Vancouver Energy
Construction Stormwater Pollution Prevention Plan

Plan No. C.01 | Revision 01

Approved by:

Name, Title: Kelly Flint, Senior Vice President and Corporate Counsel, Savage Companies
Designated Agent for EFSEC Application No. 2013-01
Date: 4 August 2015

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Vancouver Energy
Construction Stormwater Pollution Prevention Plan

EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590
4 August 2015

Prepared for

Tesoro Savage Petroleum Terminal LLC
5501 NW Old Lower River Road
Vancouver, Washington 98660

Prepared by

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Job No. A13.0267.02

Revision Summary

No.	Date	Edits/Comments
00	27 February 2015	Submittal for Application Review
01	4 August 2015	Response to EFSEC 23 June 2015 Construction Stormwater National Pollutant Discharge Elimination System (SW NPDES) Permit Application Review and Restrictive Covenant Review for Consent Decree

Vancouver Energy
Construction Stormwater Pollution Prevention Plan

Table of Contents

Section

1. Essential Information v
1.1 Facility Information v
1.2 Facility Contact Information v
1.3 Agency Information vi
1.4 Stormwater Pollution Prevention Team vi
Executive Summary viii
2. Site Description 1
2.1 Existing Conditions 4
2.1.1 Stormwater Conveyance and Treatment Systems 5
2.1.2 Surface Water Bodies 13
2.1.3 Floodplains 13
2.1.4 Wetlands 14
2.1.5 Soils Evaluation 15
2.1.6 Past Site Remediation 15
2.1.7 Climate 21
2.2 Proposed Facility Description 21
2.3 Proposed Construction Activities 22
2.3.1 Area 200 – Unloading and Office 22
2.3.2 Area 300 – Storage 23
2.3.3 Area 400 – Marine Terminal 24
2.3.4 Area 500 – Transfer Pipelines 25
2.3.5 Area 600 – West Boiler 26
2.3.6 Rail Improvements 27
2.3.7 Construction within Identified Cap Areas 28
3. Construction Stormwater BMPs 29
3.1 The 12 BMP Elements 29
3.1.1 Element 1: Preserve Vegetation/Mark Clearing Limits 30
3.1.2 Element 2: Establish Construction Access 31
3.1.3 Element 3: Control Flow Rates 33
3.1.4 Element 4A: Install Sediment Controls 37
3.1.5 Element 4B: Turbidity Control BMPs 38
3.1.6 Element 5: Stabilize Soils 41
3.1.7 Element 6: Protect Slopes 44
3.1.8 Element 7: Protect Drain Inlets 45
3.1.9 Element 8: Stabilize Channels and Outlets 46
3.1.10 Element 9: Control Pollutants 48

3.1.11 Element 10: Control Dewatering 50
3.1.12 Element 11: Maintain BMPs 54
3.1.13 Element 12: Manage the Project 54
4. Pollution Prevention Team 56
4.1 Roles and Responsibilities 56
4.2 Team Members 56
5. Site Inspections and Monitoring 57
5.1 Site Inspection 57
5.1.1 Site Inspection Frequency 57
5.1.2 Site Inspection Documentation 57
5.2 Stormwater Quality Monitoring 57
5.2.1 Turbidity 57
5.2.2 pH 58
5.2.3 Contaminates of Concern 58
6. Reporting and Recordkeeping 58
6.1 Recordkeeping 58
6.1.1 Site Logbook 58
6.1.2 Records Retention 59
6.1.3 Access to Plans and Records 59
6.1.4 Updating the Construction SWPPP 59
6.2 Reporting 59
6.2.1 Discharge Monitoring Reports 59
6.2.2 Notification and Noncompliance 59
7. List of Acronyms and Abbreviations 60

List of Tables

Table 1. Summary of Facility Areas 4
Table 2. Drainage Basin and Facility Areas 5
Table 3. Floodplains 14
Table 4. Design Storm Rainfall Intensity 21
Table 5. Facility Site Summary 22
Table 6. Area 200 - Unloading and Office - Site Summary 23
Table 7. Area 300 - Storage - Site Summary 24
Table 8. Area 400 - Marine Terminal - Site Summary 25
Table 9. Area 500 - Transfer Pipelines - Site Summary 26
Table 10. Area 600 - West Boiler - Site Summary 27
Table 11. Rail Improvements - Site Summary 28
Table 12. Areas Requiring Vegetation Preservation/Marking and Clearing Limit BMPs 30
Table 13. Areas Requiring Construction Access BMPs 31
Table 14. Areas Requiring Control Flow Rate BMPs 33
Table 15. Areas Requiring Sediment Control BMPs 37
Table 16. Areas Requiring Turbidity Control BMPs 38
Table 17. Construction Turbidity Control Sampling and Basis of Design 39
Table 18. Areas Requiring Soil Stabilization BMPs 41

Table 19. Areas Requiring Slope Protection BMPs 44
Table 20. Areas Requiring Storm Drain Inlet Protection BMPs 45
Table 21. Types/Conditions of Use of Storm Drain Inlet Protection 46
Table 22. Areas Requiring Channel and Outlet Stabilization BMPs 46
Table 23. Areas Requiring Pollutant Control BMPs 48
Table 24. Construction Pollutant Control Basis of Design 48
Table 25. Areas Requiring Dewatering Control BMPs 51
Table 26. Summary of the Deed Restricted Areas at the Proposed Project Site 51
Table 27. Preliminary Construction Schedule 55
Table 28. Pollution Prevention Team Members 56

List of Figures

Figure 1. Vicinity Map 2
Figure 2. Site Plan 3
Figure 3. Existing Terminal 4 Stormwater System 7
Figure 4. Existing Terminal 5 Stormwater System 11
Figure 5. Contaminated Areas 17

List of Appendices

Appendix A. Site Plan

Appendix B. Existing Drainage Reports

Appendix C. FEMA FIRM Maps

Appendix D. Geotechnical Investigation Reports

Appendix E. Isopluvial Mapping

Appendix F. Construction Stormwater Calculations

Appendix G. Environmental Control Drawings

Appendix H. Construction BMPs

Appendix I. Example of General Permit

Appendix J. Alternative BMPs

Appendix K. Historical Water Sampling Data

Appendix L. Sample Site Inspection Forms

Appendix M. Cap Restoration Details

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1. Essential Information

1.1 Facility Information

Facility Information	
Name of Facility:	Vancouver Energy
Site Address:	5501 NW Old Lower River Road
City, State, Zip Code	Vancouver, WA 98660
County:	Clark
SIC Code(s)	5171 Petroleum Bulk Stations and Terminals
Permit Number:	WAR (To Be Issued)
Latitude:	45˚ 39' 02" N
Longitude	122˚ 43' 41" W

1.2 Facility Contact Information

Construction Contractor(s)	
Name:	TBD prior to construction
Address:	
City, State, Zip Code	
Telephone Number:	
Fax Number:	
Email Address:	
Name:	TBD prior to construction
Address:	
City, State, Zip Code	
Telephone Number:	
Fax Number:	
Email Address:	
Facility Owner/Lessee	
Name:	Tesoro Savage Petroleum Terminal, LLC
Address:	901 W Legacy Center Way
City, State, Zip Code	Midvale, UT 94047
Telephone Number:	(801) 944-6600
Fax Number:	
Email Address:	
Property Owner	
Name:	Port of Vancouver USA
Address:	3103 NW Lower River Road
City, State, Zip Code	Vancouver, WA 98660
Telephone Number:	(360) 693-3611
Fax Number:	(360) 735-1565
Email Address:	info@portvanusa.com

Primary Construction SWPPP Contact	
Name:	TBD prior to construction
Address:	
City, State, Zip Code	
Telephone Number:	
Fax Number:	
Email Address:	

1.3 Agency Information

Responsible Agency	
Name:	Energy Facility Site Evaluation Council
Address:	1300 South Evergreen Park Drive Southwest
City, State, Zip Code	Olympia, WA 98504-3172
Telephone Number:	(360) 664-1345
Fax Number:	
Email Address:	efsec@utc.wa.gov
Name:	Washington State Department of Ecology, Southwest Regional Office
Address:	300 Desmond Drive
City, State, Zip Code	Lacey, WA 98503
Telephone Number:	(360) 407-6300
Fax Number:	(360) 407-6305
Email Address:	
Name:	Washington State Department of Ecology, Vancouver Field Office
Address:	2108 Grand Boulevard
City, State, Zip Code	Vancouver, WA 98661-4622
Telephone Number:	(360) 690-7171
Fax Number:	
Email Address:	
Emergency Numbers	
General Emergency:	9-1-1
Port of Vancouver Security	(360) 992-1120
WA DOE Report a Spill	(360) 407-6300

1.4 Stormwater Pollution Prevention Team

Primary Construction SWPPP Contact	
Name:	TBD prior to construction
Address:	
City, State, Zip Code	
Telephone Number:	
Fax Number:	
Email Address:	

Staff Name/Title	Individual Responsibilities
Construction Project Manager and Emergency Owner Contact	Individual that is the Facility owner or representative of the Facility owner to be contacted in the case of an emergency. Require individual contractors and suppliers (i.e., concrete, fuel, lubricants, coating products) to implement requirements of construction SWPPP and construction NPDES Individual Permit. Oversee construction contracts and verify work on site complies with required permit conditions.
On-site CESCL	Primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures. Coordinate implementation of construction SWPPP and construction NPDES Individual Permit including: • Installation and ongoing maintenance of required BMPs • Perform daily inspections of all applicable BMPs • Perform daily inspections of all adjacent wetlands and surface water bodies • Coordinate and/or perform sampling of construction stormwater discharges • Monitor construction dewatering for potential contaminates of concern and coordinate and/or perform sampling of construction dewatering
Resident Engineer	Resident Engineer 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 EFSEC Contact	Individual to be contacted at Energy Facility Site Evaluation Council in case of emergency.
Non-Emergency EFSEC Contact	Individual to be contacted at Energy Facility Site Evaluation Council.
Monitoring Personnel	This person is responsible for conducting water quality monitoring; may be same individual as the Certified Erosion and Sediment Control Lead.
Conveyance and Treatment System Operator and/or vendor	Perform all tasks necessary to maintain discharge water quality within permitted discharge limits. Tasks include, but are not limited to, • Design and modify water quality treatment system as necessary to maintain permitted discharge limits. • Inspect tanks, filters, chemical feed pumps, discharge pumps, isolation plugs and/or valves, piping, samplers, and other appurtenances as needed. • Replace consumable products on schedule prior to design life expectancy. • Be available (on-call) 24 hours a day for emergency modifications or equipment failure.
Contractor Project Managers	Verify all contractor staff is trained on construction SWPPP and SPCCP. Provide necessary equipment, tools, and cleanup and containment materials necessary to respond to accidental discharge. Verify all construction activities requiring BMPs are performed with BMPs in-place.
Equipment operators and construction personnel	Inspect equipment for signs of leaks from hydraulics, fueling and lubrication systems. Repair any equipment showing signs of faulty mechanical systems. Look for indications in work areas and excavations of possible contamination to groundwater or surface water including: petrochemical odors, suspect changes in colors, and symptoms of foul air.
All persons on site	Notify Construction Project Manager and/or CESCL of any sign of water quality impairment including spills, leaks, contamination, malfunctioning equipment, or violation of any BMPs, or construction management plan.

Executive Summary

This construction stormwater pollution prevention plan (SWPPP) has been prepared as part of the requirements for a National Pollutant Discharge Elimination System (NPDES) construction stormwater permit as issued by the Washington State Energy Facility Site Evaluation Council for the Vancouver Energy Facility in Vancouver, Washington. The site is located within the Port of Vancouver USA (Port) and consists of a total of 47.4[1] acres located in six distinct "areas," including the rail improvements. A vicinity map and a site map are shown in Figure 1 and Figure 2, respectively.

The site primarily consists of existing vacant or underutilized industrial land. A portion of the site is located within the northern portion of the former Evergreen/ALCOA aluminum smelter. The proposed Facility consists of the construction of a rail unloading facility, transfer pipelines, storage tanks, and vessel loading berth for the transloading of crude oil from rail to vessel. The Facility includes support buildings and structures, including administrative offices, access roads, employee parking and facilities, and a future boiler building. Detailed descriptions of the site and construction follow in sections 2.1 and 2.3.

Construction activities will include clearing and grubbing, excavation, grading, relocation of on-site services/utilities, adjustments to existing port rail lines, and the construction of facility elements discussed in detail in section 2.3.

The purpose of this construction SWPPP is to describe the proposed construction activities and all temporary and permanent erosion and sediment control measures, pollution prevention measures, inspection/monitoring activities, and recordkeeping that will be implemented during the proposed construction project. The objectives of the construction SWPPP are to

1. Protect existing water quality and will comply with all required construction phase NPDES permits.
2. Identify site conditions, such as areas of known contaminates, and design construction methods to limit impacts to these areas. Where impacts may occur, this plan will identify construction methods and monitoring and treatment techniques to mitigate for levels of anticipated contamination.
3. Identify possible construction activities that have the potential to cause surface water or groundwater contamination and identify required best management practices (BMPs) to reduce, eliminate, or prevent contamination.
4. Prevent during the construction phase, adverse water quality impacts to the receiving water body (Columbia River) by controlling peak flow rates and volumes of stormwater runoff at the outfalls and downstream of the outfalls.

[1] Previous information submitted to EFSEC indicated an approximate site acreage of 45 acres. The addition of 2.74 acres primarily occurs relative to an increase in the transfer pipeline corridor width in locations where ground surface is currently disturbed and already subject to industrial activity. This increase in acreage does not substantively modify the analysis of environmental impacts described in the Application for Site Certification Supplement as submitted to EFSEC in January 2014. However, to present accurate engineering calculations in this construction SWPPP, this adjusted site acreage has been used herein, as well as in the operations SWPPP and Engineering Report submitted under separate cover. The Applicant also acknowledges that final Facility design will take into account actual permit conditions that are not available at this time; such conditions could also result in further adjustments to the final site boundary.

This construction SWPPP was prepared in reference to the Washington State Department of Ecology (Ecology) SWPPP template downloaded from the Ecology website on 23 December 2014. The construction SWPPP was prepared based upon the requirements set forth in the NPDES Construction Stormwater General Permit and in Ecology's *2012 Stormwater Management Manual for Western Washington*[2].

This construction SWPPP is divided into eight sections with several appendices that include reference materials related to stormwater and how it will be handled on the site. The main sections describe the site, its existing conditions, and the proposed Facility. Discussions follow of each of the 12 types of construction stormwater BMPs that would be employed during the construction of the Facility. The construction SWPPP then discusses site inspections and monitoring and reporting and recordkeeping.

[2] In accordance with WAC 463-76-031 (1)(a), construction stormwater discharges will be authorized under an individual construction stormwater NPDES permit issued by EFSEC. In the absence of a permit being available, the Applicant herein uses Ecology's general permit as the basis for plan requirements. However, prior to construction, this plan will be updated to reflect actual requirements of the permit issued by EFSEC.

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2. Site Description

The proposed Vancouver Energy (Facility) would be constructed at the Port of Vancouver USA (Port) within the City of Vancouver (City) in Clark County, Washington. The Facility includes construction in different “areas,” each area serving a different function. The site is located on the Washington shore of the Columbia River. State Route 501 (SR 501) (Lower River Road) is located immediately to the north of the site and is available from the east. Each area of the proposed Facility is described in further detail below. The entire Facility would be constructed on approximately 47.4 acres. (See the vicinity map shown in Figure 1.) Facility site plans are included as Appendix A and environmental control drawings are included in Appendix G.

Most of the site will be leased from the port and will be used exclusively by Tesoro Savage Petroleum Terminal LLC (the Applicant) for the construction and operation of the Facility. The transfer pipelines and portions of the rail improvements will be located on non-exclusive easements within the port.

The site is located in the SE 1/4 of Section 18, NW 1/4 of Section 19, and the NW and NE 1/4 of Section 20, Township 2 North, Range 1 East W.M. Berths 13 and 14 are located at approximately Columbia River Mile 103.5 (RM 103.5).

This construction stormwater pollution prevention plan (SWPPP) describes the site conditions and proposed construction activities in detail and enumerates the mitigation measures and best management practices (BMPs) that apply to each activity. The construction SWPPP has been prepared as part of the requirements for the NPDES construction stormwater permit as issued by the Washington State Energy Facility Site Evaluation Council (EFSEC) for the Facility.

The Facility would be developed in six “areas.” Figure 2 is a site plan schematic that shows the site development plan, including the location of each Facility area. Table 1 lists the six Facility areas (including rail improvements) and they are discussed in detail below. Note that the designation Area 100 is used in the engineering drawings for site overview and general information that pertains to all areas of construction.

Figure 1 - Vicinity Map

LEGEND

- Project Boundary
- Vancouver_WA
- Portland,_Oregon

VANCOUVER ENERGY

Tesoro Savage Petroleum Terminal LLC

Date: February 2015

Map Notes: Aerial photo dated July 2010, courtesy of ESRI World Imagery service

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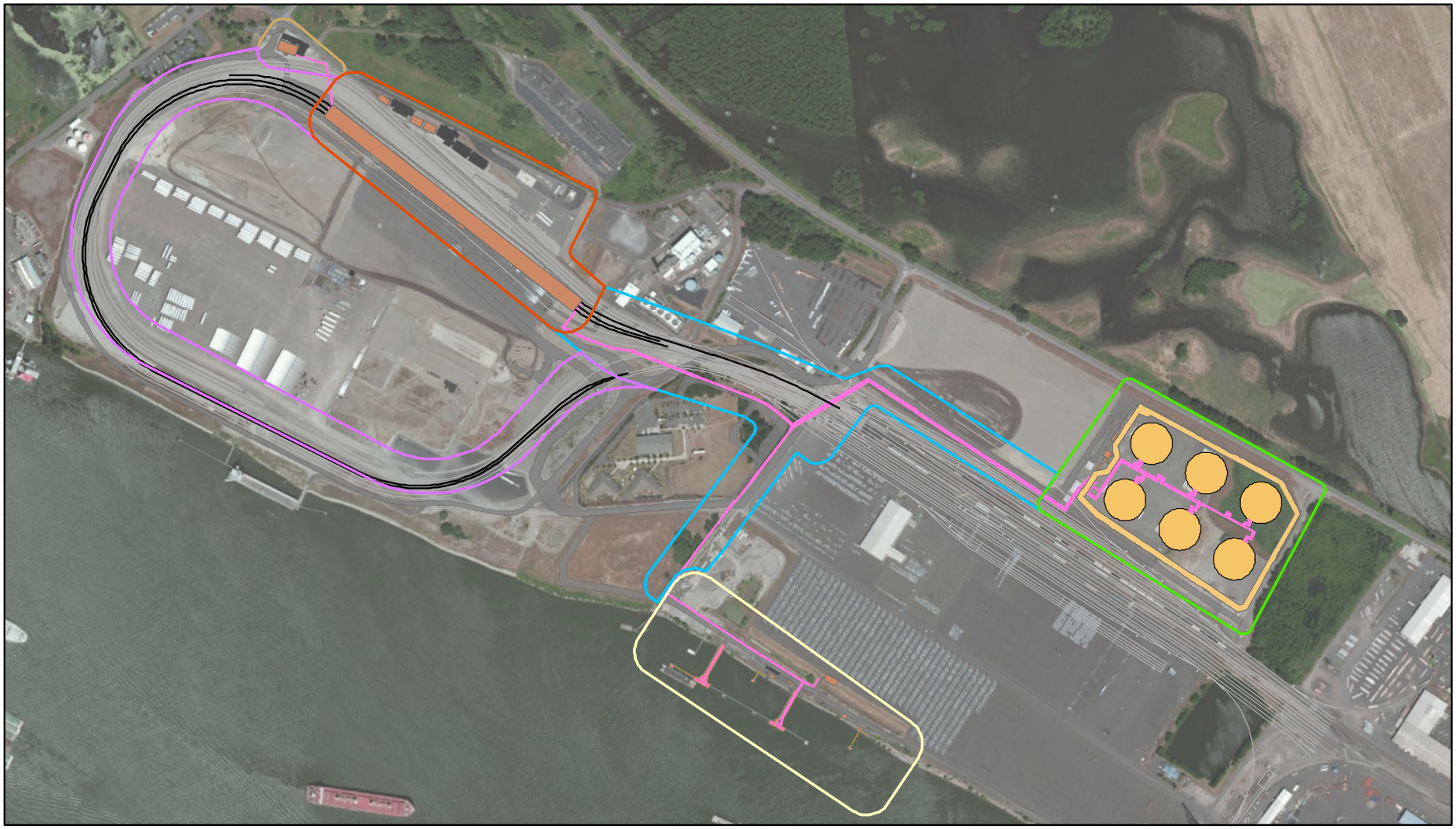

Figure 2 - Site Plan

VANCOUVER ENERGY

Tesoro Savage Petroleum Terminal LLC

Proposed Project Facilities

- Containment Berm
- Rail
- Parking
- Building
- Transfer Pipeline
- Storage Tank
- Roads
- Marine Terminal

TSPT Improvement Areas

- 200 - Unloading and Office
- 300 - Storage
- 400 - Marine Terminal
- 500 - Transfer Pipelines
- 600 - West Boiler
- Rail Infrastructure

0 250 500 1,000
Feet

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Date: February 2015

Map Notes: Aerial photo dated July 2010, courtesy of ESRI World Imagery service

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Table 1. Summary of Facility Areas

Facility Area	Project Elements	Acreage
200 – Unloading and Office	Rail Unloading Area Control Rooms/E-houses Fire Pump and Foam Building Admin/Support Buildings	7.8 Acres
300 – Storage	Crude Oil Storage Tanks Secondary Containment Berm Storage Building Pump Basin Control Room/E-house Fire Pump and Foam Building	20.8 Acres
400 – Marine Terminal	Marine Vessel Loading Hoses and Equipment Control Room/E-house Dock Safety Unit Marine Vapor Combustion Units Vapor Blower Skid Spill Prevention, Response and Containment Equipment Dock Improvements Piping from Vessel Loading to Marine Vapor Combustion Units	7.7 Acres
500 – Transfer Pipelines	Transfer Piping from Area 200 to Area 300 Transfer Piping from Area 300 to Area 400	4.9 Acres
600 – West Boiler	West Boiler Building Piping from West Boiler Building to Rail Unloading Area	0.8 Acre
Rail Improvements	Rail Transportation Corridor	5.4 Acres
Total		47.4 Acres

2.1 Existing Conditions

Thorough descriptions of the existing conditions within and adjacent to the project area follow. The descriptions are provided to delineate the geographic and natural resource elements of the Facility. Descriptions of the existing conditions include the following elements.

- Stormwater Conveyance and Treatment Systems
- Surface Water Bodies
- Floodplains
- Wetlands
- Soil Evaluations
- Past Site Remediation
- Climate

2.1.1 Stormwater Conveyance and Treatment Systems

The existing site is located in three distinct primary drainage areas. The drainage areas are segregated by topography and the stormwater is discharged to different locations. Table 2 shows which drainage area contains each of the six Facility areas.

Table 2. Drainage Basin and Facility Areas

Drainage Area	Facility Areas
Terminal 4	Area 300 – Storage Area 500 – Transfer Pipelines
Terminal 5	Area 200 – Unloading and Office Area 600 – West Boiler Building Rail Improvements
Marine Terminal	Area 400 – Marine Terminal Area 500 – Transfer Pipelines

For the purpose of this section, the three drainage areas are discussed separately. The corresponding figures indicate the drainage area in which each Facility area is located and the relationship of the Facility area to the existing collection, treatment, and detention systems.

The following sections describe each of the three primary drainage areas (Terminal 4, Terminal 5, and the Marine Terminal). The designations are intended to delineate the portion of the site described and its respective downstream drainage system. According to the port, the Marine Terminal drainage area is technically part of Terminal 4; however, it has a distinct and separate stormwater system and, for that reason, is segregated as its own descriptive area.

2.1.1.1 Terminal 4

The Terminal 4 drainage system comprises approximately 250 acres of industrial land. A system of inlets and conveyance pipelines collects stormwater from the drainage area and discharges the stormwater to the Terminal 4 water quality pond, as shown in Figure 3. The water quality pond was modified recently to increase detention time and vegetative plantings were added for shading and bio-uptake. From the water quality pond, the stormwater is routed to the southeast where it is discharged to the Columbia River through an existing outfall under an Industrial Stormwater General Permit (WAR000424) held by the Port.

Facility elements located within the Terminal 4 drainage basin are Area 300 – Storage, and a portion of Area 500 – Transfer Pipelines. There are two parallel stormwater systems running east-west along the south side of Area 300 and the portion of Area 500. The southern pipeline was installed for stormwater from the port's general use area and rail corridor. The northern pipeline was installed for the use of port tenants and is intended to bypass the water quality pond. Farwest Steel is the only current discharger into this system. During construction of the Facility, stormwater from Area 300 would be discharged into the northern pipeline. Area 500 is located within the general use area and runoff would continue to the port's stormwater system.

Both pipelines currently discharge to the Terminal 4 water quality pond. However, the port is completing a project to separate the tenant stormwater from port general use area stormwater. It is anticipated that construction of the separation project would be complete prior to construction of the Facility.

No existing stormwater collection or conveyance systems will need to be relocated or modified by construction of the Facility.

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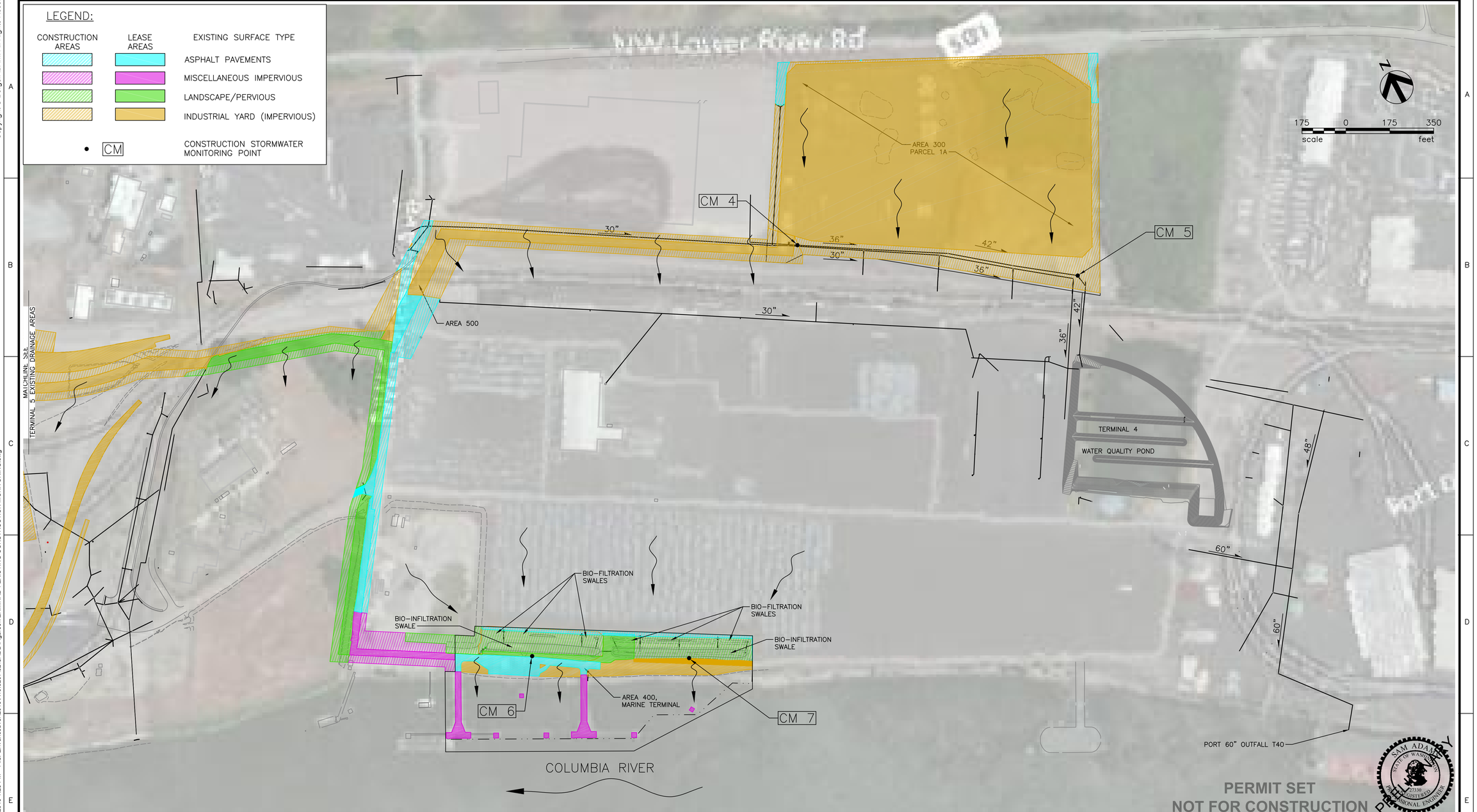

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NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

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700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: TERMINAL 4 – EXISTING CONSTRUCTION STORMWATER MONITORING

DESIGN:	DRS	START DATE:	2/26/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/26/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24x36

DRAWING NUMBER | SHEET 1/1 | REV.

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2.1.1.2 Terminal 5

The Terminal 5 drainage system was installed as part of the remediation and decommissioning of the former Evergreen/ALCOA aluminum smelter, construction of the West Vancouver Freight Access (WVFA) project, and the Terminal 5 laydown project. The drainage system was designed and analyzed as part of the analysis for the construction of the WVFA project. A copy of the report is attached as Appendix B.

The Terminal 5 drainage area consists of approximately 91 acres of industrial land that is collected through inlets and conveyed to a common stormwater pump station as shown in Figure 4. The stormwater system includes a high flow bypass that overflows to the Columbia River. During normal operations, stormwater from the basin is pumped to two treatment lagoons that were installed to treat both process water and stormwater from the Evergreen/ALCOA plant. The lagoons are capable of treating stormwater prior to its discharge to the Columbia River under a Western Washington Phase II Municipal Stormwater Permit, WAR045201.

On the Facility site, three legs of the existing stormwater system run north/south through the proposed rail unloading facility. The west lateral extends towards Old Lower River Road for future use, the middle lateral collects runoff from atop the Vanexco Cap, and the east lateral collects stormwater from a portion of Old Lower River Road and NGL Supply. The middle lateral conveys only stormwater that collects from a liner system installed above the contaminated material; stormwater from this area is only exposed to existing General Use industrial yard areas, and a portion of the rail transportation corridor. The Facility areas that would be constructed on Terminal 5 include Area 200, Area 600, and a portion of Area 500.

Modifications to the existing collection system for Terminal 5 is included in section 2.3.1. No modifications are proposed to the downstream conveyance system, pump station, or treatment lagoons.

2.1.1.3 Marine Terminal

The Marine Terminal is located within Terminal 4, however, stormwater in this area is a separate stormwater system. The system was installed with Phase I of the Columbia Gateway project in 1995. The stormwater serves three operational areas, including a gravel barge unloading operated by CalPortland/Glacier Northwest, an Auto Terminal consisting of first point of rest unloading and service facility for Subaru, and the proposed Facility infrastructure for the Marine Terminal. In total, the drainage area consists of approximately 25 acres. Stormwater is collected through a series of inlets and conveyance pipes from which it is discharged to the treatment and infiltration swales, except for the existing Marine Terminal area, which sheet flows directly into the infiltration swales.

Stormwater is collected and discharged to biofiltration swales for basic water quality treatment and then flows into two hydraulically connected infiltration swales. Figure 4 shows the general arrangement of the collection and treatment facilities located at the Marine Terminal.

Modifications to the existing collection and treatment systems would be completed within the Marine Terminal drainage area. A detailed explanation of modifications to the existing system is included in section 2.3.3.

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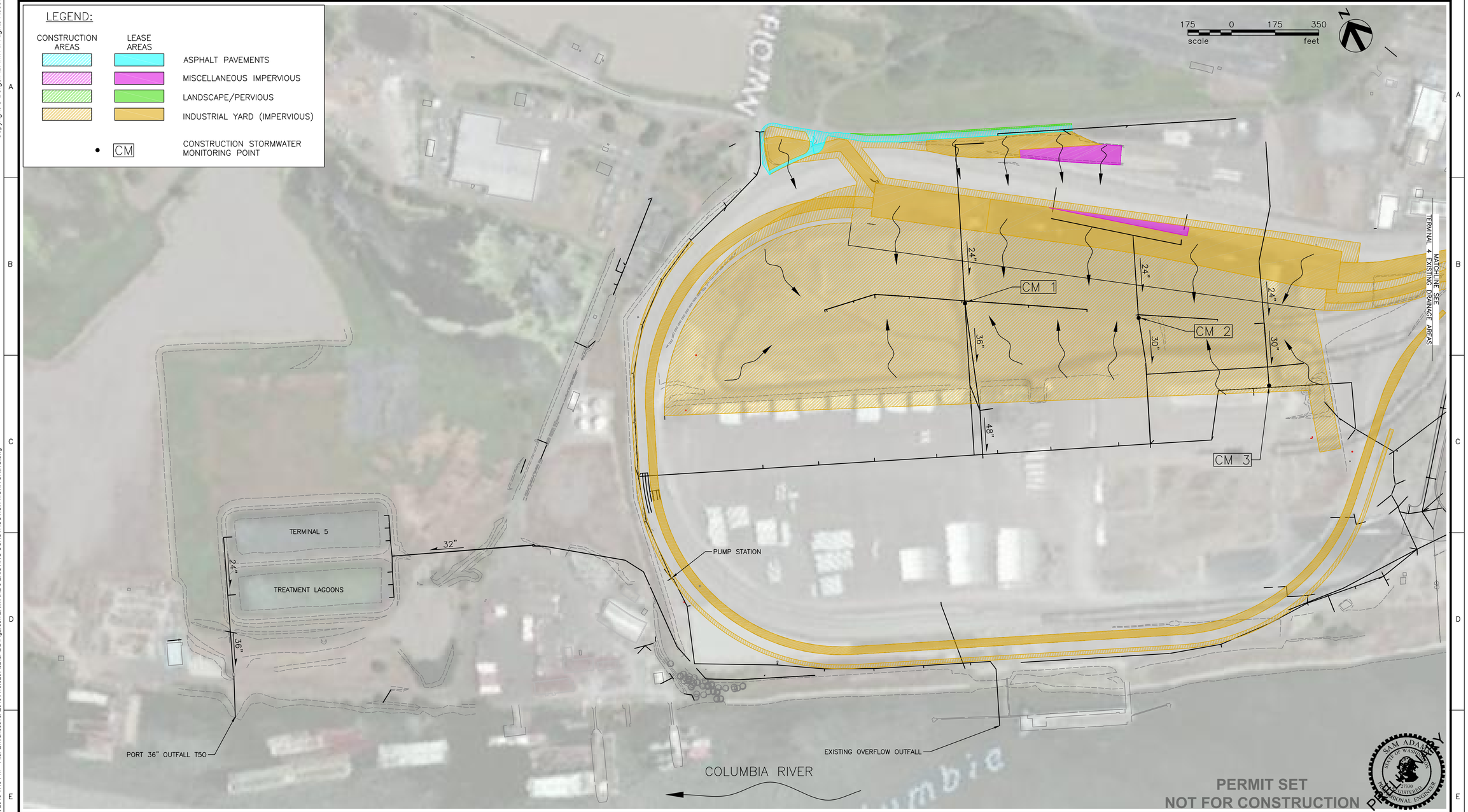

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: TERMINAL 5 – EXISTING CONSTRUCTION STORMWATER MONITORING

DESIGN:	DRS	START DATE:	2/26/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/26/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24x36
DRAWING NUMBER				SHEET	REV.
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2.1.2 Surface Water Bodies

The Facility site is located immediately north of the Columbia River and portions of the site are bordered by wetlands. A discussion of the wetlands follows in section 2.1.4. No streams or open surface water features are located within the upland areas of site development. A portion of the project will modify the existing Berth 13 and work over water is covered under separate permit.

The project site is located within the Salmon-Washougal Watershed (WRIA 28) located in southwest Washington. The nearest surface water feature is the Columbia River. The river drains an estimated basin of roughly 258,000 square miles and is approximately 1,243 miles long. The project site is located at approximately RM 103.5. The Columbia River eventually discharges to the Pacific Ocean near Astoria, Oregon.

Multiple government agencies and non-governmental organizations monitor water quality within the Columbia River. The U.S. Geological Service (USGS) is the federal agency responsible for conducting water quality testing in the river. In 2004–2005, the USGS conducted water column samples. Significant findings of the Water-Quality Data, Columbia River Estuary, 2004-2005 report are summarized below.

- None of the aquatic life or human health benchmarks established by the U.S. Environmental Protection Agency were exceeded.
- Concentrations of arsenic, copper, and lead were not present at levels of concern with regards to aquatic toxicity.
- Trace element concentration were higher downstream than at the upstream reaches of the Columbia River.
- Eight of the 54 wastewater compounds analyzed were detected at least once, usually at trace levels. Bisphenol A was the only endocrine disruptor in wastewater compounds detected in the Columbia River.
- During seasonal samplings of suspended sediment, no organochlorine compounds or polycyclic aromatic hydrocarbons (PAHs) were detected
- All 11 polybrominated diphenyl ether (PBDE) congeners were detected on suspended sediments, usually in trace amounts.
- 102 of the 209 PCB congeners were detected on suspended sediments, usually in trace amounts.

A copy of the report is available from the USGS at http://pubs.usgs.gov/ds/2006/213/#download. Additionally, the USGS report "Water Quality of the Lower Columbia River Basin: Analysis of Current and Historical Water-Quality Data through 1994" can be downloaded at http://or.water.usgs.gov/pubs_dir/Abstracts/95-4294.html.

The average water level in the Columbia River is usually 7 to 8 feet (National Geodetic Vertical Datum [NGVD] 29) during the winter. Flood stage is considered to occur at 16 feet when low level flooding begins to occur. A detailed discussion of the floodplain limits follows as section 2.1.3. The flood of record is a 1996 event when the river crested at 27.2 feet. This is not the highest recorded event, which occurred on 13 June 1948 with a crest of 31.00 feet.

2.1.3 Floodplains

The local floodplain within the project vicinity is defined by the Columbia River. This lower portion of the Columbia River is generally regulated by the upstream Bonneville Dam. Flooding in and adjacent to the site from the north watershed, including Vancouver Lake, is hydraulically connected directly to the elevation of the water surface of the Columbia River.

This site area has been extensively studied for floodplain and flood impacts. The most recent analysis was conducted by the Federal Emergency Management Agency (FEMA), which developed Flood Insurance Rate Maps (FIRM) published on 5 September 2012. The base flood elevation and limits are shown on the FIRM maps contained in Appendix C. The FEMA FIRMs that cover the project site are Map Item ID Nos. 53011C0363D and 553011C0364D.

Table 3 summarizes the floodplain elevations discussed below in the different vertical datums. North American Vertical Datum (NAVD) 88 is the vertical datum used by FEMA in the FIRM mapping, while NGVD 1929 is the datum used by the Port and the Facility. The NGVD 1929 datum is also the datum referenced in the historical flood record maintained by Clark County. The Columbia River Datum (CRD) is used by river users and is based on relative elevations to water levels.

Table 3. Floodplains

Floodplain	NAVD 88	NGVD 1929	CRD
100 Year	30.0	26.9	25.3
500 Year	33.7	30.6	29.0

2.1.3.1 100-Year Floodplain

The Base Flood Elevation (BFE) is identified in the FIRM for the 100-year floodplain as 30 feet based on the NAVD 88 datum. The limits of the 100-year floodplain are classified in the FIRMs as Zone AE, which indicates that there is a 1 percent annual chance flood, with the BFE being the water surface elevation of the 1 percent annual chance flood.

The 100-year floodplain is generally located along the top of the riverbank. The FIRMs show an isolated component of the 100-year floodplain encroaching into Area 300 on Terminal 4 and Area 600 at Terminal 5. The 2012 FIRM maps do not reflect the grading and filling of these sites that has occurred on site. Because of filling and grading completed by the Port, the existing ground elevations is outside of the 100-year floodplain at approximately Elevation 32 NGVD 1929. A detailed description of the prior authorizations for filling this area is included in the Application for Site Certification.

2.1.3.2 500-Year Floodplain

The 500-year floodplain is identified in the FIRM as Zone X with the black dotted hatch pattern. Zone X is an area with a 0.2 percent annual chance flood. The 0.2 percent annual chance flood is listed with average depth of less than 1 foot.

With very little exception, the 500-year floodplain extends across the entire project site. The rough grading completed since the adoption of the 2012 FIRMs does not affect the limits of the 500-year floodplain.

2.1.4 Wetlands

The National Wetland Inventory map for Vancouver (U.S. Fish and Wildlife Service 1989) indicates the presence of numerous wetlands within the project vicinity. Before development, nine wetlands, totaling approximately 16 acres in size, were present on this site, but they were all filled through permitted actions that began in 1996.

There are two wetland mitigation sites in the vicinity of the project site. The approximately 7.9-acre Parcel 1A wetland mitigation site, located immediately east of Area 300, was established in 1994. This is a depressional, palustrine forested wetland vegetated with mature black cottonwood trees and a variety of native shrubs and herbaceous species. Stormwater from Area 300 or Area 500 would not discharge to any existing wetlands. The wetlands are not hydraulically connected to any of the project elements.

The Parcel 2 wetland mitigation site is an approximately 16.4-acre mitigation site situated immediately north of the existing Terminal 5 site. The wetland was established in 2000 for impacts associated with the initial development of Parcel 1A. The site is currently a mosaic of forested, scrub-shrub, and emergent vegetation. Stormwater from the Facility would not discharge to Parcel 2 wetlands.

The most significant complex of wetlands in the general vicinity is associated with the southern end of Vancouver Lake. The wetlands in this area are a mosaic of emergent, scrub-shrub, and forested wetlands that are hydraulically connected to Vancouver Lake and, by extension, the Columbia River. These wetlands provide high quality seasonally inundated and tidally influenced habitats that most closely resemble the original hydrologic and wetland habitat functions of the Vancouver Lake Lowlands.

2.1.5 Soils Evaluation

Geotechnical Resources, Inc. (GRI) performed geotechnical investigations for the proposed Facility. The geotechnical investigations are attached as Appendix D. Detailed soil maps are included in Appendix D. Construction on the site would disrupt surficial soils and minor topographical grading will be necessary for facility construction. Construction of the Facility will not change the geologic condition of the site.

2.1.6 Past Site Remediation

Terminal 5 is the former location of the Evergreen/ALCOA smelter, which operated until the early 2000s. Industrial and solid wastes from the construction and operation of the aluminum smelter were stored in waste piles and consolidated in landfills on site over the years. Hazardous contaminants in these wastes include petroleum hydrocarbons, polychlorinated biphenyls (PCBs), cyanide, fluoride, trichloroethylene (TCE), low-level organic chemicals, and metals. Evergreen and ALCOA completed site remediation and facility decommissioning under Consent Decree No. 09-2-00247-2 and Enforcement Order 4931 with Ecology. Efforts included removing structures and foundations to a depth of approximately 4 feet and the site soil and sediment with concentrations of chemicals of concern above the cleanup levels established by the consent decree.

Five cap locations subject to environmental restrictive covenants are located within the boundary of the Facility. The Terminal 5 area also includes a groundwater restrictive covenant. For detailed descriptions of the landfill areas, caps, and contaminates of concern, see the contaminated media management plan (CMMP), which has been prepared under a separate cover. These areas are shown in Figure 5.

Construction of the Facility would make minor modifications to the Vanexco/Rod Mill Site Cap. The remaining construction activities located within the Facility lease boundaries have been designed to avoid impacts and work within the landfill areas. Work within the restrictive covenant areas is limited to work outside of the landfill limits or above the cap. Detailed descriptions of this work follow in section 2.3.7. Construction of the rail improvements will require minor modifications to the North/North 2 Landfill, Spent Pot Liner Storage Area, and the Ingot Cap similar to those completed as part of the current WVFA project.

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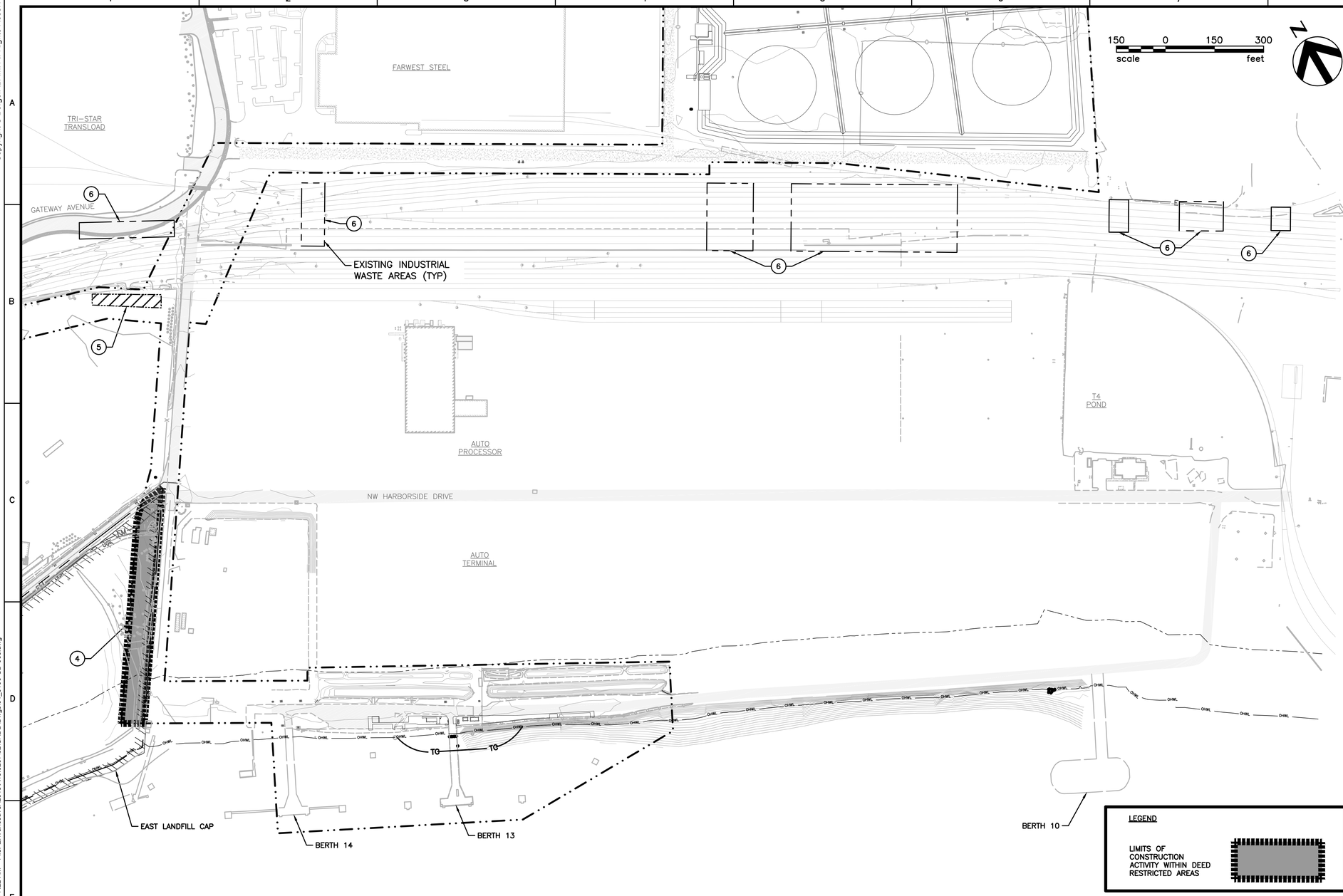

GENERAL NOTES:

1. CONTRACTOR'S ACTIVITY SHALL STRICTLY COMPLY WITH ALL PERMITTED CONDITIONS OF APPROVAL.
2. EXCAVATIONS AND GROUND DISTURBING ACTIVITIES WITHIN DEED RESTRICTED AREAS REQUIRES NOTIFICATION TO THE WASHINGTON STATE ENERGY FACILITY SITE EVALUATION COUNCIL (EFSEC) AND COMPLIANCE WITH THE APPROVED CONTAMINATED MEDIA MANAGEMENT PLAN, APPLICABLE PORT PROTOCOLS AND ADDITIONAL REQUIREMENTS PROVIDED BY EFSEC.
3. SPECIFIC LIMITS FOR THE EAST LANDFILL LIMITS ARE PROVIDED BASED UPON PRIOR SURVEY'S CONDUCTED BY HDJ DESIGN GROUP. WORK LIMIT SHALL ENCROACH UPON THE BOUNDARY OF THE EAST LANDFILL.
4. WHERE KNOWN, ADDITIONAL AREAS OF CONCERN AND POSSIBLE CONTAMINATED MEDIA LOCATIONS HAVE BEEN GENERALLY DEPICTED. CONTRACTOR SHALL COORDINATE FULLY WITH PORT OF VANCOUVER ENVIRONMENTAL STAFF AND INSPECTORS FOR MONITORING AND TESTING OF EXCAVATED MEDIA FOR POSSIBLE CONTAMINATES. PORTIONS OF AREA 200 AND AREA 500 ARE SPECIFICALLY IDENTIFIED WHERE CONTAMINATION IS LIKELY TO BE ENCOUNTERED DURING EXCAVATIONS.
5. IF MEDIA INCLUDING SOILS, OR GROUNDWATER ARE ENCOUNTERED THAT INDICATE POSSIBLE CONTAMINATION, CONTRACTOR SHALL NOTIFY VANCOUVER ENERGY SITE MANAGER, PORT OF VANCOUVER AND EFSEC IMMEDIATELY PRIOR TO PROCEEDING. SIGNS OF CONTAMINATION INCLUDE UNUSUALLY DARK SOIL AND ODORS.
6. IN AREAS OF CONCERN EXCAVATED MATERIAL SHALL BE PLACED IN SEALED WATER-TIGHT CONTAINERS OR LINED STAGING AREAS IMMEDIATELY ADJACENT TO THE WORK AREA FOR TESTING AND CLASSIFICATION OF MATERIAL PRIOR TO HAUL OFF.

CONTAMINATED MEDIA NOTES:

4. CONSTRUCTION WITHIN THE EAST LANDFILL CAP AREA CONSISTS OF GRADING A SUITABLE LEVEL BENCH WITHIN THE DEED RESTRICTED AREA TO CONSTRUCT FOUNDATIONS FOR THE CRUDE OIL PIPELINE. CONSTRUCTION ACTIVITIES SHALL NOT ENCROACH UPON THE LANDFILL AREA ITSELF AND SHALL REMAIN EAST OF THE HIGH VISIBILITY FENCING DELINEATED ON THE EROSION CONTROL PLANS.

5. PORT OF VANCOUVER IDENTIFIED POCKETS OF CONTAMINATED GROUNDWATER AND SOIL WITHIN THIS AREA. CONTRACTOR SHALL BE ADVISED THAT WORK ADJACENT TO THIS AREA WILL REQUIRE TESTING OF EXCAVATED MATERIAL PRIOR TO DISPOSAL.

6. NO CONSTRUCTION ACTIVITY IS PROPOSED IN THESE AREAS OF INDUSTRIAL WASTE. PORT HAS COMPLETED CLEANUP OF THESE SITES DURING RAIL CONSTRUCTION WHERE FEASIBLE.

PERMIT SET
NOT FOR CONSTRUCTION

SAM ADAMS — STATE OF WASHINGTON — 27330 — REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: CONTAMINATED MEDIA LOCATIONS – 2

DESIGN:	DRS	START DATE:	2/25/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/25/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-CD-003
SHEET: 1/1
REV.

Last Saved by: Tony.pritchett on: Feb 25, 2015 7:22 AM File: Q:\Vancouver\2013\A13.0267\02\CAD\D\Dwgs\04_0100-CD-003.dwg

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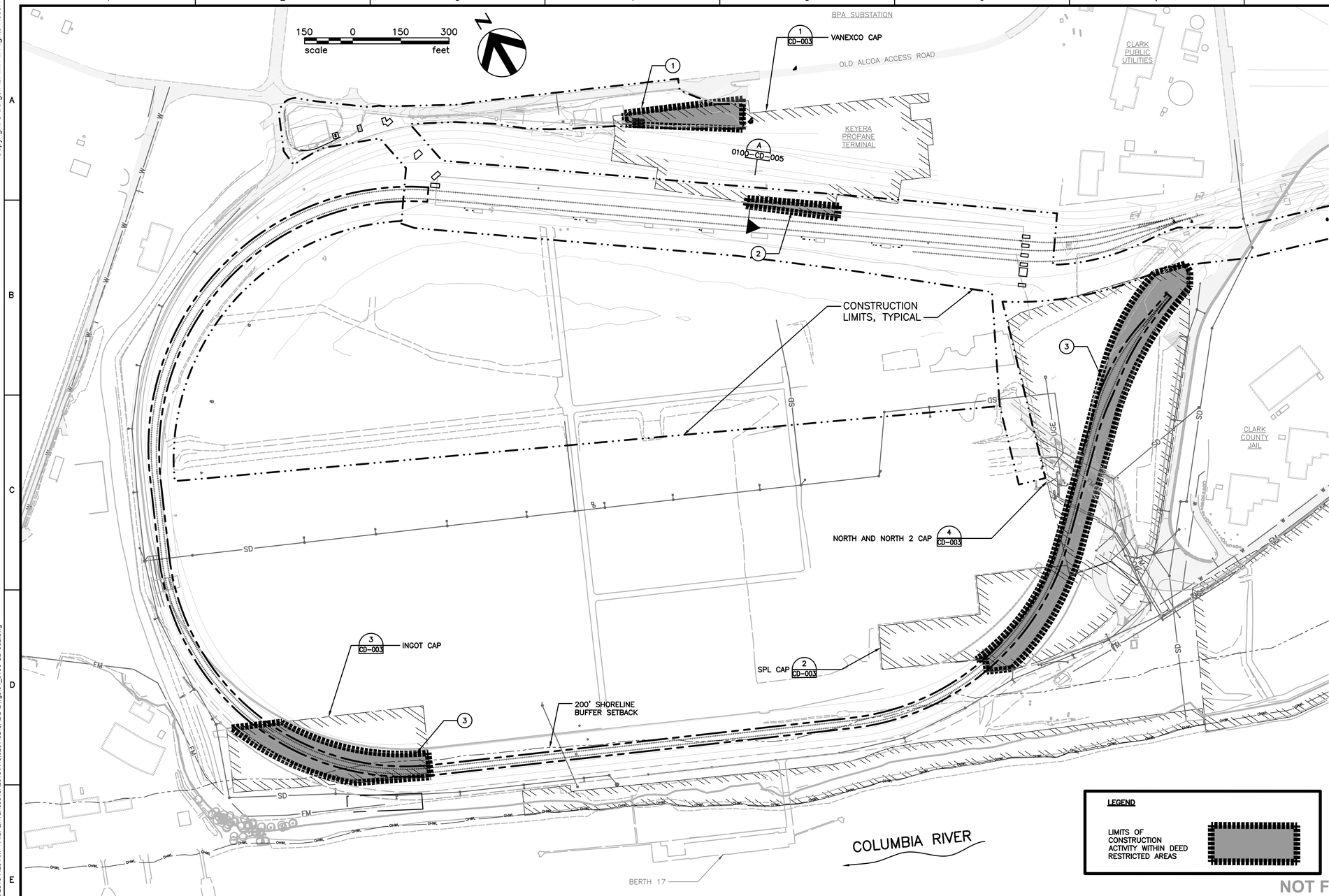

GENERAL NOTES:

1. CONTRACTOR'S ACTIVITY SHALL STRICTLY COMPLY WITH ALL PERMITTED CONDITIONS OF APPROVAL.
2. EXCAVATIONS AND GROUND DISTURBING ACTIVITIES WITHIN DEED RESTRICTED AREAS REQUIRES NOTIFICATION TO THE WASHINGTON STATE ENERGY FACILITY SITE EVALUATION COUNCIL (EFSEC) AND COMPLIANCE WITH THE APPROVED CONTAMINATED MEDIA MANAGEMENT PLAN, APPLICABLE PORT PROTOCOLS AND ADDITIONAL REQUIREMENTS PROVIDED BY EFSEC.
3. SPECIFIC LIMITS FOR THE EAST LANDFILL LIMITS ARE PROVIDED BASED UPON PRIOR SURVEY'S CONDUCTED BY HDJ DESIGN GROUP. WORK LIMIT SHALL ENCROACH UPON THE BOUNDARY OF THE EAST LANDFILL.
4. WHERE KNOWN, ADDITIONAL AREAS OF CONCERN AND POSSIBLE CONTAMINATED MEDIA LOCATIONS HAVE BEEN GENERALLY DEPICTED. CONTRACTOR SHALL COORDINATE FULLY WITH PORT OF VANCOUVER ENVIRONMENTAL STAFF AND INSPECTORS FOR MONITORING AND TESTING OF EXCAVATED MEDIA FOR POSSIBLE CONTAMINATES. PORTIONS OF AREA 200 AND AREA 500 ARE SPECIFICALLY IDENTIFIED WHERE CONTAMINATION IS LIKELY TO BE ENCOUNTERED DURING EXCAVATIONS.
5. IF MEDIA INCLUDING SOILS, OR GROUNDWATER ARE ENCOUNTERED THAT INDICATE POSSIBLE CONTAMINATION, CONTRACTOR SHALL NOTIFY VANCOUVER ENERGY SITE MANAGER, PORT OF VANCOUVER AND EFSEC IMMEDIATELY PRIOR TO PROCEEDING. SIGNS OF CONTAMINATION INCLUDE UNUSUALLY DARK SOIL AND ODORS.
6. IN AREAS OF CONCERN EXCAVATED MATERIAL SHALL BE PLACED IN SEALED WATER-TIGHT CONTAINERS OR LINED STAGING AREAS IMMEDIATELY ADJACENT TO THE WORK AREA FOR TESTING AND CLASSIFICATION OF MATERIAL PRIOR TO HAUL OFF.

CONTAMINATED MEDIA NOTES:

1. CONSTRUCTION ACTIVITIES WITHIN THIS PORTION OF THE VANEXCO CAP WILL BE LIMITED TO GROUND DISTURBANCES ABOVE THE EXISTING CONCRETE CAP. SOME MINOR EXPOSURE OF THE CONCRETE SURFACE MAY OCCUR IN LOCALIZED AREAS. NO WORK WITHIN THIS AREA WILL REMOVE OR PENETRATE PORTIONS OF THE CAP.

2. CONSTRUCTION ACTIVITIES WITHIN THIS PORTION OF THE VANEXCO CAP WILL RESULT IN MODIFICATION OF THE UNDERDRAIN SYSTEM AND HDPE LINER. DISCHARGES FROM THE UNDERDRAIN SYSTEM WILL BE RE-ROUTED TO AVOID CONFLICTS WITH THE PROPOSED RAIL UNLOADING BUILDING FOUNDATIONS AND CONTAINMENT TRENCHES, SEE DWG 0100-CD-006 FOR LINER PENETRATION DETAIL, AND SHEET 0100-CD-007 FOR NEW STORMWATER DETAILS. LINER WILL BE EXTENDED TO AND TIED INTO THE GRADE BEAMS OF THE RAIL UNLOADING BUILDING FOUNDATION SEE DWG 0100-CD-006 FOR DETAILS. FOUNDATIONS OF THE RAIL UNLOADING BUILDING WITHIN THE EXISTING CAP AREA WILL BE LIMITED TO SHALLOW SPREAD FOOTINGS TO LIMIT EXCAVATION ACTIVITIES. CONSTRUCTION OF RAIL UNLOADING BUILDING CONSISTS OF FULLY IMPERVIOUS ROOF WITH CAST-IN-PLACE CONCRETE SURFACING WITH FLOOR DRAINS. ALL RAINWATER WILL BE COLLECTED AND DIVERTED, THEREBY EXCLUDING SURFACE WATER FROM ENTERING CAP AREA.

3. CONSTRUCTION WITHIN THE INGOT CAP, SPL CAP, AND NORTH AND NORTH 2 CAP AREAS ARE LIMITED TO RAIL IMPROVEMENTS ONLY. RAIL LINES TO BE UNDER TSJV CONTROL ARE PERMITTED UNDER EFSEC APPLICATION. CONSTRUCTION DRAWINGS, DETAILS, AND CONSTRUCTION ADMINISTRATION FOR ADDITIONAL 2 RAIL LOOPS WILL BE COMPLETED BY THE PORT OF VANCOUVER AS DISCUSSED IN THE LEASE AGREEMENT.

PERMIT SET
NOT FOR CONSTRUCTION

SAM ADAMS — STATE OF WASHINGTON — 22330 — REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: CONTAMINATED MEDIA LOCATIONS – 1

DESIGN:	DRS	START DATE:	2/25/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/25/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-CD-002 — SHEET 1/1 — REV.

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2.1.7 Climate

The climate of the city is predominantly temperate, characterized by wet, mild winters and dry warm summers. The climate is influenced by the relative proximity of the Pacific Ocean and the Cascade and Coast ranges of Oregon and Washington. Temperature and precipitation measurement records from the "Vancouver 4 NNE" agricultural meteorological station were accessed to analyze the climate at the project site. The station is located approximately 4 miles northeast of the project site and has been collecting measurements since 1856. The maximum temperature ever recorded at the site was 106°F on 30 July 2009 and minimum temperature recorded was -8.0°F in 1909. The site averages about 39.6 inches of rainfall and 6.5 inches of snow a year, with most of the precipitation occurring during the winter months. Prevailing winds are from the west-northwest.

Isopluvial mapping of Washington was prepared by the National Oceanic and Atmospheric Administration. Table 4 shows estimates of precipitation amounts for the following design storms as shown in Volume IX of the NOAA Atlas 2 and attached in Appendix E.

Table 4. Design Storm Rainfall Intensity

Design Storm	Precipitation (in.)
2-Year, 24-Hour	2.4
5-Year, 24-Hour	2.7
10-Year, 24-Hour	3.2
25-Year, 24-Hour	3.6
50-Year, 24-Hour	4.0
100-Year, 24-Hour	4.3

Precipitation amounts shown in Table 4 are used in the conveyance system model which uses the SCS Type 1A rainfall distribution hydrograph to determine the peak flow rates for the design storm. The Western Washington Hydraulic Model (WWHM) used catalogued map information that is automatically selected when the project site is selected. The gauge used in the WWHM is "Portland" with a precipitation factor of 0.933.

2.2 Proposed Facility Description

The project would construct a facility to receive crude oil by rail, store it on site, and load it on marine vessels for shipment to end users primarily located on the West Coast. Unit trains would arrive at the project site and be stationed on the Facility rail loops. The trains would be brought to the unloading area (Area 200) where the crude oil would be gravity-drained into the collection piping system, and pumped into the transfer pipeline system (Area 500). Crude oil would be pumped through the transfer pipelines to the storage tanks (Area 300) where it would be held until marine vessel loading operation. Marine vessels would arrive and moor at the dock (Area 400). Crude oil would be pumped from the storage tanks or unloading building to the loading area and loaded to marine vessels. A complete facility description is located within the Application for Site Certification.

Table 5 summarizes the entire surface coverage for the Facility. Detailed Facility area data and runoff volumes is described in the following sections. The existing surface coverages used to calculate runoff for Pre-Construction and During Construction for all of the runoff tables below are derived from the surfaces indicated in Figures 3 and 4.

Table 5. Facility Site Summary

	Pre-Construction	During Construction	Completed Facility
Total Site Area	47.4 Acres	103.9 Acres	47.4 Acres
Percent Impervious	95.7 %	94.7 %	93.7 %
Disturbed Area	40.4 Acres	96.1 Acres	43.4 Acres
2-Year Peak Runoff	15.68 cfs	37.75 cfs	15.23 cfs
10-Year Peak Runoff	24.60 cfs	59.13 cfs	23.86 cfs
25-Year Peak Runoff	29.66 cfs	71.30 cfs	28.76 cfs
100-Year Peak Runoff	38.02 cfs	91.34 cfs	36.86 cfs

2.3 Proposed Construction Activities

2.3.1 Area 200 – Unloading and Office

The primary element within the Unloading and Office area is the construction of the rail unloading facility and administrative/support building areas. The rail car unloading facility is a covered structure through which the trains would be pulled and secured for unloading. The structure would be approximately 1,850 feet long by 90 feet wide and has a maximum height of approximately 50 feet. The building structure would be open on the north, west, and east sides, while the southern wall would be partially enclosed to act as a weather break along the southern wall.

Each track would include unloading stations for handling of crude oil. Each station will use a completely closed loop of piping to prevent by design any atmospheric contact with the product during unloading. The entire 1,850 feet of unloading facility includes full length coverage rail collection pans, and the interior surfaces are concrete to provide containment for any accident releases as well as provide catchments for all stormwater that drips from rail cars or is blown into the unloading facility by the wind.

All mechanical piping is primarily located in concrete secondary containment trenches and the pump basins utilized for transferring product from the unloading facility to the storage tanks are below-grade concrete basins. The collection piping from the rail drip pans and facility floor drains is also located in these concrete trenches with discharge pumps located in the pump basins. Any water collected from within the unloading facility would be collected in these systems and pumped to two containment tanks located at the administrative and support building areas. There is no connection to storm or sanitary sewer from within the rail unloading facility.

Several accessory structures and equipment pads are located adjacent to the rail unloading facility. These buildings include electrical houses (E-houses) control rooms, fire pump and foam building, electrical equipment pads, and mechanical equipment pads.

The administrative and support buildings are located north of the rail unloading facility adjacent to Old Lower River Road. This area consists of three proposed modular structures, parking, and associated landscaping. In addition, the containment tanks for discharges from the rail unloading facility are located near the parking lot. A pedestrian bridge is proposed to connect the administrative/support buildings to the rail unloading facility.

Associated utility extension and relocations for communication, electrical, water service and sanitary sewer are also included.

Construction activities in the area would include site preparation, temporary and permanent erosion and sediment control (TESC) installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, installation of underground utilities including water, sewer, and storm drainage, building foundation and pump pit excavations and construction, construction of building elements, installation of mechanical systems, and final site stabilization, including restoration of industrial yard, gravel access roads, site paving, and final landscape installation.

Stormwater runoff flow rates and volumes were calculated using the WWHM for the Area 200 facility elements. During construction, stormwater and excavation dewatering would be collected on site in above-grade tankage or sediment ponds. Stormwater from the tanks would be treated prior to discharge to the existing on-site stormwater system. A detailed discussion of the BMPs and monitoring systems used during construction is included as section 3.

Table 6 summarizes Area 200 and WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Area 200 results are included in the Analysis Results as Point of Compliance (POC) 1. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 6. Area 200 - Unloading and Office - Site Summary

.	Pre-Construction	During Construction	Completed Facility
Total Site Area	7.8 Acres	47.3 Acres	7.8 Acres
Percent Impervious	100 %	98.1 %	95.4 %
Disturbed Area	7.8 Acres	47.2 Acres	7.4 Acres
2-Year Peak Runoff	3.21 cfs	19.45 cfs	3.03 cfs
10-Year Peak Runoff	5.03 cfs	30.47 cfs	4.75 cfs
25-Year Peak Runoff	6.07 cfs	36.74 cfs	5.72 cfs
100-Year Peak Runoff	7.78 cfs	47.06 cfs	7.33 cfs

2.3.2 Area 300 – Storage

The Storage Area is dominated by the construction of the storage tanks and associated containment areas. In addition, the area includes a single pump basin used to transfer crude oil from the storage tanks to the Marine Terminal and associated support buildings and equipment pads.

The Facility includes six double-bottom, internal floating-roof aboveground storage tanks (ASTs) for storing crude oil. The tanks would be approximately 48 feet in height and 240 feet in diameter and have a shell capacity of approximately 380,000 barrells (bbl) each. Each tank can store a maximum of approximately 360,000 bbl of product, which accounts for the presence of the internal floating roof and the headspace required to allow product movement in the event of a seismic event.

The tanks would be field-erected on a ring wall style footing. Ground improvements will be required to improve soil conditions underneath the storage tanks. An impervious liner system would be installed within the containment area to protect sub-surface native soils from any accidental discharge. The containment area includes an earthen perimeter berm of approximately 6 feet in height sized to contain the release of an entire tank volume plus 10 percent and a 100-year rainfall event. Intermediate berms approximately 2 feet tall between each tank additionally segregate the containment area.

The support buildings, including a storage building, fire pump and foam building, E-houses, electrical pads, and mechanical pads, would be constructed outside of the containment area on slab on grade footings. The pump basin would be isolated from the containment area by its concrete walls and basin that would serve as secondary containment.

The containment area includes a stormwater system that is segregated from the rest of the site. The system inside the containment area includes catch basins, structures, piping, control structures, and oil-water separators. All stormwater structures inside the containment area would be installed above the liner system.

Site improvements would also include utility extensions and relocations as necessary. A portion of the aboveground crude oil transfer piping would be installed within Area 300.

Construction activities in the area include site preparation, TESC installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, installation of underground utilities including water, sewer, and storm drainage, tank and building foundation and ground improvements, tank and building construction, installation of mechanical systems, and final site stabilization including restoration of industrial yard, gravel access roads, site paving, and final landscape installation.

Stormwater runoff volumes were calculated using the WWHM. During construction stormwater and excavation dewatering would be collected on site in above-grade tankage or sediment ponds. Stormwater from the tanks would be treated prior to discharge to the existing on-site stormwater system. A detailed discussion of the BMPs and monitoring systems used on site during construction is included in section 3.

Table 7 summarizes Area 300 and the WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Area 300 results are included in the Analysis Results as POC 2. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 7. Area 300 - Storage - Site Summary

	Pre-Construction	During Construction	Completed Facility
Total Site Area	20.8 Acres	24.9 Acres	20.8 Acres
Percent Impervious	100 %	100 %	92.5 %
Disturbed Area	20.8 Acres	24.9 Acres	19.2 Acres
2-Year Peak Runoff	8.57 cfs	10.26 cfs	7.95 cfs
10-Year Peak Runoff	13.43 cfs	16.07 cfs	12.46 cfs
25-Year Peak Runoff	16.19 cfs	19.38 cfs	15.03 cfs
100-year Peak Runoff	20.74 cfs	24.83 cfs	19.25 cfs

2.3.3 Area 400 – Marine Terminal

Crude oil would be transferred from the Storage Area to the Marine Terminal. Improvements at the Marine Terminal include upland construction of support facilities and improvements to the existing dock to meet current seismic standards. Improvements at the dock includes reinforcing of the existing steel piles supporting Berth 13 and mooring points, replacement of dock deck and steel trestles, and new grated steel walkways. Improvements upland include new abutment, associated ground improvements along the shoreline, fire pump and foam building, a combined control room and E-house, marine vapor combustion units, and associated site improvements including, utilities, stormwater improvements, access roads and parking, and landscaping.

The dock includes a containment area for the work areas, including all flanges and transfer hose areas. Pedestrian walkways connecting the dock to the dolphins and mooring points would be replaced or constructed with new grated steel. The access trestle would be prefabricated steel deck with concrete infill.

Upland electrical gear and the marine vapor combustion units would be located on slab-on-grade foundations. The fire pump and foam building, and the two-story E-house/Control Room, would be on

drilled piers. Additional site improvements include ground improvements along the aboveground transfer pipeline, paved access roads and parking, underground utility relocations and extensions, stormwater improvements, and permanent landscaping.

Construction activities in the area include site preparation, TESC installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, installation of underground utilities including water and storm drainage, building foundation and ground improvements, building construction, installation of mechanical systems, and final site stabilization including paved access roads, site paving, and final landscape installation.

Stormwater runoff volumes were calculated using WWHM. During construction, stormwater and excavation dewatering would be collected and treated prior to discharge to the existing on-site stormwater system. A detailed discussion of the BMPs and monitoring systems used on site is included in section 3.

Table 8 summarizes Area 4 and the WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Area 400 results are included in the Analysis Results as POC 3. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 8. Area 400 - Marine Terminal - Site Summary

	Pre-Construction	During Construction	Completed Facility
Total Site Area	7.7 Acres	12.0 Acres	7.7 Acres
Percent Impervious	93.8 %	79.0 %	88.1 %
Disturbed Area	1.8 Acres	2.2 Acres	1.1 Acres
Undisturbed Bank & Open Water Areas	5.0 Acres	6.8 Acres	5.2 Acres
Overwater Coverage	0.5 Acres	0.5 Acres	0.5 Acres
2-Year Peak Runoff	0.74 cfs	0.91 cfs	0.48 cfs
10-Year Peak Runoff	1.16 cfs	1.42 cfs	0.75 cfs
25-Year Peak Runoff	1.40 cfs	1.71 cfs	0.90 cfs
100-Year Peak Runoff	1.80 cfs	2.19 cfs	1.16 cfs

2.3.4 Area 500 – Transfer Pipelines

A combination of above- and below-ground steel transfer pipelines would convey crude oil from the rail unloading structure in Area 200 to the storage tanks in Area 300 and from the storage tanks to the marine vessel loading system in Area 400. Three 24-inch-diameter, approximately 5,500-foot-long pipelines would connect the rail car unloading facility to the storage tanks in Area 300; one of these pipes would be electrically heat-traced to maintain the viscosity of the crude oil requiring heating would be maintained while it is conveyed from the unloading facility to the Storage Area. A 36-inch-diameter, approximately 5,300-foot-long pipeline would connect the storage tanks with the vessel loading system in Area 400. A 6-inch-diameter pipeline would return crude oil from the vessel loading system to the storage tanks and also serve as the return line for pressure relief system to prevent pipe hammer.

Aboveground pipe sections would be supported on spread footings located every 35 feet. Vertical expansion loops would be located at key locations along the pipeline and supports for the expansion loops would also be on spread footings. Underground sections of the pipelines would be located in fully sealed, welded casing sections and transition concrete vaults. The aboveground section of the transfer piping which runs parallel with the Columbia River would most likely require ground improvements to comply with current seismic standards.

The transfer pipelines are located predominately in non-exclusive lease areas with the port. Transfer pipelines would be located a minimum of 1 foot above the ground and in cleared and gravel surface corridors to facilitate frequent inspection. Downstream catch basins and drainages would be retrofitted with spill control devices capable of capturing a minimum of 5 gallons of oil.

Construction activities in the area include site preparation, TESC installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, relocation of underground utilities including water and storm drainage, pipeline foundation and ground improvements, pipeline construction, and final site stabilization including gravel surfacing and pavement restoration

Stormwater runoff volumes were calculated using WWHM. During construction, stormwater and excavation dewatering would be excluded from active work areas and stockpiles with plastic sheathing and treated with BMPs. A detailed discussion of the BMPs and monitoring systems used on site is included in section 3.

Table 9 summarizes Area 500 and the WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Area 500 results are included in the Analysis Results as POC 4. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 9. Area 500 - Transfer Pipelines - Site Summary

	Pre-Construction	During Construction	Completed Facility
Total Site Area	4.9 Acres	12.9 Acres	4.9 Acres
Percent Impervious	68.1 %	96.2 %	100 %
Disturbed Area	3.3 Acres	12.4 Acres	4.9 Acres
2-Year Peak Runoff	1.40 cfs	5.11 cfs	2.02 cfs
10-Year Peak Runoff	2.20 cfs	8.01 cfs	3.16 cfs
25-Year Peak Runoff	2.66 cfs	9.66 cfs	3.81 cfs
100-Year Peak Runoff	3.41 cfs	12.37 cfs	4.88 cfs

2.3.5 Area 600 – West Boiler

The West Boiler comprises a boiler building, paved parking and access areas, aboveground steam and condensate piping, and site landscaping. The boiler building would have a footprint of approximately 6,000 square feet and would be approximately 45 feet high. The building would house two primary and one standby natural gas-fired boilers, to provide steam for the heating of tank cars during unloading.

The boiler building, equipment pads, E-house, and pipeline supports would all utilize slab on grade or spread footings. Natural gas, water supply, and wastewater utilities would be extended onto the site to provide service. The stormwater system from Area 200 would be extended to Area 600 for storm drainage.

Construction activities in the area include site preparation, TESC installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, relocation of underground utilities including water and storm drainage, building foundation, building construction, piping and mechanical installation and final site stabilization including site paving and landscaping.

Stormwater runoff volumes were calculated using WWHM. During construction, stormwater and excavation dewatering would be excluded from active work areas and stockpiles with plastic sheathing and treated with BMPs. A detailed discussion of the BMPs and monitoring systems used on site is included in section 3.

Table 10 summarizes Area 600 and the WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Area 600 results are included in the Analysis Results as POC 5. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 10. Area 600 - West Boiler - Site Summary

	Pre-Construction	During Construction	Completed Facility
Total Site Area	0.8 Acres	1.3 Acres	0.8 Acres
Percent Impervious	100 %	100 %	87.5 %
Disturbed Area	0.8 Acres	1.3 Acres	0.7 Acres
2-Year Peak Runoff	0.32 cfs	0.58 cfs	0.31 cfs
10-Year Peak Runoff	0.52 cfs	0.90 cfs	0.48 cfs
25-Year Peak Runoff	0.62 cfs	1.09 cfs	0.58 cfs
100-Year Peak Runoff	0.80 cfs	1.40 cfs	0.75 cfs

2.3.6 Rail Improvements

One additional rail loop would be constructed on approximately 1.80 acres at Terminal 5. In addition, rail infrastructure would be relocated and modified in the west vicinity of the Area 200 rail unloading structure to facilitate the switching and departure of trains. The total area for rail improvements for the facility totals 3.47 acres. The additional rail loop will bring the total number of permitted loop tracks in Terminal 5 to six. The additional rail loop will be constructed as part of the second phase of the project.

The new rail line approximately 4,900 feet long, would be added to the Terminal 5 rail infrastructure. The track would consist of railroad ballast (rock), 115-pound hardened steel rails that are continuously welded and mounted on either 8-foot x 6-inch or 8-foot x 3-inch crossties, and other miscellaneous materials. Crossties would be concrete for the most part, except at crossings where timber would be used. The rails would be continuously welded to reduce noise and increase safety. The rail loops would be designed to comply with railroad and federal requirements.

The corridor that will be used for the additional rail loop is currently portion of a gravel inspection road. The road width will be reduced to 13-feet without modification to the southern extents of the inspection road. Pullouts will be added along the road to allow passing of vehicles along the corridor.

These improvements are anticipated to be located adjacent to the existing corridor for the WVFA project. The existing stormwater drainage systems installed as part of the WVFA project are capable of handling operational stormwater. Minor adjustments to collection systems may be needed depending upon the final location of rail lines. Existing treatment systems and capacities will not be impacted by construction.

Construction activities in the area include site preparation, TESC installation and maintenance, demolition and relocation of existing franchise utilities, rough grading, relocation of underground utilities, including storm drainage, rail construction and final site stabilization including adjacent surface restorations where necessary.

Construction of the rail improvements is not part of the first phase of work for the Vancouver Energy Facility. Construction of the additional loop will be completed based upon long-term capacity of the Terminal 5 rail infrastructure and the future phase of the Facility.

Table 11 summarizes rail improvements and the WWHM results. Detailed stormwater calculations are included in Appendix F for pre-construction and during construction. Rail improvements results are included in the Analysis Results as POC 6. Stormwater calculations for the completed facility are detailed in the facility's Industrial Stormwater Engineering Report.

Table 11. Rail Improvements - Site Summary[3]

	Pre-Construction	During Construction	Completed Facility
Total Site Area	3.5 Acres	3.5 Acres	3.5 Acres
Percent Impervious	100 %	100 %	100 %
Disturbed Area	5.4 Acres	5.4 Acres	5.4 Acres
2-Year Peak Runoff	1.44 cfs	1.44 cfs	1.44 cfs
10-Year Peak Runoff	2.26 cfs	2.26 cfs	2.26 cfs
25-Year Peak Runoff	2.72 cfs	2.72 cfs	2.72 cfs
100-Year Peak Runoff	3.49 cfs	3.49 cfs	3.49 cfs

2.3.7 Construction within Identified Cap Areas

This section is intended to provide detailed descriptions of surface area disruptions within the Deed Restrictive Areas shown in Figure 5. Detailed construction drawings indicating existing cap sections and restoration details are included in Appendix M.

2.3.7.1 Vanexco Cap

The areas of potential contaminates are contained below an existing concrete slab that has been preserved in place and buried with approximately 3 to 4 feet of fill. In areas where the rail corridor has been constructed, portions of the existing concrete slab have been removed and replaced with an impervious liner and drainage system. The combination of liner and concrete slab protects the contaminated material from exposure to stormwater.

A total of approximately 20,000 square feet of improvements is proposed as part of the parking lot and containment storage tanks at the administrative/support building area. Work in this area has been designed utilizing surface features for stormwater collection and conveyance. The amount of fill over the concrete slab allows standard construction techniques for parking lot construction. Spread footings and thickened slabs are proposed for the containment tanks. The bottom of the containment tank footings are proposed at 31.25 feet. The existing concrete cap is at Elevation 31.1 according to as-built drawings.

Construction of the rail unloading building would consist of the installation of 19 column footings and 357 linear feet of grade beam within the cap areas. Existing drawings showing cross sections from the installation of the high-density polyethylene (HDPE) liner indicate that the liner is at an approximate elevation between 28.0 and 28.3 feet. Construction of the footings within the Vanexco Cap would require foundation excavation to an elevation of 26.33 feet.

Portions of the rail unloading facility would occur within the existing HDPE liner. In those locations, this sequence of construction would follow.

1. The fill on top of the liner would be removed carefully to expose the liner and the liner would be rolled back to facilitate construction of the rail unloading facility.
2. Excavated soils from this area would be placed in separate containment bins for testing and clean backfill would be used.
3. The liner would be rolled back into place preserving positive drainage to the existing liner drainage system.
4. The liner would be tied into the grade beam of the facility while the roof and concrete surfacing would maintain the necessary stormwater segregation and the function of the existing cap.

[3] Note that the areas displayed for rail improvements within this construction SWPPP only apply to the additional rail loop being permitted by the Facility and the modifications to existing rail infrastructure to connect into the rail unloading building. The rail infrastructure discussed within the NPDES Engineering Report and Operations SWPPP specifically apply to rail infrastructure that the Facility operates on.

Work within this area would be restricted to periods of dry weather and, if rainfall is forecast, work would be stopped and the disturbed areas covered with plastic sheathing to preserve cap function.

2.3.7.2 North, North 2, SPL, and Ingot Caps

Construction is limited within the North, North 2 Landfills, SPL Storage Area, and Ingot Cap to improvements required by the rail improvements only. Construction of the rail improvements will occur within the limits of the prior project boundary for the Port's WVFA project. Construction of the outermost loop track will require reconfiguration of the inspection/access road. The road width will be reduced to 13 feet to accommodate the outer track. The southern limits of the gravel inspection road will not be adjusted. Construction within these areas would be substantially similar and is proposed to comply with all currently permitted conditions of approval for this work, and minimum cap restoration would be as follows. Complete engineering drawings and updated construction SWPPP will be prepared and submitted to EFSEC prior to construction.

- SPL Cap – This cap has been modified by the Port during expansion of the rail facility. Construction techniques generally use a system of 30-mil PVC membrane installed underneath track ballast and 10 inches of crushed rock. Construction modifications would be tied into the existing asphalt cap areas using concrete transition ties to transition from membranes to asphalt.
- North/North 2 Cap – The cap is protected by native subgrade covered by dredge and selected fill.
- Ingot Cap – The cap is protected by prepared subgrade and selected fill, with a layer of backfilled sand of various depths and 12 inches of crushed concrete.

2.3.7.3 East Landfill

Construction within the east landfill area consists of grading a suitable level bench within the area to construct foundations for the aboveground crude oil pipeline. The actual limits of the landfill areas was surveyed by the port. By design, improvements within this area would not impact the landfill area.

3. Construction Stormwater BMPs

These construction stormwater BMPs have been selected for the proposed project. Detailed environmental control plans for the project are attached in Appendix G. The plans have been designed, unless noted specifically, for wet-weather construction activities. The design of the environmental control plan places a priority on erosion prevention. Sediment controls and stormwater treatment are additionally selected at each project area in the event that erosion does occur.

Specific emphasis is placed in the environmental control plans to protect the surface water quality of nearby wetlands and the Columbia River. Perimeter improvements have been identified for all construction areas, and where ground improvements are necessary, additional perimeter improvements such as temporary berms, cutoff ditches, and/or wick drains have been included.

3.1 The 12 BMP Elements

The BMPs discussed in this section are as specified by Ecology in the *2012 Stormwater Management Manual for Western Washington* (Washington State Department of Ecology 2012). The BMPs must satisfy the requirements set forth in the General NPDES Permit (Appendix I).

To avoid potential issues that may cause a violation(s) of the permit, at the first sign that existing BMPs are ineffective or failing, the Certified Erosion and Sediment Control Lead (CESCL) will promptly initiate the implementation of one or more of the alternative BMPs listed in Appendix J. The alternate BMPs are a quick reference tool for the onsite inspector in the event the listed BMPs are deemed ineffective or inappropriate during construction.

3.1.1 Element 1: Preserve Vegetation/Mark Clearing Limits

To protect adjacent properties and to reduce the area of soil exposed to construction, the limits of construction would be clearly marked before land-disturbing activities begin. Trees that are to be preserved, as well as all sensitive areas and their buffers, would be clearly delineated, both in the field and on the plans. In general, natural vegetation and native topsoil would be retained in an undisturbed state to the maximum extent possible. The BMPs related to marking the clearing limits that may be used on this project include:

- High Visibility Plastic or Metal Fence (BMP C103)
- Silt Fence (BMP C233)

Table 12 lists the project elements that would require the use of BMPs to preserve vegetation and mark clearing limits.

Table 12. Areas Requiring Vegetation Preservation/Marking and Clearing Limit BMPs

Area	High Visibility Plastic or Metal Fence	Silt Fence
200 – Unloading & Office	Required	Required
300 – Storage	Required	Required
400 – Marine Terminal	Required	Required
500 – Transfer Pipelines	Required	Required
600 – West Boiler	Required	Required
Rail Improvements	Required	Required

High visibility fencing and silt fencing would be used on all areas of the project to delineate the construction boundaries. Where natural vegetation, wetlands, or surface water bodies are adjacent, those areas (regardless of ground slope) would be protected by silt fencing, while silt fencing would be installed in all areas on the downslope gradient of the work areas. High visibility fencing would be used on all upslope gradients of the work areas. All fencing would be held a minimum of 20 feet back from all rail corridors.

3.1.1.1 High-Visibility Plastic or Metal Fence (BMP C103)

Fencing is intended to fulfill the following purposes.

1. Restrict clearing to approved limits.
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits, or internal roads.
4. Protect areas where marking with survey tape may not provide adequate protection.

To establish clearing limits, plastic, fabric, or metal fencing may be used in the following situations.

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

3.1.1.2 Silt Fence (BMP C233)

A silt fence is used to reduce 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.

Silt fence may be used downslope of all disturbed areas, but the project would follow these Ecology caveats: The fence would prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but would allow the water to pass through the fence. The silt fence would not be used to treat concentrated flows or to treat substantial amounts of overland flow. Any concentrated flows would be conveyed through the drainage system to a sediment pond. Silt fences would not be constructed in

streams or used in V-shaped ditches because in these situations, silt fence does not provide an adequate method of silt control.

3.1.2 Element 2: Establish Construction Access

Construction access or activities occurring on unpaved areas would be minimized, yet where access points are necessary, they would be stabilized to minimize tracking sediment onto public roads, and wheel washing, street sweeping, and street cleaning would be employed to prevent sediment from entering state waters. All wash wastewater would be controlled on site. The specific BMPs related to establishing construction access that may be used on this project include:

- Stabilized Construction Entrance/Exit (BMP 105)
- Wheel Wash (BMP C106)
- Construction Road/Parking Area Stabilization (BMP C107)

Table 13 lists the areas of the project that would require stabilization and/or wheel washing.

Table 13. Areas Requiring Construction Access BMPs

Area	Stabilized Construction Entrance/Exit	Wheel Wash	Construction Road/Parking Area Stabilization
200 – Unloading & Office	Required	Required[1]	Required
300 – Storage	Required	Required[1]	Required
400 – Marine Terminal	Required	Required[1]	Required
500 – Transfer Pipelines	N/A	N/A	N/A
600 – West Boiler	Required	-	Required
Rail Improvements	Required	-	-

Wheel washing for vehicles from within the ground disturbing activity area will be required during excavations with dewatering and during ground improvement activities. A wheel wash will be installed at the staging/laydown area at Area 200 for the duration of ground-disturbing activities if needed.

Delineated construction access points have been established for each project area where ground-disturbing activities exist. Entrance locations are generally placed near the construction laydown and staging areas for each site. Wheel washes would be provided during all ground improvement activities and rough grading. Construction roads/parking areas are provided at each construction laydown/staging area. Detailed descriptions of each area are included below:

Area 200 – Unloading and Office

The primary project laydown and staging area is proposed within the Terminal 5 rail loop. Entrances and exits to the laydown area and construction area for the rail unloading facility would have stabilized construction entrances and wheel wash. Construction road/parking areas would be stabilized per BMP C107 for all parking and regular vehicular traffic areas. A high visibility fence would separate the staging/laydown area from the construction site. All trucks hauling equipment, excavated soils, or backfill material would be required to use the wheel wash at a minimum when exiting the site.

A laydown area is proposed at the location of the future office building in the administration and support area. A construction entrance is proposed adjacent to this in the alignment of the proposed parking area. The construction entrance located at Area 600 to the west would have a wheel wash for material import and haul trucks. It is anticipated that workers in this area would report to the primary laydown/staging area within the Terminal 5 rail loop and private vehicles would not be parked in this area.

Area 300 – Storage

Two construction entrances would be located at Area 300. The primary laydown and staging area would be located on the west end of the project area. This area is predominantly for construction workers, office trailers, and material storage. The entrance on the east side of the project area would include the wheel wash and is designated for excavation haul off, material import, and for concrete truck access. The water quality units and concrete washout facilities for the project are located at the southeast corner, and this entrance would additionally support that facility.

A construction road would be maintained along the south and east portions of the project for vehicles accessing the concrete washout and water quality facilities. Construction workers on this site are anticipated to report to the staging/laydown areas at the west access and construction parking would be provided in that area.

Area 400 – Marine Terminal

The Marine Terminal would use two construction entrances, one on the west end near the current CalPortland lease area and one in alignment with the current waterfront access road on the east end. The primary access into this area would be from the west near the identified staging/laydown area. Office trailers and parking for the workers would be provided. Material hauling would be in/out of this access as well and a wheel wash unit would be provided during ground-disturbing activities.

Area 500 – Transfer Pipelines

The construction of the transfer pipelines would use the project staging and laydown area within the Terminal 5 rail loop (Area 200) for staging, laydown, construction worker parking, and offices. Material stockpiling also would occur in Area 200.

Area 600 – West Boiler

Construction of the West Boiler is assumed to be completed as a second, deferred improvement. This work would include minor grading. As shown, a construction entrance would be constructed and worker parking on the site would be minimal. The remainder of the work for the pipe bridge and the mechanical improvements within the rail unloading building would use staging/laydown within the Terminal 5 loop.

Rail Improvements

The Rail Improvements construction will primarily occur within the existing project footprint for WVFA. The staging and laydown area for the construction will provide a stabilized construction entrance to delineate the location and entrance to the area. It is anticipated that this area will be located adjacent to rail construction and will be used for equipment as well.

3.1.2.1 Stabilized Construction Entrance/Exit (BMP C105)

Construction entrances are stabilized by constructing a pad of quarry spalls at their entrances and exits; this reduces the amount of sediment transported onto paved roads by vehicles or equipment. The following provisions affect the installation and operation of stabilized construction entrances.

- Construction entrances are stabilized wherever traffic enters or leaves a construction site if paved roads or other paved areas are within 1,000 feet of the site.
- Stabilized surfaces should be long and wide enough to provide vehicle access/parking, based on lot size/configuration.

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

3.1.2.2 Wheel Wash (BMP C106)

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles and are used when a stabilized construction entrance (see BMP C105) does not prevent sediment from being tracked onto pavement. The following provisions affect the installation and operation of wheel washes.

- 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 x 10-foot sump can be very effective.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with local sewer district approval.
- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.

3.1.2.3 Construction Road/Parking Area Stabilization (BMP C107)

This BMP involves reducing erosion caused by construction traffic or runoff by stabilizing roads, parking areas, and other on-site vehicle transportation routes immediately after grading.

As the BMP stipulates, whenever roads or parking areas (whether temporary or permanent) are constructed for use by construction traffic, they would be stabilized and high visibility fencing would be installed as required by BMP C103.

3.1.3 Element 3: Control Flow Rates

In order to protect the properties and waterways downstream of the project site, stormwater discharges from the site would be controlled. The specific flow control BMPs that may be used on this project include

- Check Dams (BMP C207)
- Outlet Protection (BMP C209)
- Compost Socks (BMP C235)
- Storage/Surge Tanks/Sediment Pond (Custom BMP)

Table 14. Areas Requiring Control Flow Rate BMPs

Area	Check Dams	Outlet Protection	Compost Sock	Storage/Surge Tanks
200 – Unloading & Office	Required	N/A	-	450,000 gallons Required
300 – Storage	N/A	N/A	-	250,000 gallons Required
400 – Marine Terminal	N/A	Required	Required	40,000 gallons Required
500 – Transfer Pipelines	N/A	N/A	Required	N/A
600 – West Boiler	N/A	N/A	Required	N/A
Rail Improvements	N/A	N/A	N/A	N/A

Flow control elements are identified for each construction area. The flow control is not intended to provide for detention requirements. The existing condition on site is considered to be fully impervious as a result of decades of industrial activity. Flow control is designed to maintain safe conveyance of construction stormwater, and surge protection to verify water quality treatment benchmarks are achieved.

The Stormwater Management Manual for Western Washington (SMMWW) specifies that upstream tankage required for the use of construction stormwater filtration or chemical treatment is 1.5 times the 10-year, 24-hour storm volume minus 8 hours of the provided treatment system flow rate. For this project,

the construction stormwater monitoring and treatment systems are designed with redundancy on-site and on-call personnel 24 hours a day. As such, the calculations for required tankage use an expanded 20-hour-a-day treatment period. The table above specifies the required tankage volume as determined by the modified sizing criteria specified in BMP C251 for flow control exempt water bodies. The tankage volumes above correlate to the treatment capacities specified in section 3.1.5.

Area 200 – Unloading and Office

Construction at the unloading and office area is not anticipated to have a significant impact on stormwater runoff. Silt fence would be installed along the southern boundary and ground-disturbing activities would be sequenced to, at a minimum, install the gravel surfacing immediately following grading. Runoff from this area would continue along the existing drainage patterns sheet flowing to the south.

Construction of the rail unloading building would require deep excavations for the pump pits and excavations within the Vanexco Cap. Excavation dewatering from these areas would be removed from the excavation and pumped into a storage/weir tank located to the south of the rail unloading building. This groundwater would be isolated from the remainder of the construction stormwater system, and would be tested for contaminates of concern. If testing for contaminates is negative or below surface water quality standards, the water would be released into the construction stormwater system for treatment and discharge. If tests are positive, the contaminated water would be removed from the site from a licensed disposal company for treatment and legal disposal.

Construction stormwater from the rail unloading building area will be intercepted by interceptor swales and pumped into weird tanks for treatment. The staging/laydown areas would be collected in the existing stormwater system. The staging/laydown activities for the project are consistent with the existing use of the inner Terminal 5 loop. Monitoring of the stormwater from the staging/laydown area will be conducted; and if stormwater from the staging/laydown area needs to be rerouted or receive additional treatment to comply with NPDES permit conditions treated, a cutoff ditch with check dams would be installed and directed towards existing inlets or a new sump with pump to direct stormwater to the on-site weir tanks. The downstream portion of this system would be plugged, and stormwater would be pumped out of the system and discharged into weir tanks for flow control, followed by an enhanced sand filter system as described in section 3.1.5.

Construction within the Vanexco cap area will be restricted to working periods without precipitation. The site will be covered, and runoff will be directed toward the remainder of the facility or collected in the existing storm drainage system above the contaminated media.

Area 300 – Storage

Construction stormwater within Area 300 would be directed through constructed cutoff ditches, sumps, and pumped to on-site weir tanks. The weir tanks would provide initial settling of large sediment and attenuate surges of stormwater. Stormwater following the tanks would be processed through enhanced sand filtration as described in section 3.1.5.

Area 400 – Marine Terminal

The Marine Terminal would be graded to drain into the bio-infiltration swales using a media filter drain for water quality. Runoff into the area would be controlled through compost socks installed along the slope. Compost socks also would be installed along the slope of the river embankment to protect the slope from erosion. Additionally, during ground improvements, any groundwater or jet water used and brought to the surface would be collected and pumped into weir tanks. Enhanced sand filtration for water quality treatment follows downstream of the weir tanks.

Area 500 – Transfer Pipelines

Ground disturbance of the transfer pipelines consists largely of foundation excavations. These areas would be surrounded by compost socks to control runoff flow rates. Excavations within this area would be temporary and exposed for only a short time.

Area 600 – West Boiler

The downslope portions of the West Boiler and the utility excavations to the site would use compost socks to control runoff. Excavations within this area would be temporary and exposed for a short time.

Rail Improvements

The majority of construction stormwater from the rail corridor is expected to runoff to the existing conveyance system. Additionally, the Columbia River is a flow control exempt waterbody according to Ecology's SMMWW Volume I. In the event that stormwater is not captured and flow control is needed, flow control devices specified below or in Appendix J may be necessary.

3.1.3.1 Check Dams (BMP C207)

A small dam constructed across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam. Check dams are used where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required. The following provisions affect the use of this BMP.

- Check dams may not be placed in streams unless approved by the Washington Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to provide for no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.
- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to verify that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom. Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

- Verify that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure 4.2.7 depicts a typical rock check dam.

3.1.3.2 Outlet Protection (BMP C209)

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows. Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

3.1.3.3 Compost Sock (BMP C235)

Wattles are TESC barriers consisting of straw, compost, or other material that is wrapped in biodegradable tubular plastic or similar encasing material. Wattles reduce the velocity of stormwater and can spread the flow of rill and sheet runoff and can capture and retain sediment. Typical wattles are 8 to 10 inches in diameter and 25 to 30 feet long. Wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See Figure 4.2.14 for typical construction details. WSDOT Standard Plan I-30.30-00 also provides information on wattles (http://www.wsdot.wa.gov/Design/Standards/Plans.htm#SectionI).

This BMP stipulates the use of wattles in the following circumstances.

- 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, but they usually are effective for one to two seasons. Riling beneath wattles can be prevented by properly entrenching and abutting them to prevent water from passing between them.

3.1.3.4 Storage/Surge Tanks (Custom BMP)

Storage/Surge tanks are used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin. Tanks remove sediment from runoff originating from disturbed areas of the site. The tanks are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, tanks usually reduce turbidity only slightly. This BMP stipulates that, before stormwater runoff leaves a construction site, the runoff must pass through a sediment pond, storage/surge tank, or other appropriate sediment removal BMP. Sediment ponds are used where the contributing drainage area is 3 acres or more.

3.1.4 Element 4A: Install Sediment Controls

All stormwater runoff from disturbed areas would pass through an appropriate sediment removal BMP before leaving the construction site or before the discharge of the stormwater to an infiltration facility. The specific sediment control BMPs that may be used on this project include:

- Silt Fence (BMP C233)
- Compost Sock (BMP C235)

Table 15. Areas Requiring Sediment Control BMPs

Area	Silt Fence	Compost Sock
200 – Unloading & Office	Required	Required
300 – Storage	Required	-
400 – Marine Terminal	Required	Required
500 – Transfer Pipelines	Required	Required
600 – West Boiler	Required	Required
Rail Improvements	Required	Required

Area 200 – Unloading and Office

Sediment controls at Area 200 would consist of silt fencing installed along the downslope project areas. On slopes or where localized excavations occur within the 20-foot rail clearance area, compost socks would be used.

Area 300 – Storage

Sediment controls at Area 300 would consist of silt fencing installed along all downslope project areas.

Area 400 – Marine Terminal

Sediment controls at Area 400 would consist of silt fencing installed along all downslope project areas and along the top of bank. Compost socks would be installed along the embankment and along the media filter drain.

Area 500 – Transfer Pipelines

Silt fencing would be installed along the top of bank where the transfer pipelines and ground improvements are constructed along the river. Compost socks would be used to protect downslope areas from localized foundation excavation runoff. Additionally, compost socks would be installed along river embankment.

Area 600 – West Boiler

Sediment controls would consist of silt fencing installed along all downslope project areas.

Rail Improvements

Silt fencing and straw wattles will be used to intercept stormwater as is flows from the construction site. Sediment controls will be installed along all downslope project areas.

3.1.4.1 Silt Fence (BMP C233)

Section 3.1.1.2 discusses silt fence.

3.1.4.2 Compost Socks (BMP C235)

Section 3.1.3.3 describes compost socks.

3.1.4.3 Additional Measures to Control Sediment Discharge

In addition, sediment would be removed from paved areas in and adjacent to construction 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.

Whenever possible, sediment-laden water would be discharged into relatively level, vegetated areas of the project site (BMP C240 paragraph 5, page 4-102).

