibility Fence (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.

- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.

Maintenance Standards

- Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, an increase in the dimensions of the entrance, or the installation of a wheel wash.

- Any sediment that is tracked onto pavement shall be removed by shoveling (as needed) and street sweeping on the same day that the track-out occurs. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water may be required. The sediment would then be washed into the sump where it can be controlled. Sediment-laden water shall be prevented from entering the stormwater drainage system.

- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper as these sweepers create dust and throw soil into nearby stormwater drainage systems or conveyance ditches.

- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately.

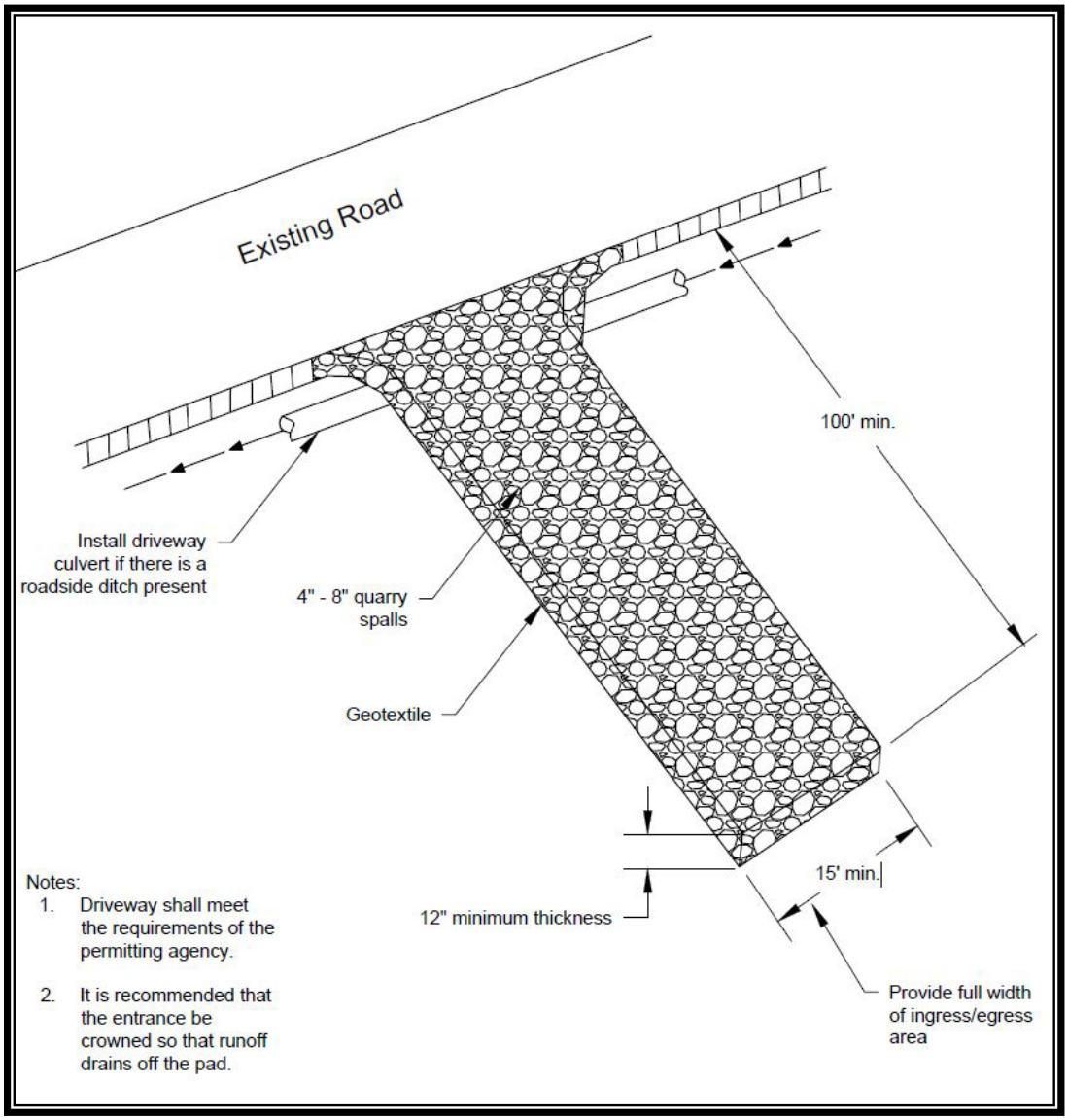
- If vehicles are entering or exiting the site at points other than the construction entrance(s), BMP C103: High-Visibility Fence shall be installed to control traffic.

- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

Approved as Functionally Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C105. However, the products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The list of products that Ecology has approved as functionally equivalent is available on Ecology's website at <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies>.

If a project wishes to use any of the "approved as functionally equivalent" BMPs in the City, the project owner or representative must obtain approval for use of the BMP from the City on a case-by-case basis (i.e., for each project or site) before use.



Source: Ecology

Figure 5.1. Stabilized Construction Access.

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by washing dirt from the wheels of motor vehicles prior to the motor vehicles leaving the construction site.

Conditions of Use

- Use a wheel wash when BMP C105: Stabilized Construction Access is not preventing sediment from being tracked off-site.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.

- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot by 10-foot sump can be very effective.

- Wheel wash wastewater is not stormwater. It is commonly called process water, and must be discharged to a separate on-site treatment system that prevents discharge to waters of the State, or to the sanitary sewer with City approval. For discharges to the sanitary sewer, permits must be obtained from the City of Lacey Wastewater Utility Department at (360) 491-5600, and/or the LOTT Clean Water Alliance at (360) 664-2333. The City manages the collection and conveyance of wastewater to the LOTT Clean Water Alliance Wastewater Treatment Plant. Note that a permit may need to be obtained by either or both entity(ies) depending on the nature of the discharge.

- Wheel washes may use closed-loop recirculation systems to conserve water use.

- Wheel wash wastewater shall not include wastewater from concrete washout areas.

- When practical, the wheel wash should be placed in sequence with BMP C105: Stabilized Construction Access. Locate the wheel wash such that vehicles exiting the wheel wash will enter directly onto BMP C105: Stabilized Construction Access. In order to achieve this, BMP C105: Stabilized Construction Access may need to be extended beyond the standard installation to meet the exit of the wheel wash.

Design and Installation Specifications

- Suggested details are shown in Figure 5.2. A minimum of 6 inches of asphalt treated base over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

- Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

- Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

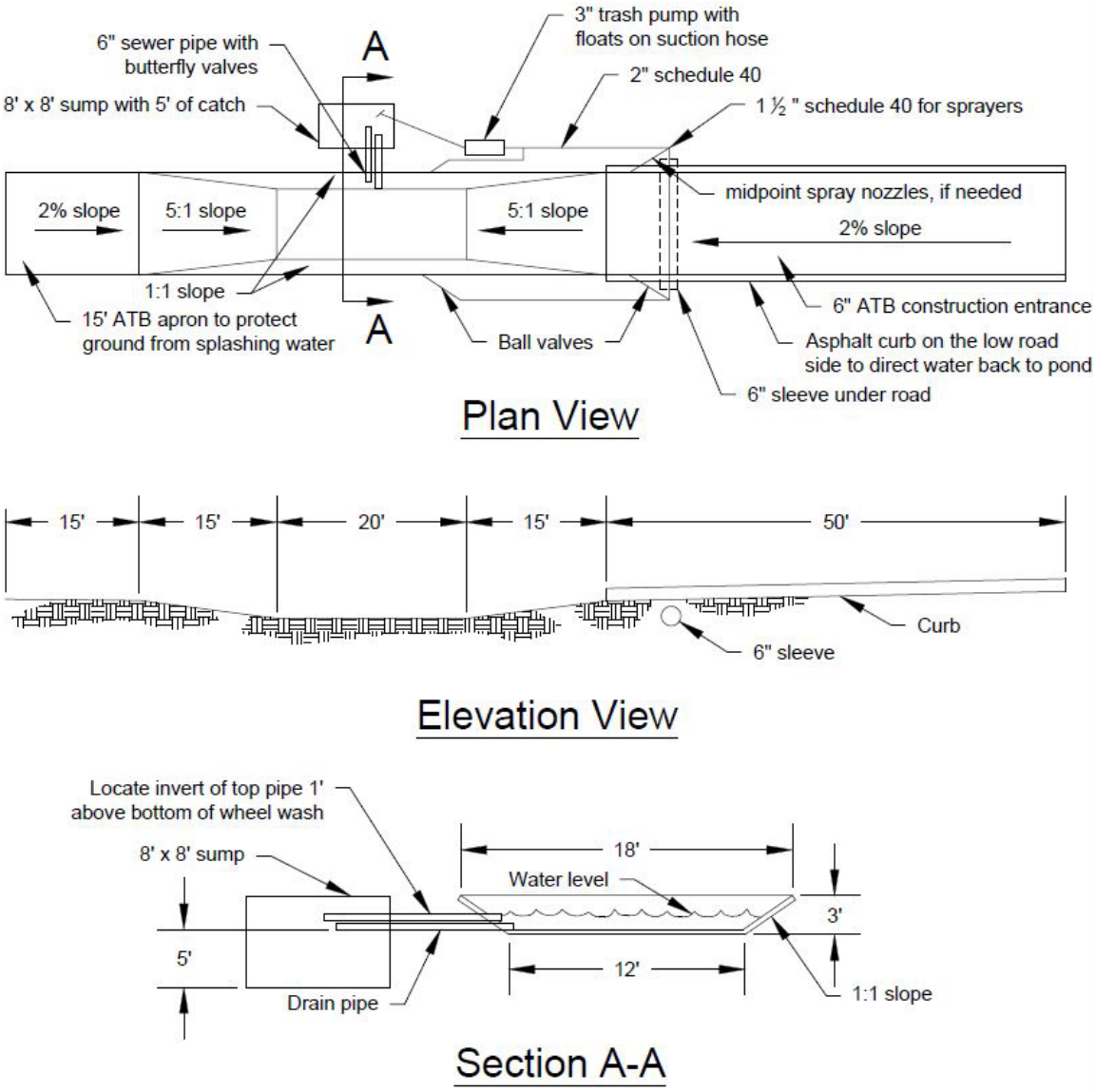
- Midpoint spray nozzles are only needed in extremely muddy conditions.

- Wheel wash systems shall be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent resuspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25– 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards

- The wheel wash shall start out each day with fresh water.

- The washwater shall be changed a minimum of once per day. On large earthwork jobs where more than 10 to 20 trucks per hour are expected, the washwater will need to be changed more often.



Notes:

1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8-foot by 8-foot sump with 5 feet of catch. Build so the sump can be cleaned with a trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15-foot ATB apron to protect ground from splashing water.

Source: Ecology and Pierce County

Figure 5.2. Wheel Wash.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other on-site vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

- Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

- BMP C103: High-Visibility Fence shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible. However, this is not appropriate when final surface is permeable pavement.

- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.

- Do not use crushed concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.

- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation that water can flow through, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheetflow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.

- Storm drain inlets shall be protected to prevent sediment-laden water entering the stormwater drainage system (see BMP C220: Inlet Protection).

Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, etc., shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.
- Following construction, these areas shall be restored to preconstruction condition or better to prevent future erosion.
- Perform street cleaning at the end of each day or more often if necessary.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding reduces erosion by stabilizing exposed soils with a well-established vegetative cover. This is one of the most effective methods of reducing erosion.

Conditions of Use

- Use seeding throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.
- The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.
- Between July 1 and August 30, seeding requires irrigation until 75 percent grass cover is established.
- Between October 1 and March 30, seeding requires a cover of mulch with straw or an erosion control blanket until 75 percent grass cover is established.
- Where the term "fully established" is used to describe vegetative cover or plantings, it shall be understood to mean that healthy vegetation covers 90 percent of exposed soil.
- Inspect all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.
- Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications for mulch; see *Design and Installation Specifications* in this BMP section for seed mix guidance.
- Seed and mulch all disturbed areas not otherwise vegetated at final site stabilization. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions, or geotextiles) that will prevent erosion.

Design and Installation Specifications

- Seed infiltration/detention ponds as required.
- Install channels intended for vegetation before starting major earthwork and hydroseeded with a Bonded Fiber Matrix (BFM). For vegetated channels that will have high flows, install erosion control blankets over hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If vegetated channels cannot be established by seed before water flow, install sod in the channel bottom—over hydromulch and erosion control blankets.

- Confirm the installation of all required surface water control measures to prevent seed from washing away.

- The seedbed should be firm and rough. All soil shall be roughened no matter what the slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.

- New and more effective restoration-based landscape practices rely on deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical the subgrade should be initially ripped to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches the rototilling process should be done in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.

- Organic matter is the most appropriate form of "fertilizer" because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form. A natural system typically releases 2 to 10 percent of its nutrients annually. Chemical fertilizers have since been formulated to simulate what organic matter does naturally.

- In general, 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer can be used at a rate of 90 pounds per acre. Slow-release fertilizers shall be used because they are more efficient and have fewer environmental impacts. It is recommended that areas being seeded for final landscaping conduct soil tests to determine the exact type and quantity of fertilizer needed. This will prevent the over-application of fertilizer. Fertilizer must not be added to the hydromulch machine and agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed.

- There are numerous products available on the market that takes the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal is a good source of long-term, slow-release, available nitrogen.

- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.

- On steep slopes, BFM or Mechanically Bonded Fiber Matrix (MBFM) products should be used. BFM/MBFM products are applied at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Application is made so that a minimum of 95 percent soil coverage is achieved.

Numerous products are available commercially and should be installed per manufacturer's instructions. Most products require 24 to 36 hours to cure before a rainfall and cannot be installed on wet or saturated soils. Generally, these products come in 40- to 50-pound bags and include all necessary ingredients except for seed and fertilizer.

- BFMs and MBFMs have some advantages over blankets:
  - No surface preparation required
  - Can be installed via helicopter in remote areas
  - On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety
  - They are at least $1,000 per acre cheaper installed.
- In most cases, the shear strength of blankets is not a factor when used on slopes, only when used in channels. BFMs and MBFMs are good alternatives to blankets in most situations where vegetation establishment is the goal.
- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil on the disturbed soil surface before application. See also postconstruction soil quality and depth in Chapter 7, Section 7.4.1.
- When installing seed via hydroseeding operations, only about one-third of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:

  1. Phase 1 – Install all seed and fertilizer with 25 to 30 percent mulch and tackifier onto soil in the first lift.
  2. Phase 2 – Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:

  1. Installing the mulch, seed, fertilizer, and tackifier in one lift.
  2. Spread or blow straw over the top of the hydromulch at a rate of 800 to 1,000 pounds per acre.
  3. Hold straw in place with a standard tackifier.

Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

- Irrigation
- Reapplication of mulch
- Repair of failed slope surfaces.

This technique works with standard hydromulch (1,500 pounds per acre minimum) and BFM or MBFM (3,000 pounds per acre minimum).

- Seed may be installed by hand if:
  - Temporary and covered by straw, mulch, or topsoil
  - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
- The seed mixes listed in the tables below include recommended mixes for both temporary and permanent seeding, and rates are provided as pounds of pure live seed per acre.
- Other mixes may be appropriate, depending on the soil type and hydrology of the area. Consult the local revegetation experts or the local conservation district for their recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the City may be used.
- Table 5.3 represents the standard mix for areas requiring a temporary vegetative cover.

Table 5.3. Temporary Erosion Control Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
Spike bentgrass	*Agrostis exarata*	0.1
California brome	*Bromus carinatus*	10.5
Tufted hairgrass	*Deschampsia cespitosa*	0.4
Blue wildrye	*Elymus glaucus*	11.4
California oatgrass	*Danthonia californica*	6.0
Native red fescue	*Festuca rubra* var. *rubra*	2.5
Meadow barley	*Hordeum brachyantherum*	8.2
Total		**39.1**

- Table 5.4 lists a recommended mix for landscaping seed.