In some cases, sediment discharge in concentrated runoff can be controlled using permanent stormwater BMPs (e.g., infiltration swales, ponds, trenches). Sediment loads can limit the effectiveness of some permanent stormwater BMPs, such as those used for infiltration or biofiltration; however, those BMPs designed to remove solids by settling (wet ponds or detention ponds) can be used during the construction phase. When permanent stormwater BMPs are used to control sediment discharge during construction, the structure would be protected from excessive sedimentation with adequate erosion and sediment control BMPs. Any accumulated sediment would be removed after construction is complete and, once the remainder of the site has been stabilized, the permanent stormwater BMP would be restabilized with vegetation per applicable design requirements.

3.1.5 Element 4B: Turbidity Control BMPs

The following BMPs will be implemented as end-of-pipe sediment controls as required to meet permitted turbidity limits in the site discharge(s). Prior to the implementation of these technologies, sediment sources and erosion control and soil stabilization BMP efforts will be maximized to reduce the need for end-of-pipe sedimentation controls. The specific turbidity control BMPs that may be used on this project include

- Weir Tanks (Custom BMP)
- Construction Stormwater Chemical Treatment (BMP C250)
- Construction Stormwater Filtration (BMP C251)
- Wick Drains (Custom BMP)

Table 16. Areas Requiring Turbidity Control BMPs

Area	Weir Tanks	Chemical Treatment	Filtration	Wick Drains
200 – Unloading & Office	2 Tanks Required	750 gpm Required	750 gpm Required	-
300 – Storage	2 Tanks Required	2,500 gpm Required	2,500 gpm Required	Required
400 – Marine Terminal	-	250 gpm Required	250 gpm Required	Required
500 – Transfer Pipelines	-	-	-	Required
600 – West Boiler	-	-	-	-
Rail Improvements	-	-	-	-

The required treatment flow rates indicated above were selected based upon sizing criteria for upstream tankage specified in BMP C250 of the SMMWW. The flow rates above are minimum flow rates that generally conform to standard intervals of available units within the industry. The flow rate of 5,000 gpm was selected at Area 200 to keep downstream conveyance systems from being overloaded. The flow rates also assume that the treatment systems will operate for 16 hours a day during the 10-year, 24-hour design storm.

The Port conducted water quality sampling during two storms in 2013. The full results of this report are located in Appendix K. Construction activity was underway during the testing period at Farwest Steel (Parcel 1A). The results of this testing are used as the basis of design for the Facilities Turbidity Control

BMPs. The results of the sampling and the resultant assumed basis of design are summarized in Table 17 below.

The basis of design assumes higher than the sampled average for turbidity to conservatively design the proposed filtration systems can adequately handle construction runoff from the Facility. The highest value of 500 was not used as the basis of design because the treatment train of construction BMPs includes pretreatment with surge/storage tanks and weir tanks prior to the filtration processes required.

The sample point of 270 mg/L for total suspended solids (TSS) is suspect as no other sampling indicated levels to this degree. The other highest TSS in the report was 55 mg/L from runoff of an adjacent parking lot/paved laydown area. The geotechnical report attached in Appendix D characterizes the Facility areas as predominately sands, which will have a much larger particle size and resulting lower TSS. A design value of 100 mg/L is considered adequate, especially with the construction BMP treatment train with upstream surge/storage tanks and weir tanks.

Table 17. Construction Turbidity Control Sampling and Basis of Design

Parameter	Sampling Data			Basis of BMP Selection and Design
	28 January 2013	28 February 2013	Average	
Turbidity (NTU)	196.1	500	348.05	400
TSS (mg/L)	34.0	270	152	100

Areas 200, 300, and 400

Construction stormwater from Area 200 would be collected and stored in weir tanks for initial sediment settling. Stormwater from the weir tanks would overflow and be processed through sand filtration. The sand filters would be equipped for the addition of chemical treatment (flocculent) to additionally provide higher levels of treatment when needed. All water resulting from ground improvements would be processed through chemical treatment BMPs.

Construction dewatering and groundwater removed from the Environmental Restrictive Covenant areas will be segregated from surface water runoff and will be tested and treated as discussed in section 3.1.11.

Areas 500 and 600

Turbidity controls are not required at areas 500 and 600. BMPs for sediment control and erosion prevention would be strictly enforced to reduce turbidity loading in the downstream stormwater system.

Rail Improvements

Turbidity controls for the rail improvements may include use of permanent stormwater controls, such as downstream ponds and trenches. Sediment deposited in these BMPs will be removed. Alternative BMPs are listed in in Appendix J if needed.

Ground Improvements

Wick drains will be used between areas of ground improvement (stone columns, soil mixing, jet grouting, etc.) and surface waters and wetlands. At Area 300, wick drains will be installed at a minimum of 16 feet on center where ground improvements are within 150 feet of the adjacent wetlands to the north and east. At areas 400 and 500, wick drains will be installed along the top of bank at 8 feet on center for the entire bank area receiving ground improvement. Visual monitoring of turbidity within the wetlands or Columbia River will occur daily during ground improvement. If any turbidity is observed as a result of ground improvement, ground improvement activities will be stopped and additional mitigation measures will be installed, including additional wick drains, turbidity curtains, or change in ground improvement methods will be considered.

3.1.5.1 Weir Tanks (Custom BMP)

Weir tanks are used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin. Tanks remove sediment from runoff originating from disturbed areas of the site. The tanks are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, tanks usually reduce turbidity only slightly. This BMP stipulates that, before stormwater runoff leaves a construction site, the runoff must pass through a sediment pond, weir tank, or other appropriate sediment removal BMP. Sediment ponds/weir tanks are used where the contributing drainage area is 3 acres or more.

3.1.5.2 Construction Stormwater Chemical Treatment (BMP C250)

This BMP applies when using stormwater chemicals in batch treatment or flow-through treatment.

Turbidity is difficult to control once fine particles have become suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt.

Traditional erosion and sediment control BMPs may not be adequate to maintain compliance with the water quality standards for turbidity in receiving water.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Chemical treatment may be required to meet turbidity stormwater discharge requirements, especially when construction is to proceed through the wet season.

Ecology must provide formal written approval for the use of chemical treatment regardless of the size of the site. The local permitting authority may also require review and approval. After the use of the chemical treatment system has been approved, it must be included in the construction SWPPP.

3.1.5.3 Construction Stormwater Filtration (BMP C251)

Filtering stormwater from construction removes the sediment from runoff that originates from the areas of the site that have been disturbed.

Filtration with sand media has been used for over a century to treat water and wastewater. Using sand filtration to treat stormwater is more recent and is generally used to treat runoff from streets, parking lots, and residential areas. The application of filtration to treating construction stormwater is currently under development.

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to maintain compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity would depend on the particle sizes in the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

The use of construction stormwater filtration does not require approval from Ecology as long as treatment chemicals are not used. Filtration in conjunction with polymer treatment requires testing under the Chemical Technology Assessment Protocol before it can be initiated. If the use of polymers is proposed, approval from the appropriate regional Ecology office must be obtained beforehand. For more guidance on the chemical treatment of stormwater, see BMP C250 in section 3.1.5.2.

3.1.6 Element 5: Stabilize Soils

Exposed and unworked soils would be stabilized throughout the life of the project by the application of BMPs that are effective in preventing erosion. The specific soil stabilization BMPs that may be used on this project include

- Temporary and Permanent Seeding (BMP C120)
- Mulching (BMP C121)
- Plastic Covering (BMP C123)
- Surface Roughening (BMP C130)
- Dust Control (BMP C140)

Table 18. Areas Requiring Soil Stabilization BMPs

Area	Temporary and Permanent Seeding	Mulching	Plastic Covering	Surface Roughening	Dust Control
200 – Unloading & Office	Required	-	Required	-	Required
300 – Storage	Required	-	Required	Required	Required
400 – Marine Terminal	Required	Required	Required	-	Required
500 – Transfer Pipelines	N/A	Required	-	-	Required
600 – West Boiler	Required	-	-	-	Required
Rail Improvements	-	-	Required	-	Required

Area 200 – Unloading and Office

Landscaping areas would be mulched or permanently seeded as soon as the area is graded. Stockpiles in the construction and laydown areas would be covered when not in active use. Dust control measures would be in place for use when needed.

Area 300 – Storage

Landscaping areas would be mulched or permanently seeded as soon as the area is graded. Stockpiles in the construction and laydown areas would be covered when not in active use. Side slopes of the containment area berm would be roughened according to BMP C130 and seeded as soon as possible. Dust control measures would be in place for use when needed.

Area 400 – Marine Terminal

Landscaping areas would be mulched or permanently seeded as soon as the area is graded. All exposed slopes and surfaces in the Marine Terminal area would be mulched. Stockpiles in the construction and laydown areas would be covered when not in active use. Dust control measures would be in place for use when needed.

Area 500 – Transfer Pipelines

All exposed soils in the transfer pipeline area would be mulched, and mulching will be placed to stabilize exposed soils. Where applicable, erosion control seeding also would be completed. The primary surfacing in this area is gravel and gravel would be placed following construction of the foundations. Dust control measures would be in place for use when needed.

Area 600 – West Boiler

Landscaping areas would be mulched or permanently seeded as soon as the area is graded. Dust control measures would be in place for use when needed.

Rail Improvements

Plastic covering will be used to provide immediate and short-term erosion for stockpiles and exposed areas. Dust control measures will be used to prevent wind transport of disturbed soils.

3.1.6.1 Temporary and Permanent Seeding (BMP C120)

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

The BMP stipulates the use of seeding throughout the project on disturbed areas that have reached final grade or that are to 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, the BMP requires irrigation until 75 percent grass cover is established. Between October 1 and March 30, seeded areas must be covered with mulch or an erosion control blanket until 75 percent grass cover is established.

The BMP also requires reviewing all disturbed areas in late August to early September and completing all seeding by the end of September; this is so the vegetation can become well enough established 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 below for specifications.
- 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) which will prevent erosion.

3.1.6.2 Mulching (BMP C121)

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. An enormous variety of mulches is available. This section discusses only the most common types. The BMP suggests using mulch as a temporary cover measure as follows.

- For less 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 or polymers. Any mulch or tackifier product used must be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at the time of application.

3.1.6.3 Plastic Covering (BMP C123)

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas. The BMP stipulates that 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 six 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 $1.50-2.00 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.

3.1.6.4 Surface Roughening (BMP C130)

Surface roughening helps the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and traps sediment. A tiller or other suitable equipment is used on the contour to create horizontal depressions or slopes are left in a roughened condition by not fine grading them. This BMP is used in conjunction with others such as seeding, mulching, or sodding. The following conditions are stipulated for the use of this BMP.

- 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.

3.1.6.5 Dust Control (BMP C140)

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters. Dust control is used in areas (including roadways) that are subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely.

The project site is located west of the crest of the Cascade Mountains. Therefore, no soils will remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils would be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, as part of dust control, cut and fill slopes would be stabilized as soon as possible and soil stockpiles would be covered temporarily with plastic sheeting. All stockpiled soils would be stabilized to prevent erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

3.1.7 Element 6: Protect Slopes

All cut and fill slopes would be designed, constructed, and protected in a manner than minimizes erosion. The specific slope protection BMPs that may be used on this project include:

- Surface Roughening (BMP C130)
- Silt Fence (BMP C233)
- Compost Socks (BMP C235)

Table 19. Areas Requiring Slope Protection BMPs

Area	Surface Roughening	Silt Fence	Compost Sock
200 – Unloading & Office	-	-	-
300 – Storage	Required	-	-
400 – Marine Terminal	-	Required	Required
500 – Transfer Pipelines	-	-	-
600 – West Boiler	-	-	-
Rail Improvements	-	-	-

Area 300 – Storage

Slopes constructed for the containment area would be stabilized initially with surface roughening. The exterior of the slope would be permanently seeded and the interior of the containment area would be surfaced with granular surfacing.

Area 400 – Marine Terminal

Silt fencing would be installed along the top of the bank. The upland areas would be graded toward the bio-infiltration swales and away from the bank. Where the bank is not hardscaped with riprap slope protection, compost socks would be installed above the water level to protect slopes during construction.

Area 500 – Transfer Pipelines

There are no slopes within this Facility area; therefore, slope protection BMPs are not applicable.

Area 600 – West Boiler

There are no slopes within this Facility area; therefore, slope protection BMPs are not applicable.

Rail Improvements

There are no slopes within this Facility area; therefore, slope protection BMPs are not applicable.

3.1.7.1 Surface Roughening (BMP C130)

See description of surface roughening in section 3.1.6.4.

3.1.7.2 Silt Fence (BMP C233)

See description of silt fence in section 3.1.4.1.

3.1.7.3 Compost Sock (BMP C235)

See description of compost socks in section 3.1.3.3.

3.1.8 Element 7: Protect Drain Inlets

All storm drain inlets and culverts made operable during construction would 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 from entering storm drains until treatment can be provided. Storm drain inlet protection (BMP C220) would be implemented for all drainage inlets and culverts that could be impacted by sediment-laden runoff on and near the project site.

Table 20. Areas Requiring Storm Drain Inlet Protection BMPs

Area	Storm Drain Inlet Protection
200 – Unloading & Office	Required
300 – Storage	Required
400 – Marine Terminal	Required
500 – Transfer Pipelines	Required
600 – West Boiler	Required
Rail Improvements	Required

All Areas

All storm drain inlets within 500 linear feet of the facility, construction boundary, or laydown areas would receive inlet protection. Inlet protection would be the type indicated in the environmental control plan required for each type of inlet.

Storm drain inlet protection devices will be maintained for the duration of construction activities. Routing of collected stormwater downstream varies by site area, construction methods, and whether the work area is located within or nearby areas of known soil and groundwater contamination. Details regarding downstream stormwater routing and additional treatment are included in sections 3.1.5, 3.1.10, and 3.1.11.

3.1.8.1 Storm Drain Inlet Protection (BMP C220)

Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to the permanent stabilization of the disturbed area. Storm drain inlet protection would be used at inlets that are operational before permanent stabilization of the disturbed drainage area. Protection would be provided for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless runoff entering catch basins is conveyed to a sediment pond or trap.

Table 21 lists several options for inlet protection (Volume II – Construction Stormwater Pollution Prevention - August 2012, page 4-80). All of these methods tend to plug and require frequent maintenance. Drainage areas would be limited to one acre or less. Where stormwater ponding would cause a hazard, emergency overflows with additional end-of-pipe treatment can be provided if appropriate.

Table 21. Types/Conditions of Use of 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 will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area. Requirement: 30' X 30'/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		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			18-month expected life

3.1.9 Element 8: Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels, or discharged to a stream or some other natural drainage point, efforts would be made to prevent downstream erosion. The specific BMPs for channel and outlet stabilization that may be used on this project include the following.

- Channel Lining (BMP C202)
- Check Dams (BMP C207)
- Outlet Protection (BMP C209)

Table 22. Areas Requiring Channel and Outlet Stabilization BMPs

Area	Cutoff Channel Design Flowrate	Channel Lining	Check Dams	Outlet Protection
200 – Unloading & Office	23.3 cfs	Required	Required	-
300 – Storage	12.3 cfs	Required	Required	-
400 – Marine Terminal	-	-	-	Required
500 – Transfer Pipelines	-	-	-	-
600 – West Boiler	-	-	-	-
Rail Improvements	-	-	-	-

Cutoff swales for the facility were designed to convey the 25-year peak runoff flow rate. A gravel-lined swale was assumed using a manning's coefficient of 0.035. Calculations showed that a standard cutoff swale for the facility would be used. Additionally, it was assumed that each of the above areas requiring

cutoff channels would direct construction runoff to a minimum of two swales. The cutoff channel, when necessary, should be a minimum of 1.5 feet wide, with 3H:1V side slopes and be a minimum 1 foot deep. Cutoff channels will use channel lining and check dams to protect against erosion of the swale. Anticipated velocities at a minimum 1 percent slope are approximately 3.5 feet per second.

Areas 200 and 300

Cutoff channels would be installed along the downslope construction area to capture construction stormwater where existing site grading is insufficient to direct stormwater into conveyances for the construction stormwater. These channels would also be used to contain ground improvement runoff where necessary. Channel lining and check dams would be used to protect channel from erosion, and check dams to assist in flow control.

The construction laydown area south of the facility construction area will be unaltered by the project. The facility will use this area for staging and storage of materials. Surface water will be conveyed to stormwater inlets and discharged to the Terminal 5 lagoon to the west. Surface water that does not reach the conveyance system will be infiltrated as-is in the current condition.

Area 400 – Marine Terminal

The discharge from the stormwater treatment system would discharge into the bio-filtration swale. This would provide additional treatment prior to infiltration. Outlet protection would be installed to diffuse concentrated runoff and maintain existing vegetation.

Area 500 – Transfer Pipelines

There are no channels or outlets requiring BMPs in this area.

Area 600 – West Boiler

There are no channels or outlets requiring BMPs in this area.

Rail Improvements

Stormwater within the rail improvement corridor is conveyed to stormwater inlets and discharged to the Terminal 5 lagoon to the west. Surface water that does not reach the stormwater conveyance systems is assumed to infiltrate on site and through the rail ballast.

3.1.9.1 Channel Lining (BMP C202)

Channels can be protected by using either blankets or riprap as channel liners. Channel lining can be used as follows.

- When natural soils or vegetated stabilized soils in a channel are not adequate to prevent channel erosion.
- When a permanent ditch or pipe system is to be installed and a temporary measure is needed.
- In almost all cases, synthetic and organic coconut blankets are more effective than riprap for protecting channels from erosion. Blankets can be used with and without vegetation. Blanketed channels can be designed to handle any expected flow and longevity requirement. Some synthetic blankets have a predicted life span of 50 years or more, even in sunlight.
- Other reasons why blankets are better than rock include the availability of blankets over rock. In many areas of the state, rock is not easily obtainable or is very expensive to haul to a site. Blankets can be delivered anywhere. Rock requires the use of dump trucks to haul and heavy equipment to place. Blankets usually only require laborers with hand tools, and sometimes a backhoe.
- The Federal Highway Administration recommends not using flexible liners whenever the slope exceeds 10 percent or the shear stress exceeds 8 pounds per square foot.

3.1.9.2 Check Dams (BMP C207)

Section 3.1.3.1 describes check dams.

3.1.9.3 Outlet Protection (BMP C209)

Section 3.1.3.2 describes outlet protection.

3.1.10 Element 9: Control Pollutants

All pollutants, including waste materials and demolition debris, that occur on site will be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventive measures will keep the site clean, well-organized, and free of debris. The BMPs that would be implemented to control specific sources of pollutants in the various project areas are shown in the following table and discussed below.

Table 23. Areas Requiring Pollutant Control BMPs

Area	Concrete Handling	Sawcutting and Surface Pollution Protection	Material Delivery, Storage and Containment	Concrete Washout Area	Chemical Filtration	Filtration	pH Neutralization
200 – Unloading & Office	Required	Required	Required	-	Required	Required	-
300 – Storage	Required	Required	Required	Required	Required	Required	Required
400 – Marine Terminal	Required	Required	Required	-	Required	Required	-
500 – Transfer Pipelines	Required	-	-	-	-	-	-
600 – West Boiler	Required	Required	Required	Required	-	-	-
Rail Improvements	Required	Required	Required	Required	-	-	-

The above pollutant control table indicates in which areas pollutants of specific concern need to be addressed. Areas 200, 300, and 400 are of greatest concern to this construction SWPPP as they are the primary areas for laydown and storage of construction equipment and materials. Concrete washout facilities are being provided for the entire facility at Area 300. As a result, pH neutralization also would occur there. Washout water would be discharged to sanitary sewer. Higher levels of pollutant control through filtration and chemical filtration would occur at the major work sites, including areas 200, 300, and 400.

The Port conducted water quality sampling for two storms during 2013. The full results of this report are located in Appendix K. Construction activity was underway during the testing period at Farwest Steel. The results of this testing are used as the basis of design for the Facilities Turbidity Control BMPs. The results of the sampling and the resultant assumed basis of design are summarized in Table 24 below.

The basis of design for the pollutant parameters below were selected based upon the average observed during prior construction activities. The basis of design values were rounded up slightly to provide additional conservatism. Higher than average levels of zinc are not anticipated as the existing galvanized fencing on the facility site will be removed as part of construction. Additionally, no known sources of copper concentrations are known to occur on site.

Table 24. Construction Pollutant Control Basis of Design

Parameter	Sampling Data			Basis of BMP Selection and Design
	28 January 2013	28 February 2013	Average	
Total Cu (µg/L)	27.3	57	42.2	45.0
Dissolve CU (µg/L)	3.5	4.5	4.0	4.0
Total Zn (µg/L)	64.6	170	117.3	120.0
Dissolved Zn (µg/L)	<4.0	<4.0	<4.0	<4.0

Additional pollutants have been categorized on site within the Deed Restrictive Areas (see Figure 5). Excavations within and adjacent to these areas would proceed with a separate discharge location for excavation dewatering as described in section 3.1.11.

3.1.10.1 Concrete Handling (BMP C151)

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. This BMP would be used to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the state. These management practices would be used whenever concrete is used, such as in the following situations.

- Curbs
- Sidewalks
- Foundations
- Floors
- Marine Structures

3.1.10.2 Sawcutting and Surface Pollution Protection (BMP C152)

Sawcutting and surfacing operations generate slurry and process water that contain 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. Containment wattles or compost socks should be placed on the downslope side of work, and all slurry and debris resulting from this work shall be removed via vacuum from the construction area, and legally disposed of.

This BMP would be used to minimize and eliminate process water and slurry created through sawcutting or surfacing from entering waters of the state whenever sawcutting or surfacing operations take place. The following situations are among those when this BMP should be used.

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

3.1.10.3 Material Delivery, Storage, and Containment (BMP C153)

The discharge of pollutants to the stormwater system or watercourses can result from the delivery and/or storage of material. This BMP is intended to prevent, reduce, or eliminate the discharge of pollutants, and to implement it, the storage of hazardous materials on site would be minimized, the potentially hazardous materials would be stored in a designated area, and secondary containment would be installed.

Ecology specifies the use of this BMP 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)
- 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

3.1.10.4 Concrete Washout Area (BMP C154)

Performing washout off site, or installing a washout area off site, prevents or reduces the discharge of pollutants to stormwater from concrete waste and prevents pollutants from entering surface waters or ground water.

Ecology specifies the use of concrete washout area BMPs 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 trucks, pumpers, or other concrete coated equipment are washed on site.
- Note: If less than 10 concrete trucks or pumpers need to be washed out on site, the wash water may be disposed of in a formed area awaiting concrete or an upland disposal site where it will not contaminate surface or ground water. The upland disposal site must be at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.

3.1.10.5 Construction Stormwater Chemical Filtration (BMP C250)

Section 3.1.5.1 describes construction stormwater chemical filtration.

3.1.10.6 Construction Stormwater Filtration (BMP C251)

Section 3.1.5.3 describes construction stormwater filtration.

3.1.10.7 Control for High pH Water (BMP C253)

A pH level range of 6.5 to 8.5 is typical of most natural watercourses, and this pH range is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die. When pH levels in stormwater rise above 8.5, they must be lowered to the acceptable range of 6.5 to 8.5 through pH neutralization.

High pH levels at construction sites are most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (Section 3.1.10.1 of BMP C151 discusses concrete handling.) The principal caustic agent in cement is calcium hydroxide (free lime).Stormwater with pH levels exceeding water quality standards may be treated by infiltration, dispersion in vegetation or compost, pumping to a sanitary sewer, disposal at a permitted concrete batch plant with pH neutralization capabilities, or carbon dioxide sparging. Additional Ecology guidelines regarding carbon dioxide sparging are discussed in BMP C252 included in Appendix J and an alternative BMP.

3.1.11 Element 10: Control Dewatering

BMPs may be required to control dewatering. If that is the case, the BMPs that may be implemented include

- Construction Stormwater Chemical Filtration (C250)
- Construction Stormwater Filtration (C251)
- Weir Tanks (Custom BMP)

Table 25. Areas Requiring Dewatering Control BMPs

Area	Construction Stormwater Chemical Filtration	Construction Stormwater Filtration	Weir Tanks
200 – Unloading & Office	Required	Required	Required
300 – Storage	Required	Required	Required
400 – Marine Terminal	Required	Required	Required
500 – Transfer Pipelines	-	-	-
600 – West Boiler	-	-	-
Rail Improvements	-	-	-

Pollutant loadings for dewatering are assumed to be consistent with the runoff assumptions used in Sections 3.1.5 and 3.1.10. For construction excavations and dewatering within the environmental restrictive covenant areas, dewatering and groundwater will need to be stored in separate systems.

Stormwater or groundwater removed from these excavations would be pumped into a separate system of storage tanks. Stormwater generated in construction areas with known soil and groundwater contamination will be collected, treated, and disposed in accordance with an Individual Construction Stormwater NPDES permit. When full, the tanks would be tested for water quality, and if the water quality meets the surface water quality limits, the stormwater would be released into the construction stormwater system. If any pollutant limits exceed the surface water quality limits, the water would discharged into the City's sanitary sewer or be removed from the site by a licensed disposal company. Detailed discussion of soil and groundwater contaminates of concern, including MTCA, EPA, and Port Acceptance criteria, are described in detail in the CMMP as submitted under separate cover.

Dewatering and groundwater from Area 200 and the portion of Area 500 within the Environmental Restrictive Covenant Areas will need to be tested for the following pollutants of concern listed for both soil and groundwater to determine appropriate disposal methods for work near each of the following Deed Restrictive Areas.

Table 26. Summary of the Deed Restricted Areas at the Proposed Project Site

Area (see Fig 6)	Summary	Contaminants of Concern[4]		Regulatory or Cleanup Status
		Soil	Groundwater	
Ecology/ALCOA Consent Decree 95-2-03268-4				
Vanexco Cap	PCB impacted soil removal occurred in 1992. Groundwater monitoring from 1996 through 2001 indicated that groundwater is not affected by residual PCB impacted soils. The building foundations and floor slabs were left in place to form a cap over the contaminated soils as required by the Consent Decree. Approximately 4 feet of surface material was placed above the foundation and is sloped to provide drainage away from the area or the foundation is replaced with an impervious	PCBs – (concentrations up to 2,000 ppm left in soil and 16,000 ppm in concrete pit chip samples left in place after EPA approval in 1992) and hydraulic oil (greater than 2,000 ppm. 9 feet below the ground surface	No COCs detected (depth ranges from approximately 15 feet to 25 feet bgs)	Vanexco Cap

[4] Anchor Environmental LLC, 2008. "ALCOA/Evergreen Vancouver Site RI/FS"

Area (see Fig 6)	Summary	Contaminants of Concern[4]		Regulatory or Cleanup Status
		Soil	Groundwater	
	layer and stormwater control facilities are located above the layer.			
Ecology/ALCOA Consent Decree 92-2-00783-9				
Spent Pot Liner (SPL) Cap	A former EPA NPL site; 47,500 cubic yards of spent pot liner and reclaimed alumina insulation were removed in 1992. The residual affected soils were capped with a high-density polyethylene (HDPE) cover. In 2010 the Port of Vancouver placed a specially engineered double layered asphalt cap over the HDPE cover.	Cyanide (concentrations up to 491 mg/kg) and fluoride (concentrations up to 2,500 mg/kg) Potentially extending from the HDPE cover to approximately 15 feet bgs, the vertical point of compliance defined in the Final 2008 Corrective Action Plan	Fluoride (concentrations up to 27,500 ug/l)	Spent Pot Liner (SPL) Cap
Ecology/Evergreen Enforcement Order 4931				
Ingot Cap	Approximately 14,000 tons of brick, concrete, and soil were removed and the area was covered with 1 foot of soil. Subsequently the Port has placed additional material over the capped area to raise the site grade.	PCBs at concentrations less than 10 mg/kg are estimated to be present from 1 foot bgs to the depth of the groundwater surface, between approximately 15 and 25 feet bgs	None detected	Ingot Cap
Ecology/ALCOA Agreed Orders DE90-I053 and DE03 TCPIS-5737				
North/North 2 Landfill	In 2004 approximately 38,000 cubic yards of contaminated soil at the North/North 2 Landfill site was removed and the area was covered with 1 foot of sand.	Concentrations likely present up to the following industrial MTCA site soil clean levels: PCBs (up to 10 mg/kg),PAHs (20 mg/kg), VOCs (up to 0.03 mg/kg trichloroethylene [TCE]) (estimated to be present from 1 foot bgs down to at least groundwater level)	VOCs [vinyl chloride at 3.3 micrograms per liter (ug/l)], PAHs [benzo(a)-pyrene up to 0.30 ug/l] and PCBs (up to 2 ug/l) Groundwater level is estimated at 15 to 25 feet bgs.	North/North 2 Landfill

Area (see Fig 6)	Summary	Contaminants of Concern[4]		Regulatory or Cleanup Status
		Soil	Groundwater	
Ecology/ALCOA Consent Decree 09-2-00247-2				
East Landfill	Contaminated material from the South Bank and North/North 2 landfills were placed into the East Landfill in 2003. A multi-layer impermeable cap consisting of a geosynthetic liner and a clay layer covered with HDPE, a synthetic drainage net, a 19-inch layer of compacted fill soil, a 6-inch layer of soil and vegetation was placed over the East Landfill in 2004. The shoreline adjacent to the East Landfill was armored to provide long-term stability of the riverbank and engineered cap.	Lead, cyanide, fluoride, PCBs (concentrations exceeding 10 mg/kg), petroleum hydrocarbons, VOCs (concentrations potentially exceeding 0.03 mg/kg for TCE) and PAHs (concentrations potentially exceeding 20 mg/kg) (estimated present in soil below approximately 2 feet bgs)	VOCs: (TCE, vinyl chloride) (TCE concentrations up to 620 ug/L in the intermediate zone)	East Landfill
Ecology/ALCOA Agreed Order DE97 TCI032				
Northeast Parcel	In 1997 approximately 12,000 tons of contaminated soil were removed from the Northeast Parcel. Confirmation soil samples indicated that the site was remediated in accordance with MTCA Method A unrestricted use soil cleanup levels. The area was covered with clean fill compacted, graded for proper surface water drainage, and vegetated.	PCBs, metals, and PAHs (estimated to be present below groundwater depth at concentrations less than MTCA Method A CULs.	VOCs (vinyl chloride – 6.6 ug/l) Groundwater level is estimated at about 10 feet bgs (Hahn and Associates, 2013)	Northeast Parcel

Areas 200, 300, and 400

Dewatering from excavations within or adjacent to capped areas would be completed in accordance with provision set forth in Element 9. Excavation dewatering from all other areas would be pumped to weir tanks or construction conveyance channels or pipes. Excavation dewatering is typically sediment laydown and large sediments would be treated with weir tanks. Additional downstream filtration would consist (at a minimum) of sand filters. When necessary, chemical treatment (flocculent) would be added to verify compliance with water quality standards.

Areas 500 and 600 and Rail Improvements

Dewatering is not anticipated in these areas, therefore BMPs are not expected to be required in these facility areas. The relatively shallow depth of the proposed excavations in these areas is such that groundwater is not anticipated.

3.1.11.1 Construction Stormwater Chemical Filtration (BMP C250)

Section 3.1.5.1 above discusses construction stormwater chemical filtration.

3.1.11.2 Construction Stormwater Filtration (BMP C251)

Section 3.1.5.3 above discusses construction stormwater filtration.

3.1.11.3 Weir Tanks (Custom BMP)

Section 3.1.3.4 above discusses weir tanks.

3.1.12 Element 11: Maintain BMPs

All TESC BMPs would be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair would be conducted in accordance with the specifications of the particular BMP (attached in Appendix H). The BMPs would be monitored at least once every calendar week and within 24 hours of any stormwater or non-stormwater discharge from the site. If the site becomes inactive and is temporarily stabilized, the frequency of inspection would be reduced to once every month.

All TESC BMPs would be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment would be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation would be permanently stabilized.

3.1.13 Element 12: Manage the Project

Erosion and sediment control BMPs 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.
- Monitor the site thoroughly and maintain all erosion and sediment control measures.
- Schedule major earthwork during the dry season.

In addition, as this project site is located west of the crest of the Cascade Mountains, the project will be managed according to the phasing discussed in sections 3.1.13.1 through 3.1.13.5.

3.1.13.1 Sequencing of Construction

Construction is being phased to the extent practicable in order to prevent soil erosion and, to the maximum extent possible, the transport of sediment from the site during construction.

Revegetation of exposed areas and the maintenance of that vegetation will be integral to clearing activities during each phase of construction, per the scheduling BMP (C 162).

3.1.13.2 Seasonal Work Limitations

From 1 October through 30 April, clearing, grading, and other soil-disturbing activities will be permitted and wet-weather BMPs are proposed to contain and treat silt-laden runoff prior to discharge from the site. The following measures are in place to protect water quality during wet weather.

- Advanced turbidity and TSS treatment methods including weir tanks, sand filtration, and enhanced sand filtration;
- Existing site infrastructure and downstream water quality treatment located on Terminal 5, and the Marine Terminal area; and
- Proposed erosion and sediment control measures.

3.1.13.3 Coordination with Utilities and Other Jurisdictions

Project planners have coordinated with utilities, other construction projects, and the local jurisdiction in preparing this construction SWPPP and scheduling the construction work.

3.1.13.4 Inspection and Monitoring

All BMPs would be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections would be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person will have 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 CESCL would be on site or on call at all times.

As stated above, whenever inspection and/or monitoring reveal that the BMPs identified in this construction SWPPP are inadequate because of the actual discharge of, or potential to discharge, a significant amount of any pollutant, the CESCL will promptly initiate the implementation of one or more of the alternate BMPs listed in Appendix J.

3.1.13.5 Maintaining an Updated Construction SWPPP

This construction SWPPP will be retained on site or will be reasonably accessible to it.

The construction SWPPP will be modified whenever there is a change in the design, construction, operation, or maintenance of the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The construction SWPPP will 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 plan is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The plan will be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the plan will be completed within seven (7) days following the inspection.

The schedule of BMP implementation will be driven by the construction schedule. Table 27 is a sequential list of the proposed construction schedule milestones.

BMP implementation is keyed to proposed phases of the construction project, and reflects differences in BMP installations and inspections that relate to wet season construction. The project site is located west of the crest of the Cascade Mountains and the dry season therefore is considered to be from 1 May to 30 September and the wet season is considered to be from 1 October to 30 April.

Table 27. Preliminary Construction Schedule

Construction Milestone	Anticipated Milestone Date
Construction Start Date	January 4, 2016
Completion of Underground Utility Installation	May 1, 2016
Initial Site Stabilization	May 1, 2016
Commissioning of proposed stormwater system	May 1, 2016
Facility Operations Startup	June 1, 2016
Completion of Grading	July 1, 2016
Landscape Installation	July 1, 2016
Facility Tanks 1-4 Operational	February 1, 2017
Final Grading (Tanks 5-6)	February 1, 2017
Landscape Installation (Tanks 5-6)	March 1, 2017
Facility Tanks 5-6 Operational	November 1, 2017

4. Pollution Prevention Team

4.1 Roles and Responsibilities

The pollution prevention team consists of personnel responsible for implementing the construction SWPPP. They include the following persons.

- Certified Erosion and Sediment Control Lead (CESCL) – primary contractor contact, responsible for site inspections (BMPs, visual monitoring, sampling, etc.); to be called upon in case of failure of any ESC measures.
- Resident Engineer – For projects with engineered structures only (sediment ponds/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 Ecology Contact – individual to be contacted at Ecology in case of emergency.
- Emergency Owner Contact – individual that is the site owner or representative of the site owner to be contacted in the case of an emergency.
- Non-Emergency Ecology Contact – individual that is the site owner or representative of the site owner than can be contacted if required.
- Monitoring Personnel – personnel responsible for conducting water quality monitoring; for most sites this person is also the Certified Erosion and Sediment Control Lead[5].

4.2 Team Members

The following pollution prevention team members have been identified. The specific names and phone numbers will be provided prior to construction will be maintained current throughout Facility construction.

Table 28. Pollution Prevention Team Members

Title	Names(s)	Phone No.
Construction Project Manager and Emergency Owner Contact	TBD	(XXX) XXX-XXXX
Certified Erosion and Sediment Control Lead (CESCL)	TBD	(XXX) XXX-XXXX
Resident Engineer	TBD	(XXX) XXX-XXXX
Emergency Ecology Contact	TBD National Response Center Washington Emergency Management	(XXX) XXX-XXXX (800) 424-8802 (800) 258-5990
Non-Emergency Ecology Contact	TBD	(XXX) XXX-XXXX
Monitoring Personnel	TBD	(XXX) XXX-XXXX
Conveyance & Treatment System Operator and/or vendor	TBD	(XXX) XXX-XXXX
Contractor Project Managers	TBD	(XXX) XXX-XXXX
Equipment operators and construction personnel	TBD	(XXX) XXX-XXXX
All persons on site	TBD	(XXX) XXX-XXXX

[5] The Applicant recognizes that EFSEC may also provide an Environmental Monitor for the construction of the Facility at the Certificate Hodler's cost. Such Environmental Monitor will be added to the Pollution Prevention Team if requested by EFSEC.

5. 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 logbook. A site logbook will be maintained for all on-site construction activities and will include records of the following.

- Implementation of the construction SWPPP and other permit requirements
- Site inspections
- Stormwater quality monitoring

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

5.1 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 above in section 1.4 of this construction SWPPP.

Site inspection will occur in all areas disturbed by construction activities and at all 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 stormwater discharges. All maintenance and repairs will be documented in the site logbook or forms provided in Appendix L. All new BMPs or design changes will be documented in the construction SWPPP as soon as possible.

Preliminary monitoring points are identified in Figures 3 and 4. Discharge locations may vary throughout construction and final Facility design. Updates to the construction SWPPP will be maintained in accordance with section 6.1.4.

5.1.1 Site Inspection Frequency

Site inspections 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 frequency of inspection can be reduced to once every month.

5.1.2 Site Inspection Documentation

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

5.2 Stormwater Quality Monitoring

5.2.1 Turbidity

Turbidity sampling and monitoring will be conducted during the entire construction phase of the project. Samples will be collected daily at each monitoring point identified. If there is no flow at any location the attempt to sample will be recorded in the site logbook and reported to Ecology in the monthly discharge

monitoring report (DMR) as “No Discharge.” Samples will be analyzed for turbidity using the EPA 180.1 analytical method.

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. Verify all BMPs specified in this construction SWPPP are installed and functioning as intended.
2. Assess whether additional BMPs should be implemented, and document modified BMPs in the construction SWPPP as necessary.
3. Sample discharge daily until the discharge is 25 NTU or lower.

If the turbidity exceeds 25 NTU at any time, the following steps will be conducted:

1. Notify Ecology by phone within 24 hours of analysis (see section 1.4 for contact information).
2. Continue sampling daily until the discharge is 25 NTU or lower.
3. 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 maximum of 7 days.
4. Describe inspection results and remedial actions taken in the site logbook and in monthly DMRs as described in section 6.2.1.

5.2.2 pH

Sampling and monitoring for pH will occur during the phase of construction when concrete pouring will be conducted until fully cured (3 weeks from last pour) and discharges are documented to be below pH 8.5. Samples will be collected weekly at the sedimentation pond prior to discharge to surface water. Samples will be analyzed for pH using a calibrated pH meter and recorded in the site logbook.

The key benchmark pH value for stormwater is a maximum of 8.5. If a pH greater than 8.5 is measured in the sedimentation trap/pond(s) that has the potential to discharge to surface water, the following steps will be conducted:

1. Prevent (detain) all discharges from leaving the site and entering surface waters or storm drains if the pH is greater than 8.5
2. Implement CO_2 sparging or dry ice treatment in accordance with Ecology BMP C252.
3. Describe inspection results and remedial actions that are taken in the site logbook and in monthly discharge monitoring reports as described in section 6 of this construction SWPPP.

5.2.3 Contaminates of Concern

A CMMP has been prepared under separate cover to address contaminates of concern in areas of the site near existing landfill areas, caps, and addresses groundwater restrictive covenant on Terminal 5. Detailed testing methodologies and regulatory limits for these contaminates are provided in that report.

6. Reporting and Recordkeeping

6.1 Recordkeeping

6.1.1 Site Logbook

A site logbook will be maintained for all on-site construction activities and will include records of the following.

- Implementation of the construction SWPPP and other permit requirements
- Site inspections
- Stormwater quality monitoring

For convenience, the inspection form and water quality monitoring forms included in this construction SWPPP include the information that is required for the site logbook.

6.1.2 Records Retention

Records of all monitoring information (site logbook, inspection reports/checklists, etc.), this construction SWPPP, 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 anticipated permit conditions similar to Industrial Stormwater General Permit condition S5.C.

6.1.3 Access to Plans and Records

The construction SWPPP, Construction Stormwater Permit No. TBD, and site logbook 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 plan will be provided to Ecology within 14 days of receipt of a written request for it from Ecology. Any other information requested by Ecology will be submitted within a reasonable time. A copy of the construction SWPPP, or access to it, will be provided to the public when requested in writing in accordance with anticipated permit conditions similar to Industrial Stormwater General Permit condition S5.G.

6.1.4 Updating the Construction SWPPP

In accordance with anticipated permit conditions similar to Industrial Stormwater General Permit conditions S3, S4.B, and S9.B.3 of the General Permit, this construction SWPPP will be modified if it is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site or if 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 construction 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.

6.2 Reporting

6.2.1 Discharge Monitoring Reports

DMRs will be submitted to Ecology electronically. If there was no discharge during a given monitoring period, the Permittee will submit the form as required, with the words “no discharge” entered in the place of monitoring results. The due date of the DMR is 15 days following the end of each month.

6.2.2 Notification and Noncompliance

If any of the terms and conditions of the permit are not met causing a threat to human health or the environment, the following steps will be taken in accordance with anticipated permit conditions similar to Industrial Stormwater General 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 the results submitted to Ecology within five days of becoming aware of the violation.
3. A detailed written report describing the noncompliance will be submitted to Ecology within five days, unless requested earlier by Ecology.

Any time turbidity sampling indicates turbidity is 25 nephelometric turbidity units (NTU) or greater, Ecology’s regional office will be notified by phone within 24 hours of analysis as required by anticipated

permit conditions similar to Industrial Stormwater General Permit t condition S5.A (see section 1.4 above for contact information).

In accordance with anticipated permit conditions similar to Industrial Stormwater General Permit condition S4.F.6.b, Ecology's regional office will be notified if chemical treatment other than CO_2 sparging is planned for adjustment of high pH water (see section 0 above for contact information).

7. List of Acronyms and Abbreviations

Applicant: Tesoro Savage Petroleum Terminal LLC

AST: aboveground storage tank

bbl: barrel and barrels

BFE: Base Flood Elevation

bgs: belowground surface

BMPs: best management practices

bpd: barrels per day

BTEX: benzene, toluene, ethylbenzene, and xylenes

CESCL: Certified Erosion and Sediment Control Lead

CFR: Code of Federal Regulations

cfs: cubic feet per second

City: City of Vancouver

CMMP: contaminated media management plan

COCs: contaminants of concern

CRD: Columbia River Datum

DMR: discharge monitoring report

Ecology: Washington State Department of Ecology

EFSEC: Energy Facility Site Evaluation Council

EPA: U.S. Environmental Protection Agency

Facility: Vancouver Energy Terminal

FEMA: Federal Emergency Management Agency

FIRMs: Flood Insurance Rate Maps

GMA: Growth Management Act

gpm: gallons per minute

GRI: Geotechnical Resources, Inc.

HAZWOPER: hazardous waste operations and emergency response

HDPE: high-density polyethylene

MTCA: Model Toxics Control Act

NAVD: North American Vertical Datum

NEPA: National Environmental Policy Act

NGVD: National Geodetic Vertical Datum

NPDES: National Pollutant Discharge Elimination System

NTU: nephelometric turbidity unit

PAHs: polynuclear aromatic hydrocarbons

PBDE: polybrominated diphenyl ether

PCBs: polychlorinated biphenyls

Port: Port of Vancouver USA

PPE: personal protection equipment

RCW: Revised Code of Washington

RM 103.5: River Mile 103.5

SEPA: State Environmental Policy Act

SMMWW: Stormwater Management Manual for Western Washington

SWPPP: stormwater pollution prevention plan

SPL: spent pot liner

SR 501: State Route 501

TAP: toxic air pollutant

TCE: trichloroethylene

TESC: temporary erosion and sediment control

TSS: total suspended solids

USGS: U.S. Geological Survey

VOC: volatile organic compound

WAC: Washington Administrative Code

WDFW: Washington State Department of Fish and Wildlife

WVFA: West Vancouver Freight Access

WWHM: Western Washington Hydrology Model

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Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix A
Site Plan

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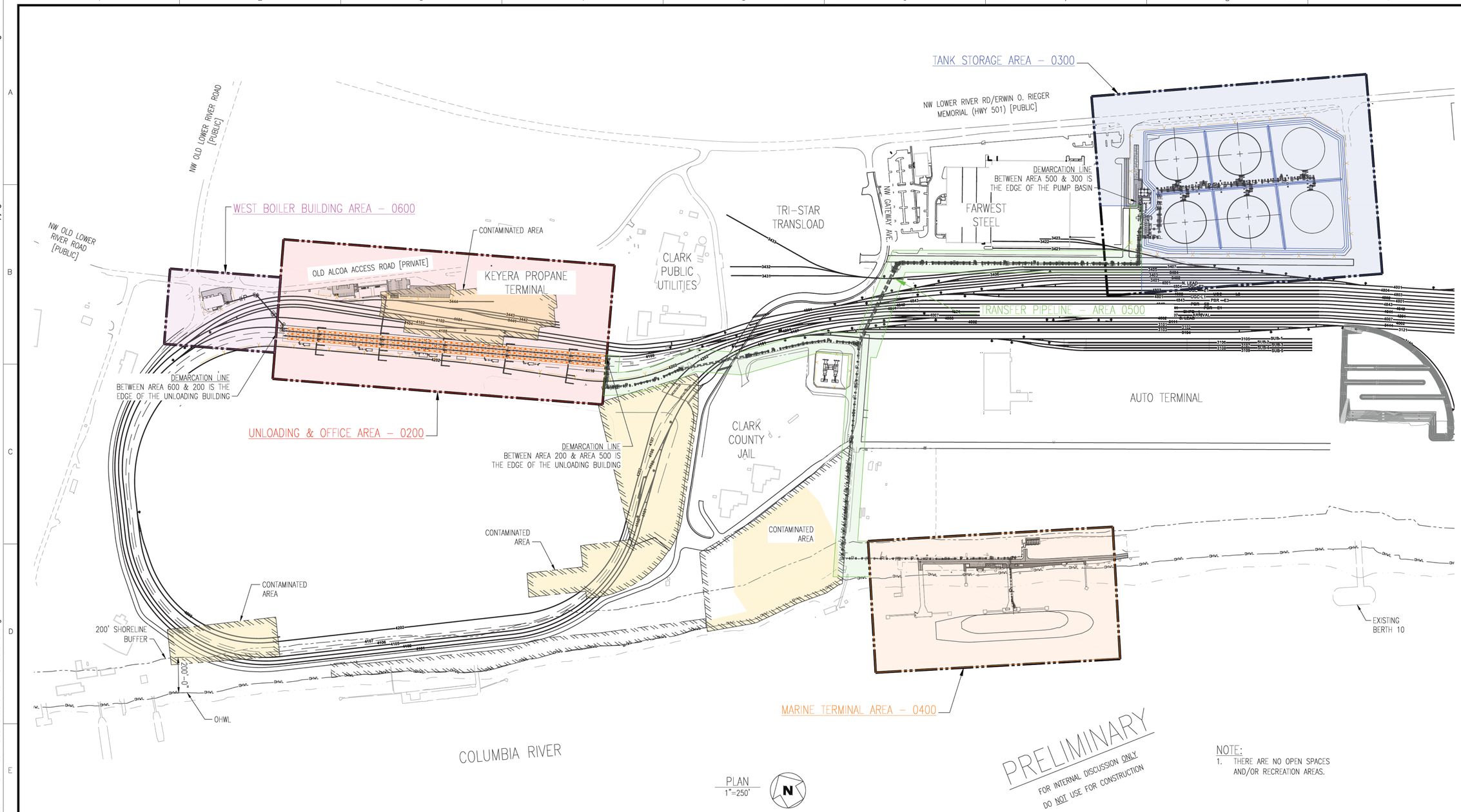

NOTE:
1. THERE ARE NO OPEN SPACES AND/OR RECREATION AREAS.

NO.	DATE	REVISION	BY	CK'D	APP

R&M ENGINEERING CONSULTANTS
SALT LAKE CITY, UTAH
(801)263-3419
13014

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: OVERALL SITE PLAN

DESIGN:		START DATE:	05-06-13	SCALE:	1"=250'
DRAWN:	JBH	PRINT DATE:	02-26-15	PROJECT MANAGER:	DC
CHECKED:		APPROVED:		SIAAE:	24x36
DRAWING NUMBER				SHEET	REV.
0100-SP-001				1/1	

Last Saved by: Jeff.hale on: Feb 26, 2015 10:36 AM File: W:\13014 Port of Vancouver\13014 Permit Site Plan.dwg

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Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

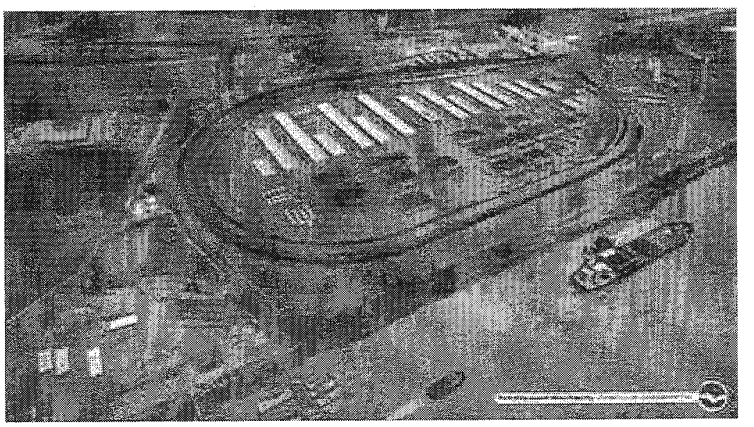
Appendix B
Existing Drainage Reports

West Vancouver Freight Access

Terminal 5 Expansion (4000A and SPL)

Final Hydrologic and Hydraulic Analysis Report

Case Number ENG2012-00016
Project PRJ2012-00414



Revision 1: May 3rd, 2012

PORT OF VANCOUVER U.S.A.

Prepared by:
HDR Engineering, Inc.
1001 SW Fifth Ave, Suite 1800, Portland, Oregon 97204

HDR

TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**

1.0 PROJECT OVERVIEW **2**

1.1 Site Description 2

1.2 Existing Conditions 2

1.3 Proposed Design 2

1.3.1 Full Build-Out 3

1.3.2 Phases of the T5 Expansion: 4000A and SPL 3

1.4 Conveyance System Analysis and Design 4

1.5 Drainage to and from Adjacent Properties 5

1.6 Downstream Boundary Condition 5

2.0 CONVEYANCE SYSTEM MODELING **5**

2.1 Model Development 5

2.2 Pipe Capacity 6

LIST OF APPENDICES

Appendix A. Project Figures

Figure 1. Vicinity Map

Figure 2. USGS Map

Figure 3. NRCS Soils Map

Figure 4. Port of Vancouver Terminal 5 Vicinity Floodplain Map

Figure 5. 25-Year and 100-Year 24-Hour Isopluvials

Figure 6. Existing Stormwater System

Figure 7. T5 Expansion Proposed Stormwater System

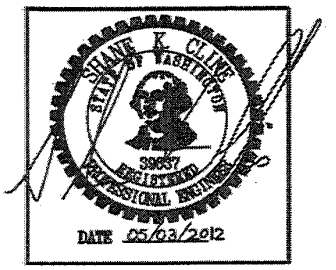
Figure 8. 4000A and SPL Pipe Alignments

Figure 9. Basin Map for Terminal 5

Appendix B. Hydrology Calculations

Appendix C. Hydraulic Calculations

Figure C1. Hydrograph Showing 100 Year Flow Rate Through Outfall Pipe to the Columbia River



EXECUTIVE SUMMARY

This report provides the stormwater system design and hydrologic and hydraulic analysis information for the Terminal 5 (T5) Expansion, part of the West Vancouver Freight Access (WVFA) Project (Project) located at the Port of Vancouver (Port), Washington.

The Project will expand the capacity of the rail system in order to reduce track congestion. Currently, stormwater runoff either infiltrates directly into the ground or is collected by an existing stormwater system and treated at the T5 lagoons. Quantity treatment or detention of stormwater will not be required on the Project because all stormwater at the Port is discharged to the Columbia River, which is an exempt water body with respect to quantity treatment.

The T5 Expansion will relocate existing tracks and construct a new perimeter access road around the outside of the track loop. Several crossings will be constructed to allow vehicular access to the inside of the track loop. New lighting and electrical conduit will be installed and multiple casings will be placed under the shifted tracks. A new tenant, Broken Hill Proprietary Billiton (BHPB), will be performing extensive site improvements at T5 beginning in the summer of 2012. These site improvements will include construction of a potash storage and transfer facility, rail dumper pit, and a ship loading facility. The stormwater design for T5 is intended to prepare the terminal for the construction associated with these site improvements.

The T5 Expansion will be constructed in phases to facilitate coordination with other projects on the site and reduce the impact of construction issues associated with groundwater. The 4000A project is the first phase of the T5 Expansion during which a portion of the complete stormwater system will be completed. The remainder of the stormwater system will be constructed during the next phase called the SPL Project. The second phase includes addition of a pump station and wet well, which will pump the water quality flow rate to the T5 lagoons. The stormwater system will not be operational during the end of the 4000A project (when the existing system is decommissioned) and during the beginning of the SPL Project (when the new stormwater system is completed).

HDR's stormwater design for the Project includes re-routing of the existing stormwater system so that the pipes do not cross the new tenant's lease area, additional stormwater infrastructure associated with roadway improvements, and a connection from BHPB's lease area to discharge treated stormwater to the existing outfall. The existing outfall will be used to discharge overflows from other portions of T5, as well as the BHPB's treated runoff, to the Columbia River. The SPL Project includes a rehabilitation of this existing outfall using a cured-in-place pipe lining method.

1.0 PROJECT OVERVIEW

1.1 Site Description

The Port's WVFA project will construct approximately 3.2 miles of new rail line to expand its rail capacity within the existing facility and relieve track congestion. Overall, the goals of the WVFA project are:

- Expand the Port rail capacity and operations within the existing Port facility;
- Relieve congestion and ensure continued safe operations as rail traffic expands in the Port and along the existing north-south and west-east main lines; and
- Minimize disruption to existing Port tenants and businesses while enhancing the rail system for future growth.

The Project site starts approximately 1,200 feet east of the Columbia River Rail Bridge, extends approximately 3.2 miles west, and ends just before the intersection of N.W. Old Lower River Road. Figures 1 and 2 provide the project location. The Port has filled the floodplain with dredge spoils which are the top layer of soils for much of the project area.

This report evaluates impacts to stormwater drainage resulting from the 4000A and SPL Projects of the T5 Expansion, associated with the full build-out of T5.

1.2 Existing Conditions

T5 currently consists of a track loop which was recently cleared to provide a graded surface for windmill turbine parts storage. The graded area is mostly compacted gravel with minimal paved roadways, several environmental caps, and a stormwater catchment and conveyance system composed of both recently constructed and older components. A trunkline collecting all of the flow conveys runoff to an existing pump station which operates as a temporary solution at this time. No power is currently routed to the existing pumps, so a generator is parked adjacent to the pump station. This generator must be manually activated to power the pumps so that water can be routed to the T5 lagoons west of the track loop.

Overflows are routed to a diversion box that spills into the outfall to the Columbia River. This system as a whole, including the T5 lagoons, was designed to drain and treat the terminal in its past condition, which included significantly more impervious pavement and roofing. Since most of the Terminal is now surfaced with gravel, the pumps are rarely activated. Figure 6 shows the layout of the existing system.

The T5 Lagoons were designed to treat industrial process water and stormwater for Terminal 5. The total area draining to the lagoons was over 130 acres when the site was used for aluminum industry related purposes.

1.3 Proposed Design

The Project includes relocation of existing tracks, construction of a new perimeter access road around the outside of the track loop and several crossings for vehicular access to the inside of the track loop, and installation of several utilities. The Port's new tenant, BHPB, will be performing extensive site improvements including construction of a

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potash storage and transfer facility, rail dumper pit, and a ship loading facility. The stormwater design for T5 is intended to provide drainage for the future build-out of T5.

The proposed stormwater system needs to satisfy the City of Vancouver's stormwater management requirements, which are based on the Department of Ecology's 2005 Stormwater Management Manual for Western Washington (SMMWW) for design of water quality treatment facilities. These requirements include the need to treat runoff from new pollutant generating impervious surfaces (PGIS) to a "basic treatment" level. Detention is generally also a consideration, but due to the Project's proximity to the Columbia River, detention is not required. Since detention is not necessary, the Soil Conservation Service Unit Hydrograph Method was used for hydrology calculations. Standards, codes, and guidelines for conveyance are as per The City of Vancouver Engineering Services General Requirements and Details 2009 (GRD) and the American Railway Engineer and Maintenance-of-Way Association Manual for Railway Engineering 2007 (AREMA).

1.3.1 Full Build-Out

The proposed fully built-out system replaces any stormwater infrastructure that lies within the future BHPB lease and routes the trunkline around this property. Additional stormwater inlets are placed along a new perimeter access road that encircles much of the track loop. The trunkline structures are mostly WSDOT Manhole Type III with a few WDSOT Catch Basin Type II structures. WSDOT Catch Basin Type I structures are used for the lateral inlets. The pipe network consists of mostly corrugated polyethylene stormwater sewer pipes (CPSSP) with ductile iron sewer pipes and reinforced concrete pipes at a few locations. The stormwater system drains to a new wet well and pump station location outside of the track loop at the southwest portion of the Terminal. A 30-inch force main will connect the proposed pump station to the T5 lagoons.

1.3.2 Phases of the T5 Expansion: 4000A and SPL

The construction of the stormwater system needs to be completed in phases due to constructability constraints. Stone columns will be installed as part of another project at T5. This stone column work is expected to cause settlement which could damage any infrastructure nearby. Hence, these stone columns must be in place before subsurface infrastructure can be placed in their vicinity. In addition, high groundwater and the degree of contamination of the groundwater will increase the cost and duration of any construction that requires excavation. In consideration of these constraints, the stormwater conveyance system for the Project will be constructed in two phases: the 4000A Project and the SPL Project.

The proposed stormwater system has been divided into seven alignments (Alignments A through G). The 4000A Project will include construction of Alignments A, B, C, and D (See Figure 7). Alignment A drains the T5 perimeter access driveway from the intersection with Old Lower River Road to the proposed pump station. Alignment B drains a portion of the T5 perimeter access driveway to the east and a portion of T5 inside the track loop. Alignment D provides the connection to the BHPB stormwater system (which has its own, separate, water quality treatment facility) and allows it to drain directly to the existing outfall. Alignment C is a single pipe connecting the inside of the track loop to Alignment A. The components constructed in the 4000A project are discontinuous and will not be operational until the remainder of the stormwater system is completed in the next phase. The existing stormwater system will remain operational as long as is reasonably possible considering construction logistics. In addition, the Port is

prepared to pump and treat water from the non-operational system as needed while there is no connection to the T5 lagoons or the existing outfall.

The SPL Project is the second phase which will include construction of the remaining portions of the stormwater conveyance system including Alignments E, F, and G and the proposed wet well and pump station connecting the system to the T5 lagoons (see Figure 7). Alignments E and F drain portions of the T5 perimeter access driveway. Alignment G, which forms a connection between Alignments B and C, drains a portion of T5 inside the track loop. The SPL contractor will be responsible for pumping and treating water in the non-operational system as soon as they are mobilized. This contractor will also be required to complete construction of the operational stormwater system by September 30th, 2012.

The existing outfall will remain in service with the new upstream connection as part of the 4000A and SPL Projects. The outfall will be rehabilitated as part of the SPL Project. This work will include removal of a portion of the outfall pipe that extends into the Columbia River, and a new liner in the outfall pipe that will improve structural integrity while maintaining adequate conveyance capacity.

1.4 Conveyance System Analysis and Design

The Port's new tenant, BHPB, will treat their own stormwater and discharge the flows to the existing outfall through a connection to the proposed stormwater system. This accounts for approximately 40 acres of drainage area. While some additional area on the perimeter of T5 will drain to the T5 lagoons through the proposed pump station, the total contributing drainage area from T5 to the lagoons will be reduced from over 130 acres in the existing scenario to approximately 91 acres. BHPB has estimated the peak flow rate for their property to be 24 cubic feet per second (cfs) for the 25-year storm event and 30 cfs for the 100-year storm event; the downstream stormwater system has been designed with consideration of this input.

This pump station is designed to pump the water quality flow rate to the T5 lagoons. The water quality flow rate has been calculated to be 9 cfs based on the drainage area of 91 acres using MGS Flood and assumes fully impervious, fully built-out conditions (see Appendix B). The complete T5 Expansion proposed stormwater system is shown in Figure 6.

Due to the long runs of pipe and the desire to keep portions of the system elevated as high as possible (such as the pump station wet well), the system has been designed *without* the usual 0.2-foot drop per structure. Backflow prevention valves are proposed in structures just downstream of the overflow structure and where the connection is made to the BHPB storm line. These valves will be elastomer duckbill-type valves that will help reduce flooding inside the track loop during extremely high flows in the Columbia River. Due to the possibility of high groundwater and a relatively empty stormwater system because of the backflow prevention valves, all manholes and catch basin type II structures have been designed with counter buoyancy bases.

All the alignments except Alignment D (connection between the BHPB drainage system and the existing outfall) will drain to the proposed pump station which is designed to pump out the water quality flow. The pipes between the existing outfall pipe and the proposed pump station are designed to flow full before the outfall is utilized. In the event that the inflow rate of stormwater runoff into the system exceeds the pump station

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pumping rate, flow in the pipeline between the pump station and the outfall will back up and discharge to the outfall while the pump station continues to pump the water quality flow rate. This allows the use of a portion of the pipe system as additional storage beyond the wet well. This reduces the number of required pump operation cycles and precludes the need for an additional storm line from the proposed pump station to the existing outfall.

1.5 Drainage to and from Adjacent Properties

The Port's facility and adjacent properties are mostly built-out and already have stormwater infrastructure installed. Offsite drainage improvements have been developed by tenants as separate projects; therefore, no offsite contributions of surface runoff are anticipated for the projects discussed here.

1.6 Downstream Boundary Condition

The two downstream boundary elements of the T5 stormwater conveyance system are the existing 36-inch outfall pipe discharging into the Columbia River and the proposed 30-inch force main between the new pump station and the T5 lagoons. The hydraulic capacity of the existing outfall pipe has been conservatively estimated to be at least 120 cfs which exceeds the maximum anticipated flow rate. The proposed pump station has been designed to pump the water quality flow rate through the 30-inch force main to the T5 lagoons.

2.0 CONVEYANCE SYSTEM MODELING

2.1 Model Development

A hydrologic and hydraulic model was developed using Bentley CivilStorm V8i to determine peak flow rates and size the conveyance system for the full build-out of the T5 Expansion. This model considers existing infrastructure that will remain in place and future infrastructure that is anticipated as part of the complete T5 Expansion project, as well as other future infrastructure that is not part of the T5 Expansion but will contribute to total runoff from the system. The model also assumes that all areas except track alignments are paved with impervious asphalt.

Civilstorm successively runs the hydrologic and hydraulic analysis. Rainfall depths for the 25-year, 24-hour and 100-year, 24-hour storm events were obtained from isopluvials for the state of Washington from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2 (See Figure 2). The SCS Type-1 rainfall distribution was used for the project location. The Soil Conservation Service (SCS) Unit Hydrograph was used for the hydrology calculations. Curve numbers for the catchments were estimated using the data provided in Table 2.2 of the 2005 SMMWW Volume III; all curve numbers are 98 assuming full build out and paving for the entire terminal except on areas occupied by railroad tracks. Appendix B provides the curve number information and hydrologic modeling results for the T5 Expansion stormwater system. All times of concentration were assumed to be five minutes with the exception of two basins that have longer than typical flowpath lengths and the basin which will be occupied by the mining company. The time of concentration for this basin is adjusted such that the modeled peak flow rate matches the peak flow rate estimated by others and provided to HDR. Table B1 only

shows basin results for basins that drain to new structures and pipes constructed as part of the Terminal 5 Expansion project. Other basins shown in Figure 9 drain to existing or proposed structures and pipes.

2.2 Pipe Capacity

The 25-year storm event was used to determine if each pipe has sufficient capacity and the 100-year storm event was used to check for surcharging of structures. The modeling results presented in this report represent fully built-out conditions of the proposed stormwater conveyance system in T5 (See Appendix C).

Velocities in some of the pipes in the system may not meet flushing velocity requirements per the City of Vancouver's requirements, but the Port has been made aware of this and is prepared to increase maintenance activities as required. Due to modeling limitations in CivilStorm, the pump station has not been included in the model. This approach is conservative, as the pump station would in reality be pumping a constant 9 cfs out of the stormwater system before the flows back up in the pipe system and discharge to the existing outfall. In some cases, modeling results show that the existing pipes do not have sufficient capacity. This could be attributed to conservatism in the model or, in other cases, limitations of the model in representing the pipe systems accurately. In particular, some of the existing pipes are perforated pipes installed at a very shallow slope, and are designed to flow full. Since the model does not accommodate perforated pipes, they have been modeled as solid pipes with an inlet upstream. The lack of capacity shown in the model results is not due to insufficient downstream conveyance capacity. These pipes are designed by others and already exist at Terminal 5.

Figure C1 shows the hydrograph for the 100 year event through the outfall pipe to the Columbia River. The peak flow rate is 94 cfs. Note that this is assuming that the pump station is not in operation since the model does not account for the water quality flow rate being pumped to the T5 Lagoons. The final outfall pipe maximum capacity depends on the methods used to reline the pipe in the future. The current capacity of the pipe is estimated to be approximately 114 cfs. The pipe will be relined in the SPL Project. With a smoother interior but reduced diameter, the future maximum capacity of the pipe is estimated to be 120 cfs.

In conclusion, the modeling results indicate that the stormwater system design functions as intended to accommodate the 25- and 100-year storm events using conservative modeling techniques.

APPENDIX A

Project Figures

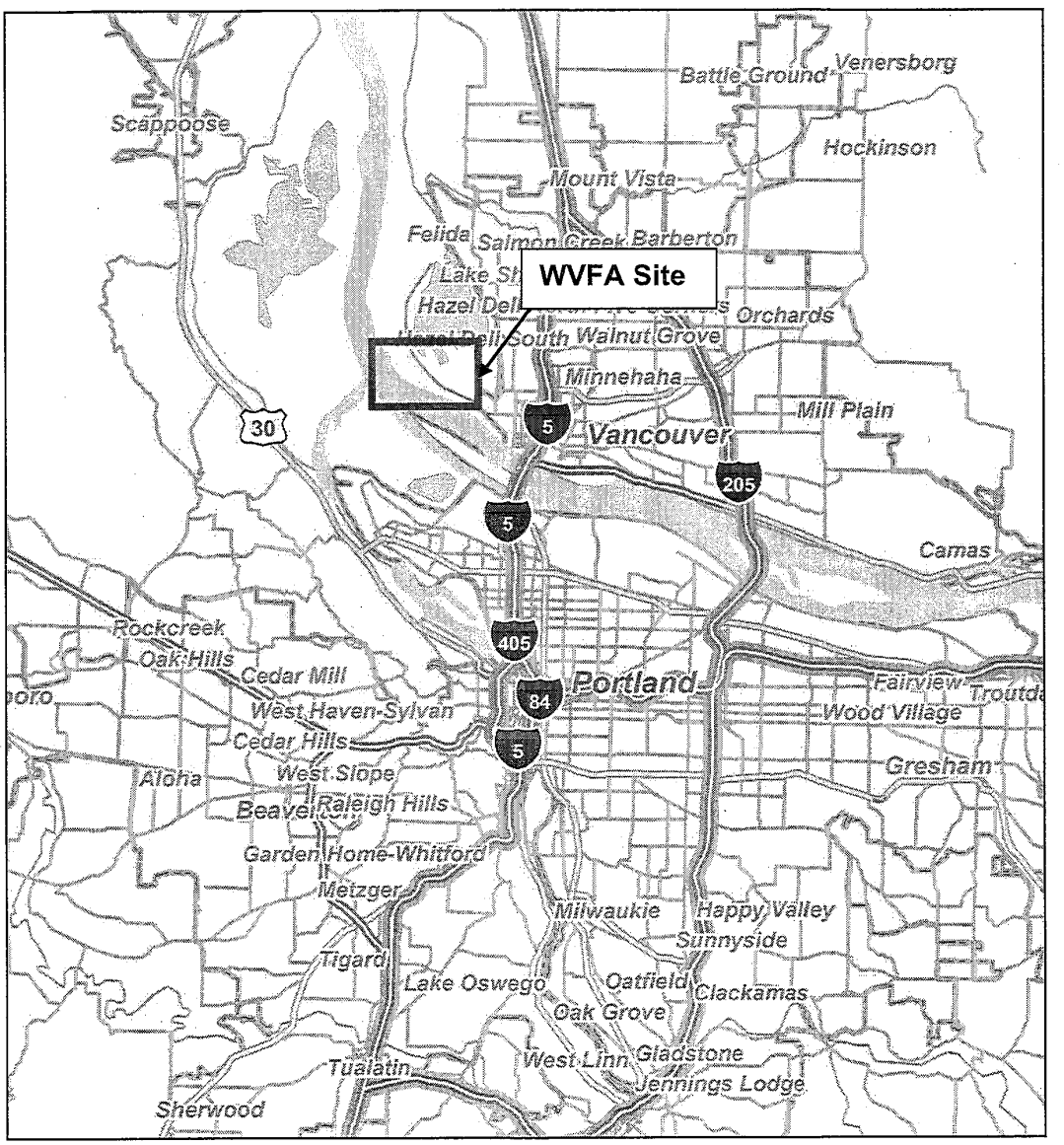
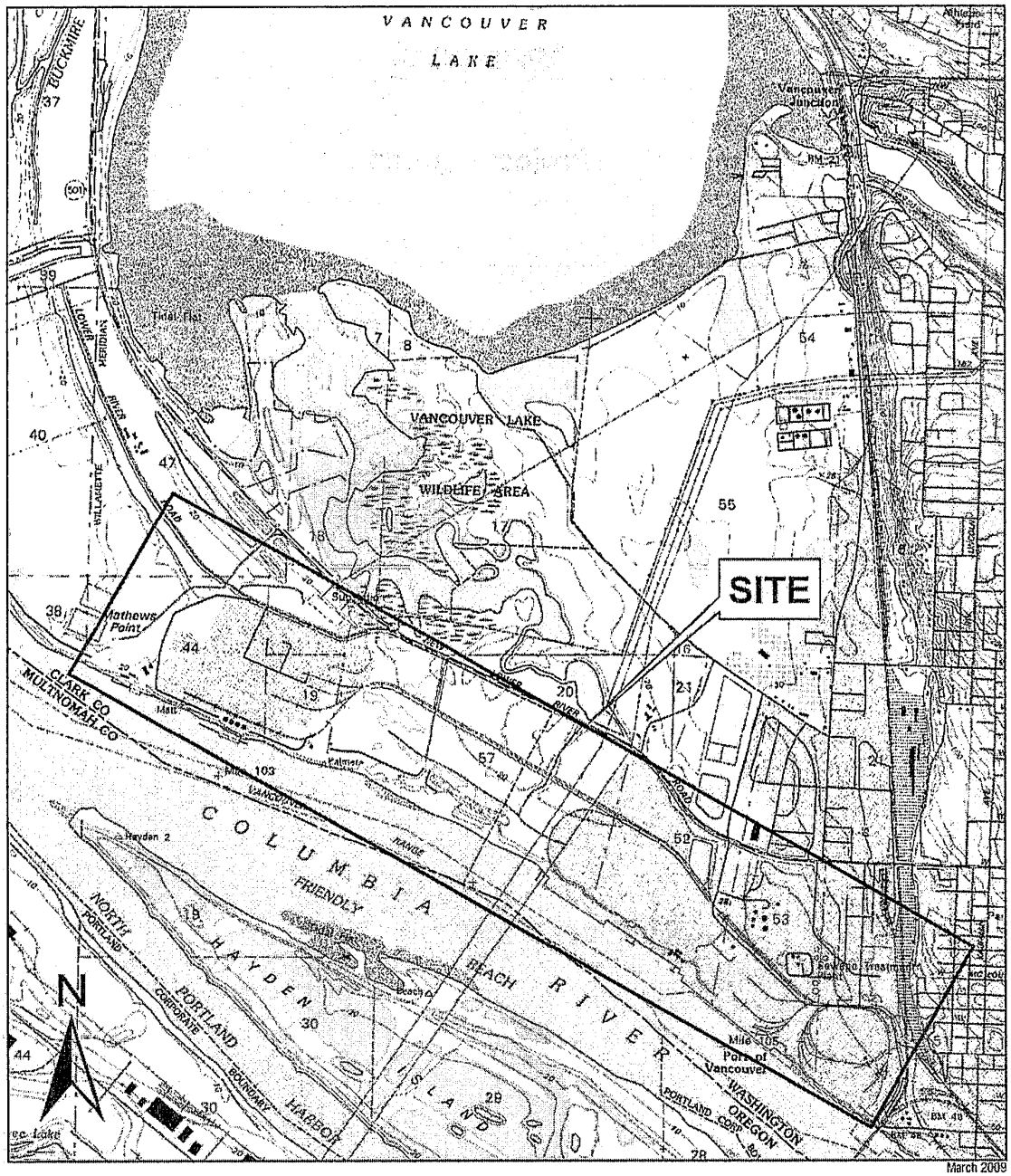


Figure 1. Vicinity Map



March 2009

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SOURCE: USGS VANCOUVER, WA
TOPOGRAPHIC QUADRANGLE

Port of Vancouver | Freight Access

Figure 2. USGS Map

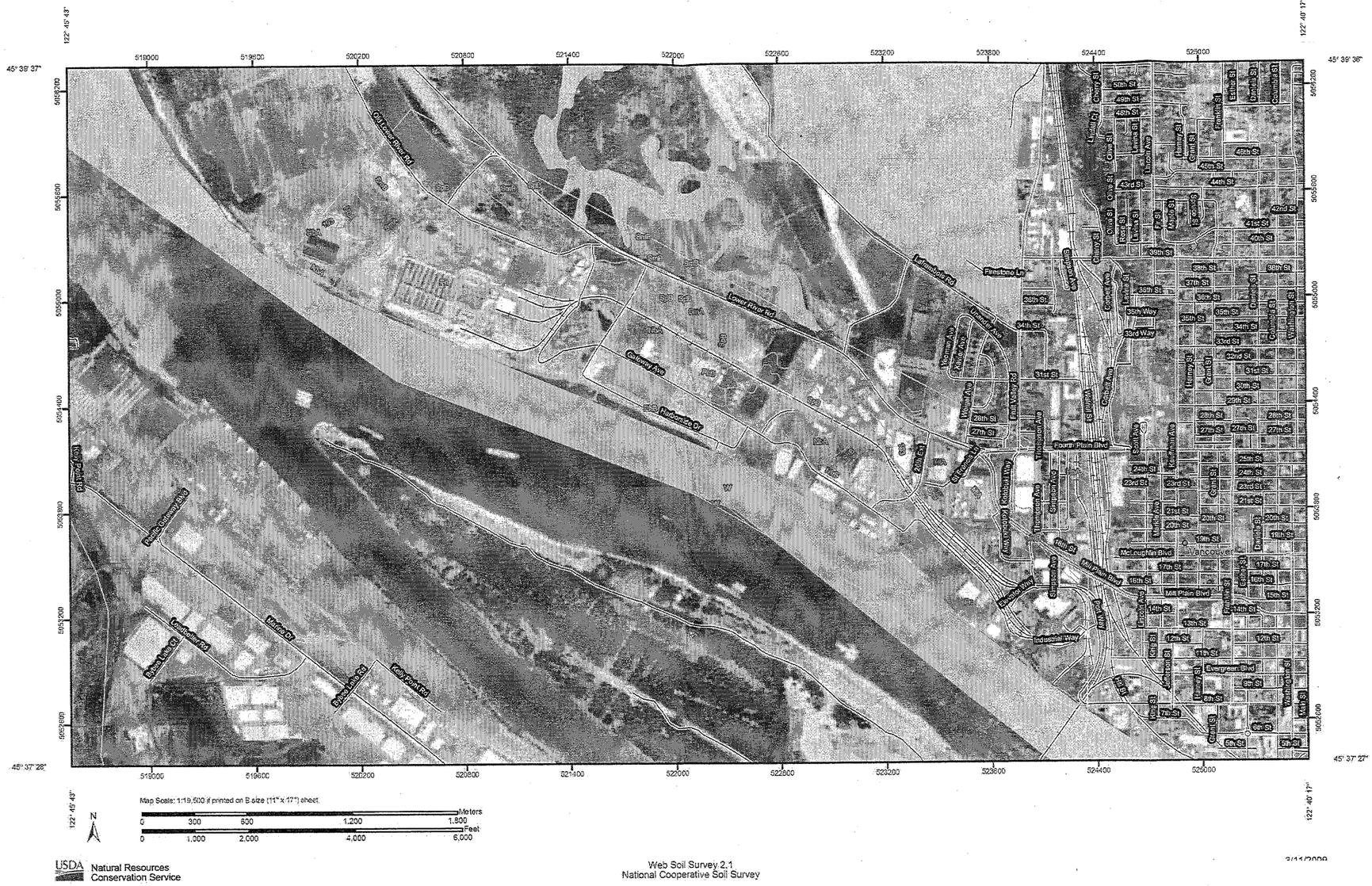


Figure 3. NRCS Soils Map

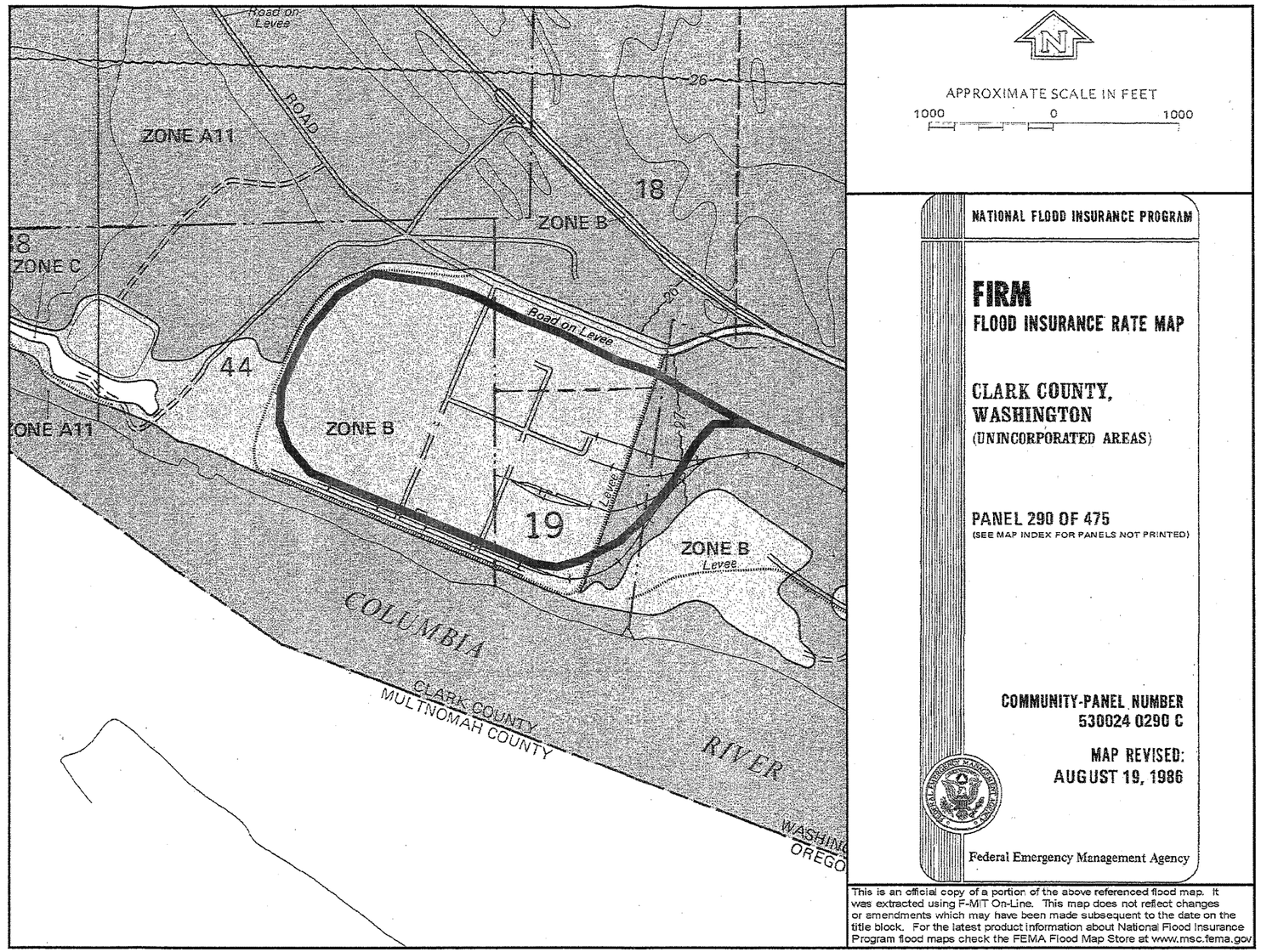
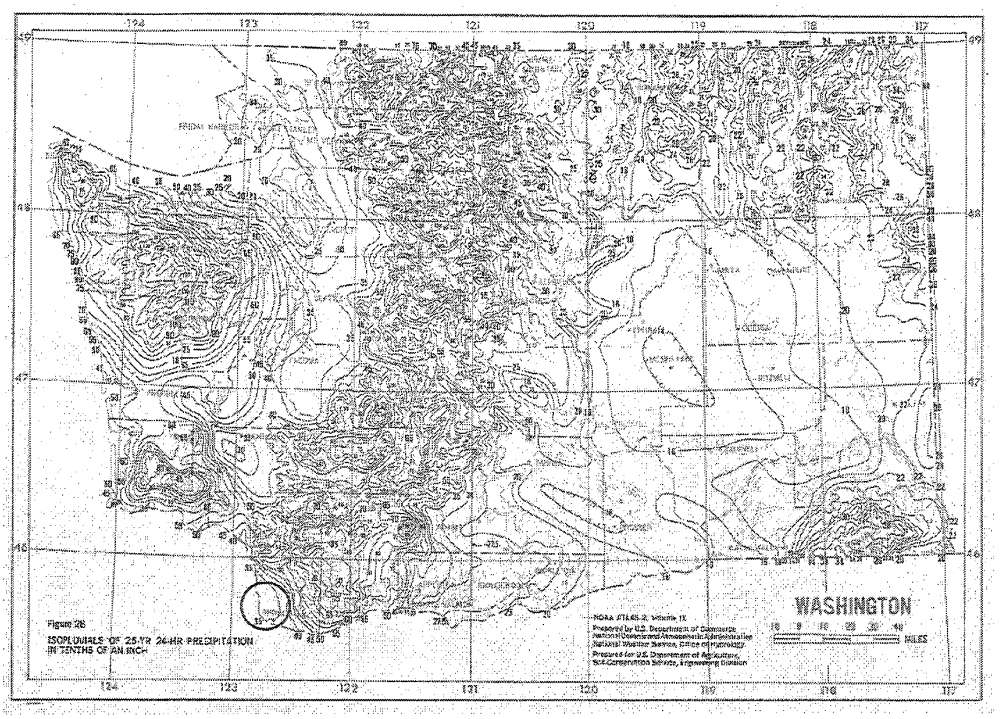


Figure 4. Port of Vancouver Terminal 5 Vicinity Floodplain Map

Key for NRCS soils map:

Clark County, Washington (WA011)	
Map Unit Symbol	**Map Unit Name**
193	Miscellaneous water
Fn	Fill land
HlA	Hillsboro silt loam, 0 to 3 percent slopes
HlB	Hillsboro loam, 3 to 8 percent slopes
HoA	Hillsboro silt loam, 0 to 3 percent slopes
MlA	McBee silt loam, coarse variant, 0 to 3 percent slopes
NbA	Newberg silt loam, 0 to 3 percent slopes
NbB	Newberg silt loam, 3 to 8 percent slopes
PhB	Pilchuck fine sand, 0 to 8 percent slopes
SmA	Sauvie silt loam, 0 to 3 percent slopes
SmB	Sauvie silt loam, 3 to 8 percent slopes
SpB	Sauvie silty clay loam, 0 to 8 percent slopes
W	Water



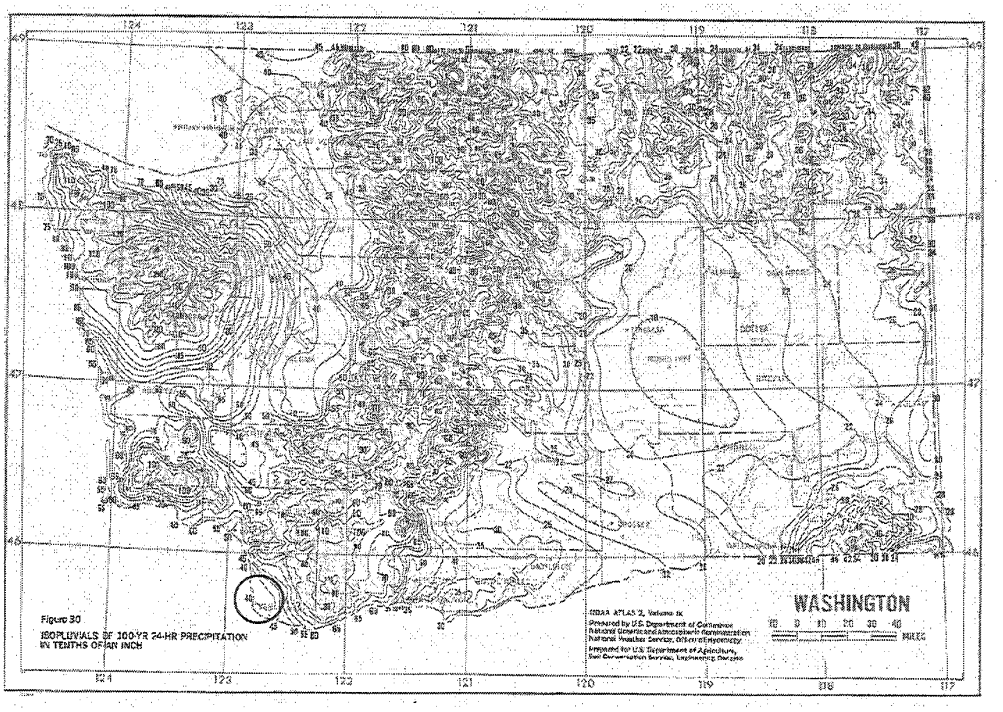


Figure 5. 25-Year and 100-Year 24-Hour Isopluvials

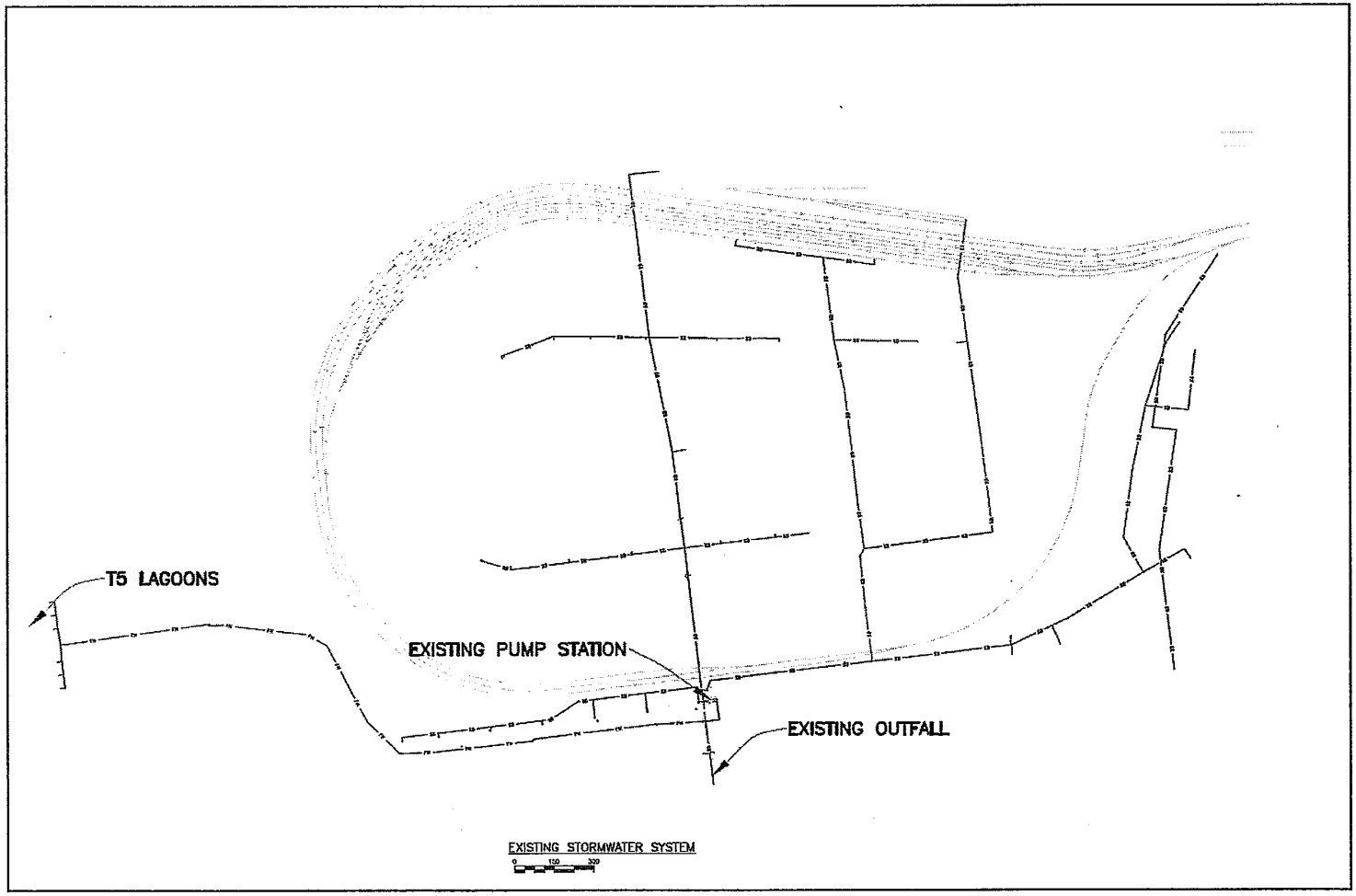


Figure 6. Existing Stormwater System

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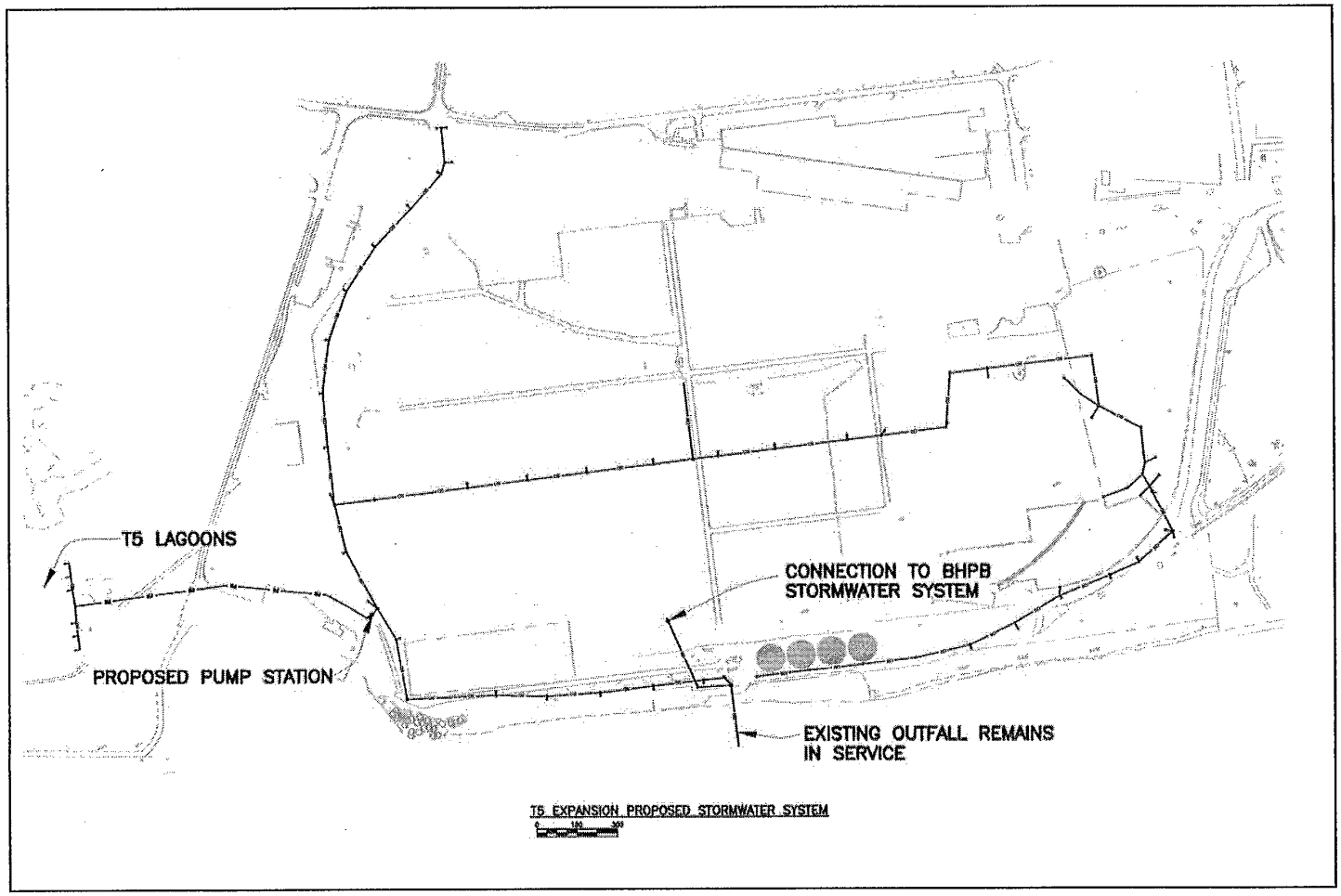

Figure 7. T5 Expansion Proposed Stormwater System

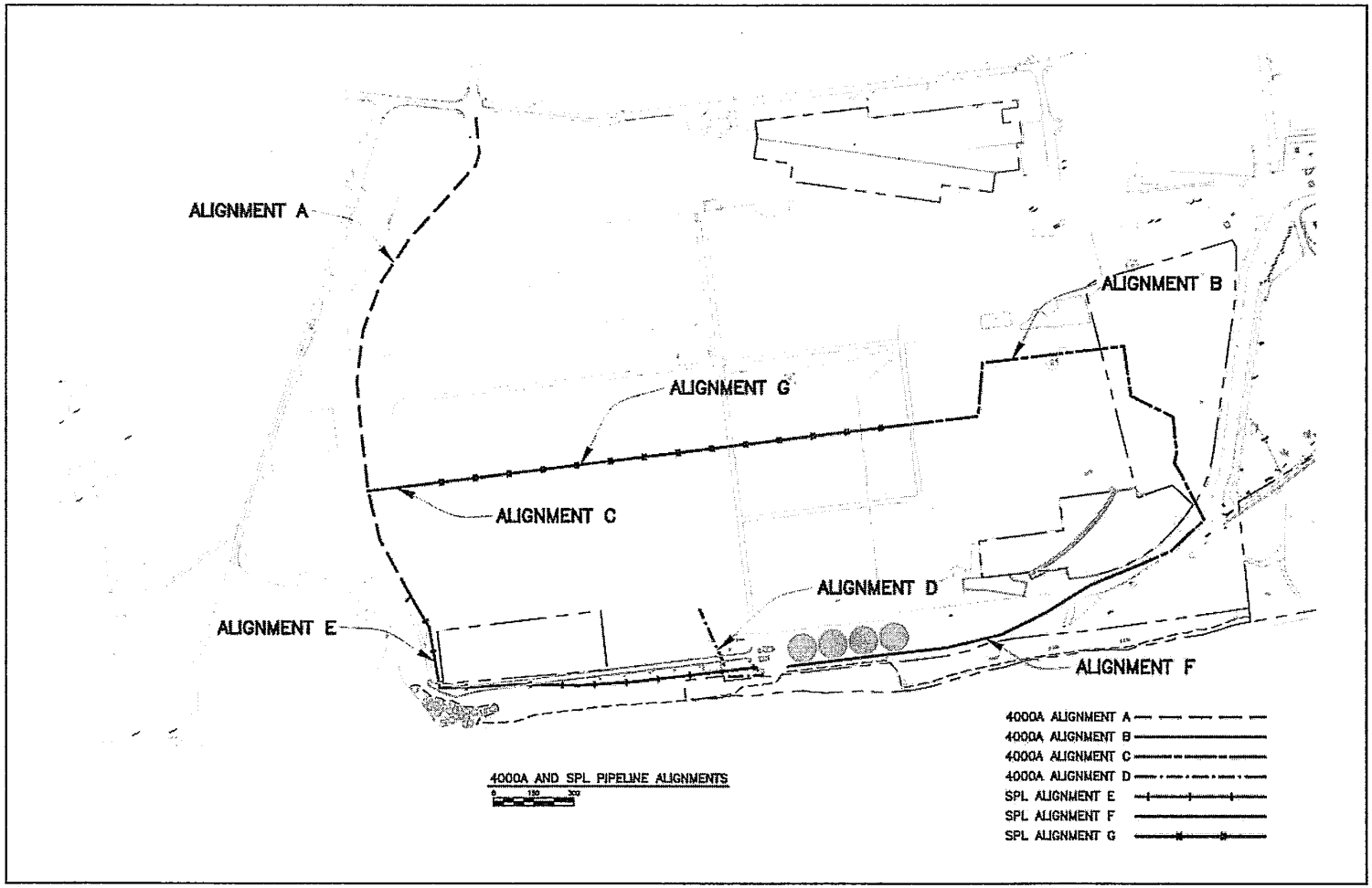

Figure 8. 4000A and SPL Pipe Alignments

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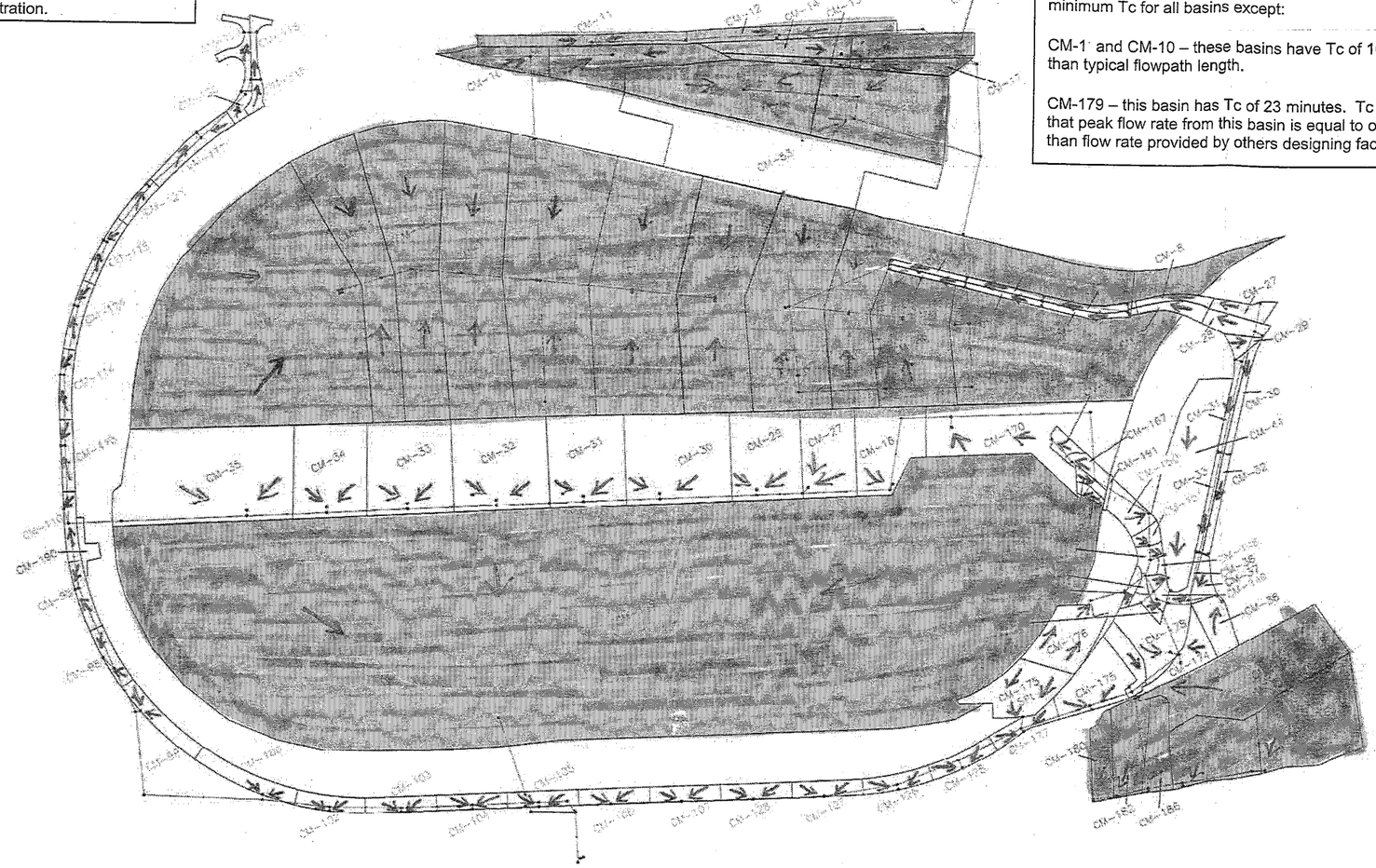
See table B1 for basin parameters such as curve number, area, peak flow generated, and time of concentration.

Time of concentration (Tc) was not calculated. Assumed 5 minute minimum Tc for all basins except:

CM-1 and CM-10 – these basins have Tc of 10 mins due to longer than typical flowpath length.

CM-179 – this basin has Tc of 23 minutes. Tc was adjusted such that peak flow rate from this basin is equal to or slightly greater than flow rate provided by others designing facilities in this basin.



Highlighting indicates basins that drain to existing or proposed inlets and conveyance systems designed by others.

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BASIN MAP FOR TERMINAL 5

DATE 5/3/12

FIGURE 1

Figure 9. Basin Map for Terminal 5

APPENDIX B

Hydrology Calculations

Curve Numbers

Curve numbers were selected for each basin based on Table 2.2 in the 2005 SMMWW Vol. III:

Table 2.2
Runoff Curve Numbers for Selected Agricultural, Suburban, and Urban Areas
(Sources: TR 55, 1986, and Stormwater Management Manual, 1992. See Section 2.1.1 for explanation)

Cover type and hydrologic condition	CNs for hydrologic soil group A	B	C	D
Curve Numbers for Pre-Development Conditions				
Pasture, grassland, or range-continuous forage for grazing:				
Fair condition (ground cover 50% to 75% and not heavily grazed).	49	69	79	84
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80
Woods:				
Fair (Woods are grazed but not burned, and some forest litter covers the soil).	36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).	30	55	70	77
Curve Numbers for Post-Development Conditions				
Open space (lawns, parks, golf courses, cemeteries, landscaping, etc.)[1]				
Fair condition (grass cover on 50% - 75% of the area).	77	85	90	92
Good condition (grass cover on >75% of the area)	68	80	86	90
Impervious areas:				
Open water bodies: lakes, wetlands, ponds etc.	100	100	100	100
Paved parking lots, roofs[2], driveways, etc. (excluding right-of-way)	98	98	98	98
Permeable Pavement (See Appendix C to decide which condition below to use)				
Landscaped area	77	85	90	92
50% landscaped area/50% impervious	87	91	94	96
100% impervious area	98	98	98	98
Paved	98	98	98	98
Gravel (including right-of-way)	76	85	89	91
Dirt (including right-of-way)	72	82	87	89
Pasture, grassland, or range-continuous forage for grazing:				
Poor condition (ground cover <50% or heavily grazed with no mulch).	68	79	86	89
Fair condition (ground cover 50% to 75% and not heavily grazed).	49	69	79	84
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80
Woods:				
Poor (Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning).	45	66	77	83
Fair (Woods are grazed but not burned, and some forest litter covers the soil).	36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).	30	55	70	77

Single family residential[3]: Dwelling Unit/Gross Acre	Should only be used for subdivisions > 50 acres	Average Percent impervious area[3,4]	
1.0 DU/GA		15	Separate curve number
1.5 DU/GA		20	shall be selected for
2.0 DU/GA		25	pervious & impervious
2.5 DU/GA		30	portions of the site or
3.0 DU/GA		34	basin
3.5 DU/GA		38	
4.0 DU/GA		42	
4.5 DU/GA		46	
5.0 DU/GA		48	
5.5 DU/GA		50	
6.0 DU/GA		52	
6.5 DU/GA		54	
7.0 DU/GA		56	
7.5 DU/GA		58	
PUD's, condos, apartments, commercial businesses, industrial areas & & subdivisions < 50 acres	%impervious must be computed	Separate curve numbers shall be selected for pervious and impervious portions of the site	

For a more detailed and complete description of land use curve numbers refer to chapter two (2) of the Soil Conservation Service's Technical Release No. 55 . (210-VI-TR-55, Second Ed., June 1986).

A curve number of 98 was used for pavement.

Table B1. Catchment Modeling Parameters and Results for the 25-year Storm Event

Catchment Name	SCS Curve Number	Scaled Area (acres)	Peak 25-year Flow (cfs)	Time of Concentration (mins)	Unit Hydrograph Method
Alignment A					
CM-121	98	0.167	0.14	5	SCS Unit Hydrograph
CM-113	98	0.161	0.13	5	SCS Unit Hydrograph
CM-110	98	0.160	0.13	5	SCS Unit Hydrograph
CM-95	98	0.168	0.14	5	SCS Unit Hydrograph
CM-98	98	0.159	0.13	5	SCS Unit Hydrograph
CM-118	98	0.100	0.08	5	SCS Unit Hydrograph
CM-119	98	0.072	0.06	5	SCS Unit Hydrograph
CM-120	98	0.082	0.07	5	SCS Unit Hydrograph
CM-117	98	0.260	0.22	5	SCS Unit Hydrograph
CM-123	98	0.114	0.09	5	SCS Unit Hydrograph
CM-115	98	0.157	0.13	5	SCS Unit Hydrograph
CM-124	98	0.158	0.13	5	SCS Unit Hydrograph
CM-114	98	0.158	0.13	5	SCS Unit Hydrograph
CM-190	98	0.100	0.07	5	SCS Unit Hydrograph
Alignment B					
CM-136	98	0.073	0.06	5	SCS Unit Hydrograph
CM-149	98	0.108	0.09	5	SCS Unit Hydrograph
CM-148	98	0.022	0.02	5	SCS Unit Hydrograph
CM-165	98	0.100	0.08	5	SCS Unit Hydrograph
CM-154	98	0.055	0.05	5	SCS Unit Hydrograph
CM-191	98	0.024	0.02	5	SCS Unit Hydrograph
CM-170	98	1.942	1.61	5	SCS Unit Hydrograph
CM-16	98	0.943	0.78	5	SCS Unit Hydrograph
CM-175	98	0.631	0.52	5	SCS Unit Hydrograph
CM-176	98	0.221	0.18	5	SCS Unit Hydrograph
CM-174	98	0.327	0.27	5	SCS Unit Hydrograph
CM-178	98	0.632	0.52	5	SCS Unit Hydrograph
CM-27	98	0.853	0.7	5	SCS Unit Hydrograph
CM-135	98	0.063	0.05	5	SCS Unit Hydrograph
CM-140	98	0.029	0.02	5	SCS Unit Hydrograph
CM-153	98	0.115	0.1	5	SCS Unit Hydrograph
CM-151	98	0.084	0.07	5	SCS Unit Hydrograph
CM-150	98	0.245	0.2	5	SCS Unit Hydrograph
CM-155	98	0.062	0.05	5	SCS Unit Hydrograph
CM-167	98	0.120	0.1	5	SCS Unit Hydrograph
CM-176	98	0.628	0.5	5	SCS Unit Hydrograph
Alignment C					
No catchments in Alignment C. Upstream basins and existing system contribute flow.					

Table B1. Catchment Modeling Parameters and Results for the 25-year Storm Event

Catchment Name	SCS Curve Number	Scaled Area (acres)	Peak 25-year Flow (cfs)	Time of Concentration (mins)	Unit Hydrograph Method
Alignment D					
CM-179	98	37.829	23.9	23	SCS Unit Hydrograph
Alignment E					
CM-105	98	0.197	0.16	5	SCS Unit Hydrograph
CM-104	98	0.197	0.16	5	SCS Unit Hydrograph
CM-103	98	0.196	0.16	5	SCS Unit Hydrograph
CM-102	98	0.193	0.16	5	SCS Unit Hydrograph
CM-100	98	0.292	0.24	5	SCS Unit Hydrograph
CM-99	98	0.265	0.22	5	SCS Unit Hydrograph
Alignment F					
CM-106	98	0.197	0.16	5	SCS Unit Hydrograph
CM-107	98	0.198	0.16	5	SCS Unit Hydrograph
CM-128	98	0.197	0.16	5	SCS Unit Hydrograph
CM-127	98	0.196	0.16	5	SCS Unit Hydrograph
CM-126	98	0.196	0.16	5	SCS Unit Hydrograph
CM-125	98	0.198	0.16	5	SCS Unit Hydrograph
CM-177	98	0.191	0.16	5	SCS Unit Hydrograph
CM-175	98	0.652	0.52	5	SCS Unit Hydrograph
Alignment G					
CM-29	98	1.111	0.83	5	SCS Unit Hydrograph
CM-30	98	1.704	1.27	5	SCS Unit Hydrograph
CM-31	98	1.254	0.92	5	SCS Unit Hydrograph
CM-32	98	1.593	1.31	5	SCS Unit Hydrograph
CM-33	98	1.418	1.17	5	SCS Unit Hydrograph
CM-34	98	1.232	1.02	5	SCS Unit Hydrograph
CM-35	98	2.970	2.46	5	SCS Unit Hydrograph

MGS Flood Water Quality Flow Rate Results

MGS FLOOD
PROJECT REPORT

Program Version: 3.13 Run Date: 01/10/2012 10:01 AM

Input File Name: **mgs test.fld**
Project Name: POV T5 WQ flow
Analysis Title: POV T5 WQ flow
Comments:

********** Precipitation Input**********

Extended Precipitation Timeseries Selected
Climatic Region Number: 20
Full Period of Record Available used for Routing
Precipitation Station : 970044 Vancouver 44 in MAP 10/01/1939-10/01/2060
Evaporation Station : 971044 Vancouver 44 in MAP
Evaporation Scale Factor : 0.750

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

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

********** Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********

***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)		
		Developed	
	Predeveloped	To Node	Bypass Node
Till Forest	0.000	0.000	0.000
Till Pasture	0.000	0.000	0.000
Till Grass	0.000	0.000	0.000
Outwash Forest	0.000	0.000	0.000
Outwash Pasture	0.000	0.000	0.000
Outwash Grass	91.320	0.000	0.000
Wetland	0.000	0.000	0.000
Impervious	0.000	91.320	0.000
Subbasin Total	91.320	91.320	0.000

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

Node No: 2
2-Year Discharge Rate : 25.033 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 14.68 cfs
Off-line Design Discharge Rate (91% Exceedance): 8.65 cfs

APPENDIX C

Hydraulic Calculations

Table C1. Conduit Modeling Parameters and Results for the 25-year Storm Event

Conduit Name	Diameter (in)	Slope (ft/ft)	Maximum 25-year Flow (cfs)	Calculated Design Capacity (cfs)	Maximum Flow to Calculated Design Capacity Ratio
Alignment A					
CO-A5	12	0.020	0.14	5.45	0.03
CO-A10	12	0.020	0.08	5.47	0.01
CO-A15	12	0.002	0.34	1.71	0.20
CO-A20	12	0.020	0.06	5.47	0.01
CO-A25	12	0.002	0.58	1.74	0.33
CO-A30	12	0.020	0.07	5.41	0.01
CO-A35	12	0.002	0.65	1.73	0.38
CO-A40	12	0.020	0.22	5.45	0.04
CO-A45	12	0.002	0.69	1.74	0.40
CO-A50	12	0.020	0.09	5.44	0.02
CO-A55	12	0.002	0.71	1.74	0.41
CO-A60	12	0.020	0.13	5.44	0.02
CO-A65	12	0.002	0.74	1.74	0.43
CO-A70	12	0.020	0.13	5.44	0.02
CO-A75	18	0.002	0.8	5.13	0.16
CO-A80	12	0.020	0.13	5.44	0.02
CO-A85	24	0.002	0.91	11.00	0.08
CO-A90	12	0.020	0.13	5.44	0.02
CO-A95	24	0.002	1.03	10.94	0.09
CO-A100	12	0.020	0.13	5.47	0.02
CO-A105	48	0.002	57.59	69.94	0.82
CO-A110	12	0.020	0.14	5.44	0.03
CO-A115	48	0.002	57.81	66.94	0.86
CO-A120	12	0.020	0.13	5.45	0.02
Alignment B					
CO-B37	12	0.020	0.52	5.40	0.10
CO-B40	30	0.002	3.96	19.99	0.20
CO-B43	12	0.020	0.18	5.44	0.03
CO-B45	30	0.002	7.58	19.63	0.39
CO-B47	12	0.020	0.27	5.48	0.05
CO-B49	12	0.020	0.52	5.48	0.09
CO-B50	30	0.003	8.87	25.07	0.35
CO-B53/300	15	0.005	2.59	4.94	0.52
CO-B55	12	0.020	0.06	5.47	0.01

Table C1. Conduit Modeling Parameters and Results for the 25-year Storm Event

Conduit Name	Diameter (in)	Slope (ft/ft)	Maximum 25-year Flow (cfs)	Calculated Design Capacity (cfs)	Maximum Flow to Calculated Design Capacity Ratio
CO-B55	30	0.003	10.91	25.10	0.43
CO-B60	12	0.020	0.09	5.45	0.02
CO-B63	12	0.005	0.52	2.51	0.21
CO-B65	30	0.002	11.06	19.87	0.56
CO-B70	12	0.020	0.57	5.45	0.10
CO-B75	30	0.002	11.44	19.87	0.58
CO-B80	12	0.020	0.02	5.45	0.00
CO-B85	30	0.002	11.54	19.88	0.58
CO-B90	30	0.002	11.6	19.87	0.58
CO-B95	30	0.002	11.75	19.87	0.59
CO-B100	12	0.020	0.08	5.45	0.01
CO-B105	12	0.020	0.18	5.46	0.03
CO-B110	12	0.020	0.06	5.45	0.01
CO-B120	36	0.002	12.04	32.05	0.38
CO-B125	36	0.002	12.1	32.41	0.37
CO-B126	12	0.020	1.61	5.46	0.29
CO-B127	36	0.002	13.02	32.20	0.40
CO-B130	36	0.002	13.07	32.31	0.40
CO-B135	12	0.020	0.78	5.49	0.14
CO-B140	36	0.002	13.56	32.32	0.42
CO-B150	12	0.020	0.71	5.49	0.13
Alignment C					
CO-C235	48	0.002	53.54	69.69	0.77
Alignment D					
CO-D5	36	0.005	23.83	51.06	0.47
CO-D10	36	0.005	23.80	51.23	0.46
Alignment E					
CO-E1/E3	36	0.025	58.71	115.15	0.51
CO-E5	48	0.002	58.71	69.93	0.84
CO-E10	12	0.020	0.16	5.44	0.03
CO-E15	48	0.002	58.66	69.83	0.84
CO-E20	12	0.020	0.16	5.44	0.03
CO-E25	48	0.002	58.5	69.59	0.84
CO-E30	12	0.020	0.16	5.44	0.03
CO-E35	48	0.002	58.29	69.95	0.83
CO-E40	12	0.020	0.16	5.44	0.03
CO-E45	48	0.002	58.15	69.50	0.84
CO-E50	12	0.020	0.24	5.48	0.04
CO-E55	48	0.002	57.94	69.44	0.83
CO-E60	48	0.002	57.97	69.35	0.84

Table C1. Conduit Modeling Parameters and Results for the 25-year Storm Event

Conduit Name	Diameter (in)	Slope (ft/ft)	Maximum 25-year Flow (cfs)	Calculated Design Capacity (cfs)	Maximum Flow to Calculated Design Capacity Ratio
CO-E65	12	0.020	57.84	5.48	0.04
CO-E70/ A127	48	0.002	58.71	70.62	0.82
Alignment F					
CO-F5	12	0.002	0.16	1.78	0.09
CO-F10	18	0.002	0.33	4.70	0.07
CO-F15	18	0.002	0.49	4.70	0.10
CO-F20	18	0.002	0.65	4.72	0.14
CO-F23	12	0.020	0.16	5.00	0.03
CO-F25	18	0.002	0.95	4.69	0.20
CO-F27	12	0.020	0.16	5.45	0.03
CO-F30	24	0.002	1.73	10.31	0.17
CO-F32	12	0.005	0.54	2.54	0.21
CO-F33	12	0.020	0.16	5.49	0.03
CO-F35	24	0.002	2.96	10.05	0.29
Alignment G					
CO-G155	36	0.002	26.18	34.85	0.75
CO-G160	12	0.020	0.92	5.46	0.17
CO-G165	42	0.002	26.66	52.42	0.51
CO-G170	12	0.020	1.41	5.46	0.26
CO-G175	42	0.002	27.46	52.65	0.52
CO-G180	12	0.020	1.04	5.46	0.19
CO-G185	42	0.002	28.36	52.54	0.54
CO-G187	36	0.002	23.29	31.37	0.74
CO-G190	48	0.002	51.34	69.63	0.74
CO-G195	12	0.020	1.32	5.44	0.24
CO-G200	48	0.002	52.49	69.58	0.75
CO-G205	12	0.020	1.17	5.49	0.21
CO-G210	48	0.002	53.54	69.72	0.77
CO-G215	12	0.020	1.02	5.46	0.19
CO-G220	48	0.002	54.26	69.72	0.78
CO-G225	12	0.020	2.46	5.44	0.45
CO-G230	48	0.002	56.55	69.42	0.81

Table C2. Structures Modeling Results for the 100-year Storm Event

Structure Name	Structure Type	Structure surcharged for the 100-year Storm?
Alignment A		
CB1-A10	WSDOT Catch Basin Type 1	No
CB1-A100	WSDOT Catch Basin Type 1	No
CB1-A110	WSDOT Catch Basin Type 1	No
CB1-A120	WSDOT Catch Basin Type 1	No
CB1-A130	WSDOT Catch Basin Type 1	No
CB1-A20	WSDOT Catch Basin Type 1	No
CB1-A30	WSDOT Catch Basin Type 1	No
CB1-A40	WSDOT Catch Basin Type 1	No
CB1-A50	WSDOT Catch Basin Type 1	No
CB1-A60	WSDOT Catch Basin Type 1	No
CB1-A70	WSDOT Catch Basin Type 1	No
CB1-A80	WSDOT Catch Basin Type 1	No
CB1-A90	WSDOT Catch Basin Type 1	No
MH-A10	WSDOT Manhole Type 3	No
MH-A20	WSDOT Manhole Type 3	No
MH-A30	WSDOT Manhole Type 3	No
MH-A40	WSDOT Manhole Type 3	No
MH-A50	WSDOT Manhole Type 3	No
MH-A60	WSDOT Manhole Type 3	No
MH-A70	WSDOT Manhole Type 3	No
MH-A80	WSDOT Manhole Type 3	No
MH-A90	WSDOT Manhole Type 3	No
MH-A100	WSDOT Manhole Type 3	No
MH-A110	WSDOT Manhole Type 3	No
MH-A120	WSDOT Manhole Type 3	No
Alignment B		
CB1-B100	WSDOT Catch Basin Type 1	No
CB1-B110	WSDOT Catch Basin Type 1	No
CB1-B130	WSDOT Catch Basin Type 1	No
CB1-B140	WSDOT Catch Basin Type 1	No
CB1-B160	WSDOT Catch Basin Type 1	No
CB1-B170	WSDOT Catch Basin Type 1	No
CB1-B180	WSDOT Catch Basin Type 1	No
CB1-B80	WSDOT Catch Basin Type 1	No
CB1-B85	WSDOT Catch Basin Type 1	No
CB1-B87	WSDOT Catch Basin Type 1	No
CB1-B90	WSDOT Catch Basin Type 1	No
CB1-B90	WSDOT Catch Basin Type 1	No
72" STM MH 22	Existing Manhole	No

Table C2. Structures Modeling Results for the 100-year Storm Event

Structure Name	Structure Type	Structure surcharged for the 100-year Storm?
MH-B80	WSDOT Manhole Type 3	No
MH-B85	WSDOT Manhole Type 3	No
MH-B90	WSDOT Manhole Type 3	No
MH-B95	WSDOT Manhole Type 3	No
MH-B100	WSDOT Manhole Type 3	No
MH-B103	WSDOT Manhole Type 3	No
MH-B160	WSDOT Manhole Type 3	No
MH-B165	WSDOT Manhole Type 3	No
MH-B170	WSDOT Manhole Type 3	No
MH-B180	WSDOT Manhole Type 3	No
Alignment C		
MH-C260	WSDOT Manhole Type 3	No
Alignment D		
MH-D10	WSDOT Manhole Type 3	No
MHV-D10	120 Inch Manhole	No
MHV-D20	120 Inch Manhole	No
Alignment E		
CB1-E10	WSDOT Catch Basin Type 1	No
CB1-E20	WSDOT Catch Basin Type 1	No
CB1-E30	WSDOT Catch Basin Type 1	No
CB1-E40	WSDOT Catch Basin Type 1	No
CB1-E50	WSDOT Catch Basin Type 1	No
CB1-E60	WSDOT Catch Basin Type 1	No
MH-E10	WSDOT Manhole Type 3	No
MH-E20	WSDOT Manhole Type 3	No
MH-E30	WSDOT Manhole Type 3	No
MH-E40	WSDOT Manhole Type 3	No
MH-E50	WSDOT Manhole Type 3	No
MH-E60	WSDOT Manhole Type 3	No
MH-E70	WSDOT Manhole Type 3	No
MH-E80	WSDOT Manhole Type 3	No
Alignment F		
CB1-F10	WSDOT Catch Basin Type 1	No
CB1-F20	WSDOT Catch Basin Type 1	No
CB1-F30	WSDOT Catch Basin Type 1	No
CB1-F40	WSDOT Catch Basin Type 1	No
CB1-F50	WSDOT Catch Basin Type 1	No
CB1-F60	WSDOT Catch Basin Type 1	No
CB1-F70	WSDOT Catch Basin Type 1	No
MH-F50	WSDOT Manhole Type 3	No

Table C2. Structures Modeling Results for the 100-year Storm Event

Structure Name	Structure Type	Structure surcharged for the 100-year Storm?
MH-F60	WSDOT Manhole Type 3	No
MH-F65	WSDOT Manhole Type 3	No
MH-F70	WSDOT Manhole Type 3	No
Alignment G		
CB1-G200	WSDOT Catch Basin Type 1	No
CB1-G210	WSDOT Catch Basin Type 1	No
CB1-G220	WSDOT Catch Basin Type 1	No
CB1-G230	WSDOT Catch Basin Type 1	No
CB1-G240	WSDOT Catch Basin Type 1	No
CB1-G250	WSDOT Catch Basin Type 1	No
CB1-G260	WSDOT Catch Basin Type 1	No
MH-G200	WSDOT Manhole Type 3	No
MH-G205	WSDOT Manhole Type 3	No
MH-G210	WSDOT Manhole Type 3	No
MH-G215	WSDOT Manhole Type 3	No
MH-G220	WSDOT Manhole Type 3	No
MH-G230	WSDOT Manhole Type 3	No
MH-G240	WSDOT Manhole Type 3	No
MH-G250	WSDOT Manhole Type 3	No

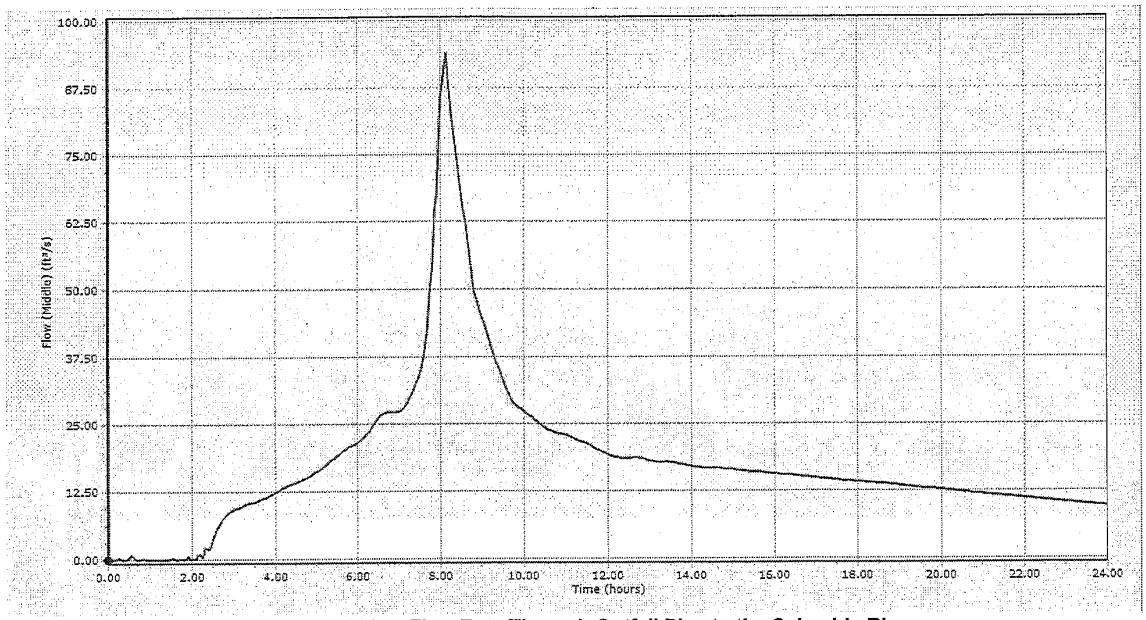


Figure C1. Hydrograph Showing 100 Year Flow Rate Through Outfall Pipe to the Columbia River

BergerABAM

700 Northeast Multnomah Street, Suite 900, Portland, Oregon 97232-4189
503/872-4100 • 503/872-4101 Fax • www.abam.com

Memorandum

Date: June 10, 2010

Subject: Port of Vancouver – West Vancouver Freight Access Project
Parcel 1A Drainage Study

From: Shawn Ellis, PE

To: Kurt Reichelt, HDR
Scott Hale, HDR

Route to: Papor-09-121 File

As requested by the Port of Vancouver, we have completed a review of drainage options for the Port's Parcel 1A property. Our understanding for the Port's desired future use of Parcel 1A and the results of our analyses based on this understanding is summarized in this memorandum.

Future Parcel 1A Sub-Basins

The purpose of this study is to determine the feasibility of providing for future drainage facilities for Parcel 1A after it is divided into three sub-basins. Two of the sub-basins will be approximately 22 acres each, and will be developed for light industrial use by outside parties or Port tenants. The balance of the parcel (15 acres) will remain Port property, and be used for rail and other Port access and as a utility corridor along the north side of the existing and future track corridor.

According to Port staff, the two 22-acre parcels will each provide on-site water quality treatment for storm water runoff. Treated storm water will be conveyed by Port-owned conveyance facilities for discharge to the Columbia River via the Port's outfall. The runoff will bypass the Port's existing water quality treatment facility (the T4 Pond). The 15-acre parcel will be conveyed for treatment in the T4 Pond.

Hydrology and Hydraulics

We have completed preliminary analyses to determine peak flows for a 25-year rainfall event from the combined 22-acre parcels and the 15-acre parcel to determine the size of the systems necessary to convey peak flows. The Santa Barbara Unit Hydrograph (SBUH) method was used for the analyses. Calculations are attached to this memo, but are summarized below. The design storm is the 25-year rainfall depth of 3.5 inches. Times of concentration are based on 100 feet of

overland flow for each system, 100 feet of concentrated flow, and the balance as pipe flow. Peak flow from the two combined parcels is predicted to be 30.8 cfs. Peak flow from the 15-acre parcel is predicted to be 9.5 cfs.

Required pipe sizes for the above peak discharges are determined from likely maximum slope requirements for each system based on the elevations for each system connection location. The 44-acre parcels will require a 36-inch pipe with a minimum slope assume to be xxx. The 15-acre parcel will require a 24-inch pipe with a minimum slope of 2.3%.

SBUH Input	**44-acre Parcels**	**15-acre Parcel**
Area (acres)	44 acres	15 acres
Percent Impervious	100%	100%
Curve Number	98	98
25-year Design Event	3.5 inches	3.5 inches
Time of Concentration	98	27.2 minutes
Peak Flow	30.8 cfs	9.5 cfs
Pipe Size	36-inch	24-inch

Grade Requirements For T4 Pond By-pass Conveyance System

The following assumptions and existing conditions have been considered to evaluate the feasibility of extending a gravity conveyance system from the western 22-acre parcel to the manhole south of the T4 pond.

- The conveyance system will be connected to the manhole just south of the T4 pond, and it has an invert elevation of 11.00 feet for the 60-inch pipe proposed from the T4 pond. The existing 60-inch outlet pipe has an invert elevation of 10.50 feet.
- Matching crowns at this manhole would require an invert elevation of 13.00 feet for the 36-inch conveyance pipe from Parcel 1A.
- Approximately 3,650 linear feet of conveyance pipe will be required to convey the two 22-acre sites runoff to the discharge at the Port's manhole south of the T4 pond. Assuming a minimum slope of 0.2% results in a 7.3-foot grade drop to this manhole.
- Approximately 900 linear feet of pipe in the westernmost 22-acre site at a slope of 0.5% will require a 4½-foot grade drop within the site.

- Site elevation in the NW corner of Parcel 1A will be at least 29 feet, based on adjacent survey data.
- The invert elevation for the upstream end of the on-site conveyance system, could be as low as 24.80 feet given the above criteria. The site elevation in the NW corner of Parcel 1A is likely to be at least 29 feet, based on adjacent survey data from Gateway Road and SR 501. Therefore, a depth of 4.2 feet for this upstream point is possible.
- Shallower depth for the on-site system may be required if water quality treatment systems selected by parcel owners/tenants require a hydraulic head to function.

It is recommended that 36-inch conveyance system be constructed as deeply as possible in order to allow for the most flexibility for design of the on-site storm water systems.

Options for Crossing the Track Corridor

An existing 42-inch pipe currently crosses the track corridor, extending towards the T4 pond from an inlet and manhole at the southeast corner of Parcel 1A. Existing Project 6 (Terminal 3 Rail Access) plans show modifications to this pipe system to provide access from Parcel 1A to the T4 pond. This pipe can be used for either the 44-acre conveyance or the 15-acre conveyance, although conditions for each are not ideal (see option discussions below).

For whichever system the 42-inch pipe is used, we recommend that a second storm pipe be installed as part of Project 6 (or partially during Project 6 with completion as part of Project 11). The second pipe will be either for conveyance of the 44-acre parcel or the 15-acre parcel.

Options for providing conveyance for the parallel pipe systems are described below:

- *Existing 42-inch Pipe for 44-acre Conveyance.* The existing 42-inch pipe could be used for conveyance of the 44-acre parcel. However, the pipe does not provide the same upstream or downstream elevations listed in the Grade Requirements above. The downstream end of the pipe on the south side of the track corridor is at elevation 15.31 feet. Approximately 1270 feet of pipe would be required to extend the system to the manhole south of the T4 pond. At a slope of 0.2% the invert at the manhole would be 12.77 feet. This would function hydraulically, but would not allow for matching pipe crowns.

  If the existing 42-inch pipe is proposed for conveyance of the 44-acre sites, a second storm crossing (24-inch pipe) should be installed for conveyance of the 15-acre parcel. The Project 6 plans should be modified to complete the connection as part of the project 6 project, so that future modification to the system won't be necessary, and to ensure that the required configuration of the both systems can function in the limited space available near the northwest corner of the pond.

- ***Existing* 42-inch Pipe for 15-acre Conveyance.** The current Project 6 plans provide for extension of the 42-inch to the T4 Pond. However, the existing pipe is below the pond water surface elevation of 16.65 feet, and is generally partially filled with water except when the pond's water surface drops due to evaporation during very dry periods. If the 15-acre parcel is used by this existing pipe, a second 36-inch storm crossing should be installed for the 44-acre parcel future conveyance.

Conveyance Calculations & Pipe Sizing

Project: West Vancouver Freight Access Project - Project 9
PAPOR-11-127
Date: 4/18/2011

Storm Drain A

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
Gateway Ave	MH P9-A1	238	2.030	0.9	1.83	1.83	6.5		6.5	2.31	4.22	18	0.0028	0.013	5.57	3.15	0.76
MH P9-A1	MH P9-A2	300	1.670	0.9	1.50	3.33		1.3	7.8	2.11	7.03	24	0.002	0.013	10.14	3.23	0.69
MH P9-A2	MH P9-A3	300	1.670	0.9	1.50	4.83		1.5	9.3	1.92	9.28	24	0.002	0.013	10.14	3.23	0.92
MH P9-A3	MH P9-A4	300	1.670	0.9	1.50	6.34		1.5	10.9	1.77	11.24	30	0.0015	0.013	15.92	3.24	0.71
MH P9-A4	MH P9-A5	300	1.670	0.9	1.50	7.84		1.5	12.4	1.66	12.99	30	0.0015	0.013	15.92	3.24	0.82
MH P9-A1	MH P9-A6	300	1.670	0.9	1.50	9.34		1.5	13.9	1.56	14.58	30	0.0015	0.013	15.92	3.24	0.92
MH P9-A5	MH P9-A7	300	1.670	0.9	1.50	10.85		1.5	15.5	1.48	16.03	36	0.0012	0.013	23.16	3.28	0.69
MH P9-A1	MH P9-A8	300	1.670	0.9	1.50	12.35		1.5	17.0	1.41	17.39	36	0.0012	0.013	23.16	3.28	0.75
MH P9-A1	MH P9-A9	241	1.670	0.9	1.50	13.85		1.5	18.5	1.35	18.66	36	0.0012	0.013	23.16	3.28	0.81
MH P9-A9	Exisiting MH	358	1.670	0.9	1.50	15.35		1.2	19.8	1.30	20.02	36	0.0012	0.013	23.16	3.28	0.86
		Total Area	17.06														

Storm Drain B

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
Farwest	MH P9-B1	5	22.000	0.9	19.80	19.80	98.0		98.0	0.57	11.32	30	0.0015	0.013	15.92	3.24	0.71
MH P9-B1	MH P9-B2	203	0.000	0.9	0.00	19.80		0.0	98.0	0.57	11.31	30	0.002	0.013	18.38	3.75	0.62
MH P9-B2	MH P9-B3	300	5.250	0.9	4.73	24.53		0.9	98.9	0.57	13.95	36	0.002	0.013	29.89	4.23	0.47
MH P9-B3	MH P9-B4	254	5.250	0.9	4.73	29.25		1.2	100.1	0.57	16.53	36	0.0015	0.013	25.89	3.66	0.64
MH P9-B4	MH P9-B5	279	5.250	0.9	4.73	33.98		1.2	101.3	0.56	19.09	42	0.0015	0.013	39.05	4.06	0.49
MH P9-B5	MH P9-B6	279	5.250	0.9	4.73	38.70		1.1	102.4	0.56	21.62	42	0.0015	0.013	39.05	4.06	0.55
MH P9-B6	Existing MH	50	1.000	0.9	0.90	39.60		1.1	103.6	0.56	22.00	42	0.0012	0.013	34.93	3.63	0.63
		Total Area	44.00														

Intensity (I)
From the WSDOT Hydraulics Manual, $I = m/Tc^n$
where m = 6.06 and n = 0.515 for the 25-year return period

Gateway Avenue Contribution to Storm Drain A taken from Project 19 calculations.
Farwest Steel contribution to Storm Drain B taken from Farwest Steel calculations.

Conveyance Calculations & Pipe Sizing

Project: West Vancouver Freight Access Project - Gateway Avenue Grade Separation
PAPOR-11-127
Date: 4/18/2011

Gateway Avenue From Lower River Road to MH-13

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I* (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
MH-15	MH-14	294	0.180	0.9	0.16	0.16	5.0		5.0	2.65	0.43	12	0.005	0.013	2.52	3.22	0.17
MH-14	MH-13	109	0.295	0.9	0.27	0.43		1.5	6.5	2.31	0.99	12	0.005	0.013	2.52	3.22	0.39
		Total Area	0.48														

Gateway Avenue From High Point at Station G22+48.47 to MH-13

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
MH-7	MH-8	125	0.390	0.9	0.35	0.35	5.0		5.0	2.65	0.93	12	0.0534	0.013	8.25	10.51	0.11
MH-8	MH-9	170	0.000	0.9	0.00	0.35		0.2	5.2	2.59	0.91	12	0.0537	0.013	8.27	10.54	0.11
MH-9	MH-10	134	0.374	0.9	0.34	0.69		0.3	5.5	2.53	1.74	12	0.0446	0.013	7.54	9.60	0.23
MH-10	MH-11	122	0.000	0.9	0.00	0.69		0.2	5.7	2.47	1.70	12	0.019	0.013	4.92	6.27	0.35
MH-11	MH-12	53	0.386	0.9	0.35	1.04		0.3	6.0	2.40	2.49	12	0.0049	0.013	2.50	3.19	0.99
MH-12	MH-13	101	0.262	0.9	0.24	1.27		0.3	6.0	2.40	3.05	15	0.005	0.013	4.58	3.73	0.67
		Total Area	1.41														

Gateway Avenue From MH-13 to Discharge to Conveyance at Parcel 1A Tract

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
MH-13	Parcel 1A	238	0.141	0.9	0.13	1.83	6.5		6.5	2.31	4.21	18	0.0028	0.013	5.57	3.15	0.76
		Total Area	2.03	Includes areas from two tables above													

Gateway Avenue From High Point at Station G22+48.47 to discharge into the Terminal 5 System

Upstream	Downstream	Length	Peak Discharge Calculation									Pipe Design					
			Area (acres)	C	CA	Sum Ca	Tc (min)	Pipe Tc (min)	Sum Tc (min)	I* (in/hr)	Q (cfs)	Dia (in)	Slope (ft/ft)	Mannings n	Capacity (cfs)	Velocity (fps)	Q/Qcap
MH-6	MH-5	93	0.512	0.9	0.46	0.46	5.0		5.0	2.65	1.22	12	0.0322	0.013	6.40	8.16	0.19
MH-5	MH-4	260	0.215	0.9	0.19	0.65		0.2	5.2	2.60	1.70	12	0.0396	0.013	7.10	9.05	0.24
MH-4	MH-3	285	0.363	0.9	0.33	0.98		0.5	5.7	2.48	2.43	12	0.0391	0.013	7.06	8.99	0.34
MH-3	MH-2	119	0.319	0.9	0.29	1.27		0.5	6.2	2.37	3.00	12	0.0172	0.013	4.68	5.96	0.64
MH-2	MH-1	69	0.440	0.9	0.40	1.66		0.3	6.5	2.31	3.84	15	0.0077	0.013	5.68	4.63	0.68
MH-1	T5		0.132	0.9	0.12	1.78		0.2	6.8	2.26	4.03	15	0.005	0.013	4.58	3.73	0.88
		Total Area	1.98														

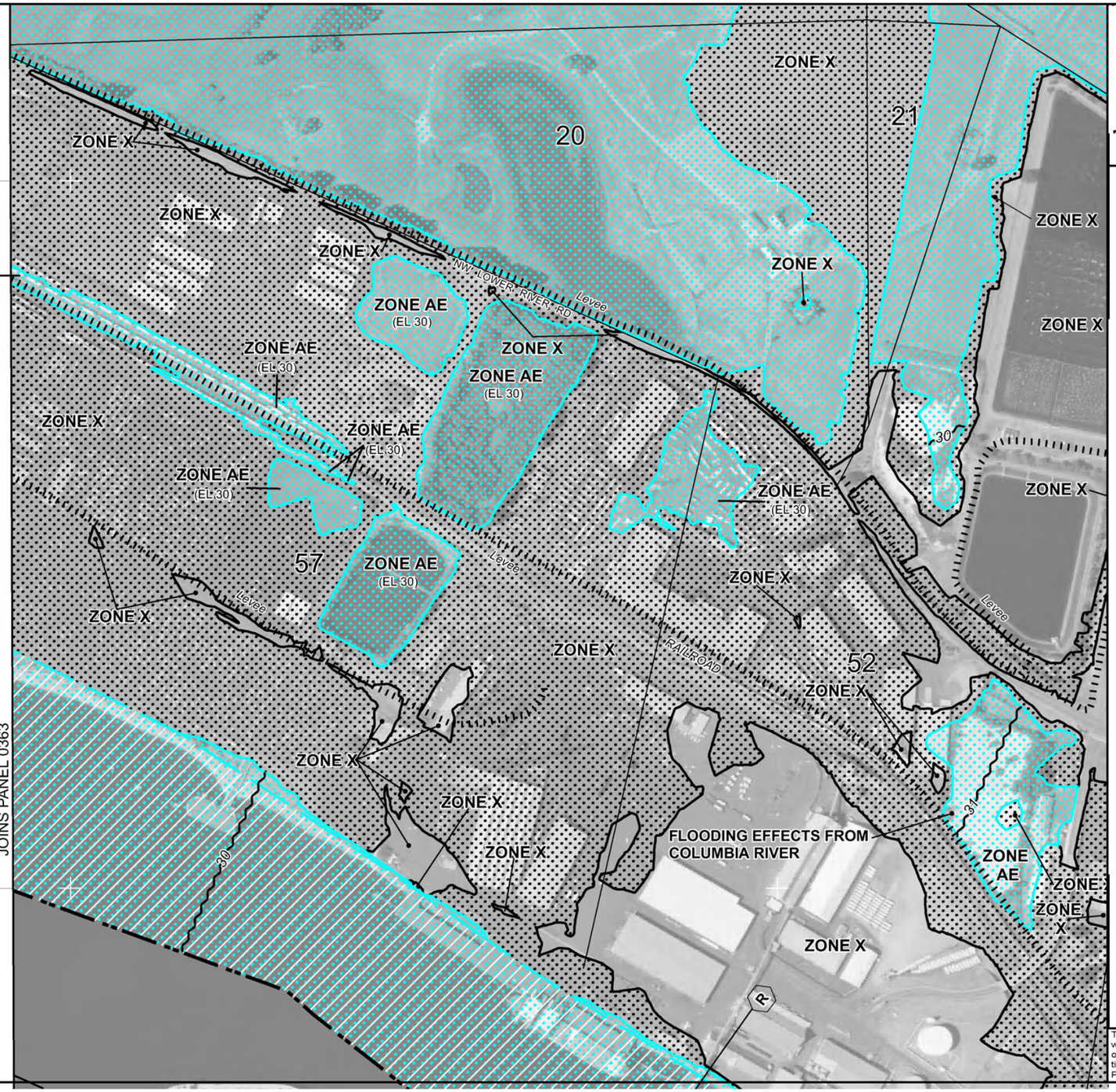
* Intensity (I)
From the WSDOT Hydraulics Manual, $I = m/Tc^n$
where m = 6.06 and n = 0.515 for the 25-year return period

EX-0001-003819-PCE

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix C
FEMA FIRM Maps



$^{50}55^{000m}$N

$^{50}54^{000m}$N

JOINS PANEL 0363

MAP SCALE 1" = 500'

250 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0364D

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY, WASHINGTON

AND INCORPORATED AREAS

PANEL 364 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLARK COUNTY	530024	0364	D
VANCOUVER, CITY OF	530027	0364	D

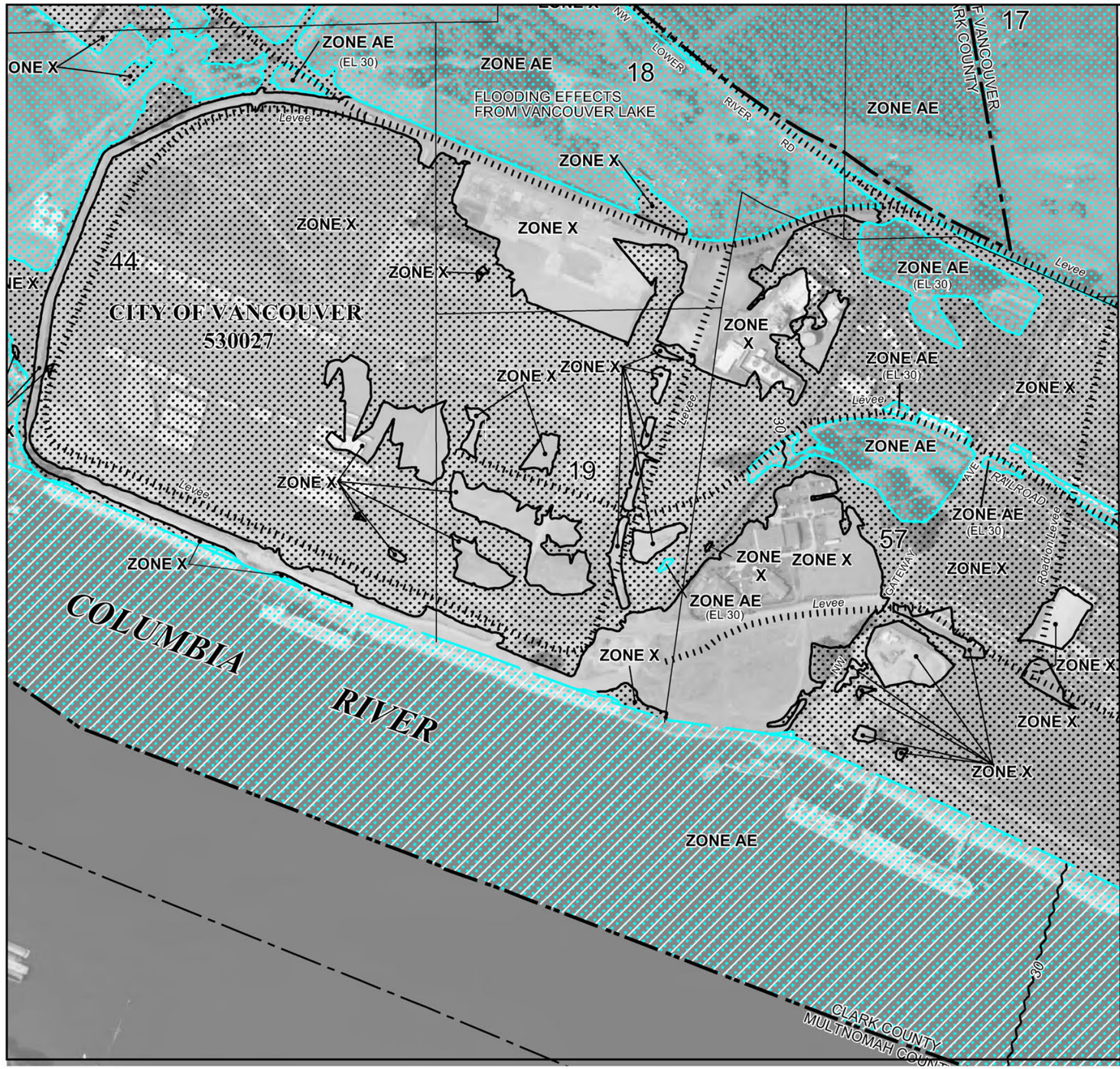
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
53011C0364D

EFFECTIVE DATE
SEPTEMBER 5, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0363D

FIRM

FLOOD INSURANCE RATE MAP

CLARK COUNTY, WASHINGTON AND INCORPORATED AREAS

PANEL 363 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLARK COUNTY	530024	0363	D
VANCOUVER, CITY OF	530027	0363	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
53011C0363D

EFFECTIVE DATE
SEPTEMBER 5, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix D
Geotechnical Investigation Report

Geotechnical Investigation

BergerABAM
1111 Main Street, Suite 300
Vancouver, WA 98660-2958

Tesoro Savage Vancouver Energy Distribution Terminal - Upland Facility Port of Vancouver, USA

Prepared by

GRI
Oregon & Washington

December 20, 2013

TABLE OF CONTENTS

Page

INTRODUCTION 1
PROJECT DESCRIPTION 1
- Overview 1
- Areas 200 and 600 (Unloading, Office and West Boiler) 2
- Areas 300 (Storage Tanks) 2
- Area 400 (Marine Terminal) 2
- Area 500 (Transfer Pipelines) 2

SITE CONDITION AND BACKGROUND 3
- Topography and Site Background 3
- Geology 4

SUBSURFACE CONDITIONS 4
- General 4
- Soils 5
- Groundwater 6

CONCLUSIONS AND RECOMMENDATIONS 7
- General 7
- Seismic Considerations 8
- Areas 200 Unloading and Office Structures and Area 600 West Boiler 12
- Area 300 Storage Tanks 14
- Area 300 Lightly Loaded Structures Foundation Support 17
- Area 400 Marine Terminal 17
- Area 500 Transfer Pipelines 18
- Spread Footings (Areas 200, 300, 400, 500, and 600) 18
- Driven Piles (Areas 200, 300, 400, 500, and 600) 19
- Site Preparation and Earthwork 23
- Structural Fill 24
- Utilities 25
- Design Review and Construction Services 25

LIMITATIONS AND CONCLUDING REMARKS 26
References 27

Figures

Figure 1 Vicinity Map
Figure 2 Project Layout Plan
Figure 3 Site Plan (Areas 200 and 600 - Unloading and Office / West Boiler)
Figure 4 Site Plan (Area 300 - Storage)
Figure 5 Site Plan (Area 400 - Marine Terminal)
Figure 6 Summary of Piezometers (Area 300)
Figure 7 Settlement Plate Detail
Figure 8 Estimated Footing Settlement

Tables

1 Tank Settlement Estimates
2 Settlement Due to Tank Preloading
3 Ultimate Pile Capacities
4 Soil Properties for L-Pile Analysis
5 P-Modifiers for Group Effects

Appendix A: Field Explorations and Laboratory Testing

Appendix B: Site-Specific Seismic Hazard Study

INTRODUCTION

At your request, GRI has completed a geotechnical investigation for the proposed petroleum-by-rail handling facility at the Port of Vancouver (Port) in Vancouver, Washington. The vicinity map, Figure 1, shows the general location of the project, which includes the northwest corner of Terminal 5 (T-5), Parcel 1A, Berths 13 and 14 in Terminal 4 (T-4), and pipeline areas that connect these three areas. This report addresses the upland portion of the facility. The supplemental investigation addressing the dock modifications and portions of the terminal along the riverbank is in progress.

The investigation was conducted to evaluate subsurface conditions at the site and provide our conclusions and recommendations for design and construction of the proposed facility. Our investigation has included a review of available geologic information, subsurface explorations, laboratory testing, and engineering analyses. This report describes the work accomplished and provides our conclusions and geotechnical recommendations for the design and construction of the proposed facility.

Preliminary design recommendations for Area 300 storage tanks were provided to you in our July 18, 2013, memorandum entitled, "Progress Memorandum and Preliminary Conclusions and Recommendations, Petroleum Tank Support and Performance, Tesoro Savage Petroleum Terminal, Port of Vancouver, USA." Preliminary design recommendations for Area 200 unloading and structure areas were provided in our July 25, 2013, memorandum entitled, "Progress Memorandum and Preliminary Conclusions and Recommendations, Area 200 – Unloading and Building Areas, Tesoro Savage Petroleum Terminal, Port of Vancouver, USA."

The following geotechnical information has been reviewed for this investigation:

> Dames and Moore, March 31, 1993, Geotechnical Investigation, Proposed T-Docks/Dolphins, Port of Vancouver, Washington; prepared for URS Consultants.
>
> GRI, May 18, 2011, Geotechnical Report, NW Gateway Avenue Rail Bridge and Access to Terminal 5, Port of Vancouver, USA; prepared for HDR Inc.
>
> GRI, August 23, 2007, Draft Geotechnical Investigation, Columbia Gateway Rail Improvements, Port of Vancouver, Washington; prepared for Jones & Stokes Environmental Specialist.
>
> GRI, December 20, 2006 (issued July 31, 2007), Geotechnical Investigation, Columbia Gateway Rail Expansion, Port of Vancouver, Washington; prepared for Jones & Stokes.

PROJECT DESCRIPTION

Overview

The Project Layout Plan, Figure 2, shows the proposed layout of the new petroleum-by-rail bulk handling facility. The facility will occupy portions of Terminals 4 and 5, and Parcel 1A at the Port. The project includes specific areas that have been designated Areas 200 through 600, as shown on Site Plans, Figures 3 through 5. Crude oil will be transported to the Port by unit railcar trains and unloaded in a railcar unloader located in Area 200. A boiler structure in Area 600, located adjacent to the west end of the unloader structure will heat the crude oil for transport through above- and below-ground pipes to up to six storage tanks located in Area 300. A boiler structure located near the storage tanks will heat the crude oil for transport from the storage tanks to ships at Berth 13 in Area 400. Additional site improvements will

include a vapor combustion structure in Area 400 located near the dock to burn off excess vapor generated during transport of the crude oil through the pipeline. In addition, a modular office structure and two changing room structures (Area 200) will be located north of the unloader structure. The pipeline is referred to as Area 500 on Figure 2. The site improvements will be designed to meet the 2013 Washington State Building Code.

Areas 200 and 600 (Unloading, Office and West Boiler)

The site layout for the rail unloading area, west boiler, and administration and support structures is shown on Figure 3. The rail unloading area will allow the simultaneous unloading of tank cars on three rail lines and will be covered by a 90-ft-wide by 1,800-ft-long, relatively light, single-bay metal framed structure. The oil transport piping will be housed in embedded reinforced concrete trenches that are 5 to 7 ft deep and 9 ft wide. The rail unloading piping racks and piping trenches will be structurally independent of the unloader structure.

A small control room and fire pump and foam structure will be located on the south side of the unloading structure, together with transformer pads and pump pit. An office structure (48 by 70 ft) and two change rooms (48 by 70 ft and 36 by 70 ft) together with employee parking areas and six small holding tanks for rail car spill containment will be located north of the unloading area and north of the existing rails. Pedestrian bridges will span the rail lines and extend from the south side of the unloading area to near the planned office structure.

The west boiler is an approximate 6,600 sq ft, lightly loaded structure located west of the unloader structure.

Areas 300 (Storage Tanks)

The site layout for the product storage tanks, secondary containment berm, boiler structure, pump basin, control room/E-house and fire pump and foam structure is shown on the Area 300 Site Plan, Figure 4. Up to six product storage tanks will be constructed in Area 300. The tanks will be 240 ft in diameter, 48 ft high, and will be spaced 120 ft apart (wall to wall). The tanks will be of steel construction with a floating roof. The 50- by 60-ft boiler structure is located west of the tank farm. A small control room, fire pump and foam structure, transformer pads, and maintenance parking stalls are planned north of the boiler. A pump basin is planned adjacent to the south side of the boiler structure.

Area 400 (Marine Terminal)

The site layout for the marine terminal is shown on Figure 5. The area includes transfer pipeline, an E-house structure, fire pump and foam structure, dock transformer, vapor control unit, and maintenance parking planned near the riverbank near berths 13 and 14. The transfer pipeline is located within about 80 ft of the riverbank and will extend west from vapor control unit for approximately 1,050 ft before turning north. In addition, modifications to the existing docks and moorage dolphins are planned. Modifications to the docks and moorage dolphins and other Area 400 elements are not part of the scope of this geotechnical report and will be addressed in a supplemental report.

Area 500 (Transfer Pipelines)

The layout for the transfer pipelines is shown on Figure 2. The pipeline will consist of three, 24-in.-diameter steel pipelines extending from the rail unloading area to the product storage tanks. A 36-in.-

diameter steel pipeline with 6-in.-diameter return pipeline will run from the product storage tanks to the dock. Outside of the rail unloading area, the pipeline will typically be built above ground and rest on concrete cradles. Portions of the pipeline will be below ground where crossing beneath existing roadways and rail tracks. Based on conversations with the design team, underground portions of the 24- and 36-in.-diameter transfer pipelines will be housed inside 36-and 48-in.-diameter steel pipes, respectively.

SITE CONDITION AND BACKGROUND

Topography and Site Background

Areas 200 and 600. Existing topographic information indicates the ground surface in the area of planned improvements typically ranges from elevation +28 to +35 ft based on the National Geodetic Vertical Datum of 1929 (NGVD 29). All elevations in this report are reported in NGVD. The ground surface in the area of the planned unloader and boiler structure is typically mantled with crushed rock. The ground surface in the area of the office and changing room structure is mantled with sand fill or crushed rock. At the time of our investigation, the Port was placing and compacting additional sand fill in the area of the office and changing room structures. Up to eight rail tracks are located immediately north of the planned unloader structure. There are asphaltic-concrete (AC) paved roads around the planned boiler structure and north of the office and changing room structures.

T-5 was formerly occupied by an aluminum smelting facility owned and operated by Aluminum Company of America (Alcoa), Vancouver Aluminum Company (Vanalco), and Evergreen Aluminum at various periods beginning in 1940. Alcoa, in conjunction with Vanexco, also operated an aluminum rod and wire extrusion facility at T-5 until 1991. Soils in the area of the aluminum facility were contaminated with hazardous materials during the years of the aluminum facilities operations (ICF Jones and Stokes, 2009). As a result of the contamination, Alcoa and Evergreen Aluminum conducted a cleanup effort throughout T-5 that included construction of engineered landfills and caps that include the Vanexco concrete cap located adjacent to the north edge of the unloader structure. Soils in the Vanexco cap are impacted with polychlorinated biphenyls (PCBs). Based on current plans, the majority of the improvements are outside the area of the Vanexco cap except for a small portion of the unloader facility and the pedestrian bridge that provides access to the unloader rack from the facility offices.

Area 300. Existing topographic information indicates the ground surface of Area 300 typically ranges from elevation +27 to +30 ft and is mantled with crushed rock over the western half and sand fill over the eastern half. The northeast corner of the area contains a partially filled stormwater retention pond with the bottom at approximate elevation +12 ft and side slopes of about 2H:1V or flatter. It is our understanding the Port will complete filling of the remnant of the stormwater pond with compacted structural fill to match the surrounding site grades. A large scrap-metal stockpile is located in the southeast portion of the tanks site. The scrap metal piles are in the area of the southeast and middle south tank footprints, see Figure 4. Several stockpiles of concrete rubble were located on the western portion of the site and have subsequently been removed by the Port. Several rail lines are located adjacent to the south boundary of Area 300.

Area 400. Area 400 consists of two existing dock structures, identified as Berths 13 and 14, consisting of 250-ft-long pile-supported T-docks. Existing topographic information indicates the ground surface at the trestle abutments for the docks is relatively flat at about elevation +27 ft and is typically mantled with AC pavement, gravel, or grass. Two stormwater infiltration swales with the ground surface ranging from

elevation +23 to +25 ft are located north of the paved areas and are mantled with grass and shrubs. A 2H:1V riprap protected slope extends from the trestle abutment down to the sandy beach at about elevation 17 ft. The dredge line at the face of the dock is at about elevation -38 ft. It is our understanding the berths will be dredged to elevation -41 ft.

Area 500. The pipeline alignment is relatively flat with the ground surface ranging from about elevation +22 to +32 ft. The ground is typically mantled with crushed rock with portions of the pipeline along AC-paved NW Gateway Avenue and NW Harborside Drive.

The pipeline alignment is adjacent to the N/N2 landfill east of the unloader structure, near the East Landfill south of the intersection of NW Gateway Avenue and NW Harborside Drive. The N/N2 landfill and East Landfill areas were impacted by contamination during the Alcoa operations and are considered part of the Department of Ecology restricted covenant.

Geology

Based on our understanding of the geology at the site, our experience with nearby sites, and the available exploration data, the project area is mantled by fill that is underlain by recent alluvial soils to depths of 50 to 90 ft below the existing ground surface. The manmade fills typically consist of fine to coarse granular soils, with silt, silty sand, and sandy silt. The alluvial soils typically consist of very soft to medium stiff silt with varying percentages of clay interbedded with layers of sandy silt and sand that are underlain by sand with a trace of silt. The recent alluvial soils are typically underlain by alluvial gravels that range from gravel in a matrix of sand to open-graded gravel. Recent geologic investigations near the Interstate 5 bridge about 3 miles upstream from the project site indicate the alluvial gravels on the Washington side of the Columbia River can be up to 100 ft thick near the project site.

Available geologic information indicates the alluvial gravels are underlain by the Troutdale Formation, a Pliocene-age unit of well-consolidated or cemented conglomerate and sandstone (Beeson, et al., 1991).

SUBSURFACE CONDITIONS

General

Subsurface materials and conditions at the site were investigated between June 5 and October 29, 2013, with 26 borings, designated B-1 through B-26, and six cone penetration test (CPT) probes, designated CPT-1 through CPT-6. The borings were advanced to depths of 21.5 to 104.2 ft, and the probes were advanced to depths of about 54 to 83 ft.

The locations of borings and probes performed for this investigation are shown on Figures 2 through 5. Referring to Figure 4, note that explorations have not been completed for the southeast and middle south tank footprints. Access to this area was not permitted due to the presence of a large stockpile of scrap metal. The field exploration and laboratory testing programs completed for this investigation are described in Appendix A. Logs of the borings and CPT probes are shown on Figures 1A through 32A. The terms used to describe the soils encountered in the borings and CPTs are defined in Tables 1A and 2A.

In addition to the borings and CPT probes made for this investigation, GRI also reviewed and utilized the logs of previous explorations made by GRI and others in the site vicinity for other projects. Overall, the

results of the explorations recently completed for this investigation are in good agreement with previous work.

Soils

For the purpose of discussion, the materials disclosed by the explorations have been grouped into four units based on their physical characteristics, geologically significant features, and engineering properties. Listed as they were encountered from the ground surface downward, the units are:

1. **FILL**
2. **SILT**
3. **SAND**
4. **GRAVEL**

1. FILL. Fill was encountered at the ground surface in all explorations except B-26 and extends to depths ranging from about 5 to 25 ft (elevation +24.5 to +2 ft). The fill was thinnest near the northeast area of Parcel 1A (Area 300), where the Port plans to place additional fill, and near the northwest boundary of the unloader structure. The fill is thickest at the top of the riverbank in the dock area, where it is typically 20 to 25 ft thick.

The fill consists of layers of silt, sand, and gravel. Based on N-values and CPT tip resistances that vary widely across the site, the relative consistency of the sand and gravel fill varies from very loose to very dense, and the relative consistency of the silt fill ranges from very soft to hard. The fill in Area 300 is typically sand and gravel and medium dense to dense. The fill in Area 200 and 600 typically consists of layers of sand and gravel, is typically medium dense to dense, and grades to loose to medium dense below depths of 5 to 12.5 ft in several borings in the area. The fill in Area 400 consists primarily of sand and is typically loose to medium dense. The moisture content of sand fill ranges from 7 to 33% and increases with increasing silt content. The moisture content of silty fill ranges from 15 to 48%.

2. SILT. Silt was encountered in all explorations except borings B-10, B-23, and B-26. The silt was encountered beneath the fill in all borings and CPTs, except B-11, B-12, B-16, B-17, B-20, and B-25, where the silt was encountered beneath a layer of native sand that ranges from 2.5 to 15 ft thick. The silt extends to depths of 15 to 26 ft, and to the maximum depth explored in borings B-9, B-12 through B-14, and B-19. The silt ranges from 4-in.-thick interbedded layers to 19-ft-thick zone in Area 200 and 600; from 4 to 17 ft thick in Area 300; from 4 in. to 5 ft thick in Area 400; and from 12.5 to 17.5 ft thick in Area 500. Sand layers ranging from 3 to 4.5 ft thick are interbedded in the silt in Area 200. Based on N-values, Torvane shear strengths, and CPT side friction, the relative consistency of the silt ranges from very soft to stiff. Based on Atterberg limits testing, the liquid limit (LL) of the silt ranges from 27 to 76%, and the plasticity index (PI) ranges from 5 to 33%, indicating the soil has a low to high plasticity. The results of the Atterberg limits testing are shown on the Plasticity Charts, Figures 33A and 34A. The silt in Area 300 is typically very soft to medium stiff and has a medium to high plasticity with a PI greater than 16%. The silt in Area 200 and 600 is typically very soft to medium stiff and has a relatively low plasticity with a PI ranging from 5 to 15% and more typically 5 to 6%. The silt in Area 500 is very soft of medium stiff. The silt in Area 400 is medium stiff. An approximately 1-ft-thick layer of silt with varying gravel content was encountered above the gravel in the explorations in Area 400.

Consolidation test data for selected samples of silt obtained from borings B-4, B-5, B-7, B-8, B-11, and B-19 at depths of 10 to 32 ft indicate the silt is slightly preconsolidated and displays a relatively low compressibility in the preconsolidated range and a moderate compressibility in the normally consolidated range of stresses. Consolidation test results are shown on Figures 35A to 40A. Secondary compression testing was completed on selected samples and is shown on Figures 41A and 42A in the form of curves showing dial reading versus the log of time.

3. SAND. Sand was encountered at the ground surface in boring B-26 and beneath the silt in the remaining borings and CPTs and extends to the underlying gravel at depths ranging from 40 to 64 ft. Borings B-10, B-11, B-15, B-17, B-18, and B-20 were terminated in sand. The sand is fine to coarse grained and contains varying percentages of silt, ranging from a trace of silt to silty. A trace of gravel was present in some of the sand. The thickness of the sand ranges from 20 to 67 ft. Interbedded layers of silt ranging from 1 to 14 ft thick are present in the sand in Area 200 and 600. N-values recorded in the borings in Areas 200 and 600 indicate the relative density of the sand is typically loose from 10 to 20 ft and medium dense below a depth of about 30 ft. In Area 300, the sand is typically loose in the upper 5 to 10 ft of the sand layer and typically grades to medium dense below depths of 25 to 40 ft. In Area 400, the sand is typically loose to a depth of 35 ft and medium dense below a depth of 35 ft. In Area 500, the sand is typically loose in the upper 5 to 10 ft of the sand layer and grades to medium dense below a depth of 30 to 40 ft.

4. GRAVEL. Gravel was encountered beneath the sand in borings B-1 through B-8, B-16, B-21 through B-26, and probes CPT-1 through CPT-6. Gravel was encountered at about elevation -24 to -30 ft in Area 300, elevation -64.5 ft in Area 200, elevation -25.5 ft in Area 500, and elevations -43.5 to -60 ft in Area 400. The gravel is typically in a matrix of sand and silt and contains scattered cobbles and possible boulders. Layers of relatively open-graded gravels were noted in Area 300. Interbedded layers of sand ranging from 4 in. to 4.5 ft thick occur in the gravel in Area 300. Based on N-values, the relative density of the gravel ranges from medium dense to very dense.

Groundwater

Groundwater levels in the project area fluctuate in response to seasonal river levels, precipitation, and daily tidal fluctuations in the river. Shallow perched groundwater conditions can develop above the less-permeable silty deposits at the site and approach the ground surface during periods of prolonged or intense rainfall.

The Columbia River level is lowest in late summer and early fall. Historical low water in the last 20 years is about elevation +2.5 ft. The 100-year flood level is about elevation +28 ft. The ordinary high water level (OHW) is about elevation 17 ft. The higher river levels typically occur during storm events and the spring freshet, when snowmelt runoff causes high river flows.

Vibrating-wire piezometers were installed in borings B-4 and B-7 in Area 300. The piezometers are connected to data logger systems that automatically record the groundwater level. Installation details for the piezometers are described in Appendix A. The groundwater elevations between June 7 and July 10, and August 2 through 23, 2013, were recorded at up to 2-hour intervals and are shown on Figure 6. The piezometer data indicate the groundwater elevation fluctuated between elevation +4 and +10 ft over the recorded period. Hydrograph river levels recorded at a nearby station on the Columbia River during the same period were converted to NGVD elevations and are shown on the figure. Comparison of the

recorded groundwater and river levels suggests the groundwater is typically near or slightly higher than the river elevation. In this regard, it should be anticipated the groundwater level at the site could rise to or very near the ground surface during flood events. The groundwater elevations shown on Figure 6 are based on survey data provided to GRI by McKay Sposito. The batteries in the data loggers recording piezometer data in borings B-4 and B-7 stopped working on June 19 and July 10, 2013, respectively, and were replaced on August 2, 2013. It should be anticipated the groundwater level in the project area will reflect the water levels in the Columbia River.

CONCLUSIONS AND RECOMMENDATIONS

General

The borings and CPT probes completed for this investigation indicate the site is mantled with 5 to 25 ft of silt, sand, and gravel fill that is underlain by alluvial silt and sand. Explorations for previous work at the port indicate a lesser thickness of fill is present along the proposed pipeline alignment between Gateway Avenue and the new Gateway Avenue bridge. Where there is less fill, the native silt soils are present near the ground surface. Boring B-26, completed on the beach near Berth 13 encountered sand at the ground surface. Dense gravel is present below depths of 40 to 95 ft. Groundwater levels at the site will fluctuate in response to precipitation and levels in the nearby Columbia River. Shallow perched groundwater conditions may develop in the fill and approach the ground surface during periods of prolonged precipitation.

Our studies indicate that during the design level earthquake, the loose to medium dense sands and layers of low-plasticity, soft to medium stiff silt and sandy silt that are present below the groundwater level in all areas of the site could liquefy to the top of the gravel layer. Liquefaction results in settlement, a reduction of soil strength, and significant lateral spreading deformations near the riverbank. Ground improvement, such as stone columns, vibro-compaction, jet-grouted columns, and soil mixing, can be designed to mitigate liquefaction-induced settlement and lateral spreading deformations. Ground improvement will likely be necessary in Area 400 and portions of Area 500 to limit lateral spreading along the riverbank. The section of the Area 500 pipeline adjacent to the riverbank is also close to the East Landfill. Geotechnical borings were not allowed in the landfill.

A compressible layer of silt is present in Area 300. The heavy product storage loads will induce significant consolidation (static) settlement beneath the tanks that will likely need to be mitigated with ground improvement.

Due to the static and seismic settlement considerations and lateral spread due to seismic loading, conventional spread footings may not be able to support some of the structures during the design seismic event. In this regard, portions of the improvements may be supported on driven steel piles or ground improvement to limit static and seismic deformations.

The following sections of this report provide our conclusions and recommendations for design and construction of the site improvements. Static settlements will be in addition to liquefaction-induced settlements following a strong earthquake.

Seismic Considerations

General. We understand seismic design of the project elements, except the dock structure, will be in accordance with the 2012 International Building Code (2012 IBC), which was recently adopted by the Washington State Building Code and incorporates recommendations from the ASCE 7-10, Minimum Design Loads for Building and Other Structures (ASCE 7-10). The 2012 IBC and ASCE 7-10 seismic hazard levels are based on a Risk-Targeted Maximum Considered Earthquake (MCE_R). The ground motion associated with the probabilistic MCE_R represents a targeted risk level of 1% in 50 years probability of collapse in the direction of maximum horizontal response. In general, these risk-targeted ground motions are developed by applying adjustment factors of directivity and risk coefficients to the 2% probability of exceedance in 50 years, or a 2,475-year return period hazard level ground motion developed from the 2008 U.S. Geologic Survey (USGS) probabilistic seismic hazard maps. The maximum horizontal direction spectral response accelerations were obtained from the USGS Seismic Design Maps for the coordinates of 45.65° N latitude and 122.71° W longitude. The S_S and S_1 values identified for the site are 0.94 and 0.41 g, respectively. These bedrock spectral ordinates are adjusted for Site Class with the short- and long-period site coefficients, F_a and F_v, based on subsurface conditions or with a site-specific response analysis. The design-level response spectrum is calculated as two-thirds of the Site Class-adjusted MCE_R-level spectrum.

Our analysis has identified a potential risk of liquefaction throughout the site. In accordance with ASCE 7-10, sites with subsurface conditions identified as vulnerable to failure or collapse, such as liquefied soils, shall be classified as Site Class F. For Site Class F sites, ASCE 7-10 section 20.3 requires completion of a site-specific ground motion analysis unless the structures have a fundamental period of vibration less than or equal to 0.5 second. The design response spectrum for sites with structures of fundamental period less than 0.5 second can be derived using the non-liquefied subsurface profile.

We expect the large storage tanks in Area 300 will have fundamental periods of vibration that exceed 0.5 second. Due to these anticipated longer periods, a site-specific seismic ground motion analysis is required due to the presence of liquefiable soils. For Areas 300 and 400, a site-specific ground motion analysis was completed with the aid of the computer software D-MOD, a non-linear seismic soil response software developed by GeoMotions, LLC. The D-MOD analyses are further discussed in the site-specific ground motion analysis in Appendix B. The site-specific seismic ground motion analysis completed for Area 400 was completed as part of a separate scope of work to assist with evaluating the existing dock.

The recommended spectra with no ground improvement are summarized below by Area. Depending on the final type and extent of ground improvement selected, the Site Class assumption should be confirmed during final design.

Areas 200, 500, and 600. For Areas 200, 500, and 600, we understand the structures have a fundamental period of vibration less than or equal to 0.5 second. Based on the site conditions and no ground improvement, we recommend using Site Class E, soft soil profile, and the corresponding code site coefficients to develop the design spectra for those areas. The subsurface conditions in Area 500 within about 300 ft of the riverbank are more sandy than the rest of the area and are similar to the Area 400 site conditions (i.e., more sand). Therefore, we recommend the design spectrum for the section of pipeline within 300 ft of the river be developed based on the recommendations for Area 400.

Area 300. For Area 300, the results of the site-specific modeling indicates the 2012 IBC code-based Site Class D spectrum provides an appropriate estimate of the spectral accelerations in Area 300 for short periods. For longer periods, a response spectrum consisting of the site-specific spectral response values and the spectral values corresponding to 80% of the Site Class E response spectrum is appropriate. The recommended design-level spectral acceleration for Area 300, based on the site-specific ground motion analysis with no ground improvement, is shown on Figure 12B.

Area 400. For Area 400, the results of the site-specific modeling indicate the 2012 IBC code-based Site Class D spectrum provides an appropriate estimate of the spectral accelerations at short periods, while a response spectrum encompassing the site-specific spectral values and 80% of Site Class E is considered to be appropriate at longer periods. The design-level spectral acceleration spectrum for Area 400 is shown on Figure 12B.

Liquefaction. Liquefaction is a process by which saturated, granular materials, such as sand, and to a somewhat lesser degree, non-plastic silts, temporarily lose strength during and immediately after a seismic event. Liquefaction occurs as seismic shear stresses propagate through a saturated soil and distort the soil structure causing loosely packed groups of particles to contract or collapse. If drainage is impeded and cannot occur quickly, the collapsing soil structure increases the porewater pressure between the soil grains. If the porewater pressure increases to a level approaching the weight of the overlying soil, the granular layer temporarily behaves as a viscous liquid rather than a solid. As strength is lost, there is an increased risk of settlement, lateral spread, and/or slope instability, particularly along waterfront areas. Liquefaction-induced settlement occurs as the elevated porewater pressures dissipate and the soil consolidates after the earthquake.

The potential for liquefaction is typically estimated using the simplified method which compares the cyclic shear stresses induced within a soil profile during an earthquake to the ability of the soils to resist these stresses. The stresses induced within the profile are estimated on the basis of earthquake magnitude and the accelerations within the profile. The ability of the soils to resist these stresses are based on their strength as characterized by SPT N-values and CPT cone tip resistances normalized for overburden pressures and corrected for factors, such as fines content. Bray and Sancio (2006) provide additional screening criteria regarding the liquefaction susceptibility of silty soils that are not addressed by the simplified method. According to Bray and Sancio, soils with a water content to liquid limit ratio greater than 0.85 and a plasticity index (PI) less than 12% are susceptible to liquefaction.

The potential for liquefaction at the site was evaluated with the simplified method based on two methodologies. The first methodology was utilized for all areas and is based on the simplified procedure by Youd, et al (2001). The analysis was completed with the aid of the computer software LiquefyPro, a seismically induced liquefaction and settlement analysis software developed by CivilTech Corporation. The Youd, et al., methodology utilizes the peak ground acceleration (PGA) to predict the cyclic shear stresses experienced by the soil. The second methodology is based on the simplified procedure by Idriss and Boulanger (2008) and was utilized for Area 300. The Idriss and Boulanger (2008) analysis was used to evaluate the liquefaction potential of soils based on cyclic shear stresses and increased pore pressures estimated by the site response analysis output from the computer program D-MOD. In accordance with ASCE 7-10 Section 11.8.3, the PGA used in liquefaction hazard evaluation is the Maximum Considered Earthquake Geometric Mean (MCE_G) PGA adjusted for site amplification and is determined either through

site-specific ground motion analyses or is the mapped MCE_G PGA determined from ASCE 7-10, Figure 22-7. The mapped MCE_G is based on the 2008 USGS SDM and reflects a seismic hazard of 2% probability of exceedance in 50 years. The mapped bedrock MCE_G PGA for the site is 0.41 g.

It should be emphasized that the hazard level (MCE_G) used to estimate liquefaction hazards based on the new ASCE 7-10 document is approximately 50% larger than in previous code cycles. This new requirement results in much larger ground deformation estimates.

Based on the 2008 USGS interactive deaggregations, the subduction, subcrustal, and local crustal earthquakes all provide a significant contribution to the probabilistic seismic hazard at the site. We have considered magnitude M6.8 and M9.0 earthquakes, corresponding to a local crustal and subduction zone earthquake, respectively, with a PGA of 0.37 g and 0.45 g for Site Class E and D, respectively, for our liquefaction studies. These analyses indicate the crustal and subduction zone earthquake control the seismic hazard and contribute similar liquefaction hazards to the site. For the purpose of liquefaction studies, we have assumed a groundwater level at elevation 12 ft, corresponding to a seasonally averaged daily high river level.

The results of the liquefaction hazard analysis indicate the loose to medium dense sands and layers of low-plasticity, soft to medium stiff silt and sandy silt present below the groundwater level could liquefy to the top of the gravel layer at depths of up to 60 to 80 ft. Laboratory testing indicates the PI of the silt samples obtained from Area 300 ranges from 16 to 33%, which indicates the silt has a low risk of liquefaction based on the Bray and Sancio criteria. Our laboratory testing indicates the PI of the silt samples obtained from Areas 200 and 600 ranges from 5 to 15% and is typically 5 to 6% and has a moderate risk of liquefaction based on the Bray and Sancio criteria. For the purpose of estimating liquefaction-induced settlements, we have estimated the silt soils in Areas 200 and 600 are susceptible to liquefaction, and the silt soils in Area 300 are not susceptible to liquefaction. Based on these assumptions and on the new MCE_G ground motions, we estimate liquefaction-induced settlements will be on the order of 10 to 16 in. in Areas 200 and 600, 6 to 10 in. in Area 300, 3 to 15 in. in Area 500, and 12 to 24 in. in Area 400.

Lateral Spreading. Lateral spreading involves the horizontal displacement of large volumes of soil as a result of the liquefaction of underlying layers. The ground displacement occurs in response to the combination of gravitational forces and inertial forces generated by an earthquake acting upon the soil mass. Lateral spread can develop on shallow sloping ground or as a flow slide moving toward a moderately to steeply sloping free face, such as a river channel or lake bottom. Differential internal movements within the spreading mass usually create surface features, such as ground cracks or fissures, scarps, and grabens, in overlying unsaturated or non-liquefied soils. Lateral displacement may range from a few inches to many feet depending on soil conditions, the steepness of the slope, and the magnitude and epicentral distance of the earthquake. Associated differential vertical movements, or ground surface subsidence, may range up to about half of the total horizontal movement.

The method of analysis developed by Youd, et al. (2002), can be used to estimate lateral spread for both free-face and continuous slopes in free-field conditions. Calculations were completed assuming a subduction zone earthquake with a moment magnitude M9.0 at an epicentral distance of about 86 km and a crustal earthquake with a moment magnitude M6.8 at an epicentral distance of about 7 km to represent the MCE_G hazard level defined in ASCE 7-10. The 2008 USGS interactive deaggregations indicate these

magnitude-distance pairs provide the highest contribution to the seismic hazard at the site for subduction zone and crustal earthquake scenarios, respectively. The analysis indicates a potential for tens of feet of horizontal deformation 100 ft from the top of the riverbank, 4 to 9 ft of movement 650 ft from the riverbank, and 0 ft of horizontal deformation 1,150 ft from the riverbank.

The methods used to estimate the seismically induced horizontal and vertical ground displacement at the site are largely based on empirical methods and, consequently, do not provide a precise estimate of the actual ground movement that may occur. Seismic events of a lesser magnitude, or of the same magnitude but occurring at a greater epicentral distance from the site, would be expected to produce lesser horizontal and vertical ground displacements. As discussed in the liquefaction section the hazard level required by the current code is much greater than previous codes. For estimating lateral spreading deformations, the greater hazard level results in lateral spreading displacement estimates that can be larger by an order of magnitude.

In summary, at the new MCE_G hazard level, it is estimated that lateral spreading can occur within about 1,150 ft of the riverbank. Lateral spreading causes horizontal displacement of structures and additional lateral structural loads on piles and walls if not mitigated. Based on the lateral spreading estimates provided above, the pipeline and other structures may not be able to accommodate the estimated horizontal movement or lateral spreading loads, if ground improvement is not completed, in particular near the riverbank.

Ground Improvement. A ground improvement program can be designed to improve the existing subsurface soils and reduce potential seismic-induced settlement and lateral spreading. We anticipate ground improvement, if used for Areas 200, 300, 500, and 600, would be designed by a specialty ground improvement contractor to meet specified performance criteria. Ground improvement design to reduce lateral spreading near the river could be designed by the project team or a contractor to limit seismic deformation to tolerable levels.

Lateral spreading is often mitigated by constructing a zone, or buttress, of improved soil along the riverbank that will not liquefy. The buttress needs to be of sufficient width and extend to adequate depth to maintain stability following ground shaking and minimize or prevent lateral displacement toward the river of the upland portion of the site behind the buttress.

Several ground improvement alternatives, including vibro-compaction, vibro-replacement (stone columns), displacement piles, soil mixing and jet grouting are feasible to mitigate seismically induced settlement and lateral spreading. Vibro-compaction is a ground improvement technique that densifies clean granular soils, such as clean sand, using a vibratory probe. The probe is vibrated and jetted into the ground until reaching the bottom of the improvement zone. The soils are densified by the vibratory process as the probed is removed. Stone columns are similar to vibro-compaction, except stone aggregate is added to the void created by the probe after reaching the bottom of the treatment zone. The aggregate is densified by lowering the probe into the aggregate in small lifts until reaching the ground surface, creating columns of compacted aggregate. Stone columns are typically used in sand that contains a significant portion of fine-grained soils (silt or clay) or in low-plasticity, fine-grained soils with risk of liquefaction.

Vibro-compaction is most effective in sands with fines contents (percentage passing the No. 200 sieve) of less than 15%, and stone columns are more effective for soils with a fines content greater than 15%. Due to the silt layers and relatively high fines content over most of the upland portion of the project site, ground improvement by vibro-replacement with stone columns is more appropriate than vibro-compaction over most of the site to limit liquefaction-induced settlement. However, subsurface conditions near the Area 400 riverbank are predominantly sand, which could be modified using vibro-compaction methods.

Soil mixing and jet grouting are ground improvement methods that mix cement into the in situ soils to create columns of soil with improved strength and stiffness. The soil mixing method mixes wet or dry cement by use of a mechanical paddle that is advanced similar to a drill. The diameter of the soil-mixed column is dependent on the diameter of the paddle tool. Jet grouting makes soil/cement columns by injecting cement grout through high-velocity grout jets. The jets erode the in situ soil and mix it with cement and sometimes air and water. Jet grouting can be used to construct improved soil/cement columns or overlapped to create continuous panels.

Other Seismic Considerations. In our opinion, the potential for earthquake-induced fault displacement and ground rupture at the site is low unless occurring on a previously unknown or unmapped fault, and the risk of tsunami at the site is absent. Due to the topography of the site, it is our opinion the risk of damage by seiche is low.

Areas 200 Unloading and Office Structures and Area 600 West Boiler

General. As previously mentioned, the site layout for the rail unloading area, administrative and support structures, and west boiler are shown on Figure 3. It is our understanding the unloader structure, boiler structure, trenches, office, changing rooms, control room, and fire pump and foam structure, and transformer pads will be lightly loaded. As discussed in the Seismic Considerations section of this report, we estimate 10 to 16 in. of liquefaction-induced settlement in Areas 200 and 600 during a design seismic event. It is reasonable to assume that differential settlement could be half of the total liquefaction-induced settlement over horizontal distances of about 50 ft.

Foundation Support. Spread footings for support of Area 200 and 600 units can be designed using the criteria summarized in the Spread Footings section of this report. Liquefaction-induced settlement of structures founded on spread footings is estimated to be the same as noted in the previous paragraph. Seismic settlement of structures can be reduced to less than 1 in. by using driven pipe pile foundations. Pile support for structures in Areas 200 and 600 can be designed using the criteria provided in Table 3 of the Driven Piles section of this report. LPILE criteria are provided in Table 4 of the Pile Lateral Load section of this report. Alternatively, a foundation system consisting of spread footings following ground improvement could likely be designed to limit seismic settlements to acceptable levels.

Unloading Trenches. The oil will be pumped from rail cars into transport pipelines supported in two embedded concrete trenches located adjacent to the rails for the length of the unloader structure. The unloader trench will have a reinforced concrete bottom and sidewalls and an open top. The floor will be established 5 to 7 ft below the ground surface.

For design of the unloader trench, it is prudent to assume the groundwater level could rise to the ground surface during periods of heavy rainfall, together with river flooding.

Design lateral earth pressures for retaining walls depend on the type of construction, i.e., the ability of the wall to yield. Possible conditions are 1) a wall that is laterally supported at its base and top and, therefore, is unable to yield (at rest condition), and 2) a conventional cantilevered retaining wall that yields (active condition) by tilting about its base.

Assuming groundwater at the ground surface, non-yielding walls should be designed using a lateral earth pressure based on an equivalent fluid having a unit weight of 90 pcf. Walls that are allowed to yield by tilting about their base can be designed using a lateral earth pressure based on an equivalent fluid having a unit weight of 80 pcf. These design lateral earth pressures assume the grade adjacent to the trenches is horizontal. We understand additional lateral loading on the embedded trench walls induced by nearby rails will be evaluated by the project designer.

Assuming the design-level earthquake and 100-year flood event will not occur concurrently, our analyses indicate the above design criteria result in larger lateral earth forces than a design-level earthquake with groundwater below the bottom of the trench. Our analyses indicate the critical lateral earth pressures for design of the vault walls are associated with groundwater at the ground surface, rather than the seismic loading conditions.

Resistance to buoyant forces, if necessary, is typically provided by increasing the weight/volume of concrete and/or by extending the base slab beyond the walls. The buoyant unit weight of backfill over the slab extension can be taken as 53 pcf.

The unloader trench excavation can be backfilled with excavated sand compacted to 95% of the maximum dry density as determined by ASTM D 698 (Standard Proctor). To avoid buildup of excessive lateral earth pressures, overcompaction of backfill within 5 ft of the walls should be avoided.

Based on review of the logs of borings along the unloader, the bottom of the excavation will expose sand and silt. We recommend placing a minimum 8-in. thickness of compacted crushed rock to prevent disturbance of the subgrade and provide a firm working surface. Areas of soft or unsuitable material exposed in the subgrade should be overexcavated and backfilled with compacted crushed rock. The crushed rock should be installed in a single lift and compacted by at least four passes with a vibratory roller. For the support of point loads on the trench bottom slab, we recommend using a modulus of subgrade reaction of 125 pci. We estimate the static settlement of the unloader trench will be less than 1 in. for a relatively uniform net bearing pressure of 1,500 psf.

As noted previously, liquefaction could induce an additional 10 to 16 in. of settlement in Area 200. It is reasonable to assume that differential settlement could be one-half of the total liquefaction-induced settlement over horizontal distances of about 50 ft.

Although the unloader trench is a stiff structure, we understand the estimated liquefaction-induced settlements are excessive. To mitigate seismic-induced settlements, the unloading trench can be supported on ground modified by ground improvement methods or on driven steel pipe piles. If used, piles can also provide uplift resistance to buoyancy.

Ground Improvement. We understand ground improvement is being considered as an alternative to limit liquefaction-induced settlements beneath the structures. If used, ground improvement would be designed by a specialty contractor to meet performance criteria developed by the design team. Vibro-compaction, vibro-replacement (stone columns), soil mixing, and jet grouting are typical ground improvement types that can be used to mitigate seismically induced settlement.

Area 300 Storage Tanks

General. The site layout for the storage tanks, boiler structure, pump basin, control room, and fire pump and foam structure is shown on Figure 4. As discussed in the Seismic Considerations section of this report, we estimate 6 to 10 in. of liquefaction induced settlement in Area 300 during a design seismic event. In addition, the storage area is underlain by compressible silt soils that will induce non-seismic consolidation settlement due to the weight of the storage tanks.

Steel Storage Tanks. The steel tanks will be 240 ft in diameter, 48 ft high, and have a floating roof. Based on conversations with the project structural designer, R&M Structural Engineering (R&M), the tanks can tolerate 8 in. of settlement at the center of the tanks. The perimeter of the tanks can tolerate up to 2 in. of total settlement and differential settlement of 1/2 in. over 32 ft.

Static Tank Settlement. Assuming a product unit weight of 52 pcf, we estimate the bearing pressure of the full tank filled with crude oil will be about 2,500 psf. Estimated total settlements at the center of tanks established at grade with no ground improvement under static conditions are summarized in Table 1 below. The range of settlements between tank locations is due primarily to the variable thickness of compressible silt soil in the tank area, which ranges from about 3 to 17 ft.

TABLE 1: TANK SETTLEMENT ESTIMATES

Location	Estimated Settlement, in. *
Northwest Tank	3 to 5.5
Middle North Tank	2 to 4.5
Northeast Tank	2 to 4.5
Southwest Tank	3.5 to 7
Middle South Tank	No Exploration Data
Southeast Tank	No Exploration Data

* Inner two-thirds of tank footprint

Settlements at the perimeter of the tanks are estimated to be about two-thirds of the settlement in the inner two-thirds of the tank. Subsurface explorations for the middle south and southeast tanks were not completed due to the presence of large stockpiles of scrap steel. Areas under the steel stockpiles will experience less consolidation settlement. Depending on the locations of the middle south and southeast tanks, the preloading by the stockpiles may result in significant differential settlement of the tanks. Additional field explorations and settlement analysis are planned for the middle south and southeast tanks when the area is accessible.

We anticipate 90% of the estimated settlement will occur over a timeframe of about 1 to 2 months. The estimated rate of settlement is based on available laboratory data and one-dimensional time-rate of

consolidation theory, and compares well with settlement data from recent projects completed at the Port. The actual time to achieve the settlement may vary from the theoretical estimates depending on natural variations in the compressibility of the underlying soils, the time that may be required for the load to be applied, and variations in seasonal groundwater levels. The maximum amount of settlement will occur after a period where the groundwater levels are at their lowest, which typically corresponds to the seasonally lowest levels of the Columbia River in the late summer and early fall. The settlement estimates in Table 1 are based on a low groundwater level of elevation 2.5 ft.

In addition to the settlement discussed above, it is likely the tank loads will result in a small amount of secondary compression, which typically occurs over a long period of time. We estimate less than 1 in. of secondary compression over 20 years.

As an additional consideration, a portion of the northeast tank footprint is currently occupied by a remnant of a former stormwater facility. It appears that 17 ft or more of fill will be needed to match existing grades. Because the fill will induce settlement, we recommend installing the fill at least 3 months prior to final grading of the tank pad so the fill-induced settlement can occur prior to tank construction.

Ground Improvement. Ground improvement methods will likely be required to limit consolidation (static) and liquefaction-induced settlements beneath the tanks. Preliminary evaluation of combined ground improvement by vibro-replacement (stone columns) and soil mixing is being completed by a foundation specialty contractor to meet static and seismic deformation criteria. Ground improvement methods to improve drainage, such as wick drains, can also be designed to reduce the timeframe for static settlement of the tanks to occur.

Water Testing. We understand the tanks will be filled with water to test for leaks and allow the tanks to settle prior to attaching exterior piping to the tanks. We estimate the tanks completely filled with water will induce a bearing pressure of about 3,000 psf. Surcharging the tanks to 3,000 psf and allowing sufficient time for consolidation to occur will reduce post-construction settlement. Although water testing the tanks will not reduce liquefaction-induced settlements, it may reduce the amount of overall ground improvement required to meet the foundation performance criteria.

Based on conversations with R&M Engineering Consultants, filling the tanks in approximate one-quarter capacity or greater increments to allow re-leveling of the tank at each stage is being considered as an alternative to mitigate static settlement. Estimates of the total settlement for each loading increment are tabulated below.

TABLE 2: SETTLEMENT DUE TO TANK PRELOADING

	Estimated Total Settlement, in. *			
Location	**1/4 Full of Water**	**1/2 Full of Water**	**3/4 Full of Water**	**Full of Water**
Northwest Tank	< 1	1 to 2.5	2.5 to 5.5	4 to 7.5
Middle North Tank	< 1	1 to 2	2.5 to 4.5	3 to 5.5
Northeast Tank	<1	1 to 2	1 to 4.5	3 to 5.5

	Estimated Total Settlement, in. *			
Location	**1/4 Full of Water**	**1/2 Full of Water**	**3/4 Full of Water**	**Full of Water**
Southwest Tank	< 1	1.5 to 3.5	3.5 to 7	5 to 9.5
Middle South Tank	No Exploration Data			
Southeast Tank	No Exploration Data			

* Inner two-thirds of tank footprint

The estimated settlements tabulated above are total settlement for a given loading. Incremental settlement is the difference between one load increment and another. We anticipate 90% of the settlement at each stage will occur over a timeframe of about 1 to 2 months.

As an alternative to filling the tanks with water, the tank footprints may be preloaded or surcharged with a temporary fill to reduce post-construction settlement. We estimate 25- to 30-ft-thick temporary fill placed above finished floor elevation will be necessary to induce a load equivalent to a full tank of water, depending somewhat on the material used to construct the temporary fill. The top edge of the temporary preload fill should extend a minimum of 5 ft beyond the limits of the planned tanks. The sides of the preload fill can be sloped at about 1.5H:1V. We estimate 90% of the preload or surcharge settlement will occur over a timeframe of about 1 to 2 months.

For areas surcharged with a full tank of water or an equivalent stockpile of fill and with no ground improvement, we estimate the subsequent post-construction static settlement resulting from the 2,500-psf tank service bearing pressure will be reduced to about 0.5 to 2 in. The estimates of the magnitude and rate of settlement in this section assume no ground improvement. As noted previously, ground improvement will reduce the magnitude and timeframe of settlement and would be designed by a specialty contractor.

Settlement Monitoring. We recommend monitoring settlement during water testing or preloading. The monitoring data will serve as the basis for evaluating the rate of filling and settlement, when additional stages can be completed, and the duration of the water testing or preloading. In our opinion, settlement plates will provide the most direct and effective method of monitoring movement during and following preloading if a stockpile fill is used. Survey markers on the side of the tanks will be the most effective if preloading the tanks with water is used. For water testing, settlement in the central portion of each tank can be measured by installing electronic settlement transducers beneath the tanks. We recommend installing at least three settlement plates or transducers within the central portion of each tank. In addition, we recommend at least three additional vibrating-wire piezometers installed beneath the tank locations to allow collection of available groundwater/piezometric data. Piezometric data can be used to estimate the degree of consolidation completed. Depending on the rate of fill construction, the settlement plates or survey markers should be surveyed twice a week during preloading or water testing. A typical settlement plate detail is shown on Figure 7.

It is important to collect groundwater level data during the course of preloading the tank. As mentioned in the Groundwater section of this report, vibrating-wire piezometers were installed in borings B-4 and B-7. Care should be taken to protect these piezometers to allow accurate recording of groundwater levels at the site, important for monitoring settlement during the preload or water testing period.

The settlement monitoring program should be further developed during final design of the tanks once the foundation preparation and support details are known.

Driven Piles. As an alternative to ground improvement and surcharging the site, the tanks could be supported on driven steel piles. Pile support can be designed using the criteria provided in Table 3 of the Driven Piles section of this report. LPILE criteria for Area 300 are provided in Table 4 of the Pile Lateral Load section of this report.

Area 300 Lightly Loaded Structures Foundation Support

It is our understanding the boiler structure, pump basin, control room, and fire pump and foam structure will be lightly loaded. The ancillary structures in the tank area can be supported on spread footings; however, without ground improvement, the structures could settle up to about 10 in. due to liquefaction. Spread footings could be designed using the criteria summarized in the Spread Footings section of this report. Seismic settlements of structures can be reduced to less than 1 in. by using driven pipe pile foundations. Pile support for the structures in Area 300 can be designed using the criteria provided in Table 3 in the Driven Piles section of this report. LPILE criteria for Area 300 are provided in Table 4 in the Pile Lateral Load section of this report. Alternatively, a foundation system consisting of spread footings following ground improvement could likely be designed to limit seismic settlements to acceptable levels.

Area 400 Marine Terminal

General. Area 400 includes about 1,050 ft of transfer pipeline, a transformer pad, E-house structure, fire pump and foam structure, and vapor control unit. The layout is shown on Figure 5. Improvements planned for the existing dock structure and moorage dolphins are outside the scope of this report and will be addressed in a supplemental report. It is our understanding the transfer pipeline, structures, and transformer pad will be lightly loaded. As discussed in the Seismic Considerations section of this report, we estimate 12 to 24 in. of liquefaction-induced settlement in Area 400 and tens of feet of lateral spread within 100 ft of the riverbank slope. As shown on the Figure 5, approximately 1,050 ft of the transfer pipeline will be located within about 100 ft of the riverbank, including a section that extends into Area 500. Due to the potential for large lateral spreading deformations, it is our opinion that ground improvement will likely be required to mitigate the impact of large seismic lateral displacements on the proposed pipeline and structures located near the river.

We anticipate foundation support can be designed using the criteria provided in the Spread Footing or Pile Foundation sections of this report. However, foundation support for the Area 400 structures will depend on the ground improvement design, including the type of ground improvement and the performance criteria. Recommendations for support of structures in Area 400 should be evaluated concurrently with design of the ground improvement during final design of the facility.

Ground Improvement. Ground improvement, such as vibro-compaction or stone column methods, can be designed to reduce lateral spreading deformations and liquefaction-induced settlements within Area 400. Lateral spreading is typically mitigated by the construction of a zone, or buttress, of densified (improved) soil along the riverbank. We anticipate the ground improvement buttress for Area 400 will be constructed by a specialty contractor in accordance with plans and performance specifications developed by the design team.

The design of ground improvement (type, depth, width, and length) depends on the project performance criteria, such as allowable deformations and lateral loads on structures. The design will require detailed discussions with the project team to develop the performance criteria. For preliminary planning and cost estimating, we estimate a ground improvement buttress will be on the order of 90 ft deep, 100 ft wide, and extend about 100 ft beyond the upstream and downstream ends of the project improvements (about 1,200 ft along the river). The dimensions of the buttress could vary significantly based on the type of ground improvement used. It should be noted that portions of the transfer pipeline are located adjacent to the East Landfill Cap. Due to restrictions associated with the landfill, geotechnical borings were not completed within the landfill boundaries.

Area 500 Transfer Pipelines

General. Based on discussions with the design team, foundation support for the pipeline will consist of spread footings or driven pipe piles. In Area 500, for unimproved ground conditions, we estimate the liquefaction-induced settlement of spread footings will be in the range 3 to 15 in., and lateral spreading deformations may occur within about 1,100 ft of the river based on the MCE_G hazard level. As noted in the discussion above for Area 400, we anticipate a ground improvement buttress will be installed along the riverbank to mitigate lateral spreading deformations that could affect the pipeline. In our opinion, a ground improvement buttress would also mitigate lateral spreading of upland areas behind the improved zone, including the north-south run of pipeline that extends from the river north along Gateway Avenue.

Foundation Support. It is our understanding the pipeline will be lightly loaded. We estimate up to 15 in. of liquefaction-induced settlement of the pipeline if supported on spread footings. Spread footings can be designed using the criteria summarized in the Spread Footings section of this report. Seismic settlements of structures can be reduced to less than 1 in. by using driven pipe pile foundations. Pile support for the pipeline in Area 500 can be designed using the criteria provided in Table 3 of the Driven Piles section of this report. LPILE criteria for Area 500 are provided in Table 4 of the Pile Lateral Load section of this report. Alternatively, a foundation system consisting of spread footings following ground improvement could likely be designed to limit seismic settlements to acceptable levels. As previously noted, a portion of the Area 500 pipeline is located adjacent to the riverbank and may require ground improvement. Foundation support for that section should be developed in conjunction with the design of the ground improvement as discussed for Area 400.

Spread Footings (Areas 200, 300, 400, 500, and 600)

The lightly loaded structures in Areas 200, 300, 400, 500, and 600 can be supported on conventional spread footings established in medium dense sand fill, undisturbed silt, or new structural fill. However, as noted in the above report sections regarding specific project areas, relatively large seismic-related settlements are estimated for spread footings unless ground improvement is undertaken.

Based on the borings completed for this project and for past projects at the Port, most of the project area is mantled by at least 5 to 10 ft of medium dense sand fill. However, explorations for previous work at the Port indicate a lesser thickness of fill is present along the proposed pipeline alignment between Gateway Avenue and the new Gateway Avenue bridge. Where there is less fill, silt subgrade may be present at the bottom of the footings. Footings should be established in firm, undisturbed soil or compacted structural fill at a minimum depth of 18 in. below the lowest adjacent finished grade. The width of footings should not be less 24 in. All foundation subgrade should be observed by a qualified geotechnical engineer. Soft,

loose, or unsuitable soils encountered at footing subgrade should be overexcavated and backfilled with granular structural fill. Excavations for all footings should be made using a smooth-edged bucket and evaluated by a geotechnical engineer. For spread footings established in silt or silty sand during wet weather conditions, we recommend placing a minimum 3 in. of crushed rock over the subgrade to prevent disturbance and softening by construction activities.