Table 5.4. Landscaping Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
Sideoats grama	*Bouteloua curtipendula*	7.3
California oatgrass	*Danthonia californica*	6.6
Native red fescue	*Festuca rubra* var. *rubra*	4.2
Prairie Junegrass	*Koeleria macrantha*	0.9
Total		**19.0**

- Table 5.5 lists a low-maintenance turf seed mix that may be used in dry situations where there is little to no watering.

Table 5.5. Low-Growing Turf Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
Hard fescue	*Festuca brevipila*	3.1
Sheep fescue	*Festuca ovina*	3.1
Native red fescue	*Festuca rubra* var. *rubra*	3.5
Prairie Junegrass	*Koeleria macrantha*	0.6
Total		**10.2**

- Table 5.6 lists a mix for bioswales and other intermittently wet areas.

Table 5.6. Bioswale Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
American sloughgrass	*Beckmannia syzigachne*	0.9
Tufted hairgrass	*Deschampsia cespitosa*	0.6
Blue wildrye	*Elymus glaucus*	11.4
Native red fescue	*Festuca rubra* var. *rubra*	2.8
Meadow barley	*Hordeum brachyantherum*	9.8
Northwestern mannagrass	*Glyceria occidentalis*	5.2
Total		**30.7**

- Table 5.7 lists a low-growing seed mix appropriate for very wet areas that are not regulated wetlands. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

Table 5.7. Low Growing Wet Area Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
California brome	*Bromus carinatus*	10.5
Columbia brome	*Bromus vulgaris*	8.7
Tufted hairgrass	*Deschampsia cespitosa*	0.4
California oatgrass	*Danthonia californica*	5.0
Native red fescue	*Festuca rubra* var. *rubra*	2.4
Western manna grass	*Glyceria occidentalis*	3.5
Meadow barley	*Hordeum brachyantherum*	8.2
Total		**38.5**

- Table 5.8 lists a recommended meadow seed mix that is intended for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months.

Table 5.8. Meadow Seed Mix.

Common Name	Species	Pounds Pure Live Seed per Acre
Common yarrow	*Achillea millefolium*	0.07
Pearly everlasting	*Anaphalis margartacae*	0.01
California brome	*Bromus carinatus*	7.84
California oatgrass	*Danthonia californica*	3.73
Blue wildrye	*Elymus glaucus*	7.60
Idaho fescue	*Festuca idahoensis*	1.74
Native red fescue	*Festuca rubra* var. *rubra*	1.88
Sickle keeled lupine	*Lupinus albicaulis*	2.22
Fowl bluegrass	*Poa palustris*	0.36
Total		**22.9**

Maintenance Standards

- Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows). If reseeding is ineffective, an alternate method, such as sodding, mulching, or nets/blankets, shall be used. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the City when sensitive areas would otherwise be protected.

- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.

- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Approved as Functionally Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C120. However, the products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The list of products that Ecology has approved as functionally equivalent is available on Ecology's website at <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies>.

If a project wishes to use any of the "approved as functionally equivalent" BMPs in the City, the project owner or representative must obtain approval for use of the BMP from the City on a case-by-case basis (i.e., for each project or site) before use.

BMP C121: Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch shall be used:

- For fewer than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and during the hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.
- Mulch may be applied at any time of the year and must be refreshed periodically.
- For seeded areas, mulch may be made up of 100 percent: cottonseed meal; fibers made of wood, recycled cellulose, hemp, kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide (PAM) or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40- to 50-pound bags. Seed and fertilizer are added at time of application.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 5.9. Always use a 2-inch minimum mulch thickness; increase the thickness until the ground is 95 percent covered (i.e., not visible under the mulch layer). Note: Thicknesses may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Where the option of "compost" is selected, it must be a coarse compost that meets the following size gradations when tested in accordance with the U.S. Composting Council "Test Methods for the Examination of Compost and Composting" Test Method 02.02-B.

Table 5.9. Mulch Standards and Guidelines.

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2″ to 3″ thick; five bales per 1,000 sq. ft. or 2 to 3 tons per acre	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw may be reduced by half when used in conjunction with seeding. In windy areas straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits. It should also not be used within the ordinary high water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 25 to 30 lbs per 1,000 sq. ft. or 1,500 to 2,000 lbs per acre	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about 0.75 to 1 inch clog hydromulch equipment. Fibers should be kept to less than 0.75 inch.
Compost	No visible water or dust during handling. Must be produced per WAC 173-350, Solid Waste Handling Standards, but may have up to 35% biosolids.	2″ thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)	More effective control can be obtained by increasing thickness to 3 inches. Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Compost used for mulch has a coarser size gradation than compost used for BMP C125 or the postconstruction soil quality and depth BMP see Chapter 7, Section 7.4.1. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	Average size should be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.	2″ thick min.	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10 percent because of its tendency to be transported by runoff. It is not recommended within 200 feet of surface waters. If seeding is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment.

Table 5.9 (continued). Mulch Standards and Guidelines.

Mulch Material	Quality Standards	Application Rates	Remarks
Wood-based Mulch or Wood Straw	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.	2″ thick min.; approx. 100 tons per acre (approx. 800 lbs per cubic yard)	This material is often called “wood straw” or “hog fuel.” The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).
Wood Strand Mulch	A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.	2″ thick min.	Cost-effective protection when applied with adequate thickness. A minimum of 95 percent of the wood strand shall have lengths between 2 and 10 inches, with a width and thickness between 1/16 and 3/8 inch. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life. Sawdust or wood shavings shall not be used as mulch. [WSDOT Standard Specification 9-14.4(4)].

Coarse Compost

- Mulch may be applied at any time of the year and must be refreshed periodically
- Minimum Percent passing 3-inch sieve openings 100 percent
- Minimum Percent passing 1-inch″ sieve openings 90 percent
- Minimum Percent passing 0.75-inch sieve openings 70 percent
- Minimum Percent passing 0.25-inch sieve openings 40 percent

Mulch used within the ordinary high water mark of surface waters must be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material.

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area remulched.

BMP C122: Nets and Blankets

Purpose

Erosion control nets and blankets are intended to prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. In addition, some nets and blankets can be used to permanently reinforce turf to protect drainage ways during high flows. Nets (commonly called matting) are strands of material woven into an open, but high-tensile strength net (for example, coconut fiber matting). Blankets are strands of material that are not tightly woven, but instead form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). They generally have lower tensile strength than nets, but cover the ground more completely. Coir (coconut fiber) fabric comes as both nets and blankets.

Conditions of Use

Erosion control nets and blankets shall be used:

- To aid permanent vegetated stabilization of slopes 2H:1V or greater and with more than 10 feet of vertical relief.
- For drainage ditches and swales (highly recommended). The application of appropriate netting or blanket to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established. Nets and blankets also can capture a great deal of sediment due to their open, porous structure. Nets and blankets can be used to permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap. One hundred percent synthetic blankets manufactured for use in ditches may be easily reused as temporary ditch liners.

Disadvantages of blankets include:

- Surface preparation required
- On slopes steeper than 2.5H:1V, blanket installers may need to be roped and harnessed for safety
- They cost at least $4,000 to $6,000 per acre installed.

Advantages of blankets include:

- Installation without mobilizing special equipment
- Installation by anyone with minimal training
- Installation in stages or phases as the project progresses

- Installers can hand place seed and fertilizer as they progress down the slope
- Installation in any weather
- There are numerous types of blankets that can be designed with various parameters in mind. Those parameters include: fiber blend, mesh strength, longevity, biodegradability, cost, and availability.

Design and Installation Specifications

- See Figures 5.3 and 5.4 for typical orientation and installation of blankets used in channels and as slope protection. Note: These are typical only; all blankets must be installed per manufacturer's installation instructions.
- Installation is critical to the effectiveness of these products. If good ground contact is not achieved, runoff can concentrate under the product, resulting in significant erosion.
- Installation of Blankets on Slopes:
    - Complete final grade and track walk up and down the slope.
    - Install hydromulch with seed and fertilizer.
    - Dig a small trench, approximately 12 inches wide by 6 inches deep along the top of the slope.
    - Install the leading edge of the blanket into the small trench and staple approximately every 18 inches. NOTE: Staples are metal, U-shaped, and a minimum of 6 inches long. Longer staples are used in sandy soils. Biodegradable stakes are also available.
    - Roll the blanket slowly down the slope as installer walks backwards. NOTE: The blanket rests against the installer's legs. Staples are installed as the blanket is unrolled. It is critical that the proper staple pattern is used for the blanket being installed. The blanket is not to be allowed to roll down the slope on its own as this stretches the blanket making it impossible to maintain soil contact. In addition, no one is allowed to walk on the blanket after it is in place.
    - If the blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket must overlap the leading edge of the lower blanket and be stapled. On steeper slopes, this overlap must be installed in a small trench, stapled, and covered with soil.
- With the variety of products available, it is impossible to cover all the details of appropriate use and installation. Therefore, it is critical that the design engineer

consult the manufacturer's information and that a site visit takes place in order to ensure that the product specified is appropriate. Information is also available at the following web site:

- WSDOT Temporary Erosion and Sediment Control Manual (Section 3.2.4):

  <www.wsdot.wa.gov/publications/manuals/fulltext/M3109/TESCM.pdf>.

- Use jute matting in conjunction with mulch (BMP C121). Excelsior, woven straw blankets and coir (coconut fiber) blankets may be installed without mulch. There are many other types of erosion control nets and blankets on the market that may be appropriate in certain circumstances.

- In general, most nets (e.g., jute matting) require mulch in order to prevent erosion because they have a fairly open structure. Blankets typically do not require mulch because they usually provide complete protection of the surface.

- Extremely steep, unstable, wet, or rocky slopes are often appropriate candidates for use of synthetic blankets, as are riverbanks, beaches, and other high-energy environments. If synthetic blankets are used, the soil should be hydromulched first.

- One hundred percent biodegradable blankets are available for use in sensitive areas. These organic blankets are usually held together with a paper or fiber mesh and stitching, which may last up to a year.

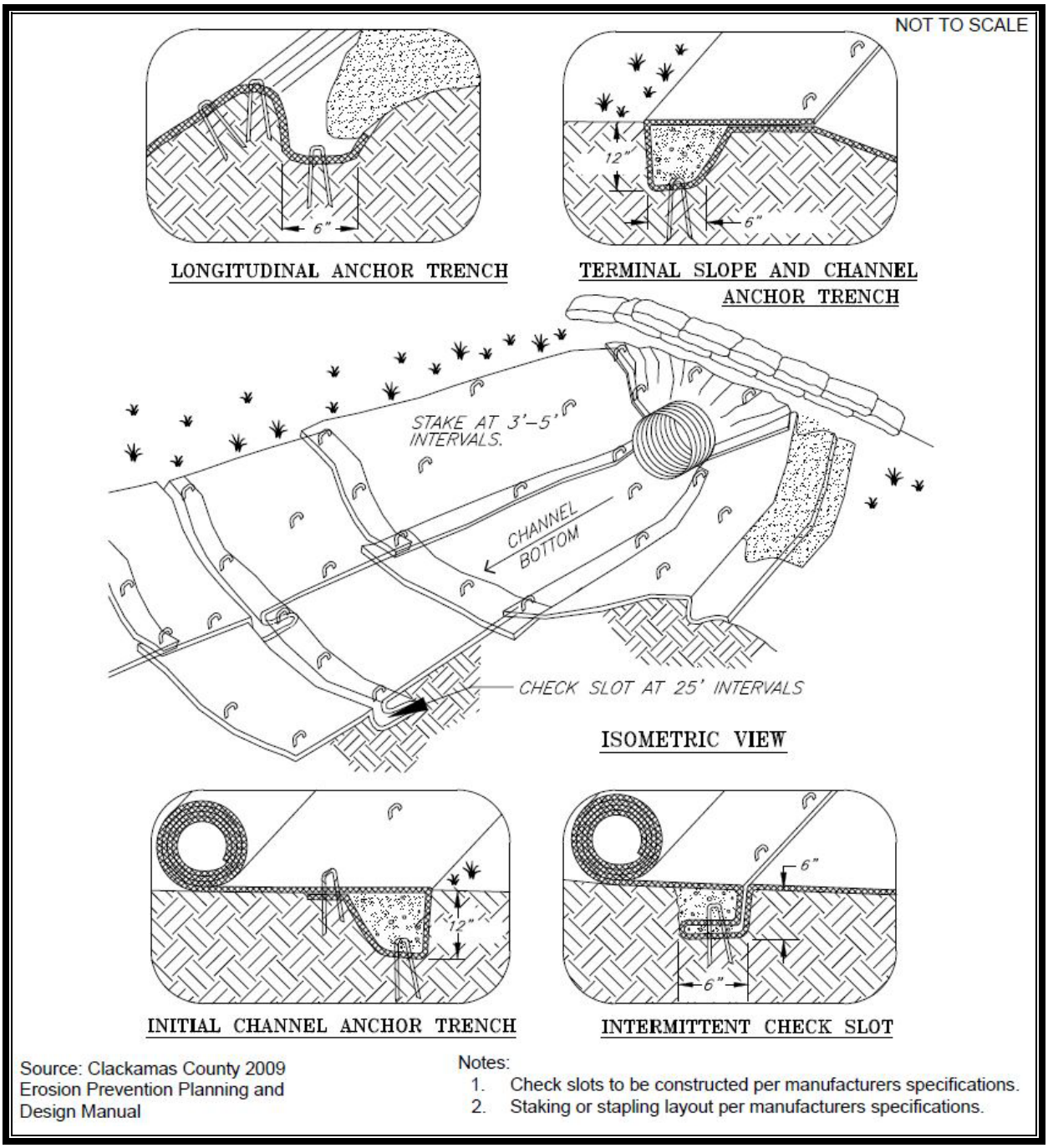
- Most netting used with blankets is photodegradable, meaning they break down under sunlight (not UV stabilized). However, this process can take months or years even under bright sun. Once vegetation is established, sunlight does not reach the mesh. It is not uncommon to find non-degraded netting still in place several years after installation. This can be a problem if maintenance requires the use of mowers or ditch cleaning equipment. In addition, birds and small animals can become trapped in the netting.

Maintenance Standards

- Maintain good contact with the ground. Erosion must not occur beneath the net or blanket.