Settlement estimates for square and continuous/rectangular spread footings founded on silt subgrade in accordance with the above criteria are shown on Figure 8. The figure summarizes settlement as a function of column load, bearing pressure, and footing dimensions. As previously noted, we anticipate that most of the footings will be underlain by medium dense sand fill, and the settlement estimates for footings underlain by at least 2 ft of sand can be reduced by about 20%.

The bearing pressures apply to the total of dead load plus permanently and/or frequently applied live load and can be increased to 2,500 psf for the total of all loads; dead, live, and wind or seismic. For seismic conditions, the 2,500-psf seismic allowable bearing capacity includes a factor of safety of about 2 and assumes the footings are underlain by at least 2 ft of medium dense to dense sand subgrade. The minimum 2-ft thickness of granular fill should be verified during construction, and some overexcavation and backfilling with granular structural fill should be anticipated. The ultimate bearing capacity for seismic loading depends somewhat on the amount of foundation soil that is submerged and susceptible to soil strength reduction due to liquefaction of soils during the design earthquake. We have assumed a groundwater elevation of +12 ft during seismic loading.

Horizontal shear forces can be resisted partially or completely by frictional forces developed between the base of the spread footing foundations and the underlying soil and by soil passive resistance. The total frictional resistance between the footing and the soil is the normal force times the coefficient of friction between the soil and the base of the footing. We recommend using an ultimate value of 0.35 for the coefficient of friction; the normal force is the sum of the vertical forces (dead load plus real live load). If additional lateral resistance is required, passive earth pressures against embedded footings can be computed on the basis of an equivalent fluid having a unit weight of 250 pcf. This design passive earth pressure value assumes that backfill around footings will be placed as granular structural fill.

If ground improvement is used to mitigate seismic settlement of lightly loaded structures, the allowable bearing pressure could likely be increased accordingly depending upon the type and design of the ground improvement.

Driven Piles (Areas 200, 300, 400, 500, and 600)

As discussed in the above report sections for Areas 200 through 600, elements of the improvements that cannot tolerate the estimated static and/or liquefaction-induced settlements can be supported on driven steel piles. Although pile structural loads are not available at this time, we anticipate that with the exception of Area 300 the piles will be relatively lightly loaded. However, due to potential loss of support and downdrag loading as a result of liquefaction and seismic settlement, the piles will need to be driven to the underlying gravel to minimize the risk of pile settlement during the design earthquake. To develop sufficient end bearing capacity and minimize penetration into the gravel, we recommend driving the piles closed end with a flush-fitting end plate. Recommended ultimate capacities for potential pipe pile sizes driven into the gravel are provided for each Area in the table below for the static and seismic cases. As

previously indicated, pile foundation recommendations for Area 400 should be developed after ground improvement has been designed for the Area.

TABLE 3: ULTIMATE PILE CAPACITIES

AREAS 200, 500, AND 600

Pile Size	Ultimate Capacity, kips		Seismic Downdrag Load, kips
	Static	Seismic *	
PP 12.75 x 0.500-in.	420	325	90
PP 16 x 0.500-in.	650	525	110

* Includes downdrag reduction

Assumed gravel elevation for pile design:

Area 200 and 600 = below elevation -60 ft
Area 500 = below elevation -34 ft

AREA 300

Pile Size	Ultimate Capacity, kips		Seismic Downdrag Load, kips
	Static	Seismic *	
PP 12.75 x 0.500-in.	420	375	60
PP 16 x 0.500-in.	650	500	80
PP 24 x 0.500-in.	1,000	910	120

* Includes downdrag reduction

Assumed gravel elevation for pile design:

Area 300 = below elevation -28 ft

The ultimate capacities in the above table are based on soil-support considerations and may be limited by structural properties. Based on soil support properties, a factor of safety (FS) of 2 is recommended for the static case, and a FS of 1.5 is recommended for the seismic case. The ultimate capacities assume piles will have a minimum center-to-center spacing of at least three diameters (3D). The seismic capacity includes a reduction due to liquefaction and downdrag loading. Estimated seismic downdrag loads should be included in the structural design of piles. However, downdrag loads do not have to be included in determining the allowable seismic capacity because the seismic capacity includes a reduction for downdrag. For piles embedded at least 5 ft into dense gravel, we estimate that static and seismic settlements will be limited to about the elastic shortening of the piles. We conservatively estimate that the piles may penetrate up to 10 to 15 ft into the gravel. Structural loads on the piles are not available at this time, and we acknowledge that other pile types or sizes may be used to support the structural loads. The use of driven grout piles as an alternative pile type is discussed in our July 18, 2013, progress memorandum for Area 300 referenced on page 1. Larger pile capacities, if needed, may be feasible. Steel pipe piles driven to practical refusal in the gravel with a sufficiently large pile-driving hammer can essentially develop the allowable structural capacity of the pile section.

The appropriate size of impact hammer to drive the piles into the gravel and develop sufficient end-bearing resistance will depend on the actual design pile capacities. The appropriate hammer size should be evaluated on a preliminary basis with a wave equation analyses using the computer program GRLWEAP published by Pile Dynamics, Inc. We recommend completing widely spaced Pile Dynamic Analyzer (PDA) testing during the initial pile installation to evaluate the appropriate terminal driving criteria. Restrike testing after a 24-hour waiting, or set-up, period can also be used to evaluate the ultimate pile capacity using the Modified Gates equation.

Pile Lateral Loads. For conditions of lateral loading, we anticipate the piles will be evaluated using the computer software L-Pile Plus developed by Ensoft, Inc. of Austin, Texas. For lateral load analysis, we have assumed the water table is at elevation +12 ft (NGVD) to correspond to seasonally averaged high water levels for the nearby Columbia River.

Recommended input parameters for the various soil units for L-Pile analysis are tabulated below for static and seismic conditions. The parameters for use in L-pile for liquefied soil conditions were calculated using the residual undrained shear strength evaluated using the relationship between clean-sand corrected N-values (SPT test) and residual strength described by Idriss and Boulanger (2007). Residual undrained shear strength and effective overburden pressure were then used to estimate a reduced soil friction for liquefied conditions and a corresponding initial modulus, k_i.

TABLE 4: SOIL PROPERTIES FOR L-PILE ANALYSIS

AREAS 200 AND 600

Soil Unit	Elevation, ft (NGVD 29)	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill	Above +24	Sand (Reese)	Static & Seismic	60	0.067	34	N/A	N/A
SILT	+12 to +24	Soft Clay	Static	N/A	0.06	N/A	2.1	0.02
		Soft Clay	Seismic	N/A	0.06	N/A	1.7	0.02
Submerged SILT[1]	-3 to +12	Soft Clay	Static	N/A	0.025	N/A	2.1	0.02
		Sand (API)	Seismic	10	0.025	4	N/A	N/A
Submerged SAND[1]	-60 to -3	Sand (Reese)	Static	60	0.030	35	N/A	N/A
		Sand (API)	Seismic	10	0.030	12	N/A	N/A
Submerged GRAVEL[1]	Below -60	Sand (Reese)	Static & Seismic	125	0.04	40	N/A	N/A

AREA 300

Soil Unit	Elevation, ft	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill	Above +12	Sand (Reese)	Static & Seismic	150	0.07	36	N/A	N/A
Submerged SILT[1]	+12 to -4	Soft Clay	Static	N/A	0.025	N/A	3.5	0.02
		Soft Clay	Seismic	N/A	0.025	N/A	2.8	0.02
Submerged SAND[1]	-4 to -30	Sand (Reese)	Static	60	0.030	35	N/A	N/A
		Sand (API)	Seismic	10	0.030	12	N/A	N/A

Submerged GRAVEL[(1)]	Below -30	Sand (Reese)	Static & Seismic	125	0.04	40	N/A	N/A

AREA 500 (NORTH OF HARBORSIDE DRIVE [3])

Soil Unit	Elevation, ft	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill	Above +24	Sand (Reese)	Static & Seismic	60	0.07	35	N/A	N/A
Sand and Silt	+24 to +12	Soft Clay	Static & Seismic	N/A	0.064	N/A	3.2	0.02
Submerged Sand and Silt	+12 to -16	Soft Clay	Static	N/A	0.028	N/A	3.2	0.02
		Soft Clay	Seismic	N/A	0.028	N/A	0.6	0.02
Submerged SAND	-16 to -34	Sand (Reese)	Static	60	0.030	35	N/A	N/A
		Sand (API)	Seismic	10	0.030	12	N/A	N/A
Submerged GRAVEL	Below -34	Sand (Reese)	Static & Seismic	125	0.04	40	N/A	N/A

AREA 500 (SOUTH OF HARBORSIDE DRIVE [3])

Soil Unit	Elevation, ft	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill	Above +21	Sand (Reese)	Static & Seismic[4]	60	0.07	35	N/A	N/A
Sand and Silt	+21 to +12	Sand (Reese)	Static & Seismic[4]	25	0.064	32	N/A	N/A
Submerged Sand and Silt	+12 to -7	Sand (Reese)	Static	20	0.028	32	N/A	N/A
		Sand (API)	Seismic[4]	10	0.028	6	N/A	N/A
Submerged SAND	-7 to -57	Sand (Reese)	Static	60	0.030	35	N/A	N/A
		Sand (API)	Seismic[3,5]	10	0.030	12	N/A	N/A
Submerged GRAVEL	Below -57	Sand (Reese)	Static & Seismic	125	0.04	40	N/A	N/A

Notes:

1) Submerged soils are below the groundwater level.
2) Groundwater table assumed at elevation +12 ft NGVD.
3) Harborside Drive is identified on Project Layout Plan, Figure 2.
4) Assumes no lateral spreading due to ground improvement in Area 400.

The soil properties provided in Table 4 will be affected by ground improvement. If piles are installed through areas where ground improvement is used to mitigate liquefaction, the static soil properties are appropriate for use in the seismic case to the depth of the ground improvement.

It should be noted that L-pile provides isolated single-pile capacities. Depending on the direction of the loading and layout of the piles, group effects may need to be considered. Group effects can be modeled in L-pile by applying an appropriate p-modifier in non-liquefiable soils. The p-modifier is a function of the center-to-center spacing and tabulated below.

TABLE 5: P-MODIFIERS FOR GROUP EFFECTS

Center-to-Center Pile/Shaft Spacing	P-Modifiers for Rows 1, 2, and 3+
3D	0.8, 0.4, 0.3
5D	1.0, 0.85, 0.7

For liquefied conditions the p-modifier is 1.0

If additional lateral resistance is required, passive earth pressures against embedded pile caps can be computed on the basis of an equivalent fluid having a unit weight of 325 pcf. This passive earth pressure would be applicable only if the backfill for the pile caps is placed as granular structural fill and above the groundwater level.

Site Preparation and Earthwork

Demolition of improvements within the limits of the new structures and pipelines should include removal of existing pavements; floor slabs; foundations and walls; underground utilities, and associated unsuitable backfill. Where fine-grained subgrade soils are present, we recommend using hydraulic excavators equipped with smooth cutting edges for site stripping and excavation. Excavations made during demolition to remove existing improvements should be backfilled with structural fill.

In previously unimproved areas, the ground surface within areas of mass grading or within the limits of proposed pathways or structures should be stripped of vegetation, surface organics, and loose surface soils. We estimate that stripping will generally be necessary to a depth of about 4 to 6 in. in the lightly vegetated areas. Strippings should be removed from the site or used in landscaped areas. Following stripping and prior to filling, the resulting subgrade should be evaluated by the geotechnical engineer for the presence of soft areas. If present, soft areas should be overexcavated and replaced with compacted structural fill as described below. During and following stripping and excavation, the contractor must use care to protect the subgrade from disturbance by construction traffic.

The borings, CPT probes, and existing geotechnical information indicate the site is typically surfaced with sand fill or crushed rock base course. These materials will generally provide a good working surface; however, the contractor will need to use care during wet conditions to avoid disturbing and loosening the subgrade. Sand subgrade should be moisture conditioned and compacted with a medium- to large-size vibratory roller to meet the compaction criteria of structural fill immediately prior to fill placement. Recommendations for structural fill are provided in the Structural Fill section below.

Due to the variable nature of the fill at the site, it should be anticipated that silty soils will be encountered near the ground surface in localized areas. Silty soil is fine grained and sensitive to moisture content. During wet conditions, silty soils are easily disturbed, rutted, and weakened by construction activities. If silty subgrade is encountered during site stripping, haul roads or work pads constructed of imported granular fill will be needed to provide access and protect areas of fine-grained subgrade from damage due to construction traffic during wet conditions. In our opinion, a 12-in.-thick granular work pad should be sufficient to prevent disturbance of the silt subgrade by lighter construction equipment and limited traffic by dump trucks. Haul roads and other high-density traffic areas will require at least 18 to 24 in. of crushed rock to prevent subgrade deterioration. Any subgrade soils that are disturbed by construction activity should be overexcavated to firm soil and backfilled with structural fill placed and compacted as

recommended in the Structural Fill section of this report. Haul road requirements will be minimized if work is accomplished during the driest months of the year. The performance of haul roads can usually be improved by placing a geotextile fabric over the fine-grained subgrade soils prior to placing the rock.

Temporary cut and fill slopes should be 1H:1V or flatter. Permanent cut and fill slopes should be constructed at 2H:1V or flatter. Containment berms will be constructed around the tank farm in Area 300. The berms will likely be constructed of sand obtained within the project limits or imported materials. Sand can be placed as structural fill and maintain 2H:1V side slopes. However, the surface of the berm slopes may experience shallow sloughing due to wetting/drying and freeze/thaw cycles. Periodic maintenance may be required and can be minimized by initially overbuilding the structural fill and subsequently trimming back to the neat slope lines, or by constructing the berms with a flatter slope.

Structural Fill

On-site soils that are free of organics and other deleterious materials and debris are suitable for construction of compacted structural fill. As noted above, it should be anticipated that near-surface, silty soils will be encountered locally. Silty soils are sensitive to moisture content and can be placed and adequately compacted only during the dry, summer months. For construction during the wet, winter and spring months, fills should be constructed using granular materials that are relatively clean, i.e., less than about 7% passing the No. 200 sieve (washed analysis), such as on-site surficial sand fill material.

In general, approved on-site or imported, organic-free, fine-grained sand and silty soils used to construct structural fills within areas of mass filling, structures, and pathways should be placed in 9-in.-thick lifts (loose) and compacted to at least 95% of the maximum dry density as determined by ASTM D 698. Pieces of rock or concrete larger than about 6 in. should be removed from the fill prior to compaction. Fill placed in landscaped areas should be compacted to a minimum of about 90% of the maximum dry density as determined by ASTM D 698. The moisture content of structural fill soils at the time of compaction should be controlled to within 3% of optimum. Some moisture conditioning of fine-grained sand and silty soils may be required to achieve the recommended compaction criteria. All structural fills should extend a minimum horizontal distance of 5 and 2 ft beyond the limits of structures and pavement areas, respectively. Vibratory equipment is most effective for compacting the on-site sand and imported granular materials.

On-site or imported granular material used to construct structural fills or work pads during wet weather can consist of relatively clean granular material, such as sand, sand and gravel, or crushed rock with a maximum size of about 4 in. and with not more than about 7% passing the No. 200 sieve (washed analysis). The first lift of granular fill material placed over silt subgrade should be in the range of 12 to 18 in. thick (loose). Subsequent lifts should be placed 12 in. thick (loose). All lifts should be compacted to at least 95% of the maximum dry density as determined by ASTM D 698 using a medium-weight (48-in.-diameter drum), smooth, steel-wheeled, vibratory roller. Generally, a minimum of four passes with the roller are required to achieve compaction.

Backfill placed in utility trench excavations within the limits of the roadways, pavements, or structures should consist of sand, sand and gravel, or crushed rock with a maximum size of up to 1 1/2 in. and not more than 7% passing the No. 200 sieve (washed analysis). The granular backfill should be compacted to

at least 95% of the maximum dry density as determined by ASTM D 698. Flooding or jetting the backfilled trenches with water to achieve the recommended compaction should not be permitted.

Utilities

In our opinion, there are three major considerations associated with design and construction of new utilities.

1) Provide stable excavation side slopes or support for trench sidewalls to minimize loss of ground.
2) Provide a safe working environment during construction.
3) Minimize post-construction settlement of the utilities and ground surface.

The method of excavation and design of trench support is the responsibility of the contractor and subject to applicable local, state, and federal safety regulation, including the current OSHA excavation and trench safety standards. The means, methods, and sequencing of construction operations and site safety are also the responsibility of the contractor. The information provided below is for the use of our client and should not be interpreted to mean that we are assuming responsibility for the contractor's actions or site safety.

According to current OSHA regulations, the majority of the sand, fine-grained soils, and gravelly materials encountered in the explorations may be classified as Type C. In our opinion, trenches less than 4 ft deep that do not encounter groundwater or sandy soils may be cut vertically and left unsupported during the normal construction sequence, i.e., assuming trenches are excavated and backfilled in the shortest possible sequence, and excavations are not allowed to remain open longer than 8 hours. Excavations more than 4 ft deep or through sandy soils should be laterally supported or alternatively provided with stable side slopes of 1H:1V or flatter. In our opinion, adequate lateral support may be provided by common methods, such as the use of a trench shield or hydraulic shoring systems.

Groundwater seepage, running soil conditions, and unstable trench sidewalls or soft trench subgrades, if encountered, will require dewatering of the excavation and trench sidewall support. The impact of these conditions can be minimized by completing trench excavation during the summer months when groundwater levels are lowest and by minimizing the depth of the trenches. All excavation sidewalls should be properly sloped or shored to conform to applicable local, state, or federal regulations. The design of dewatering systems is the responsibility of the contractor. However, we anticipate that groundwater inflow, if encountered, can be controlled by pumping from sumps.

Design Review and Construction Services

We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GRI should be retained to review all geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. Additionally, to observe compliance with the intent of our recommendations, design concepts, and the plans and specifications, we are of the opinion that all construction operations dealing with earthwork, ground improvement and pile installation should be observed by a GRI representative. Our construction-phase services will allow for timely design changes if site conditions are encountered that are different from those described in our report. If we do not have the opportunity to

confirm our interpretations, assumptions, and analyses during construction, we cannot be responsible for the application of our recommendations to subsurface conditions that are different from those described in this report.

LIMITATIONS AND CONCLUDING REMARKS

This report has been prepared to aid the project team in the design of the project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of the earthwork and foundations. In the event that any changes in the design and location of the project elements as outlined in this report are planned, we should be given the opportunity to review the changes and to modify or reaffirm the conclusions and recommendations of this report in writing.

The conclusions and recommendations submitted in this report are based on the data obtained from the borings and probes made at the locations indicated on Figures 2 through 5 and from other sources of information discussed in this report. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in soil conditions may exist between exploration locations. This report does not reflect any variations that may occur between these locations. The nature and extent of variation may not become evident until construction. If, during construction, subsurface conditions different from those encountered in the explorations are observed or encountered, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Submitted for GRI,

MATTHEW S. SHANAHAN
STATE OF WASHINGTON
44077
REGISTERED
PROFESSIONAL ENGINEER

(12/20/13) *Expires 4/2014*

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This document has been submitted electronically.

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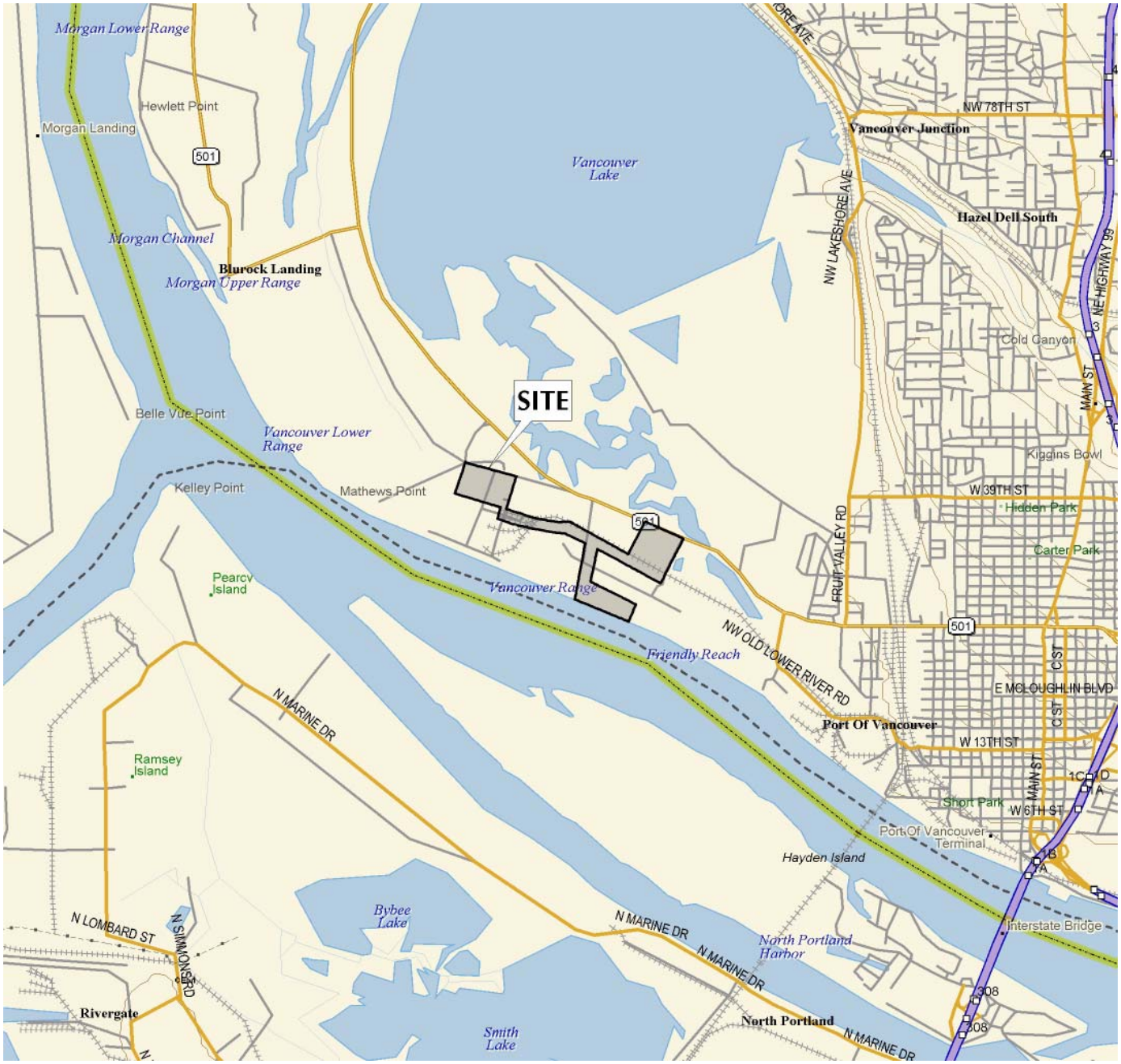

DELORME 3-D TOPOQUADS, WASHINGTON
VANCOUVER, WASH. (3cb, 3ca, & 3db) 2004

North

0 1 2 MILES

GRI

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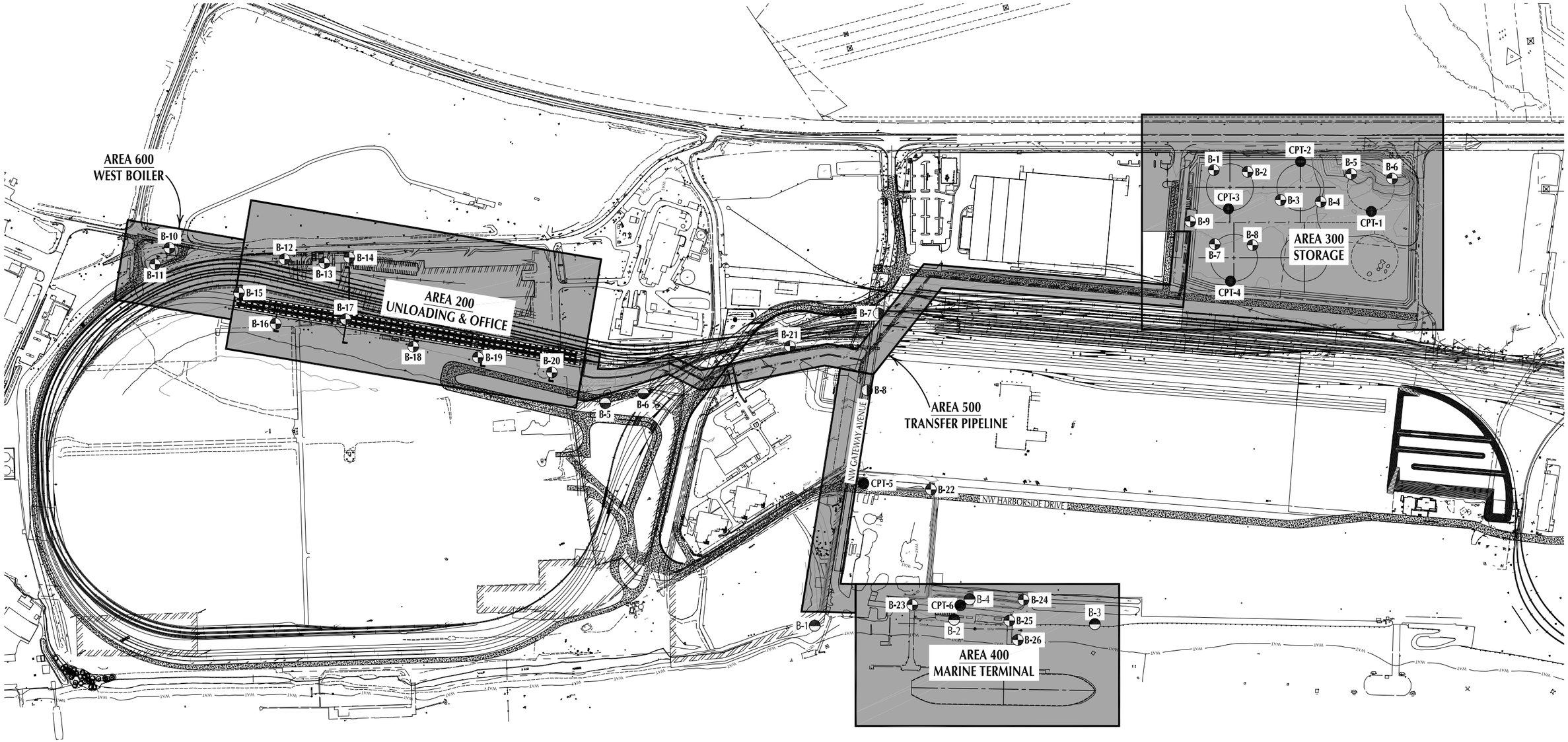
TSVEDT-UPLAND FACILITY

VICINITY MAP

DEC. 2013 JOB NO. W1114-T2 FIG. 1

EX-0001-003860-PCE



BORING MADE BY GRI
(JUNE 5 - OCTOBER 29, 2013)

CONE PENETRATION TEST MADE BY GRI
(JUNE 6, - AUGUST 5, 2013)

BORING MADE BY GRI
(JANUARY 18 - 19, 2011)

BORING MADE BY GRI
(SEPTEMBER 6 - 11, 2006)

BORING MADE BY DAMES & MOORE
(1993)

SITE PLAN FROM FILE BY MACKAY + SPOSITO

North

0 500 1,000 FT

GRI

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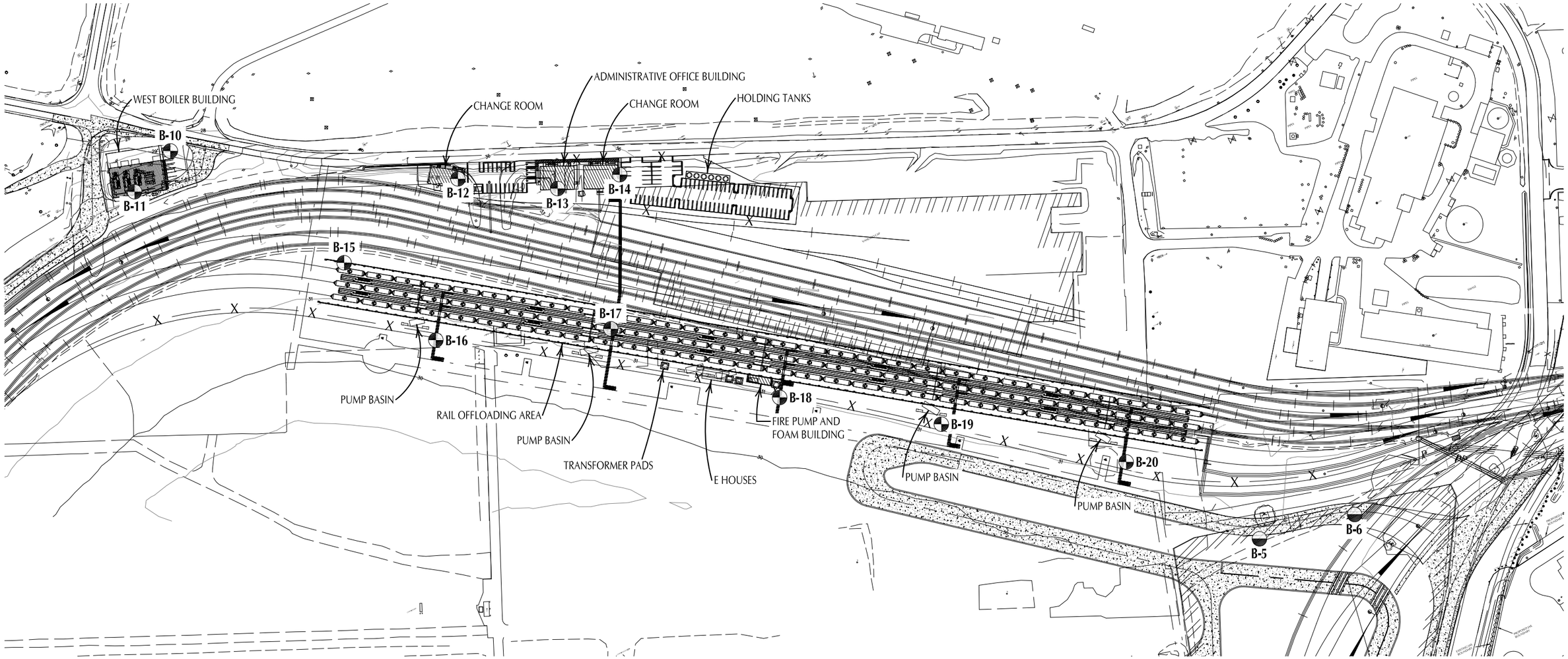
TSVEDT-UPLAND FACILITY

PROJECT LAYOUT PLAN

DEC. 2013 JOB NO. W1114-T2 FIG. 2

EX-0001-003861-PCE



BORING MADE BY GRI
(JULY 1 - 9, 2013)

BORING MADE BY GRI
(JANUARY 18 - 19, 2011)

SITE PLAN FROM FILE BY MACKAY + SPOSITO

North

0 200 400 FT

GRI

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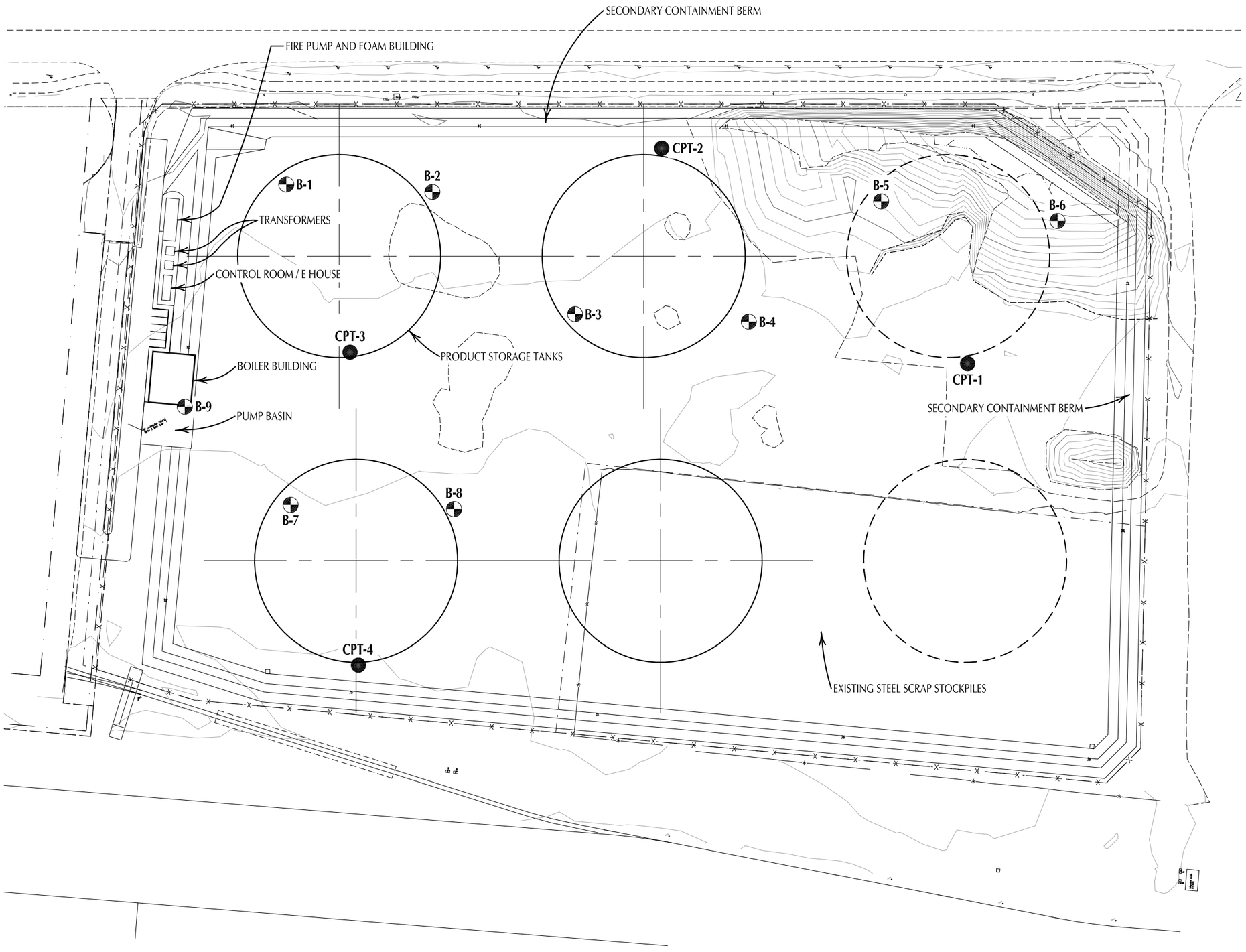
TSVEDT-UPLAND FACILITY

SITE PLAN

(AREAS 200 AND 600 - UNLOADING AND OFFICE / WEST BOILER)

DEC. 2013 JOB NO. W1114-T2 FIG. 3

EX-0001-003863-PCE



BORING MADE BY GRI
(JUNE 5 - 11, 2013)

CONE PENETRATION TEST MADE BY GRI
(JUNE 6 - 10, 2013)

SITE PLAN FROM FILE BY MACKAY + SPOSITO

North

0 120 240 FT

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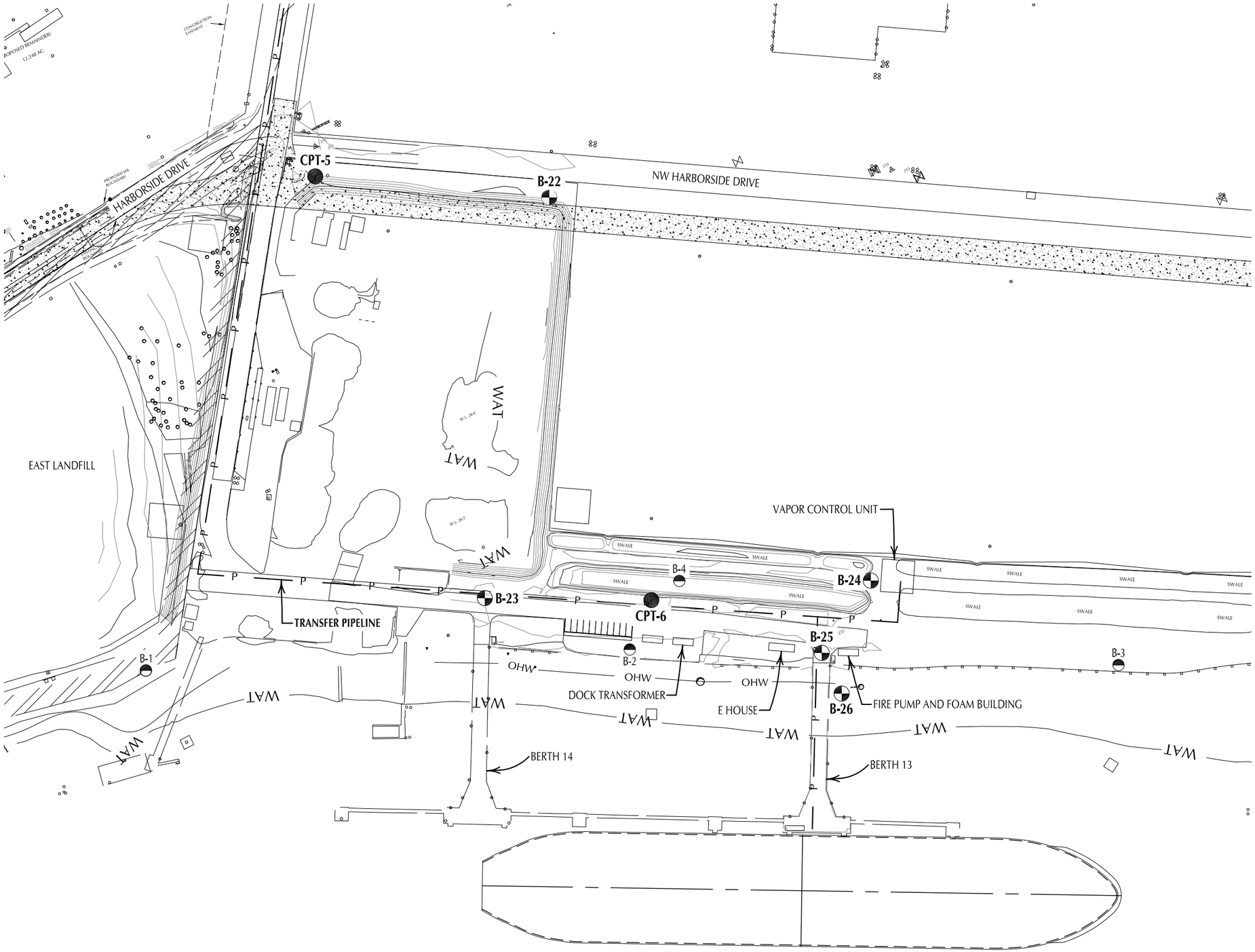
SITE PLAN
(AREA 300 - STORAGE)

DEC. 2013 JOB NO. W1114-T2 FIG. 4

EX-0001-003865-PCE



BORING MADE BY GRI
(JULY 29 - OCTOBER 29, 2013)

CONE PENETRATION TEST MADE BY GRI
(JULY 29 - AUGUST 5, 2013)

BORING MADE BY DAMES & MOORE
(1993)

SITE PLAN FROM FILE BY MACKAY + SPOSITO

North

0 150 300 FT

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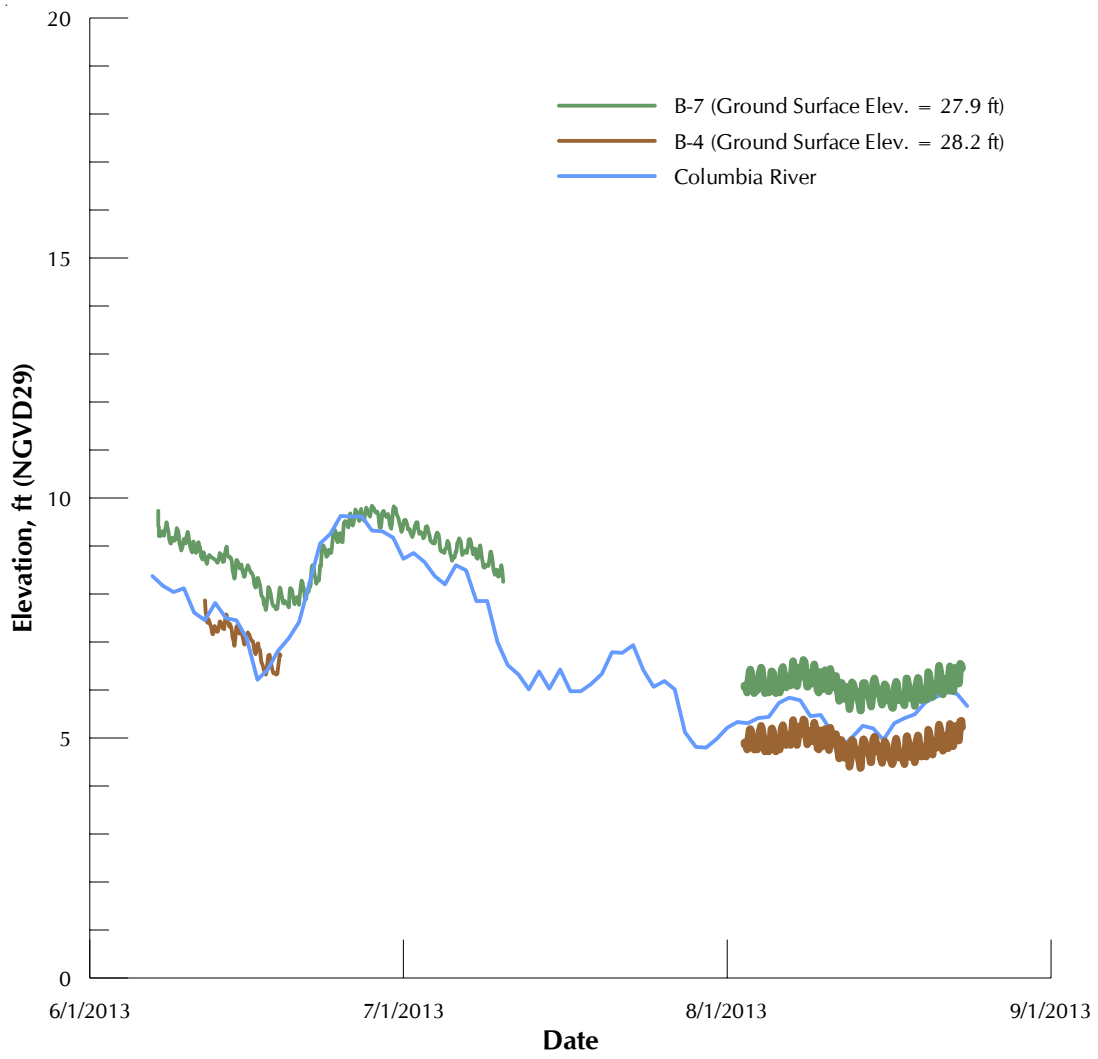
SITE PLAN

(AREA 400 - MARINE TERMINAL)

DEC. 2013 JOB NO. W1114-T2 FIG. 5

EX-0001-003867-PCE



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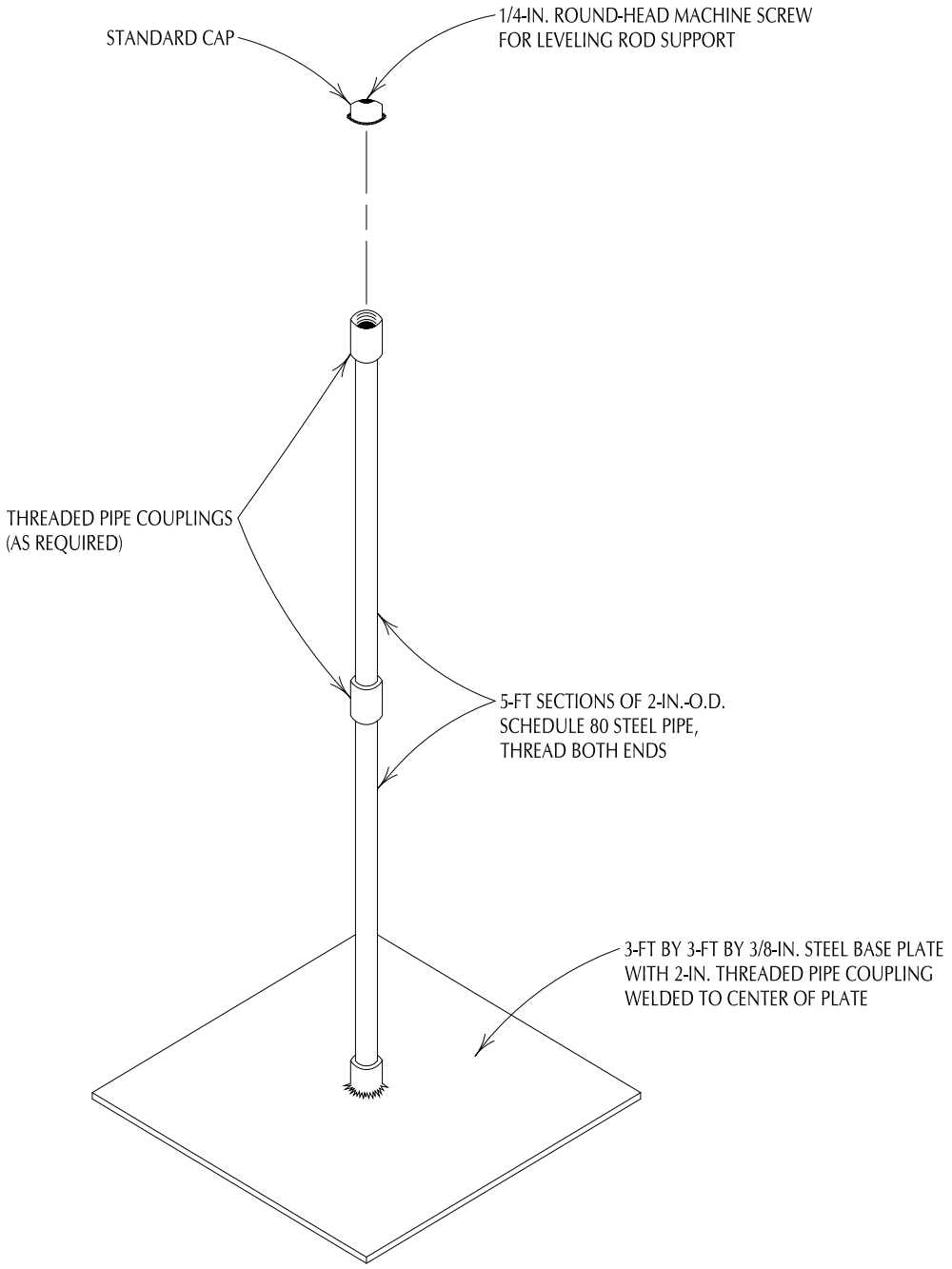
SUMMARY OF PIEZOMETERS

(AREA 300)

DEC. 2013 JOB NO. W1114-T2 FIG. 6



NOT TO SCALE

GRI

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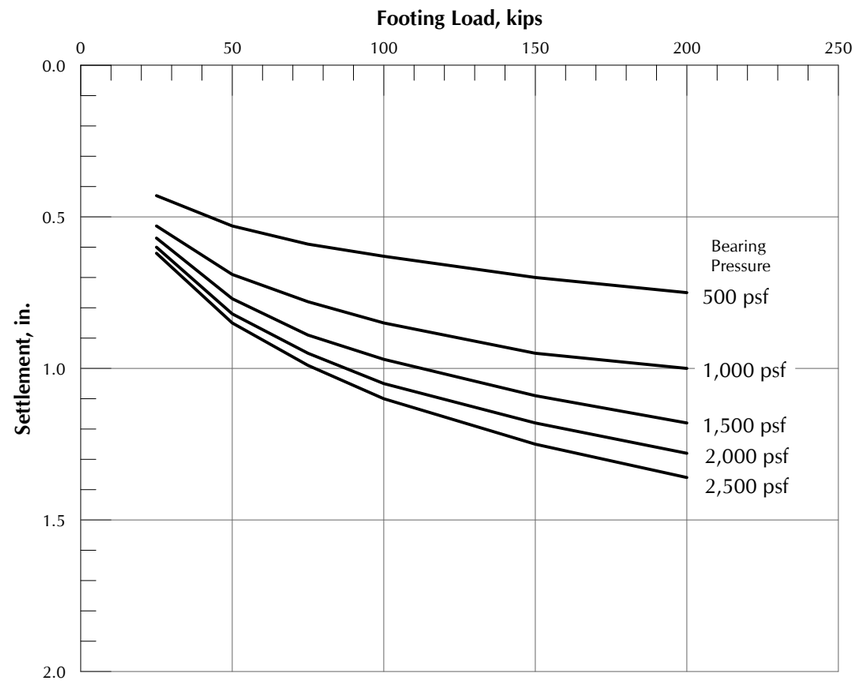
SETTLEMENT PLATE DETAIL

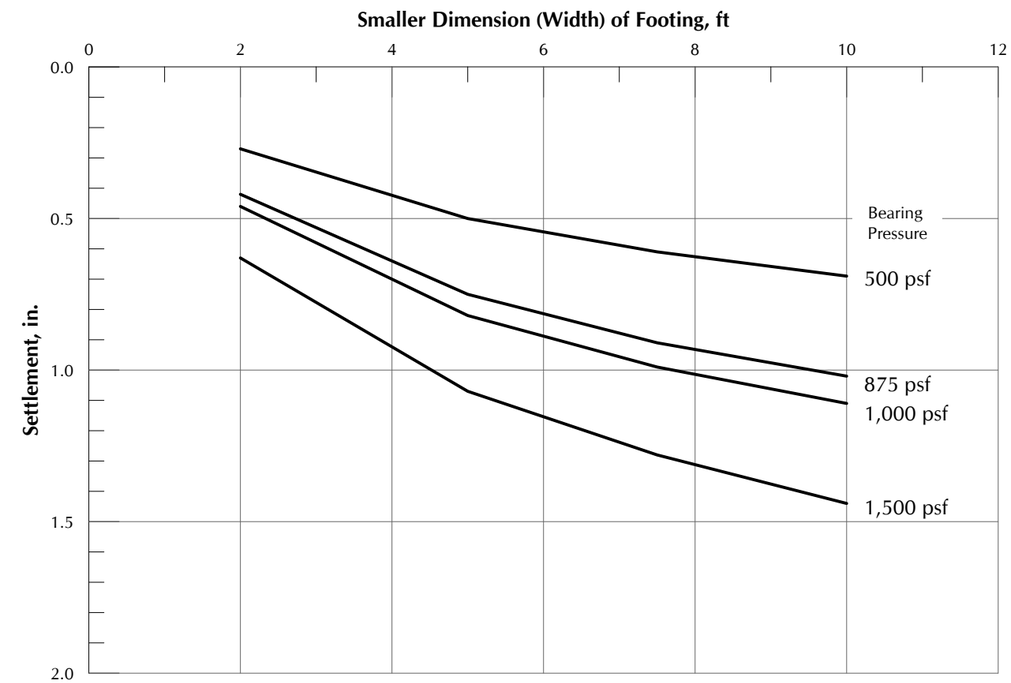
DEC. 2013 JOB NO. W1114-T2 FIG. 7

EX-0001-003870-PCE

Square Footing Bearing Chart



Continuous/Rectangular Footing Bearing Chart



Settlement estimates are for footings established on silt subgrade. As noted in the text of this report, the majority of the footings will be founded in medium dense sand fill, and settlement estimates for footings underlain by at least 2 ft of sand can be reduced by 20%

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ESTIMATED FOOTING SETTLEMENT

DEC. 2013 JOB NO. W1114-T2 FIG. 8

APPENDIX A

Field Explorations, Instrumentation, and Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS, INSTRUMENTATION, AND LABORATORY TESTING

FIELD EXPLORATIONS

General

Subsurface materials and conditions in the upland project area were investigated with 26 borings and six cone penetration test probes (CPTs). The approximate locations of the explorations are shown on Figures 2 through 5. An experienced geotechnical engineer from GRI directed the drilling and maintained a detailed log of the materials and conditions disclosed during the course of the work. The locations of the borings with respect to areas of the proposed facility are discussed below.

Borings

Disturbed and undisturbed samples were typically obtained from the borings at 2.5-ft intervals of depth in the upper 15 ft and at 5-ft intervals below this depth. Disturbed samples were obtained using a standard split-spoon sampler. At the time of sampling, the Standard Penetration Test was conducted. This test consists of driving a standard split-spoon sampler into the soil a distance of 18 in. using a 140-lb hammer dropped 30 in. The number of blows required to drive the sampler the last 12 in. is known as the standard penetration resistance, or N-value. The N-values provide a measure of the relative density of granular soils, such as sand or gravel, and the relative consistency, or stiffness, of cohesive soils, such as silt or clay. The split-spoon samples were carefully examined in the field and representative portions were saved in airtight jars. All samples were returned to our laboratory for further examination and physical testing.

Relatively undisturbed samples of fine-grained, cohesive soils were obtained by pushing 3-in.-O.D. Shelby tubes into the undisturbed soil a maximum distance of 24 in. using the drill rig. The soils exposed in the ends of the Shelby tubes were examined and classified in the field. After classification, the ends of the tubes were sealed with plastic end caps and tape to preserve the natural moisture content of the soils. All samples were returned to our laboratory for further examination and testing.

Logs of the borings are provided on Figures 1A through 26A. Each log presents a descriptive summary of the various types of materials encountered in the boring and notes the depth at which the materials and/or characteristics of the materials change. To the right of the descriptive summary, the depth to groundwater and the numbers and types of samples are indicated. Farther to the right, N-values are shown graphically, along with natural moisture contents and percent passing the No. 200 sieve. The terms used to describe the soils encountered in the borings are defined in Table 1A.

Details regarding the drilling in the various areas of the proposed facility are provided below.

Area 300. Borings in Area 300 were completed between June 5 and July 1, 2013, with nine borings, designated B-1 through B-9. The borings were advanced to depths of 50.9 to 82.0 ft with mud-rotary drilling methods using a truck-mounted CME drill rig provided and operated by Western States Soil Conservation of Hubbard, Oregon.

Areas 200 and 600. Borings in Areas 200 and 600 were completed between July 1 and 9, 2013, with 11 borings, designated B-10 through B-20. The borings were advanced to depths of 21.5 to 96.0 ft with mud-

rotary drilling methods using a truck-mounted CME drill rig provided and operated by Western States Soil Conservation of Hubbard, Oregon.

Area 400. Borings in Area 400 were completed between July 29 and October 31, 2013, with four borings, designated B-23 through B-26. The borings were advanced to depths of 80 to 104.2 ft with mud-rotary drilling methods using a truck- or- track-mounted CME drill rig provided and operated by Cascade Drilling LP of Clackamas, Oregon.

Area 500. Borings in Area 500 were completed between July 31 and August 2, 2013, with two borings, designated B-21 and B-22. The borings were advanced to depths of 60.5 and 75.5 ft with mud-rotary drilling methods using a truck-mounted CME drill rig provided and operated by Cascade Drilling LP of Clackamas, Oregon.

Electric Cone Penetration Test (ECPT) Probes

Six CPT probes, designated CPT-1 through CPT-6, were advanced to practical refusal at depths of 54 to 84 ft below the ground surface using a truck-mounted Dutch Cone Unit provided and operated by Vandehey Exploration, Inc. of Banks, Oregon. Probes CPT-1 through CPT-4 were advanced to depths of about 54 to 56 ft in Area 300, CPT-5 was advanced to a depth of about 78 ft in Area 500, and CPT-6 was advanced to a depth of about 83 ft in Area 400.

The equipment is mounted on a truck and operated from within an enclosure on the back of the truck that houses the electrical equipment. The electrical cone probe has a cone and a sleeve that are similar to a mechanical probe, but the forces are measured electronically. In addition to the cone and sleeve transducers, a piezometer is fitted between the cone and the sleeve, which allows measurement porewater pressure and rate of dissipation as the probe is advanced. An accelerometer can also be fitted within the electrical probe. The accelerometer is used to measure the arrival times of shear waves produced at the ground surface as the exploration is advanced. Using these measurements, the shear wave velocity of the soils penetrated can be estimated. The shear wave velocities characterize the soils for the purpose of seismic studies. Shear wave measurements were made during advancement of probes CPT-1 and CPT-6. The terms used to describe the soils encountered in the CPT probes are defined in Table 2A. Logs of the CPT probes are provided on Figures 27A through 32A.

INSTRUMENTATION

Vibrating-Wire Piezometers

Geokon Model 4500 ALV low-pressure, vented vibrating-wire piezometers were installed in borings B-4 and B-7 at about elevation -22 and -17 ft, respectively. The piezometers are equipped with a Geokon Model 8002 (LC-2) single-channel data logger programmed to record data at 2-hr intervals. At the time of installation, the piezometers were saturated with water, taped to a 1-in.-O.D. PVC grout pipe in an inverted position to maintain saturation, and inserted into the open borehole to the desired depth. The borings were then filled with cement-bentonite grout to near the ground surface. The performance of each piezometer was verified before installation and immediately after insertion to design depth with a manual readout box. Each of the installations is equipped with a steel monument casing that was cement grouted into the borehole collar to protect the data logger and readout cables from vandalism and the elements. The data loggers are being downloaded periodically to evaluate the data. The piezometer data with the Columbia River hydrograph data are summarized graphically on Figure 6. The Columbia River

hydrograph data are provided by the USGS station "14144700 Columbia River at Vancouver, WA" located about 3 miles upstream from the site.

LABORATORY TESTING

General

All samples obtained from the field were returned to our laboratory where the physical characteristics of the samples were noted, and the field classifications were modified where necessary. At the time of classification, the natural moisture content of each sample was measured. Additional testing included Torvane shear strength, Atterberg limits, washed sieve analysis, sieve analysis, dry unit weight determinations, and one-dimensional consolidation testing. The following sections describe the testing program in more detail.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM D 2216. The results are provided on Figures 1A through 26A.

Dry Unit Weight

The dry unit weight of 32 undisturbed samples was determined in the laboratory in accordance with ASTM D 2937 by cutting a cylindrical specimen of soil from a Shelby tube sample. The dimensions of the specimen were carefully measured, the volume calculated, and the specimen weighed. After oven-drying, the specimen was reweighed and the moisture content calculated. The dry unit weight was then computed. The dry unit weights are summarized below.

SUMMARY OF DRY UNIT WEIGHT DETERMINATIONS

Boring	Sample	Depth, ft	Natural Moisture Content, %	Dry Unit Weight, pcf	Soil Type
B-1	S-8	21.5	32	90	SILT; some clay, trace fine-grained sand, scattered gravel
B-2	S-8	21.5	34	80	SILT; trace to some clay and fine-grained sand
	S-11	31.5	26	91	Sandy SILT; fine grained sand, trace to some clay, trace organics
B-4	S-7	16.5	31	67	SILT; some clay, trace fine-grained sand and organics
	S-10	27.5	28	92	SAND; fine to medium grained, some silt
B-5	S-6	14.7	36	84	SILT: some clay, trace fine-grained sand
B-6	S-2	5	40	76	SILT; trace to some clay, trace fine-grained sand
	S-5	11.5	30	91	SAND; fine to medium grained, trace to some silt, trace subrounded gravel
B-7	S-12	31.5	21	87	Silty SAND; fine-grained
B-8	S-9	23.5	30	69	SILT; trace to some clay, trace fine-grained sand
B-9	S-7	20	38	82	SILT; some fine-grained sand, trace organics
B-11	S-4	10	28	89	Silty SAND; fine grained
B-12	S-6	15	33	88	Silty SAND; fine grained
	S-9	21.5	35	85	Sandy SILT: fine-grained sand
B-14	S-8	21.5	32	87	SILT; trace clay, fine-grained sand, and organics
B-15	S-4	10	30	84	Silty SAND; fine grained
	S-8	23	37	82	SILT; some fine-grained sand

Boring	Sample	Depth, ft	Natural Moisture Content, %	Dry Unit Weight, pcf	Soil Type
B-16	S-7	20	22	96	Silty SAND; fine grained
	S-11	33	28	88	Sandy SILT; fine-grained sand
B-17	S-7	18	24	92	SILT; some fine-grained sand
B-18	S-5	12.5	34	86	Silty SAND; fine grained
	S-8	23	21	95	SILT; trace fine-grained sand
B-19	S-5	12.5	18	102	Sandy SILT; fine-grained sand
	S-8	21.5	26	76	Sandy SILT; fine-grained sand
B-20	S-4	10	14	89	FILL: SAND; fine to medium grained, trace to some silt
	S-7	20	33	86	Silty SAND; fine grained
B-21	S-7	20	42	78	SILT; trace to some clay and fine grained sand
B-22	S-6	15	36	85	SILT; some sand
B-24	S-18	70	29	88	SAND; fine grained, trace silt
B-26	S-12	40	39	80	SAND; some silt, scattered wood debris
	S-14	45	34	81	SAND; some silt,
	S-16	50	31	90	SAND; some silt

Torvane Shear Strength

The approximate undrained shear strength of relatively undisturbed fine-grained soil samples was determined using a Torvane shear device. The Torvane is a hand-held apparatus with vanes that are inserted into the soil. The torque required to fail the soil in shear around the vanes is measured using a calibrated spring. The results of the Torvane shear tests are summarized on Figures 1A through 22A.

Atterberg Limits

Atterberg limits determinations were completed on nine representative soil samples in substantial conformance with ASTM D 4318. The test data are summarized on Figures 33A and 34A.

One-Dimensional Consolidation

Consolidation testing was performed in accordance with ASTM D 2435 to obtain data on the compressibility characteristics of six samples of relatively undisturbed fine-grained soil. Test results are summarized on Figures 35A through 40A in the form of a curve showing effective stress versus percent strain. The initial and final moisture content and unit weight of the sample are provided at the top of the figure.

Secondary compression was recorded in substantial conformance to ASTM D 2434 Test Method B during the one-dimensional consolidation tests. Compression was recorded at select compressive loads between 1 and 2 tsf for a minimum of 1,200 minutes following application of a compressive load increment. The results are summarized on Figures 41A and 42A in the form of curves showing dial reading versus the log of time.

Grain Size Analysis

Washed-Sieve Method. Washed sieve analyses were performed on representative soil samples to assist in their classification. The test is performed by taking a sample of known dry weight and washing it over a

No. 200 sieve. The material retained on the sieve is oven-dried and weighed, and the percentage of material passing the No. 200 sieve is calculated. The test results are shown on the Boring Logs, Figures 1A through 26A.

Dry Sieve Method. Sieve analyses were performed on five representative samples of sand in substantial conformance with ASTM D 6913. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed, and the percentage of material passing the No. 200 sieve is calculated. The soil retained on the No. 200 sieve is then screened through a series of sieves of various sizes using a sieve shaker. The weight of each sieve is measured prior to and after the soil has been run through the shaker. The weight of the soil retained on each sieve is recorded and expressed as a percentage of the total sample weight. The test data are summarized on Figures 43A and 44A in the form of curves showing the percent of the total soil sample by weight finer versus sieve number or grain size in millimeters.

Table 1A

GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values) blows per foot
very loose	0 – 4
loose	4 – 10
medium dense	10 – 30
dense	30 – 50
very dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values) blows per foot	Torvane Undrained Shear Strength, tsf
very soft	2	less than 0.125
soft	2 - 4	0.125 - 0.25
medium stiff	4 - 8	0.25 - 0.50
stiff	8 - 15	0.50 - 1.0
very stiff	15 - 30	1.0 - 2.0
hard	over 30	over 2.0

Sandy silt materials which exhibit general properties of granular soils are given relative density description.

Grain-Size Classification

Boulders
12 - 36 in.

Cobbles
3 - 12 in.

Gravel
1/4 - 3/4 in. (fine)
3/4 - 3 in. (coarse)

Sand
No. 200 - No. 40 sieve (fine)
No. 40 - No. 10 sieve (medium)
No. 10 - No. 4 sieve (coarse)

Silt/Clay - pass No. 200 sieve

Modifier for Subclassification

Adjective	Percentage of Other Material In Total Sample
clean	0 - 2
trace	2 - 10
some	10 - 30
sandy, silty, clayey, etc.	30 - 50

Table 2A

SOIL CLASSIFICATION
BASED ON CONE PENETRATION TEST

Friction Ratio (Percent)	Soil Classification
0 to 2	Clean sand or slightly silty sand
2 to 5	Silty sand, clayey sand, or silt
> 5	Clayey silt, silty clay, or clay

COHESIVE SOILS

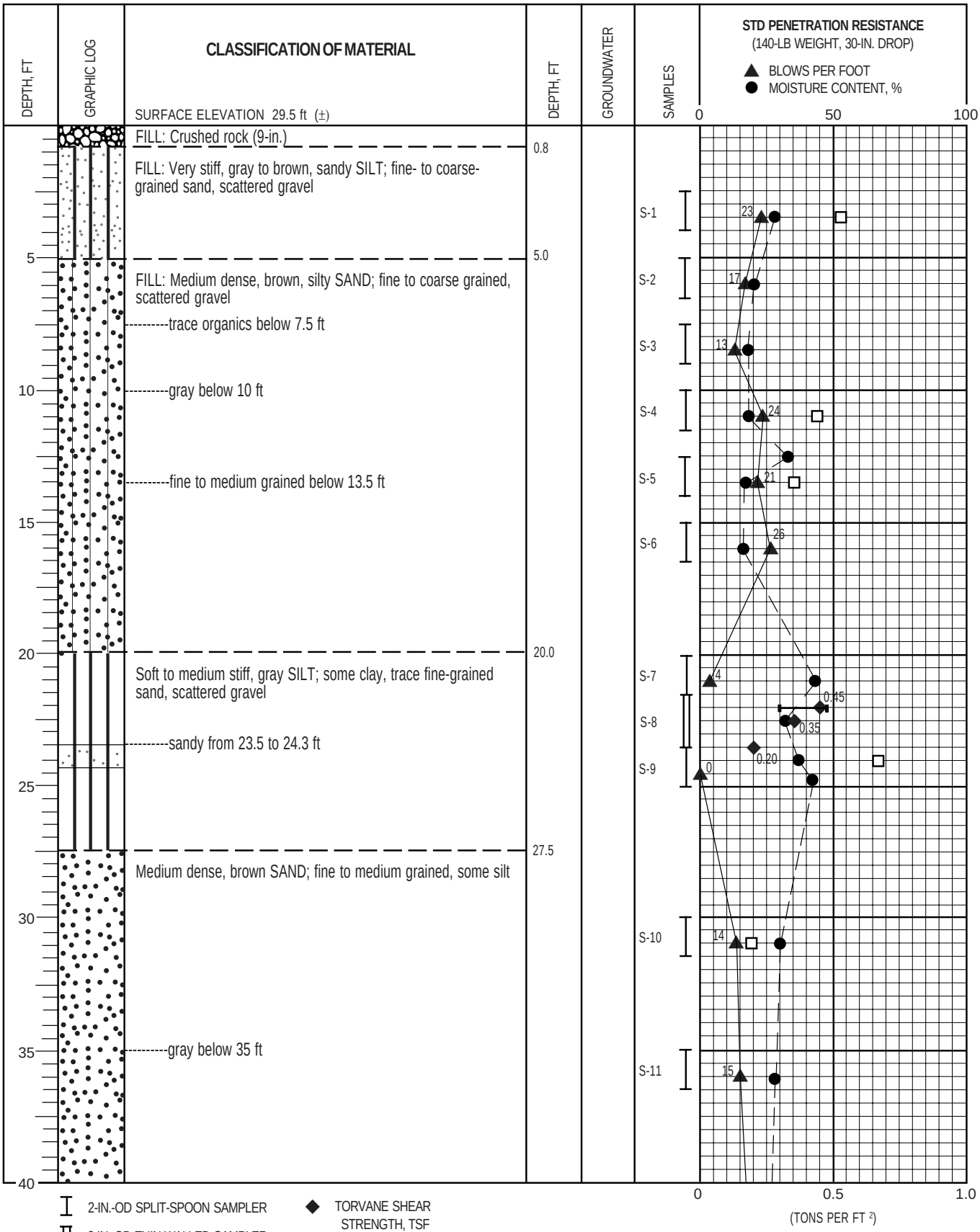
Sleeve Friction, tsf	Relative Consistency
<0.12	Very Soft
0.12 to 0.25	Soft
0.25 to 0.50	Medium Stiff
0.50 to 1.00	Stiff
1.00 to 2.00	Very Stiff
>2.00	Hard

COHESIONLESS SOILS

	Soil Type*			
	ML, SM	SM, SP, SW	SP, SW, GW	SW, GP
Relative Density	Cone Penetration Resistance, tsf			
Very Loose	0 - 8	0 - 14	0 - 20	0 - 24
Loose	8 - 20	14 - 35	20 - 50	24 - 60
Med. Dense	20 - 60	35 - 105	50 - 150	60 - 180
Dense	60 - 100	105 - 175	150 - 250	180 - 300
Very Dense	> 100	> 175	> 250	> 300

* Unified Soil Classification System

1) Friction ratio is equal to sleeve friction (tsf) divided by cone penetration (tsf) expressed as a percent.



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

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BORING B-1

DEC. 2013 JOB. NO. W1114 FIG. 1A

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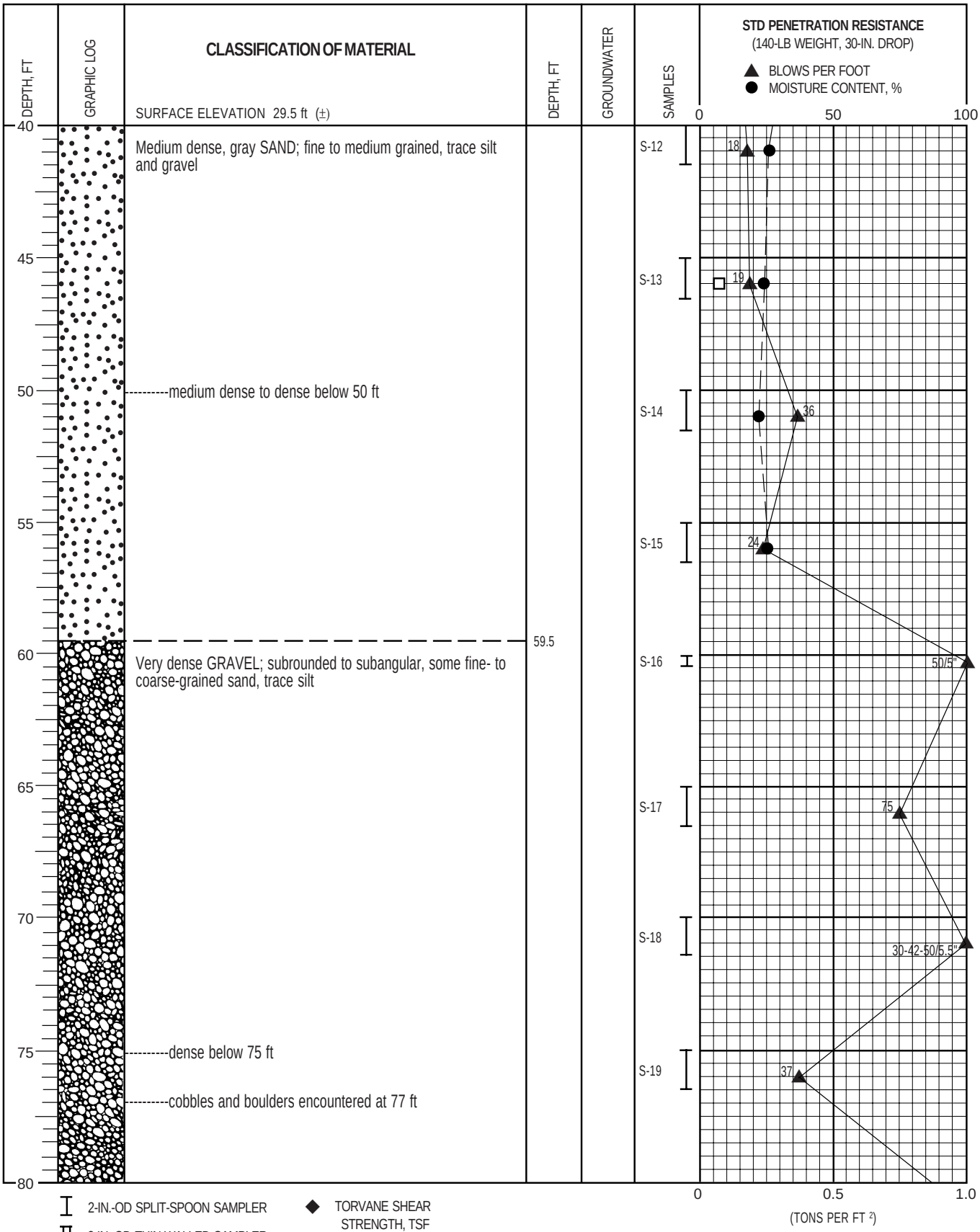


2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-1 (cont.)

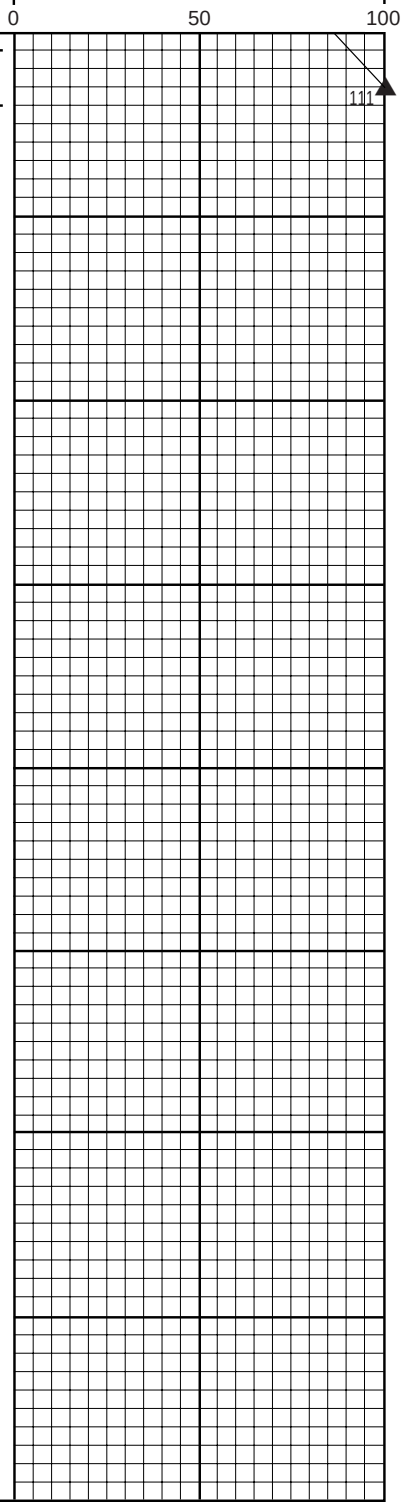
DEC. 2013 JOB. NO. W1114 FIG. 1A

EX-0001-003883-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 29.5 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
80		Very dense GRAVEL; subrounded to subangular, some fine- to coarse-grained sand, trace silt	82.0		S-20 *
		(6/6/2013) Sidewall of boring caved to 35 ft while drilling at 70 ft; Circulation of drilling fluid lost at 74 ft (40 gallons)			
85					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
P VIBRATING-WIRE PIEZOMETER
SLOTTED PVC PIPE
Water Level (date)

TORVANE SHEAR STRENGTH, TSF
PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

Liquid Limit
Moisture Content
Plastic Limit

GRI

BORING B-1 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 1A

EX-0001-003884-PCE

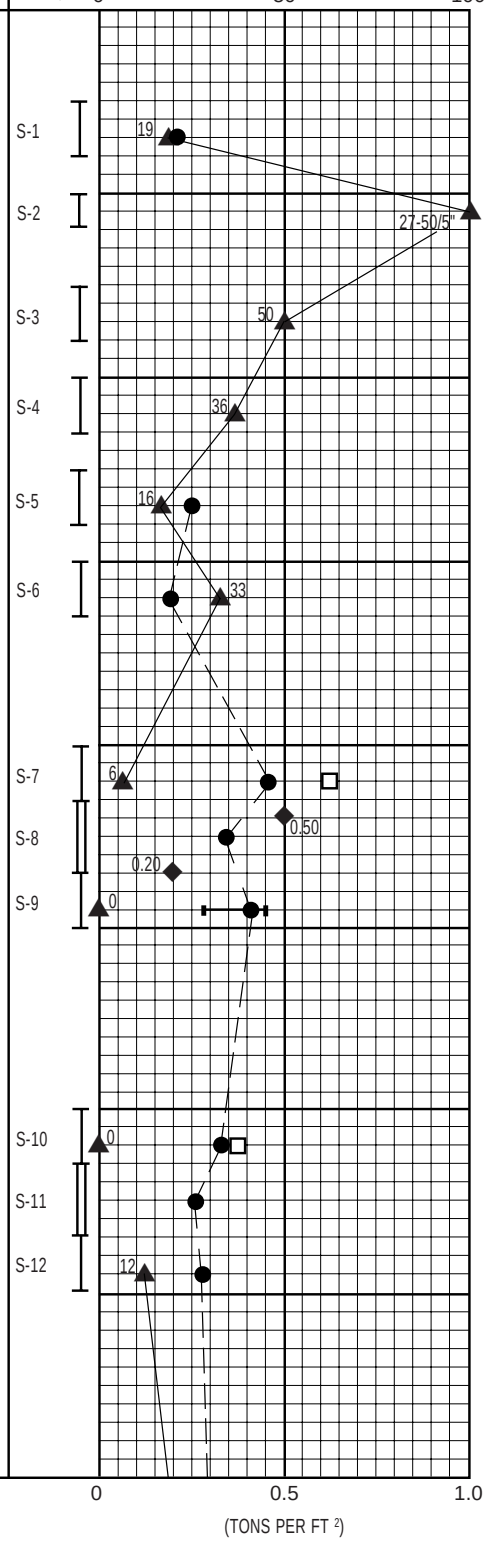
DEPTH, FT	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 29.7 ft (±)	DEPTH, FT
	FILL: Crushed rock (9-in.)	0.8
	FILL: Medium dense, brown, silty SAND; fine to coarse grained, some subangular to subrounded gravel	
5	FILL: Very dense, sandy GRAVEL; subangular to subrounded, fine- to coarse-grained sand, trace to some silt	5.0
	---------gray, scattered brick debris below 7.5 ft	
10	---------dense below 10 ft	
	FILL: Medium dense, gray SAND; fine to medium grained, trace silt, organics, and subrounded to subangular gravel	12.5
15	-------brown, silty below 13.5 ft -------dense, some silt and organics, gravel absent below 15 ft	
	Medium stiff to stiff, gray sandy SILT; fine- to medium-grained sand, trace organics	17.0
20	---------gray mottled rust, trace to some clay and fine-grained sand below 22 ft	
	---------very soft below 24 ft	
25		
	---------sandy, trace organics below 28.5 ft	
30		
	Medium dense, gray SAND; fine to medium grained, trace silt and subrounded gravel	33.5
35		
40		

GROUNDWATER

SAMPLES

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
P VIBRATING-WIRE PIEZOMETER
SLOTTED PVC PIPE
Water Level (date)

TORVANE SHEAR STRENGTH, TSF
PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

Liquid Limit
Moisture Content
Plastic Limit

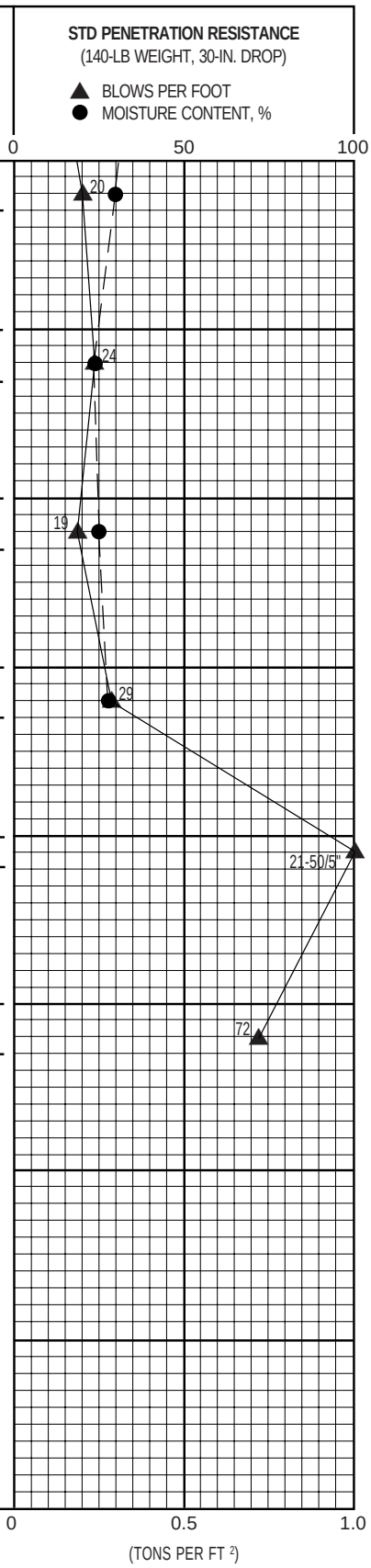
GRI

BORING B-2

DEC. 2013 JOB. NO. W1114 FIG. 2A

EX-0001-003885-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 29.7 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to medium grained, trace silt			S-13
45		---------fine to coarse grained below 45 ft			S-14
50		---------fine to medium grained below 50 ft			S-15
55		---------trace subrounded gravel below 55 ft			S-16
			58.5		
60		Very dense GRAVEL; subangular to subrounded, some fine- to coarse-grained sand, trace silt			S-17 *
65					S-18
			66.5		
		(6/7/2013)			
70					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

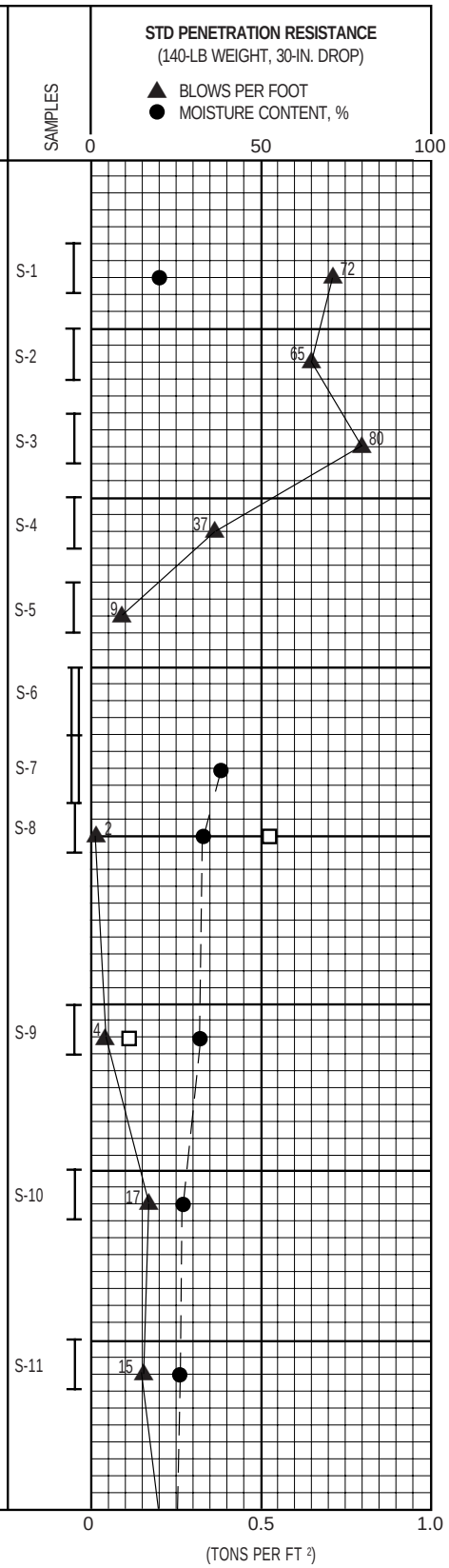
BORING B-2 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 2A

EX-0001-003886-PCE

SURFACE ELEVATION ----- ft (±)

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 28.7 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Crushed rock (9-in.)	0.8	
		FILL: Very dense GRAVEL; subrounded to subangular, some fine- to coarse-grained sand, trace silt and organics, scattered brick debris		
5				
10		----------dense below 10 ft		
			12.0	
		FILL: Loose, gray, silty SAND; fine to medium grained		
			14.0	
15		Very soft, gray SILT; some clay, trace fine- to medium-grained sand		
		----------sandy, trace organics below 19 ft		
20				
			22.0	
		Very loose to loose, gray to brown SAND; fine to medium grained, some silt		
25				
30		----------medium dense, gray below 30 ft		
35				
40				



I 2-IN.-OD SPLIT-SPOON SAMPLER

II 3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF

□ PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit
Moisture Content
Plastic Limit

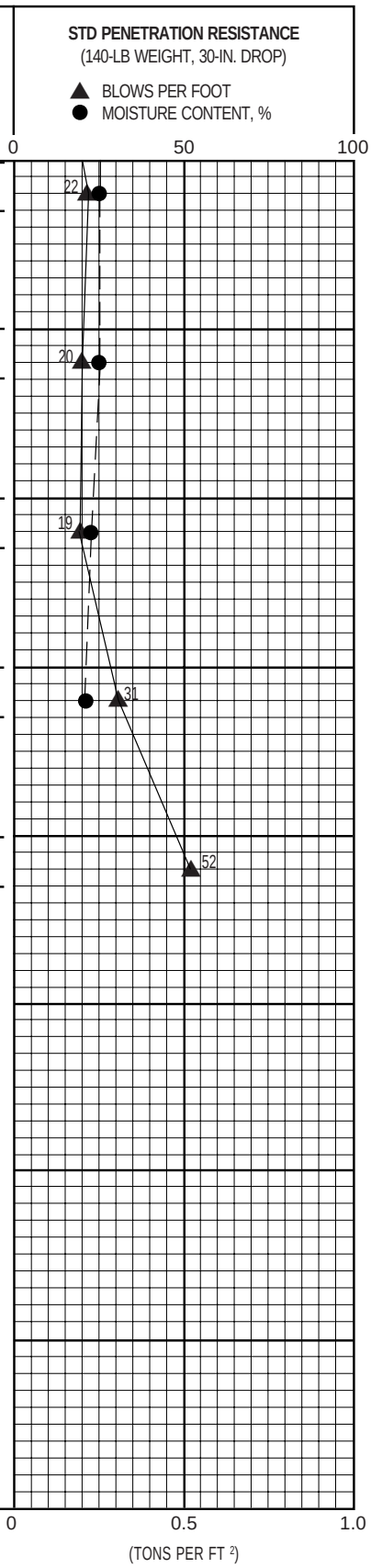
GRI

BORING B-3

DEC. 2013 JOB. NO. W1114 FIG. 3A

EX-0001-003887-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 28.7 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to medium grained, trace silt			S-12
45					S-13
50					S-14
55		---------scattered subrounded gravel below 55 ft			S-15
			57.0		
60		Very dense GRAVEL; subangular to subrounded, some fine- to coarse-grained sand, trace silt			S-16
			61.5		
		(6/12/2013)			
65					
70					
75					
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

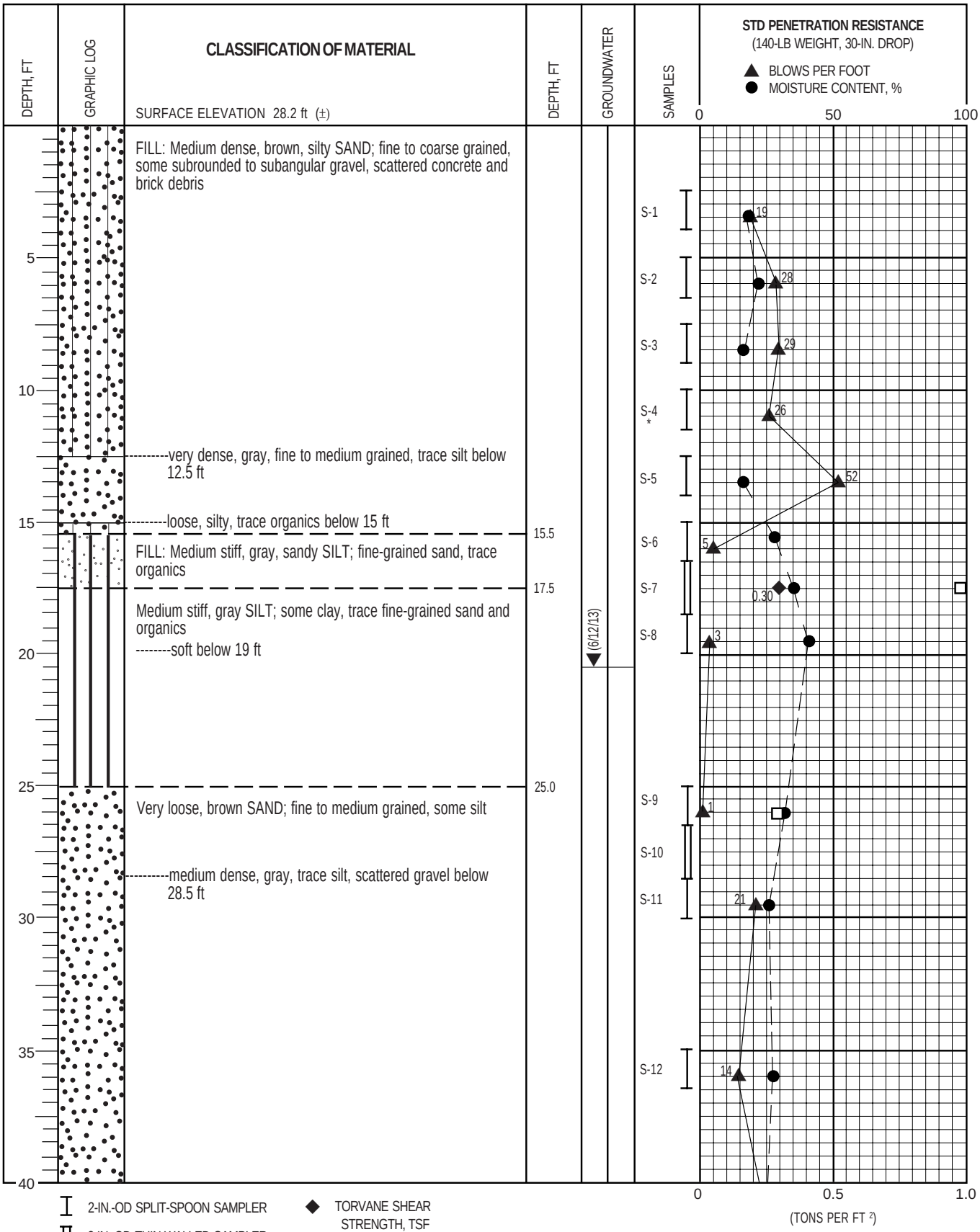
Plastic Limit

GRI

BORING B-3 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 3A

EX-0001-003888-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

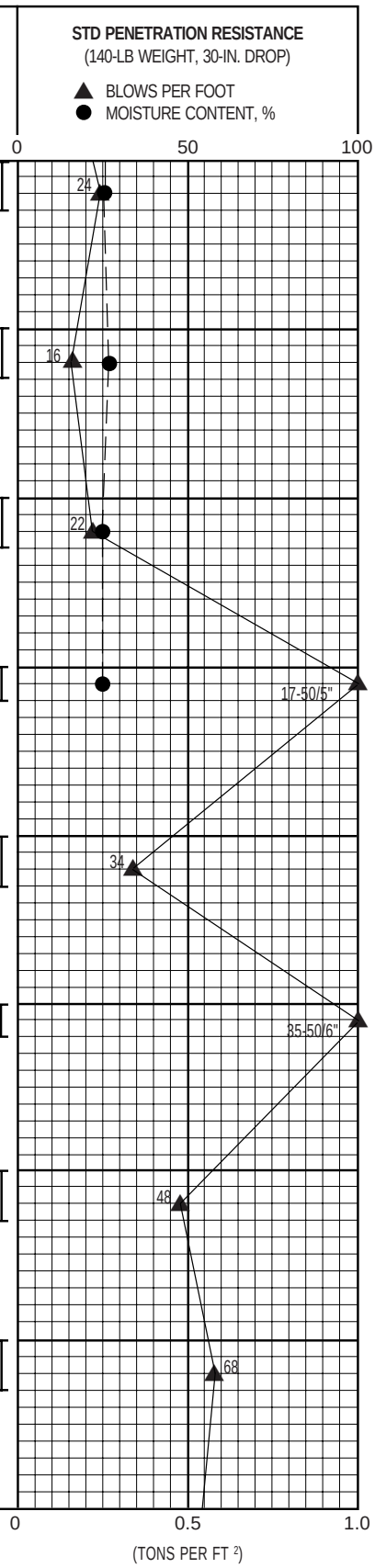
GRI

BORING B-4

DEC. 2013 JOB. NO. W1114 FIG. 4A

EX-0001-003889-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 28.2 ft (±)	DEPTH, FT	GROUNDWATER
40		Medium dense, gray SAND; fine to medium grained, trace silt		
45				
50				P
55		---------fine to coarse grained, some subangular to subrounded gravel below 55 ft		
			56.0	
		Very dense GRAVEL; subrounded to subangular, some fine- to coarse-grained sand, trace silt		
60				
65				
70				
			73.0	
		Very dense, gray SAND; fine to coarse grained, some subrounded gravel, trace silt		
75				
			77.5	
		Very dense GRAVEL; subrounded to subangular, fine to coarse, trace silt		
80				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-4 (cont.)

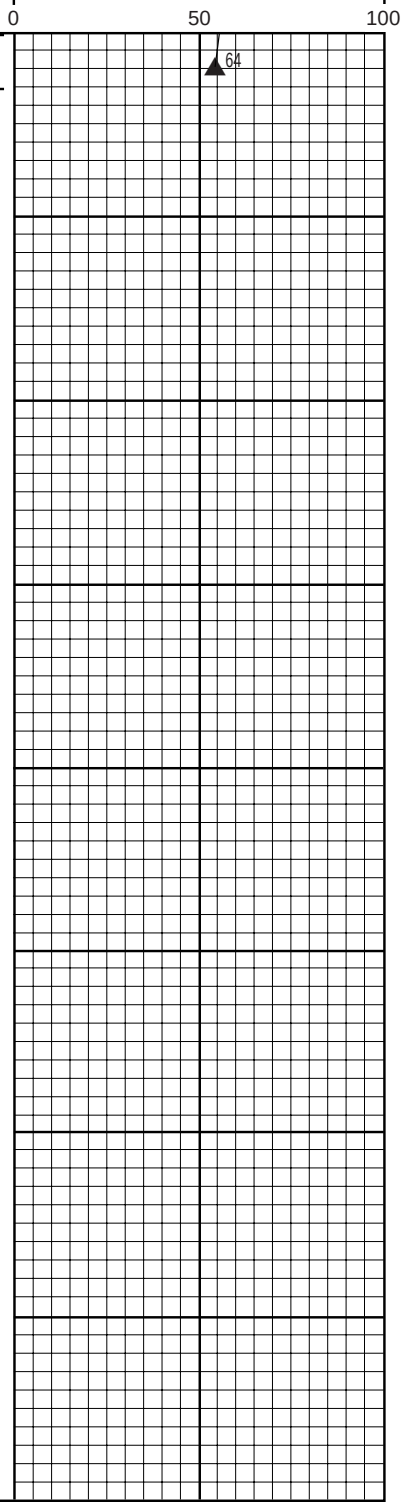
DEC. 2013 JOB. NO. W1114 FIG. 4A

EX-0001-003890-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES
		SURFACE ELEVATION 28.2 ft (±)			
80		Very dense GRAVEL; subrounded to subangular, some fine- to coarse-grained sand, trace silt	81.5		S-21
		(6/10/2013)			
		Circulation of drilling fluid lost at 57 ft (40 gallons) and 62 ft (40 gallons)			
85					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
P VIBRATING-WIRE PIEZOMETER
SLOTTED PVC PIPE
Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF
□ PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

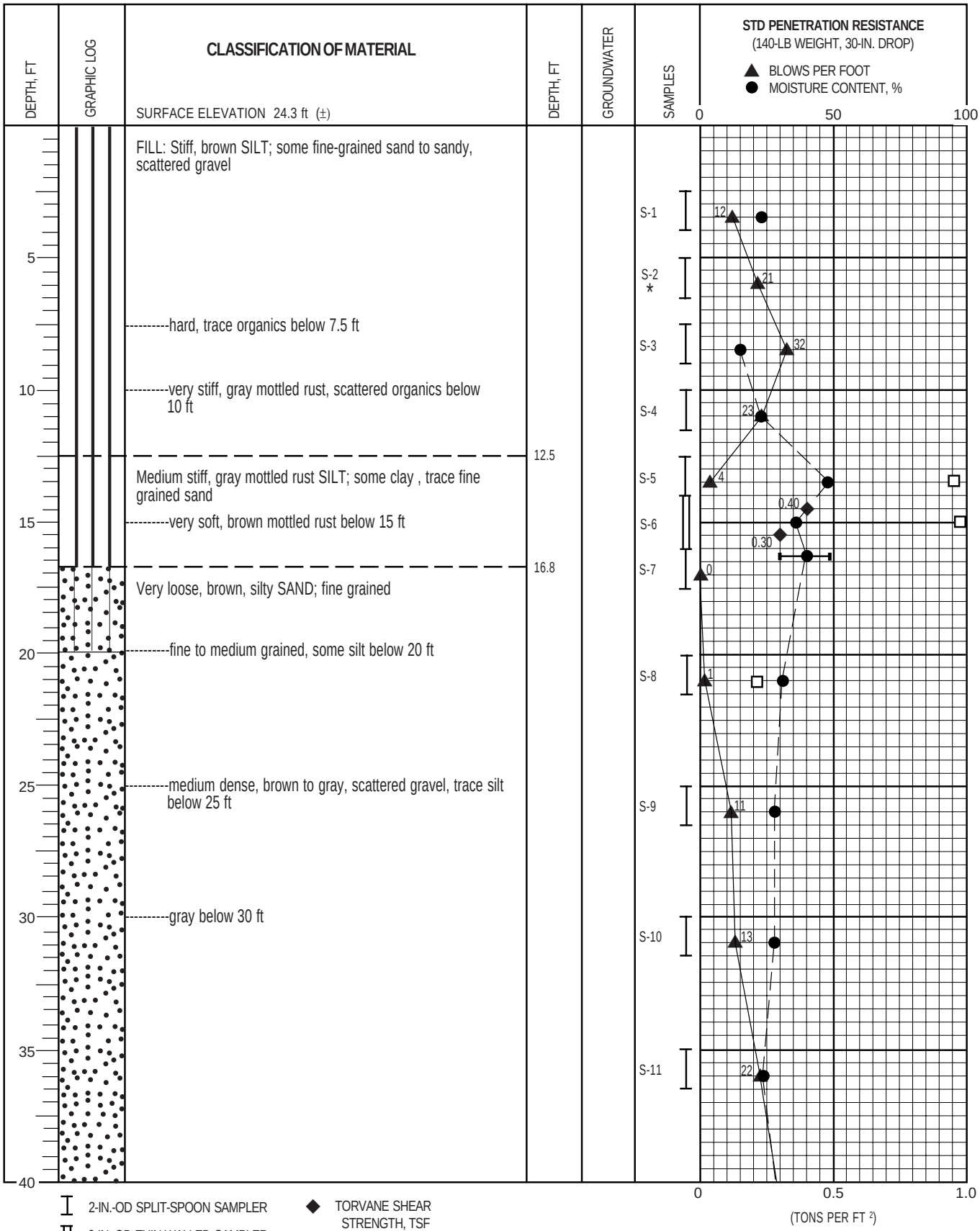
Liquid Limit
Moisture Content
Plastic Limit

GRI

BORING B-4 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 4A

EX-0001-003891-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

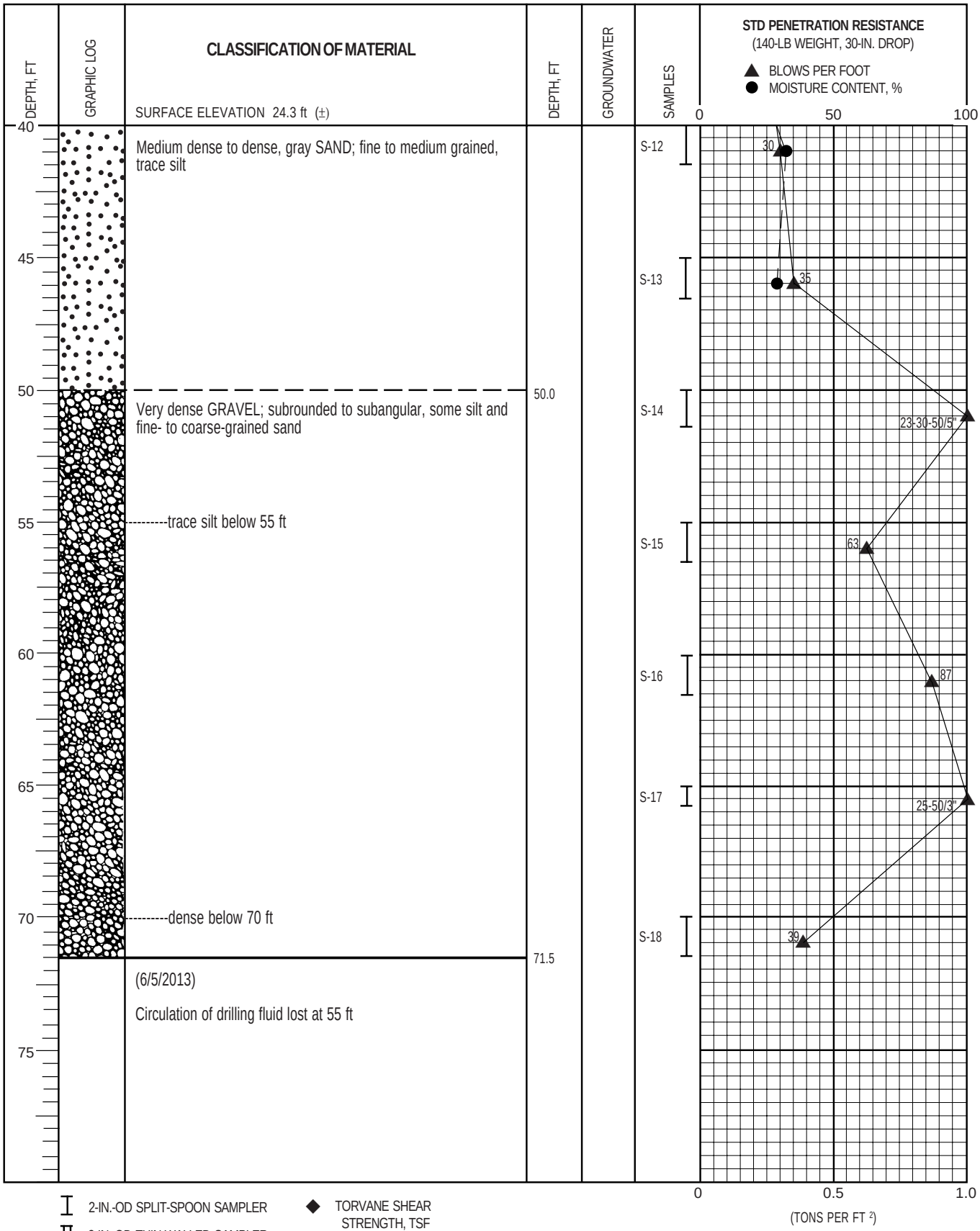
Plastic Limit

GRI

BORING B-5

DEC. 2013 JOB. NO. W1114 FIG. 5A

EX-0001-003892-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

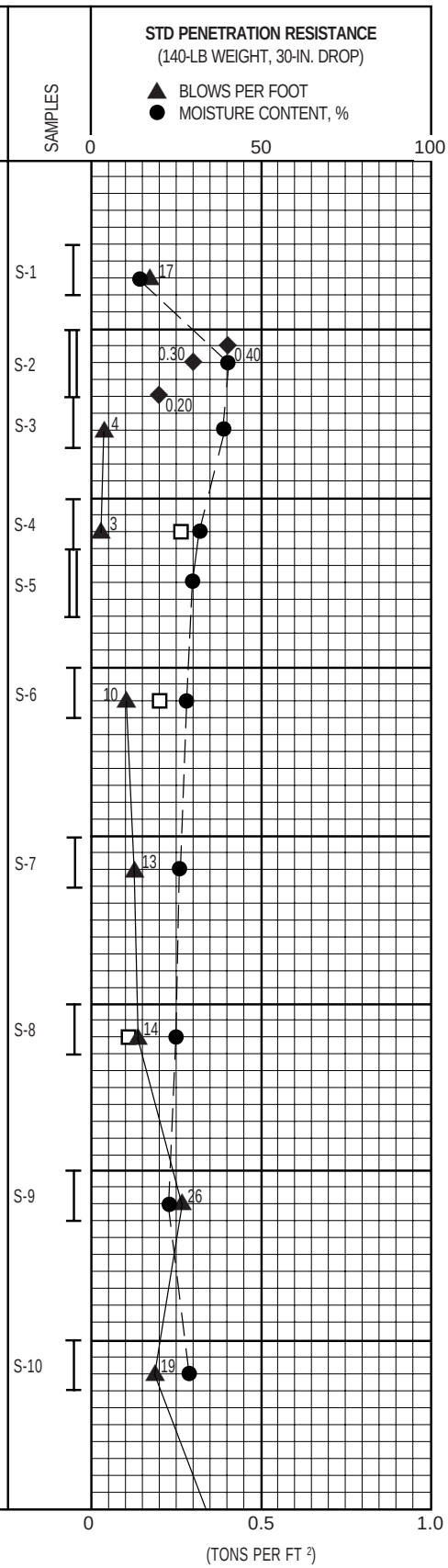
GRI

BORING B-5 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 5A

EX-0001-003893-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 15.3 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Medium dense, gray and brown, gravelly SAND; fine to coarse grained, subangular to angular gravel, some silt		
5		Soft to medium stiff, gray mottled rust and dark gray SILT; trace to some clay, trace fine-grained sand	5.3	
10		Very loose, brown SAND; fine to medium grained, trace to some silt, trace subrounded gravel	10.0	
		---------medium dense, gray, fine grained, trace to some silt below 13 ft		
15				
20		---------trace subrounded gravel below 20 ft		
25				
30		---------fine to coarse grained below 30 ft		
35		---------fine grained below 35 ft		
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

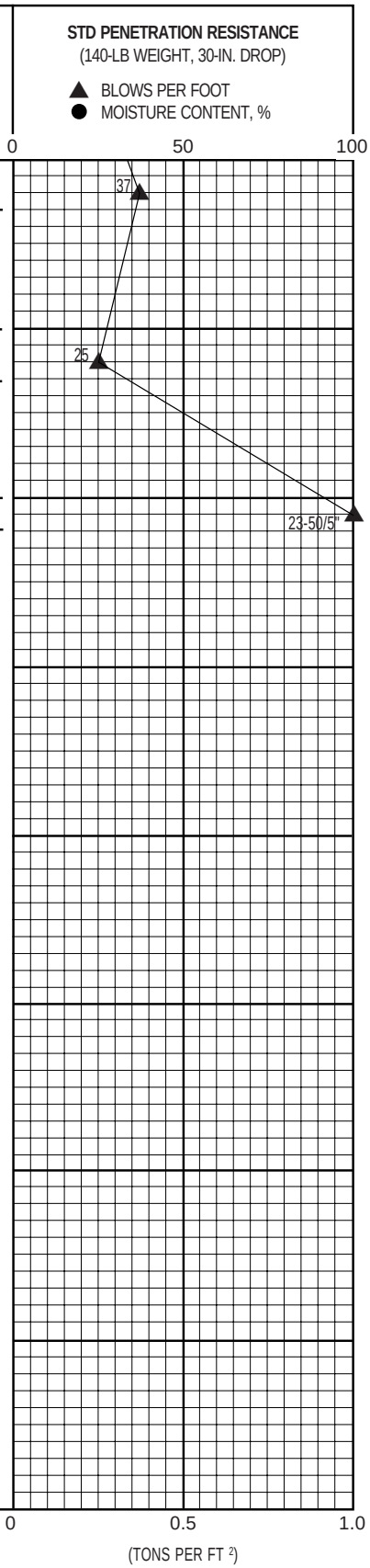
GRI

BORING B-6

DEC. 2013 JOB. NO. W1114 FIG. 6A

EX-0001-003894-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 15.3 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Dense GRAVEL; subrounded to subangular, some fine- to coarse-grained sand to sandy, trace silt			S-11
45		---------4- to 6-in. interbedded sand lenses from 45 to 48 ft			S-12
50			50.9		S-13
		(6/6/2013) Circulation of drilling fluid lost from 44.5 to 46 ft			
55					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

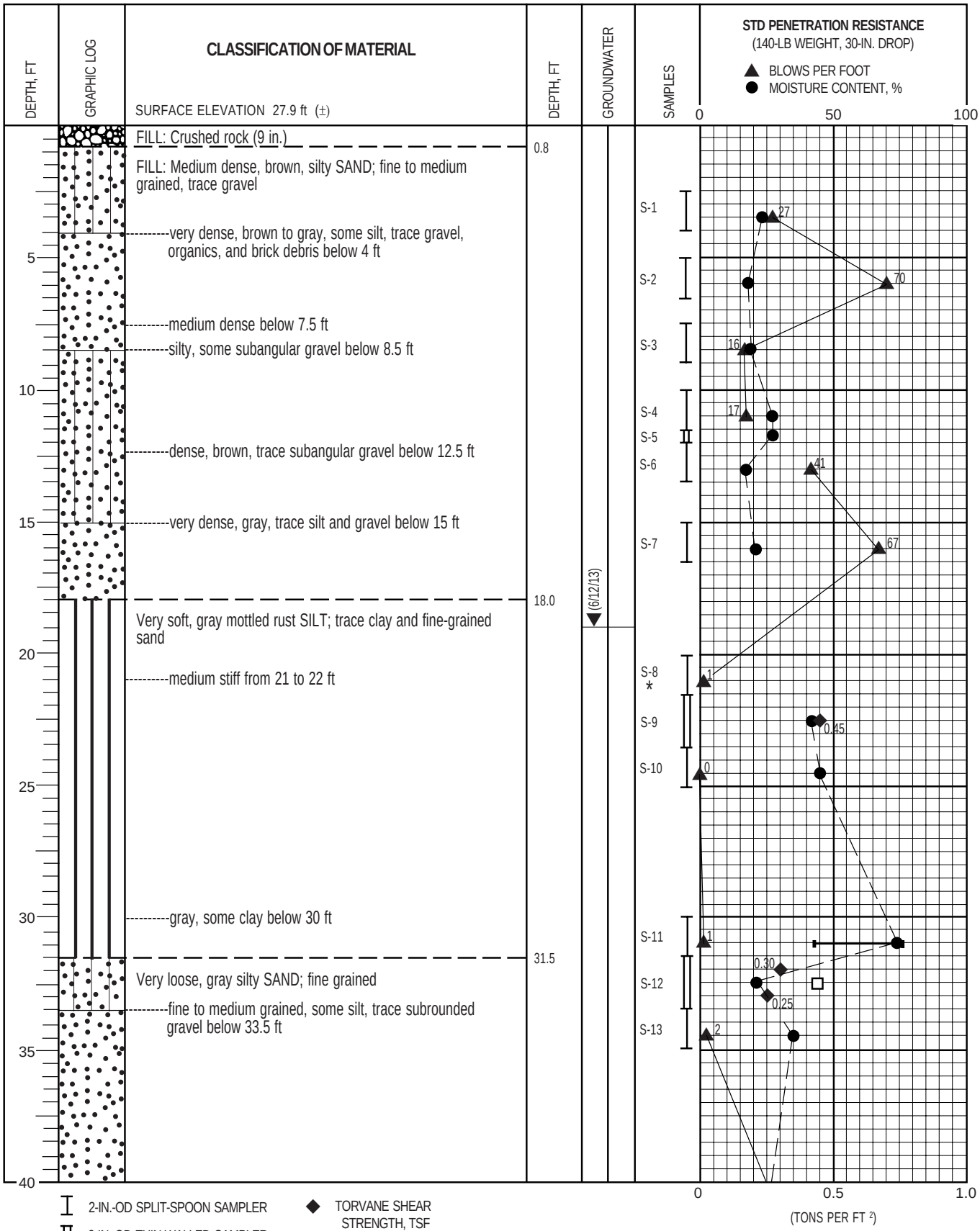
Plastic Limit

GRI

BORING B-6 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 6A

EX-0001-003895-PCE

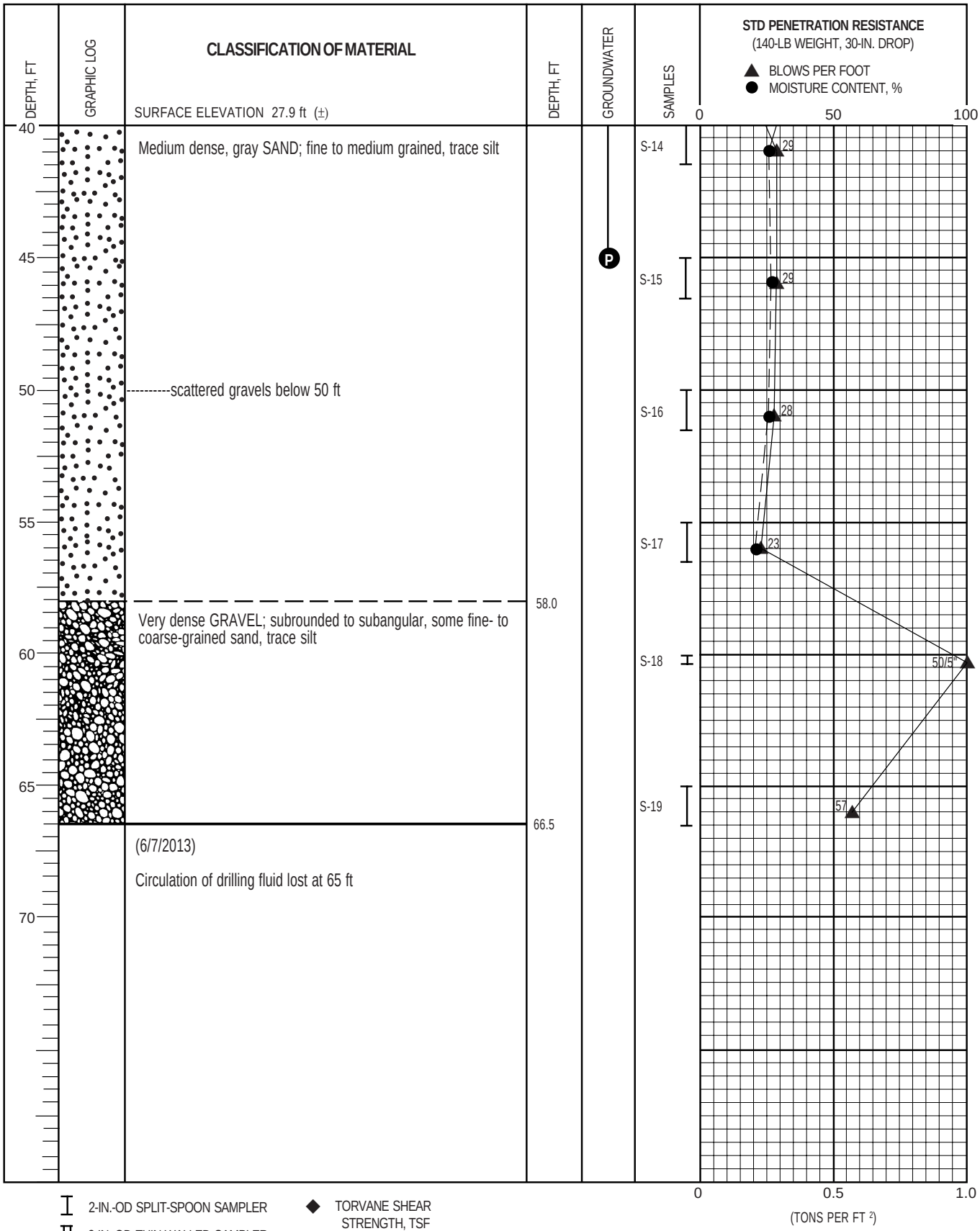


GRI

BORING B-7

DEC. 2013 JOB. NO. W1114 FIG. 7A

EX-0001-003896-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

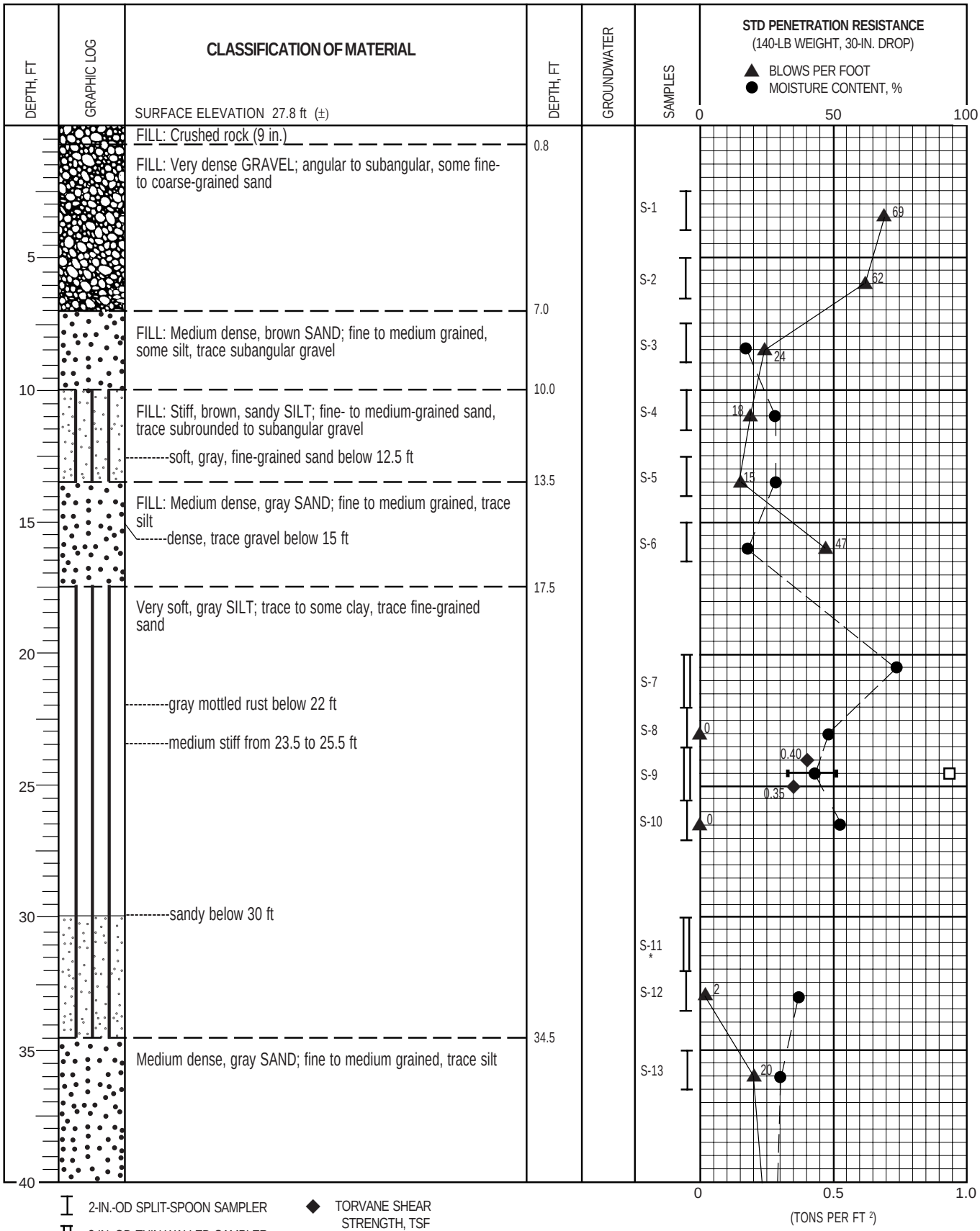
Plastic Limit

GRI

BORING B-7 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 7A

EX-0001-003897-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

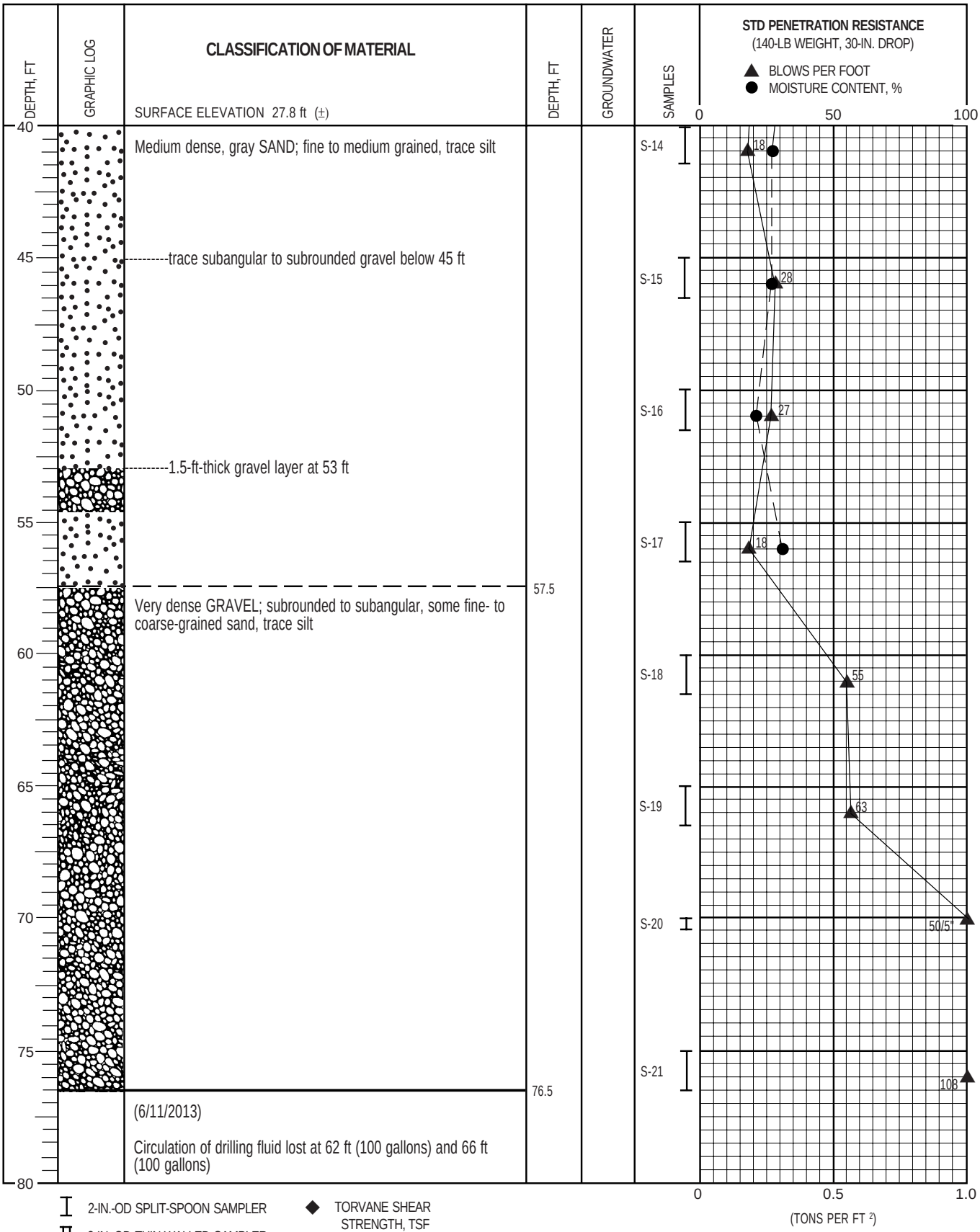
Plastic Limit

GRI

BORING B-8

DEC. 2013 JOB. NO. W1114 FIG. 8A

EX-0001-003898-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

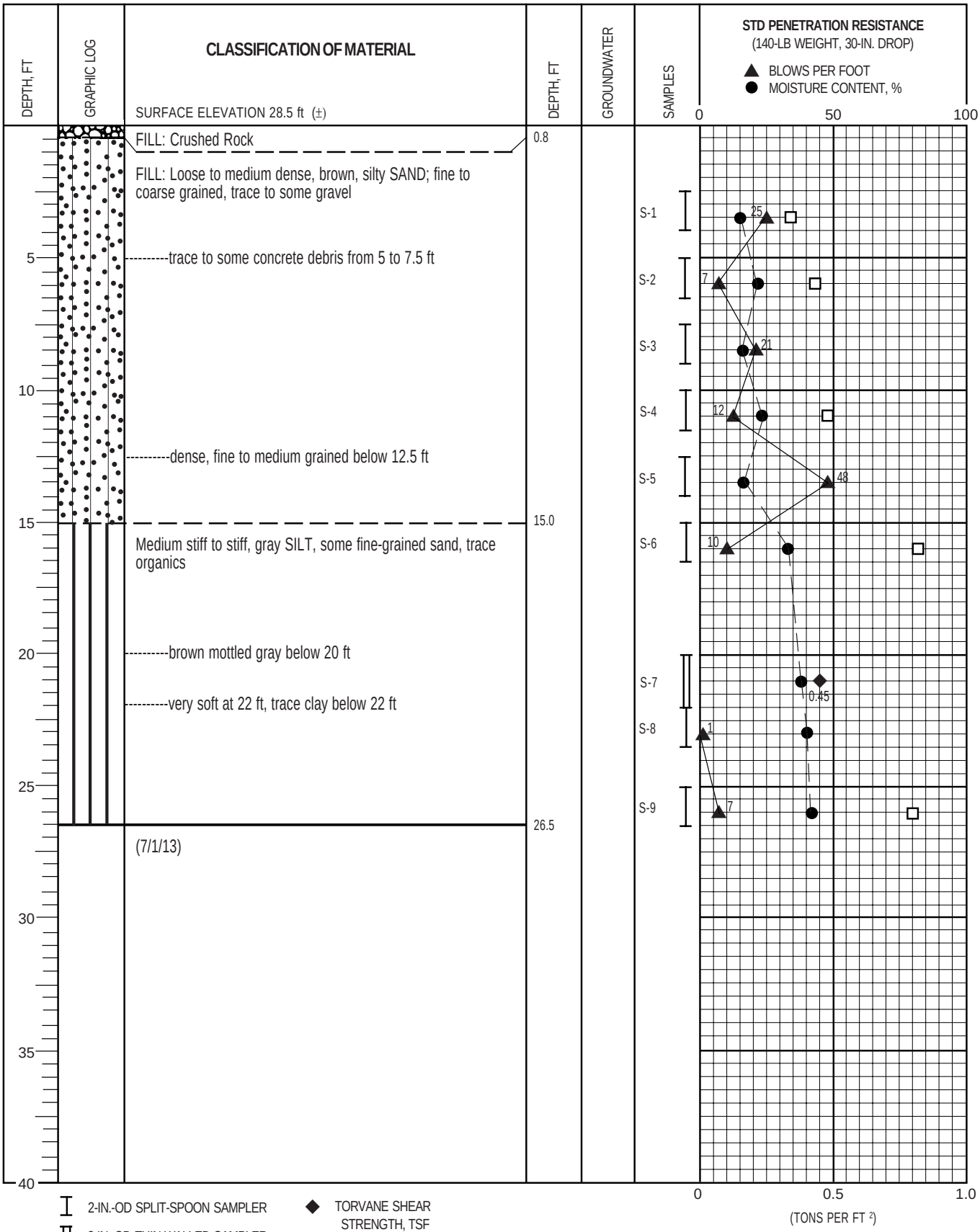
Plastic Limit

GRI

BORING B-8 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 8A

EX-0001-003899-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

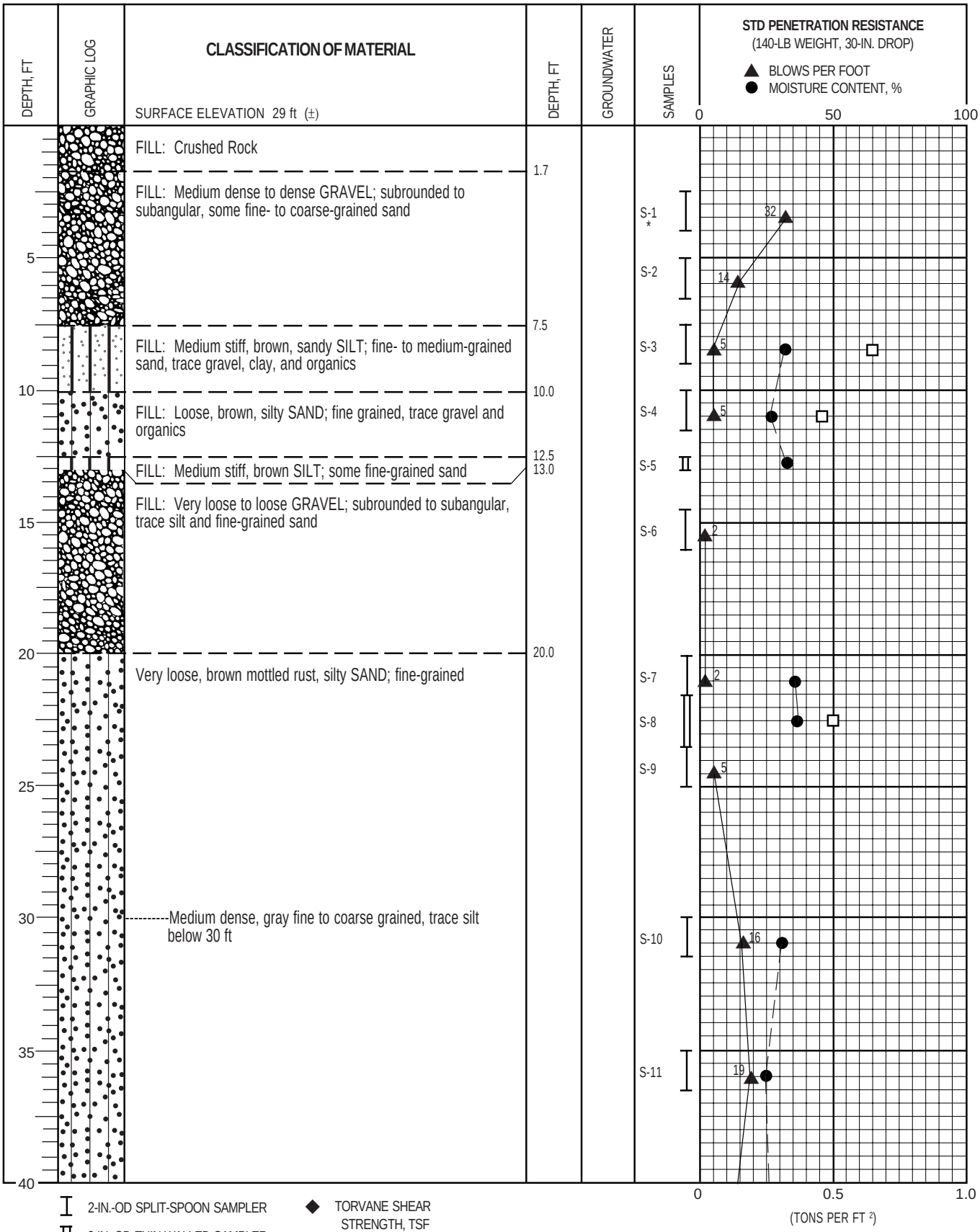
Plastic Limit

GRI

BORING B-9

DEC. 2013 JOB. NO. W1114 FIG. 9A

EX-0001-003900-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

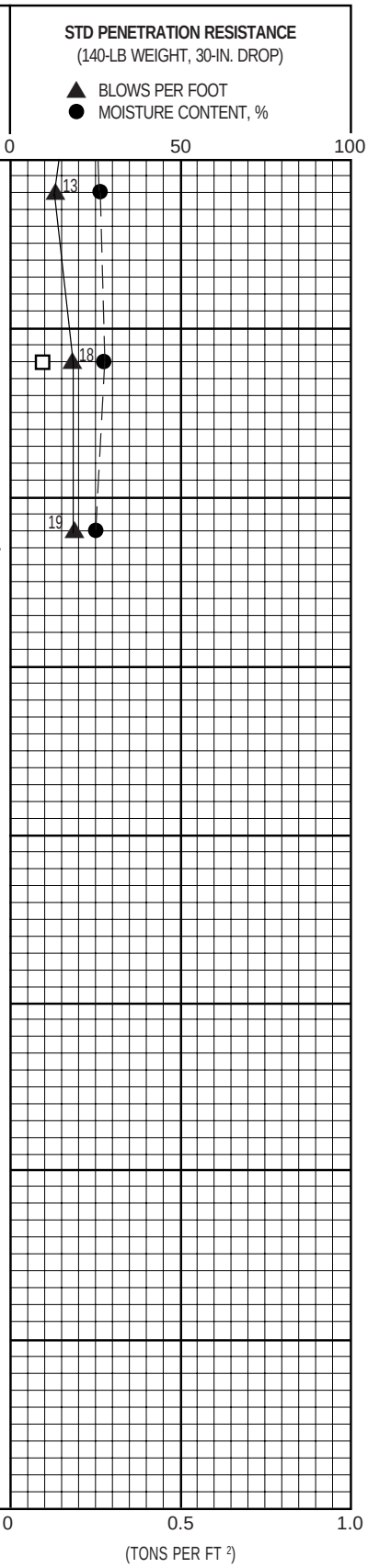
GRI

BORING B-10

DEC. 2013 JOB. NO. W1114 FIG. 10A

EX-0001-003901-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 29 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to coarse grained, trace silt and gravel			S-12
45					S-13
50					S-14
		(7/1/2013)	51.5		
55					
60					
65					
70					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

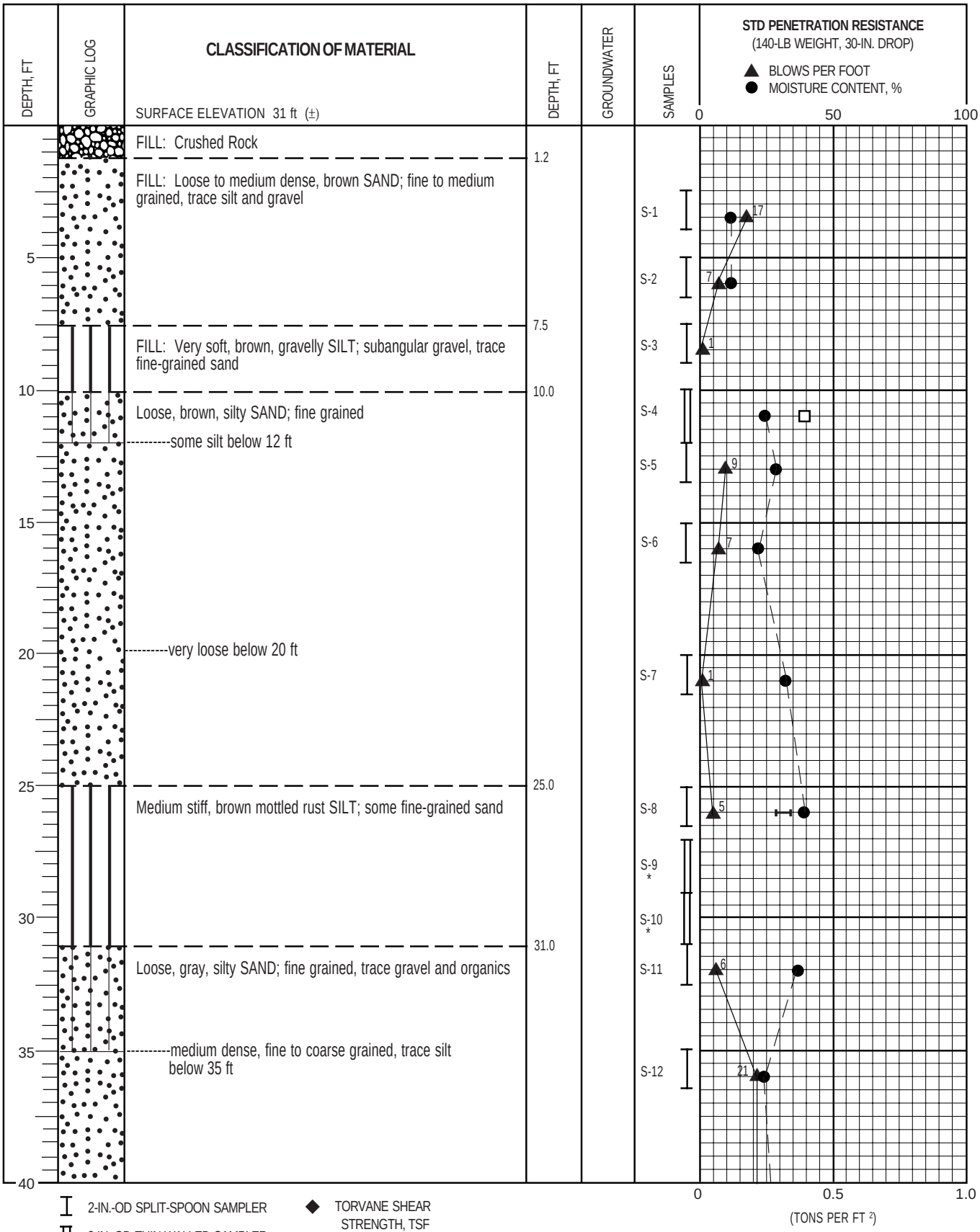
Plastic Limit

GRI

BORING B-10 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 10A

EX-0001-003902-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

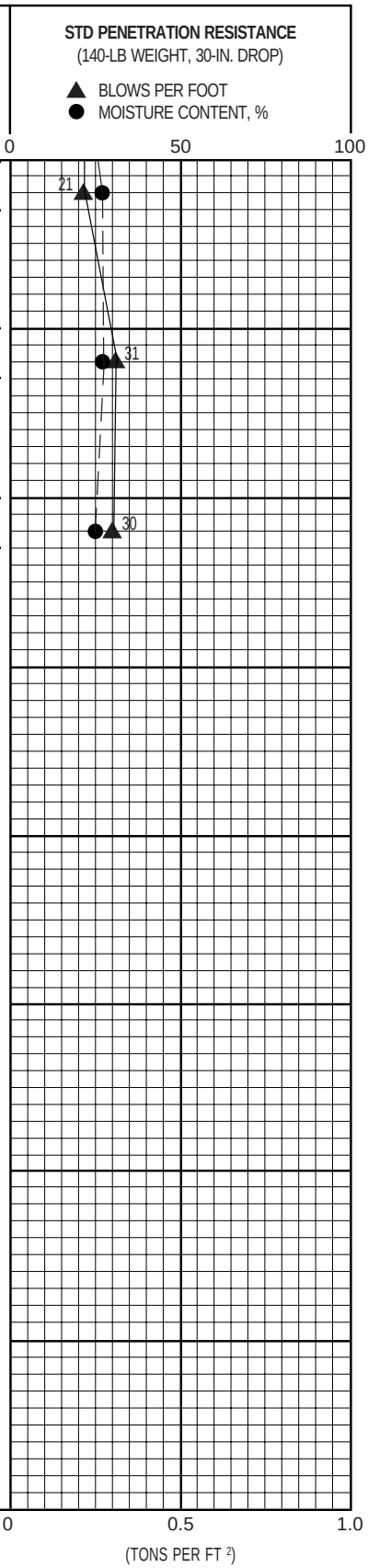
GRI

BORING B-11

DEC. 2013 JOB. NO. W1114 FIG. 11A

EX-0001-003903-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 31 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense to dense, gray SAND; fine to medium grained, trace silt			S-13
45					S-14
50					S-15
		(7/1/2013)	51.5		
55					
60					
65					
70					
75					
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

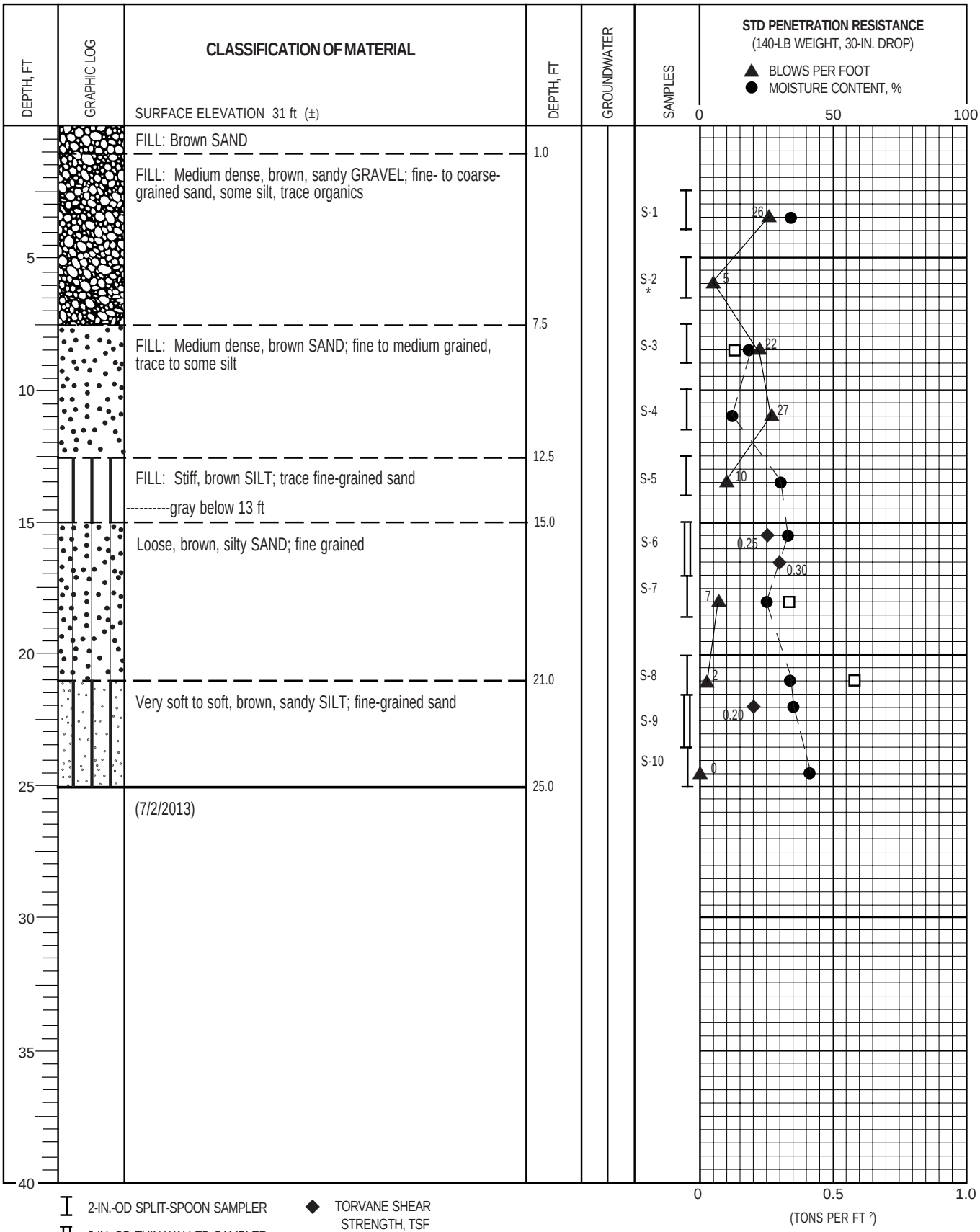
Plastic Limit

GRI

BORING B-11 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 11A

EX-0001-003904-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

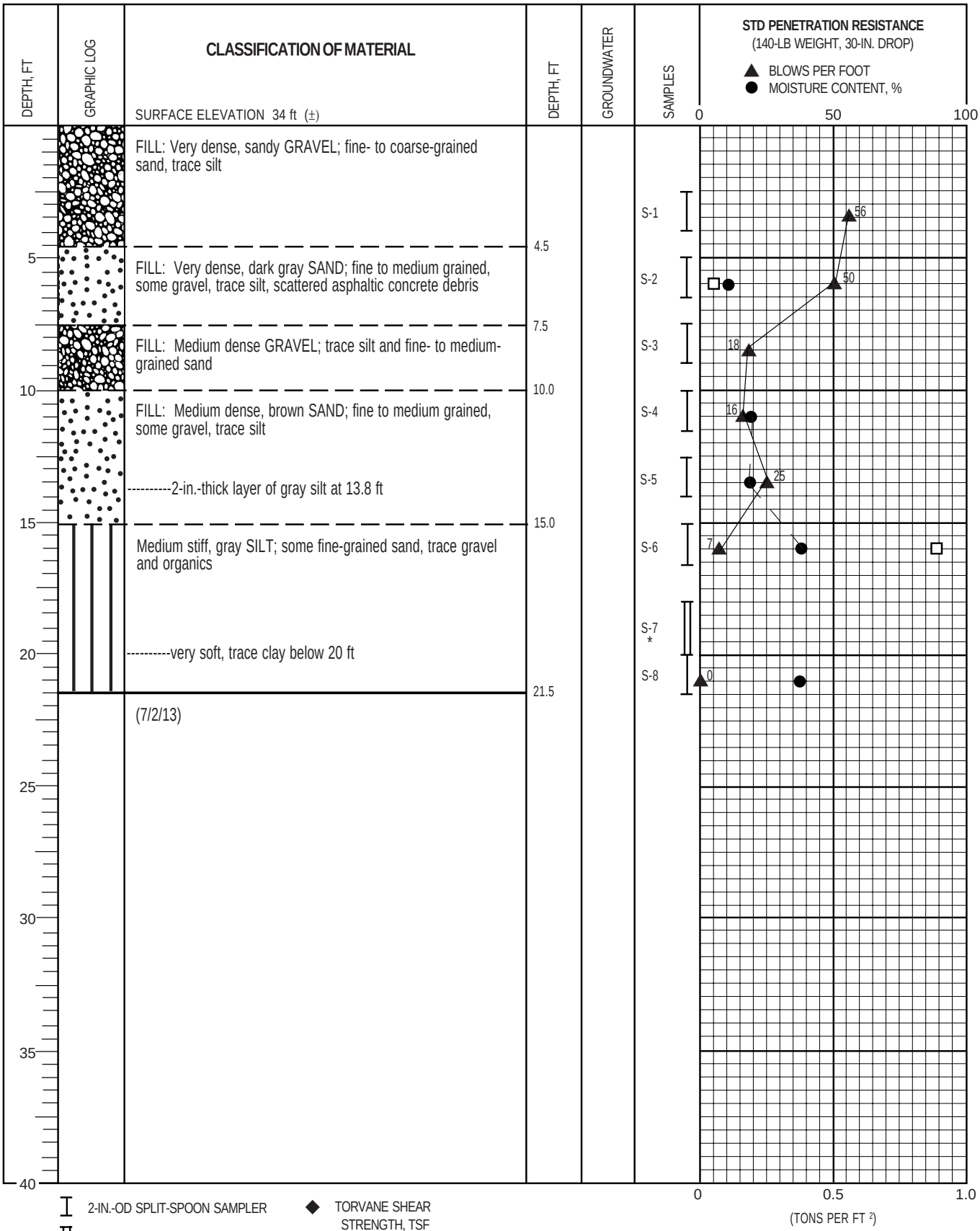
Plastic Limit

GRI

BORING B-12

DEC. 2013 JOB. NO. W1114 FIG. 12A

EX-0001-003905-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

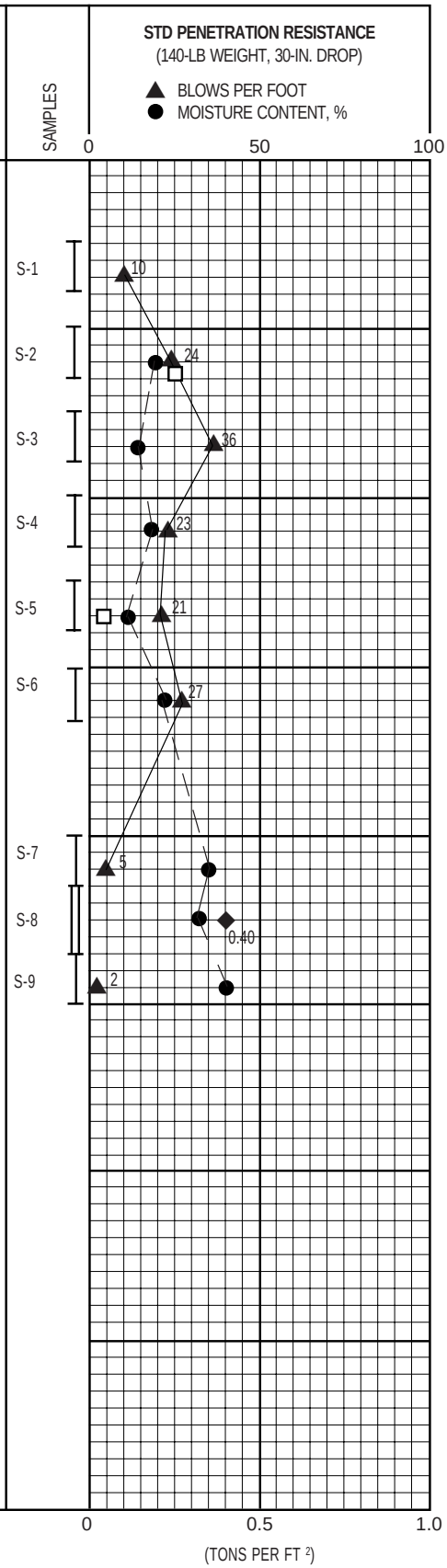
GRI

BORING B-13

DEC. 2013 JOB. NO. W1114 FIG. 13A

EX-0001-003906-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 34 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Loose, brown SAND	1.0	
		FILL: Medium dense, brown, sandy GRAVEL; fine- to coarse-grained and, trace silt and organics		
5			5.0	
		FILL: Medium dense to dense, brown SAND; fine to medium grained, trace to some silt		
10		---------trace gravel below 10 ft		
15				
20			20.0	
		Soft to medium stiff, brown and gray SILT; trace to some clay, trace fine-grained sand, and organics		
25			25.0	
		(7/2/13)		
30				
35				
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

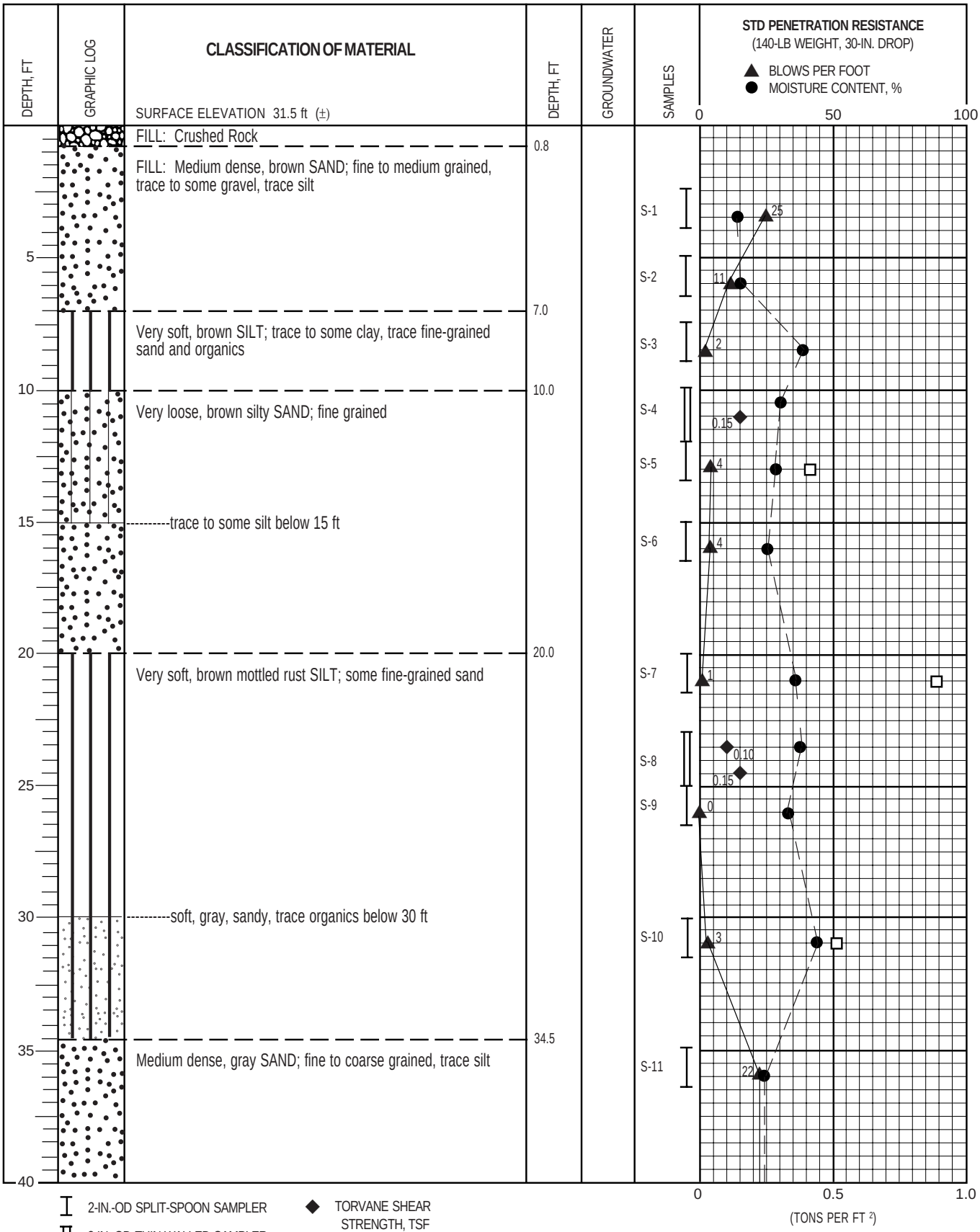
Plastic Limit

GRI

BORING B-14

DEC. 2013 JOB. NO. W1114 FIG. 14A

EX-0001-003907-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-15

DEC. 2013 JOB. NO. W1114 FIG. 15A

EX-0001-003908-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES	STD PENETRATION RESISTANCE (140-LB WEIGHT, 30-IN. DROP) ▲ BLOWS PER FOOT ● MOISTURE CONTENT, %
		SURFACE ELEVATION 31.5 ft (±)				
40		Medium dense, gray SAND; fine to coarse grained, some silt, trace gravel	41.5		S-12	22
		(7/8/2013)				
45						
50						
55						
60						
65						
70						

0 50 100

0 0.5 1.0

(TONS PER FT ^{2})

2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF

□ PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

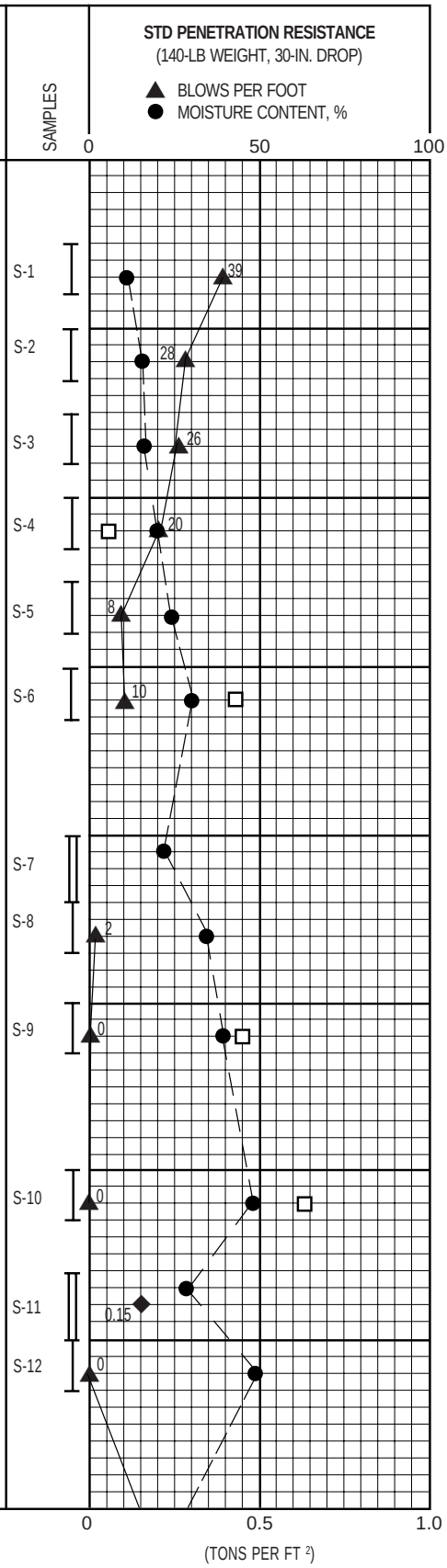
GRI

BORING B-15 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 15A

EX-0001-003909-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 30.5 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Crushed Rock	0.8	
		FILL: Medium dense to dense, brown SAND; fine to medium grained, trace to some gravel, trace silt		
5				
10				
		---------loose below 12.5 ft		
15			15.0	
		Very loose to loose, brown mottled rust, silty SAND; fine grained		
20				
25				
30			30.0	
		Very soft to soft, gray, sandy SILT; fine-grained sand		
35				
			38.5	
40		Medium dense, gray SAND; fine to medium grained, trace silt		



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

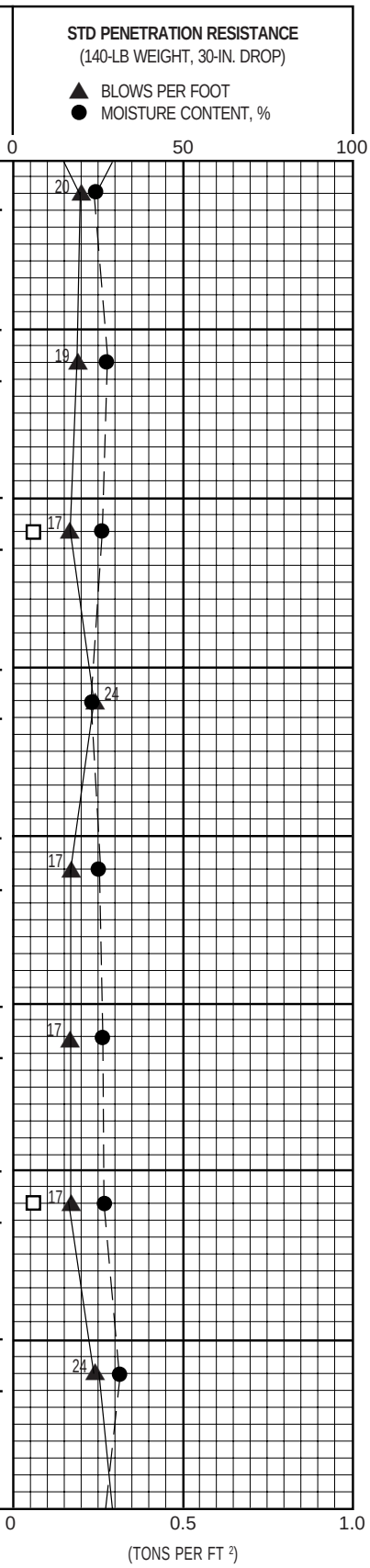
GRI

BORING B-16

DEC. 2013 JOB. NO. W1114 FIG. 16A

EX-0001-003910-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 30.5 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to coarse grained, trace silt			S-13
45					S-14
50					S-15
55					S-16
60					S-17
65					S-18
70					S-19
75					S-20
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

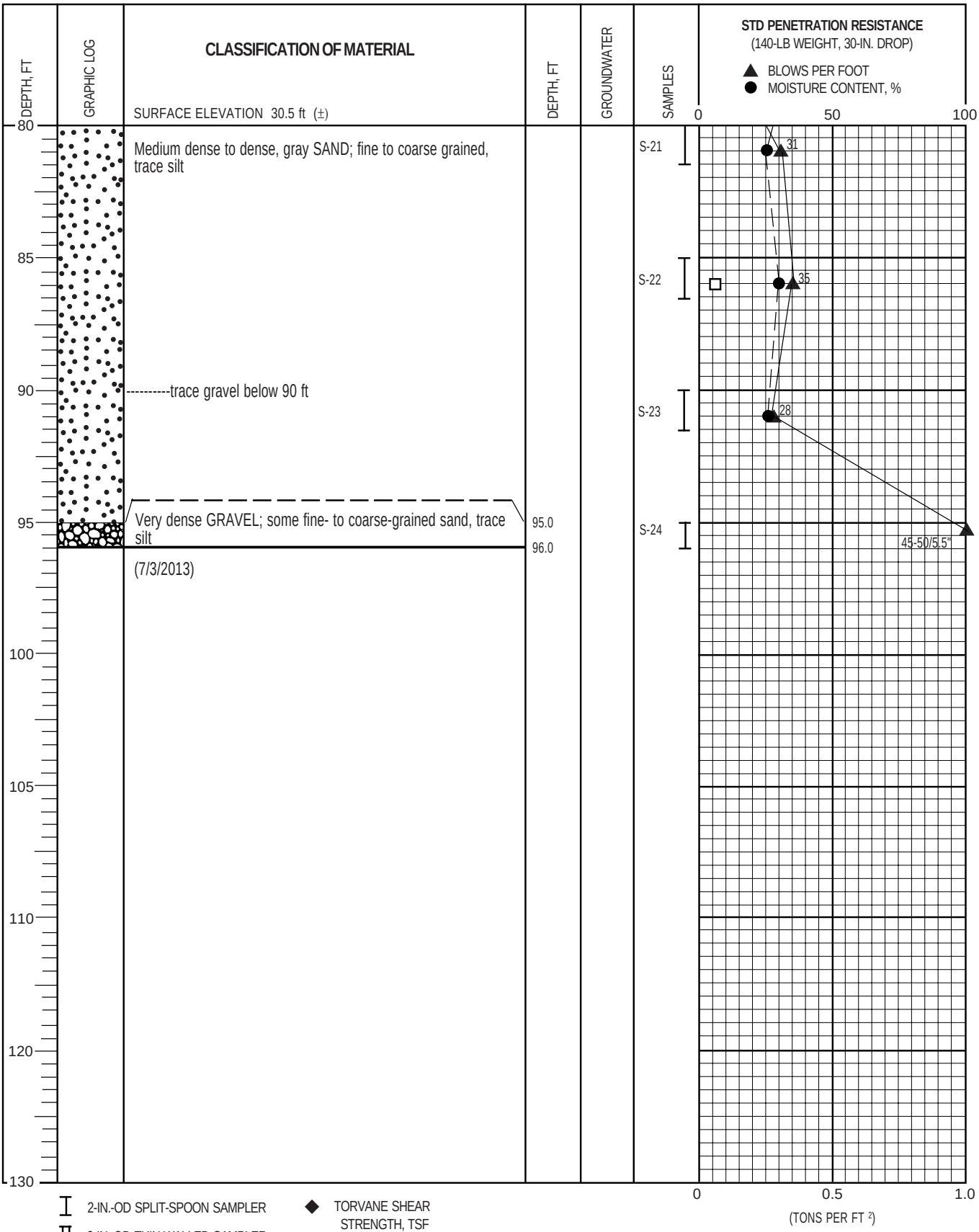
Plastic Limit

GRI

BORING B-16 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 16A

EX-0001-003911-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

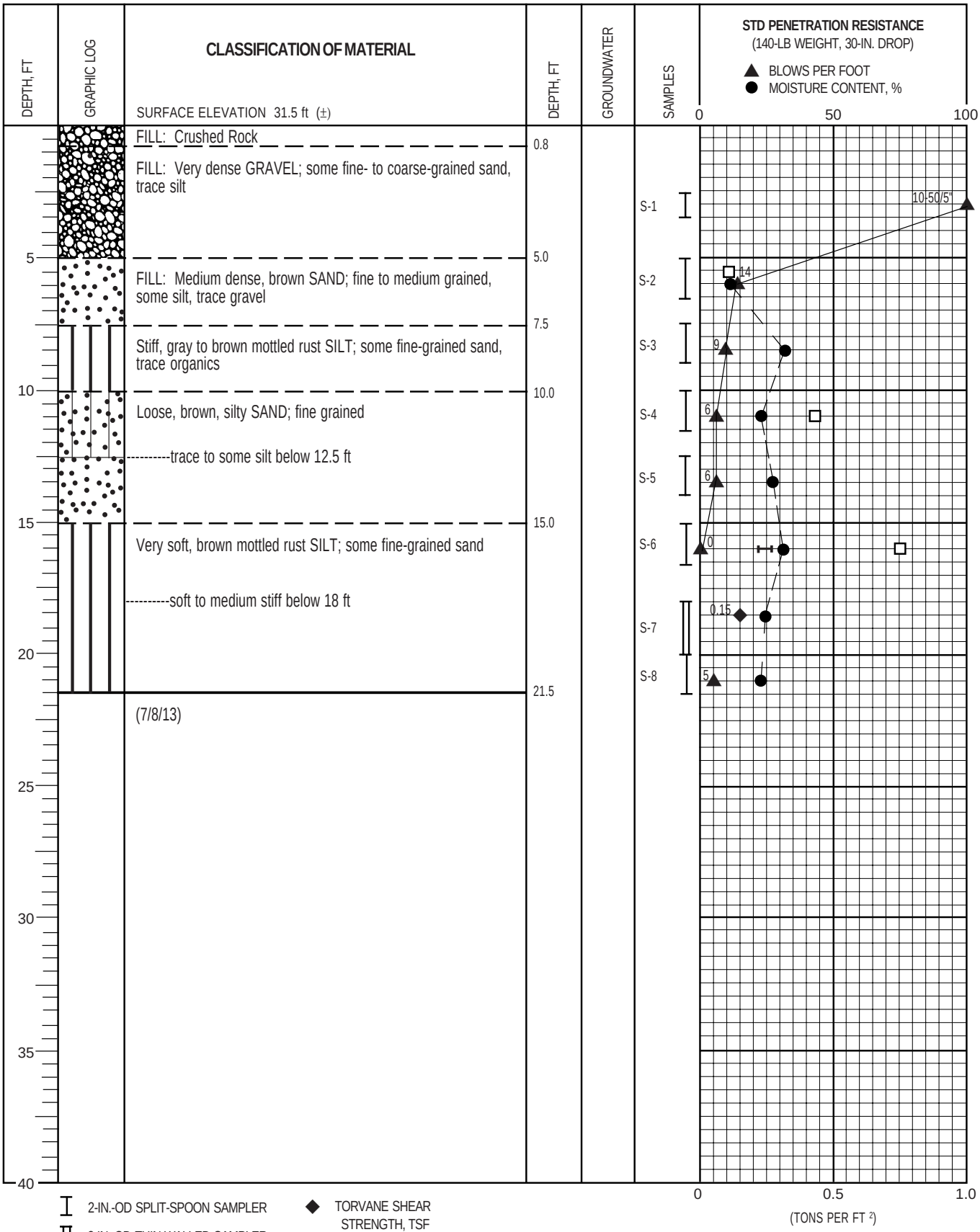
Plastic Limit

GRI

BORING B-16 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 16A

EX-0001-003912-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-17

DEC. 2013 JOB. NO. W1114 FIG. 17A

EX-0001-003913-PCE

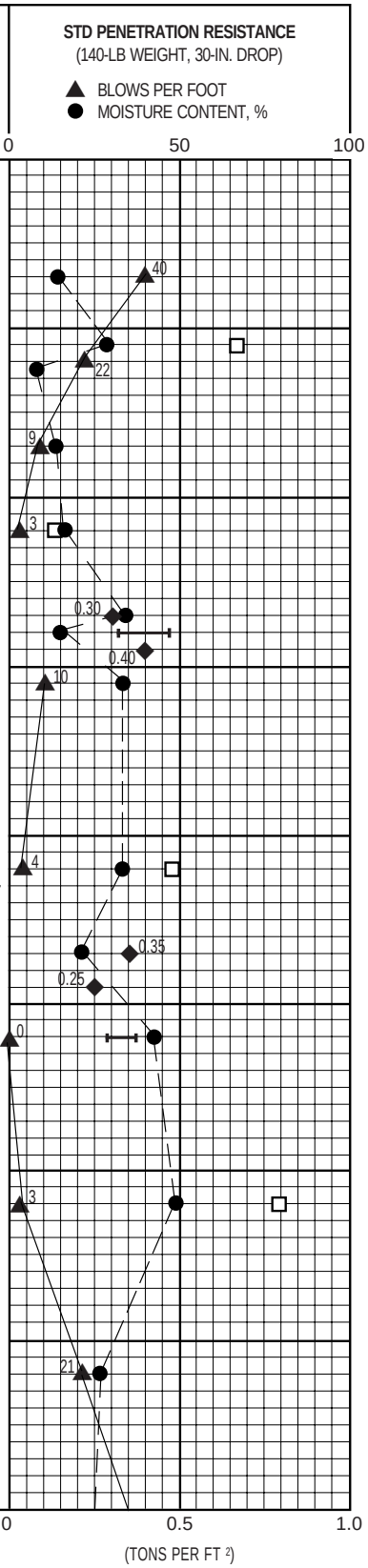
SURFACE ELEVATION ----- ft (±)

DEPTH, FT	CLASSIFICATION OF MATERIAL (SURFACE ELEVATION 31 ft (±))	DEPTH, FT
	FILL: Crushed Rock	0.8
	FILL: Dense, brown SAND; fine to coarse grained, trace gravel and silt	
5		5.0
	FILL: Stiff, gray mottled rust, sandy SILT; fine-grained sand	5.7
	FILL: Medium dense, brown SAND; fine to medium grained, trace silt	
	----------very loose to loose below 7.5 ft	
10	----------trace gravel below 10 ft	
	----------silty, fine grained below 12 ft	
		14.0
15	Medium stiff to stiff, gray mottled rust SILT; trace to some clay and fine-grained sand	
20		20.0
	Very loose to loose, brown, silty SAND; fine grained	
		23.0
	Medium stiff, brown mottled rust SILT; trace to some fine-grained sand	
25	----------very soft to soft, gray mottled rust below 25 ft	
30	----------gray, trace organics below 30 ft	
		34.0
35	Medium dense, gray SAND; fine to medium grained, some silt	
40		

GRAPHIC LOG

GROUNDWATER

SAMPLES: S-1, S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9, S-10, S-11



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-18

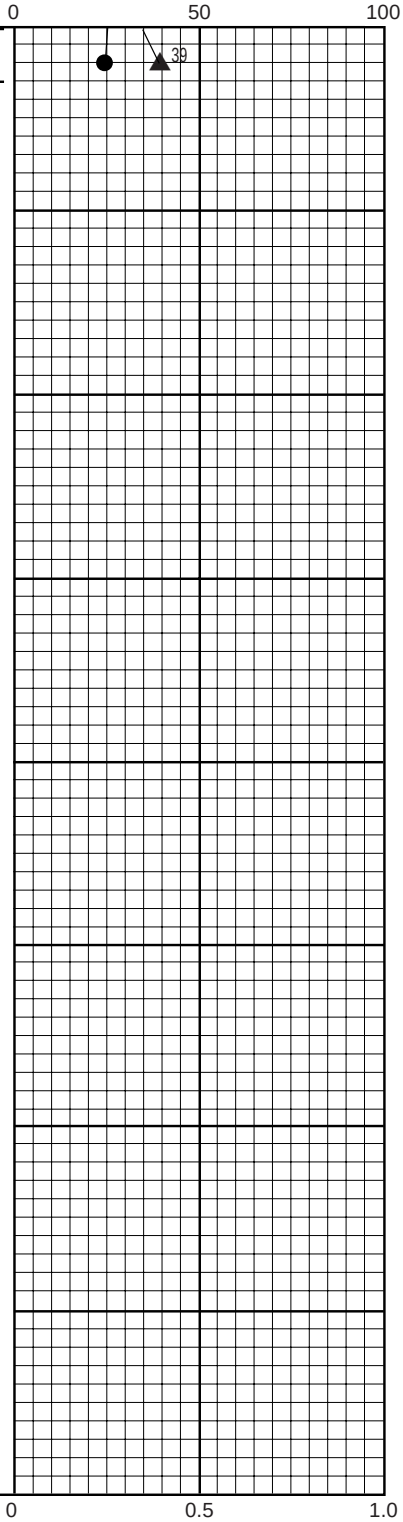
DEC. 2013 JOB. NO. W1114 FIG. 18A

EX-0001-003914-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES
		SURFACE ELEVATION 31 ft (±)			
40		Dense, brown SAND; fine to medium grained, trace silt	41.5		S-12
		(7/8/2013)			
45					
50					
55					
60					
65					
70					
75					
80					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
P VIBRATING-WIRE PIEZOMETER
SLOTTED PVC PIPE
Water Level (date)

TORVANE SHEAR STRENGTH, TSF
PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

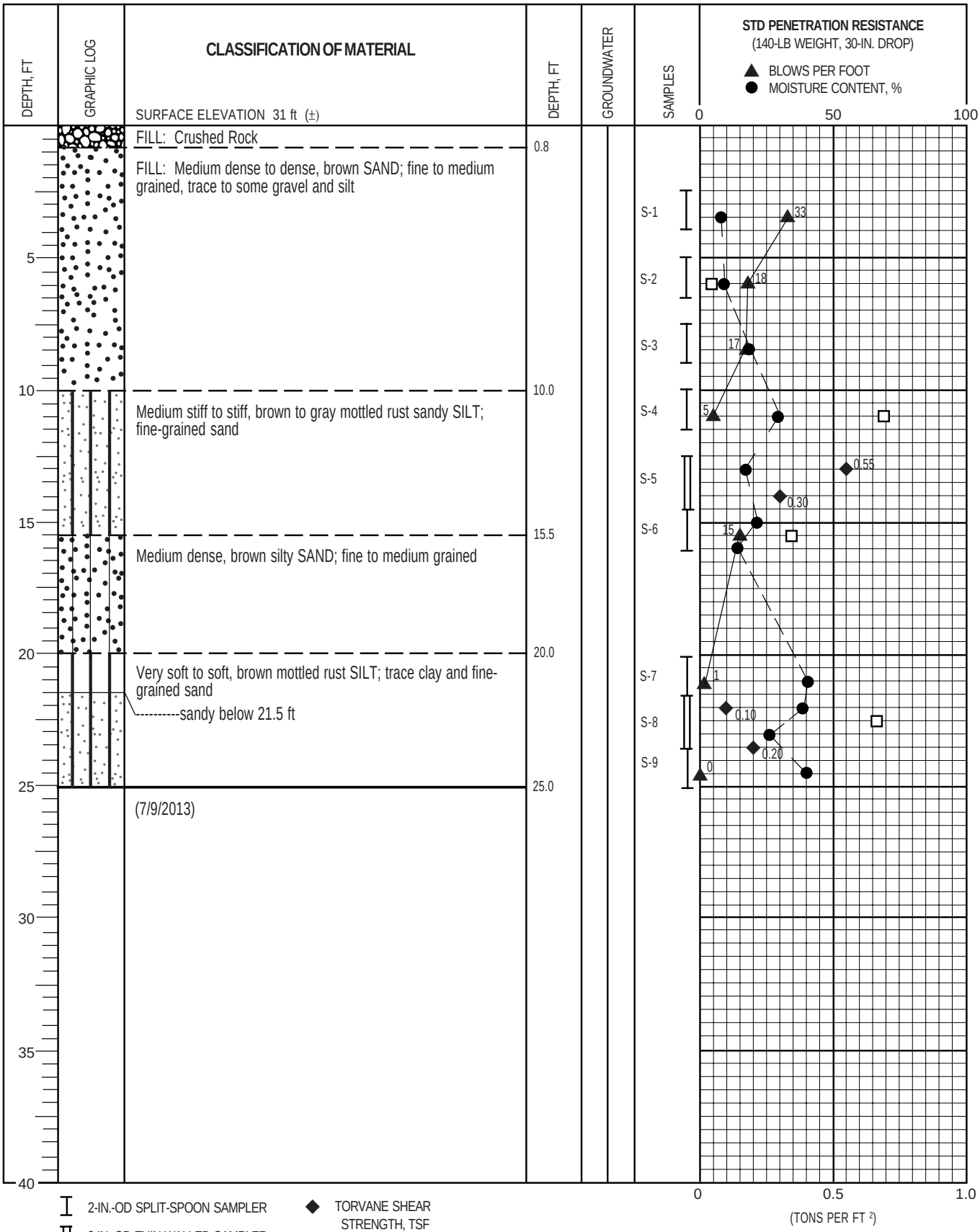
Liquid Limit
Moisture Content
Plastic Limit

GRI

BORING B-18 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 18A

EX-0001-003915-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

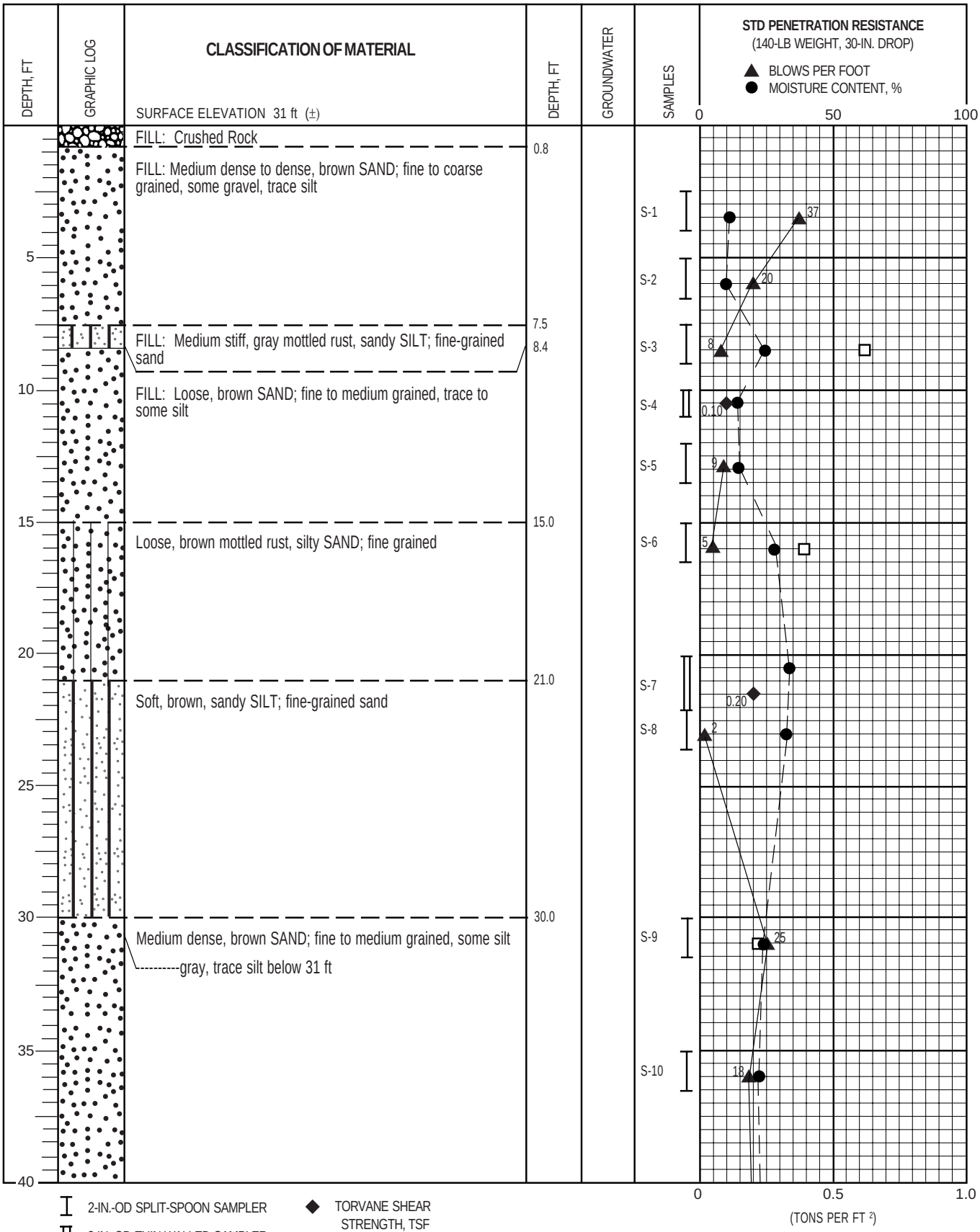
Plastic Limit

GRI

BORING B-19

DEC. 2013 JOB. NO. W1114 FIG. 19A

EX-0001-003916-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

P VIBRATING-WIRE PIEZOMETER

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-20

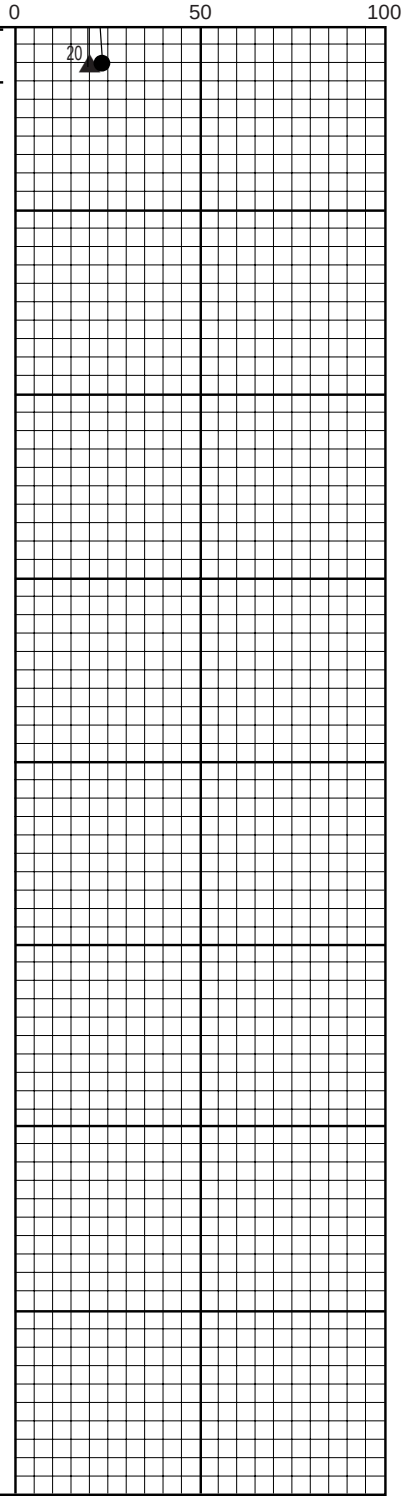
DEC. 2013 JOB. NO. W1114 FIG. 20A

EX-0001-003917-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 31 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to medium grained, trace silt	41.5		S-11
		(7/9/2013)			
45					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



I 2-IN.-OD SPLIT-SPOON SAMPLER
II 3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
P VIBRATING-WIRE PIEZOMETER
SLOTTED PVC PIPE
▼ Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF
□ PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

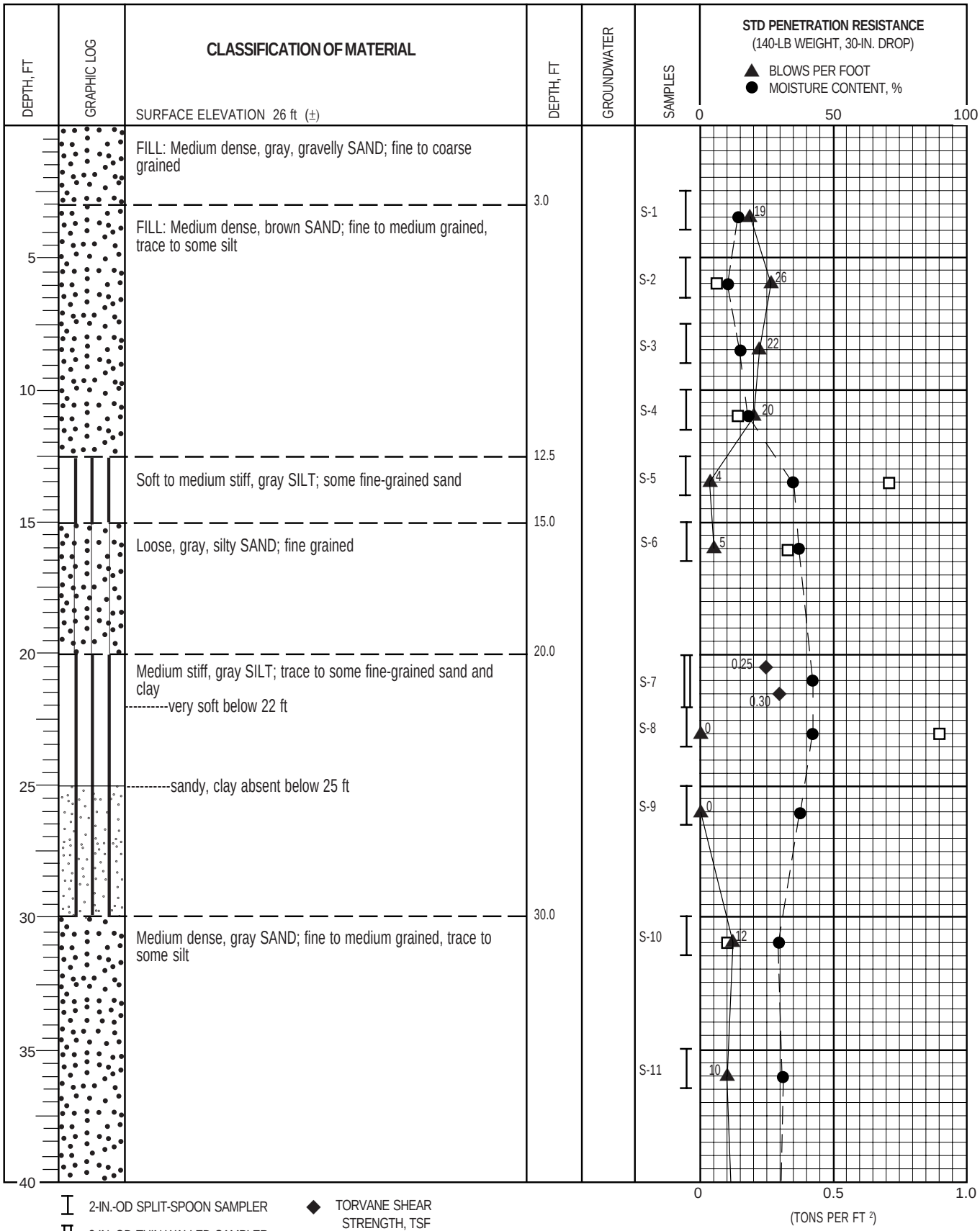
Liquid Limit
Moisture Content
Plastic Limit

GRI

BORING B-20 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 20A

EX-0001-003918-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

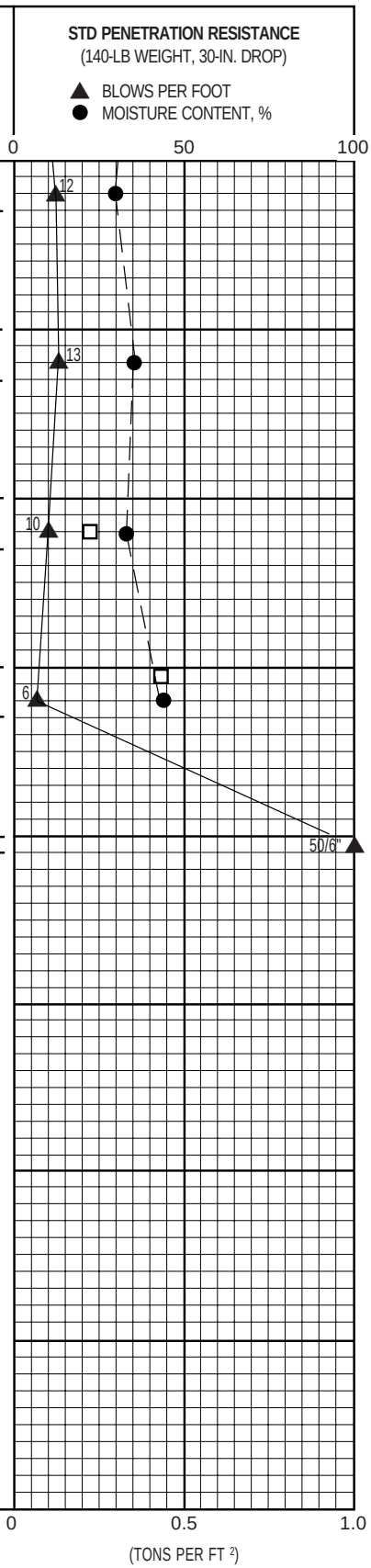
GRI

BORING B-21

DEC. 2013 JOB. NO. W1114 FIG. 21A

EX-0001-003919-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 26 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, gray SAND; fine to medium grained, trace to some silt, trace organics			S-12
45		organics absent below 45 ft			S-13
50					S-14
55		silty below 55 ft	55.5		S-15
		Medium stiff, gray SILT; trace clay, gravel, and fine- to coarse-grained sand	59.0		
60		Very dense GRAVEL	60.5		S-16
		(8/2/2013)			
65					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

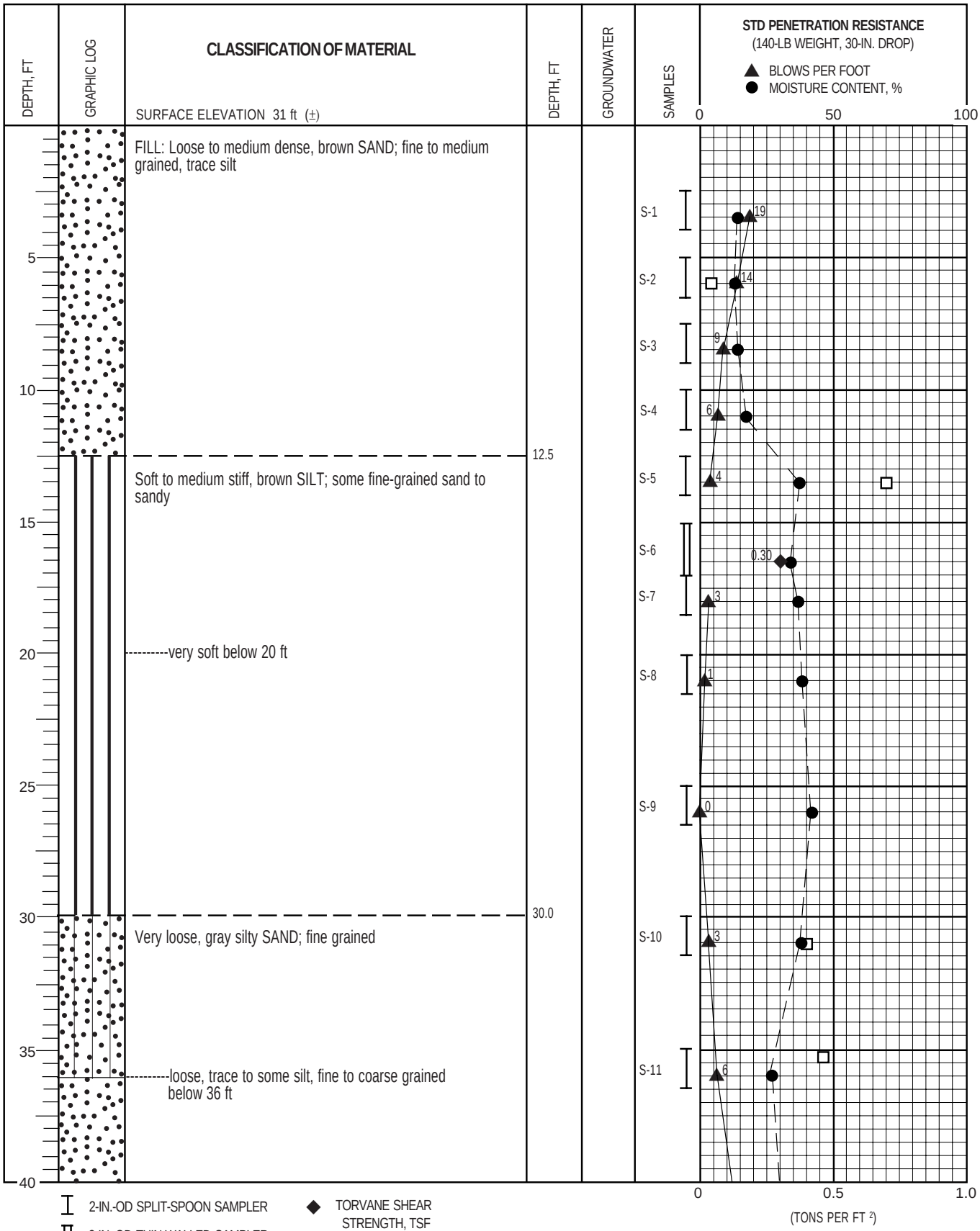
Plastic Limit

GRI

BORING B-21 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 21A

EX-0001-003920-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

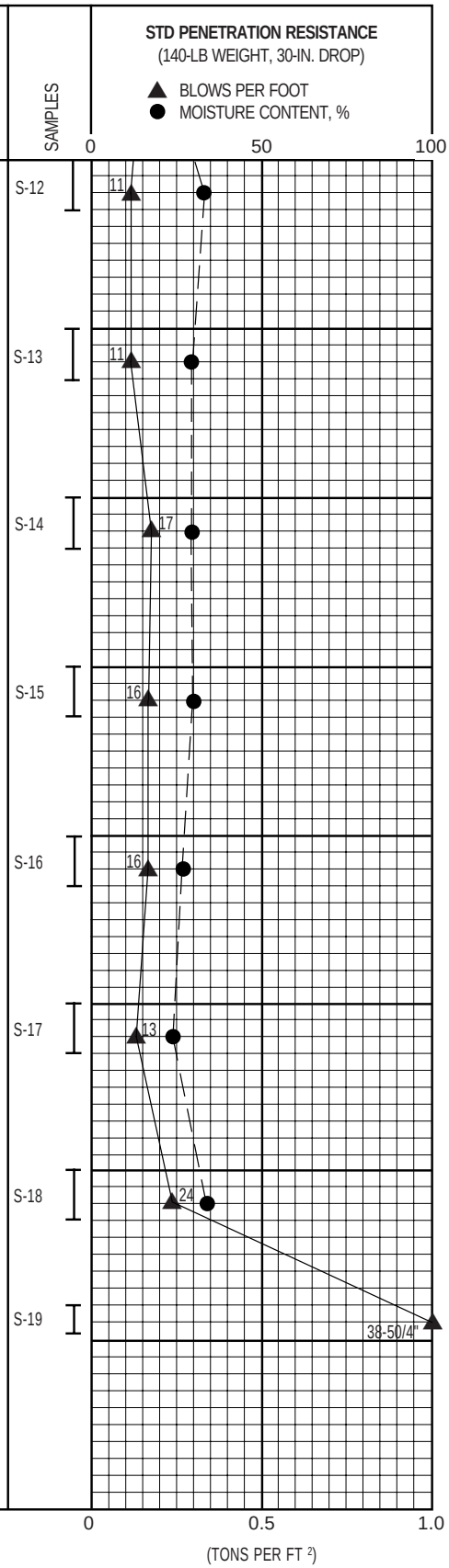
GRI

BORING B-22

DEC. 2013 JOB. NO. W1114 FIG. 22A

EX-0001-003921-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 31 ft (±)	DEPTH, FT	GROUNDWATER
40		Medium dense SAND; fine to coarse grained, trace silt		
45				
50				
55				
60				
65				
70		trace subrounded gravel at 71.3 ft	71.4	
		Stiff, gray, sandy SILT; fine grained	72.5	
		Very dense GRAVEL; some fine- to coarse-grained sand, trace silt		
75			75.5	
		(8/1/2013)		
80				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

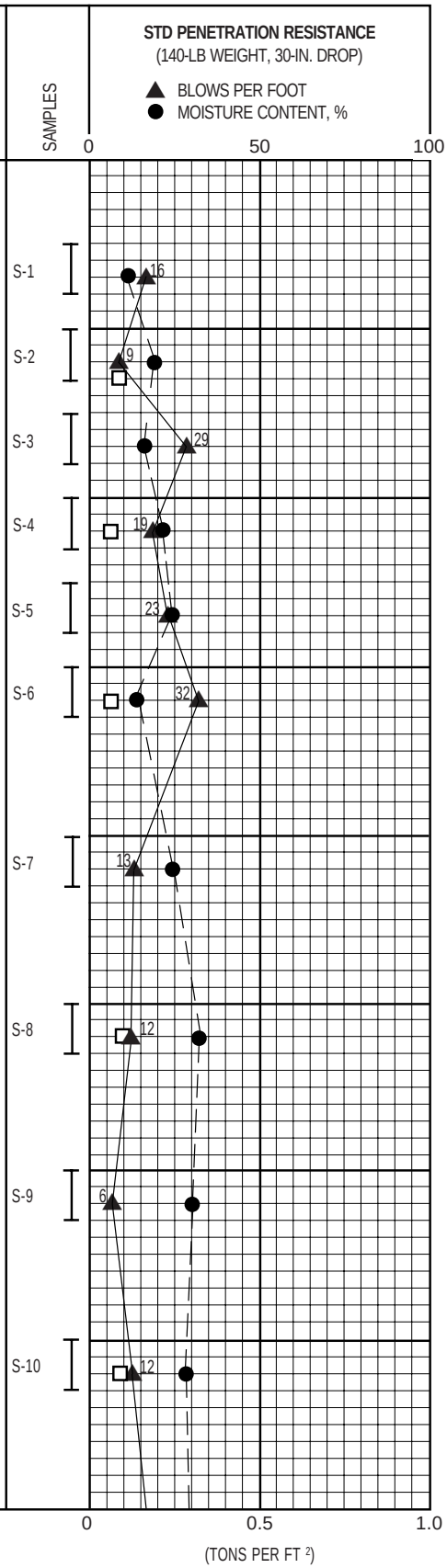
GRI

BORING B-22 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 22A

EX-0001-003922-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
		Asphaltic-concrete PAVEMENT (4 in.) over crushed rock BASE COURSE (10 in.)	1.2	
		FILL: Loose to medium dense, brown SAND; fine to medium grained, trace silt and gravel		
5				
		----------medium dense below 7.5 ft		
10				
		----------gray below 12.5 ft		
		----------scattered wood debris at 13.8 ft		
15		----------4-in.-thick layer of sandy silt at 15 ft		
20			20.0	
		Medium dense, gray SAND; fine to medium grained, trace silt, 1-in.-thick layer of silt at 20.1 ft		
25		----------brown, trace to some silt below 25 ft		
30		----------loose, trace silt below 30 ft		
		----------medium dense, fine grained below 32 ft		
35				
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

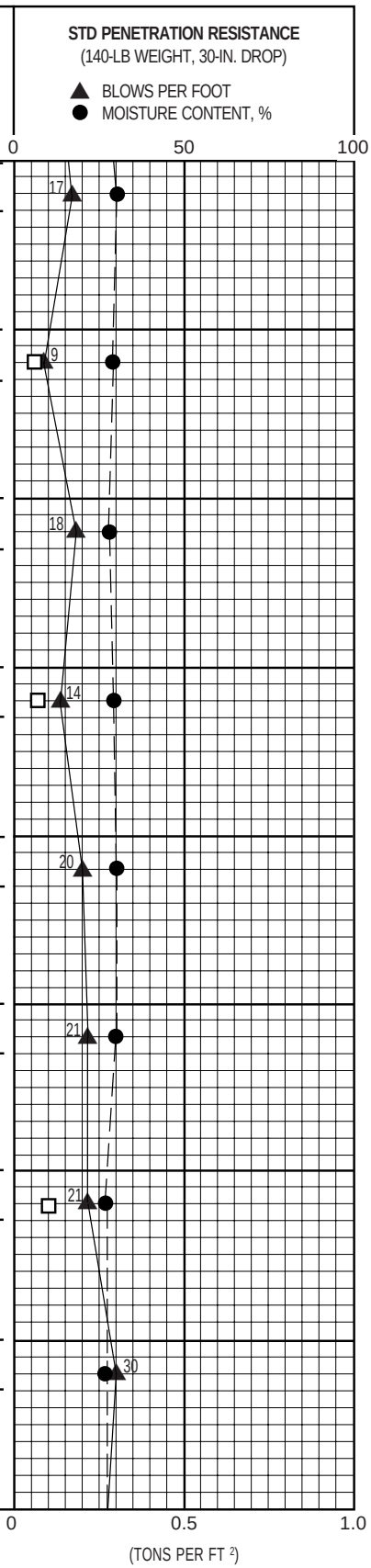
GRI

BORING B-23

DEC. 2013 JOB. NO. W1114 FIG. 23A

EX-0001-003923-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, brown SAND; fine to medium grained, trace silt			S-11
45		---------loose, gray below 45 ft			S-12
50		---------medium dense below 50 ft			S-13
55					S-14
60					S-15
65					S-16
70		---------trace to some silt below 70 ft			S-17
75					S-18
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-23 (cont.)