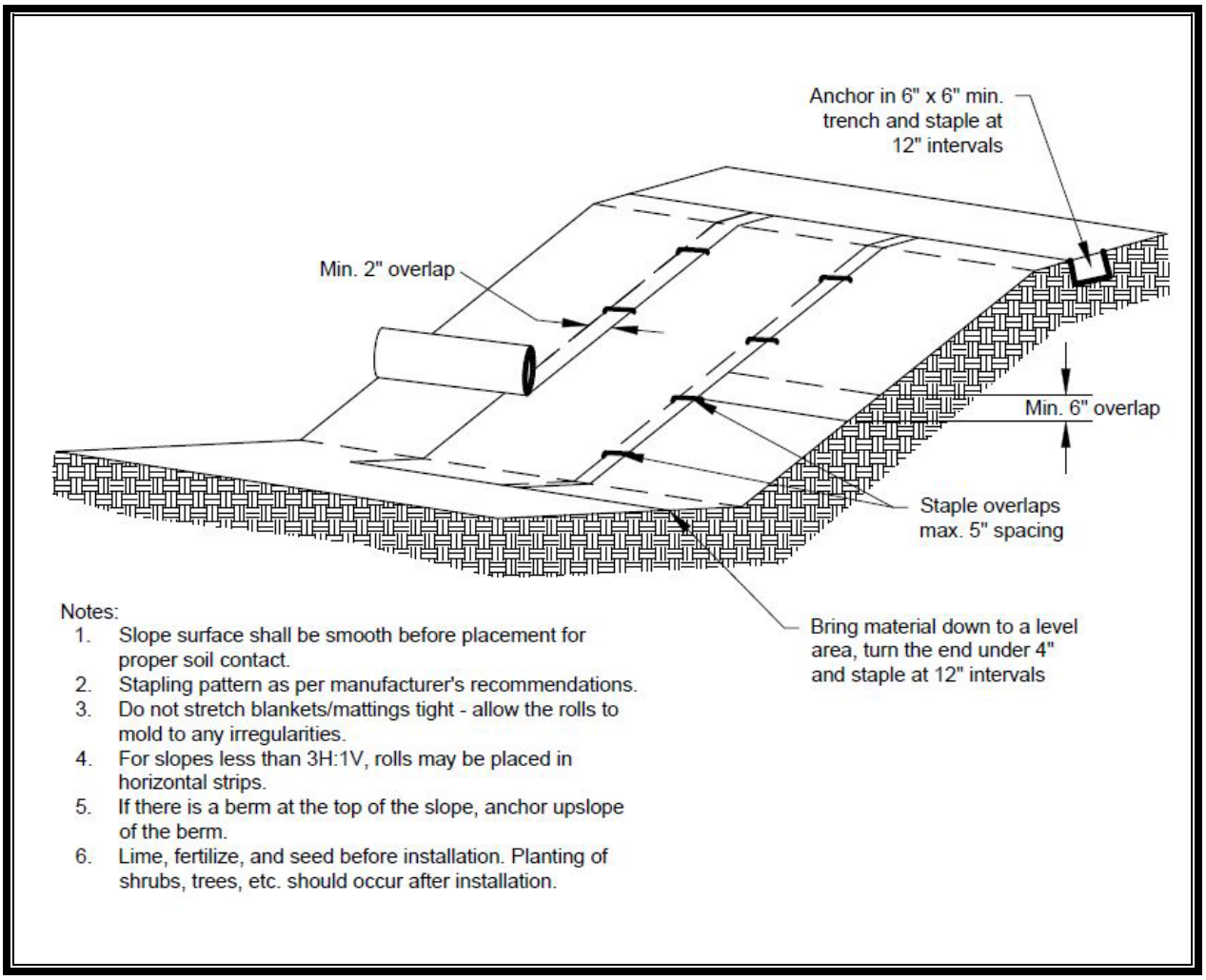
- Repair and staple any areas of the net or blanket that are damaged or not in close contact with the ground.

- Fix and protect eroded areas if erosion occurs due to poorly controlled drainage.



Source: Clackamas County

Figure 5.3. Channel Installation.



Source: Ecology

Figure 5.4. Slope Installation.

BMP C123: Plastic Covering

Purpose

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

Conditions of Use

- Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.
- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than 6 months) applications.
- Due to rapid runoff caused by plastic covering, do not use this method upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring additional on-site measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50 to $2 per square yard.
- Whenever plastic is used to protect slopes install water collection measures at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
    - Temporary ditch liner
    - Pond liner in temporary sediment pond
    - Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored
    - Emergency slope protection during heavy rains
    - Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    - Run plastic up and down slope, not across slope.
    - Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
    - Minimum of 8-inch overlap at seams.
    - On long or wide slopes, or slopes subject to wind, tape all seams.
    - Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
    - Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine to hold them in place.
    - Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil, which causes extreme erosion.
    - Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.
- Plastic sheeting shall have a minimum thickness of 6 mil.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced, and open seams repaired.
- Completely remove and replace the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

Approved as Functionally Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C123. However, the products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The list of products that Ecology has approved as functionally equivalent is available on Ecology's website at <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies>.

If a project wishes to use any of the "approved as functionally equivalent" BMPs in the City, the project owner or representative must obtain approval for use of the BMP from the City on a case-by-case basis (i.e., for each project or site) before use.

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1 inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be overexcavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than 10 percent or the permeability is less than 0.6 inches per hour. See <https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Waste-reduction-programs/Organic-materials/Managing-organics-compost> for further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1 to 2 inches into the soil and smooth the surface.
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.
- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined, and appropriate action taken to re-establish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling/Composting

Purpose

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding. Note that this BMP is functionally the same as the postconstruction soil quality and depth BMP (see Chapter 7, Section 7.4.1), which is required for all disturbed areas that will be developed as lawn or landscaped areas at the completed project site.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.

- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted condition if functioning properly.

- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.

- Restore, to the maximum extent practicable, native soils disturbed during clearing and grading to a condition equal to or better than the original site condition's moisture-holding capacity. Use on-site native soil, incorporate amendments into on-site soil, or importing blended topsoil to meet this requirement.

- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.

- Beware of where the topsoil comes from, and what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.

- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using off-site topsoil.

Design and Installation Specifications

Meet the following requirements for disturbed areas requiring disruption and topsoiling: that will be developed as lawn or landscaped areas at the completed project site:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
    - A minimum depth of 8 inches. Scarify subsoils below the topsoil layer at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or restructuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.
    - A minimum organic content of 10 percent dry weight in planting beds, and 5 percent organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
    - A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
    - If blended topsoil is imported, then fines shall be limited to 25 percent passing through a U.S. #200 sieve.
    - Mulch planting beds with 2 inches of organic material.
- Accomplish the required organic content, depth, and pH by returning native topsoil to the site, importing topsoil of sufficient organic content, and/or incorporating organic amendments.
    - When using the option of incorporating amendments to meet the organic content requirement, use compost that meets the composted material specification for bioretention (see Chapter 7, Section 7.4.4), with the exception that the compost may have up to 35 percent biosolids or manure.
    - Sections 3 through 7 of *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* (Stenn et al. 2018) provides useful guidance for implementing whichever option is chosen. It includes guidance for preapproved default strategies and guidance for custom strategies. This document is available at: <www.buildingsoil.org>.

- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.

- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.

- Take care when applying topsoil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural groundwater recharge.

- Stripping shall be confined to the immediate construction area. A 4-inch to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.

- Do not place topsoil while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.

- In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.

- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2H:1V

- Between October 1 and April 30:

    - An interceptor dike with gravel outlet and silt fence shall surround all topsoil

    - Within 2 days, complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.

- Between May 1 and September 30:
    - An interceptor dike with gravel outlet and silt fence shall surround all topsoil if the stockpile will remain in place for a longer period of time than active construction grading.
    - Within 7 days, complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
    - Re-install topsoil within 4 to 6 weeks
    - Do not allow the saturation of topsoil with water
    - Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides, and pesticides, rather than continuing to implement formerly established practices.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Conditions of Use

- All slopes steeper than 3H:1V and greater than 5 vertical feet require surface roughening to a depth of 2 to 4 inches prior to seeding
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place
- Slopes with a stable rock face do not require roughening
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 5.5 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

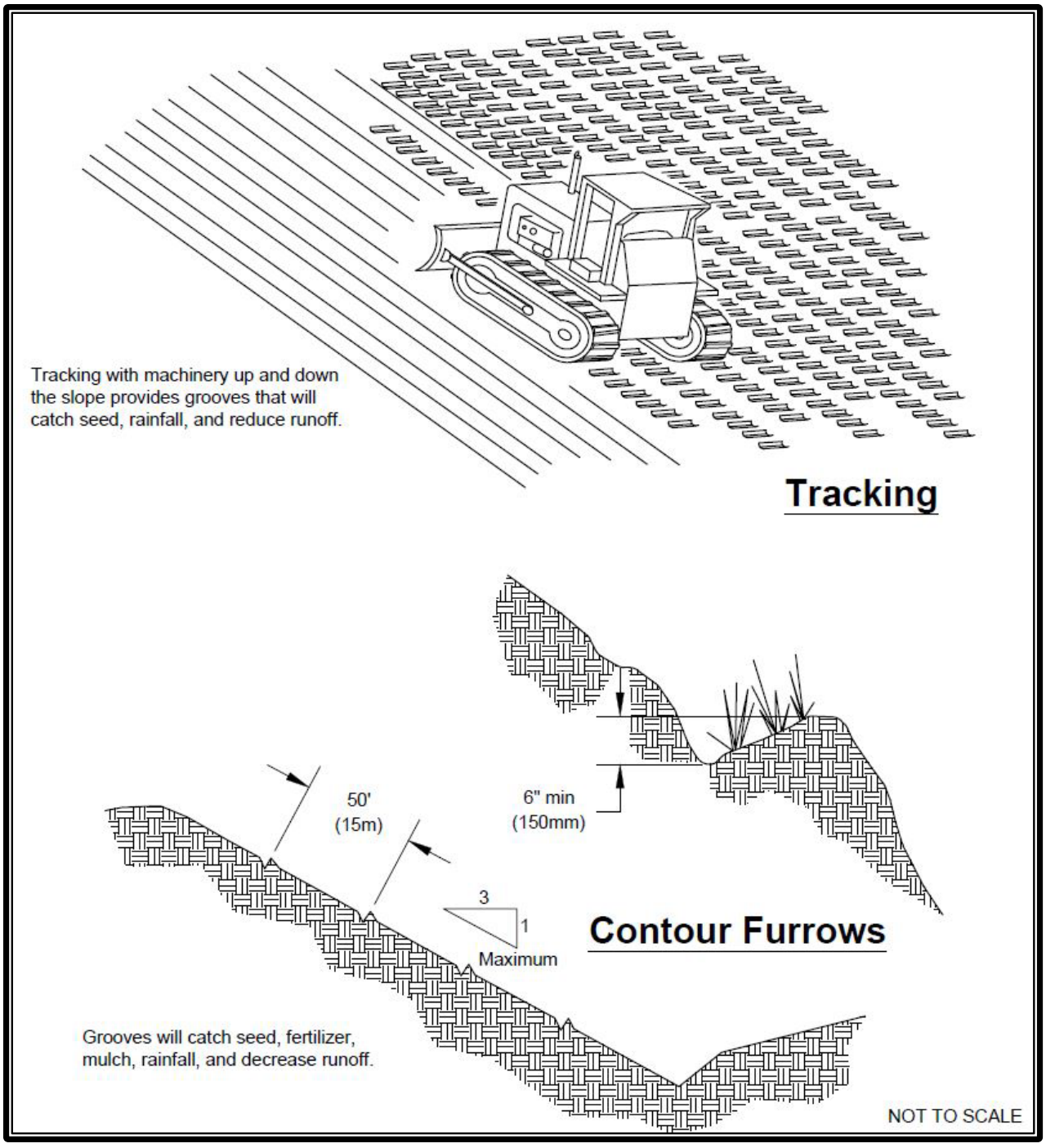
- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each “step” catches material that sloughs from above and provides a level site where vegetation can become established. Stairs must be wide enough to work with standard earth moving equipment. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3H:1V) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes steeper than 3H:1V but less than 2H:1V shall be roughened before seeding. This can be accomplished in a variety of ways,

including “track walking,” or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.

- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be regraded and reseeded immediately.



Source: Ecology

Figure 5.5. Surface Roughening by Tracking and Contour Furrows.

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

For use in areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

Design and Installation Specifications

Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.

- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition. Maintain the original ground cover as long as practical.

- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.

- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to BMP C105: Stabilized Construction Access.

- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern.

- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Oil based products are prohibited from use as a dust suppressant. The City may approve other dust palliatives such as calcium chloride or PAM.

- BMP C126: PAM added to water at a rate of 0.5 pounds per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control. Use of PAM could be a cost-effective dust control method.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than 0.075 mm) to 10 to 20 percent.
- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
- Encourage the use of alternate, paved routes, if available.
- Restrict use of paved roadways by tracked vehicles and heavy trucks to prevent damage to road surface and base.
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
- Pave unpaved permanent roads and other trafficked areas.
- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.

Contact your Puget Sound Clean Air Agency <www.pscleanair.gov> for guidance and training on other dust control measures. Compliance with Puget Sound Clean Air Agency guidance and BMPs constitutes compliance with this BMP.

Maintenance Standards

- Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose

Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric, and steel T-posts.

- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A contractor or developer could keep a stockpile of materials that are available for use on several projects.

- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum list of items that will cover numerous situations includes:

Material
Clear Plastic, 6 mil
Drainpipe, 6- or 8-inch diameter
Sandbags, filled
Straw Bales for mulching
Quarry Spalls
Washed Gravel
Geotextile Fabric
Catch Basin Inserts
Steel “T” Posts
Silt Fence Material
Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel T-posts, and gravel must be kept covered and out of both sun and rain.

- Restock materials used as needed.

BMP C151: Concrete Handling

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the State.

Conditions of Use

Any time concrete is used, utilize these management practices. Concrete construction projects include, but are not limited to, the following:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Disposal options for concrete, in order of preference are:

1. Off-site disposal
2. Concrete washout areas (see BMP 154: Concrete Washout Area)
3. *De minimus* washout to formed areas awaiting concrete

Design and Installation Specifications

- Ensure that washout of concrete trucks, chutes, pumps, and internals is performed at an approved off-site location or in designated concrete washout areas, in accordance with BMP C154: Concrete Washout Area. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams.

- Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete on site, except in designated concrete washout areas as allowed in BMP C154: Concrete Washout Area.

- Wash small concrete handling equipment (e.g., hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) into designated concrete washout areas or into formed areas awaiting concrete pour.

- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.

- Do not allow washwater from areas, such as concrete aggregate driveways, to drain directly (without detention or treatment) to natural or constructed stormwater conveyances.

- Contain washwater and leftover product in a lined container when no designated concrete washout areas (or formed areas, allowed as described above) are available. Dispose of contained concrete and concrete washwater (process water) properly.

- Always use forms or solid barriers for concrete pours, such as pilings, within 15 feet of surface waters.

- Refer to BMP C252: Treating and Disposing of High pH Water for pH adjustment requirements.

- Refer to the CSWGP for pH monitoring requirements if the project involves one of the following activities:

    - Significant concrete work (greater than 1,000 cubic yards poured concrete or recycled concrete used over the life of a project)

    - The use of engineered soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.

    - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

- Check containers for holes in the liner daily during concrete pours and repair the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting or surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose of collected slurry and cuttings in a manner that does not violate groundwater or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose process water in a manner that does not violate groundwater or surface water quality standards.

- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at an appropriate disposal site.

Maintenance Standards

- Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the State. If inspections show that a violation of water quality standards could occur, stop operations, and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

BMP C153: Material Delivery, Storage, and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials on site, store materials in a designated area, and install secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil, and grease
- Soil stabilizers and binders (e.g., Polyacrylamide [PAM])
- Fertilizers, pesticides, and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents, and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Safety Data Sheets (SDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on site should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (October 1 to April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as

detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.

- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.

- Temporary secondary containment facilities shall provide for a spill containment volume able to contain 10 percent of the total enclosed container volume of all containers, or 110 percent of the capacity of the largest container within its boundary, whichever is greater.

- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.

- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.

- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- During the wet weather season (October 1 to April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.

- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill cleanup material (spill kit).

- The spill kit shall include, at a minimum:

    - 1 water resistant nylon bag

    - 3 oil absorbent socks 3 inches by 4 feet

    - 2 oil absorbent socks 3 inches by 10 feet

- 12 oil absorbent pads 17 inches by 19 inches
- 1 pair splash resistant goggles
- 3 pair nitrile gloves
- 10 disposable bags with ties
- Instructions

BMP C154: Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout off-site, or performing on-site washout in a designated area.

Conditions of Use

Concrete washout areas are implemented on construction projects where:

- Concrete is used as a construction material.
- It is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Concrete truck drums are washed on site.