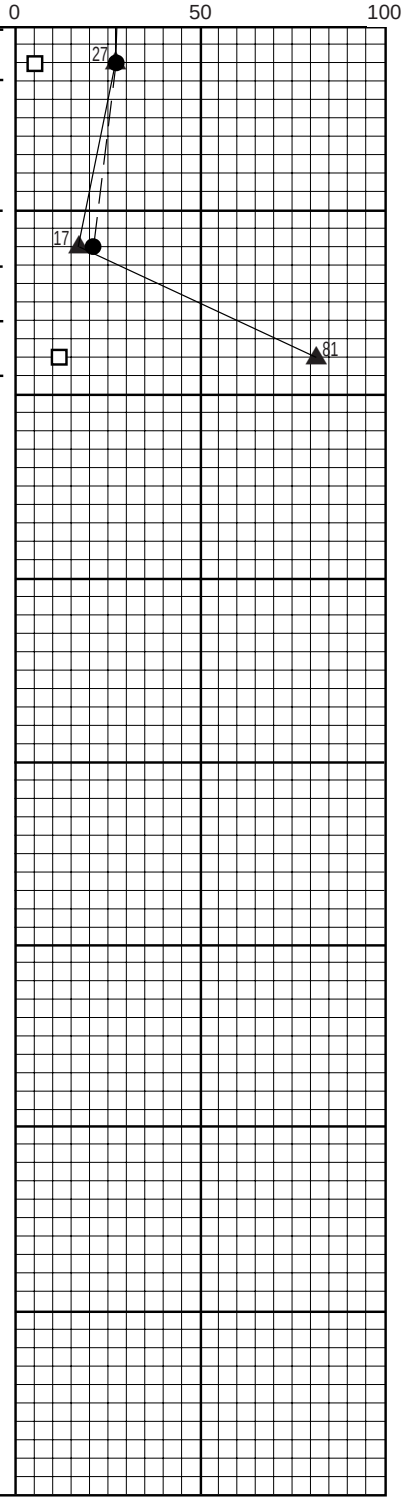
DEC. 2013 JOB. NO. W1114 FIG. 23A

EX-0001-003924-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
80		Medium dense, gray SAND; fine grained, trace silt			S-19
85		----------fine to medium grained below 85 ft; scattered gravel below 85.5 ft			S-20
			87.0		
		Very dense GRAVEL; trace to some silt and fine- to coarse-grained sand			S-21
			89.5		
90		(7/29/2013)			
95					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
NX CORE RUN
SLOTTED PVC PIPE
Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF
□ PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

Liquid Limit
Moisture Content
Plastic Limit

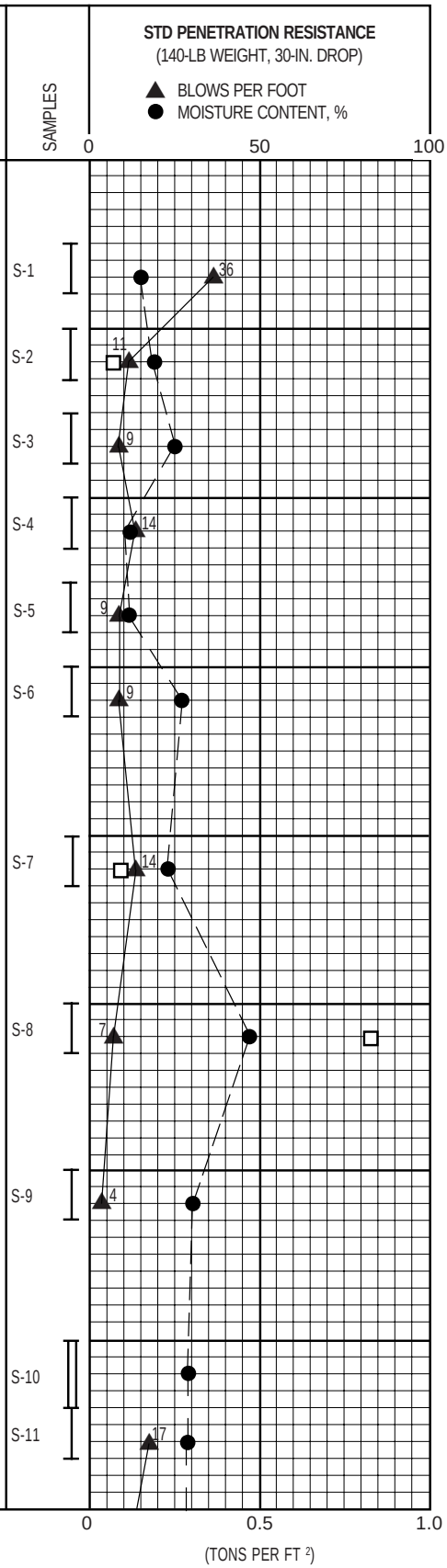
GRI

BORING B-23 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 23A

EX-0001-003925-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Dense, gray, gravelly SAND; fine to coarse grained, trace silt		
5		---------loose to medium dense, gravel absent below 5 ft, trace organics at 5 ft		
10				
15				
20				
25			25.0	
		Medium stiff, gray SILT; some fine-grained sand		
30			30.0	
		Loose to medium dense, gray SAND; fine grained, trace to some silt -------4-in.-thick sandy silt layer at 31 ft		
35		---------up to 1-in.-thick silt layers between 35 and 37 ft		
		---------brown, silty below 37 ft		
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

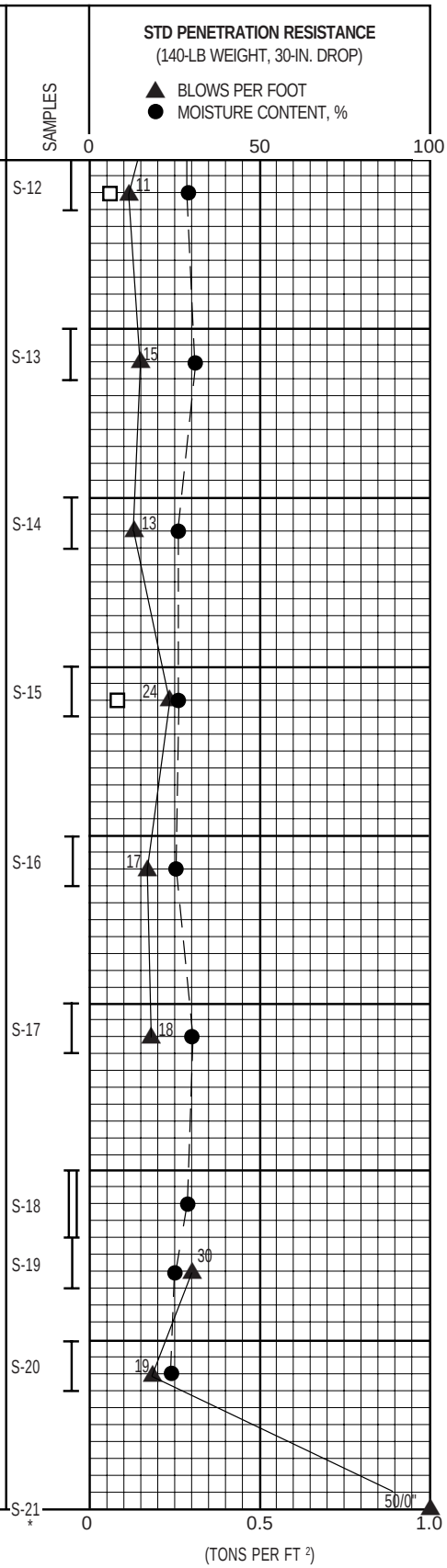
GRI

BORING B-24

DEC. 2013 JOB. NO. W1114 FIG. 24A

EX-0001-003926-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
40		Medium dense, brown SAND; fine grained, trace silt -------gray below 41 ft		
45				
50				
55				
60				
65				
70		---------medium dense to dense, reddish gray, fine to coarse grained below 72.5 ft		
75				
		Very dense GRAVEL (7/31/2013)	78.0	
80			80.0	



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

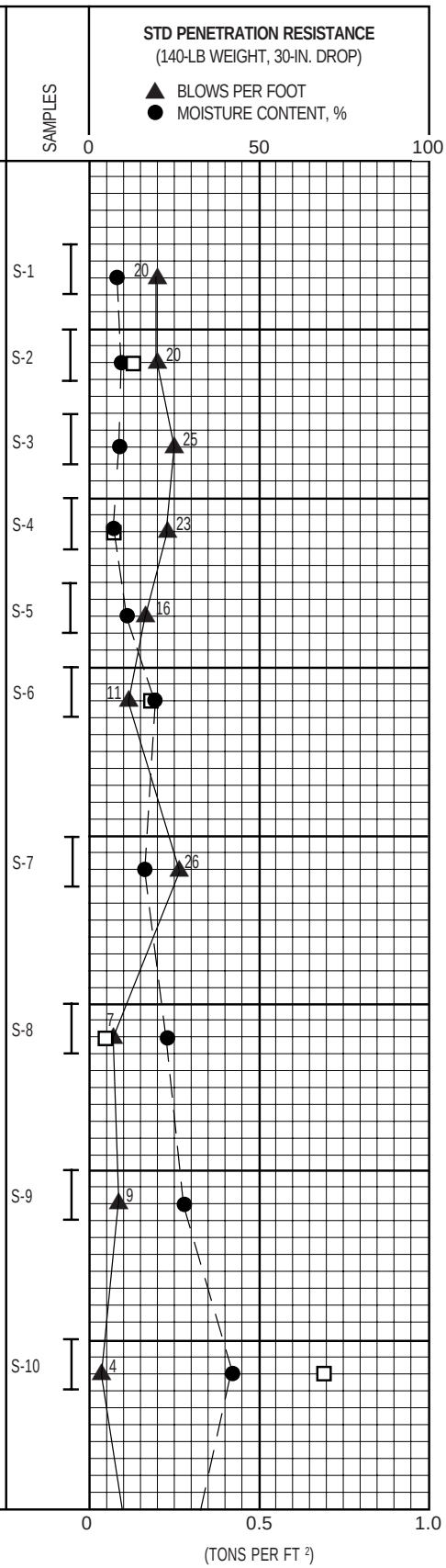
GRI

BORING B-24 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 24A

EX-0001-003927-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
		Asphaltic-concrete PAVEMENT (12 in.) over crushed rock BASE COURSE (24 in.)		
		FILL: Medium dense, light brown SAND; fine grained, trace rounded gravel, trace silt	3.0	
5		-------gray and brown below 5 ft ----------1-in.-thick silt layer at 6.5 ft		
10				
15				
20				
25		Loose, dark gray SAND; fine grained, trace silt	25.0	
30				
35		Medium stiff, dark gray, sandy SILT; fine-grained sand	35.0	
		Loose, dark gray SAND; fine to medium grained, trace to some silt	36.0	
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

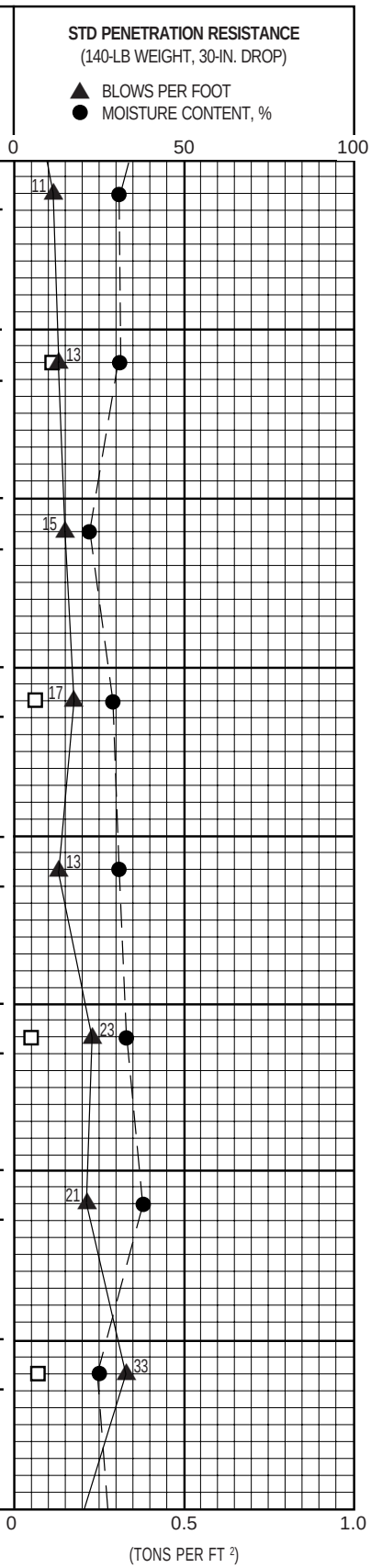
GRI

BORING B-25

DEC. 2013 JOB. NO. W1114 FIG. 25A

EX-0001-003928-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, dark gray SAND; fine to medium grained, trace to some silt, trace gravel			S-11
45					S-12
50		---------fine to coarse grained below 50 ft			S-13
55					S-14
60					S-15
65					S-16
70					S-17
75		---------dense below 75 ft			S-18
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

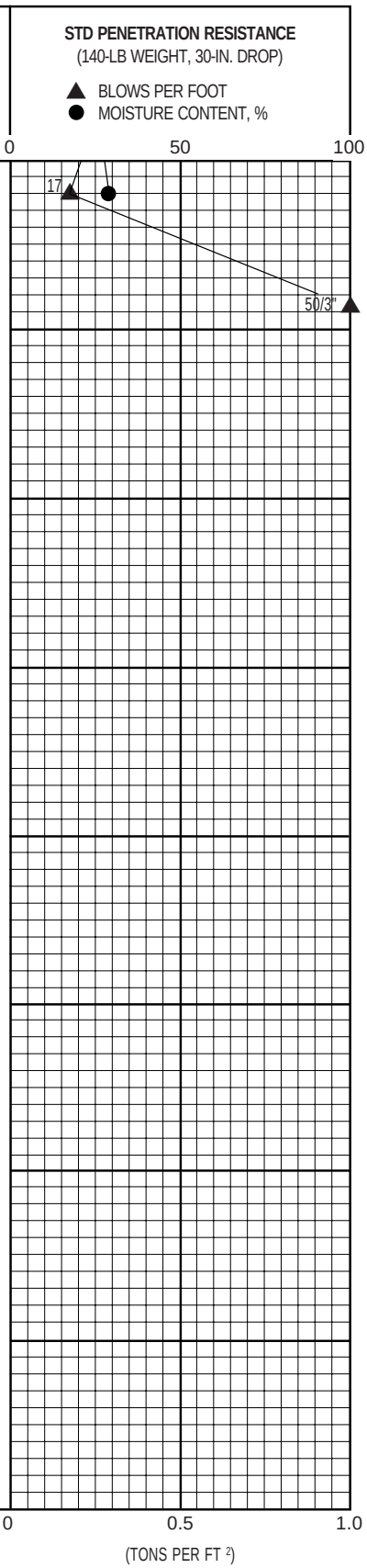
GRI

BORING B-25 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 25A

EX-0001-003929-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES
		SURFACE ELEVATION 27 ft (±)			
80		Medium dense, dark gray SAND; fine to coarse grained, trace silt			S-19
			82.0		
		Very dense GRAVEL; scattered cobbles			
			84.3		S-20
85		(7/30/2013)			



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

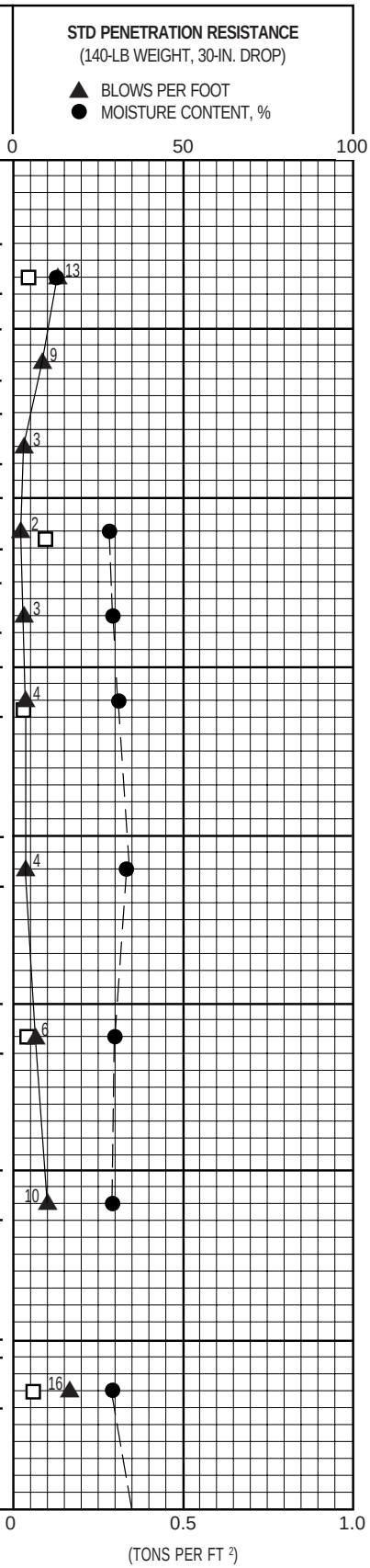
GRI

BORING B-25 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 25A

EX-0001-003930-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 7 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
		Medium dense, gray SAND; fine to medium grained, trace silt, scattered gravel			
		----------1-ft-thick layer of gravel at 4 ft			S-1
5		----------very loose to loose below 5 ft			S-2
					S-3 *
10		----------fine to coarse grained at 10 ft			S-4
					S-5
15					S-6
20		----------3-in.-thick layer of gray silt at 20.5 ft			S-7
25		----------scattered wood debris below 25 ft			S-8
30		----------medium dense below 30 ft, fine to coarse grained at 30 ft			S-9
35					S-10 * S-11
40					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

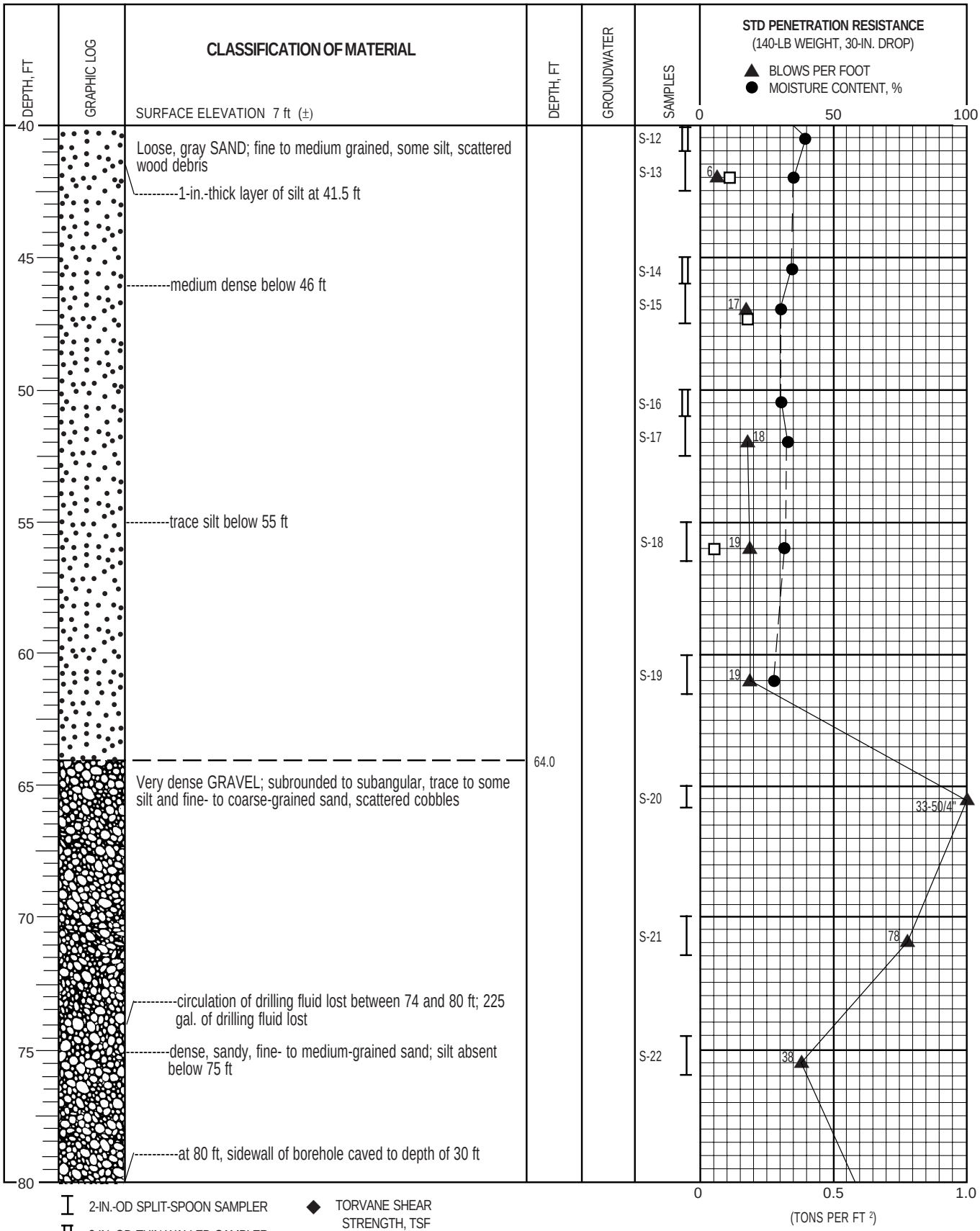
Plastic Limit

GRI

BORING B-26

DEC. 2013 JOB. NO. W1114 FIG. 26A

EX-0001-003931-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-26 (cont.)

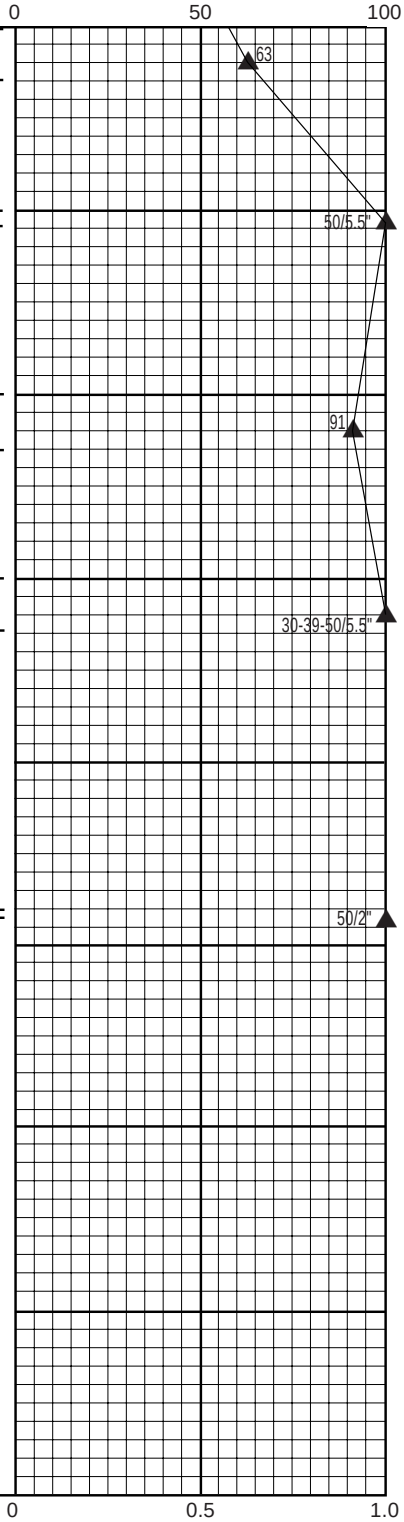
DEC. 2013 JOB. NO. W1114 FIG. 26A

EX-0001-003932-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES
		SURFACE ELEVATION 7 ft (±)			
80		Very dense GRAVEL; subrounded to subangular, trace to some fine- to coarse-grained sand, trace silt, scattered cobbles			S-23
85					S-24
90					S-25
95					S-26
100					
			104.2		S-27
105		(10/29/2013) 5.5-in.-diameter casing installed to 20 ft as part of drilling permit requirements			

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



0 0.5 1.0
(TONS PER FT ^{2})

2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
NX CORE RUN
SLOTTED PVC PIPE
Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF
□ PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

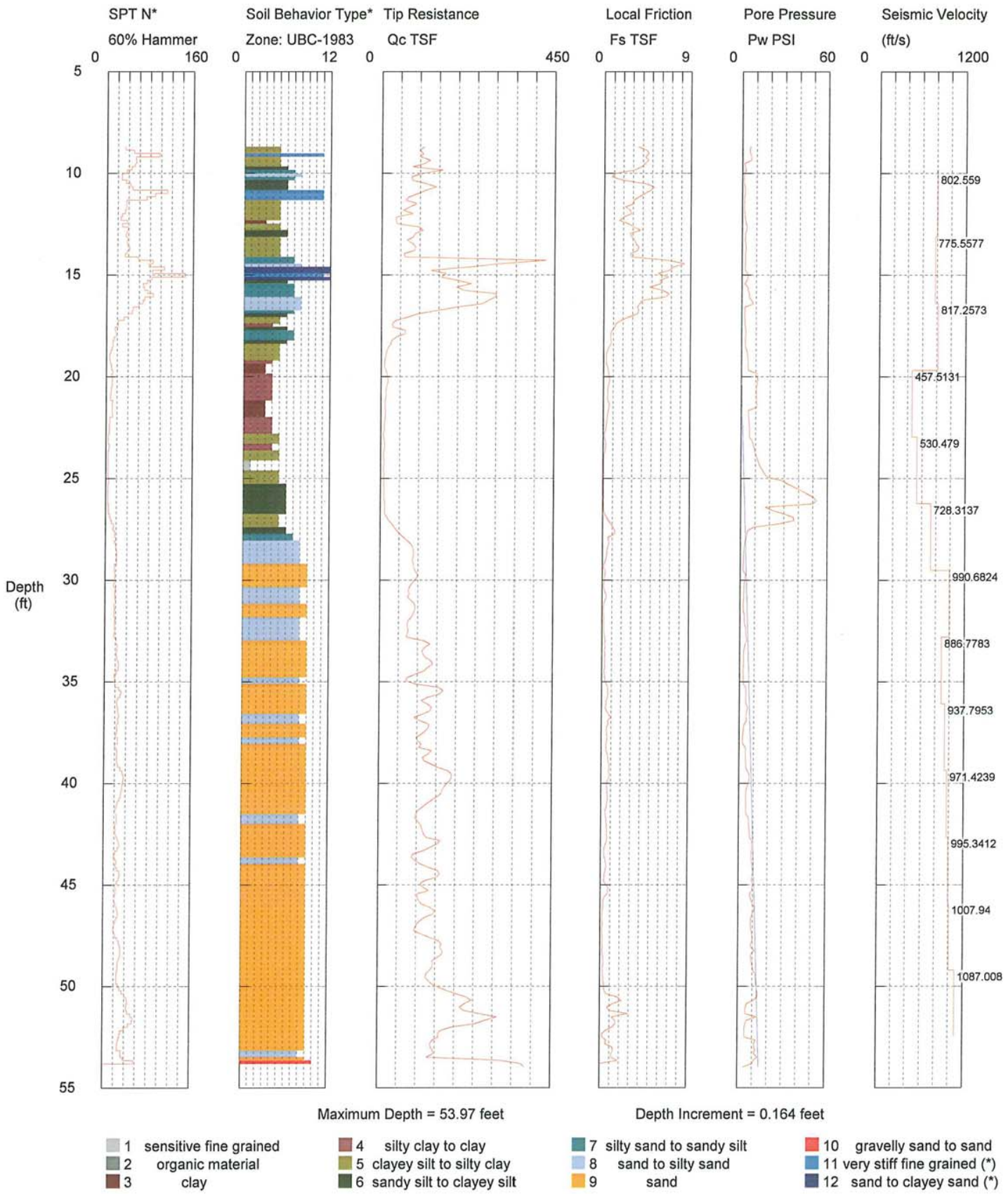
Liquid Limit
Moisture Content
Plastic Limit

GRI

BORING B-26 (cont.)

DEC. 2013 JOB. NO. W1114 FIG. 26A

EX-0001-003933-PCE



SURFACE ELEVATION = 28.5 FT

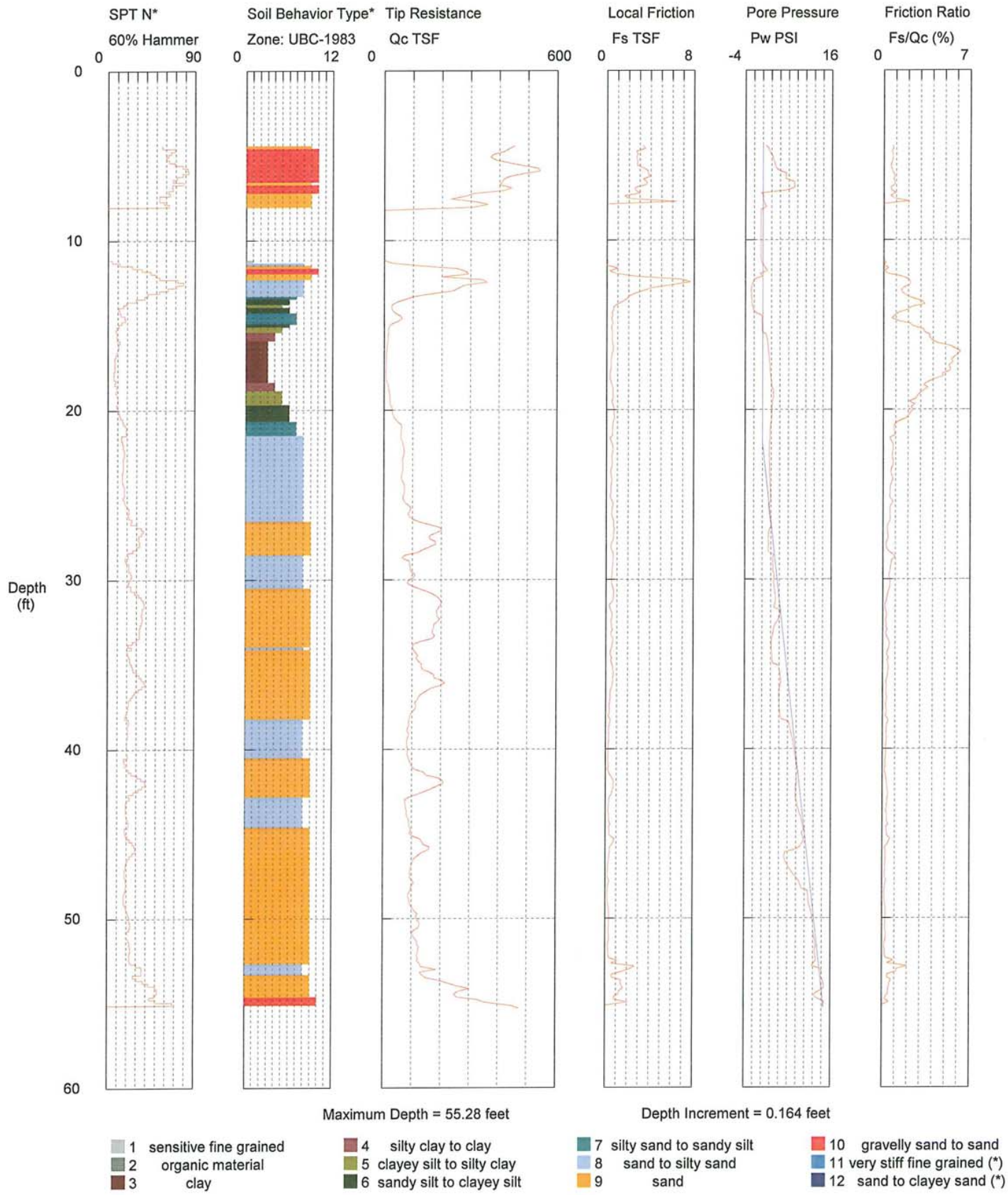
GRI

CONE PENETRATION TEST CPT-1

(WITH SEISMIC VELOCITY)

DEC. 2013 JOB NO. W1114 FIG. 27A

EX-0001-003934-PCE



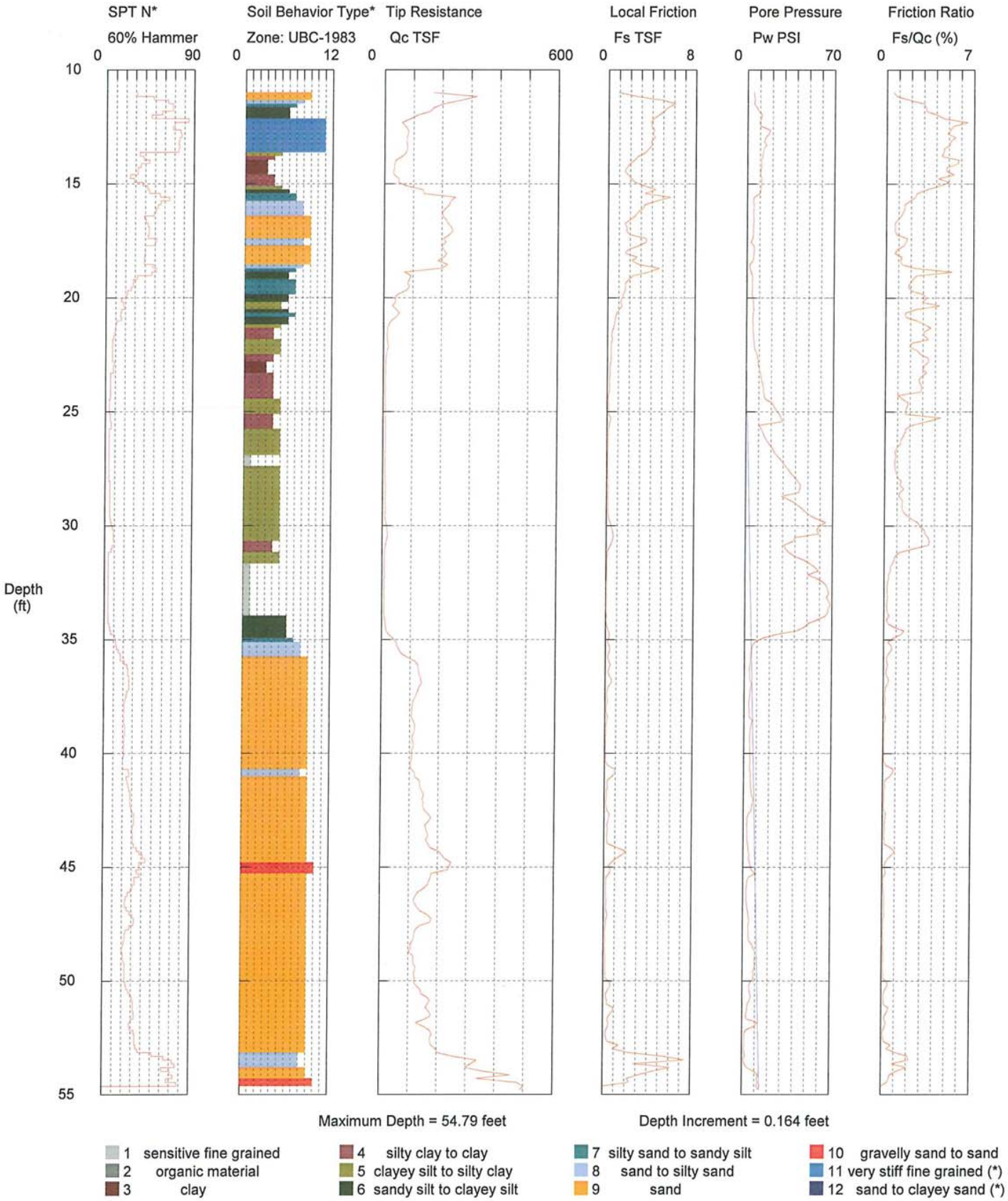
SURFACE ELEVATION = 29.9 FT

GRI

CONE PENETRATION TEST CPT-2

DEC. 2013 JOB NO. W1114 FIG. 28A

EX-0001-003935-PCE



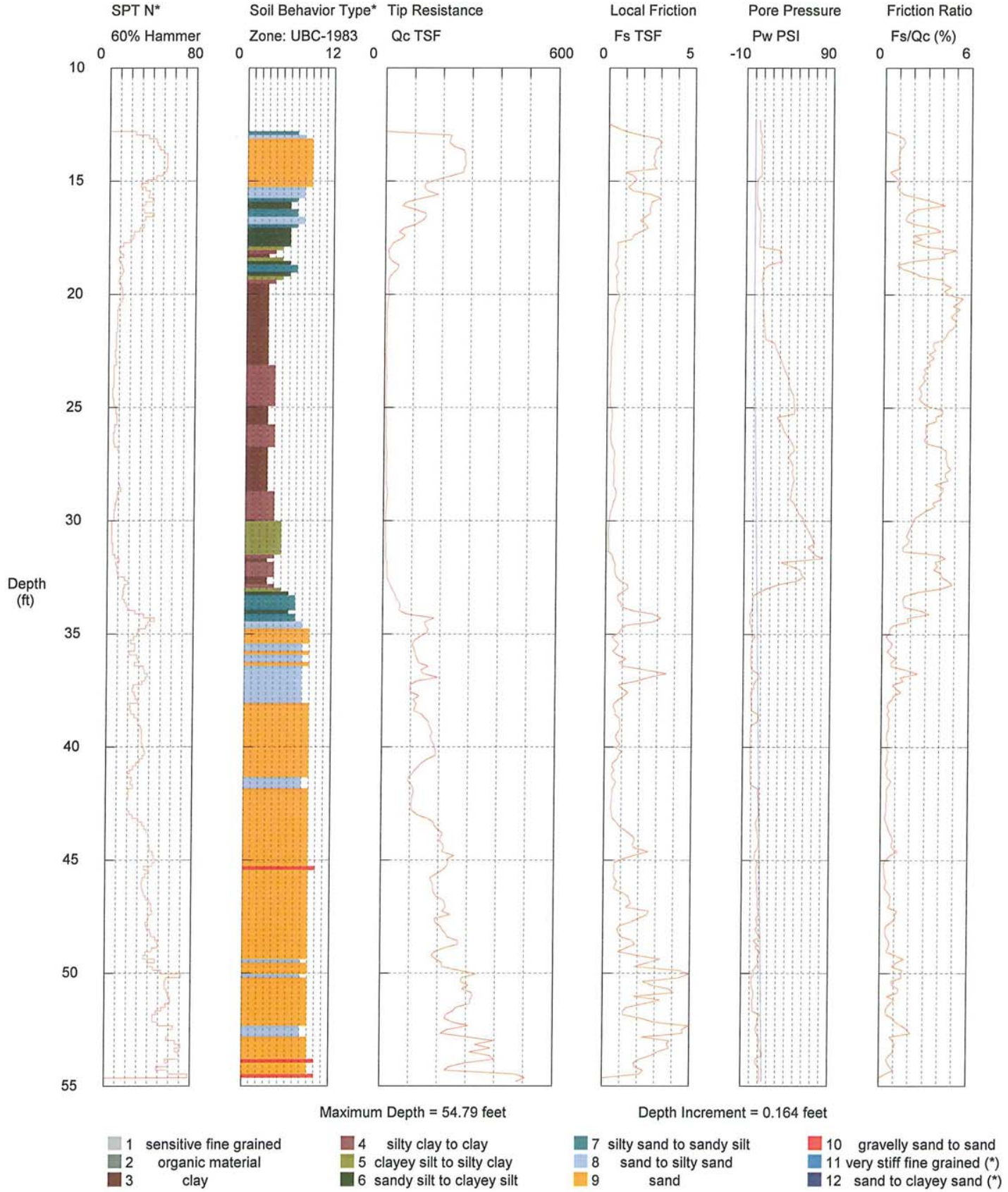
SURFACE ELEVATION = 28.5 FT

GRI

CONE PENETRATION TEST CPT-3

DEC. 2013 JOB NO. W1114 FIG. 29A

EX-0001-003936-PCE



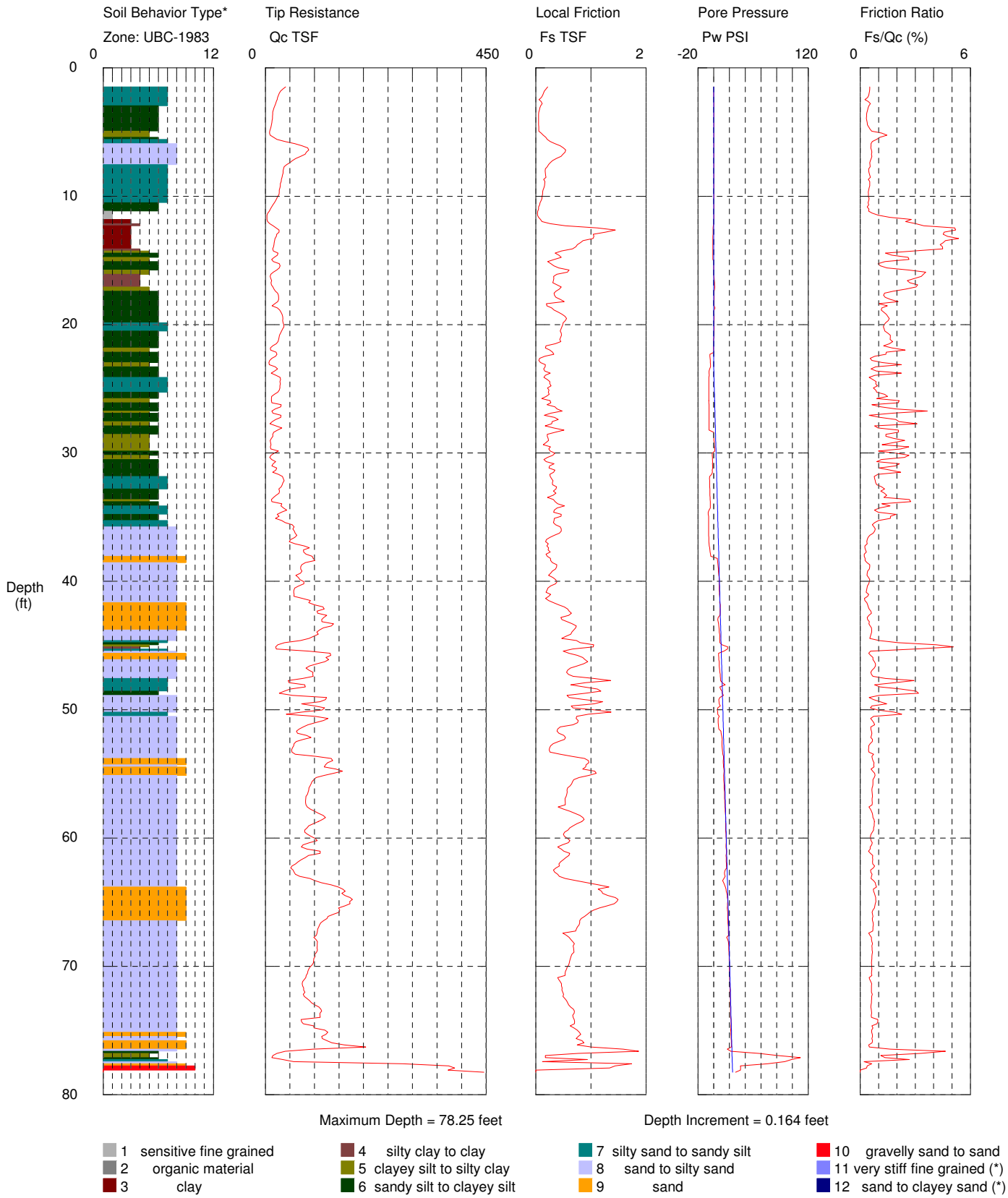
SURFACE ELEVATION = 26.8

GRI

CONE PENETRATION TEST CPT-4

DEC. 2013 JOB NO. W1114 FIG. 30A

EX-0001-003937-PCE



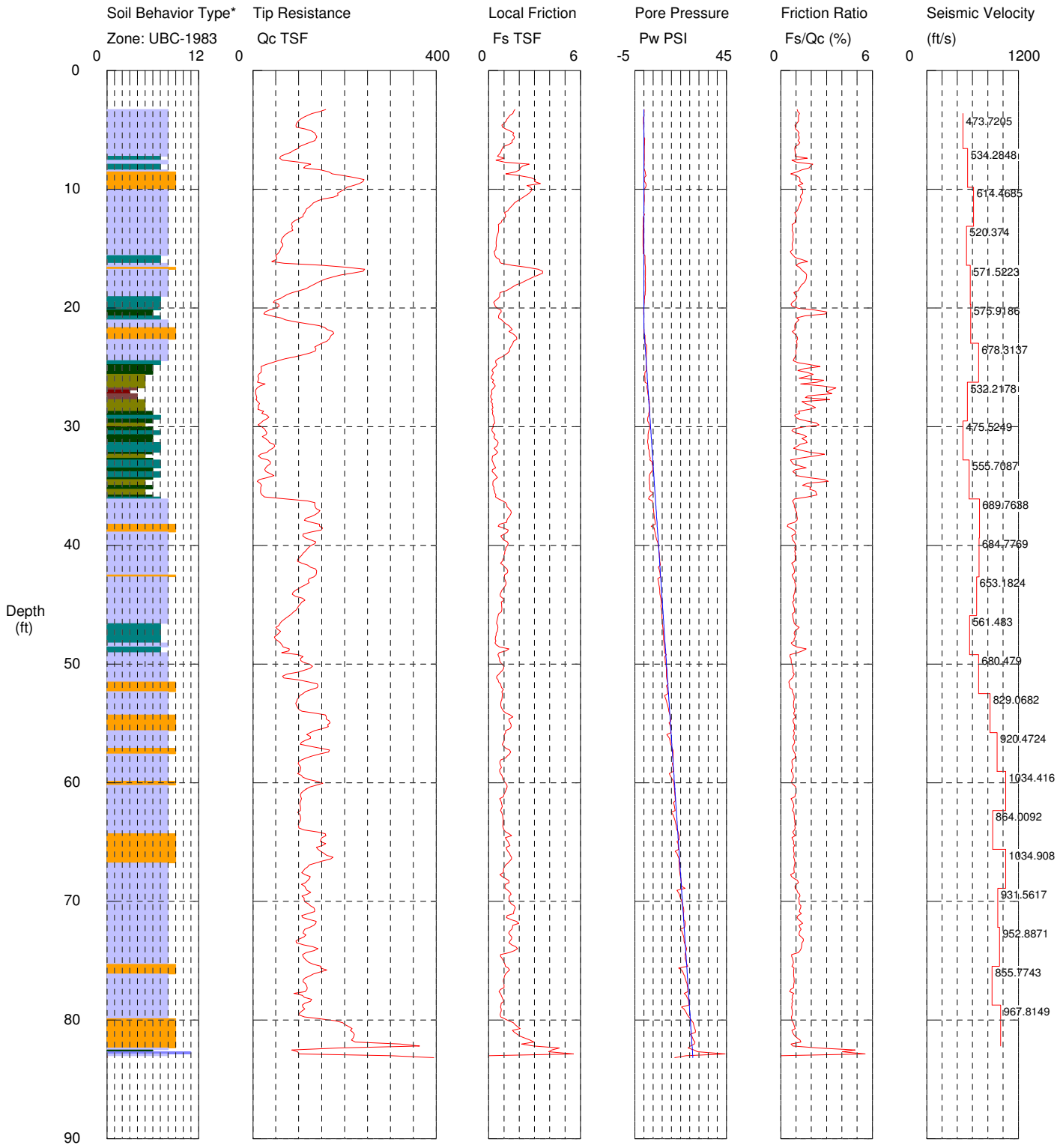
SURFACE ELEVATION = 31 FT

GRI

CONE PENETRATION TEST CPT-5

DEC. 2013 JOB NO. W1114 FIG. 31A

EX-0001-003938-PCE



SURFACE ELEVATION = 27 FT

GRI

CONE PENETRATION TEST CPT-6

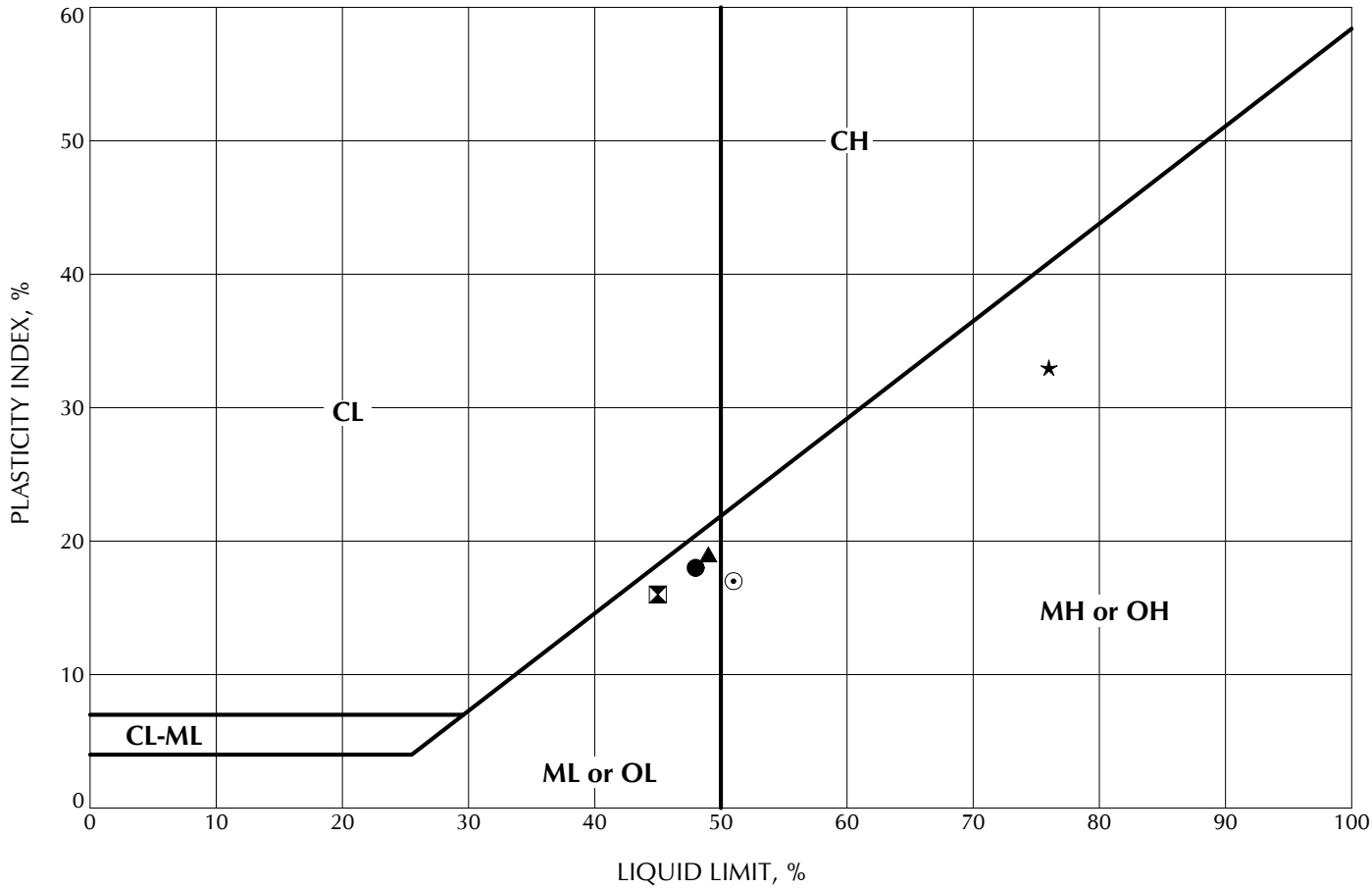
(WITH SEISMIC VELOCITY)

DEC. 2013 JOB NO. W1114 FIG. 32A

EX-0001-003939-PCE

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-01	S-8	21.8	SILT; some clay, trace sand	48	30	18	32
⧗	B-02	S-9	24.0	SILT; some clay, trace to some sand	45	29	16	41
▲	B-05	S-7	16.0	SILT; some clay	49	30	19	40
★	B-07	S-11	31.0	SILT; some clay, trace sand	76	43	33	74
⊙	B-08	S-9	25.3	SILT; trace to some clay, trace sand	51	34	17	43

GRI

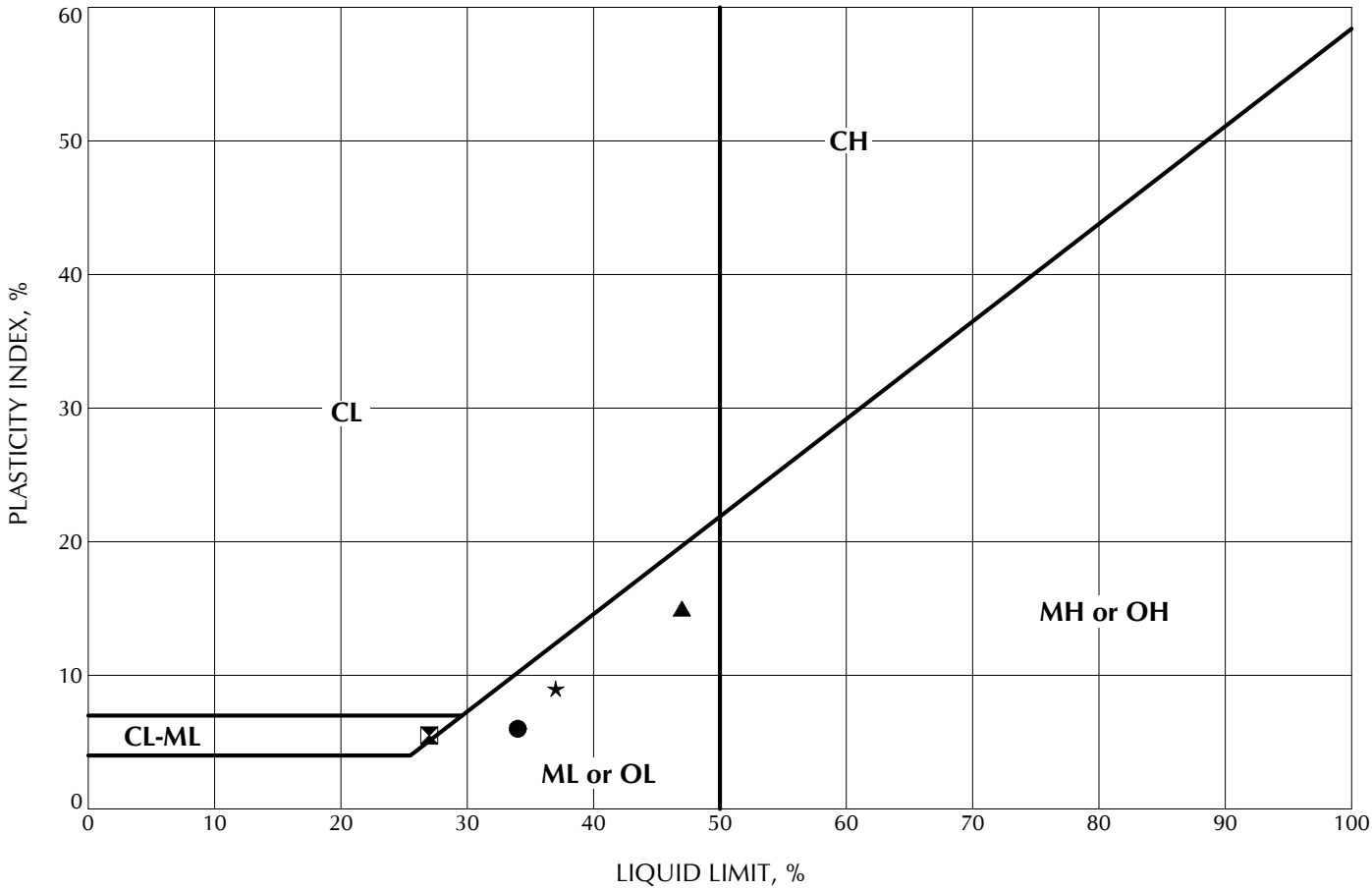
PLASTICITY CHART

DEC. 2013 JOB NO. W1114 FIG. 33A

ATTERBERG-PLASTICITY 5 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-11	S-8	25.0	SILT; some sand	34	28	6	39
⧗	B-17	S-6	15.0	SILT; some sand	27	22	5	31
▲	B-18	S-5	12.5	SILT; trace to some clay and sand	47	32	15	16
★	B-18	S-9	25.0	SILT; trace to some clay and sand	37	28	9	42
⊙								

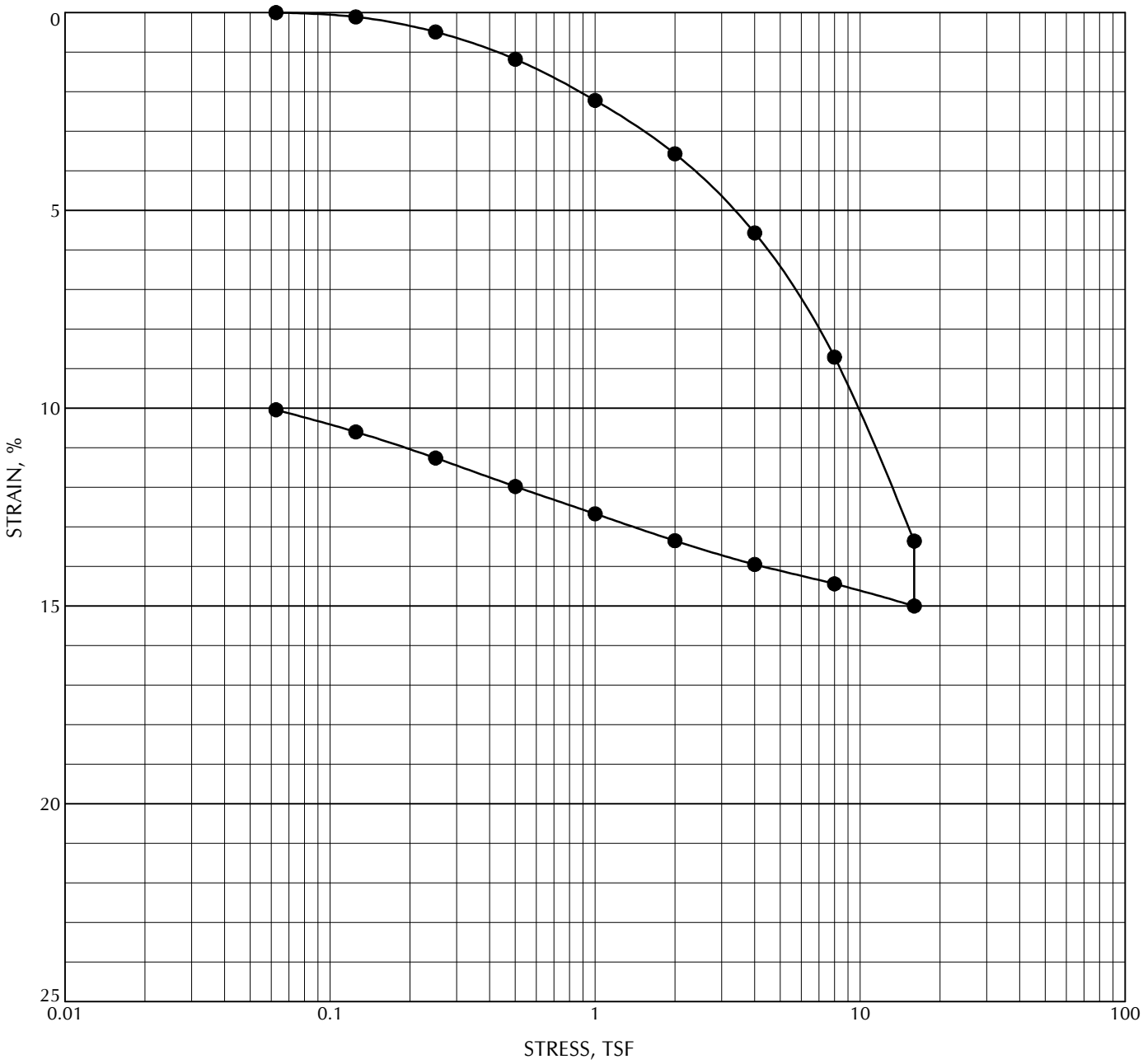
GRI

PLASTICITY CHART

DEC. 2013 JOB NO. W1114 FIG. 34A

ATTERBERG-PLASTICITY 5 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13

EX-0001-003941-PCE



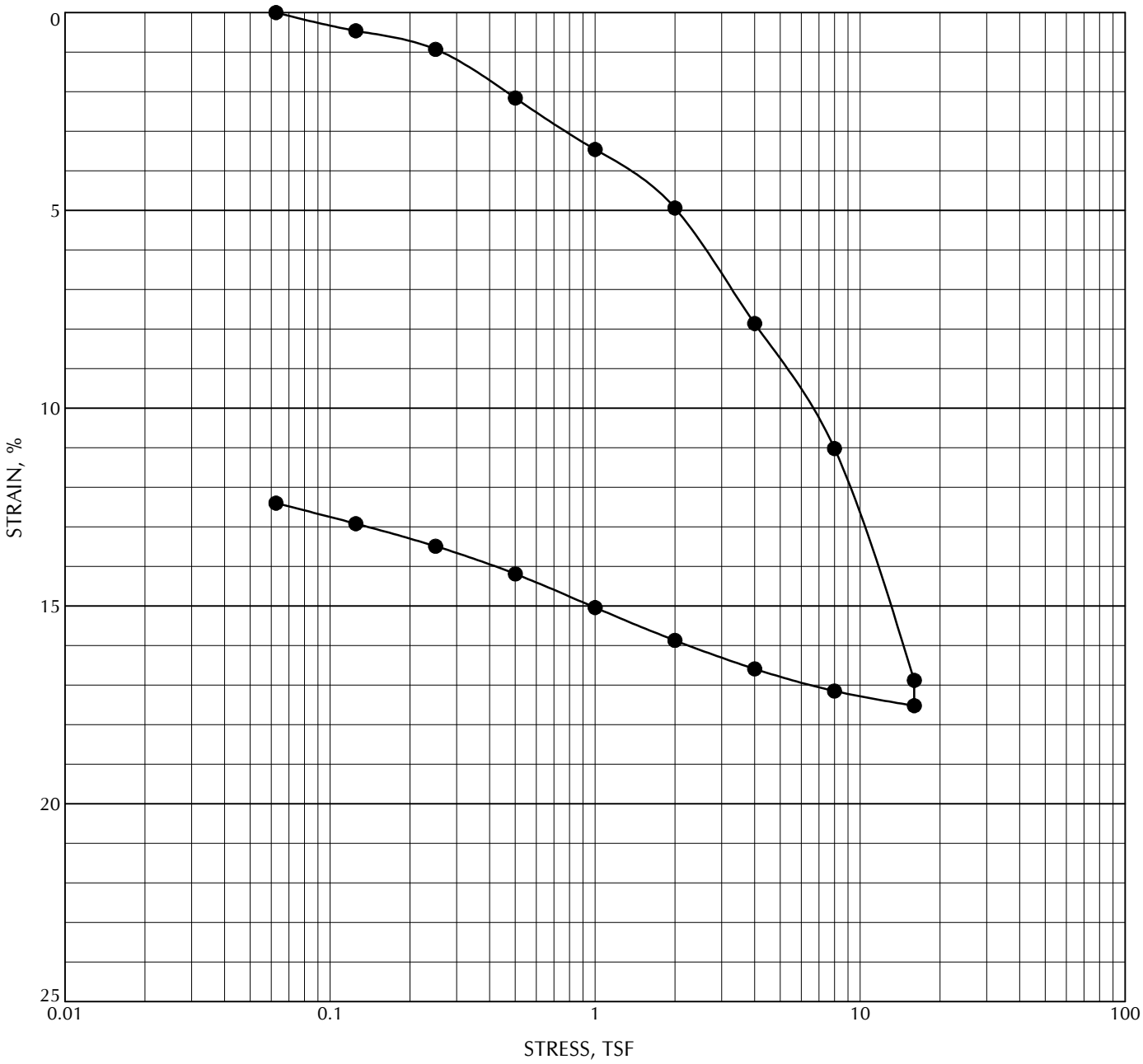
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-04	S-7	18.1	SILT; some clay, trace sand and organics	92	30

GRI

CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 35A

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



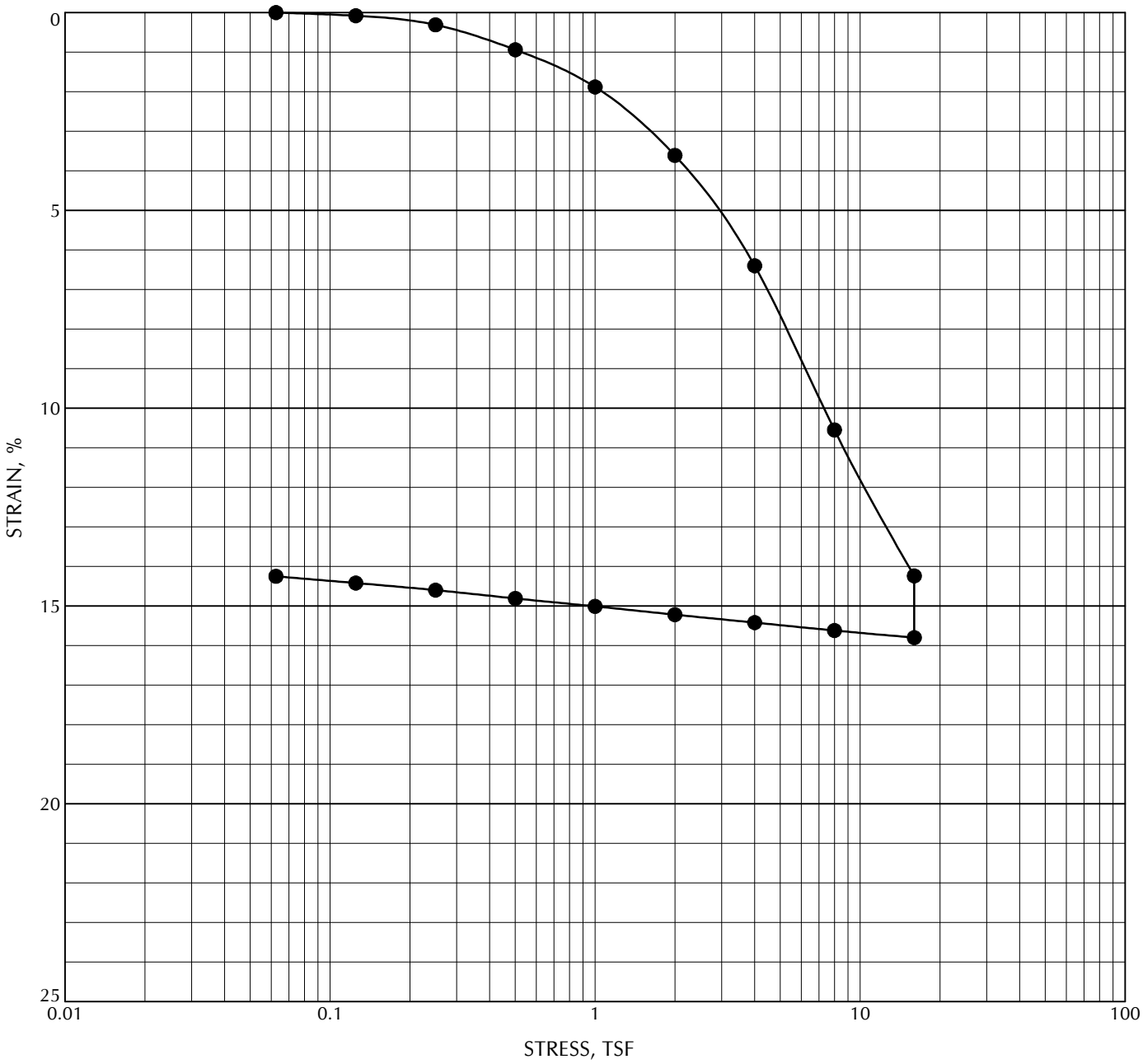
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-05	S-6	14.7	SILT; some clay, trace sand	84	36

GRI

CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 36A

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-07	S-12	32.0	Silty SAND	71	49

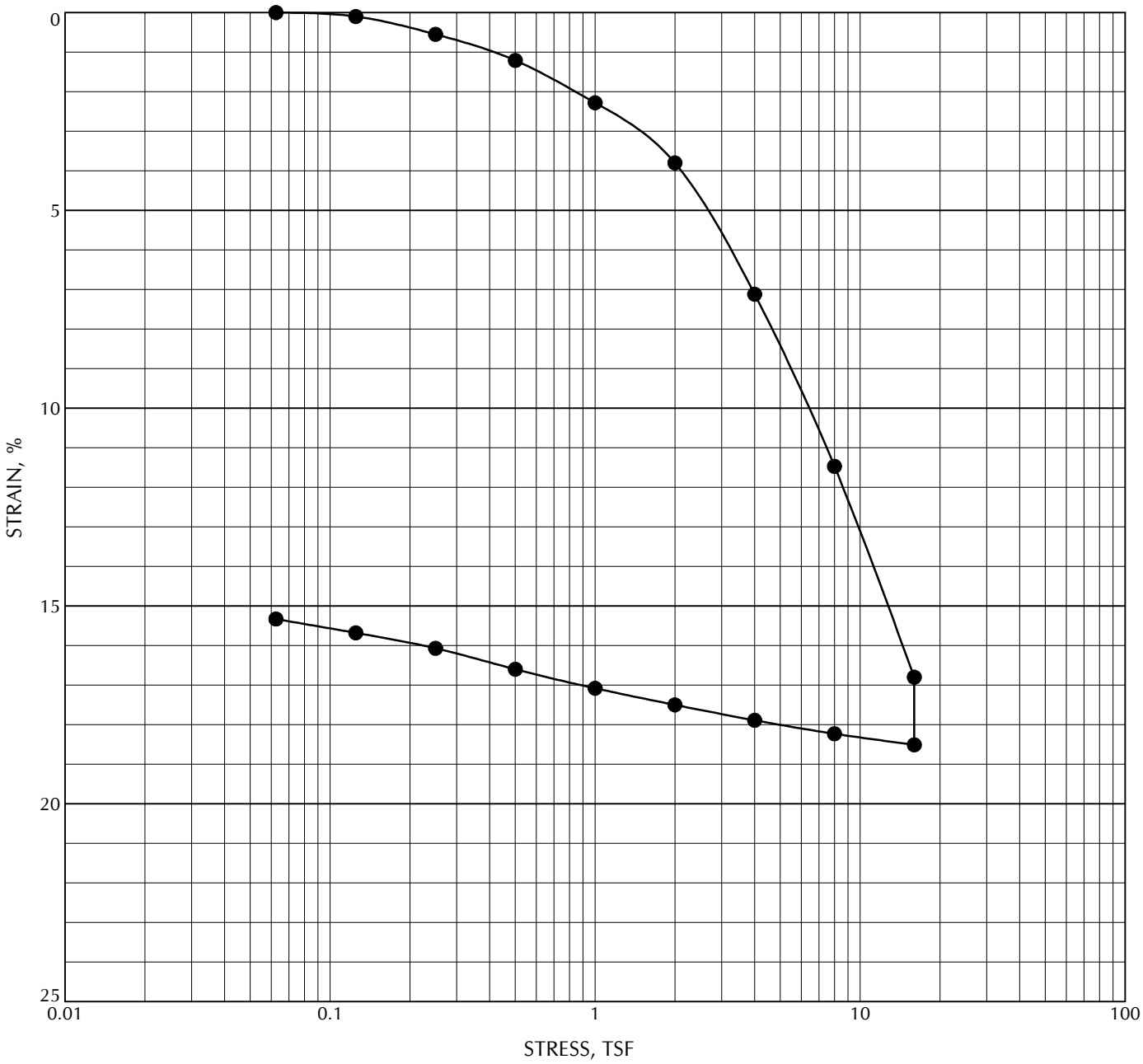
GRI

CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 37A

EX-0001-003944-PCE

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



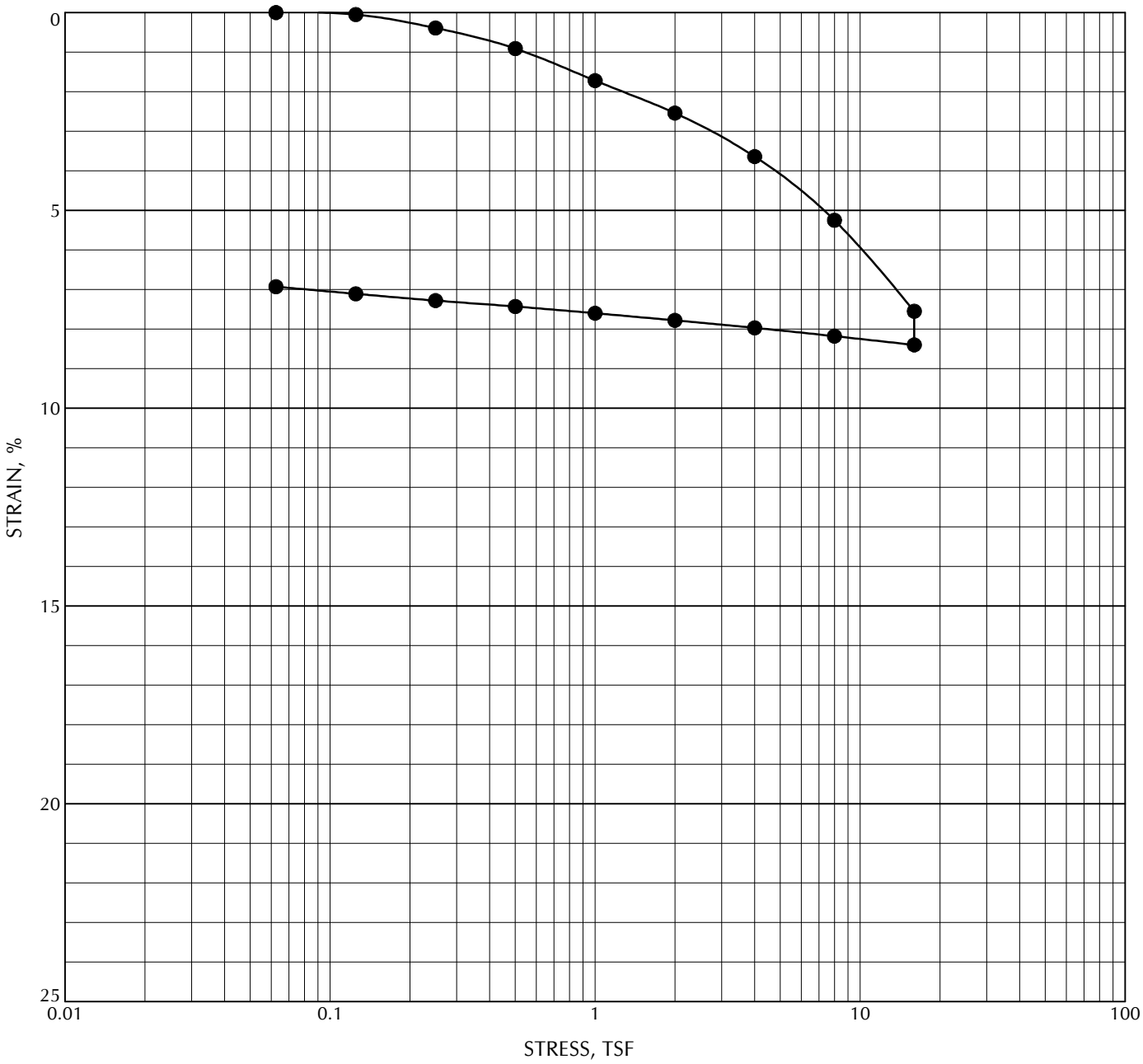
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-08	S-9	25.3	SILT; trace to some clay, trace sand	80	41

GRI

CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 38A

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



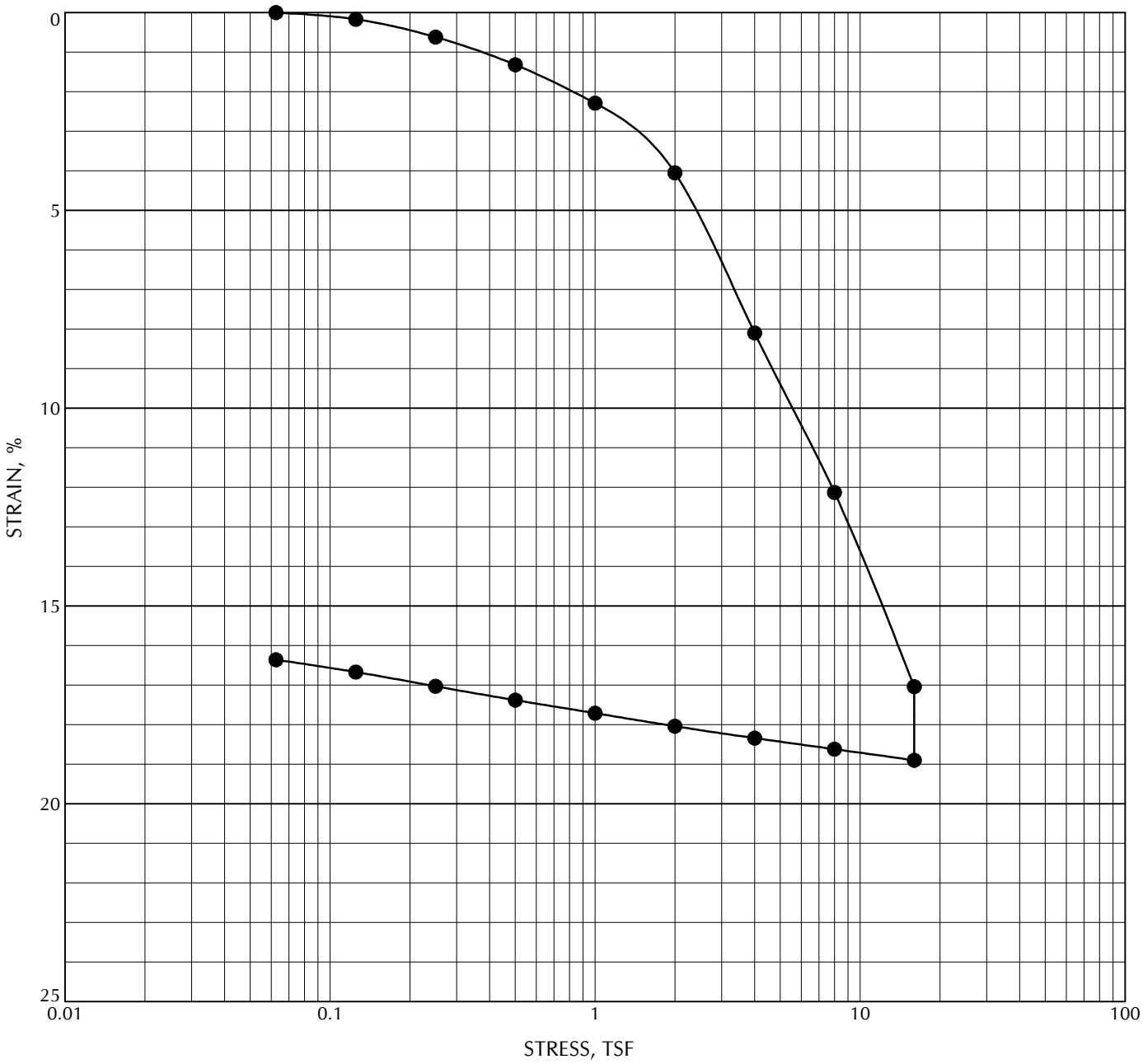
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-11	S-4	10.0	Silty SAND	89	28

GRI

CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 39A

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-19	S-8	21.5	Sandy SILT	80	41

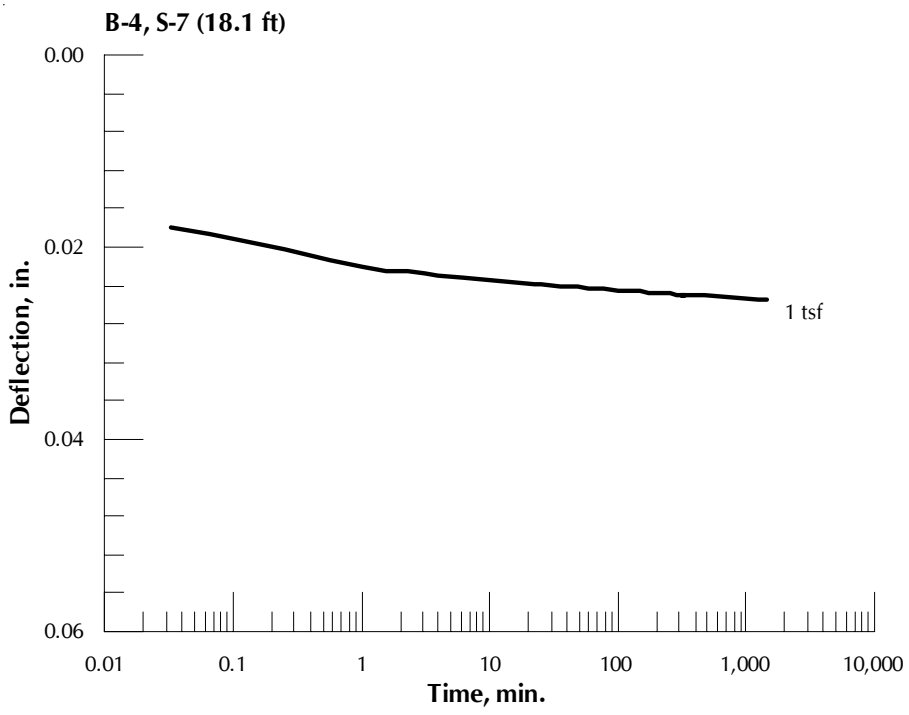
GRI

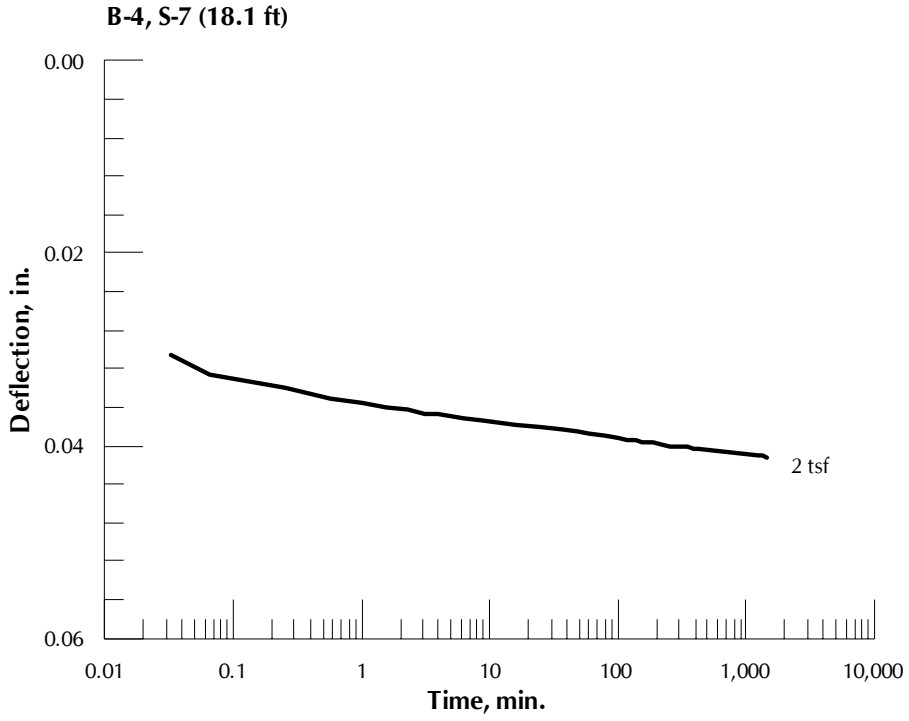
CONSOLIDATION TEST

DEC. 2013 JOB NO. W1114 FIG. 40A

EX-0001-003947-PCE

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



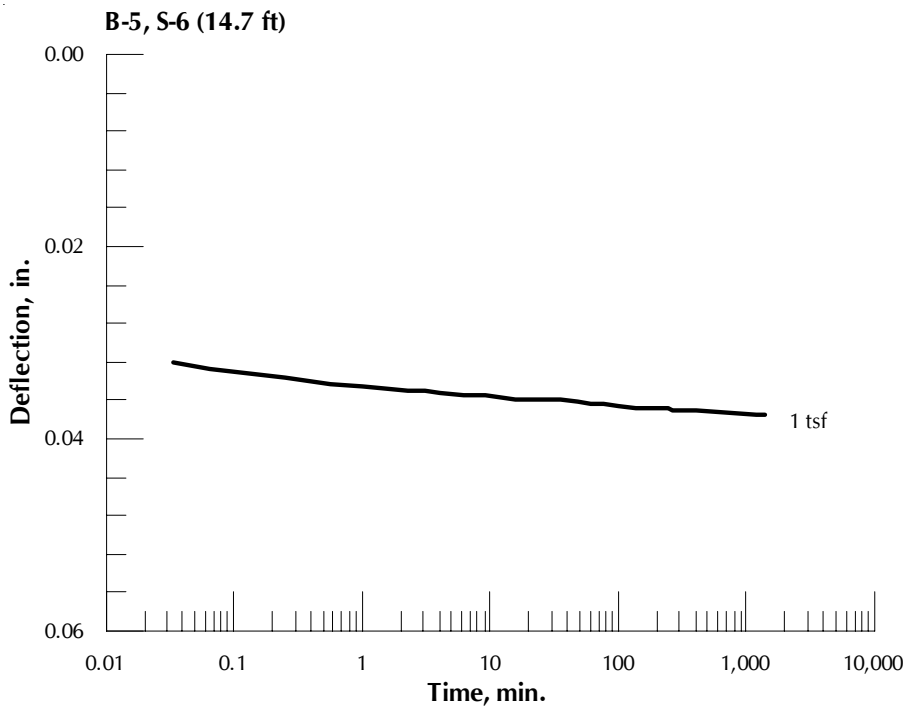


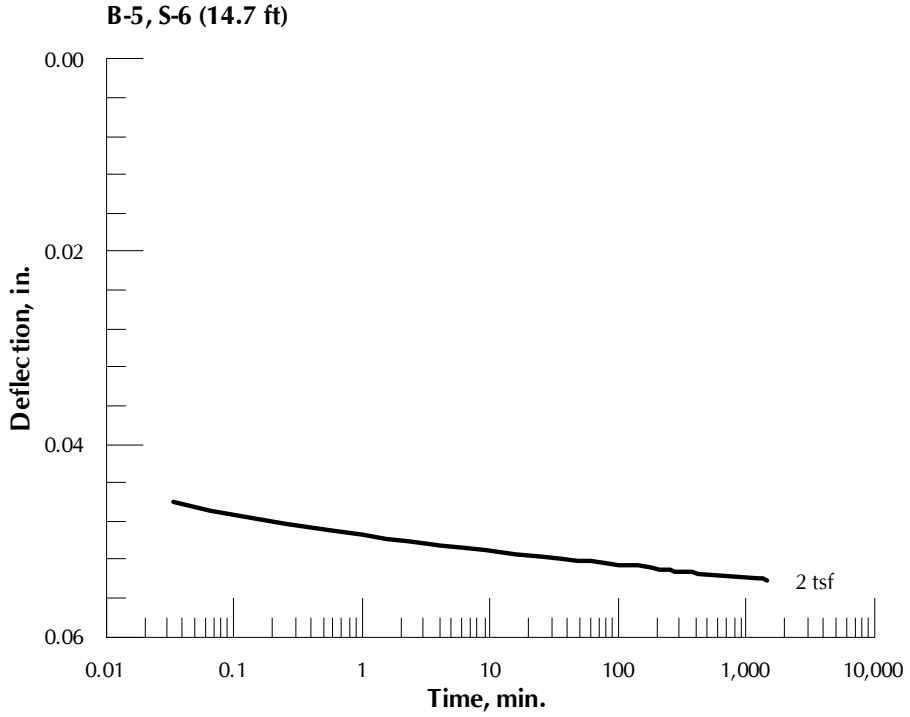
GRI

SECONDARY COMPRESSION

DEC. 2013 JOB NO. W1114 FIG. 41A

EX-0001-003948-PCE



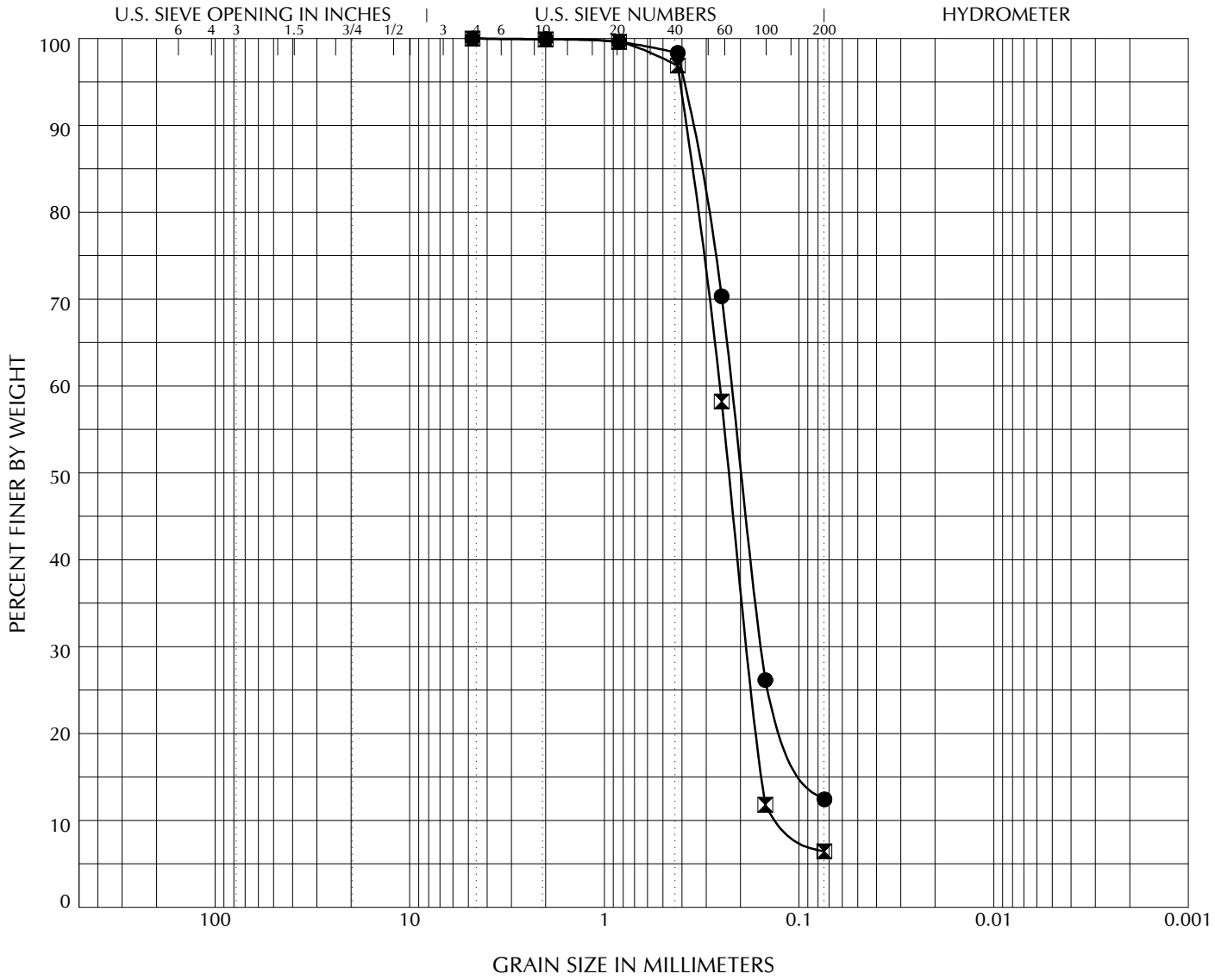


GRI

SECONDARY COMPRESSION

DEC. 2013 JOB NO. W1114 FIG. 42A

EX-0001-003949-PCE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

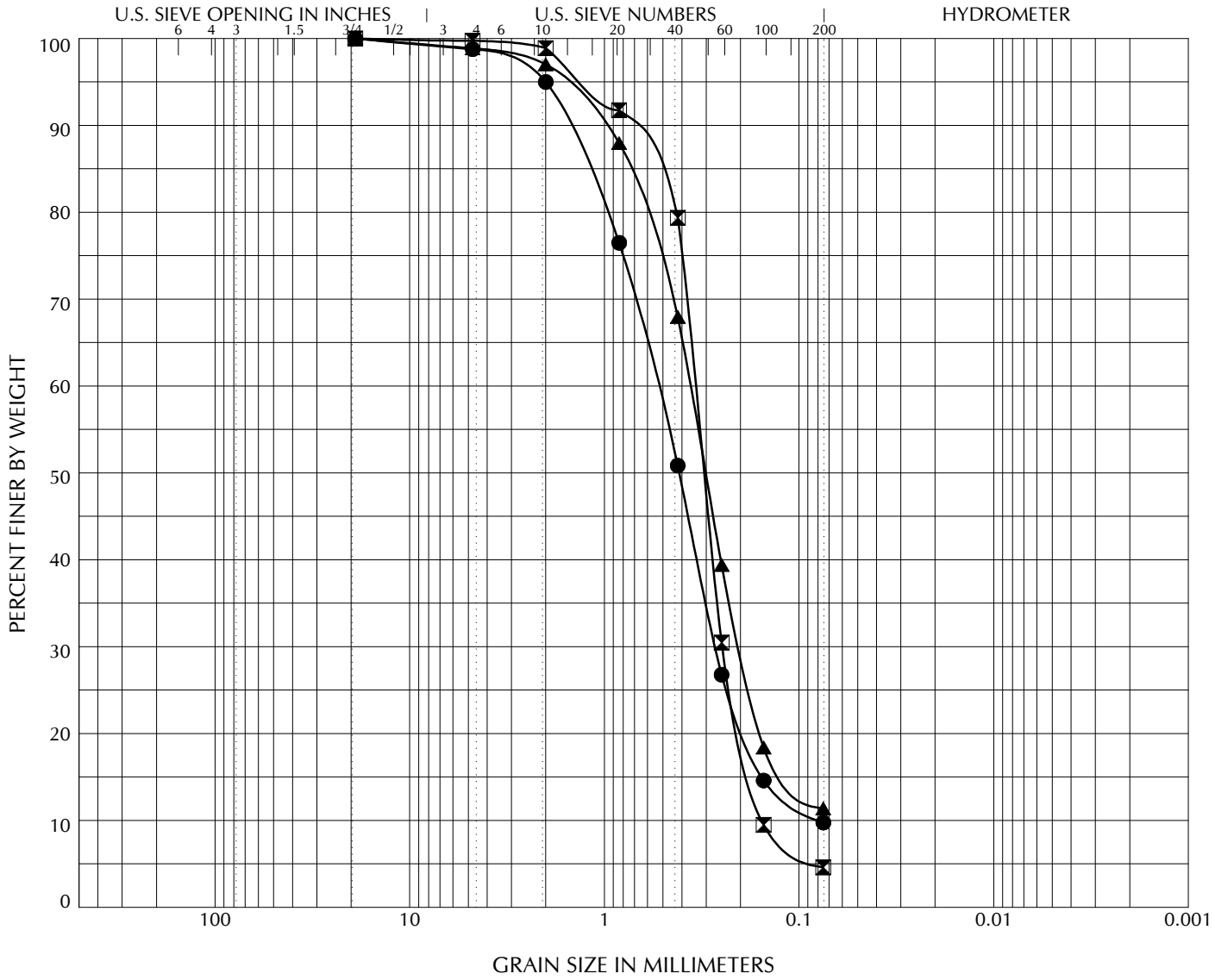
	Location	Sample	Depth, ft	Classification	Gravel, %	Sand, %	Fines, %
●	B-23	S-8	25.0	SAND; fine to medium grained, some silt	0.0	87.3	12.7
⊠	B-23	S-12	45.0	SAND; fine grained, trace silt	0.0	93.5	6.5

GRI

GRAIN SIZE DISTRIBUTION

DEC. 2013 JOB NO. W1114 FIG. 43A

GRAIN SIZE GRI-TWO PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

	Location	Sample	Depth, ft	Classification	Gravel, %	Sand, %	Fines, %
●	B-26	S-4	10.0	Very loose, gray SAND; fine- to coarse-grained, trace silt	1.2	89.0	9.8
⊠	B-26	S-8	25.0	Loose, gray SAND; fine- to medium-grained, trace silt, scattered wood debris	0.3	95.2	4.6
▲	B-26	S-13	41.0	Loose, gray SAND; fine- to medium-grained, some silt, scattered wood debris	1.1	87.5	11.4

GRI

GRAIN SIZE DISTRIBUTION

DEC. 2013 JOB NO. W1114-T3 FIG. 44A

GRAIN SIZE GRI-THREE PER PAGE W1114-T3 LAB.GPJ GRI DATA TEMPLATE.GDT 12/10/13

APPENDIX B

Site-Specific Seismic Hazard Study

APPENDIX B

SITE-SPECIFIC SEISMIC HAZARD STUDY

General

GRI has completed a site-specific seismic hazard study for Areas 300 and 400 at the proposed Tesoro Savage Vancouver Energy Distribution Terminal - Upland Facility (TSVEDT) in Vancouver, Washington. The purpose of the study was to evaluate the potential seismic hazards associated with regional and local seismicity. The site-specific hazard study is intended to meet the requirements of the 2012 International Building Code (IBC), in compliance with the requirements of ASCE 7-10 Chapter 21. Our work was based on the potential for regional and local seismic activity, as described in the existing scientific literature, and on the subsurface conditions at the site, as disclosed by the geotechnical explorations completed for the project. Specifically, our work included the following tasks:

1) A detailed review of available literature, including published papers, maps, open-file reports, seismic histories and catalogs, and other sources of information regarding the tectonic setting, regional and local geology, and historical seismic activity that might have a significant effect on the site.

2) Compilation, examination, and evaluation of existing subsurface data gathered at and in the vicinity of the site, including classification and laboratory analyses of soil samples. This information was used to prepare a generalized subsurface profile for Areas 300 and 400 within the TSVEDT property.

3) Identification of the potential seismic sources appropriate for the site and characterization of those sources in terms of magnitude, distance and spectral response spectra.

4) Office studies, based on the generalized subsurface profile and the controlling seismic sources, resulting in conclusions and recommendations concerning:

    a) specific seismic events and characteristic earthquakes that might have a significant effect on Areas 300 and 400;

    b) the potential for seismic energy amplification in Areas 300 and 400; and

    c) site-specific acceleration response spectra for design of the proposed structures in Areas 300 and 400.

This appendix describes the work accomplished and summarizes our conclusions and recommendations.

Geologic Setting

General. On a regional scale, the site lies within the Willamette-Puget Sound lowland trough of the Cascadia convergent tectonic system (Blakely, et al., 2000). The lowland areas consist of broad north-south-trending basins in the underlying geologic structure between the Coast Range to the west and the

Cascade Mountains to the east. The lowland trough is characterized by alluvial plains with areas of buttes and terraces. The site lies approximately 95 km inland from the down-dip edge of the seismogenic extent of the Cascadia Subduction Zone (CSZ), an active convergent plate boundary along which remnants of the Farallon Plate (the Gorda, Juan de Fuca, and Explorer plates) are being subducted beneath the western edge of the North American continent. The subduction zone is a broad, eastward-dipping zone of contact between the upper portion of the subducting slabs and the over-riding North American Plate as shown on Figure 1B.

On a local scale, the site lies within the Portland Basin, a large, well-defined, northwest-trending structure characterized as a right-lateral pull-apart basin in the forearc of the CSZ. The Portland Basin is bounded by high-angle, northwest-trending, right-lateral strike-slip faults that are considered to be seismogenic; however, the relationship between specific earthquakes and individual faults in the area is not well understood since few of these faults are expressed clearly at the ground surface. A limited number of intrabasin faults have been mapped on the basis of stratigraphic offsets and geophysical evidence, and the site is located in close proximity to the inferred traces of the Portland Hills Fault and the East Bank Fault indicated on published geologic mapping (Personius, et al., 2003). The distribution of these crustal faults relative to the site is shown on the Regional Geologic Map and Local Fault Map, Figures 2B and 3B, respectively. The fault locations on the geologic map are inferred or approximate. Other faults may be present within the basin, but clear stratigraphic evidence regarding their location and extent is not presently available.

Because of the proximity of the site to the CSZ and its location within the Portland Basin, three seismic sources contribute to the potential for damaging earthquake motions at the site. Two of these sources are associated with tectonic activity related to the Cascadia Subduction Zone, the third is associated with movement on relatively shallow faults within and adjacent to the Portland Basin.

Site Soil and Geologic Conditions. The Area 300 and 400 portions of the project site are mantled by up to 25 ft of fill that is underlain by alluvial sand and silt deposited by the Columbia River. The alluvial deposits are underlain by gravel associated with late-Pleistocene catastrophic flood deposits that extend hundreds of feet below the ground surface in this portion of Vancouver. The catastrophic flood deposits consist of interbedded sands, silts, and gravels deposited by the repeated Missoula Flood events that occurred between 13,500 and 15,000 years ago. The flood deposits are underlain by interbedded sands and gravels of the Troutdale formation (Pliocene to Pleistocene) which are, in turn, underlain by the Columbia River Basalt bedrock (middle Miocene).