  Note that auxiliary concrete truck components (e.g., chutes and hoses) and small concrete handling equipment (e.g., hand tools, screeds, shovels, rakes, floats, trowels, and wheel-barrows) may be washed into formed areas awaiting concrete pour.

At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

Design and Installation Specifications

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Perform washout of concrete trucks at an approved off-site location or in designated concrete washout areas only.
- Do not wash out concrete onto non-formed areas, or into storm drains, open ditches, streets, or streams.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas as allowed above.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).

- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.

- If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.

- Self-installed above-grade structures should only be used if excavation is not practical.

- Concrete washout areas shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

Education

- Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.

- Educate employees and subcontractors on the concrete waste management techniques described in this BMP.

- Arrange for contractor's superintendent or CESCL to oversee and enforce concrete waste management procedures.

- A sign should be installed adjacent to each temporary concrete washout area to inform concrete equipment operators to utilize the proper facilities.

Contracts

Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

Location and Placement

- Locate washout area at least 50 feet from sensitive areas such as storm drains, open ditches, water bodies, or wetlands.

- Allow convenient access to the concrete washout area for concrete trucks, preferably near the area where the concrete is being poured.

- If trucks need to leave a paved area to access the concrete washout area, prevent track-out with a pad of rock or quarry spalls (see BMP C105: Stabilized Construction Access). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.

- The number of concrete washout areas installed will depend on the expected demand for storage capacity.

- On large sites with extensive concrete work, concrete washout areas must be placed in multiple locations for ease of use by concrete truck drivers.

Concrete Truck Washout Procedures

- Washout of concrete truck drums shall be performed in designated concrete washout areas only.

- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated concrete washout areas or properly disposed of off-site.

Concrete Washout Area Installation

- Concrete washout areas should be constructed as shown in the figures below, with a recommended minimum length and minimum width of 10 feet, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.

- Lath and flagging shall be commercial type.

- Plastic lining material should be a minimum of 10 mil polyethylene sheeting and must be free of holes, tears, or other defects that compromise the impermeability of the material.

- Liner seams shall be installed in accordance with manufacturers' recommendations.

- Soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Maintenance Standards

Inspection and Maintenance

- Inspect and verify that concrete washout areas are in place prior to the commencement of concrete work.

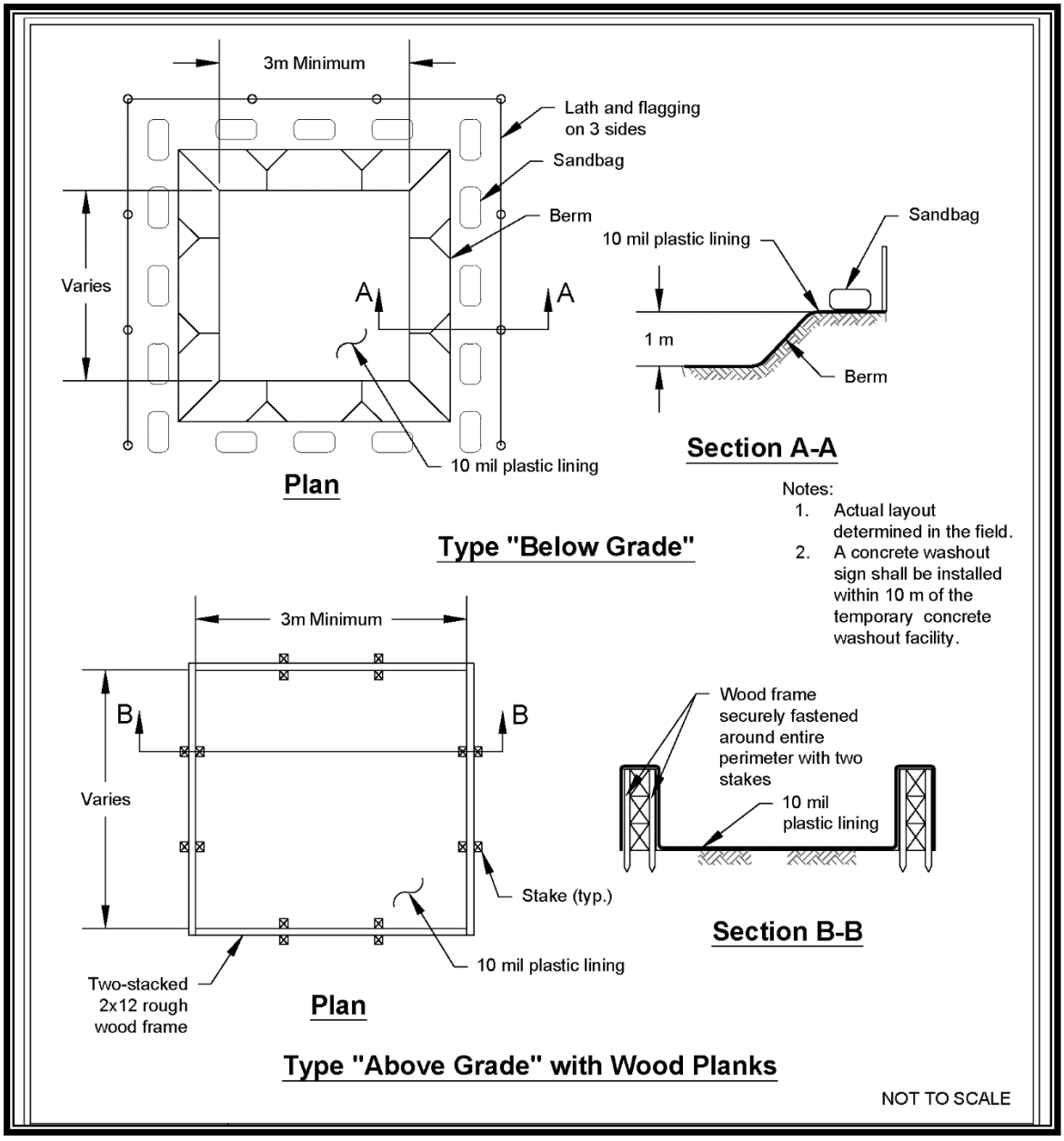
- Once concrete wastes are washed into the designated washout area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.

- During periods of concrete work, inspect the concrete washout areas daily to verify continued performance.
    - Check overall condition and performance
    - Check remaining capacity (percent full)
    - If using self-installed concrete washout areas, verify plastic liners are intact and sidewalls are not damaged
    - If using prefabricated containers, check for leaks.
- Maintain the concrete washout areas to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Concrete washout areas must be cleaned, or new concrete washout areas must be constructed and ready for use once the concrete washout area is 75 percent full.
- If the concrete washout area is nearing capacity, vacuum and dispose of the waste material in an approved manner.
    - Do not discharge liquid or slurry to waterways, storm drains or directly onto ground.
    - Do not use sanitary sewer without a permit that must be obtained either from the City of Lacey Wastewater Utility Department at (360) 491-5600, or the LOTT Clean Water Alliance at (360) 664-2333. The City manages the collection and conveyance of wastewater to the LOTT Clean Water Alliance Wastewater Treatment Plant. Note that a permit may need to be obtained by either or both entity(ies) depending on the nature of the discharge.
    - Place a secure, non-collapsing, non-water collecting cover over the concrete washout area prior to predicted wet weather to prevent accumulation and overflow of precipitation.
    - Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused on site or hauled away for disposal or recycling.
- When you remove materials from the self-installed concrete washout, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new plastic after each cleaning.

Removal of Concrete Washout Areas

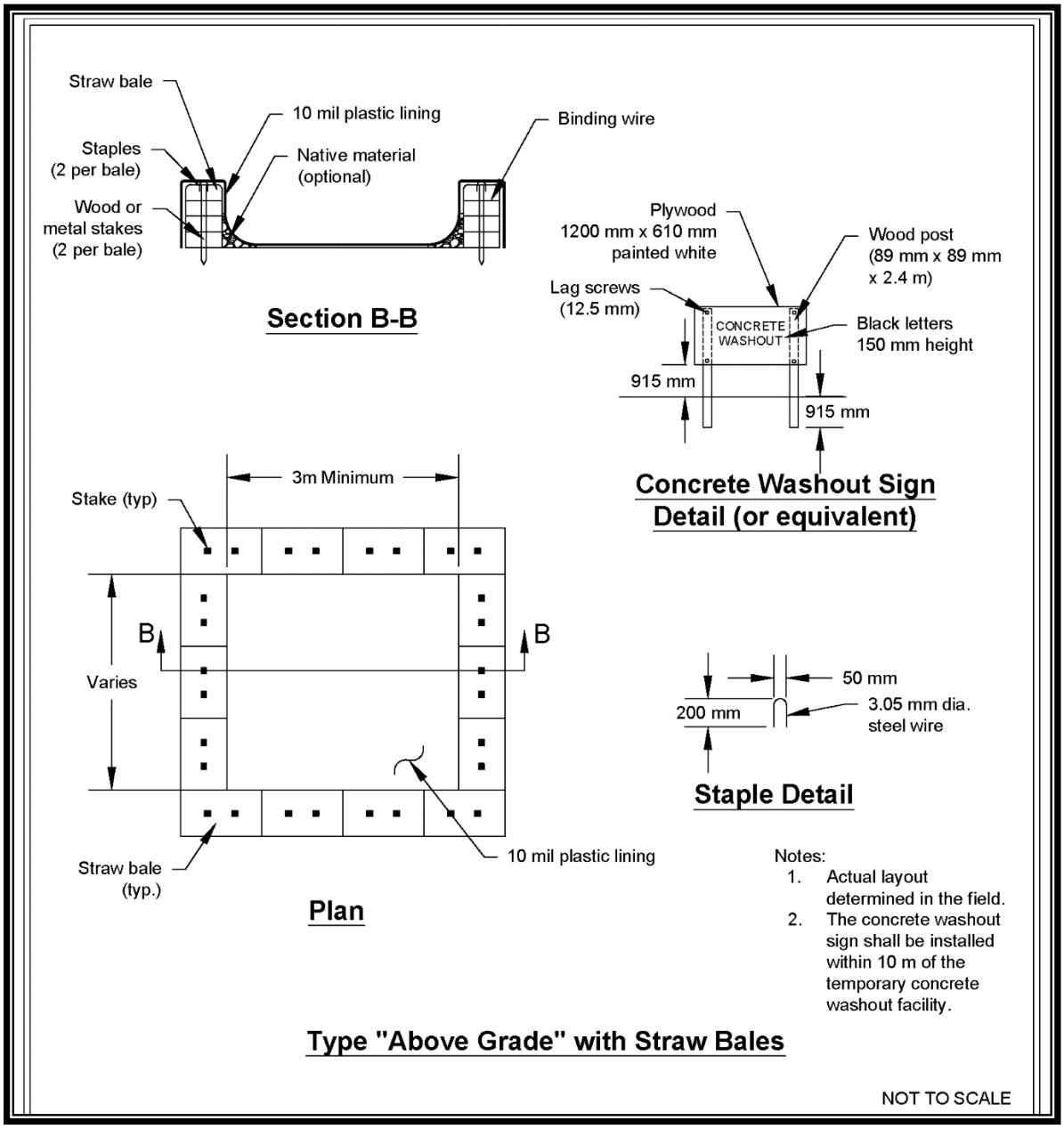
- When concrete washout areas are no longer required for the work, the hardened concrete, slurries, and liquids shall be removed and properly disposed of.
- Materials used to construct concrete washout areas shall be removed from the site of the work and disposed of or recycled.

- Holes, depressions, or other ground disturbance caused by the removal of the concrete washout areas shall be backfilled, repaired, and stabilized to prevent erosion.



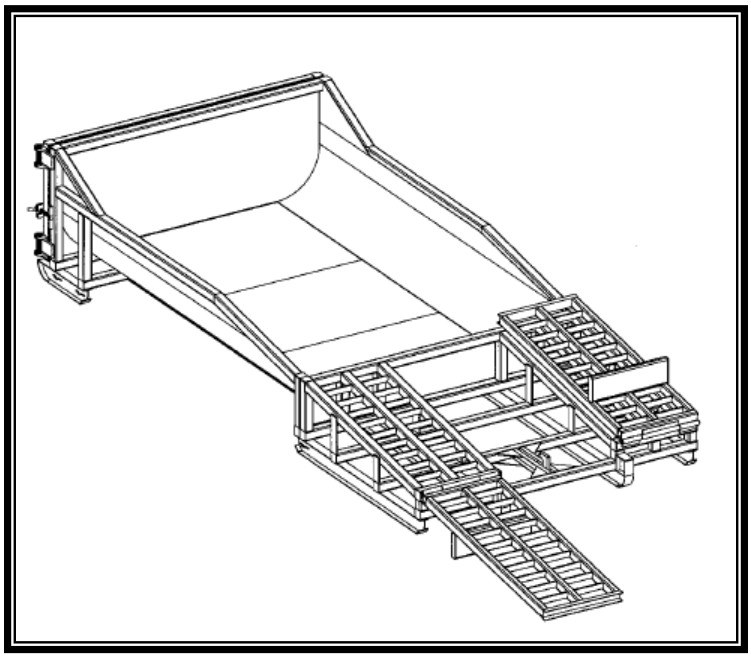
Source: Ecology

Figure 5.7a. Concrete Washout Area with Wood Planks.



Source: Ecology

Figure 5.7b. Concrete Washout Area with Straw Bales.



Source: Ecology

Figure 5.8. Prefabricated Concrete Washout Container with Ramp.

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project applicant designates at least one person as the responsible representative in charge of erosion and sediment control, and water quality protection. The designated person shall be the CESCL who is responsible for ensuring compliance with all local, state, and federal Construction SWPPP and water quality requirements.

Conditions of Use

A CESCL shall be made available on projects required to prepare a Construction SWPPP.

The CESCL shall:

- Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum training and certification requirements established by Ecology.

  Ecology has provided the minimum requirements for CESCL course training, as well as a list of ESC training and certification providers at: <https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Certified-erosion-sediment-control>

OR

- Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: <http://www.envirocertintl.org/cpesc/>.

Specifications

- Certification shall remain valid for 3 years.

- The CESCL shall have authority to act on behalf of the contractor or developer and shall be available, or on call, 24 hours per day throughout the period of construction.

- The Construction SWPPP shall include the name, telephone number, email address, fax number, and address of the designated CESCL.

- A CESCL may provide inspection and compliance services for multiple construction projects in the same geographic region, but must be on site whenever earthwork activities are occurring that could generate release of turbid water.

Duties and responsibilities of the CESCL shall include, but are not limited to the following:

- Maintaining permit file on site at all times, which includes the Construction SWPPP and any associated permits and plans.
- Directing BMP installation, inspection, maintenance, modification, and removal.
- Updating all project drawings and the Construction SWPPP with changes made.
- Completing any sampling requirements including reporting results using WebDMR.
- Keeping daily logs, and inspection reports. Inspection reports must include:
    - Inspection date/time.
    - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
    - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
        - Locations of BMPs inspected
        - Locations of BMPs that need maintenance
        - Locations of BMPs that failed to operate as designed or intended
        - Locations of where additional or different BMPs are required
    - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
    - Any water quality monitoring performed during inspection.
    - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
- Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.

BMP C162: Scheduling

Purpose

Sequencing a construction project reduces the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Minimize construction during rainy periods.

- Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent stormwater runoff from entering the work area or sediment-laden runoff from leaving the construction site.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control BMP that can safely contain the stormwater:

- Locate upslope of a construction site to prevent runoff from entering disturbed area
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope
- Locate downslope to collect runoff from a disturbed area and direct water to a sediment basin.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Subbasin tributary area shall be 1 acre or less.
- Design the dike and/or swale to contain flows calculated by one of the following methods:
    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm or the worst-case land cover condition.

OR

- Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition.

Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

- **Interceptor dikes** shall meet the following criteria:
  - Top Width: 2 feet minimum.
  - Height: 1.5 feet minimum on berm.
  - Side Slope: 2H:1V or flatter.
  - Grade: Depends on topography; however, dike system minimum is 0.5 percent, maximum is 1 percent
  - Compaction: Minimum of 90 percent ASTM D698 standard proctor.
  - Horizontal Spacing of Interceptor Dikes:

Average Slope	Slope Percent	Flow Path Length
>20H:1V or flatter	3% to <5%	300 feet
(>10 to 20)H:1V	5% to <10%	200 feet
(>4 to 10)H:1V	10% to <25%	100 feet
(2 to 4)H:1V	25% to 50%	50 feet

  - Stabilization depends on velocity and reach:
    - Slopes less than 5 percent: Seed and mulch applied within 5 days of dike construction (see BMP C121: Mulching).
    - Slopes 5 to 40 percent: Dependent on runoff velocities and dike materials. Stabilization must be done immediately using either sod or riprap or other measures to avoid erosion.
  - The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping BMP.
  - Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

- **Interceptor swales** shall meet the following criteria:
    - Bottom Width: 2-foot minimum; the cross-section bottom shall be level.
    - Depth: 1-foot minimum.
    - Side Slope: 2H:1V or flatter.
    - Grade: Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
    - Stabilization: Seed as per BMP C120: Temporary and Permanent Seeding, or BMP C202: Riprap Channel Lining, 12 inches thick of riprap pressed into the bank and extending at least 8 inches vertical from the bottom.
- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.
- Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill, and stabilize the channel to blend with the natural surface.

BMP C201: Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. See Figure 5.9 for typical grass-lined channels.

Conditions of Use

This practice applies to construction sites where concentrated runoff needs to be contained to prevent erosion or flooding.

- When a vegetative lining can provide sufficient stability for the channel cross-section and at lower velocities of water (normally dependent on grade). This means that the channel slopes are generally less than 5 percent and space is available for a relatively large cross-section.

- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas.

- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a bonded fiber matrix (BFM). The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod must be installed in the bottom of the ditch in lieu of hydromulch and blankets.

Design and Installation Specifications

- Locate the channel where it can conform to the topography and other features such as roads.

- Locate them to use natural drainage systems to the greatest extent possible.

- Avoid sharp changes in alignment or bends and changes in grade.

- Do not reshape the landscape to fit the drainage channel.

- The maximum design velocity shall be based on soil conditions, type of vegetation, and method of revegetation, but at no times shall velocity exceed 5 feet/second. The channel shall not be overtopped by the peak volumetric flow rate calculated by one of the following methods:

    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using minute time step from a Type 1A, 10-year, 24-hour frequency storm or the worst-case land cover condition.

OR

- Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time for the worst-case land cover condition.

Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

- Where the grass-lined channel will also function as a permanent stormwater conveyance BMP, the channel must meet the drainage conveyance requirements defined in Chapter 6.

- An established grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets or blankets.

- If design velocity of a channel to be vegetated by seeding exceeds 2 feet/second, a temporary channel liner is required. Geotextile or special mulch protection such as straw or netting provides stability until the vegetation is fully established. See Figure 5.10.

- Check dams shall be removed once the grass roots and aboveground biomass have grown enough to stabilize soils and sufficiently protect the swale bottom and side slopes from erosion. Check dams will remain when swale slopes are greater than 4 percent for long term erosion protection. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

- If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed.

- Do not subject grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel.

- **V-shaped grass channels** generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross-section is least desirable because it is difficult to stabilize the bottom where velocities may be high.

- **Trapezoidal grass channels** are used where runoff volumes are large and slope is low so that velocities are nonerosive to vegetated linings. (Note: it is difficult to construct small parabolic shaped channels.)

- Subsurface drainage, or riprap channel bottoms, may be necessary on sites that are subject to prolonged wet conditions due to long duration flows or a high water table.

- Provide outlet protection at culvert ends and at channel intersections.

- Grass channels, at a minimum, must carry peak runoff for temporary construction drainage BMPs from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.

- Grassed channel side slopes generally are constructed 3H:1V or flatter to aid in the establishment of vegetation and for maintenance.

- Construct channels a minimum of 0.2 foot larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup.

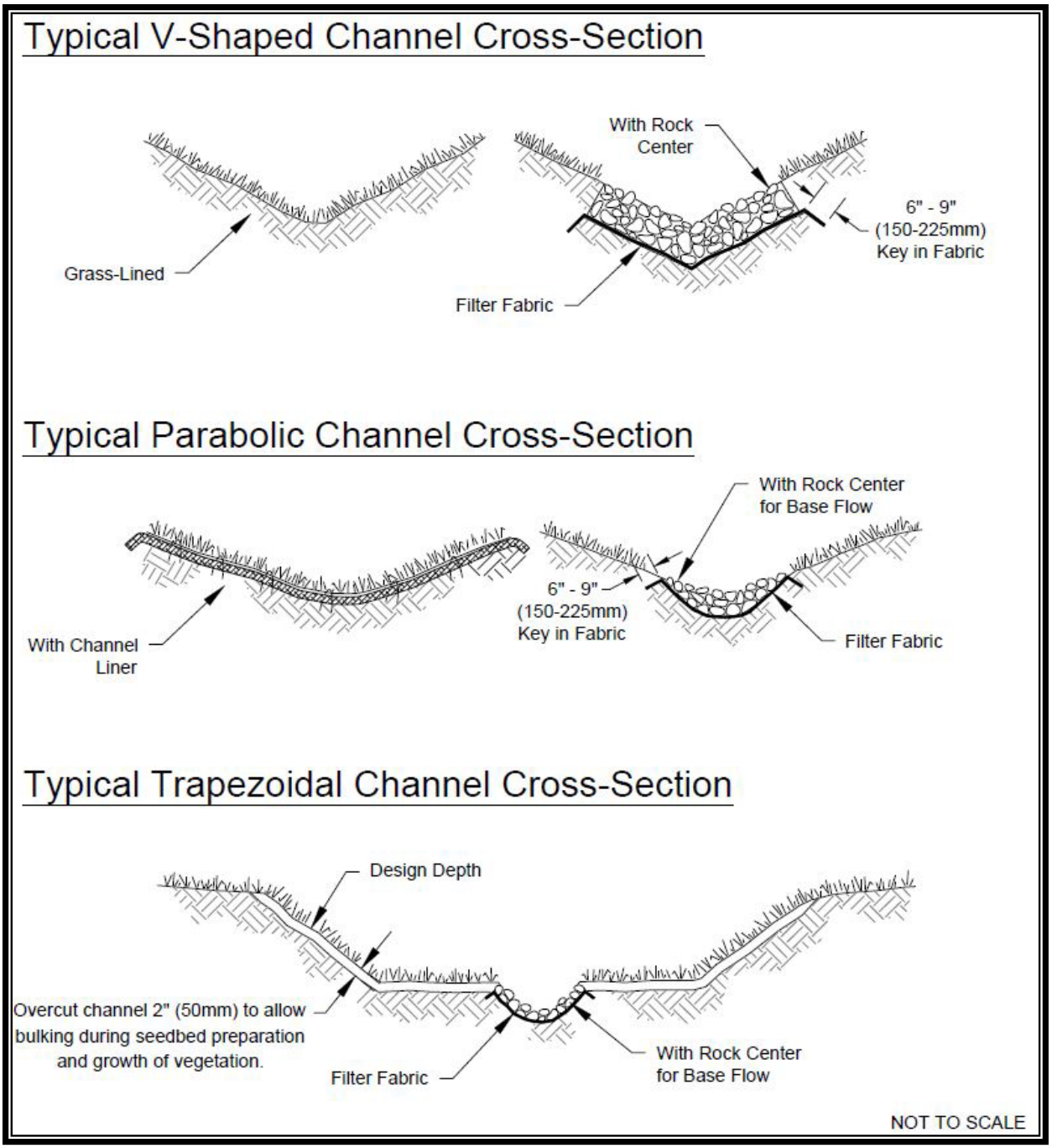
Maintenance Standards

- During the establishment period, check grass-lined channels after every rainfall.

- After grass is established, periodically check the channel; check it after every heavy rainfall event. Immediately make repairs.

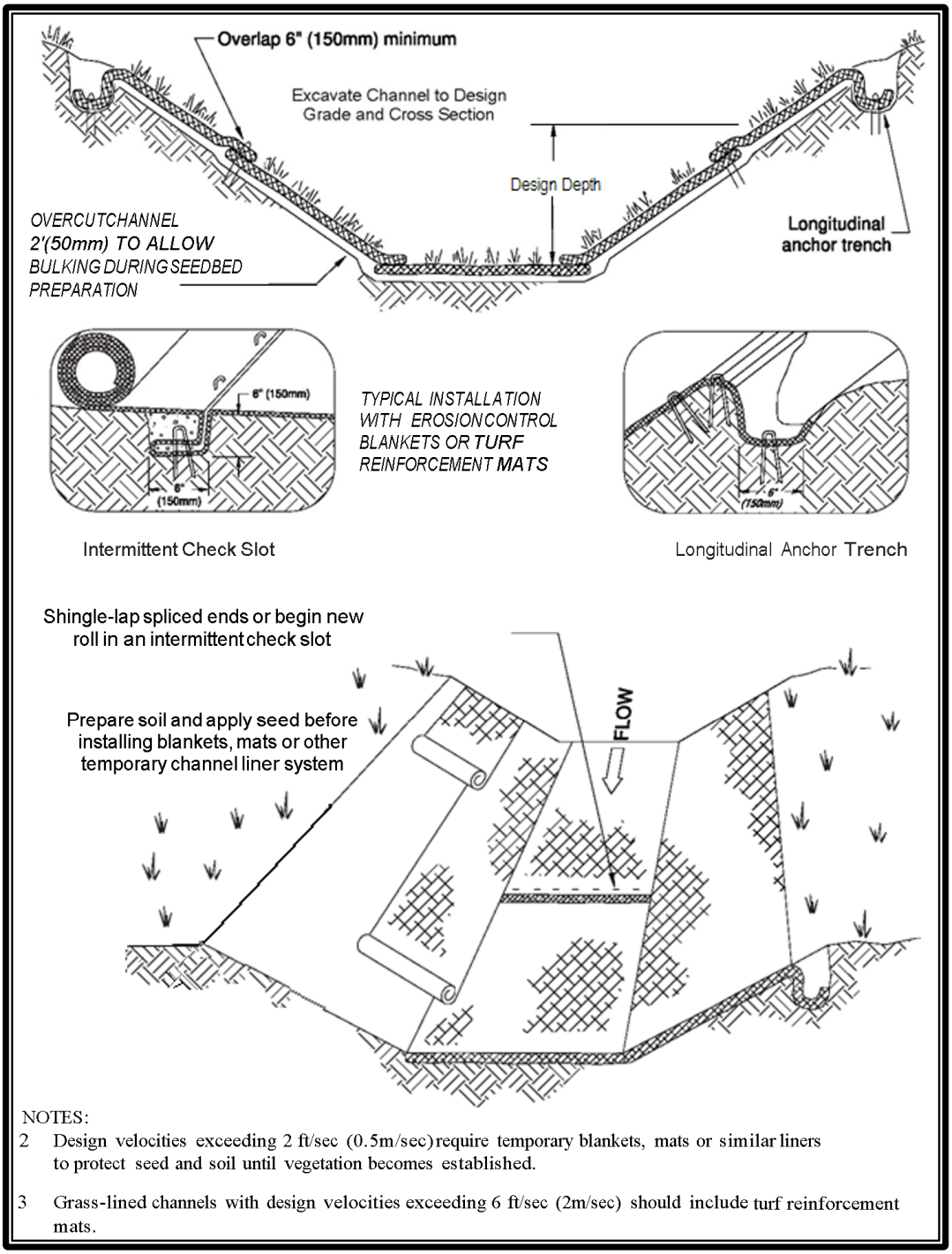
- It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes.

- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times since it is the primary erosion protection for the channel.



Source: Ecology

Figure 5.9. Typical Grass-Lined Channels.



Source: Ecology and Pierce County

Figure 5.10. Temporary Channel Liners.

BMP C220: Inlet Protection

Purpose

Inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use inlet protection at storm drain inlets that are operational before permanent stabilization of the disturbed drainage area. If these BMPs are used on active roadways, projects shall install appropriate traffic control to ensure vehicle and pedestrian traffic is not exposed to the roadway obstructions. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless conveying runoff entering catch basins to a sediment pond or trap.

Also use inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters in new home construction can add significant amounts of sediment into the roof drain system. If possible, delay installing lawn and yard drains until just before landscaping or cap these drains to prevent sediment from entering the system until completion of landscaping. Consider erosion protection methods around each finished lawn and yard drain until area is stabilized.

Table 5.10 lists several options for inlet protection. All of the methods for inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to 1 acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 5.10. Storm Drain Inlet Protection.

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding may occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area requirement: 30- by 30-feet/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No	Paved or Earthen	Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap	N/A	N/A	18-month expected life.

Design and Installation Specifications

- **Excavated Drop Inlet Protection:** An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.
    - Provide a depth of 1 to 2 feet as measured from the crest of the inlet structure
    - Slope sides of excavation no steeper than 2H:1V
    - Minimum volume of excavation 35 cubic yards
    - Shape basin to fit site with longest dimension oriented toward the longest inflow area
    - Install provisions for draining to prevent standing water problems
    - Clear the area of all debris
    - Grade the approach to the inlet uniformly
    - Drill weep holes into the side of the inlet
    - Protect weep holes with screen wire and washed aggregate
    - Seal weep holes when removing structure and stabilizing area
    - Build a temporary dike, if necessary, to the down slope side of the structure to prevent bypass flow.
- **Block and Gravel Filter:** A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure 5.16.
    - Provide a height of 1 to 2 feet above inlet
    - Recess the first row 2 inches into the ground for stability
    - Support subsequent courses by placing a 2 by 4 through the block opening
    - Do not use mortar
    - Lay some blocks in the bottom row on their side for dewatering the pool
    - Place hardware cloth or comparable wire mesh with 0.5-inch openings over all block openings
    - Place washed rock, 0.75- to 3-inch diameter, just below the top of blocks on slopes of 2H:1V or flatter.

- **Gravel and Wire Mesh Filter:** A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.
    - Use a hardware cloth or comparable wire mesh with 0.5-inch openings
    - Use coarse aggregate
    - Provide a height 1 foot or more, 18 inches wider than inlet on all sides
    - Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure
    - Overlap the strips if more than one strip of mesh is necessary
    - Place coarse aggregate over the wire mesh
    - Provide at least a 12-inch depth of gravel over the entire inlet opening and extend at least 18 inches on all sides.
- **Catch Basin Filters:** Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements, combine a catch basin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way. See Figure 5.17.
    - Provides 5 cubic feet of storage
    - Requires dewatering provisions
    - Provides a high-flow bypass that will not clog under normal use at a construction site
    - Insert the catch basin filter in the catch basin just below the grating.
- **Curb Inlet Protection with Wooden Weir:** Barrier formed around a curb inlet with a wooden frame and gravel.
    - Use wire mesh with 0.5-inch openings
    - Use extra strength filter cloth
    - Construct a frame
    - Attach the wire and filter fabric to the frame
    - Pile coarse washed aggregate against wire/fabric
    - Place weight on frame anchors.

- **Block and Gravel Curb Inlet Protection:** Barrier formed around an inlet with concrete blocks and gravel. See Figure 5.18.
    - Use wire mesh with 0.5-inch openings.
    - Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
    - Place a 2 by 4 stud through the outer holes of each spacer block to align the front blocks.
    - Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
    - Place wire mesh over the outside vertical face.
    - Pile coarse aggregate against the wire to the top of the barrier.
- **Curb and Gutter Sediment Barrier:** Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure 5.19.
    - Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet
    - Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

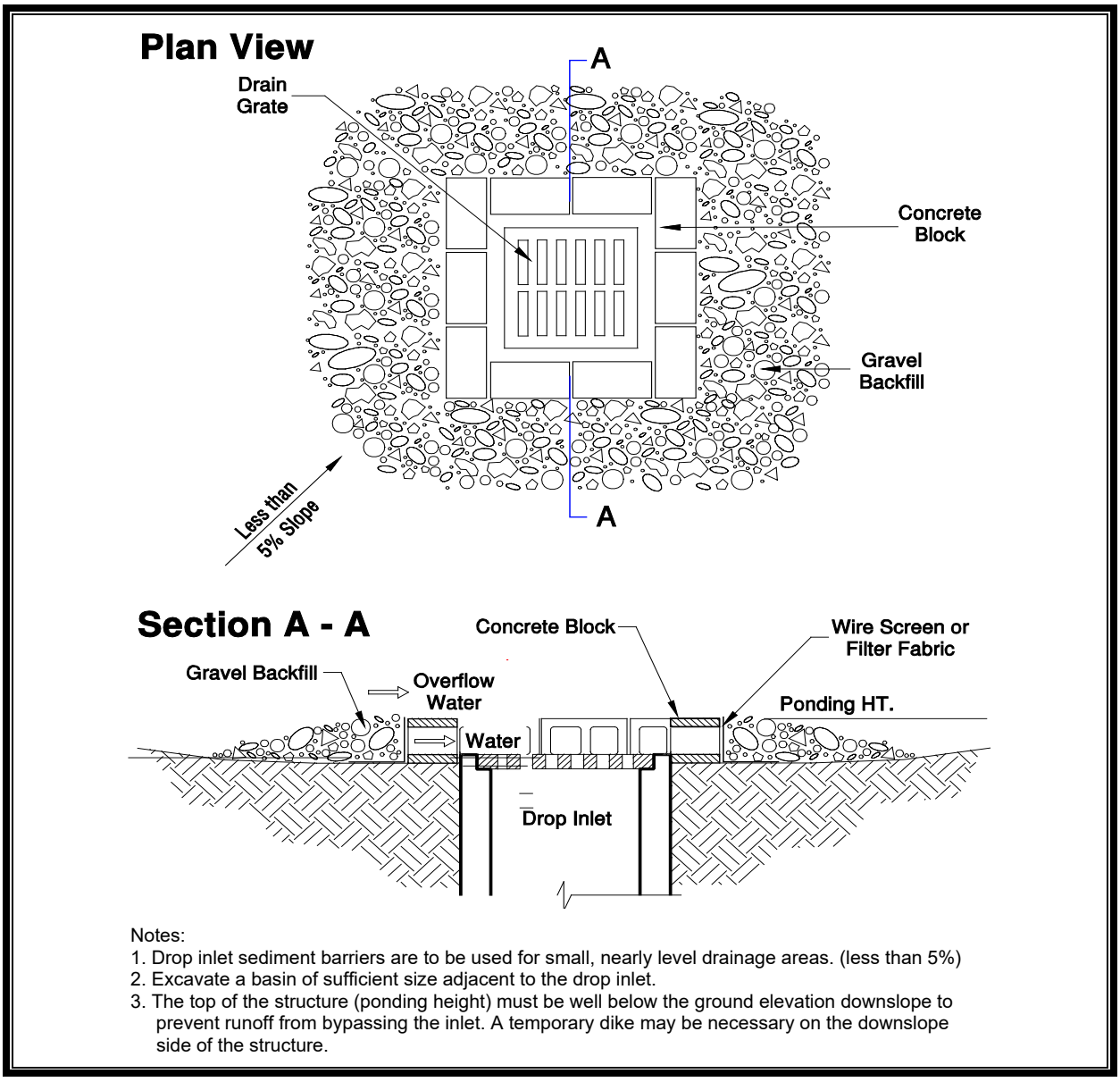
Maintenance Standards

- Inspect all forms of inlet protection frequently, especially after storm events. Clean or replace clogged catch basin filters. For rock and gravel filters, pull away the rocks from the inlet and clean or replace. An alternative approach would be to use the clogged rock as fill and put fresh rock around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.

Approved as Functionally Equivalent

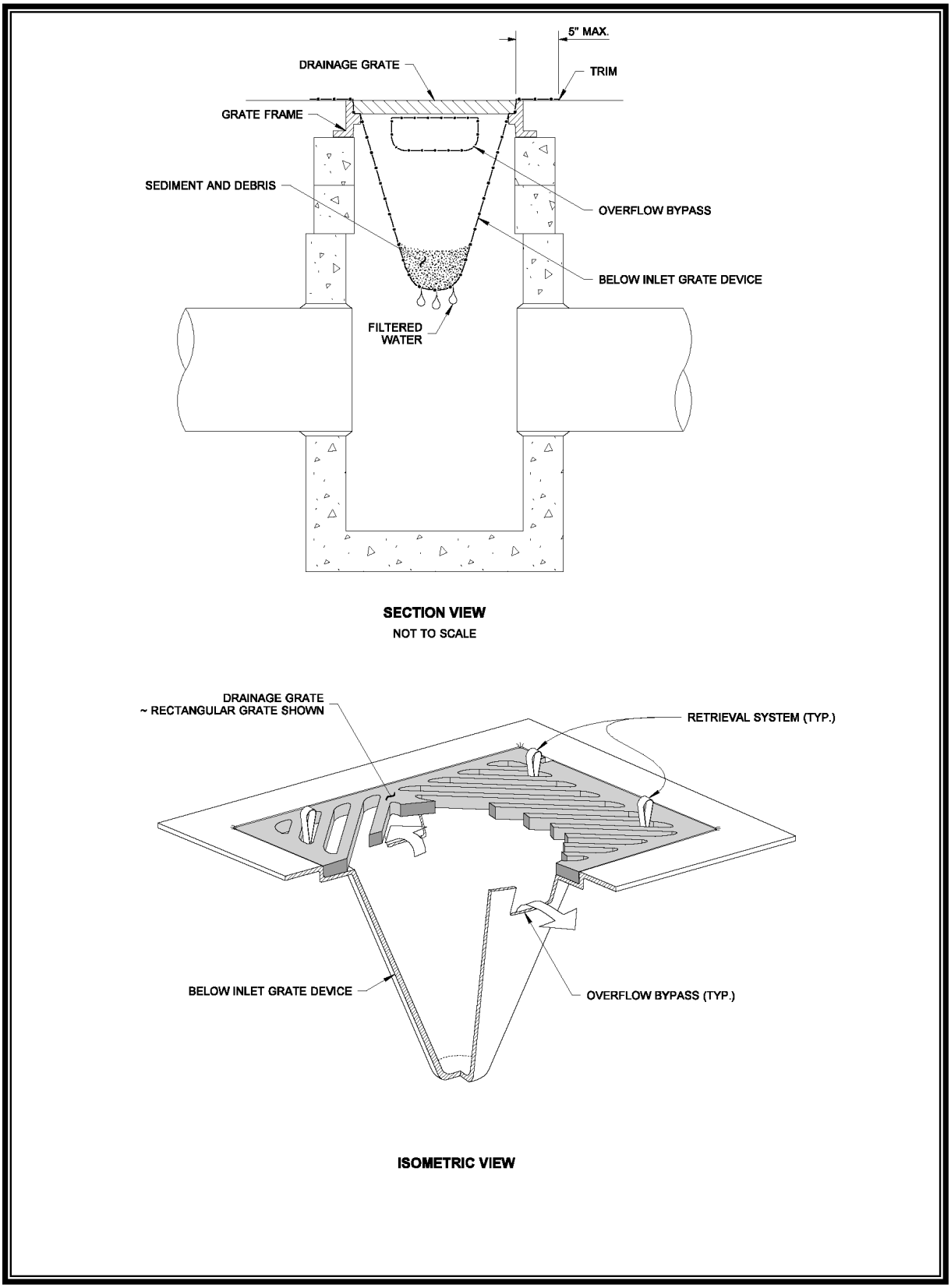
Ecology has approved specific products as able to meet the requirements of BMP C220. However, the products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The list of products that Ecology has approved as functionally equivalent are available on Ecology's website at <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies>.

If a project wishes to use any of the "approved as functionally equivalent" BMPs in the City, the project owner or representative must obtain approval for use of the BMP from the City on a case-by-case basis (i.e., for each project or site) before use.



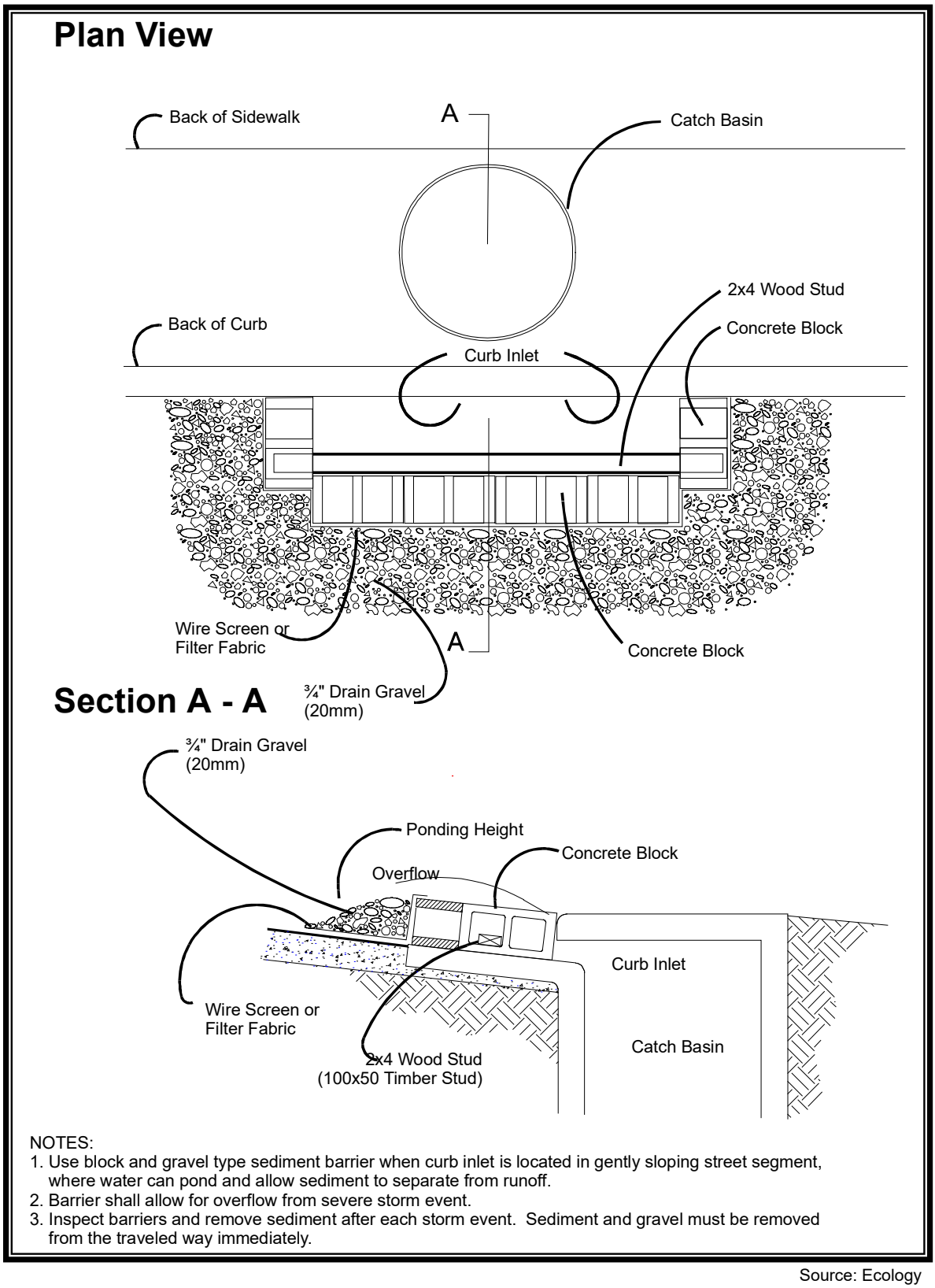
Source: Ecology

Figure 5.16. Block and Gravel Filter.



Source: WSDOT

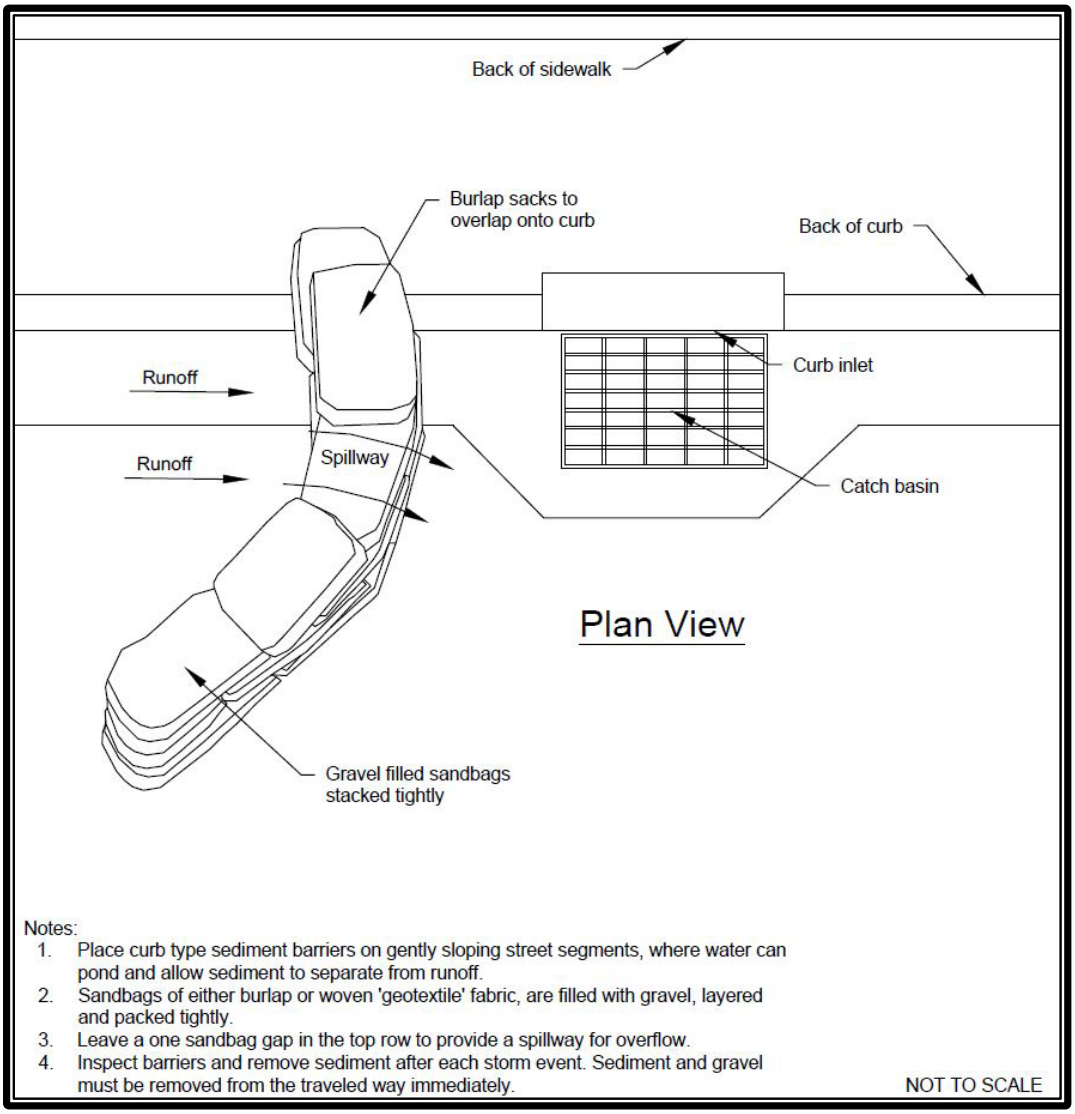
Figure 5.17. Catch Basin Filter Example.