Seismicity

General. The geologic and seismologic information available for identifying the potential seismicity at the site is incomplete, and large uncertainties are associated with estimates of the probable magnitude, location, and frequency of occurrence of earthquakes that might affect the site. The available information indicates the potential seismic sources that may affect the site can be grouped into three independent categories: *subduction zone events* related to sudden slip between the upper surface of the Juan de Fuca plate and the lower surface of the North American plate, *subcrustal (intraslab) events* related to deformation and volume changes within the deeper portion of the subducted Juan de Fuca plate, and *local crustal events* associated with movement on shallow, local faults within and adjacent to the Portland Basin. Based on our review of currently available information, we have developed parameters for each of these

potential seismic sources. The seismic sources are characterized by three important parameters: magnitude, distance to the subject site, and the peak horizontal bedrock accelerations produced by the controlling earthquake on the seismic source. The size of an earthquake is commonly defined by its moment magnitude M_W. Distance is measured using the closest horizontal distance to the surface projection of the rupture plane or the closest distance to the rupture plane, in kilometers. Peak horizontal bedrock accelerations are expressed in units of gravity (1 g = 32.2 ft/sec^2 = 981 cm/sec^2).

Subduction Zone Event. Written Japanese tsunami records provide evidence that a great CSZ earthquake occurred in January 1700. Geological studies show that great megathrust earthquakes have occurred repeatedly in the past 7,000 years (Atwater et al., 1995; Clague et al., 1997; Goldfinger, 2003; and Kelsey et al., 2005), and geodetic studies (Hyndman and Wang, 1995; Savage, et al., 2000) indicate rate of strain accumulation consistent with the assumption that the CSZ is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia (Fluck, et al., 1997; Wang, et al., 2001). Numerous geological and geophysical studies suggest the CSZ may be segmented (Hughes and Carr, 1980; Weaver and Michaelson, 1985; Guffanti and Weaver, 1988; Goldfinger, 1994; Kelsey, et al., 1994; Mitchell, et al., 1994; Personius, 1995; Nelson and Personius, 1996; Witter, 1999), but the most recent studies suggest that for the last great earthquake in 1700, most of the subduction zone ruptured in a single M_w 9 earthquake (Satake, et al., 1996; Atwater and Hemphill-Haley, 1997; Clague, et al., 2000). Published estimates of the probable maximum size of subduction zone events range from moment magnitude M_W 8.3 to >9.0. Numerous detailed studies of coastal subsidence, tsunamis, and turbidites yield a wide range of recurrence intervals, but the most complete records (>4,000 years) indicate average intervals of 350 to 600 years between great earthquakes on the CSZ (Adams, 1990; Atwater and Hemphill-Haley, 1997; Witter, 1999; Clague, et al., 2000; Kelsey, et al., 2002; Kelsey, et al., 2005; Witter, et al., 2003). Tsunami inundation in buried marshes along the Washington and Oregon coast and stratigraphic evidence from the Cascadia margin support these recurrence intervals (Kelsey, et al., 2005; Goldfinger, 2003).

The USGS probabilistic analysis assumes four potential locations for the eastern edge of the earthquake rupture zone for the CSZ, as shown in Figure 4B. The 2008 USGS mapping effort indicates two rupture scenarios are assumed to represent these megathrust events: 1) M9±0.2 events that rupture the entire CSZ every 500 years and 2) M8.0 to 8.7 events with rupture zones that occur on segments of the CSZ and occur over the entire length of the CSZ during a period of about 500 years (Petersen, et al., 2008). The assumed distribution of earthquake magnitudes is shown on Figure 5B. This distribution assumes the larger M9.0 earthquakes likely occur more often than the smaller segmented ruptures. Therefore, for our deterministic analysis, we have chosen to represent the subduction zone event by a design earthquake of M_W 9.0 at a focal depth of 15 km and a rupture distance of 86 km. This corresponds to a sudden rupture of the entire length of the Juan de Fuca-North American plate interface with an assumed rupture zone along the coastline due west of Vancouver. Based on an average of the attenuation relationships published by Zhao (2006), Atkinson and Macias (2009), and Abrahamson (2012), a subduction zone earthquake with these parameters would result in an average peak bedrock acceleration of approximately 0.19 g at the project site.

Deaggregation of the 2008 USGS data suggests the Cascadia Subduction Zone contributes approximately 41% to the site seismic hazard.

Subcrustal Event. There is no historic earthquake record of subcrustal, intraslab earthquakes in Southwest Washington. Although both the Puget Sound and Northern California regions have experienced many of these earthquakes in historic times, Wong (2005) hypothesizes that due to subduction zone geometry, geophysical conditions and local geology, Southwest Washington/Oregon may not be subject to intraslab earthquakes. In the Puget Sound area, these moderate to large earthquakes are deep (40 to 60 km) and over 200 km from the deformation front of the subduction zone. Offshore, along the Northern California coast, the earthquakes are shallower (up to 40 km) and located along the deformation front. Estimates of the probable magnitude, distance, and frequency of subcrustal events in Southwest Washington are generally based on comparisons of the CSZ with active convergent plate margins in other parts of the world and on the historical seismic record for the region surrounding Puget Sound, where significant events known to have occurred within the subducting Juan de Fuca plate have been recorded. Published estimates of the probable maximum size of these events range from moment magnitude M_w 7.0 to 7.5. The 1949, 1965, and 2001 documented subcrustal earthquakes in the Puget Sound area correspond to M_w 7.1, 6.5, and 6.8, respectively. Published information regarding the location and geometry of the subducting zone indicates that a focal depth of 50 km is probable (Weaver and Shedlock, 1989). We have chosen to represent the subcrustal event by a characteristic earthquake of moment magnitude M_w 7.0 at a focal depth of 50 km and a rupture distance of 50 km. Based on the attenuation relationships published by Zhao (2006), and Atkinson and Boore (2003), and Abrahamson (2012), a subcrustal earthquake of this magnitude and distance would result in a peak horizontal bedrock acceleration of approximately 0.14 g at the site.

The results of the USGS deaggregation suggest a seismic hazard contribution of 22% from a subcrustal or intraslab earthquake.

Local Crustal Event. Sudden crustal movements along relatively shallow, local faults in the southwest Washington area, although rare, have been responsible for local crustal earthquakes. The precise relationship between specific earthquakes and individual faults is not well understood, since few of the faults in the area are expressed at the ground surface, and the foci of the observed earthquakes have not been located with precision. The history of local seismic activity is commonly used as a basis for determining the size and frequency to be expected of local crustal events. Although the historical record of local earthquakes is relatively short (the earliest reported seismic event in the area occurred in 1920), it can serve as a guide for estimating the potential for seismic activity in the area.

Based on fault mapping conducted by the U.S. Geological Survey (USGS, 2008), the Portland Hills Fault is the closest mapped crustal fault to the site that is considered active in the probabilistic hazard maps. The Portland Hills Fault is located approximately 7 km from the site and has a characteristic earthquake magnitude of M_w 7.0. A crustal earthquake of this magnitude and distance would result in a peak horizontal bedrock acceleration of approximately 0.33 g at the site based on an average of the NGA ground motion relations developed by the Pacific Earthquake Engineering Research (PEER) by Boore and Atkinson (2008), Campbell and Bozorgnia (2008), Idriss (2008) and Chiou and Youngs (2008).

Deaggregation of the 2008 USGS data suggests local crustal faults contribute approximately 35% to the site seismic hazard.

Other Seismic Hazards. Based on the presence of loose sands and soft silts below the water table at the site, there is a high risk of liquefaction and lateral spreading during a design-level earthquake. More detailed discussions regarding liquefaction and lateral spreading are provided in the Seismic Considerations section of the report. Although detailed tsunami modeling of the Columbia River due to a Cascadia Subduction Zone earthquake has not been completed, we anticipate the risk of upland damage by tsunami at the site is low due to the distance from the coast. River fluctuations may result from a tsunami generated by a CSZ earthquake. Due to the proximity of the Columbia River, there is a risk of seiche. Unless occurring on a previously unmapped fault, it is our opinion the risk of ground rupture at the site is very low.

Deterministic Earthquake Parameters

As discussed above, three distinctly different seismic sources affect seismicity in the project area. Deterministic evaluation of the earthquake sources using published attenuation relations provides estimates of peak bedrock accelerations and response spectra for each seismic source. These deterministic estimates are not associated with a relative hazard level or probability of occurrence like probabilistic estimates, but simply provide an estimate of the ground motion parameters for each seismic source at a given distance from the site. The basic parameters of each earthquake source are as follows:

TABLE 1B: DETERMINISTIC EARTHQUAKE PARAMETERS

Earthquake Source	Attenuation Relationships	Magnitude, M_w	Rupture Distance, km	Focal Depth, km	Median Peak Bedrock Acceleration, g	Average Median Peak Bedrock Acceleration, g
Subduction Zone	Zhao (2006)	9.0	86	15	0.19	
	Atkinson and Macias (2009)	9.0	86	15	0.17	0.19
	Abrahamson (2012)	9.0	86	15	0.23	
	Gregor, et al.(2002)					
Subcrustal	Zhao (2006)	7.0	50	50	0.15	
	Atkinson and Boore, (2003)	7.0	50	50	0.10	0.14
	Abrahamson (2012)	7.0	50	50	0.18	
Local Crustal	Campbell and Bozorgnia (2008)	7.0	7	NA	0.32	
	Chiou and Youngs (2008)	7.0	7	NA	0.36	0.33
	Boore and Atkinson (2008)	7.0	7	NA	0.27	
	Idriss (2008)	7.0	7	NA	0.38	

The values summarized in Table 1B represent the average of median peak bedrock accelerations for the characteristic earthquake on the controlling faults. IBC and its reference document, ASCE 7-10, require evaluating the 84th percentile (median plus one standard deviation) rock response spectrum in the maximum horizontal direction for developing the deterministic MCE_R level earthquake. The risk-targeted deterministic (MCE_R) bedrock spectra shown in Figure 6B represent a weighted average of the individual spectra produced by the attenuation relationships presented in Table 1B at the 84th percentile level.

These risk-targeted deterministic spectra were compared with the deterministic lower limit on MCE_R response spectrum, constructed per Figure 21.2-1 of ASCE 7-10, for selection of the MCE_R deterministic bedrock spectrum. Figure 6B shows that the individual fault deterministic response spectra are essentially

at or lower than the deterministic lower limit on MCE_R response spectrum. Per Section 21.2.2 of ASCE 7-10, the deterministic spectrum shall be the greater of the fault deterministic spectrum or the lower limit deterministic spectrum of Figure 21.2-1. Therefore, the lower limit deterministic MCE_R response spectrum is selected to represent the bedrock deterministic (MCE_R) response spectrum.

Probabilistic Considerations

The probability of an earthquake of a specific magnitude occurring at a given location is commonly expressed by its return period, i.e., the average length of time between successive occurrences of an earthquake of that size or larger at that location. The return period of a design earthquake is calculated once a project design life and some measure of the acceptable risk that the design earthquake might occur or be exceeded are specified. These expected earthquake recurrences are expressed as a probability of exceedance during a given time period or design life. Historically, building codes have adopted an acceptable risk level by identifying ground acceleration values that meet or exceed a 10% probability of exceedance in 50 years, which corresponds to an earthquake with an expected recurrence interval of 475 years. Previous versions of the IBC developed response spectra based on ground motions associated with the Maximum Considered Earthquake (MCE), which is generally defined as a probabilistic earthquake with a 2% probability of exceedance in 50 years (return period of about 2,500 years), except where subject to deterministic limitations (Leyendecker, et al., 2000).

The current 2012 IBC develops response spectra using a Risk-Targeted Maximum Considered Earthquake (MCE_R), which is defined as the response spectrum that is expected to achieve a 1% probability of building collapse within a 50-year period. In addition, the spectral response values for the 2012 IBC are for the direction of maximum horizontal acceleration rather than the geometric mean horizontal acceleration used in previous codes. The design-level response spectrum is calculated as two-thirds of the MCE_R ground motions. The 2012 IBC changes to the site response spectra based on probability of building collapse and maximum directional accelerations result in a very slight increase in the code site response compared with the 2009 IBC. Although the MCE_R site response is similar to the previous code, it should be noted that seismic hazards, such as liquefaction and soil strength loss, are now evaluated using the MCE-level geometric mean (MCE_G) peak ground acceleration. Under previous codes, these seismic hazards were evaluated using the design-level peak ground acceleration. The design-level peak ground acceleration is two-thirds of the MCE_G peak ground accelerations, the same ratio as between the MCE_R and design response spectra.

The 2012 IBC design methodology uses two mapped spectral acceleration parameters, S_S and S_1, corresponding to periods of 0.2 and 1.0 second, to develop the Site Class B MCE_R response spectrum. The S_S and S_1 coefficients are 0.94 and 0.41 g, respectively, for the site located at the approximate latitude and longitude coordinates of 45.65°N and 122.71°W.

Target Bedrock Spectrum

Chapter 21 of ASCE 7-10, requires comparing the deterministic MCE_R response spectrum with the probabilistic MCE_R response spectrum to select the controlling spectrum. The probabilistic and deterministic MCE_R response spectra are shown in Figure 7B. The site-specific MCE_R bedrock response spectrum is taken as the lower of these two spectra per ASCE 7-10 Section 21.2.3. The probabilistic MCE_R spectrum is lower than the deterministic spectrum and, therefore, based on the above criterion, the probabilistic spectrum is defined to be the MCE_R bedrock spectrum. The risk-targeted probabilistic

spectrum is also compared with the geometric mean probabilistic bedrock spectrum (i.e., defined by 2% probability of exceedance within a 50-year period) as shown on Figure 8B. Review of Figure 8B indicates the geometric mean bedrock spectrum is comparable with the MCE_R bedrock spectrum. The 2,475-year geometric mean bedrock spectrum was chosen as the target bedrock spectrum for the TSVEDT site to allow the use of one target bedrock spectrum for both structural analysis and liquefaction evaluation.

Estimated Site Response

The effect of a specific seismic event on the site is related to the type and thickness of soil overlying the bedrock at the site and the type and quantity of seismic energy delivered to the bedrock beneath the site by the earthquake. Site response analysis was completed to estimate this site-specific behavior in accordance with section 21.1 of ASCE 7-10. The site response analysis consisted of three components: 1) selection of target bedrock response spectrum, 2) numerical modeling to analyze the site-specific behavior of the soils using horizontal ground motion acceleration time histories scaled to the approximate level of the target bedrock response spectrum over the periods of interest, and 3) calculation of the ratio of the surface response spectra values to the bedrock response spectra values, at each spectral period, to develop a recommended ground surface response spectrum. The following paragraphs describe details of the site response modeling.

The target bedrock response spectrum for the site was developed for Site Class B, or rock site, conditions in accordance with the method outlined in the Target Bedrock Spectrum section of this report. A series of earthquake acceleration-time histories have been selected to estimate the earthquake motions in D-MOD 2000 (D-MOD), a non-linear site response program. From the available records, corrected free-field and basement/ground floor accelerograms were selected for input as bedrock time histories. Wherever possible, earthquakes of similar magnitude and duration to the characteristic earthquakes were selected. These records were checked for obvious errors, missing data points, and other anomalies and were transformed into a uniform data format. The selected strong-motion records are as follows:

Earthquake	Recording Station	Magnitude	Fault Distance, km	Peak Bedrock Acceleration, g
Loma Preita (1989)	San Jose - Santa Teresa Hills	6.9	14.7	0.28
Nisqually (2001)	Olympia, WSDOT Test Lab	6.8	18.3	0.22
Chile (2010)	Curico	8.8	65.1	0.47
Chile (2010)	Hualane	8.8	50	0.46
Japan (2011)	Kuroiso (TCG001)	9	102	0.42
Japan (2011)	Yamatsuri (FKS 014)	9	76	0.23
Japan (2011)	Hachinohe (AOM 012)	9	99	0.19

The time histories were scaled to reasonably match the bedrock target spectrum at periods of interest including the site fundamental period.

A generalized subsurface profile for the site was developed for use in D-MOD based on our subsurface explorations. To estimate shear wave velocities for the soil profiles for Areas 300 and 400, probes CPT-1 and CPT-6, respectively, were operated with an accelerometer fitted to the probe that allows measuring the arrival times of shear waves at the probe from impulses generated at the ground surface. Based on the arrival times, a shear wave velocity profile was generated for Areas 300 and 400. These assumed soil profiles are tabulated below.

AREA 300 SUBSURFACE PROFILE

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
FILL (Dense silty SAND or GRAVEL)	6	120	800
FILL (Dense silty SAND or GRAVEL)	6	120	800
FILL (Dense silty SAND or GRAVEL)	6	120	800
Soft SILT	5	110	500
Soft SILT	4	110	500
Soft SILT	4	110	500
Soft SILT	4	110	500
SAND	5	120	950
SAND	5	100	950
SAND	5	100	950
SAND	5	110	950
Gravel with sand	8	125	1,300
Gravel with sand	7	125	1,325
Gravel with sand	7	125	1,350
Gravel with cobbles	8	130	1,425
Gravel with cobbles	8	130	1,500
Gravel with cobbles	8	130	1,550
Gravel with cobbles	8	130	1,625
Gravel with cobbles	8	130	1,700
Gravel with cobbles	12	130	1,775
Gravel with cobbles	12	130	1,850
Gravel with cobbles	12	130	1,925
Gravel with cobbles	12	130	1,975
Gravel with cobbles	12	130	2,050
Gravel with cobbles	12	130	2,125
Gravel with cobbles	12	130	2,200
Gravel with cobbles	12	130	2,250
Gravel with cobbles	12	130	2,325
Gravel with cobbles	12	130	2,400
Gravel with cobbles	12	130	2,475
Troutdale	N/A	140	2,500

AREA 400 SUBSURFACE PROFILE

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
Medium dense SAND	3	110	473
Medium dense SAND	3	110	473
Medium dense SAND	3	110	534
Medium dense SAND	4	110	615
Medium dense SAND	3	110	520
Medium dense SAND	4	110	573

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
Medium dense SAND	3	110	573
Medium dense SAND	3	110	678
Loose SAND	4	110	532
Loose SAND	3	110	475
Loose SAND	3	110	555
Medium dense SAND	4	110	690
Medium dense SAND	3	110	686
Medium dense SAND	3	110	653
Medium dense SAND	3	110	560
Medium dense SAND	4	110	680
Medium dense SAND	3	110	830
Medium dense SAND	3	110	920
Medium dense SAND	3	110	1,034
Medium dense SAND	4	110	865
Medium dense SAND	3	110	1,034
Medium dense SAND	3	110	950
Medium dense SAND	3	110	950
Medium dense SAND	4	110	860
Medium dense SAND	3	110	1,000
Very dense GRAVEL	5	125	1,200
Very dense GRAVEL	5	125	1,400
Very dense GRAVEL	5	125	1,450
Very dense GRAVEL	5	125	1,500
Very dense GRAVEL	10	125	1,550
Very dense GRAVEL	10	125	1,600
Very dense GRAVEL	10	125	1,650
Very dense GRAVEL	10	125	1,700
Very dense GRAVEL	10	125	1,750
Very dense GRAVEL	10	125	1,800
Very dense GRAVEL	10	125	1,850
Very dense GRAVEL	10	125	1,900
Very dense GRAVEL	10	125	1,950
Very dense GRAVEL	10	125	2,000
Very dense GRAVEL	10	125	2,100
Very dense GRAVEL	10	125	2,150
Very dense GRAVEL	10	125	2,200
Very dense GRAVEL	10	125	2,250
Very dense GRAVEL	10	125	2,350
Very dense GRAVEL	10	125	2,400
Troutdale	N/A	140	2,500

Using the generalized subsurface profiles for Areas 300 and 400, the peak bedrock accelerations estimated for the design event, and the strong-motion records listed in the preceding tables, pseudo acceleration response spectra were calculated with D-MOD. The spectra were produced for a ground surface elevation damped at 5% of critical damping. The ground surface spectra were compared to the input rock spectra to

quantify amplification and/or attenuation through the soil column at the site. The ratio of ground surface to bedrock spectral accelerations, defined as the spectral amplification ratio (SAR), is shown on Figure 9B for Areas 300 and 400. To estimate ground surface site response throughout the range of spectral periods, the target response spectra is multiplied by the SAR to determine the ground surface response spectrum in accordance with Section 21.1.3 of ASCE 7-10. The results of the site-specific response modeling are shown on Figures 10B and 11B for Areas 300 and 400, respectively.

Figures 10B and 11B also include the code-based MCE_R hazard level spectrum, developed using site amplification factors based on the appropriate Site Class type. A discussion of the code-based site amplification factors and site class is provided in the following paragraph.

Area 300 is designated as Site Class D based on the average shear wave velocity (Vs_{100}) in the upper 100 ft per Section 20.4 of ASCE 7-10. However, Area 300 would be designated as Site Class E based on the average standard penetration resistance for the upper 100 ft of the soil profile in accordance with Section 20.4 of ASCE 7-10. Area 400 is designated Site Class D, based on the average shear wave velocities and average standard penetration resistance in the upper 100 ft. Short- and long-period site coefficients, F_a and F_v, of 1.12 and 1.59, respectively, were used to develop the MCE_R Site Class D spectrum. The MCE_R Site Class E spectrum was developed using F_a and F_v of 0.97 and 2.40, respectively.

Sites that are underlain by soils subject to liquefaction are designated as Site Class F per Section 20.3.1 of ASCE 7-10 and are required to have a site response analysis performed to develop the ground surface response spectrum. Structures that have a fundamental period less than 0.5 second are exempted from this requirement. Ground surface response spectrum developed from site response analysis for Site Class F may not be less than 80% of Site Class E spectral acceleration values per Section 21.3 of ASCE 7-10. Both Site Class D and 80% of Site Class E spectra are shown on Figures 10B and 11B for comparison with the site-specific spectra. For Area 300, the site-specific response modeling resulted in a ground surface response spectrum with peak spectral acceleration values greater than the Site Class D peak spectral value. Per Section 21.4 of ASCE 7-10, the short-period spectral acceleration value is taken as 90% of the peak spectral acceleration that occurs at a period greater than 0.2 second. The site-specific peak spectral value, multiplied by 90%, is essentially the Site Class D peak spectral value. Therefore, the Site Class D curve is recommended for estimation of the spectral accelerations at short periods. The site-specific spectral response parameter at 1 second is selected as the greater of the spectral value at 1 second or two times the spectral value at 2 seconds. The site-specific response spectrum has a 1-second spectra value greater than twice the 2-second spectral value and is thus the 1-second spectral value. The peak horizontal portion of the Site Class D curve was extended to a period of 1 second to encompass the site-specific 1-second value. For periods in excess of 1 second, the site-specific response spectrum was used to the period where site-specific values are below 80% of Site Class E (approximately 1.5 seconds). At periods in excess of 1.5 seconds, 80% of Site Class E provides the spectral acceleration values that meet the requirement of ASCE 7-10.

For Area 400, the site-specific response modeling provided a ground surface response spectrum with peak spectral acceleration values lower than that of Site Class D. Site Class D peak spectral values were recommended for estimating short-period spectral accelerations to be consistent with Area 300. At longer periods, the Site Class D curve was modified to encompass the higher site-specific spectral values. At periods in excess of approximately 1.75 seconds, where the site-specific response spectrum falls below

80% if Site Class E, response spectral values corresponding to 80% of the Site Class E response spectrum is used to satisfy the requirement of ASCE 7-10.

Conclusions

The site specific response modeling for the TSVEDT site was completed using the 2,475-year geometric mean spectral accelerations as a target bedrock spectrum with spectral acceleration values of S_s and S_1, corresponding to periods of 0.2 and 1.0 second, equal to 0.96 and 0.37 g respectively.

For Area 300, the results of the site-specific modeling in accordance with ASCE 7-10 indicate the 2012 IBC code-based Site Class D spectrum provides an appropriate estimate of the spectral accelerations for short periods. For longer periods, a response spectrum consisting of the site-specific spectral response values and the spectral values corresponding to 80% of the Site Class E response spectrum is appropriate. The design-level spectral acceleration recommended for Area 300 is shown on Figure 12B.

For Area 400, the results of the site-specific modeling indicate the 2012 IBC code-based Site Class D spectrum provides an appropriate estimate of the spectral accelerations at short periods, while a response spectrum encompassing the site-specific spectral response values and 80% of the Site Class E response spectrum is appropriate. The design-level spectral acceleration spectrum for Area 400 is shown on Figure 12B.

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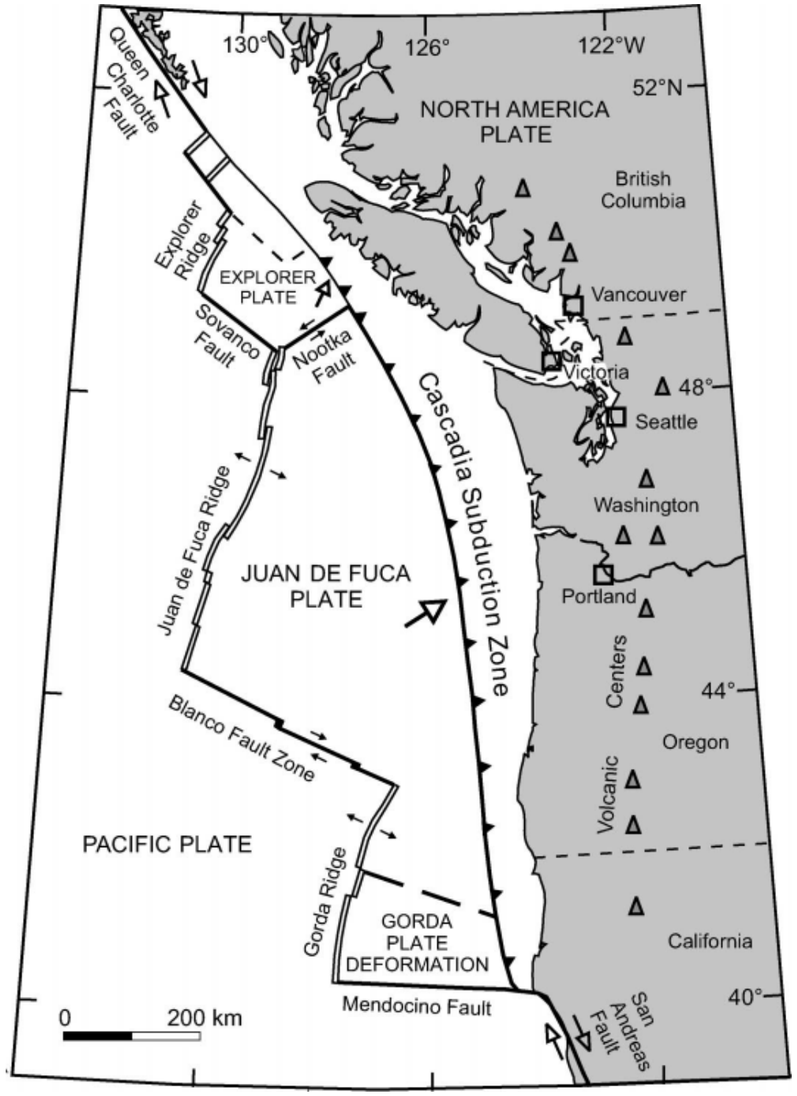
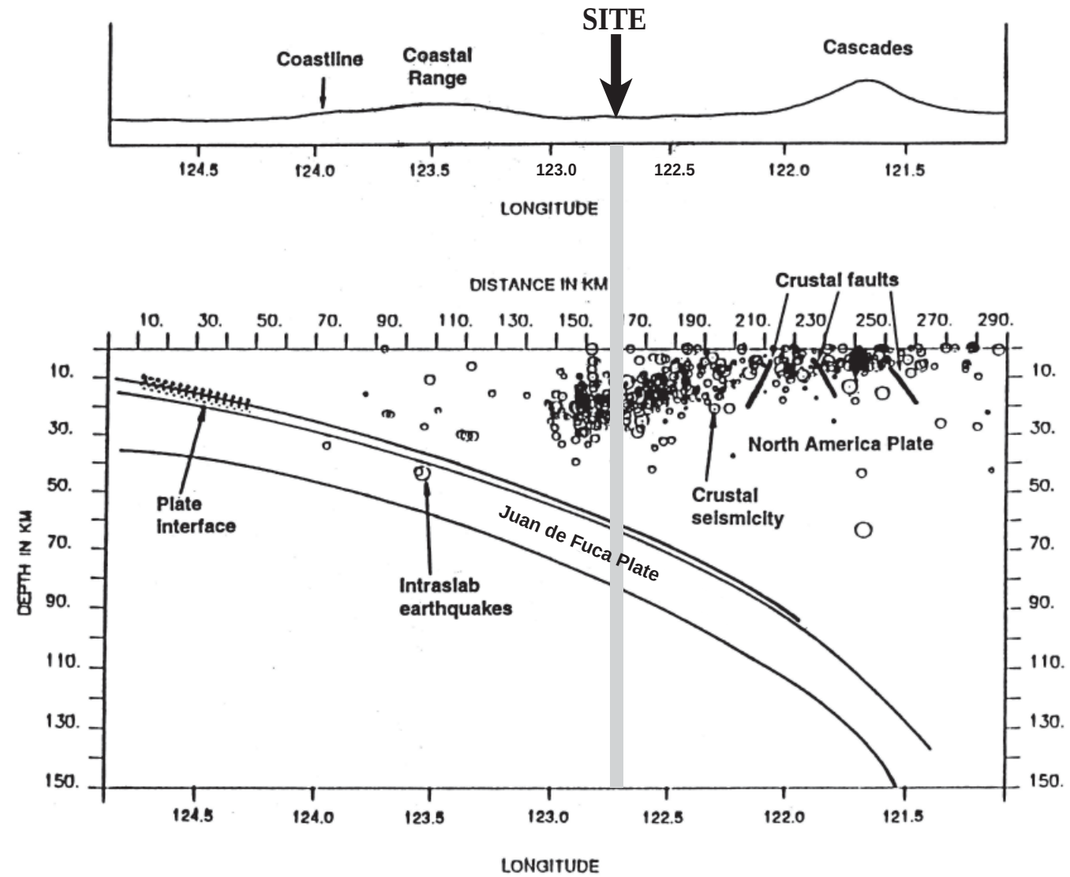


A) TECTONIC MAP OF PACIFIC NORTHWEST, SHOWING ORIENTATION AND EXTENT OF CASCADIA SUBDUCTION ZONE (MODIFIED FROM DRAGERT AND OTHERS, 1994)



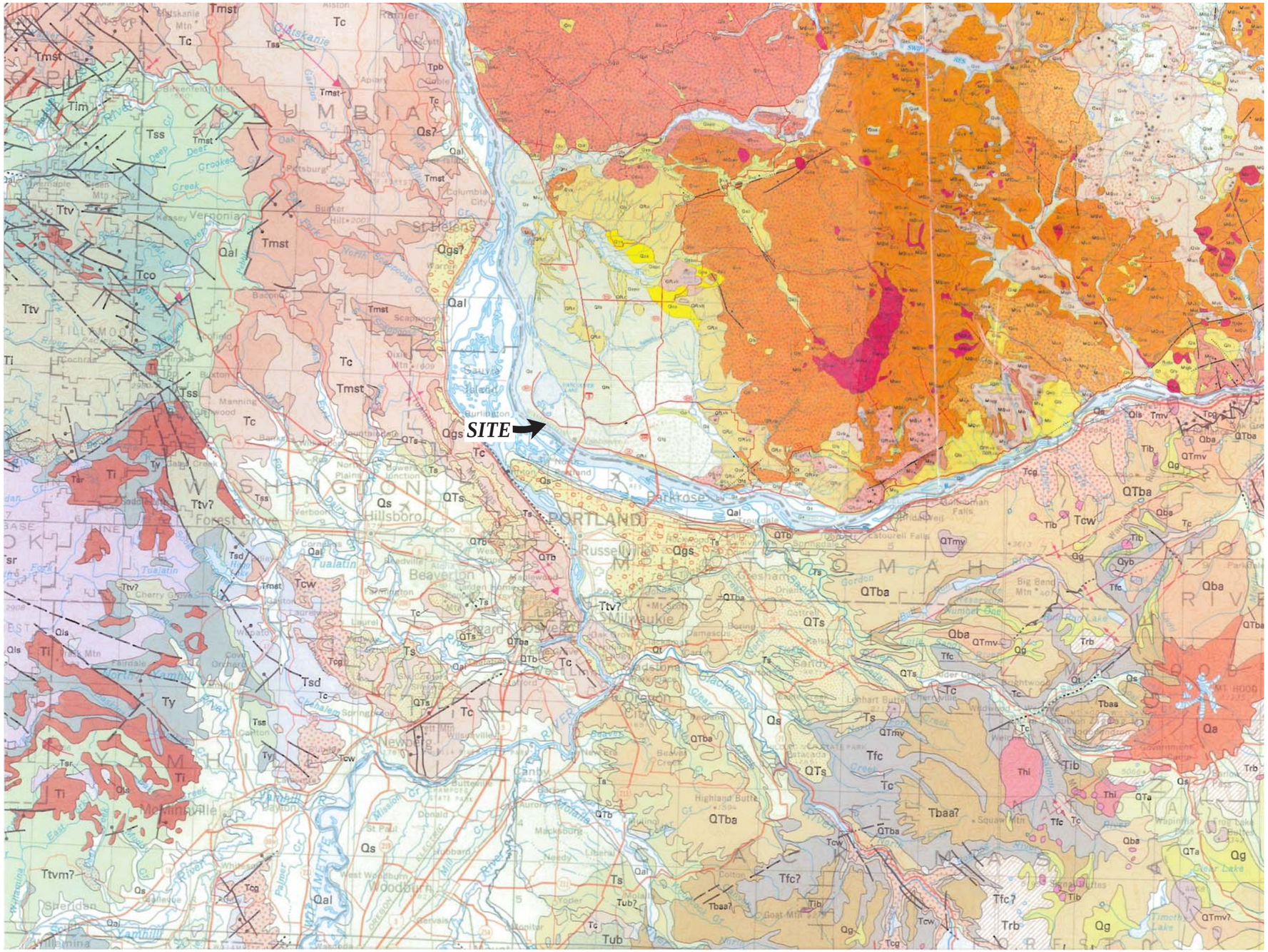
B) EAST-WEST CROSS-SECTION THROUGH WESTERN WASHINGTON AT THE LATITUDE OF VANCOUVER, SHOWING THE SEISMIC SOURCES CONSIDERED IN THE SITE-SPECIFIC SEISMIC HAZARD STUDY (MODIFIED FROM GEOMATRIX, 1995)

GRI

TECTONIC SETTING SUMMARY

DEC. 2013 JOB NO. W1114 FIG. 1B

EX-0001-003969-PCE



Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side

Thrust fault — Dashed where inferred; dotted where concealed; queried where doubtful; sawteeth on upper plate

Strike and dip of bed

FROM:

WALSH, T.J., KOROSEC, M.A., PHILLIPS, W.M., LOGAN, R.L., AND SCHASSE, H.W., 1987, GEOLOGIC MAP OF WASHINGTON-SOUTHWEST QUADRANT; 1:250,000: WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES, 6M-34

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North

0 10 20 MILES

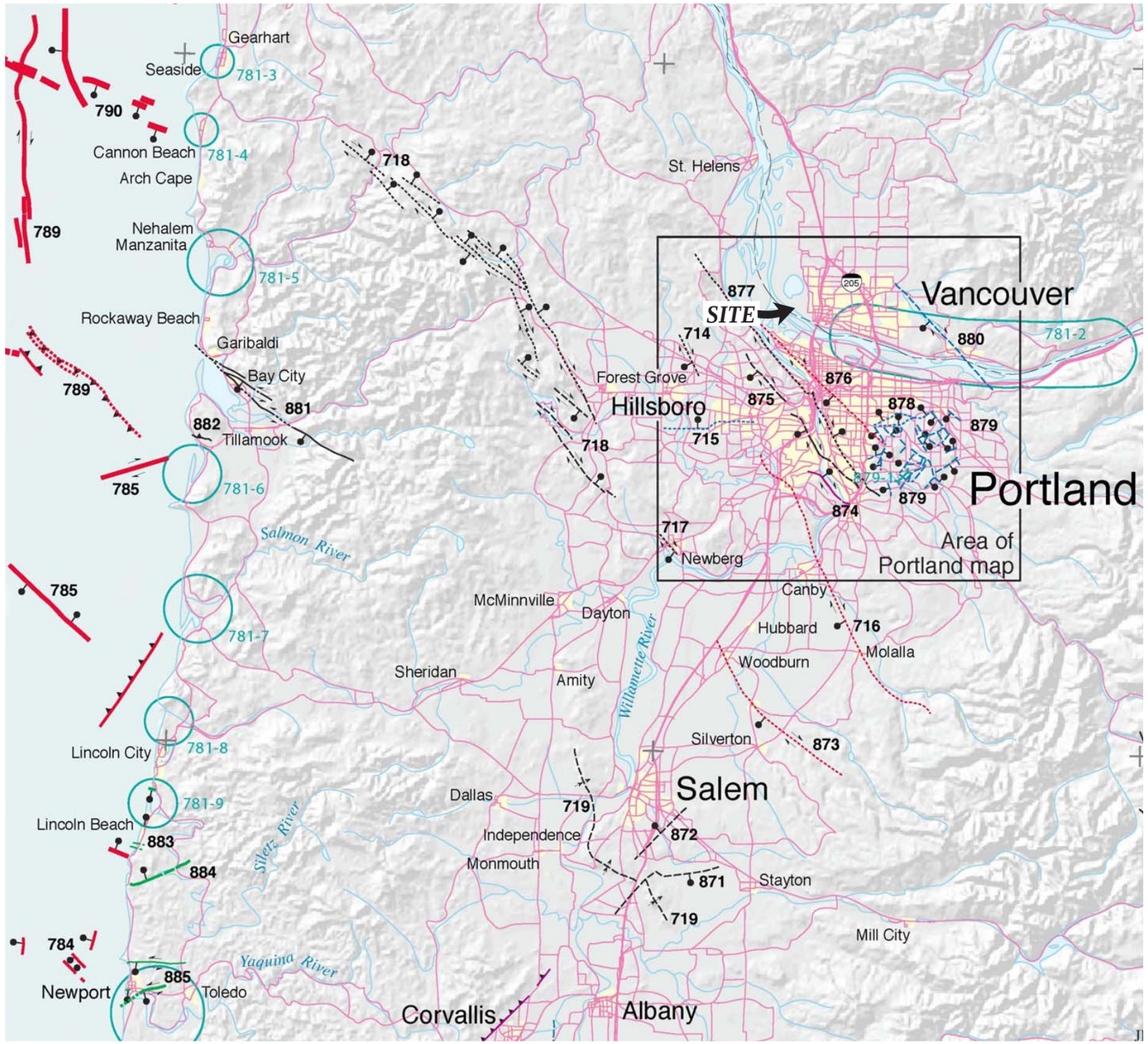
0 10 20 KILOMETERS

GRI

REGIONAL GEOLOGIC MAP

DEC. 2013 JOB NO. W1114 FIG. 2B

EX-0001-003971-PCE



MAP EXPLANATION

TIME OF MOST RECENT SURFACE RUPTURE

- Holocene (<10,000 years) or post last glaciation (<15,000 years; 15 ka); no historic ruptures in Oregon to date
- Late Quaternary (<130,000; post penultimate glaciation)
- Late and middle Quaternary (<750,000 years; 750 ka)
- Quaternary, undifferentiated (<1,600,000 years; <1.6 Ma)
- Class B structure (age or origin uncertain)

SLIP RATE

- >5 mm/year
- 1.0-5.0 mm/year
- 0.2-1.0 mm/year
- <0.2 mm/year

TRACE

- Mostly continuous at map scale
- Mostly discontinuous at map scale
- Inferred or concealed

STRUCTURE TYPE AND RELATED FEATURES

- Normal or high-angle reverse fault
- Strike-slip fault
- Thrust fault
- Anticlinal fold
- Synclinal fold
- Monoclinal fold
- Plunge direction of fold
- Fault section marker

DETAILED STUDY SITES

- 731-2 Trench site
- 781-2 Subduction zone study site

CULTURAL AND GEOGRAPHIC FEATURES

- Divided highway
- Primary or secondary road
- Permanent river or stream
- Intermittent river or stream
- Permanent or intermittent lake

FAULT NUMBER	NAME OF STRUCTURE
876	EAST BANK FAULT
877	PORTLAND HILLS FAULT
880	LACAMAS LAKE FAULT
878	GRAND BUTTE FAULT

FROM: PERSONIUS, S.F., AND OTHERS, 2003, MAP OF QUATERNARY FAULTS AND FOLDS IN OREGON, USGS OPEN FILE REPORT OFR-03-095.

North

0 5 10 MILES

0 5 10 KILOMETERS

GRI

LOCAL FAULT MAP

DEC. 2013 JOB NO. W1114 FIG. 3B

EX-0001-003973-PCE

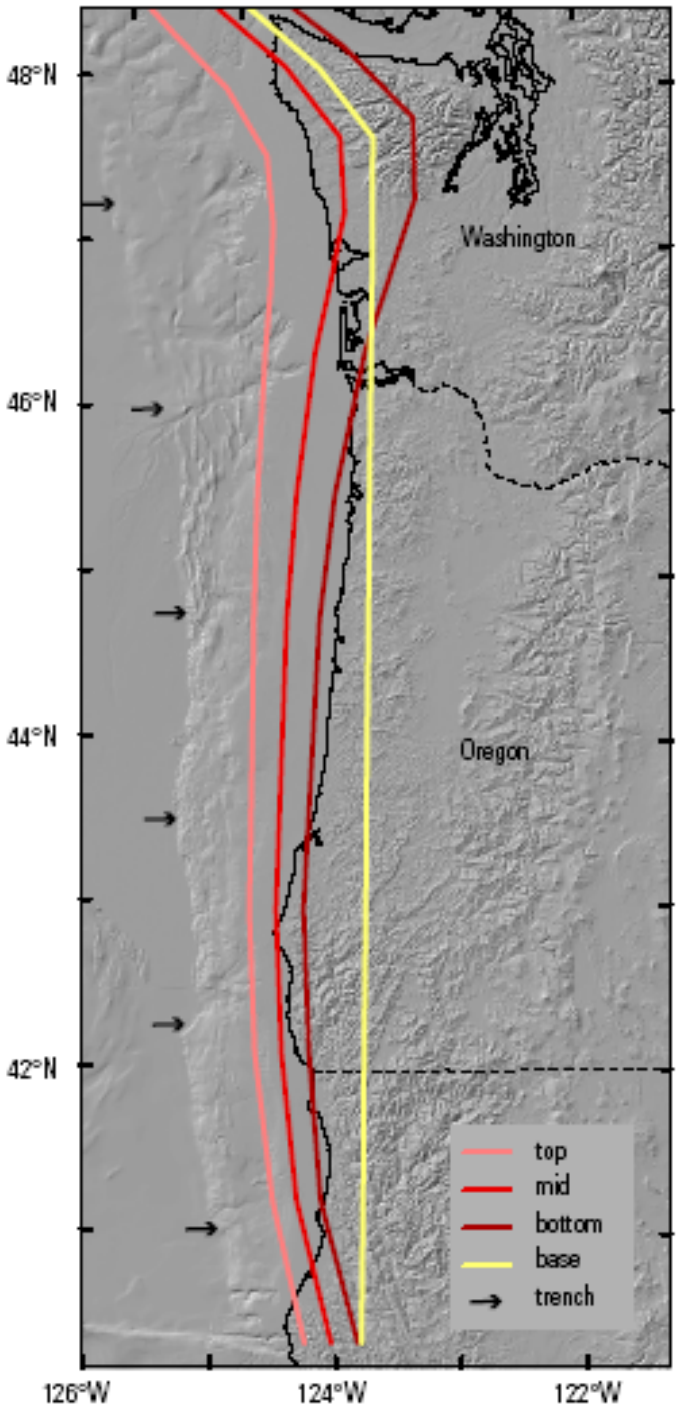


Figure 21. Location of the eastern edge of earthquake-rupture zones on the Cascadia subduction zone for the various models used in this study relative to the surficial expression of the trench: top, base of the elastic zone; mid, midpoint of the transition zone; bottom, base of the transition zones; base, base of the model that assumes ruptures extend to about 30-kilometers depth. Figure provided by Ray Weldon.

FROM: PETERSEN, MD, FRANKEL, AD, HARMSEN, SC, AND OTHERS, 2008, DOCUMENTATION FOR THE 2008 UPDATE OF THE UNITED STATES NATIONAL SEISMIC HAZARD MAPS: US GEOLOGICAL SURVEY, OPEN FILE REPORT 2008-1128

GRI

ASSUMED RUPTURE LOCATIONS

(CASCADIA SUBDUCTION ZONE)

DEC. 2013 JOB NO. W1114 FIG. 4B

EX-0001-003975-PCE

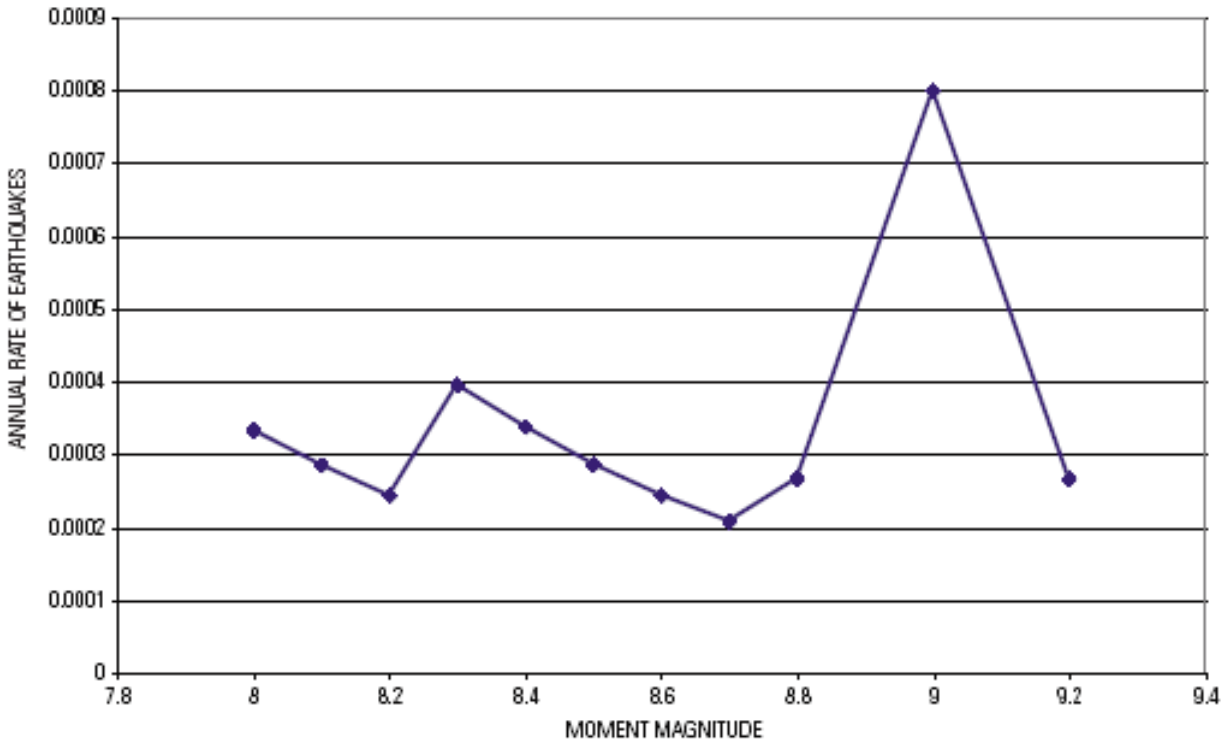


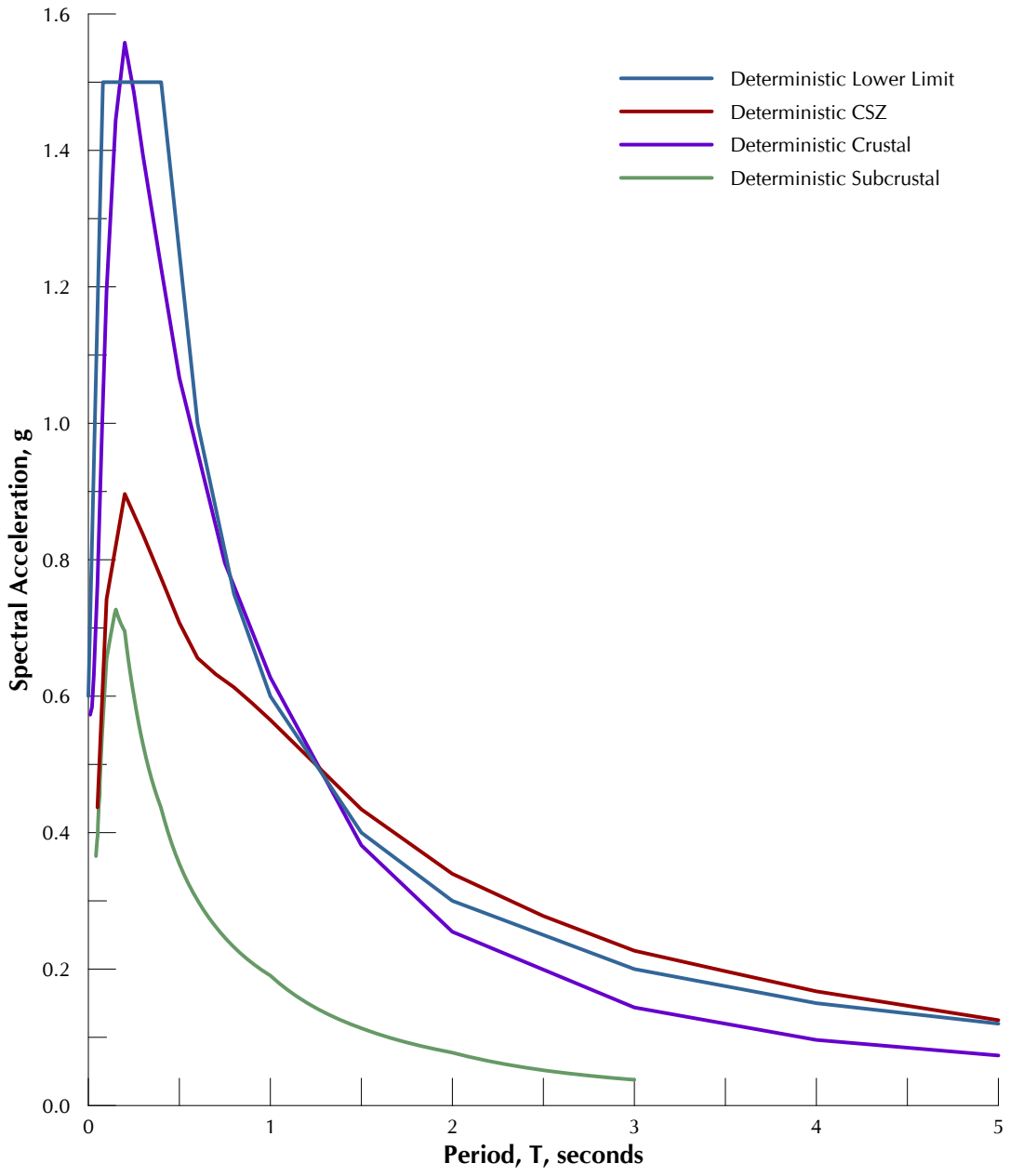
Figure 22. Magnitude-frequency distribution of the Cascadia subduction zone.

FROM: PETERSEN, M, FRANKEL, A, HARMSEN, S, AND OTHERS, 2008, DOCUMENTATION FOR THE 2008 UPDATE OF THE UNITED STATES NATIONAL SEISMIC HAZARD MAPS: US GEOLOGICAL SURVEY, OPEN FILE REPORT 2008-1128

GRI

ASSUMED
MAGNITUDE-FREQUENCY DISTRIBUTION
(CASCADIA SUBDUCTION ZONE)

DEC. 2013 JOB NO. W1114 FIG. 5B

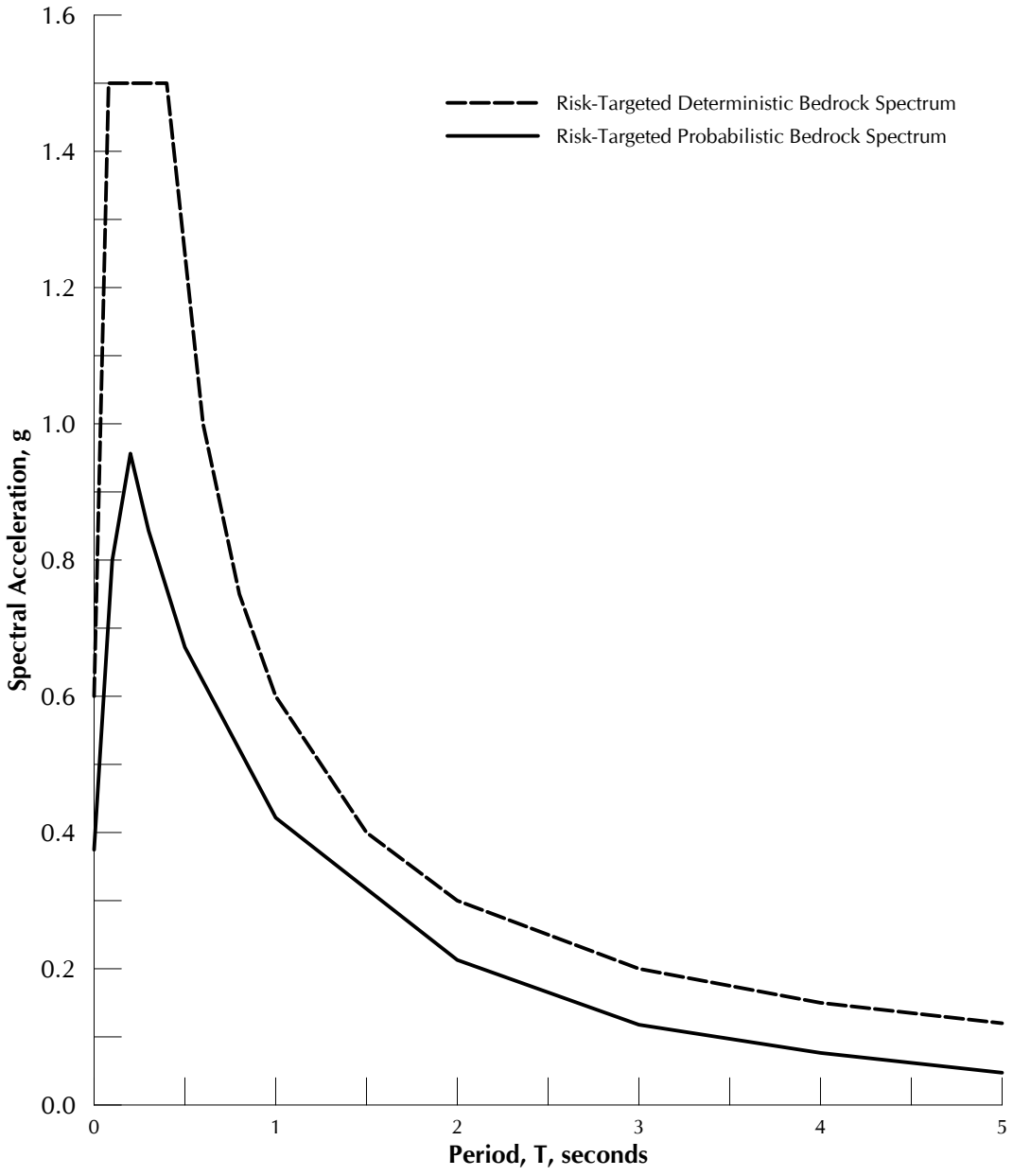


GRI

RISK-TARGETED DETERMINISTIC (MCE_R)
BEDROCK RESPONSE SPECTRA
(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 6B

EX-0001-003977-PCE

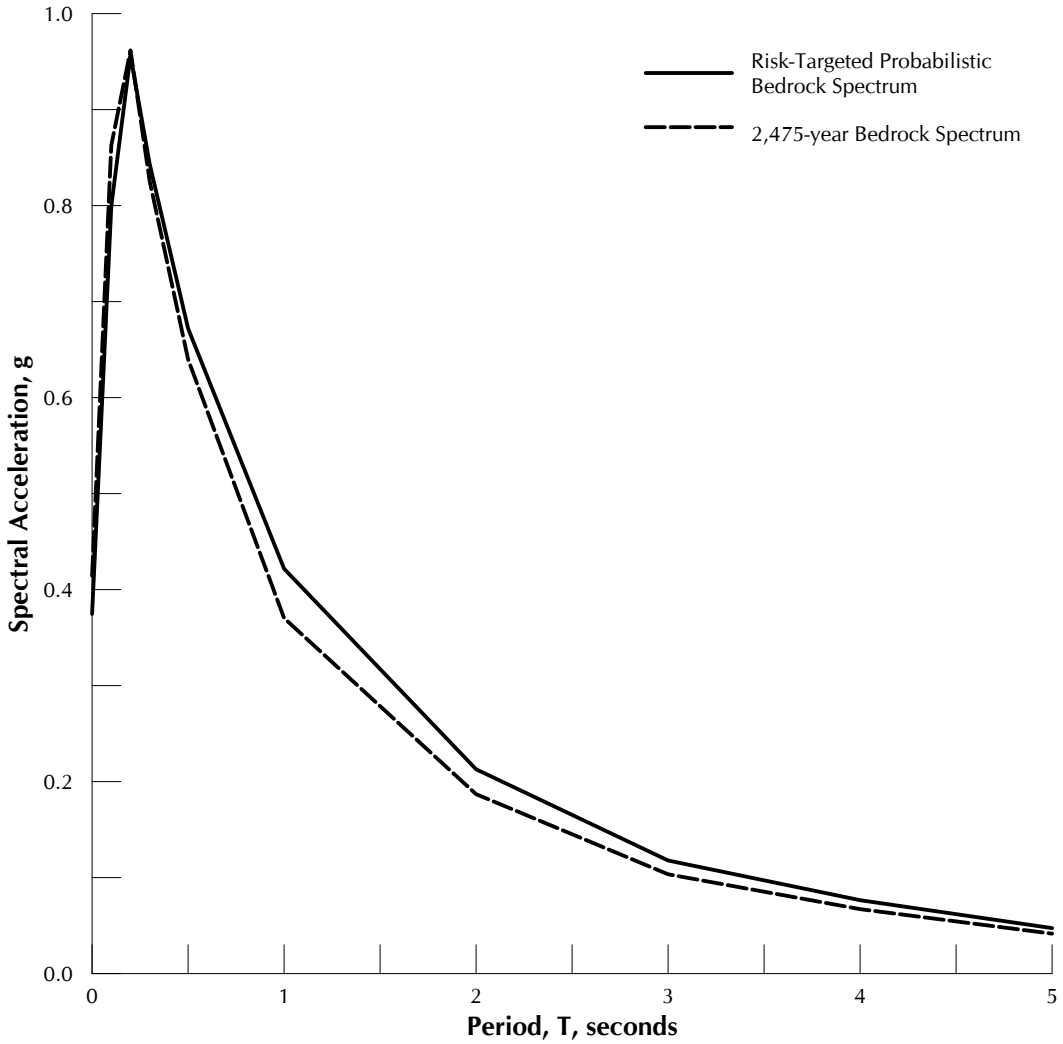


GRI

RISK-TARGETED DETERMINISTIC AND PROBABLILISTIC (MCE_R) BEDROCK RESPONSE SPECTRA

(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 7B

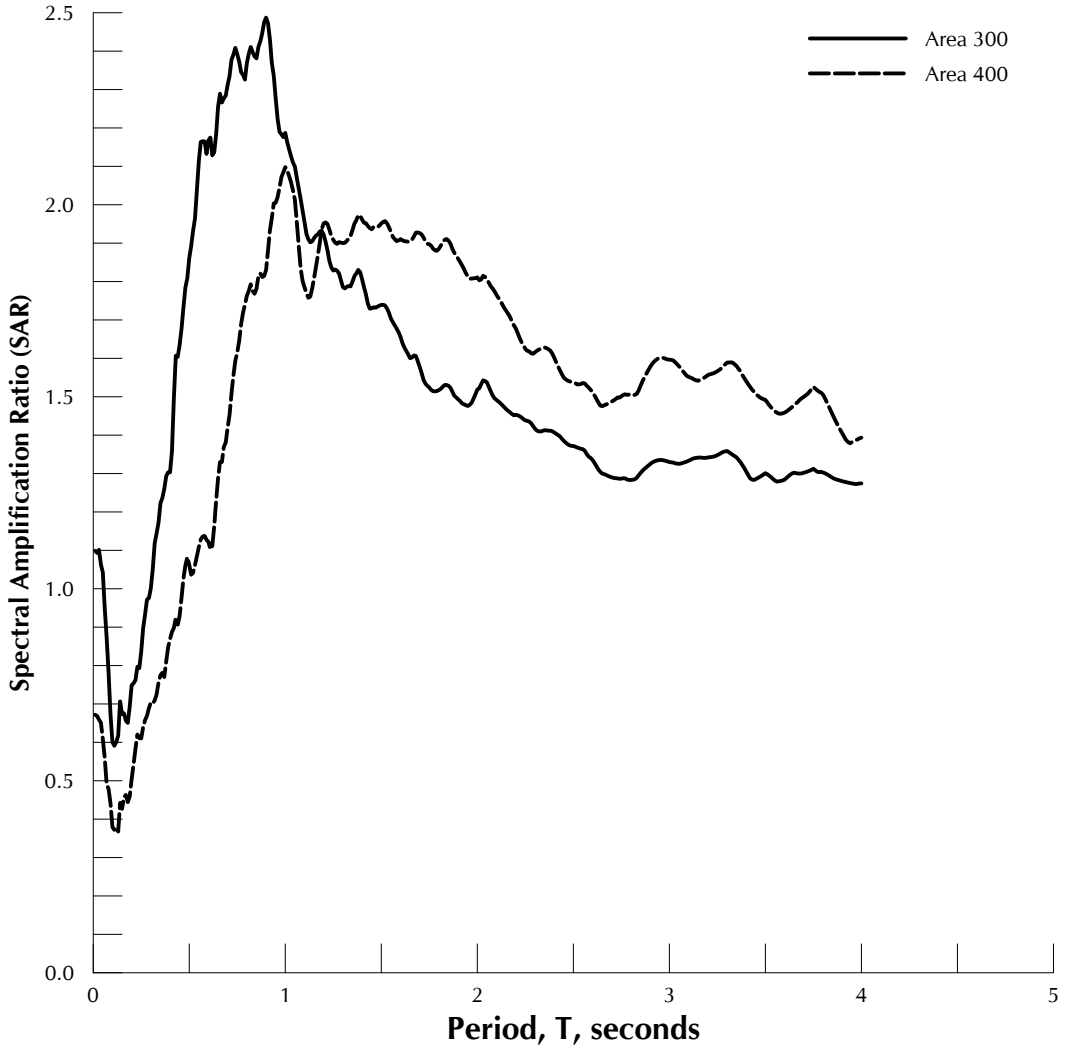


GRI

COMPARISON OF RISK-TARGETED PROBABILISTIC AND 2,475-YEAR HAZARD LEVEL BEDROCK RESPONSE SPECTRA

(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 8B

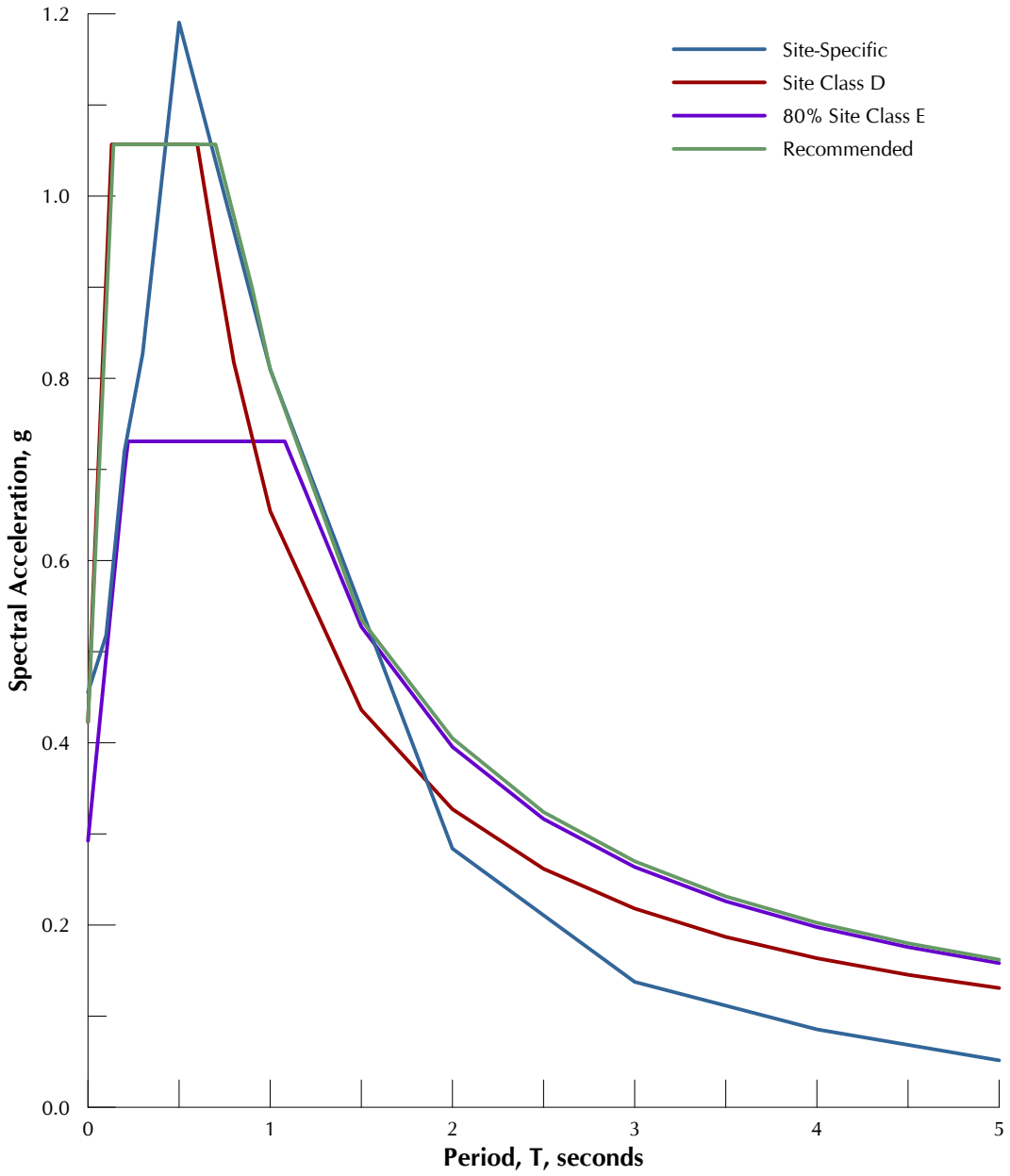


GRI

AREA 300 AND 400

SPECTRAL AMPLIFICATION RATIO (SAR)

DEC. 2013 JOB NO. W1114-T2 FIG. 9B



GRI

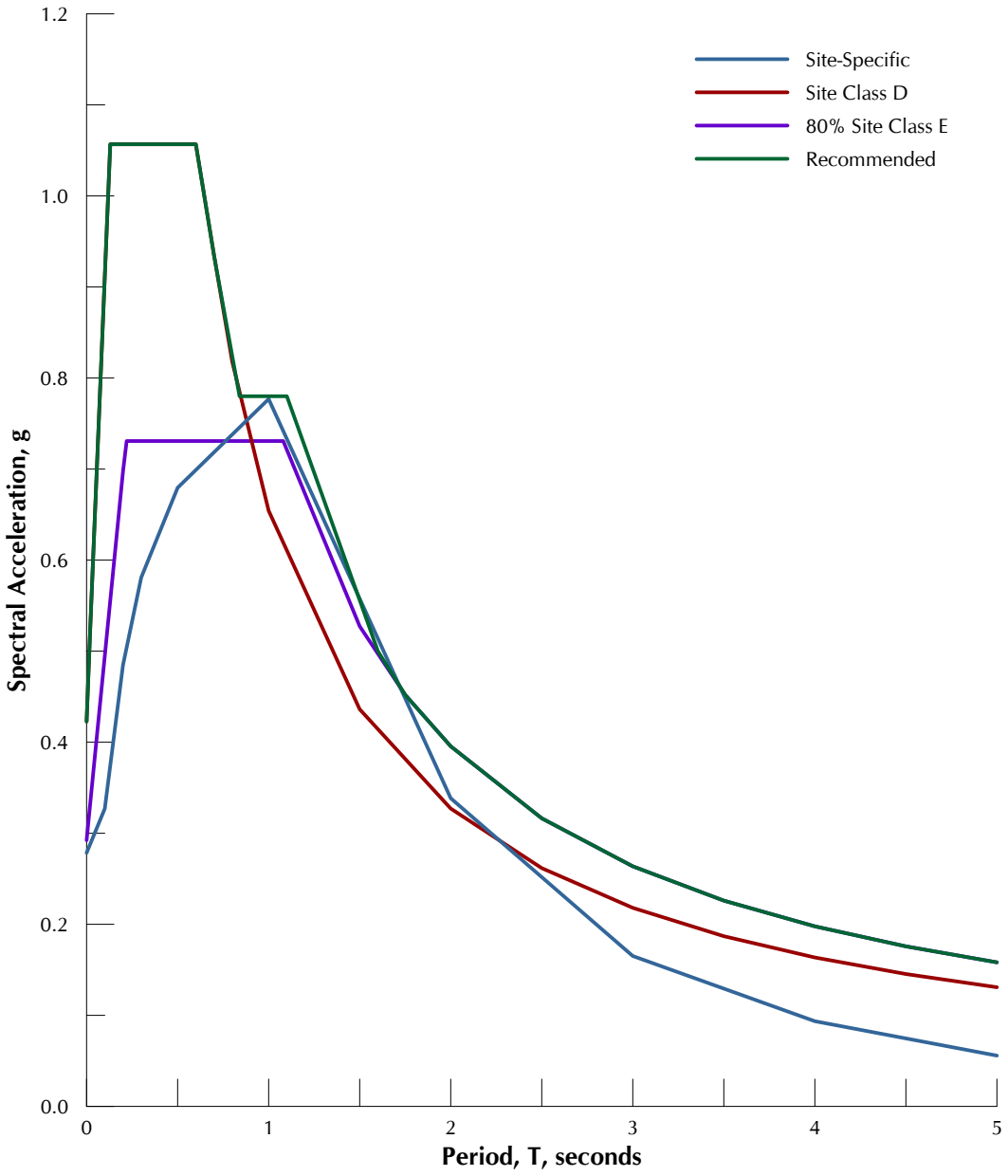
AREA 300

GROUND SURFACE DESIGN SPECTRA

(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 10B

EX-0001-003981-PCE



GRI

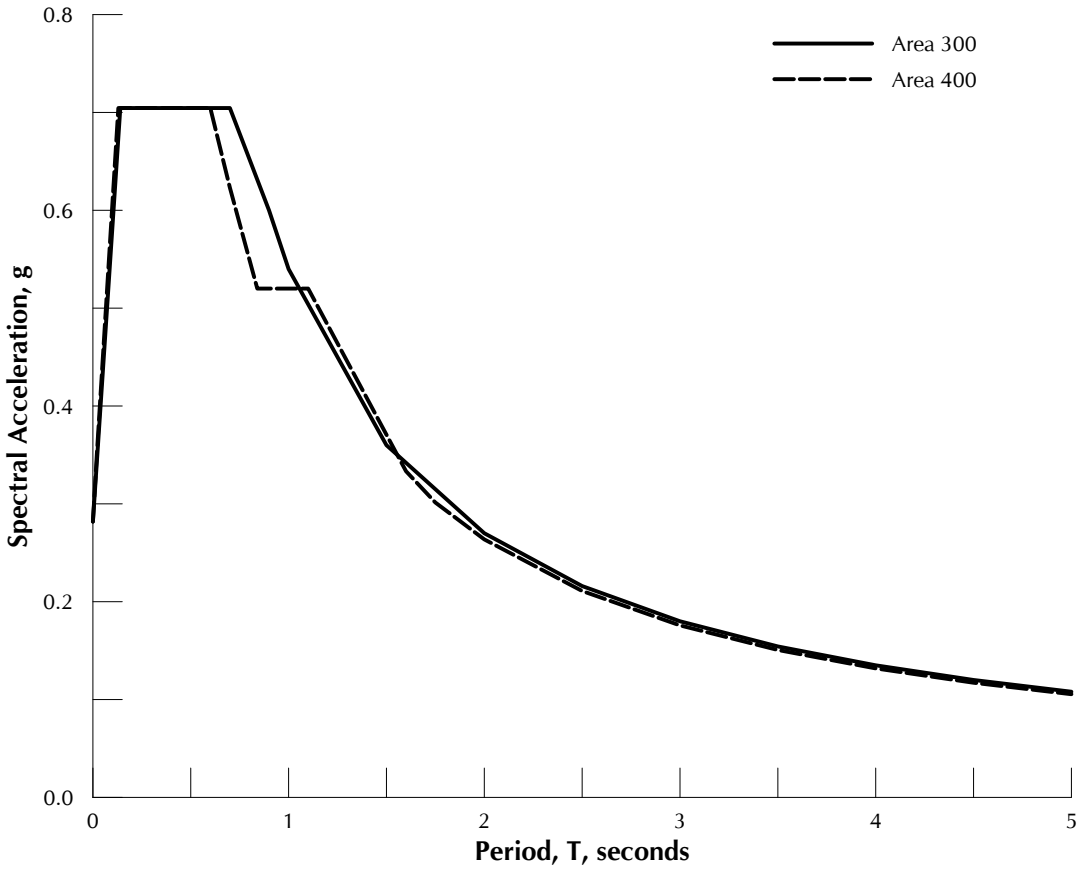
AREA 400

GROUND SURFACE RESPONSE SPECTRA

(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 11B

EX-0001-003982-PCE



GRI

AREA 300 AND 400

DESIGN RESPONSE SPECTRA

(5% DAMPING)

DEC. 2013 JOB NO. W1114-T2 FIG. 12B

Geotechnical Investigation

BergerABAM
1111 Main Street, Suite 300
Vancouver, WA 98660-2958

Tesoro Savage Vancouver Energy Distribution Terminal – Dock Facility Port of Vancouver, USA

Prepared by

GRI
Washington & Oregon

September 5, 2014

TABLE OF CONTENTS

Page

INTRODUCTION 1
PROJECT DESCRIPTION 1
Overview 1
SITE CONDITION AND BACKGROUND 2
Topography, Bathymetry, and Site Background 2
Geology 2
SUBSURFACE CONDITIONS 2
General 2
Soils 3
Groundwater 3
CONCLUSIONS AND RECOMMENDATIONS 4
General 4
Seismic Considerations 4
Slope Grading and Protection 9
Pile Support 9
Trestle Abutment Earth Pressures 13
Design Review and Construction Services 14
LIMITATIONS 15

Figures
Figure 1: Vicinity Map
Figure 2: Site Plan
Figure 3: Liquefaction Hazard Analysis – Contingency Level Earthquake
Figure 4: Liquefaction Hazard Analysis – Design Earthquake
Figure 5: Berth 13 Trestle and Dock Profile
Figure 6: Lateral Spreading Loads Trestle and Dock Piles
Figure 7: Surcharge-Induced Lateral Pressure

Appendix A: Field Explorations and Laboratory Testing

Appendix B: Site-Specific Seismic Hazard Study

INTRODUCTION

At your request, GRI has completed a geotechnical investigation at the Port of Vancouver (Port) Berth 13 dock and trestle as part of the Tesoro Savage Vancouver Energy Distribution Terminal (TSVEDT). The Vicinity Map, Figure 1, shows the general location of the project. The investigation was conducted to evaluate subsurface conditions at the site and provide our conclusions and recommendations for design and construction of the proposed modifications. Our investigation has included a review of available geotechnical information, subsurface explorations, laboratory testing, and engineering analyses.

The following geotechnical information has been reviewed for this investigation:

> GRI, December 2013, Geotechnical Report, Tesoro Savage Vancouver Energy Distribution Terminal - Upland Facility, Port of Vancouver, USA; prepared for BergerABAM
>
> Dames and Moore, March 31, 1993, Geotechnical Investigation, Proposed T-Docks/Dolphins, Port of Vancouver, Washington; prepared for URS Consultants
>
> GRI, May 18, 2011, Geotechnical Report, NW Gateway Avenue Rail Bridge and Access to Terminal 5, Port of Vancouver, USA; prepared for HDR, Inc.
>
> Goble, Rauche, Likins and Associates, Inc., 1993, Dynamic Pile Measurements, October 11, 1993, T1 and T2 Dock, Port of Vancouver, Vancouver, Washington

PROJECT DESCRIPTION

Overview

Modifications to the existing Berth 13 dock and trestle are being designed to update the facility to current seismic design standards. Berth 13 consists of a T-shape dock and trestle, as shown on Figure 2. Proposed modifications will be primarily located between an area of proposed ground improvement on the riverbank and the Columbia River channel. We have assumed the area of ground improvement will include the trestle abutment. BergerABAM has indicated the channel depth in front of the dock is a minimum of elevation -43 ft Columbia River Datum (CRD). All elevations within this report reference NGVD29 datum, which is the project datum. Elevations can be converted to NGVD29 by adding approximately 1.78 ft to CRD.

Modifications include reconstruction of the existing deck; strengthening the existing dock, trestle, and mooring structures; and installation of ground anchors inside existing dock and dolphin piles. Landward of the Ordinary High Water Mark (OHWM), there will be two new dolphin pile structures located on the riverbank, new pile structures to support walkways that access existing dolphins, and new piles for the trestle abutment foundation. Additional improvements in the dock area (Area 400) are described in our above-referenced December 2013 report for the upland facility.

Seismic design of the dock modifications is intended to meet the requirements of the upcoming American Society of Civil Engineers (ASCE) standard, *Seismic Design of Pile-Supported Piers and Wharves*.

The proposed riverbank ground improvement is being designed by Hayward Baker, Inc., a ground improvement specialty contractor, to meet specified seismic performance criteria. The ground

improvement design will affect the performance of the proposed Berth 13 modifications along the shore. We anticipate the impact of ground improvement on design of the dock elements will be further evaluated as the ground improvement design is developed.

SITE CONDITION AND BACKGROUND

Topography, Bathymetry, and Site Background

The existing site topography and bathymetry in the vicinity of Berth 13 is shown on Figure 2. The ground surface in the upland area located behind the trestle abutment is relatively flat at about elevation +27 ft and is typically surfaced with AC pavement, gravel, or grass. Two shallow stormwater infiltration swales with a bottom elevation of about +21 to +22 ft are located north of the paved areas and are mantled with grass and shrubs. The riverbank is protected with riprap and slopes down at about 2H:1V to a sandy beach at about elevation +17 ft. The sandy beach is relatively flat and slopes down at about 6H:1V to elevation +3 ft. Below elevation +3 ft, the slope increases to about 2.5H:1V. The existing mudline at the face of the dock is in the range of elevation -35 to -38 ft.

Geology

Based on our understanding of the geology at the site, our experience with nearby sites, and the available exploration data, the upland portion of the project area is mantled by fill that is underlain by recent alluvial soils. The fill typically consists of fine- to coarse-grained sand with silt, silty sand, sandy silt, and gravel. The alluvial soils beneath the fill and the mudline in the river typically consist of loose to medium dense sand and very soft to medium stiff silt. Gravel ranging from gravel in a matrix of sand to open-graded gravel with cobbles and possible boulders is present below elevations ranging from about -50 to -60 ft. Geologic investigations for the proposed Interstate 5 bridge replacement, about 3 miles upstream from the project site, indicate the alluvial gravels on the Washington side of the Columbia River can be up to 100 ft thick.

Available geologic information indicates the alluvial gravels are underlain by the Troutdale Formation, a Pliocene-age unit of well-consolidated or cemented conglomerate and sandstone (Beeson et al., 1991).

SUBSURFACE CONDITIONS

General

Subsurface materials and conditions at the dock site were investigated between July 29 and October 29, 2013, with four borings, designated B-23 through B-26, and one cone penetration test (CPT) probe, designated CPT-6. The borings were advanced to depths of 80 to 104 ft, and the probe was advanced to a depth of about 83 ft. The locations of the borings and CPT probe are shown on Figure 2.

The field exploration and laboratory testing programs completed for this investigation are described in Appendix A. Logs of the borings and CPT probe are shown on Figures 1A through 5A. The terms used to describe the soils encountered in the borings and CPTs are defined in Tables 1A and 2A.

In addition to the borings and CPT probe for this investigation, GRI also reviewed and utilized the logs of previous explorations made by GRI and others for other nearby projects. The soils encountered in the explorations for this investigation are consistent with previous investigations.

Soils

For the purpose of discussion, the materials disclosed by the explorations have been grouped into three units based on their physical characteristics, geologically significant features, and engineering properties. Listed as they were encountered from the ground surface downward, the units are:

1. **FILL**
2. **SAND**
3. **GRAVEL**

1. FILL. Fill was encountered at the ground surface in the upland explorations (Borings B-23 through B-25 and CPT-6) and extends to depths ranging from about 20 to 25 ft (about elevation +7 to +2 ft). Asphaltic-concrete pavement between 4 and 12 in.-thick over 10 to 24 in. of crushed rock base course was encountered at the ground surface in boring B-23 and B-25. Below the pavement and base course in boring B-23 and B-25, and at the ground surface of the other upland explorations, the fill consists of fine to coarse-grained sand with a trace of silt and scattered gravel and organic debris. Interbedded layers of silt and sandy silt up to about 4 in. thick were encountered in the fill. Based on N-values of 9 to 36 blows/ft and CPT tip resistances of about 50 to 240 tsf, the relative density of the fill ranges from loose to dense and is more typically medium dense. The moisture content of fill ranges from 7 to 27% and generally increases with increasing silt content.

2. SAND. Sand was encountered below the fill in the upland borings and at the ground surface in boring B-26. The sand extends to depths ranging from 64 to 87 ft (elevation -51 ft to -60 ft). The sand is fine to coarse grained and contains a trace to some silt. Interbedded layers of sandy silt and silt ranging from 1 in. to 5-ft-thick are present in the sand. The sand contains scattered a trace of gravel in all of the borings except boring B-24. Scattered wood debris was encountered below a depth of 25 ft in boring B-26. Based on N-values of 6 to 33 blows/ft and CPT tip resistances of about 50 to 150 tsf, the relative density of the sand typically ranges from loose to dense. More typically, the sand is medium dense with the exception of the sand in boring B-26 which has N-values of 2 to 10 blows/ft in the upper 40 ft indicating the upper 40 ft of sand is relatively loose. The moisture content of the sand ranges from 21 to 39%. The moisture content of silt layers ranges from 41 to 46%.

3. GRAVEL. Gravel was encountered beneath the sand in all four new borings. The gravel has a matrix of sand and silt and contains scattered cobbles and possible boulders. Loss of drilling fluid and caving of the borehole in Boring B-26 indicates that there are open-graded gravels. Based on N-values of 38 blows/ft and 50 blows for less than 6 in. of penetration, the relative density of the gravel ranges from dense to very dense.

Groundwater

Groundwater levels in the project area fluctuate in response to seasonal river levels, precipitation, and daily tidal fluctuations in the river. It should be anticipated the groundwater level in the project area will reflect the water levels in the Columbia River. Shallow perched groundwater conditions can develop above the less-permeable silty deposits at the site and approach the ground surface during periods of prolonged or intense rainfall.

The Columbia River level is lowest in late summer and early fall and is highest during winter storm events and the spring freshet, when snowmelt runoff causes high river flows. Historical low water in the last 20 years is about elevation +2.5 ft. The 100-year flood and OHWM is about elevation +27 and +17 ft, respectively.

CONCLUSIONS AND RECOMMENDATIONS

General

The borings and CPT probe completed for this investigation indicate the upland area is mantled with about 20 to 25 ft of sand fill that is underlain by alluvial sand and gravel that extend into the Columbia River. The top of a dense gravel unit ranges from about elevation -51 to -60 ft. Groundwater levels at the site will fluctuate in response to precipitation and levels in the nearby Columbia River. Shallow perched groundwater conditions may develop in the fill and approach the ground surface during periods of prolonged precipitation.

The primary geotechnical considerations for the Berth 13 modifications include axial and lateral capacity of proposed and existing piles and seismic hazard considerations. As discussed with BergerABAM, we understand new piles or foundation elements will be installed landward of the OHWM.

The loose to medium dense sand below the water table is liquefiable for the larger seismic hazard levels evaluated. Liquefaction of these soils will result in settlement, a reduction of soil strength, and significant lateral spreading near the riverbank. Lateral spreading is the horizontal displacement of large volumes of soil toward the river as a result of the liquefaction of underlying layers. Lateral ground movement will cause lateral loading and deformation of piles located within the zone of movement. Ground improvement is planned along the riverbank to mitigate the impacts of liquefaction-induced settlement and lateral spreading deformation on the TSVEDT facility improvements near the river. Although the ground improvement design is under development, we have assumed ground improvement will be completed upland of the trestle abutment to limit deformation of the abutment. Ground improvement will not be completed waterward of the OHWM; therefore, seismic-induced ground deformations will impact design of the riverside dock and trestle piles. Further evaluation of the dock modifications may be required as the ground improvement design is developed.

The following sections of this report provide our conclusions and recommendations for design and construction of the proposed modifications.

Seismic Considerations

General. The upcoming ASCE standard, *Seismic Design of Pile-Supported Piers and Wharves* (ASCE SSDPW), defines ground motions for three seismic hazard levels: the Operating Level Earthquake (OLE), the Contingency Level Earthquake (CLE), and the Design Earthquake (DE).

> OLE is defined by 50% probability of exceedance in 50 years, which corresponds to an earthquake with an expected recurrence interval of 72 years and represents a performance level with minimal structural damage.

CLE is defined by 10%probability of exceedance in 50 years, which corresponds to an earthquake with an expected recurrence interval of 475 years, and represents a performance level of controlled and repairable structural damage.

DE is defined per ASCE 7-05 which develops the response spectra based on ground motions associated with the Maximum Considered Earthquake (MCE), which is generally represented by a probabilistic earthquake with a 2% probability of exceedance in 50 years (return period of about 2,500 years), except where subject to deterministic limitations (Leyendecker et al., 2000). The design-level response spectrum that represents the DE is obtained by taking two-thirds of the MCE level ground motions.

The bedrock earthquake motions for each of the hazard levels were selected from the 2008 U.S. Geologic Survey (USGS) probabilistic seismic hazard maps for the coordinates of 45.65° N latitude and 122.71° W longitude. The code-based spectra are developed using two spectral response coefficients, S_S and S_1, corresponding to periods of 0.2 and 1.0 second. These bedrock spectral ordinates are adjusted for Site Class with the short- and long-period site coefficients, F_a and F_v, based on subsurface conditions or with a site-specific response analysis. A summary of the OLE, CLE, and DE hazard level S_S and S_1 coefficients for the dock are tabulated below.

SUMMARY OF SEISMIC DESIGN PARAMETERS

Hazard Level	S_S	S_1
Operating Level Earthquake (OLE)	0.11	0.03
Contingency Level Earthquake (CLE)	0.45	0.16
Design Earthquake (DE)	0.94	0.41

The site is generally designated as Site Class D based on the average shear wave velocity (V_s100) in the upper 100 ft per Section 20.4 of ASCE 7-05. Based on our evaluation, the seismic shaking from the OLE is insufficient to cause liquefaction, and the code-based Site Class D is recommended to estimate the ground response spectral acceleration. However, our analysis has identified a potential risk of liquefaction for the CLE and DE hazard levels. In accordance with ASCE SSDPW, sites with subsurface conditions identified as vulnerable to failure or collapse, such as liquefiable soils, shall be classified as Site Class F. For Site Class F sites, ASCE SSDPW Section 4.3.2 requires completion of a site-specific ground motion analysis for structures with a fundamental period of vibration greater than 0.5 second. BergerABAM has indicated the fundamental period of the dock is between 0.5 and 1.0 second. Due to these anticipated longer periods, a site-specific seismic ground motion analysis was completed for CLE and DE hazard levels at the dock and trestle area. The ground motion analysis was completed with the aid of the computer software D-MOD2000, a non-linear seismic soil response software developed by GeoMotions, LLC. The D-MOD2000 analyses are further discussed in Appendix B.

The site-specific response modeling results were compared with both Site Class D and E spectra due to the liquefaction considerations. The modeling indicates that 80% of code-based Site Class E spectral accelerations provide an appropriate estimate of the CLE hazard level in accordance with the ASCE SSDPW. The site-specific response modeling indicates the MCE hazard level spectral accelerations are greater than Site Class D spectral accelerations at periods less than 1.8 seconds. However, based on the

research by Youd and Carter (2005), Site Class D is likely conservative for structures with a period less than 1 second. In this regard, the code-based Site Class D is recommended to estimate the spectral accelerations at short periods ($T < 0.89$ second). At periods between 0.89 and 1.8 seconds, we conservatively recommend the design spectrum include an increase above Site Class D and E to transition to longer periods and envelop the estimated site-specific ground surface response. At periods greater than approximately 1.8 seconds, the site-specific response spectrum is less than 80% of Site Class E, which is the minimum spectral amplification allowed by ASCE 7-05 for liquefied conditions. The DE is determined by taking two-thirds of the MCE. The results of our site-specific ground motion analysis, including plots of the spectral amplification ratio and recommended response spectra, are provided in Appendix B.

Liquefaction. Liquefaction is a process by which saturated, granular materials, such as sand, and non-plastic silts, temporarily lose strength during and immediately after a seismic event. Liquefaction occurs as seismic shear stresses propagate through a saturated soil and distort the soil structure causing loosely packed groups of particles to contract or collapse. If drainage is impeded and cannot occur quickly, the collapsing soil structure increases the pore water pressure between the soil grains. If the pore water pressure increases to a level approaching the weight of the overlying soil, the granular layer temporarily behaves as a viscous liquid rather than a solid. As strength is lost, there is an increased risk of settlement, lateral spread, and/or slope instability, particularly along waterfront areas. Liquefaction-induced settlement occurs as the elevated pore water pressures dissipate and the soil consolidates after the earthquake.

The potential for liquefaction at the site was evaluated with the simplified method based on two methodologies. The first methodology is based on the simplified procedure by Youd, et al. (2001). The analysis was completed with the aid of the computer software LiquefyPro, a seismically induced liquefaction and settlement analysis software developed by CivilTech Corporation. The second methodology is based on the simplified procedure by Idriss and Boulanger (2008). Both methodologies utilize the peak ground acceleration (PGA) adjusted for site amplification to estimate the cyclic shear stress ratio (CSR) experienced by the soil and in situ test data from the borings or CPTs to estimate the cyclic resistance ratio (CRR) of the soil. The factor of safety (FS) against liquefaction is estimated as the CRR divided by the CSR. The OLE PGA was based on the USGS 2008 interactive deaggregations. The CLE and DE PGAs were based on the results of site-specific ground motion analyses. The earthquake magnitudes chosen to represent the earthquake hazard levels for our liquefaction studies were based on the 2008 USGS interactive deaggregations for the OLE, CLE, and DE return intervals as well as the results of our site-specific ground motion analysis for the CLE and DE hazard level. The input values used for our liquefaction studies are tabulated below.

Hazard Level	PGA, g	Earthquake Magnitude, M
Operating Level Earthquake (OLE)	0.07	5.8
Contingency Level Earthquake (CLE)	0.26	8.4
Design Earthquake (DE)	0.28	9.0

For the purpose of liquefaction studies, we have conservatively assumed a groundwater level at elevation +12 ft, which corresponds to the seasonal high average daily river level. Based on our liquefaction studies, we estimate the risk of liquefaction for the OLE hazard level is low, i.e., the FS against liquefaction is greater than 1. The output from our liquefaction studies indicates the loose to medium dense sands

below the groundwater level have a factor of safety against liquefaction less than 1 and could liquefy during the CLE and DE hazard level. A maximum free-field seismic settlement of about 24 in. was estimated for both the CLE and DE hazard levels based on the existing unimproved soil profile at boring B-26. The factor of safety against liquefaction for the CLE and DE hazard levels is summarized on Figures 3 and 4.

Lateral Spreading. Lateral spreading involves the horizontal displacement of large volumes of soil as a result of the liquefaction of underlying soil layers. Ground displacement occurs in response to the combination of gravitational forces and inertial forces generated by an earthquake acting upon the soil mass. Lateral spread can develop on shallow sloping ground or as a flow slide moving toward a moderately steep to steep free face, such as a river channel or lake bottom. Differential internal movement within the spreading mass usually creates surface features, such as ground cracks or fissures, scarps, and/or grabens, in overlying unsaturated or non-liquefied soils. Lateral displacement may range from a few inches to many feet depending on soil conditions, the steepness of the slope, and the magnitude and epicentral distance of the earthquake. Associated differential vertical movements, or ground surface subsidence, may range up to about half of the total horizontal movement.

The method of analysis summarized in Idriss and Boulanger (2008) were used to estimate lateral spreading deformations in free-field conditions. The methodology utilizes the same inputs as the simplified method for liquefaction hazard evaluation. Additionally, lateral spreading deformations were estimated using the methods of Youd et al. (2002). The basic inputs for Youd et al. (2002) include a characterization of the soil profile in terms of grain size, fines content (silt and clay), and Standard Penetration Test N-values; the overall geometry of the riverfront slope; and the magnitude and epicentral distance of the design-basis earthquakes. The risk of liquefaction at the OLE hazard level was estimated to be very low and therefore lateral spreading was not evaluated for the OLE. The range of estimates of lateral deformation for the CLE and DE hazard levels are tabulated below.

LATERAL SPREADING ESTIMATES
(without ground improvement)

Hazard Level	Earthquake Magnitude, M	Epicentral Distance, km	Estimated Range of Lateral Deformation, ft
Contingency Level Earthquake (CLE)	8.4	86	5 to 12
Design Earthquake (DE)	9.0	86	12 to 20

The methods used to estimate the seismically induced horizontal and vertical ground displacement at the site are largely based on empirical methods and, consequently, do not provide a precise estimate of the actual ground movement that may occur. Seismic events of a lesser magnitude, or of the same magnitude but occurring at a greater epicentral distance from the site, would be expected to produce lesser horizontal and vertical ground displacements.

Design Estimates for Lateral Displacement Forces. Earthquake-induced damage to waterfront structures at sites with liquefiable soils is well documented. Stresses induced on piles are typically generated from the inertial mass of the structure and lateral soil loading from both the lateral spreading liquefied soils and the non-liquefied crust of soil generally present above the groundwater table. Case histories have shown that the forces or displacements induced by the non-liquefied soil crust are generally significantly larger than

the forces generated from the liquefied soils with reduced strengths. Design for the lateral spreading soils is typically completed by either applying estimates of soil displacements or forces to the structure. The displacement approach is commonly applied if the structure is somewhat flexible and can accommodate some deformation. The force approach is applied if the structure is more rigid and cannot accommodate the estimated movement. Based on discussions with BergerABAM, we understand the evaluation of the dock and trestle piles will likely be based on a force-based approach. Because the seismic lateral movements of the trestle abutment will be mitigated by ground improvement, we understand the abutment will be evaluated based on a displacement-based approach. The magnitude of displacement at the abutment will depend on the ground improvement design and should be evaluated as the design is developed. Preliminary earth pressures for the abutment are provided in the Trestle Abutment Earth Pressures section of this report.

A schematic cross section of the trestle alignment with the estimated lateral spreading failure surface is shown on Figure 5. The failure surface shown on Figure 5 assumes that sufficient ground improvement will be installed to limit lateral spreading at the trestle to the area below the OHWM at the CLE and DE hazard levels, which is discussed subsequently. Based on the soil profile and bathymetry, it should be assumed that lateral spreading will occur to a depth of about 35 ft below the mudline or ground surface, but no deeper than elevation -48 ft, for the CLE and DE hazard levels.

For the purpose of lateral spreading studies, we have assumed a groundwater level at elevation +7.5 ft that corresponds to the average level of the Columbia River. Based on our assumptions, the estimated soil movements will result in two different pressures acting on the trestle and dock piles: 1) unsaturated sand moving against the piles, and 2) saturated loose, liquefied sand moving against the piles. For the unsaturated sand above the ground water table, a lateral earth pressure based on an equivalent fluid unit weight of 400 pcf may be assumed to act against the trestle piles in the direction of the river for the CLE and DE hazard levels. Where the sand is saturated, a uniform rectangular pressure distribution of 250 psf may be assumed to act against the trestle piles in the direction of the river. In non-liquefied soils, passive lateral earth pressures tend to "arch" or develop a larger tributary area against piles. In this regard, we recommend assuming the lateral earth pressure against piles in the unsaturated sand material will act over an equivalent of two pile diameters. The lateral pressure against piles in the saturated liquefied sand material will act over one pile diameter. The recommended seismically induced lateral pressures are summarized on Figure 6. The extents of lateral spreading and the lateral spreading forces should be further evaluated as the ground improvement design is developed.

As noted in the ASCE SSDPW peak inertial forces do not necessarily occur at the same time as the peak soil (kinematic) loading on the structure. For this reason, consideration can be given to applying only a portion of the peak inertial loading at the same time as the kinematic loads. Design methods for evaluating combined inertial and kinematic loads are not well documented in the available literature, and ASCE SSDPW does not provide a recommended loading combination. However, another marine structures code, the Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), includes recommended load combinations for inertial and kinematic loading. In our opinion, it is reasonable to use inertial and kinematic load combinations similar to those provided in MOTEMS to evaluate the dock design.

Ground Improvement. Lateral spreading is often mitigated by constructing a zone, or buttress, of improved soil along the riverbank that will not liquefy. The buttress needs to be of sufficient width and extend to adequate depth to maintain stability following ground shaking and minimize or prevent lateral displacement toward the river of the upland portion of the site behind the buttress.

Due to the potential for large lateral spreading deformations, ground improvement will be designed and constructed to mitigate the impact of large seismic lateral displacements on the proposed transfer pipeline and structures located near the river.

Other Seismic Considerations. In our opinion, the potential for earthquake-induced fault displacement and ground rupture at the site is low unless occurring on a previously unknown or unmapped fault. Due to the topography of the site, it is our opinion the risk of damage by seiche is low. We are not aware of rigorous tsunami modeling for the Columbia River in available literature. However, based on the paper, "Tsunami Hydrodynamics in the Columbia River" (Yeh, 2012), the amplitude of potential tsunami waves at the Port is anticipated to be small at this distance from the Pacific Ocean.

Slope Grading and Protection

We understand the existing riprap and concrete debris slope protection will be left in place wherever possible. We anticipate this slope protection will have to be removed and replaced in the vicinity of the new piles to minimize the risk of obstructions during installation. Depending on the degree of disturbance and the subgrade conditions underlying the existing slope protection, a graded filter material may need to be placed prior to replacing the slope protection. GRI should observe the subgrade conditions during construction to recommend and appropriate filter gradation.

Pile Support

General. New 24-in.-diameter pipe piles (plumb and battered) are being considered for two proposed landside mooring dolphins, the reconstructed abutment, and walkway support piles. New driven piles will be located landward of the OHWM. Some strengthening of the existing 18-in.-diameter dock, trestle, and dolphin pipe piles is planned that includes installing grouted anchors or micropiles through the pipe piles into the gravel, and filling the piles with concrete. Based on discussions with the team, we understand the installation and testing of micropiles or grouted anchors will be through an assumed 10$^{1}/_{2}$-in.-diameter hole in the plate at the tip of the existing pipe pile. Our recommendations regarding axial and lateral capacity of the new and existing piles are summarized below.

Proposed Dolphin Piles. The locations of two proposed landside mooring dolphins are shown on Figure 2. At the request of BergerABAM, GRI evaluated 24-in.-diameter pipe piles at the proposed dolphin locations. We anticipate the piles will be driven open-end into the underlying gravel unit. We estimate 24-in.-diameter pipe piles driven with sufficiently large hammers to adequate penetration resistance can develop an ultimate compression capacity of at least 750 kips. The explorations and our experience in the area indicate the sand content and the relative density of the underlying gravel unit tend to be highly variable. As a result, it is difficult to accurately predict the actual penetration of piles into the gravel to develop the estimated ultimate capacities. However, based on our experience, we anticipate the piles will develop the design capacity at a depth of about 15 ft into the gravel plus or minus 10 ft. Assuming penetration of 15 ft into the dense gravel, the resulting pile tips will be at about elevation -68 to -70 ft based

on the available explorations. Due to the variation in subsurface conditions we recommend the piles are ordered at least 10 ft longer than the estimated tip elevation to limit the risk of splices.

Since a significant portion of the estimated ultimate compression pile capacity is derived from end-bearing resistance, the uplift capacity of the piles will be significantly less than the compressive capacity. For preliminary purposes, we estimate the 24-in.-diameter piles can develop an ultimate vertical uplift capacity of about 300 kips assuming the piles will penetrate a minimum of 15 ft into relatively dense gravel.

As discussed in the Liquefaction section of this report, the sand below the groundwater level is subject to liquefaction and/or seismically induced strength loss during the two larger hazard level events. Liquefaction-induced settlements will result in downdrag loads on the piles. In this regard, we recommend assuming a downward skin friction acting along the outside perimeter of the piles of 250 psf above elevation +12 ft and 150 psf from elevation +12 ft to the top of the gravel unit. The top of the gravel unit is estimated at about elevation -57 ft. For seismic conditions the ultimate axial capacities estimated above should be reduced to 280 kips in compression, and 170 kips uplift to account for seismically-induced loss of strength. For piles located within the zone of ground improvement, the depth of liquefaction and magnitude of the downdrag loads will depend on the ground improvement design. The effects of ground improvement on the potential for downdrag induced loads should be evaluated as the ground improvement design is developed.