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Source: Ecology

Figure 5.18. Block and Gravel Curb Inlet Protection.



Source: Ecology

Figure 5.19. Curb and Gutter Barrier.

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure 5.22 for details on silt fence construction.

Conditions of Use

- Silt fence may be used downslope of all disturbed areas.
- Silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment trapping BMP.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

Design and Installation Specifications

- Use in combination with other construction stormwater BMPs.
- Maximum slope steepness (normal [perpendicular] to fence line) 1H:1V.
- Maximum sheet or overland flow path length to the fence of 100 feet.
- Do not allow flows greater than 0.5 cubic feet per second.
- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table 5.11).

Table 5.11. Geotextile Standards.	
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for film wovens (U.S. #30 sieve) 0.30 mm maximum for all other geotextile types (U.S. #50 sieve) 0.15 mm minimum for all fabric types (U.S. #100 sieve)
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs minimum for extra strength fabric 100 lbs minimum for standard strength fabric
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Standard strength geotextiles must be supported with wire mesh, chicken wire, 2-inch by 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric to the 180 lbs minimum threshold. Silt fence materials are available that have synthetic mesh backing attached.

- Silt fence material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F to 120°F.

- Include the following standard notes for silt fence on construction plans and specifications:

    - The contractor shall install and maintain temporary silt fences at the locations shown in the plans.

    - Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.

    - The silt fence shall have a 2-foot minimum and 2.5-foot maximum height above the original ground surface.

    - The geotextile fabric shall be sewn together at the point of manufacture to form fabric lengths as required. Locate all sewn seams at support posts. Alternatively, two sections of silt fence can be overlapped, provided the contractor can demonstrate, to the satisfaction of the engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.

    - Attach the geotextile fabric on the upslope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the geotextile fabric to the posts in a manner that reduces the potential for tearing.

- Support the geotextile fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the upslope side of the posts with the geotextile fabric upslope of the mesh.

- Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2 inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 pounds grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the geotextile fabric it supports.

- Bury the bottom of the geotextile fabric 4 inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the geotextile fabric, so that no flow can pass beneath the fence and scouring cannot occur. The wire or polymeric mesh shall extend into the ground 3 inches min.

- Drive or place the fence posts into the ground 18 inches minimum. A 12-inch minimum depth is allowed if topsoil or other soft subgrade soil is not present and 18 inches cannot be reached. Increase fence post min. depths by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.

- Use wood, steel, or equivalent posts. The spacing of the support posts shall be a maximum of 6 feet. Posts shall consist of either:

  - Wood with dimensions of 2-inch by 2-inch minimum width and a 3-foot minimum length. Wood posts shall be free of defects such as knots, splits, or gouges.

  - No. 6 steel reinforcement bar or larger.

  - ASTM A 120 steel pipe with a minimum diameter of 1 inch.

  - U, T, L, or C shape steel posts with a minimum weight of 1.35 pounds/feet.

  - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.

- Locate silt fences on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.

- If the fence must cross contours, with the exception of the ends of the fence, place check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
    - Check dams shall be approximately 1 foot deep at the back of the fence. Check dams shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.
    - Check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Check dams shall be located every 10 feet along the fence where the fence must cross contours.

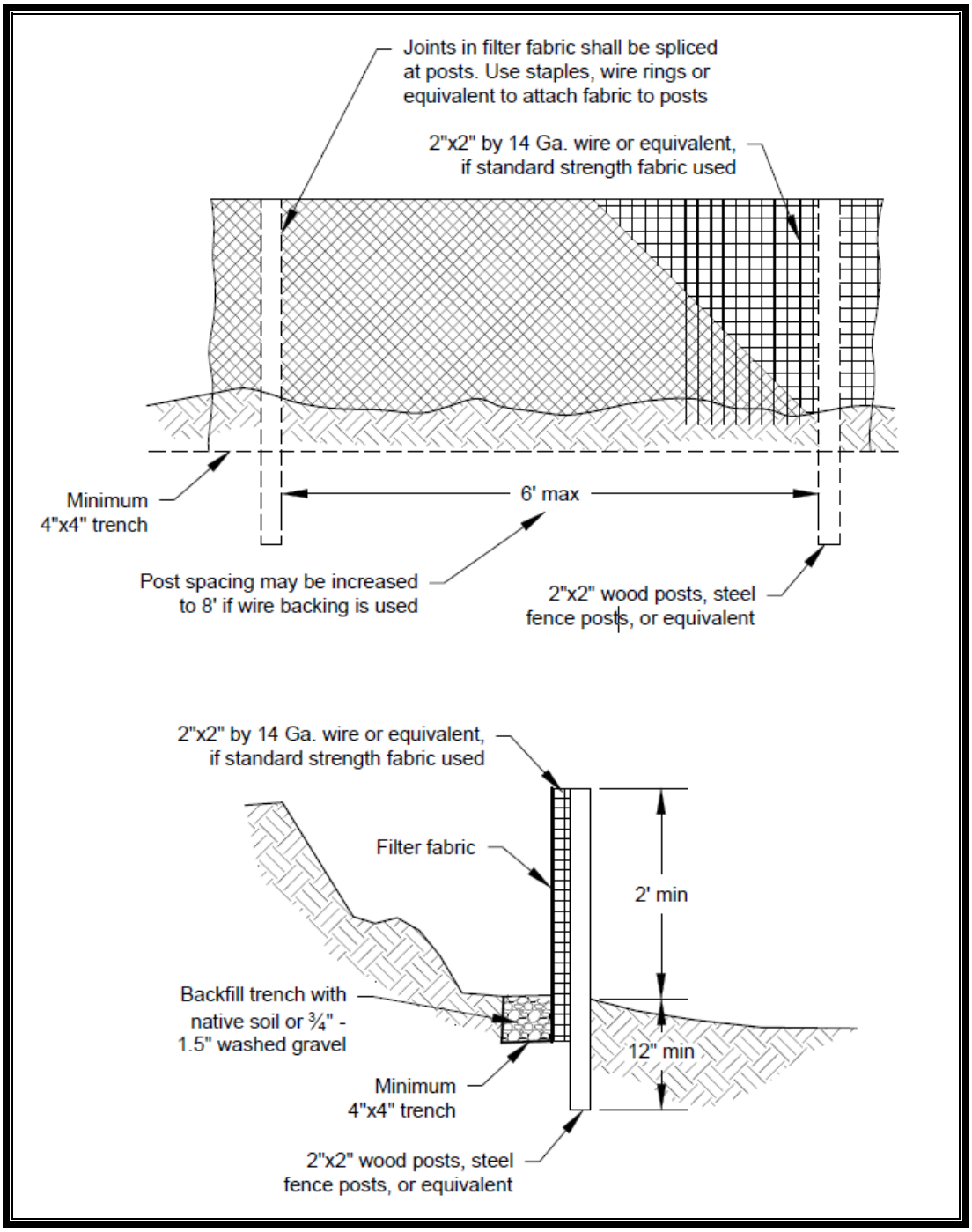
- Silt fence installation using the slicing method specification details follow. See also Figure 5.22:
    - The base of both end posts must be at least 2 to 4 inches above the top of the geotextile fabric on the middle posts for ditch check dams to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
    - Install posts 3 to 4 feet apart in critical retention areas and 6 to 7 feet apart in standard applications. Install posts 24 inches deep on the downstream side of the silt fence, and as close as possible to the geotextile fabric, enabling posts to support the geotextile fabric from upstream water pressure.
    - Install posts with the nipples facing away from the geotextile fabric.
    - Attach the geotextile fabric to each post with three ties, all spaced within the top 8 inches of the geotextile fabric. Attach each tie diagonally 45 degrees through the geotextile fabric, with each puncture at least 1 inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.
    - Wrap approximately 6 inches of geotextile fabric around the end posts and secure with three ties.
    - Between 24 and 28 inches of a 36-inch geotextile fabric is allowed above ground level, 8 to 12 inches must be buried.

- Compact the soil immediately next to the geotextile fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

- Remove silt fence upon completion of construction.

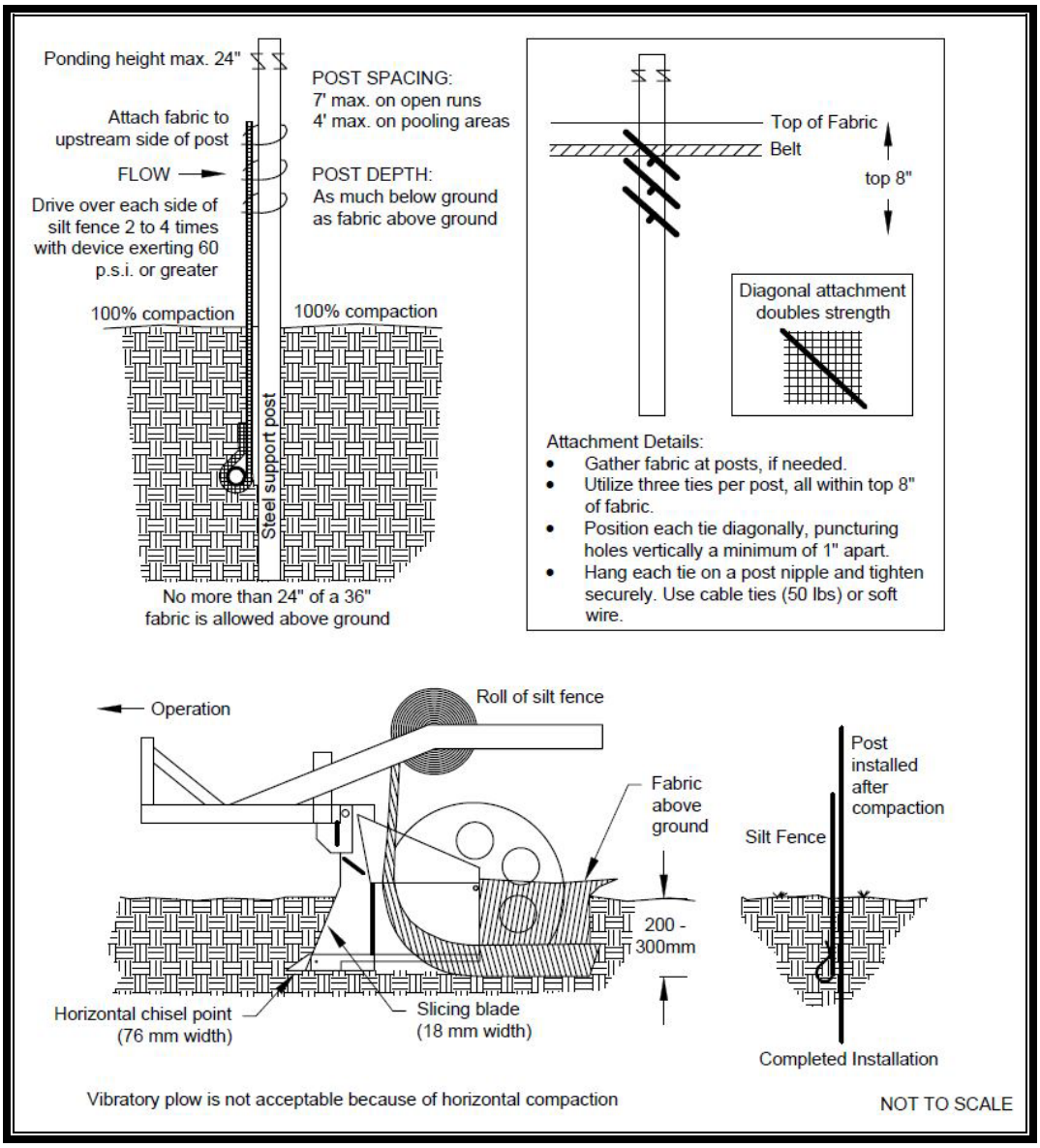
Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment trapping BMP.
- Check the uphill side of the fence for signs of the silt fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence or install a second silt fence.
- Replace geotextile fabric that has deteriorated due to ultraviolet breakdown.



Source: Ecology

Figure 5.22. Silt Fence.



Source: Ecology

Figure 5.23. Silt Fence Installation by Slicing Method.

BMP C235: Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in netting made of natural plant fiber or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff and can capture and retain sediment. See Figure 5.24 for typical construction details.

Conditions of Use

- Wattles shall consist of cylinders of plant material such as weed-free straw, coir, wood chips, excelsior, or wood fiber or shavings encased within netting made of natural plant fibers unaltered by synthetic materials.
- Use wattles:
    - In disturbed areas that require immediate erosion protection
    - On exposed soils during the period of short construction delays, or over winter months
    - On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Typically, wattles are effective for one to two seasons.
- Prevent rilling beneath wattles by properly entrenching and overlapping wattles together to prevent water from passing between them.

Design Criteria

- Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length.
- Wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes.
- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches shall be dug across the slope on contour to a depth of 3 to 5 inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches shall be dug to a depth of 5 to 7 inches, or one-half to two-thirds of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Spread excavated material evenly along the uphill slope and compacted using hand tamping or other methods.

- Construct trenches on contours at intervals of 10 to 25 feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope, the closer together the trenches.

- Install the wattles snugly into the trenches and overlap the ends of adjacent wattles 12 inches behind one another.

- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.

- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.

- Wooden stakes should be approximately 0.75 by 0.75 by 24 inches min. Willow cuttings or 0.375-inch rebar can also be used for stakes. Note: rebar must be removed at end of project if used, while other fasteners may be permitted to remain if all parts of the wattles are biodegradable and shown in plans for permanent erosion control.

- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

Maintenance Standards

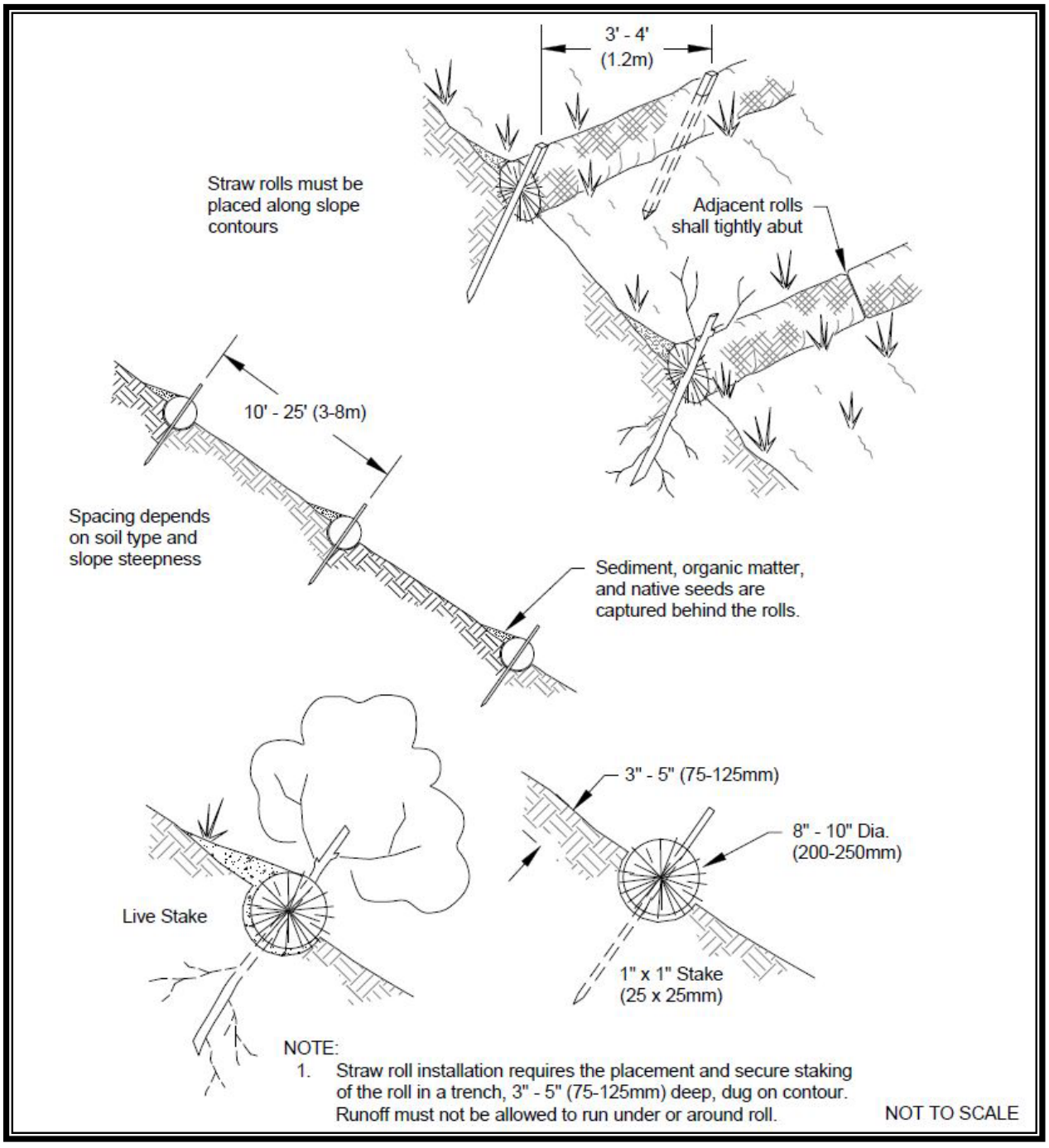
- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.

- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.

Approved as Functionally Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C235. However, the products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The list of products that Ecology has approved as functionally equivalent are available on Ecology's website at <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies>.

If a project wishes to use any of the "approved as functionally equivalent" BMPs in the City, the project owner or representative must obtain approval for use of the BMP from the City on a case-by-case basis (i.e., for each project or site) before use.



Source: Pierce County

Figure 5.24. Straw Wattles.

BMP C240: Sediment Trap

Purpose

A sediment trap is a small temporary ponding area with a gravel outlet used to collect and store sediment from sites cleared and/or graded during construction. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Conditions of Use

- Sediment traps are intended for use on sites where the tributary drainage area is less than 3 acres, with no unusual drainage features, and a projected build-out time of 6 months or less. The sediment trap is a temporary measure (with a design life of approximately 6 months) and shall be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

- Sediment traps are only effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.

- Projects that are constructing permanent flow control or runoff treatment BMPs that use ponding for treatment, may use the rough-graded or final-graded permanent BMP footprint for the temporary sediment trap. When permanent BMP footprints are used as temporary sediment traps, the surface area requirement of a sediment trap must be met. If the surface area requirement of the sediment trap is larger than the surface area of the permanent BMP, then the sediment trap shall be enlarged beyond the permanent BMP footprint to comply with the surface area requirement.

- A floating pond skimmer may be used for the sediment trap outlet if approved by the City.

- Sediment traps may not be feasible on utility projects due to the limited work space or the short-term nature of the work. Portable tanks may be used in place of sediment traps for utility projects.

Design and Installation Specifications

- See Figures 5.26 and 5.27 for details.

- To determine the sediment trap geometry, first calculate the design surface area (SA) of the trap, measured at the invert of the weir. Use the following equation:

$$SA = FS(Q2/Vs)$$

Where: Q_2 = Option 1 - Single Event Hydrograph Method:

Q2 = Peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 2-year, 24-hour frequency storm for the developed condition. The 10-year peak volumetric flow rate shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection.

Option 2 - For construction sites that are less than 1 acre, the Rational Method may be used to determine Q2

V_S = The settling velocity of the soil particle of interest. The 0.02 mm (medium silt) particle with an assumed density of 2.65 g/cm^3 has been selected as the particle of interest and has a settling velocity (Vs) of 0.00096 foot per second.

FS = A safety factor of 2 to account for non-ideal settling.

- Therefore, the equation for computing surface area becomes:

$$SA = 2 \times Q_2/0.00096$$

OR

2,080 square feet per cubic feet per second of inflow

Note: Even if permanent BMPs are used, they must still have a surface area that is at least as large as that derived from the above formula. If they do not, the pond must be enlarged.

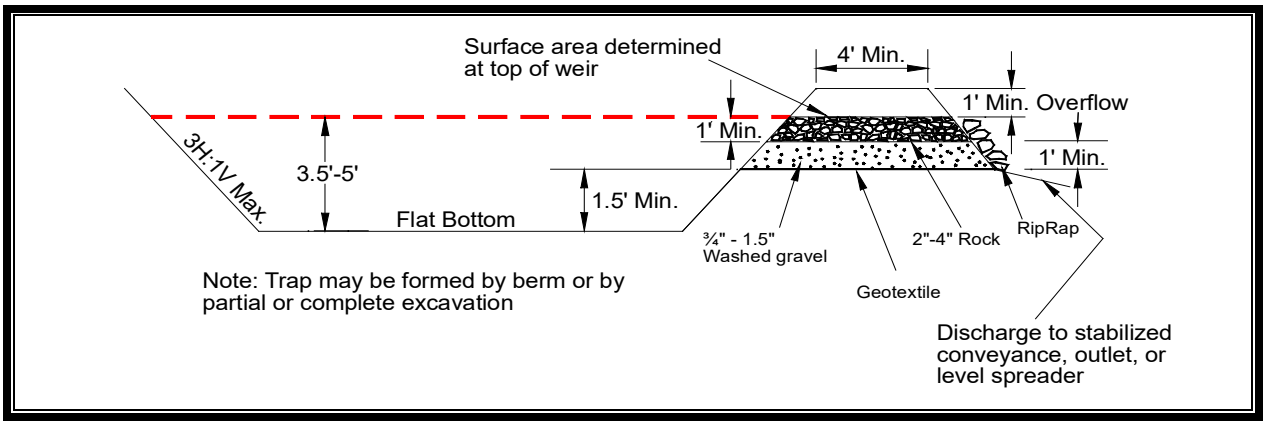
- Sediment trap depth shall be 3.5 feet minimum from the bottom of the trap to the top of the overflow weir.

- To aid in determining sediment depth, all sediment traps shall have a staff gauge with a prominent labeled mark each 1-foot interval above the bottom of the trap.

- Design the discharge from the sediment trap by using the guidance for discharge from temporary sediment ponds in BMP C241: Sediment Pond (Temporary).

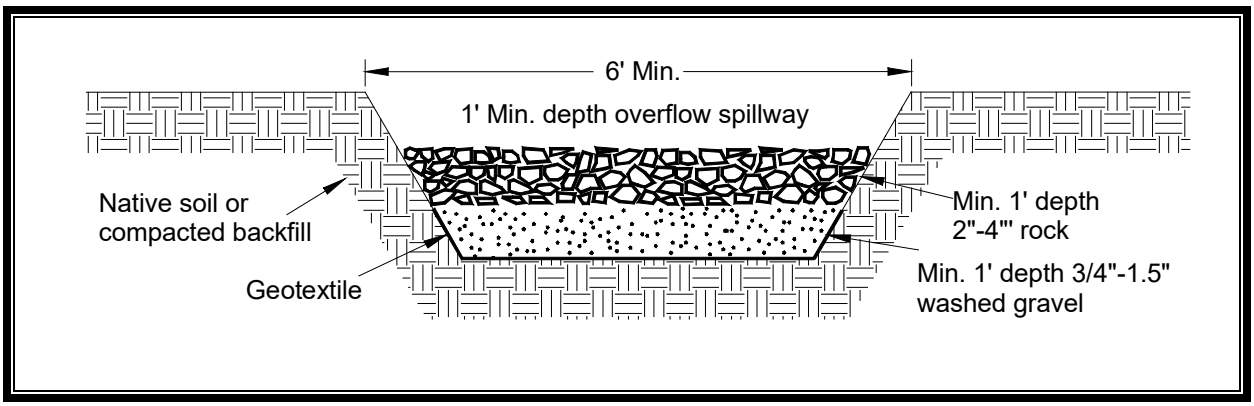
Maintenance Standards

- Sediment shall be removed from the trap when it reaches 1 foot in depth.
- Any damage to the trap embankments or slopes shall be repaired.



Source: Ecology

Figure 5.26. Cross-Section of Sediment Trap.



Source: Ecology

Figure 5.27. Sediment Trap Outlet.

APPENDIX C
SITE INSPECTION FORMS (AND SITE LOG)

Construction Stormwater Site Inspection Form

Project Name _____ Permit # _____ Inspection Date _____ Time _____

Name of Certified Erosion Sediment Control Lead (CESCL) or qualified inspector if *less than one acre*
Print Name: _____

Approximate rainfall amount since the last inspection (in inches): _____

Approximate rainfall amount in the last 24 hours (in inches): _____

Current Weather Clear ☐ Cloudy ☐ Mist ☐ Rain ☐ Wind ☐ Fog ☐

A. Type of inspection: Weekly ☐ Post Storm Event ☐ Other ☐

B. Phase of Active Construction (*check all that apply*):

Pre Construction/installation of erosion/sediment controls	☐	Clearing/Demo/Grading	☐	Infrastructure/storm/roads	☐
Concrete pours	☐	Vertical Construction/buildings	☐	Utilities	☐
Offsite improvements	☐	Site temporary stabilized	☐	Final stabilization	☐

C. Questions:

1. Were all areas of construction and discharge points inspected? Yes ___ No ___
2. Did you observe the presence of suspended sediment, turbidity, discoloration, or oil sheen Yes ___ No ___
3. Was a water quality sample taken during inspection? (*refer to permit conditions S4 & S5*) Yes ___ No ___
4. Was there a turbid discharge 250 NTU or greater, or Transparency 6 cm or less?* Yes ___ No ___
5. If yes to #4 was it reported to Ecology? Yes ___ No ___
6. Is pH sampling required? pH range required is 6.5 to 8.5. Yes ___ No ___

If answering yes to a discharge, describe the event. Include when, where, and why it happened; what action was taken, and when.

_____

_____

_____

_____

*If answering yes to # 4 record NTU/Transparency with continual sampling daily until turbidity is 25 NTU or less/ transparency is 33 cm or greater.

Sampling Results: Date: _____

Parameter	Method (circle one)	Result			Other/Note
		NTU	cm	pH	
Turbidity	tube, meter, laboratory				
pH	Paper, kit, meter				

Construction Stormwater Site Inspection Form

D. Check the observed status of all items. Provide "Action Required "details and dates.

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
1 Clearing Limits	Before beginning land disturbing activities are all clearing limits, natural resource areas (streams, wetlands, buffers, trees) protected with barriers or similar BMPs? (high visibility recommended)						
2 Construction Access	Construction access is stabilized with quarry spalls or equivalent BMP to prevent sediment from being tracked onto roads?						
	Sediment tracked onto the road way was cleaned thoroughly at the end of the day or more frequent as necessary.						
3 Control Flow Rates	Are flow control measures installed to control stormwater volumes and velocity during construction and do they protect downstream properties and waterways from erosion?						
	If permanent infiltration ponds are used for flow control during construction, are they protected from siltation?						
4 Sediment Controls	All perimeter sediment controls (e.g. silt fence, wattles, compost socks, berms, etc.) installed, and maintained in accordance with the Stormwater Pollution Prevention Plan (SWPPP).						
	Sediment control BMPs (sediment ponds, traps, filters etc.) have been constructed and functional as the first step of grading.						
	Stormwater runoff from disturbed areas is directed to sediment removal BMP.						
5 Stabilize Soils	Have exposed un-worked soils been stabilized with effective BMP to prevent erosion and sediment deposition?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
5 Stabilize Soils Cont.	Are stockpiles stabilized from erosion, protected with sediment trapping measures and located away from drain inlet, waterways, and drainage channels?						
	Have soils been stabilized at the end of the shift, before a holiday or weekend if needed based on the weather forecast?						
6 Protect Slopes	Has stormwater and ground water been diverted away from slopes and disturbed areas with interceptor dikes, pipes and or swales?						
	Is off-site storm water managed separately from stormwater generated on the site?						
	Is excavated material placed on uphill side of trenches consistent with safety and space considerations?						
	Have check dams been placed at regular intervals within constructed channels that are cut down a slope?						
7 Drain Inlets	Storm drain inlets made operable during construction are protected.						
	Are existing storm drains within the influence of the project protected?						
8 Stabilize Channel and Outlets	Have all on-site conveyance channels been designed, constructed and stabilized to prevent erosion from expected peak flows?						
	Is stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream conveyance systems?						
9 Control Pollutants	Are waste materials and demolition debris handled and disposed of to prevent contamination of stormwater?						
	Has cover been provided for all chemicals, liquid products, petroleum products, and other material?						
	Has secondary containment been provided capable of containing 110% of the volume?						
	Were contaminated surfaces cleaned immediately after a spill incident?						
	Were BMPs used to prevent contamination of stormwater by a pH modifying sources?						

Construction Stormwater Site Inspection Form

Element #	Inspection	BMPs Inspected			BMP needs maintenance	BMP failed	Action required (describe in section F)
		yes	no	n/a			
9 Cont.	Wheel wash wastewater is handled and disposed of properly.						
10 Control Dewatering	Concrete washout in designated areas. No washout or excess concrete on the ground.						
	Dewatering has been done to an approved source and in compliance with the SWPPP.						
	Were there any clean non turbid dewatering discharges?						
11 Maintain BMP	Are all temporary and permanent erosion and sediment control BMPs maintained to perform as intended?						
12 Manage the Project	Has the project been phased to the maximum degree practicable?						
	Has regular inspection, monitoring and maintenance been performed as required by the permit?						
	Has the SWPPP been updated, implemented and records maintained?						
13 Protect LID	Is all Bioretention and Rain Garden Facilities protected from sedimentation with appropriate BMPs?						
	Is the Bioretention and Rain Garden protected against over compaction of construction equipment and foot traffic to retain its infiltration capabilities?						
	Permeable pavements are clean and free of sediment and sediment laden-water runoff. Muddy construction equipment has not been on the base material or pavement.						
	Have soiled permeable pavements been cleaned of sediments and pass infiltration test as required by stormwater manual methodology?						
	Heavy equipment has been kept off existing soils under LID facilities to retain infiltration rate.						

E. Check all areas that have been inspected. ✔

All in place BMPs ☐ All disturbed soils ☐ All concrete wash out area ☐ All material storage areas ☐
All discharge locations ☐ All equipment storage areas ☐ All construction entrances/exits ☐

F. Elements checked "Action Required" (section D) describe corrective action to be taken. List the element number; be specific on location and work needed. Document, initial, and date when the corrective action has been completed and inspected.

Element #	Description and Location	Action Required	Completion Date	Initials

Attach additional page if needed

Sign the following certification:

"I certify that this report is true, accurate, and complete, to the best of my knowledge and belief"

Inspected by: (print) _____ (Signature) _____ Date: _____

Title/Qualification of Inspector: _____

DRAINAGE CONTROL PLAN
ATTACHMENT 2
MAINTENANCE AND SOURCE CONTROL MANUAL

NOT INCLUDED AT THIS TIME