Recommended factors of safety for allowable capacity are discussed in the Recommended Factor of Safety section of this report.

Trestle Abutment Piles. As currently planned, new 24-in.-diameter pipe piles are being considered at the reconstructed trestle abutment to resist seismic inertial loads from the dock and trestle structure. We have assumed that ground improvement will be designed to extend around the abutment piles to a sufficient depth to mitigate liquefaction and lateral spreading. In this regard the non-seismic axial capacity estimates presented in the previous section for dolphin piles can be used to preliminarily design abutment piles for the non-seismic and seismic loading conditions. The pile capacities at the abutment should be reevaluated as the ground improvement design is developed.

Existing Trestle, Dock, and Dolphin Piles. The existing piles are 18-in.-diameter pipe piles with 3/8-in.-thick walls. The piles were reportedly fitted with a type of endplate that included a 10 1/2-in.-diameter center cut-out. The trestle piles are all plumb piles. The dock and dolphin piles are a combination of plumb and batter (5H:12V and 6H:12V) piles. The total embedded length of the piles typically ranged from about 34 to 100 ft depending primarily on the mudline elevation at the pile location. The piles at the dock typically have the least embedment and range from about 34 to 52 ft. The length of pile embedment into the gravel unit is typically in the range of 10 to 25 ft.

GRI evaluated the axial capacity of the existing piles based on available geotechnical data including pile driving logs and results of Pile Driving Analyzer (PDA) re-strike testing completed when the piles were installed. The PDA results are summarized in the above-referenced report by GRL (1993). The ultimate capacity computed from restrike PDA tests ranges from 435 to 550 kips. The PDA estimated skin friction resistance values of 210 kips and 225 kips for piles 91 and 96, respectively. Pile 91 and 96 were

embedded 36 and 48 ft, and it is our opinion that the estimated ultimate skin friction is representative for the range of pile embedment at Berth 13.

Based on the wide variation in pile embedment depths we recommend an ultimate compression capacity of 435 kips. We estimate the pile tip provides about 200 kips of resistance and the skin friction on the outside of the pile provides the remaining resistance. Since a significant portion of the estimated ultimate compression pile capacity is derived from end-bearing resistance on the partially closed-end plate, the uplift capacity of the piles will be significantly less than the compressive capacity. To consider decreased skin friction values for tension piles relative to compression piles (FHWA, 2006), we recommend an ultimate uplift capacity of about 150 kips for the range of pile embedments at Berth 13.

As discussed in the Liquefaction section of this report, the sand below the groundwater level is subject to liquefaction and/or seismically induced strength loss. Liquefaction-induced settlements will result in downdrag loads on the piles. For the existing dock and trestle piles, we recommend assuming a downward skin friction of 100 psf acting along the outside perimeter of the piles from the mudline to the top of the gravel unit. The top of the gravel unit can be estimated at about elevation -57 ft for this purpose. For seismic conditions, the ultimate axial capacities estimated above should be reduced to 400 kips (compression) and 100 kips (uplift) to account for seismically induced loss of strength.

Recommended Factor of Safety. We recommend applying a factor of safety to the ultimate pile capacities provided above based on soil support properties. A minimum FS of 2 is recommended for typical non-seismic conditions. For seismic conditions we recommend a factor of safety of 1 in accordance with the ASCE SSDPW. For extreme moorage loading combinations such as flood and extreme wind conditions a FS of 1.5 is appropriate for dolphin piles.

Pile Installation. The new dolphin piles should be driven with a pile hammer of sufficient energy to develop the pile ultimate capacity and obtain adequate penetration into the gravel. During installation, we anticipate the top of the gravel can be identified by a noticeable increase in penetration resistance. Based on our experience on adjacent sites with similar soils, a vibratory hammer will likely not be effective in penetrating the gravel layer to the design embedment. In this regard, the contractor should assume final installation of steel pipe piles will require an air, steam, or diesel, impact hammers.

As discussed previously, our experience in the area indicates the driving resistance in the gravel tends to be highly variable. There is some risk that piles may encounter practical refusal before reaching the planned tip elevations.

We recommend an indicator-pile installation program as the initial step in the installation of production piles. The purpose of the program would be to evaluate the contractor's equipment and develop terminal pile driving resistance criteria. We recommend dynamic pile testing of two or three piles with the PDA during initial driving. As a guide, if 24-in.-diameter piles are being considered for the pile program, we recommend using a pile hammer with rated energy of at least 100,000 ft-lbs. The contractor should provide an impact hammer submittal and installation plan for the project team to review at least 2 weeks prior to pile driving.

We understand the pipe piles will likely have a 0.5-in. wall thickness. All piles should be fitted with commercially available tip protection that fit flush with the outside wall of the pile.

Lateral Pile Capacity. Lateral structural loads can be resisted by the piles in bending. The lateral load behavior of the piles can be analyzed using the computer program L-Pile 5.0 by Ensoft, Inc. We recommend using the input parameters summarized in the following tables to model the soils at the site.

SOIL PROPERTIES FOR L-PILE ANALYSIS [1]
Berth 13 Dock, Trestle, and Riverbank Dolphin Piles

Static, Frequently Applied Live Loads, and Operating Level Earthquake (72-year Return Interval)[2]

Soil Unit	Elevation, ft	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill: SAND	Above +17	Sand (Reese)	Non-Liquefied	25	0.067	32	N/A	N/A
Submerged Fill: SAND	+17 to +2	Sand (Reese)	Non-Liquefied	20	0.03	32	N/A	N/A
Submerged SAND	+2 to -38	Sand (Reese)	Non-Liquefied	20	0.030	32	N/A	N/A
Submerged SAND	-38 to -57	Sand (Reese)	Non-Liquefied	60	0.030	35	N/A	N/A
Submerged GRAVEL	Below -57	Sand (Reese)	Non-Liquefied	125	0.040	40	N/A	N/A

Contingency Level and Design Level Earthquakes (475-year and 2/3 MCE Return Intervals, respectively) [3] [4]

Soil Unit	Elevation, ft	L-Pile Soil Type	Condition	Soil Properties				
				K, pci	γ', pci	ϕ'	c, psi	ε_{50}
Fill: SAND	Above +7.5	Sand (Reese)	No Lateral Resistance	N/A	0.067	N/A	N/A	N/A
Submerged Fill: SAND	+7.5 to +2	Sand (Reese)	Liquefied	10	0.030	6	N/A	N/A
Submerged SAND	+2 to -38	Sand (Reese)	Liquefied	10	0.030	6	N/A	N/A
Submerged SAND	-38 to -57	Sand (Reese)	Liquefied	10	0.030	12	N/A	N/A
Submerged GRAVEL	Below -57	Sand (Reese)	Non-Liquefied	125	0.040	40	N/A	N/A

Notes:

1) Applicable for the river side of the trestle abutment.
2) Design groundwater level assumed at OHWM Columbia River Elevation +17 ft (NGVD).
3) Design groundwater level assumed at Average Columbia River Elevation +7.5 ft.
4) Lateral spreading occurs to depths/elevations shown on Figure 5.
5) Submerged soils are below the design groundwater level.

For preliminary planning we have assumed that ground improvement will be installed around the abutment and will be sufficient to mitigate liquefaction. In this regard, the lateral resistance of abutment piles can be estimated based on the static L-Pile parameters presented in the above table. Ground slope effects can be taken into consideration with the input of an appropriate slope angle.

It should be noted that L-Pile provides isolated, single-pile capacities. Depending on the direction of the loading and orientation of the piles, group effects should be considered for spacings less than eight (8) pile diameters. This reduction is often applied as a group efficiency or a p-multiplier. L-Pile uses a p-multiplier as a reduction of the k_h value for pile spacing less than eight pile diameters. The following table provides a summary of p-multipliers and reported group efficiencies in sand.

LATERAL PILE GROUP ANALYSIS

Center-to-Center Pile Spacing	Calculated p-multipliers for Rows 1, 2, and 3	Reported Group Efficiency
3d	0.80, 0.40, 0.30	0.75
5d	1.0, 0.85, 0.70	0.95
8d	1.0, 1.0, 1.0	1.0

Caution should be used when applying the reported group efficiencies to pile groups with significantly more than three rows of piles. Additional design methodology of laterally loaded pile groups is provided in the Federal Highway Administration (FHWA) publication entitled, "Design and Construction of Driven Pile Foundations."

Micropiles or Ground Anchors. Micropiles or ground anchors drilled through the tip of the existing piles are being considered to increase the existing pile capacity. We estimate micropiles or ground anchors in the gravel may develop ultimate capacities on the order of 350 kips. Larger capacities may be possible but could be limited by structural design considerations. The micropiles or ground anchors would be drilled and installed through the existing pipe piles and into the underlying gravel.

Drilling through the gravel at the tip of the existing pipe piles will alter the pile tip resistance. For preliminary planning purposes, we recommend considering no tip resistance for the existing pipe piles if micropiles or ground anchors are installed through the pile tip. Installation of micropiles or ground anchors will not reduce the skin friction of the existing pipe piles.

Grouted micropiles or ground anchors are typically designed by specialty contractors to meet specified performance criteria. As a general guideline, we recommend a minimum bonded length of 30 ft into the relatively dense gravel. Micropiles or ground anchors should be designed with a minimum factor of safety of 1.5 in compression and 2 in tension, based on soil support properties.

Micropile or ground anchor capacities should be evaluated by field testing which will be challenging because the existing piles are supporting the dock structure. The maximum test loads and the number of test anchors will depend on the total number and design of the micropiles or ground anchors. The testing program should be developed with the final plans and specifications. The unbonded and bonded lengths may need to be modified based on the actual gravel conditions encountered during drilling and the contractor's equipment and procedures. Micropiles and ground anchors should be provided with permanent corrosion protection.

Trestle Abutment Earth Pressures

Design lateral earth pressures for the trestle abutment depend on the type of construction, i.e., the ability of the abutment to yield. For static conditions, we anticipate the trestle abutment will be relatively rigid and

can be designed to resist an at-rest lateral earth pressure computed on the basis of an equivalent fluid having a unit weight of 50 pcf. Additional lateral earth pressures due to surcharge loadings may be estimated using the guidelines presented on Figure 7.

Additional lateral loads due to seismic forces on retaining walls will be dependent on design of the ground improvement around the abutment and the seismic hazard level. Our studies indicate that liquefaction induced seismic deformations are not likely for the OLE hazard level. Based on this assumption, the abutment may be designed on the basis of static at-rest earth pressure plus an additional seismic load increment during the OLE seismic event. The additional load due to seismic forces can be evaluated based on a rectangular lateral earth pressure distribution with a uniform pressure equal to $H*\gamma$, where H is the height of the wall and γ is an equivalent unit weight of 2 pcf for the OLE.

We have assumed that ground improvement will be designed around the trestle abutment to mitigate liquefaction and lateral spreading loads and deformations at the CLE and DE hazard levels to meet a specified ground movement performance criteria. We understand that the final seismic performance criteria have not yet been selected. Seismic lateral ground deformations toward the river will cause lateral spreading loads on the abutment wall and foundations. Lateral spreading loads should be applied to the wall and piles until the wall has displaced the amount specified by the performance criteria. For preliminary planning, lateral spreading loads can be estimated based on an equivalent fluid unit weight of 400 pcf for the unsaturated sand above elevation 7.5 ft. Below elevation 7.5 ft where the sand is saturated and susceptible to liquefaction, a uniform rectangular pressure distribution of 250 psf may be assumed to act in the direction of the river. The depth of seismic deformation and lateral spreading loads will depend on the ground improvement design and the seismic design of the abutment should be re-evaluated once the ground improvement design is complete. We recommend assuming the lateral earth pressure against piles in the unsaturated sand material will act over an equivalent of two pile diameters due to arching. The lateral pressure against piles in the saturated liquefied sand material will act over one pile diameter. Once the seismic deformation has occurred, the earth pressures can be estimated based on the static at-rest earth pressures provided above.

Based on our discussion with the project team, we understand lateral loads at the trestle abutment may be resisted by battered piles or tieback anchors. Anchor capacities can be provided during final design if needed.

The above criteria assume drained conditions and that the abutment is backfilled with relatively clean, granular material, i.e., medium sand, sand and gravel, or well-graded gravel, with not more than 5% passing the No. 200 sieve (washed analysis). We recommend that this material be compacted to about 95% of the maximum dry density as determined by ASTM D 698. Heavy compaction equipment should not operate within 5 ft of the abutment.

Design Review and Construction Services

We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GRI should be retained to review all geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. Additionally, to observe compliance with the intent of our recommendations, design concepts, and the plans and specifications, we are of the opinion that all construction operations

dealing with pile installation should be observed by a GRI representative. Our construction-phase services will allow for timely design changes if site conditions are encountered that are different from those described in this report. In our opinion, this is of particular importance during pile-driving operations. If we do not have the opportunity to confirm our interpretations, assumptions, and analyses during construction, we cannot be responsible for the application of our recommendations to subsurface conditions that are different from those described in this report.

LIMITATIONS

This report has been prepared to assist BergerABAM and the design team in the design of this project. The scope is limited to the specific project and location described herein. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of the trestle, platform, dolphins, and other supports. In the event that any changes in the design and location of the facilities, as outlined in this report, are planned, we should be given the opportunity to review the changes and to modify or reaffirm the conclusions and recommendations of this report in writing.

The analyses and recommendations submitted in this report are based on the data obtained from the borings made at the locations indicated on the Site Plan and from other sources of information discussed in this report. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in soil conditions may exist between the boring locations, and groundwater levels fluctuate seasonally. This report does not reflect any variations that may occur between these explorations. The nature and extent of variations may not become evident until construction. If, during construction, subsurface conditions different from those encountered in the exploratory holes are observed or encountered, or appear to be present beneath or beyond foundations, we should be advised at once so that we can observe these conditions and reconsider our recommendations where necessary.

Submitted for GRI,

Expires 4/2016

Matthew S. Shanahan, PE
Associate

Scott M. Schlechter, PE
Principal

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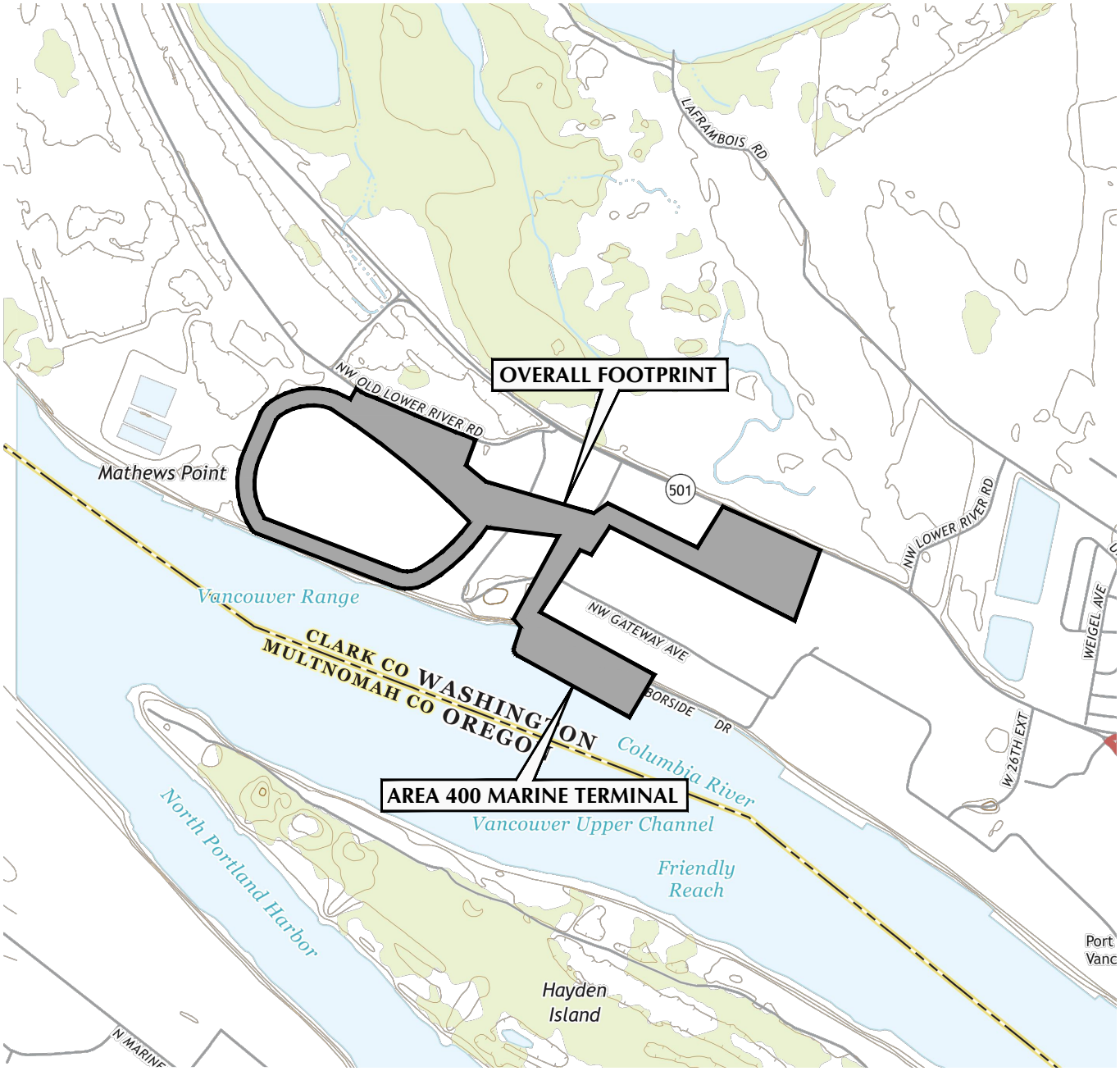


USGS TOPOGRAPHIC MAP
VANCOUVER, WASHINGTON (2011)

North

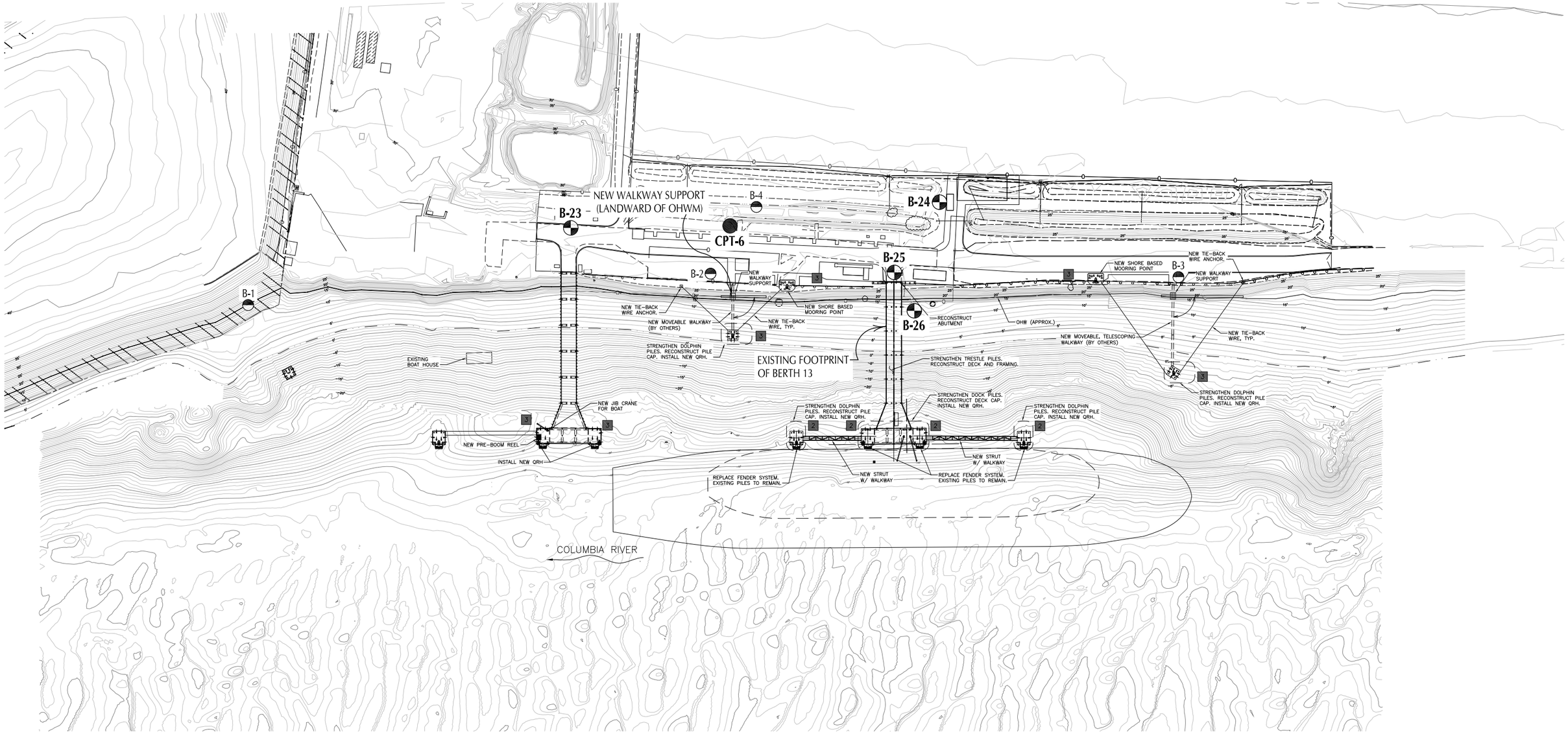
0 1/2 1 MILE

GRI BERGERABAM TSVEDT DOCK STRUCTURE

VICINITY MAP

SEP. 2014 JOB NO. W1114-T3 FIG. 1

EX-0001-004003-PCE



BORING MADE BY GRI
(JULY 29 - OCTOBER 29, 2013)

CONE PENETRATION TEST MADE BY GRI
(JULY 29 - AUGUST 5, 2013)

BORING MADE BY DAMES & MOORE
(1993)

SITE PLAN FROM FILE BY MACKAY + SPOSITO

North

0 150 300 FT

GRI

BERGERABAM
TSVEDT DOCK STRUCTURE

SITE PLAN

SEP. 2014 JOB NO. W1114-T3 FIG. 2

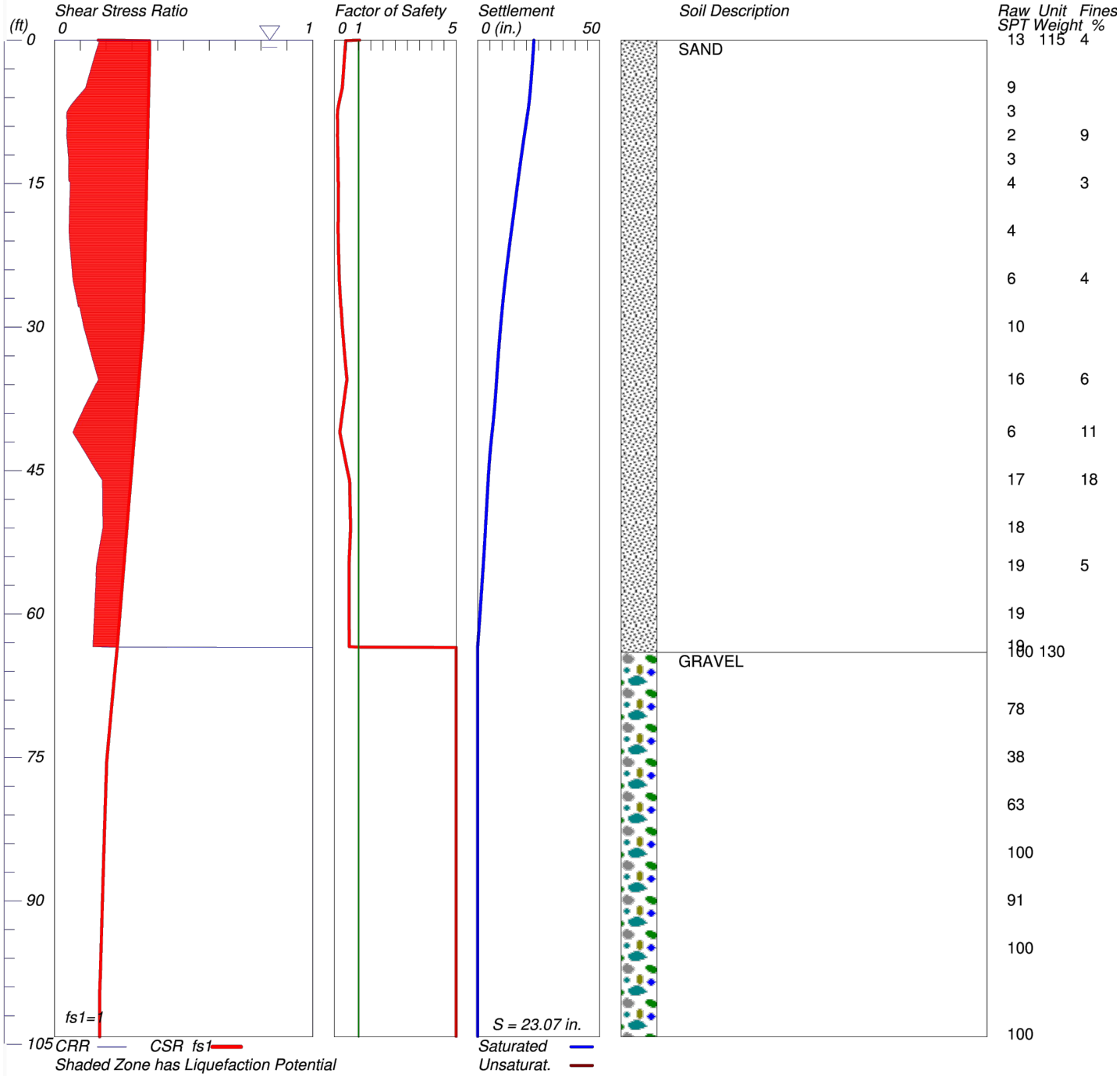
EX-0001-004005-PCE

LIQUEFACTION ANALYSIS

Tesoro Savage Vancouver Energy Distribution Terminal

Hole No.=B-26 Water Depth=0 ft Surface Elev.=7

Magnitude=8.4
Acceleration=0.26g



Contingency Level Earthquake (CLE)

GRI BERGERABAM TSVEDT DOCK STRUCTURE

LIQUEFACTION HAZARD ANALYSIS

SEP. 2014 JOB NO. W1114-T3 FIG. 3

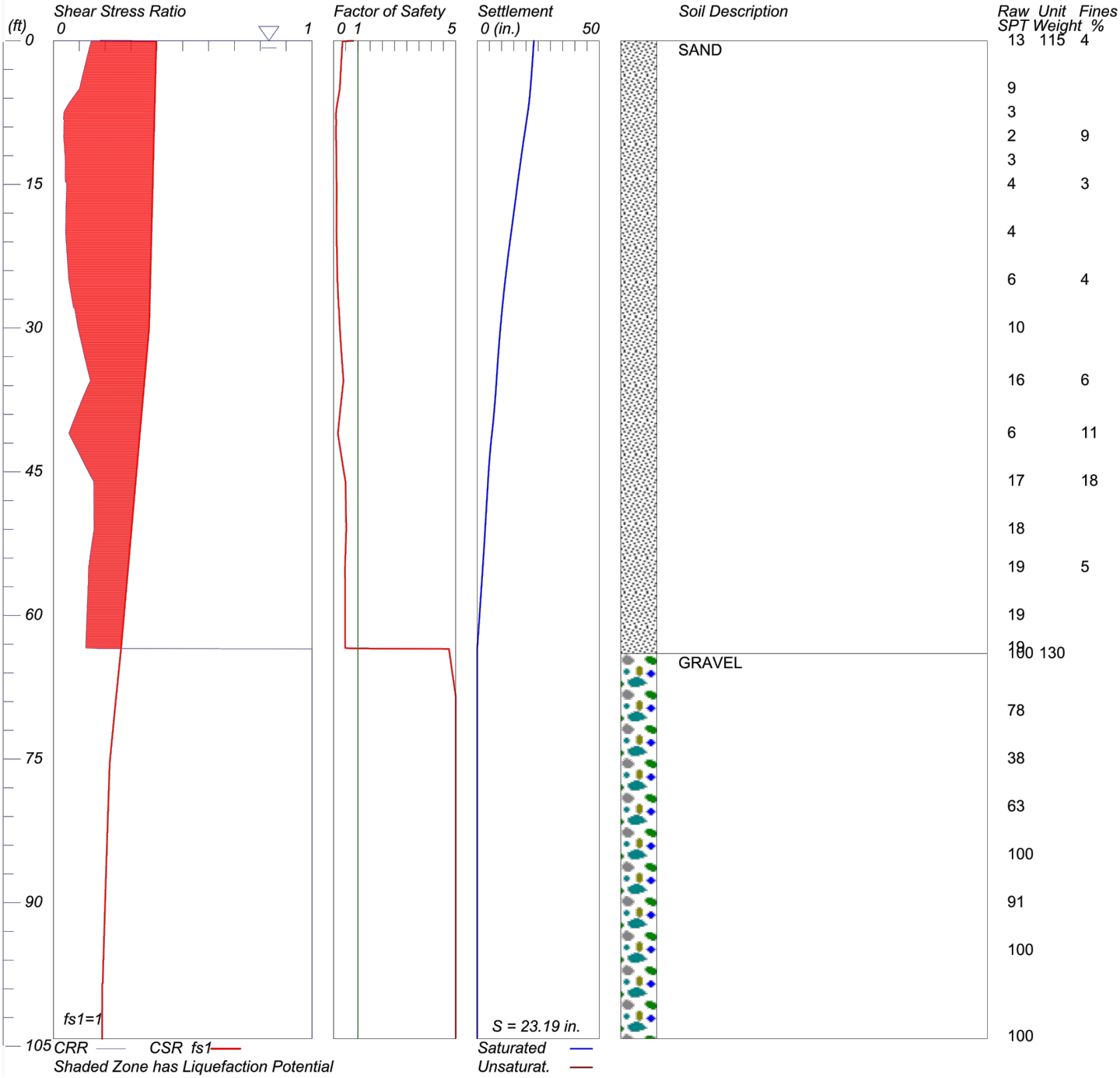
EX-0001-004007-PCE

LIQUEFACTION ANALYSIS

Tesoro Savage Vancouver Energy Distribution Terminal

Hole No.=B-26 Water Depth=0 ft Surface Elev.=7

Magnitude=9.0
Acceleration=0.28g



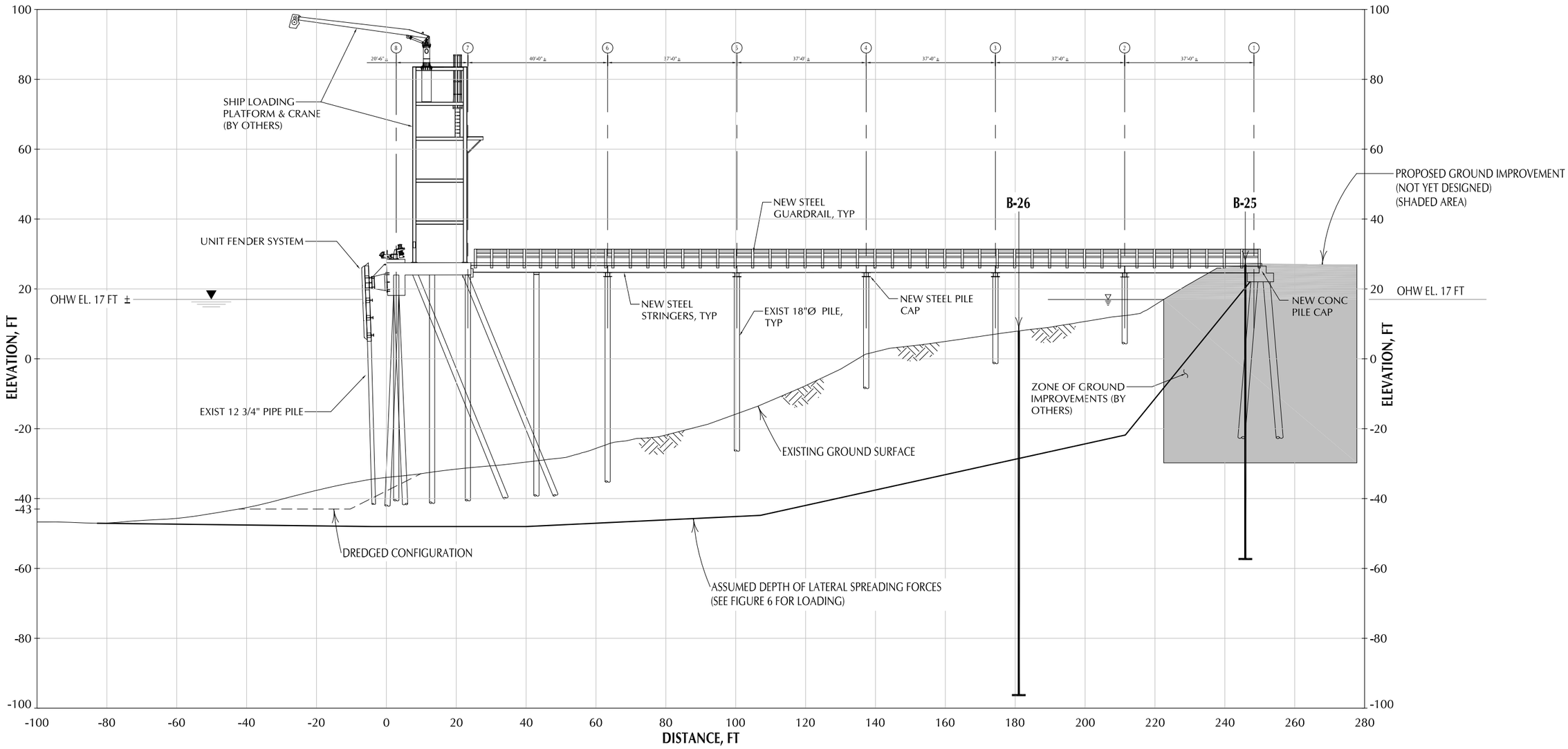
Design Earthquake (DE)

GRI BERGERABAM TSVEDT DOCK STRUCTURE

LIQUEFACTION HAZARD ANALYSIS

SEP. 2014 JOB NO. W1114-T3 FIG. 4

EX-0001-004008-PCE



ELEVATION LOOKING WEST

NOTES:

1) THE EXTENT OF LATERAL SPREAD SHOULD BE FURTHER EVALUATED AS THE GROUND IMPROVEMENT DESIGN IS DEVELOPED.

2) DATUM IS NGVD29.

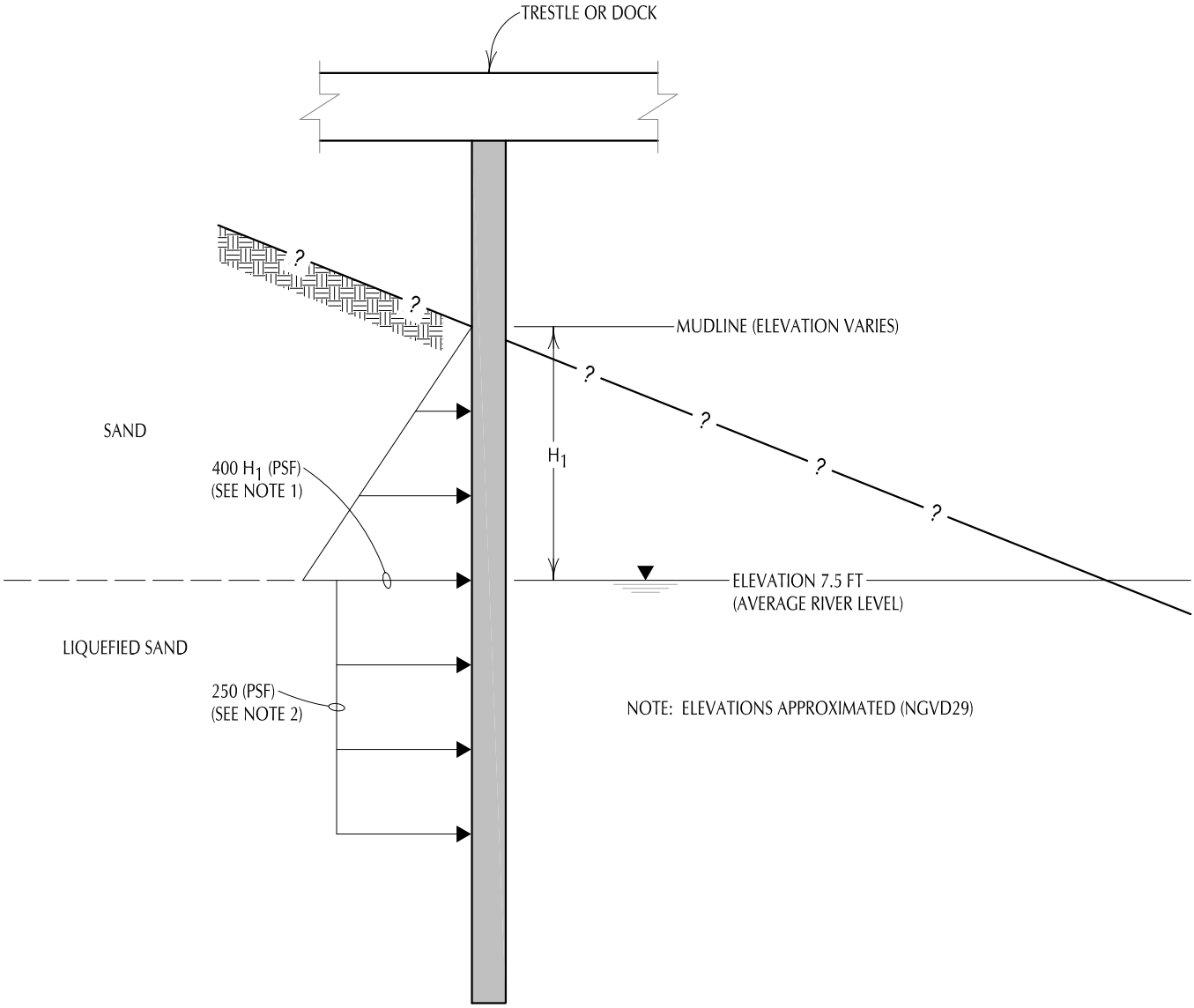
3) EXISTING PILE TIPS ESTIMATED TO RANGE FROM ELEVATION -69 TO -93 FT BASED ON AVAILABLE PILE DRIVING RECORDS.

GRI BERGERABAM TSVEDT DOCK STRUCTURE

BERTH 13 TRESTLE AND DOCK PROFILE

SEP. 2014 JOB NO. W1114-T3 FIG. 5

EX-0001-004009-PCE



NOTES:

1) ACTS OVER TWO PILE DIAMETERS.

2) ACTS OVER ONE PILE DIAMETER. LATERAL SPREADING FORCES ARE ASSUMED TO ACT ON THE PILES TO THE DEPTH SHOWN ON FIGURE 3.

3) FORCES ARE FOR CONTINGENCY LEVEL (475 YEAR RETURN PERIOD) AND DESIGN EARTHQUAKE (⅔ MCE) HAZARD LEVELS.

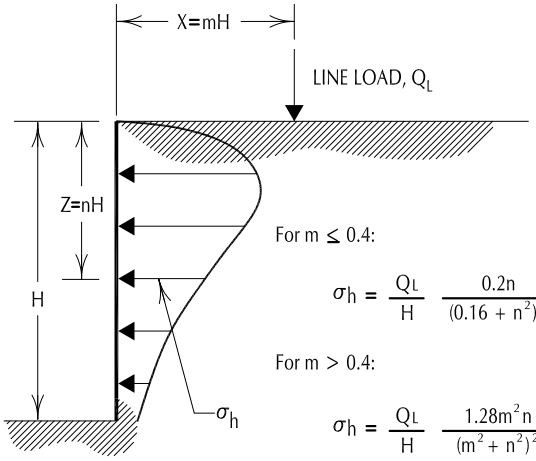
4) THE LATERAL SPREADING FORCES INDICATED ABOVE ARE FOR TRESTLE AND DOCK PILES ONLY. LATERAL SPREADING FORCES ON THE TRESTLE ABUTMENT WILL DEPEND ON THE GROUND IMPROVEMENT DESIGN WHICH HAS NOT BEEN COMPLETED AT THIS TIME.

GRI BERGERABAM
TSVEDT DOCK STRUCTURE

LATERAL SPREADING LOADS TRESTLE AND DOCK PILES

SEP. 2014 JOB NO. W1114-T3 FIG. 6

EX-0001-004011-PCE



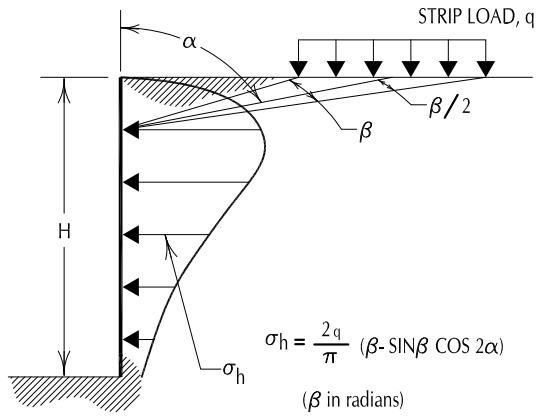
For $m \leq 0.4$:

$$\sigma_h = \frac{Q_L}{H} \frac{0.2n}{(0.16 + n^2)^2}$$

For $m > 0.4$:

$$\sigma_h = \frac{Q_L}{H} \frac{1.28m^2 n}{(m^2 + n^2)^2}$$

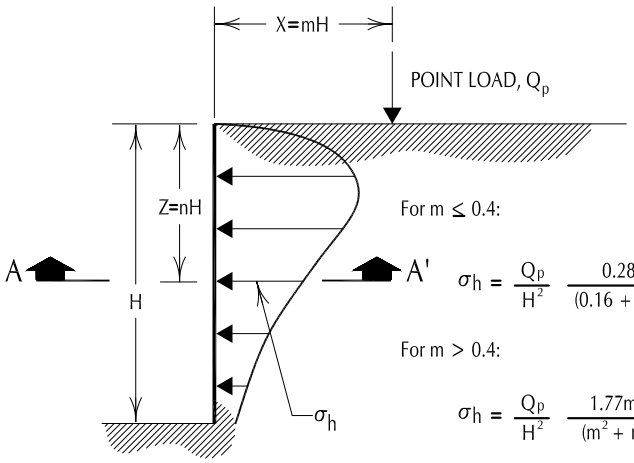
LINE LOAD PARALLEL TO WALL



$$\sigma_h = \frac{2q}{\pi} (\beta - \sin\beta \cos 2\alpha)$$

(β in radians)

STRIP LOAD PARALLEL TO WALL

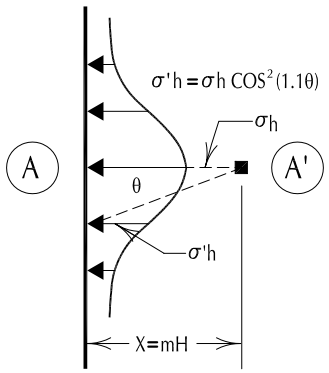


For $m \leq 0.4$:

$$\sigma_h = \frac{Q_p}{H^2} \frac{0.28n^2}{(0.16 + n^2)^3}$$

For $m > 0.4$:

$$\sigma_h = \frac{Q_p}{H^2} \frac{1.77m^2 n^2}{(m^2 + n^2)^3}$$



DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

1. THESE GUIDELINES APPLY TO RIGID WALLS WITH POISSON'S RATIO ASSUMED TO BE 0.5 FOR BACKFILL MATERIALS.

2. LATERAL PRESSURES FROM ANY COMBINATION OF ABOVE LOADS MAY BE DETERMINED BY THE PRINCIPLE OF SUPERPOSITION.

GRI BERGERABAM TSVEDT DOCK STRUCTURE

SURCHARGE-INDUCED LATERAL PRESSURE

SEP. 2014 JOB NO. W1114-T3 FIG. 7

EX-0001-004012-PCE

APPENDIX A

Field Explorations and Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

General

Subsurface materials and conditions in the marine terminal project area were investigated between July 29 and October 29, 2013 with four borings and one electric cone penetration test (CPT) probe. The approximate locations of the explorations are shown on Figure 2. An experienced geotechnical engineer from GRI directed the drilling and maintained a detailed log of the materials and conditions disclosed during the course of the work. The locations of the borings with respect to areas of the proposed facility are discussed below.

Borings

The borings were advanced to depths of approximately 80 to 104 ft with mud-rotary drilling methods. Borings B-23 through B-25 were completed using a truck-mounted drill rig provided and operated by Western States Soil Conservation of Hubbard, Oregon. Boring B-26 was completed using a track-mounted drill rig provided and operated by Hardcore Drilling Inc. of Dundee, Oregon. Disturbed and undisturbed soil samples were typically obtained at 2.5-ft intervals of depth in the upper 15 ft and at 5-ft intervals below this depth. Disturbed samples were obtained using a standard split-spoon sampler. At the time of sampling, the Standard Penetration Test was conducted. This test consists of driving a standard split-spoon sampler into the soil a distance of 18 in. using a 140-lb hammer dropped 30 in. The number of blows required to drive the sampler the last 12 in. is known as the standard penetration resistance, or N-value. The N-values provide a measure of the relative density of granular soils, such as sand or gravel, and the relative consistency, or stiffness, of cohesive soils, such as silt or clay. The split-spoon samples were carefully examined in the field and representative portions were saved in airtight jars. All samples were returned to our laboratory for further examination and physical testing.

Relatively undisturbed samples were obtained by pushing 3-in.-O.D. Shelby tubes into the undisturbed soil a maximum distance of 24 in. using the drill rig. The soils exposed in the ends of the Shelby tubes were examined and classified in the field. After classification, the ends of the tubes were sealed with plastic end caps and tape to preserve the natural moisture content of the soils. All samples were returned to our laboratory for further examination and testing.

Logs of the borings are provided on Figures 1A through 4A. Each log presents a descriptive summary of the various types of materials encountered in the boring and notes the depth at which the materials and/or characteristics of the materials change. To the right of the descriptive summary, the numbers and types of samples are indicated. Farther to the right, N-values are shown graphically, along with natural moisture contents and percent passing the No. 200 sieve. The terms used to describe the soils encountered in the borings are defined in Table 1A.

Electric Cone Penetration Test (CPT) Probes

One CPT probe, designated CPT-6, was advanced to practical refusal at a depth of about 83 ft below the ground surface using a truck-mounted Dutch Cone unit provided and operated by Vandehey Exploration,

Inc. of Banks, Oregon. The equipment is mounted on a truck and operated from within an enclosure on the back of the truck that houses the electrical equipment. The electrical cone probe has a cone and a sleeve that are similar to a mechanical probe, but the forces are measured electronically. In addition to the cone and sleeve transducers, a piezometer is fitted between the cone and the sleeve, which allows measurement of pore water pressure and rate of dissipation as the probe is advanced. An accelerometer can also be fitted within the electrical probe. The accelerometer is used to measure the arrival times of shear waves produced at the ground surface as the exploration is advanced. Using these measurements, the shear wave velocity of the soils penetrated can be estimated. The shear wave velocities characterize the soils for the purpose of seismic studies. Shear wave measurements were made during advancement of probe CPT-6. The terms used to describe the soils encountered in the CPT probes are defined in Table 2A. A log of the CPT probe is provided on Figure 5A.

LABORATORY TESTING

General

All samples obtained from the field were returned to our laboratory where the physical characteristics of the samples were noted, and the field classifications were modified where necessary. At the time of classification, the natural moisture content of each sample was measured. Additional testing included washed sieve analysis, sieve analysis, and dry unit weight determinations. The following sections describe the testing program in more detail.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM D 2216. The results are provided on Figures 1A through 4A.

Dry Unit Weight

The dry unit weight of four undisturbed samples was determined in the laboratory in accordance with ASTM D 2937 by cutting a cylindrical specimen of soil from a Shelby tube sample. The dimensions of the specimen were carefully measured, the volume calculated, and the specimen weighed. After oven-drying, the specimen was reweighed and the moisture content calculated. The dry unit weight was then computed. The dry unit weights are summarized below.

SUMMARY OF DRY UNIT WEIGHT DETERMINATIONS

Boring	Sample	Depth, ft	Natural Moisture Content, %	Dry Unit Weight, pcf	Soil Type
B-24	S-18	70	29	88	SAND; fine grained, trace silt
B-26	S-12	40	39	80	SAND; some silt, scattered wood debris
	S-14	45	34	81	SAND; some silt, scattered wood debris
	S-16	50	31	90	SAND; some silt, scattered wood debris

Grain Size Analysis

Washed-Sieve Method. Washed sieve analyses were performed on representative soil samples to assist in their classification. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed, and the percentage of material passing the No. 200 sieve is calculated. The test results are shown on the Boring Logs, Figures 1A through 4A.

Dry Sieve Method. Sieve analyses were performed on five representative samples of sand in substantial conformance with ASTM D 6913. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed, and the percentage of material passing the No. 200 sieve is calculated. The soil retained on the No. 200 sieve is then screened through a series of sieves of various sizes using a sieve shaker. The weight of each sieve is measured prior to and after the soil has been run through the shaker. The weight of the soil retained on each sieve is recorded and expressed as a percentage of the total sample weight. The test data are summarized on Figures 6A and 7A in the form of curves showing the percent of the total soil sample by weight finer versus sieve number or grain size in millimeters.

Table 1A: GUIDELINES FOR CLASSIFICATION OF SOIL

RELATIVE DENSITY FOR GRANULAR SOIL

Relative Density	Standard Penetration Resistance (N-values) blows per foot
very loose	0 - 4
loose	4 - 10
medium dense	10 - 30
dense	30 - 50
very dense	over 50

CONSISTENCY FOR FINE-GRAINED (COHESIVE) SOIL

Consistency	Standard Penetration Resistance (N-value) blows per foot	Torvane or Undrained Shear Strength, tsf
very soft	0 - 2	less than 0.125
soft	2 - 4	0.125 - 0.25
medium stiff	4 - 8	0.25 - 0.50
stiff	8 - 15	0.50 - 1.0
very stiff	15 - 30	1.0 - 2.0
hard	over 30	over 2.0

Sandy silt materials which exhibit general properties of granular soils are given relative density description.

Grain-Size Classification	Modifier for Subclassification	
	Adjective	Percentage of Other Material In Total Sample
Boulders >12 in.		
Cobbles 3 - 12 in.	clean	0 - 2
Gravel 1/4 - 3/4 in. (fine)	trace	2 - 10
3/4 - 3 in. (coarse)	some	10 - 30
Sand No. 200 - No. 40 sieve (fine) No. 40 - No. 10 sieve (medium) No. 10 - No. 4 sieve (coarse)	sandy, silty, clayey, etc.	30 - 50
Silt/Clay - pass No. 200 sieve		

GRI

Table 2A

SOIL CLASSIFICATION
BASED ON CONE PENETRATION TEST

Friction Ratio (Percent)	Soil Classification
0 to 2	Clean sand or slightly silty sand
2 to 5	Silty sand, clayey sand, or silt
> 5	Clayey silt, silty clay, or clay

COHESIVE SOILS

Sleeve Friction, tsf	Relative Consistency
<0.12	Very Soft
0.12 to 0.25	Soft
0.25 to 0.50	Medium Stiff
0.50 to 1.00	Stiff
1.00 to 2.00	Very Stiff
>2.00	Hard

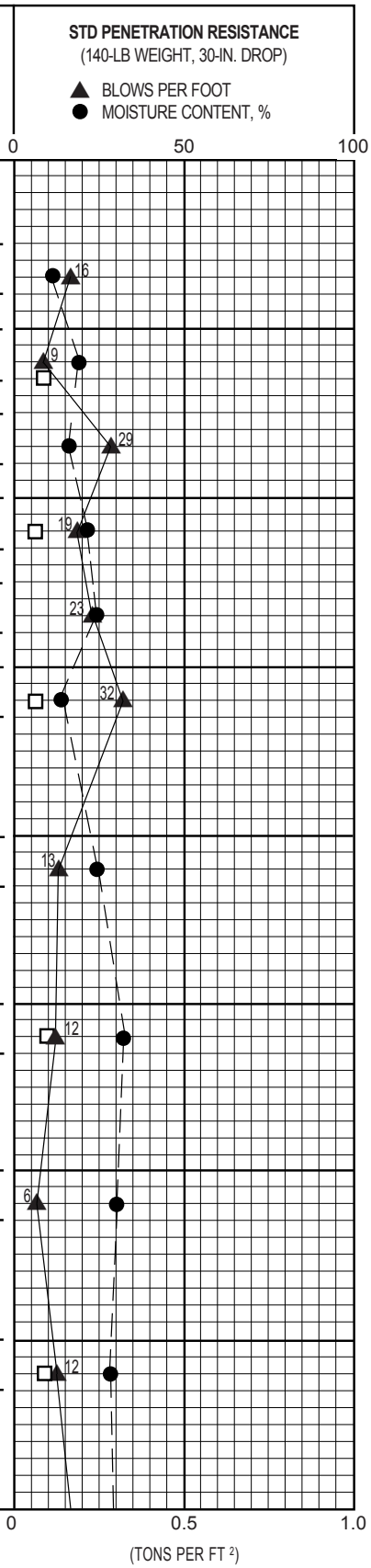
COHESIONLESS SOILS

	Soil Type*			
	ML, SM	SM, SP, SW	SP, SW, GW	SW, GP
Relative Density	**Cone Penetration Resistance, tsf**			
Very Loose	0 - 8	0 - 14	0 - 20	0 - 24
Loose	8 - 20	14 - 35	20 - 50	24 - 60
Med. Dense	20 - 60	35 - 105	50 - 150	60 - 180
Dense	60 - 100	105 - 175	150 - 250	180 - 300
Very Dense	> 100	> 175	> 250	> 300

* Unified Soil Classification System

1) Friction ratio is equal to sleeve friction (tsf) divided by cone penetration (tsf) expressed as a percent.

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
		Asphaltic-concrete PAVEMENT (4 in.) over crushed rock BASE COURSE (10 in.)	1.2		
		FILL: Loose to medium dense, brown SAND; fine to medium grained, trace silt and gravel			S-1
5					S-2
		----------medium dense below 7.5 ft			S-3
10					S-4
		----------gray below 12.5 ft			S-5
		----------scattered wood debris at 13.8 ft			
15		----------4-in.-thick layer of sandy silt at 15 ft			S-6
20			20.0		
		Medium dense, gray SAND; fine to medium grained, trace silt, 1-in.-thick layer of silt at 20.1 ft			S-7
25		----------brown, trace to some silt below 25 ft			S-8
30		----------loose, trace silt below 30 ft			S-9
		----------medium dense, fine grained below 32 ft			
35					S-10
40					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

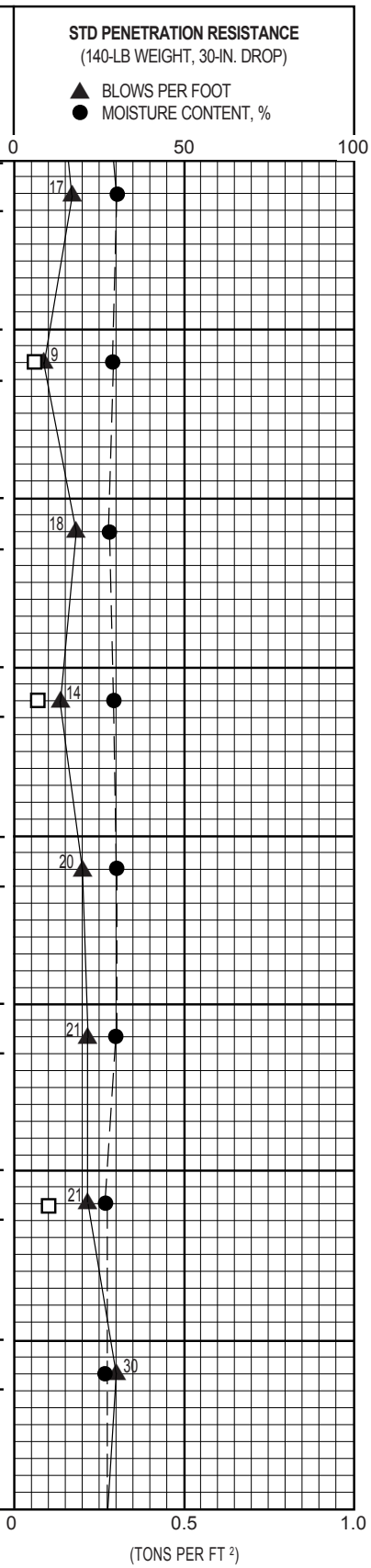
GRI

BORING B-23

SEP. 2014 JOB NO. W1114 FIG. 1A

EX-0001-004019-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, brown SAND; fine to medium grained, trace silt			S-11
45		----------loose, gray below 45 ft			S-12
50		----------medium dense below 50 ft			S-13
55					S-14
60					S-15
65					S-16
70		----------trace to some silt below 70 ft			S-17
75					S-18
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

GRI

BORING B-23 (cont.)

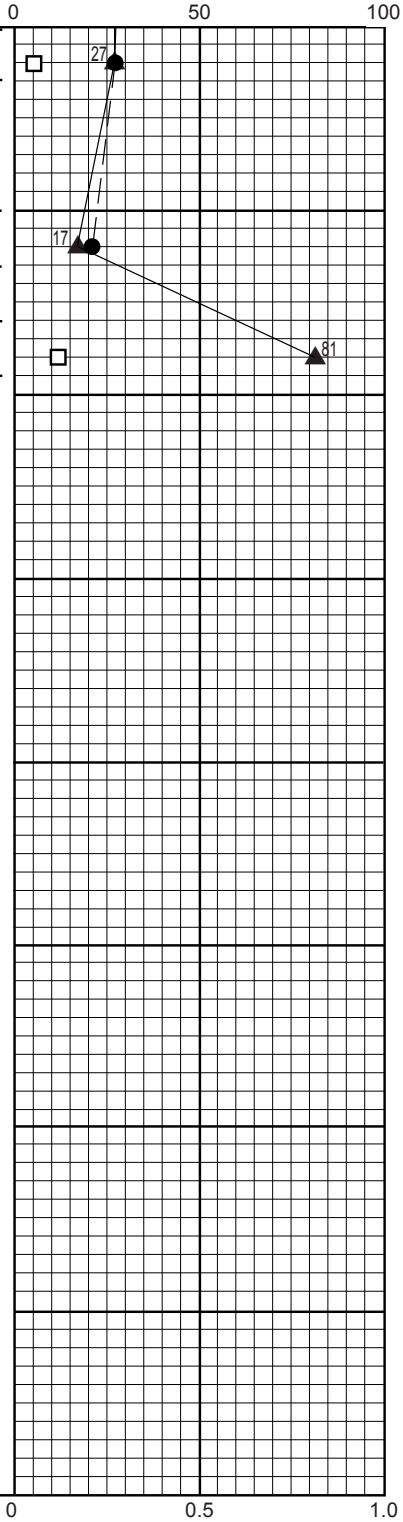
SEP. 2014 JOB NO. W1114 FIG. 1A

EX-0001-004020-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
80		Medium dense, gray SAND; fine grained, trace silt			S-19
85		----------fine to medium grained below 85 ft; scattered gravel below 85.5 ft			S-20
			87.0		
		Very dense GRAVEL; trace to some silt and fine- to coarse-grained sand			S-21
90		(7/29/2013)	89.5		
95					

STD PENETRATION RESISTANCE
(140-LB WEIGHT, 30-IN. DROP)

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %



2-IN.-OD SPLIT-SPOON SAMPLER
3-IN.-OD THIN-WALLED SAMPLER
G GRAB SAMPLE OF DRILL CUTTINGS
NX CORE RUN
SLOTTED PVC PIPE
Water Level (date)

◆ TORVANE SHEAR STRENGTH, TSF
□ PERCENT PASSING NO. 200 SIEVE (WASHED)
* NO RECOVERY

Liquid Limit
Moisture Content
Plastic Limit

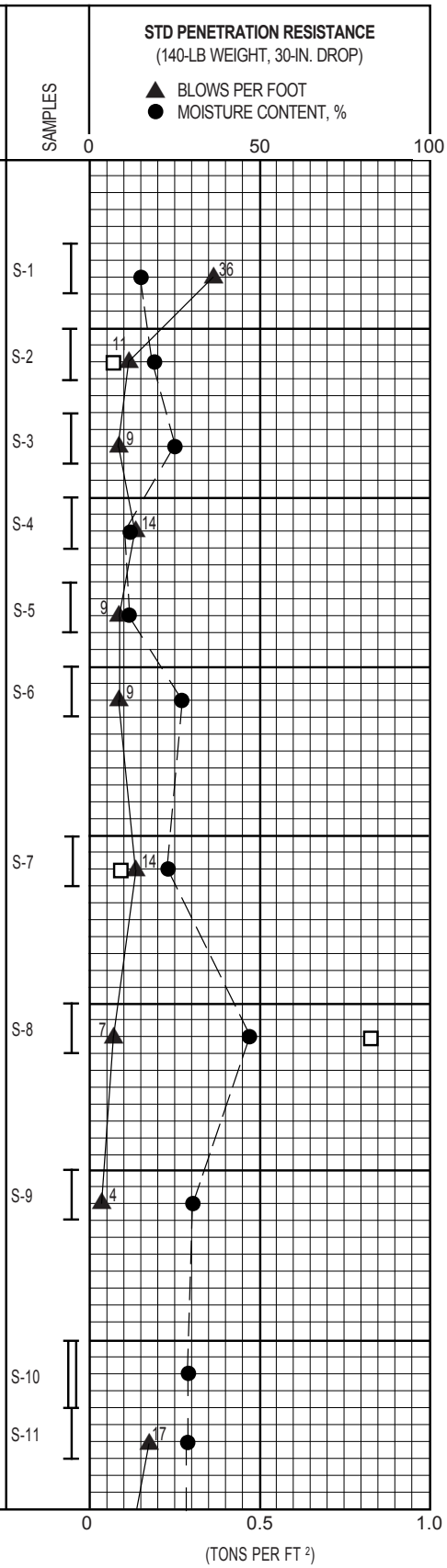
GRI

BORING B-23 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 1A

EX-0001-004021-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
		FILL: Dense, gray, gravelly SAND; fine to coarse grained, trace silt		
5		---------loose to medium dense, gravel absent below 5 ft, trace organics at 5 ft		
10				
15				
20				
25		Medium stiff, gray SILT; some fine-grained sand	25.0	
30		Loose to medium dense, gray SAND; fine grained, trace to some silt -------4-in.-thick sandy silt layer at 31 ft	30.0	
35		---------up to 1-in.-thick silt layers between 35 and 37 ft ---------brown, silty below 37 ft		
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

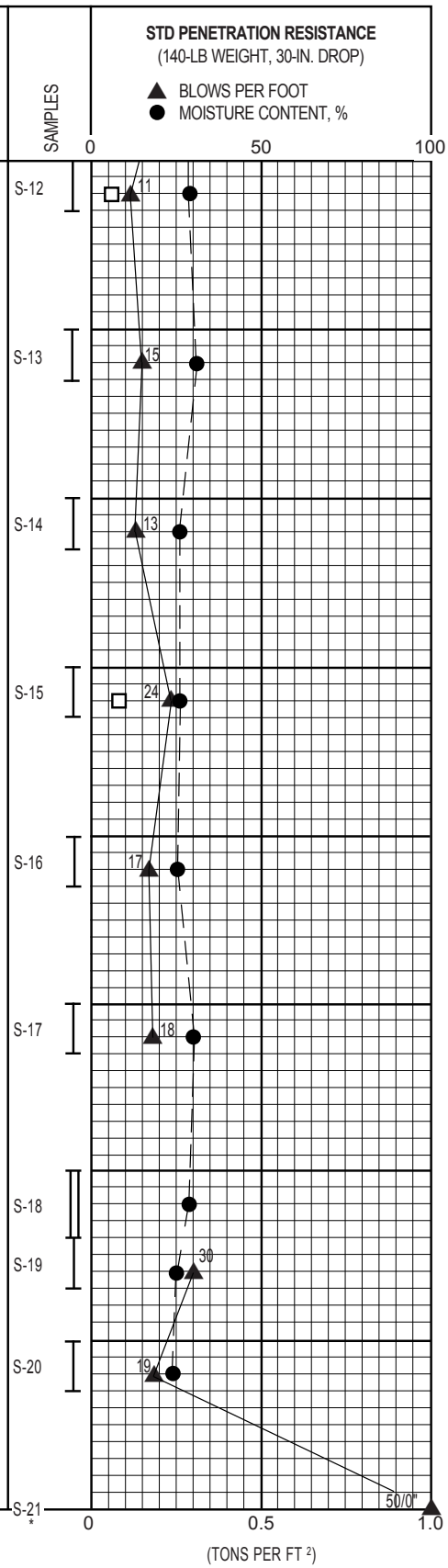
GRI

BORING B-24

SEP. 2014 JOB NO. W1114 FIG. 2A

EX-0001-004022-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, brown SAND; fine grained, trace silt -------gray below 41 ft			S-12
45					S-13
50					S-14
55					S-15
60					S-16
65					S-17
70		----------medium dense to dense, reddish gray, fine to coarse grained below 72.5 ft			S-18 S-19
75					S-20
			78.0		
80		Very dense GRAVEL (7/31/2013)	80.0		S-21 *



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

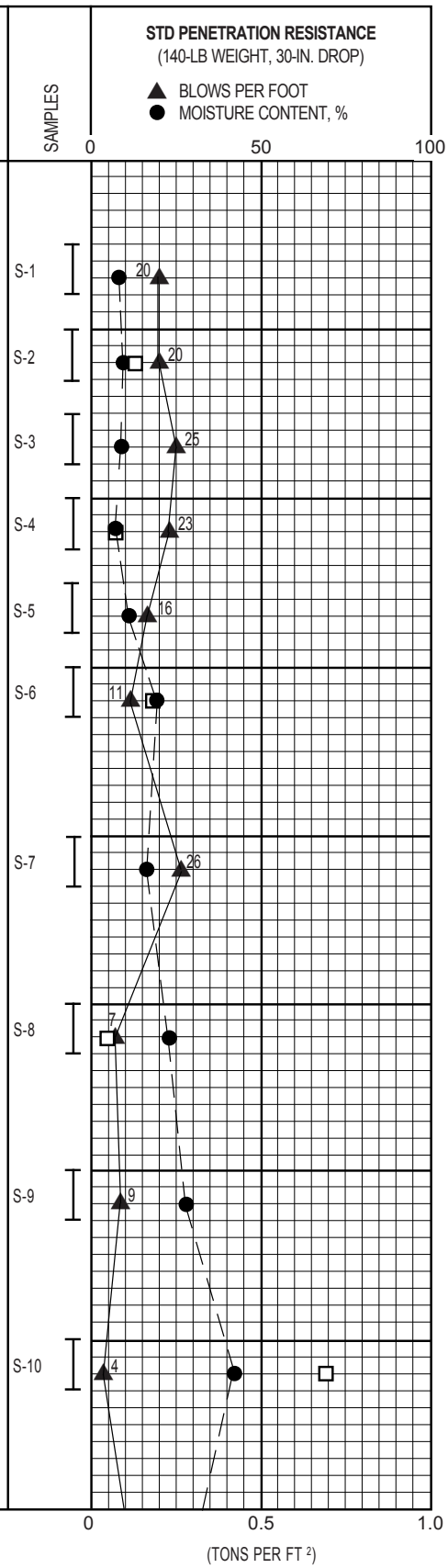
GRI

BORING B-24 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 2A

EX-0001-004023-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER
		Asphaltic-concrete PAVEMENT (12 in.) over crushed rock BASE COURSE (24 in.)		
		FILL: Medium dense, light brown SAND; fine grained, trace rounded gravel, trace silt	3.0	
5		-------gray and brown below 5 ft		
		----------1-in.-thick silt layer at 6.5 ft		
10				
15				
20				
25		Loose, dark gray SAND; fine grained, trace silt	25.0	
30				
35		Medium stiff, dark gray, sandy SILT; fine-grained sand	35.0	
			36.0	
		Loose, dark gray SAND; fine to medium grained, trace to some silt		
40				



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

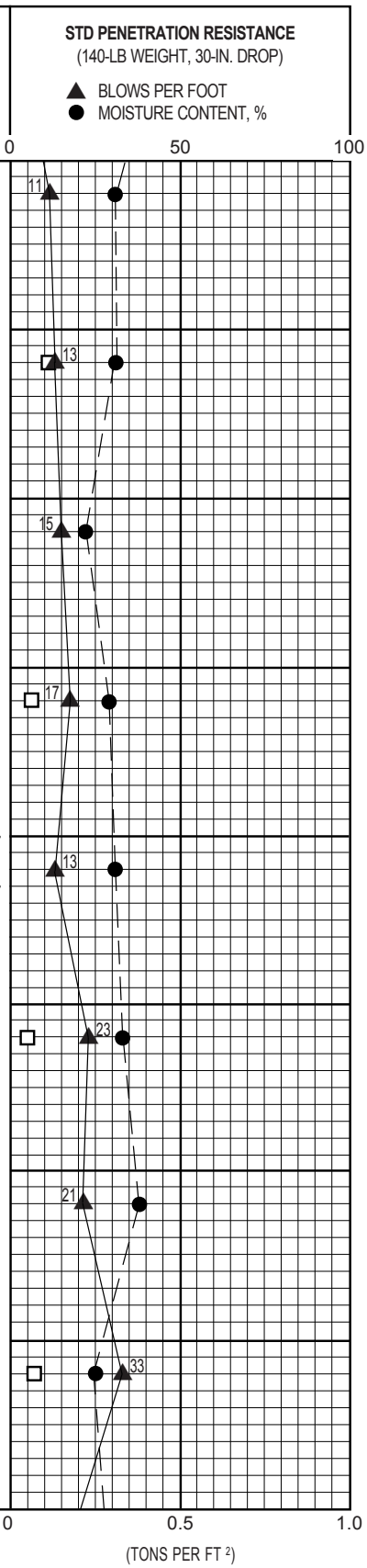
GRI

BORING B-25

SEP. 2014 JOB NO. W1114 FIG. 3A

EX-0001-004024-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 27 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
40		Medium dense, dark gray SAND; fine to medium grained, trace to some silt, trace gravel			S-11
45					S-12
50		----------fine to coarse grained below 50 ft			S-13
55					S-14
60					S-15
65					S-16
70					S-17
75		----------dense below 75 ft			S-18
80					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

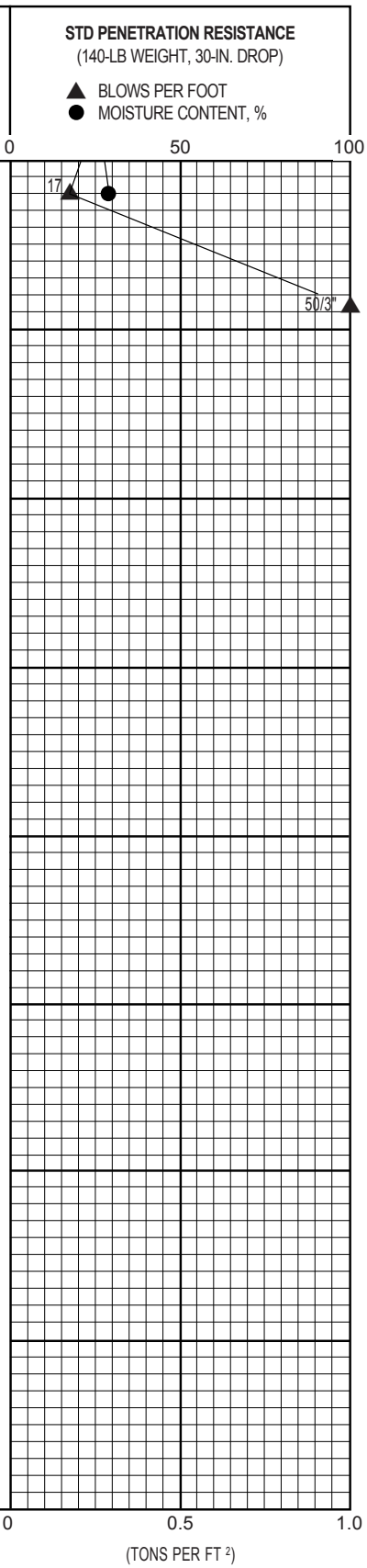
GRI

BORING B-25 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 3A

EX-0001-004025-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	GROUNDWATER	SAMPLES
		SURFACE ELEVATION 27 ft (±)			
80		Medium dense, dark gray SAND; fine to coarse grained, trace silt			S-19
			82.0		
		Very dense GRAVEL; scattered cobbles			
			84.3		S-20
85		(7/30/2013)			



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

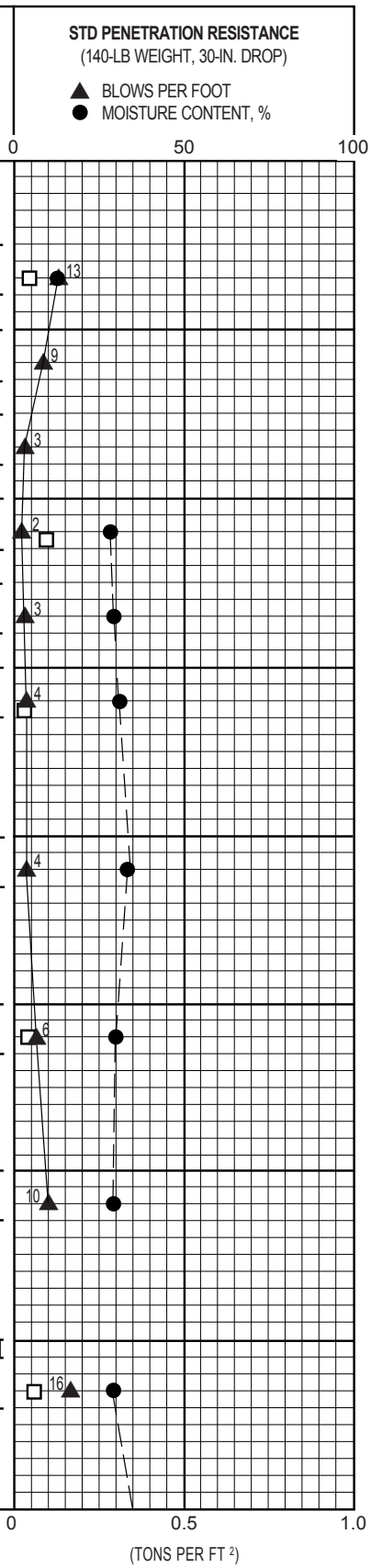
GRI

BORING B-25 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 3A

EX-0001-004026-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 7 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
		Medium dense, gray SAND; fine to medium grained, trace silt, scattered gravel			
		----------1-ft-thick layer of gravel at 4 ft			S-1
5		----------very loose to loose below 5 ft			S-2
					S-3 *
10		----------fine to coarse grained at 10 ft			S-4
					S-5
15					S-6
20		----------3-in.-thick layer of gray silt at 20.5 ft			S-7
25		----------scattered wood debris below 25 ft			S-8
30		----------medium dense below 30 ft, fine to coarse grained at 30 ft			S-9
35					S-10 *
					S-11
40					



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

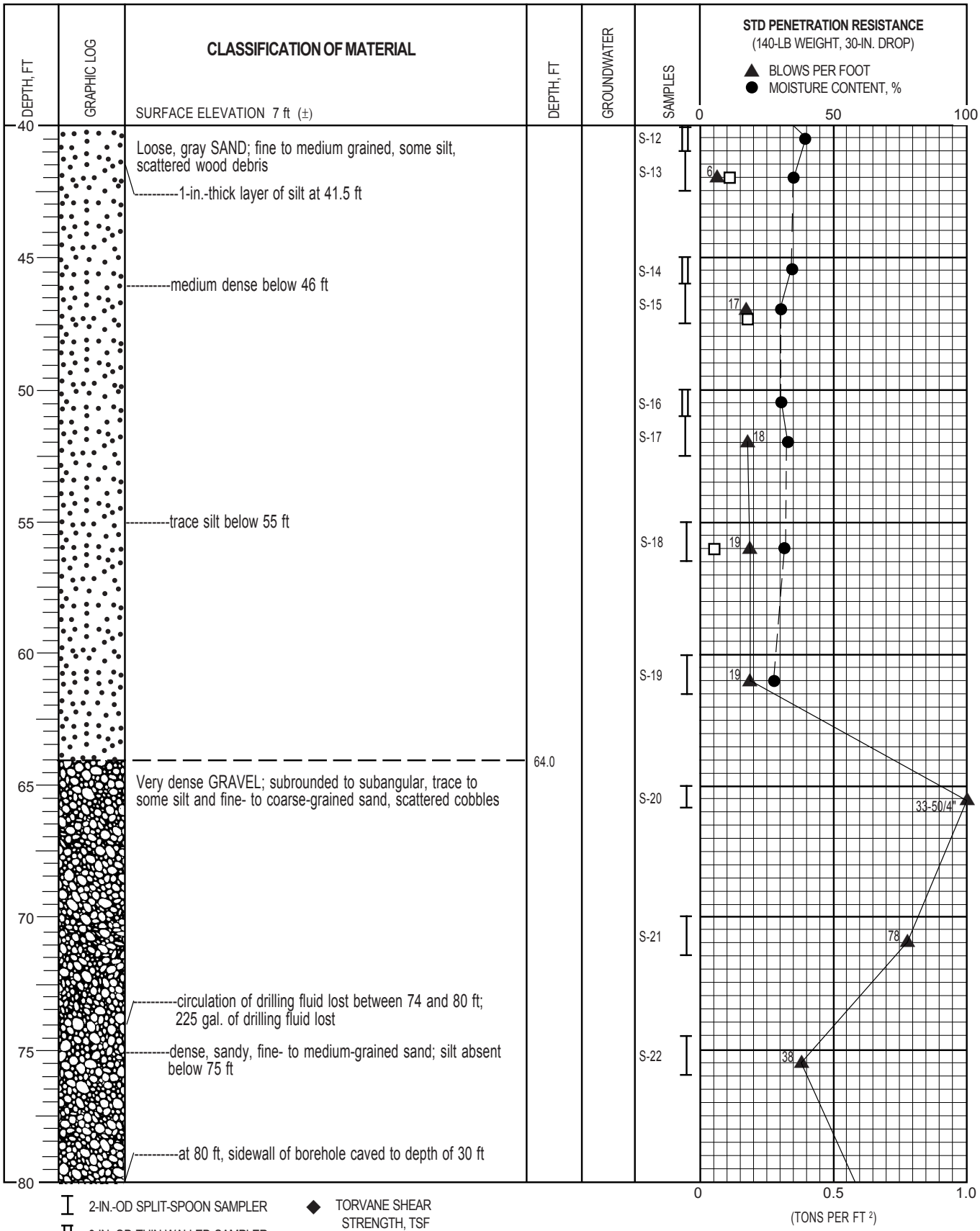
Plastic Limit

GRI

BORING B-26

SEP. 2014 JOB NO. W1114 FIG. 4A

EX-0001-004027-PCE



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

Plastic Limit

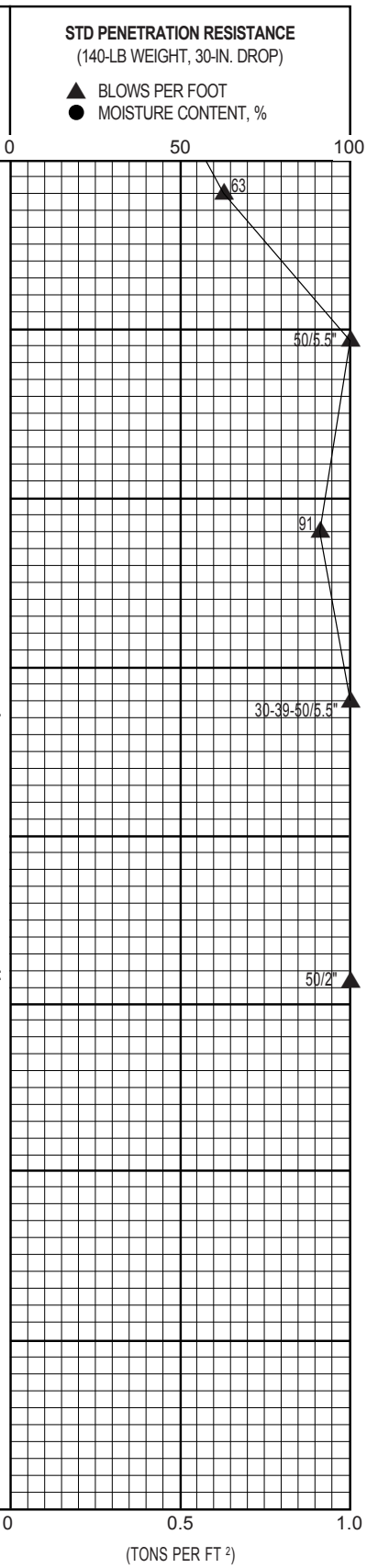
GRI

BORING B-26 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 4A

EX-0001-004028-PCE

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL SURFACE ELEVATION 7 ft (±)	DEPTH, FT	GROUNDWATER	SAMPLES
80		Very dense GRAVEL; subrounded to subangular, trace to some fine- to coarse-grained sand, trace silt, scattered cobbles			S-23
85					S-24
90					S-25
95					S-26
100					
			104.2		S-27
105		(10/29/2013) 5.5-in.-diameter casing installed to 20 ft as part of drilling permit requirements			



2-IN.-OD SPLIT-SPOON SAMPLER

3-IN.-OD THIN-WALLED SAMPLER

G GRAB SAMPLE OF DRILL CUTTINGS

NX CORE RUN

SLOTTED PVC PIPE

Water Level (date)

TORVANE SHEAR STRENGTH, TSF

PERCENT PASSING NO. 200 SIEVE (WASHED)

* NO RECOVERY

Liquid Limit

Moisture Content

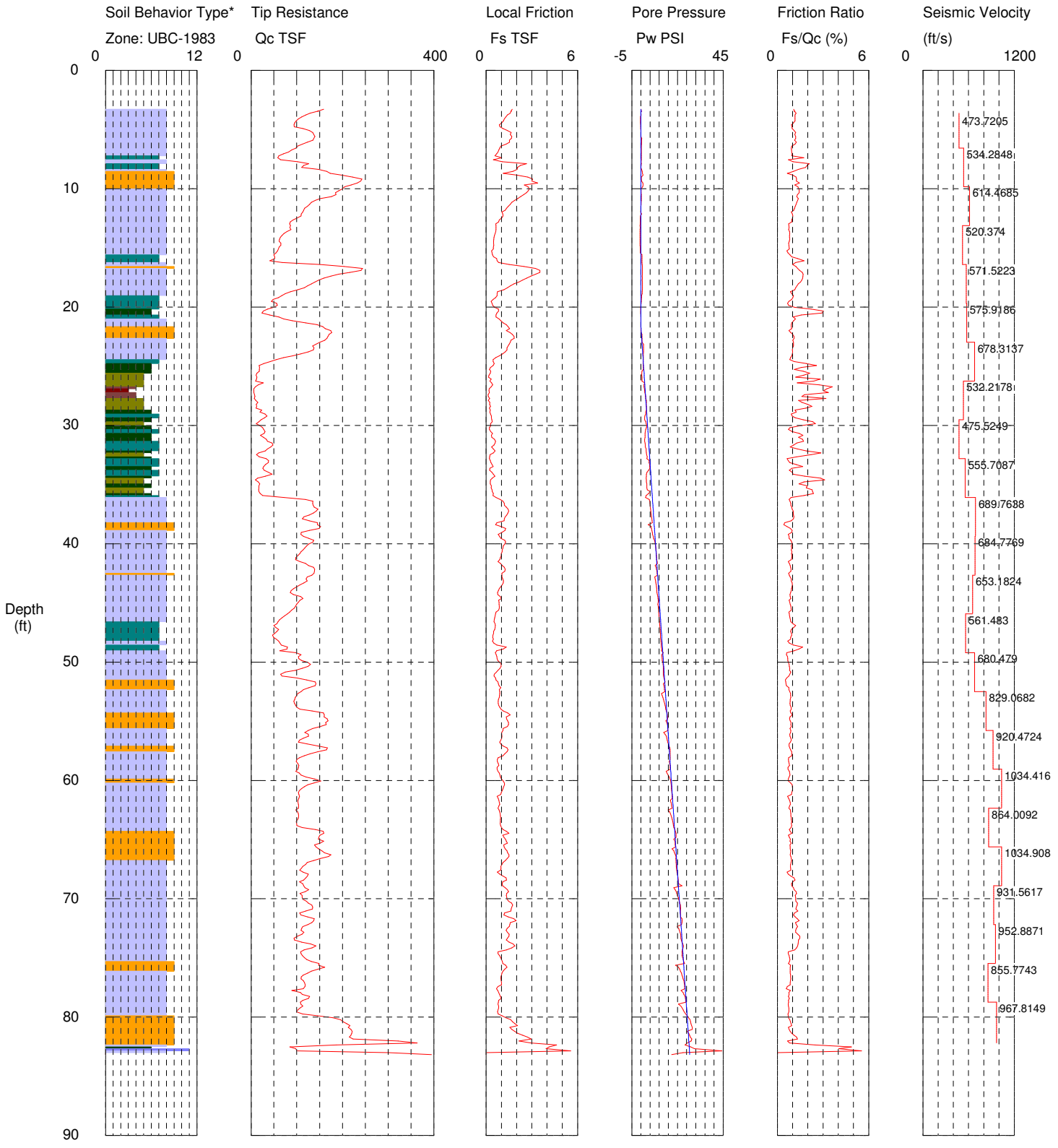
Plastic Limit

GRI

BORING B-26 (cont.)

SEP. 2014 JOB NO. W1114 FIG. 4A

EX-0001-004029-PCE



SURFACE ELEVATION = 27 FT

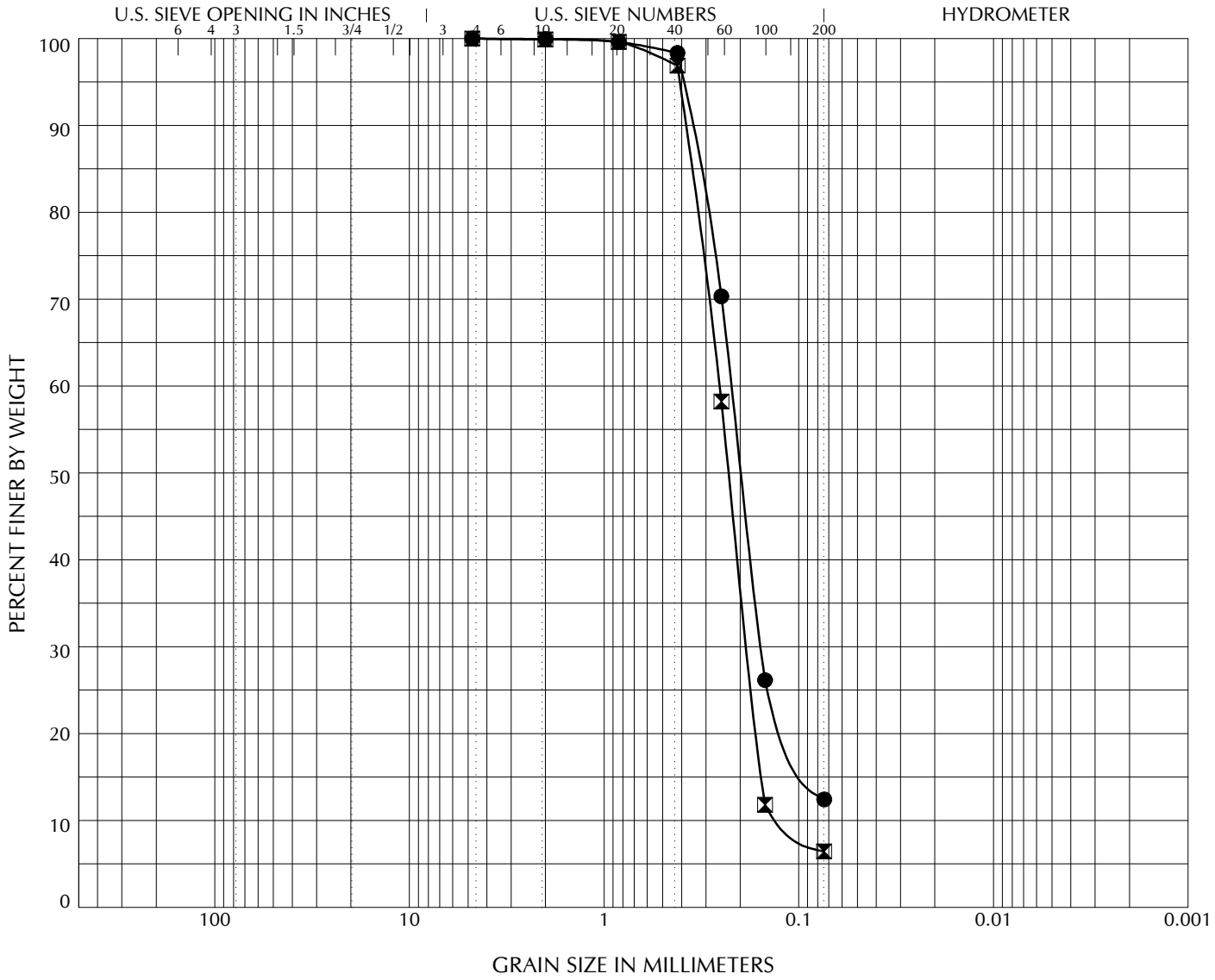
GRI

CONE PENETRATION TEST CPT-6

(WITH SEISMIC VELOCITY)

SEP. 2014 JOB NO. W1114 FIG. 5A

EX-0001-004030-PCE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

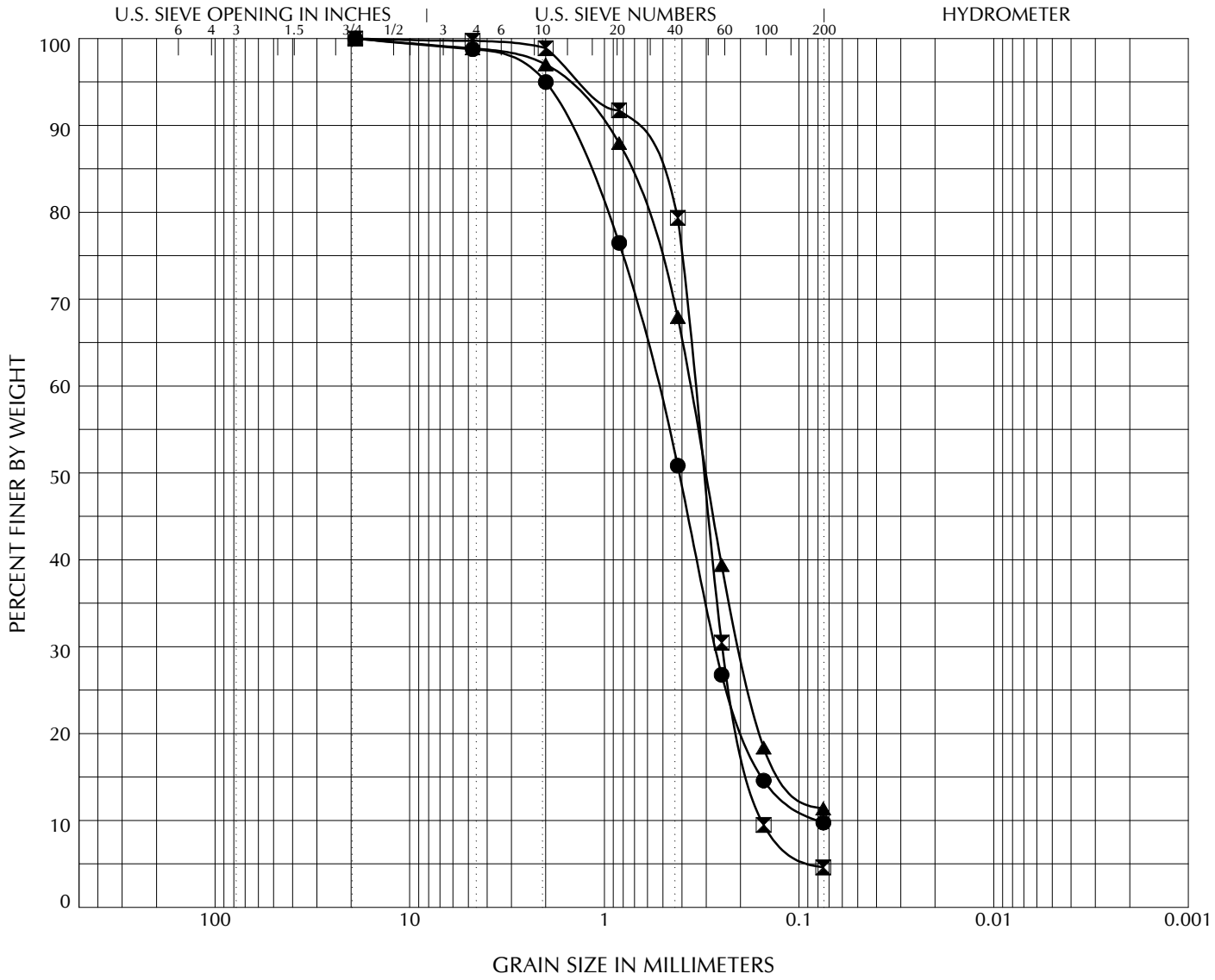
	Location	Sample	Depth, ft	Classification	Gravel, %	Sand, %	Fines, %
●	B-23	S-8	25.0	SAND; fine to medium grained, some silt	0.0	87.3	12.7
⧗	B-23	S-12	45.0	SAND; fine grained, trace silt	0.0	93.5	6.5

GRI

GRAIN SIZE DISTRIBUTION

SEP. 2014 JOB NO. W1114 FIG. 6A

GRAIN SIZE GRI-TWO PER PAGE W1114-LAB.GPJ GRI DATA TEMPLATE.GDT 2/3/14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	Coarse	Fine	Coarse	Medium	Fine	

	Location	Sample	Depth, ft	Classification	Gravel, %	Sand, %	Fines, %
●	B-26	S-4	10.0	Gray SAND; fine to coarse grained, trace silt	1.2	89.0	9.8
⊠	B-26	S-8	25.0	Gray SAND; fine to medium grained, trace silt, scattered wood debris	0.3	95.2	4.6
▲	B-26	S-13	41.0	Gray SAND; fine to medium grained, some silt, scattered wood debris	1.1	87.5	11.4

GRI

GRAIN SIZE DISTRIBUTION

SEP. 2014 JOB NO. W1114-T3 FIG. 7A

GRAIN SIZE GRI-THREE PER PAGE W1114-T3 LAB.GPJ GRI DATA TEMPLATE.GDT 6/4/14

APPENDIX B

Site-Specific Seismic Hazard Study

APPENDIX B

SITE-SPECIFIC SEISMIC HAZARD STUDY

General

GRI has completed a site-specific seismic hazard study for the docks at the proposed Tesoro Savage Vancouver Energy Distribution Terminal - Upland Facility (TSVEDT) in Vancouver, Washington. The purpose of the study was to evaluate the potential seismic hazards associated with regional and local seismicity. The site-specific hazard study is intended to meet the requirements of the upcoming American Society of Civil Engineers (ASCE) *Seismic Design of Pile-Supported Piers and Wharves* in compliance with the requirements of ASCE 7-05 Chapter 21. Our work was based on the potential for regional and local seismic activity, as described in the existing scientific literature, and on the subsurface conditions at the site, as disclosed by the geotechnical explorations completed for the project. Specifically, our work included the following tasks:

1) A detailed review of available literature, including published papers, maps, open-file reports, seismic histories and catalogs, and other sources of information regarding the tectonic setting, regional and local geology, and historical seismic activity that might have a significant effect on the site.

2) Compilation, examination, and evaluation of existing subsurface data gathered at and in the vicinity of the site, including classification and laboratory analyses of soil samples. This information was used to prepare a generalized subsurface profile for the docks on the TSVEDT property.

3) Identification of potential seismic sources appropriate for the site and characterization of those sources in terms of magnitude, distance, and acceleration response spectra.

4) Office studies, based on the generalized subsurface profile and the controlling seismic sources, resulting in conclusions and recommendations concerning:

    a) specific seismic events and characteristic earthquakes that might have a significant effect on the Docks;

    b) the potential for seismic energy amplification at the Docks; and

    c) site-specific acceleration response spectra for design of the Docks

This appendix describes the work accomplished and summarizes our conclusions and recommendations.

Geologic Setting

General. On a regional scale, the site lies within the Willamette-Puget Sound lowland trough of the Cascadia convergent tectonic system (Blakely et al., 2000). The lowland areas consist of broad north-south-trending basins in the underlying geologic structure between the Coast Range to the west and the Cascade Mountains to the east. The lowland trough is characterized by alluvial plains with areas of buttes and terraces. The site lies approximately 95 km inland from the down-dip edge of the seismogenic extent

of the Cascadia Subduction Zone (CSZ), an active convergent plate boundary along which remnants of the Farallon Plate (the Gorda, Juan de Fuca, and Explorer plates) are being subducted beneath the western edge of the North American continent. The subduction zone is a broad, eastward-dipping zone of contact between the upper portion of the subducting slabs and the over-riding North American Plate as shown on Figure 1B.

On a local scale, the site lies within the Portland Basin, a large, well-defined, northwest-trending structure characterized as a right-lateral pull-apart basin in the forearc of the CSZ. The Portland Basin is bounded by high-angle, northwest-trending, right-lateral strike-slip faults that are considered to be seismogenic; however, the relationship between specific earthquakes and individual faults in the area is not well understood since few of these faults are expressed clearly at the ground surface. A limited number of intrabasin faults have been mapped on the basis of stratigraphic offsets and geophysical evidence, and the site is located in close proximity to the inferred traces of the Portland Hills Fault and the East Bank Fault indicated on published geologic mapping (Personius et al., 2003). The distribution of these crustal faults relative to the site is shown on the Regional Geologic Map and Local Fault Map, Figures 2B and 3B, respectively. The locations of faults on the geologic map are inferred or approximate. Other faults may be present within the basin, but clear stratigraphic evidence regarding their location and extent is not presently available.

Because of the proximity of the site to the CSZ and its location within the Portland Basin, three seismic sources contribute to the potential for damaging earthquake motions at the site. Two of these sources are associated with tectonic activity related to the Cascadia Subduction Zone, the third is associated with movement on relatively shallow faults within and adjacent to the Portland Basin.

Site Soil and Geologic Conditions. The dock site is covered by alluvial sand and silt deposited by the Columbia River. The alluvium extends to variable depths, ranging from 16 ft at the T-section of the docks to 64 ft at pier 3 of the trestle. The sand and silt deposits are underlain by gravel associated with late Pleistocene catastrophic flood materials deposited by repeated Missoula Flood events that occurred between 13,500 and 15,000 years ago. Geologic investigations for the proposed Interstate 5 bridge replacement, about 3 miles upstream from the project site, indicate the gravel on the Washington side of the Columbia River can be up to 100 ft thick. The flood deposits are underlain by well-consolidated or cemented conglomerate and sandstone units of the Troutdale Formation (Pliocene), which are, in turn, underlain by the Sandy River Mudstone bedrock (Miocene to Pliocene; Beeson et al., 1991; Trimble, 1963).

Seismicity

General. The geologic and seismologic information available for identifying the potential seismicity at the site is incomplete, and large uncertainties are associated with estimates of the probable magnitude, location, and frequency of occurrence of earthquakes that might affect the site. The available information indicates the potential seismic sources that may affect the site can be grouped into three independent categories: *subduction zone events* related to sudden slip between the upper surface of the Juan de Fuca plate and the lower surface of the North American plate, *subcrustal (intraslab) events* related to deformation and volume changes within the deeper portion of the subducted Juan de Fuca plate, and *local crustal events* associated with movement on shallow, local faults within and adjacent to the Portland Basin. Based on our review of currently available information, we have developed parameters for each of these

potential seismic sources. The seismic sources are characterized by three important parameters: magnitude, distance to the subject site, and the peak horizontal bedrock accelerations produced by the controlling earthquake on the seismic source. The size of an earthquake is commonly defined by its moment magnitude M_W. Distance is measured using the closest horizontal distance to the surface projection of the rupture plane or the closest distance to the rupture plane, in kilometers. Peak horizontal bedrock accelerations are expressed in units of gravity (1 g = 32.2 ft/sec^2 = 981 cm/sec^2).

Subduction Zone Event. Written Japanese tsunami records provide evidence that a great CSZ earthquake occurred in January 1700. Geological studies show that great megathrust earthquakes have occurred repeatedly in the past 7,000 years (Atwater et al., 1995; Clague, 1997; Goldfinger, 2003; and Kelsey et al., 2005), and geodetic studies (Hyndman and Wang, 1995; Savage et al., 2000) indicate rate of strain accumulation consistent with the assumption that the CSZ is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia (Fluck et al., 1997; Wang et al., 2001). Numerous geological and geophysical studies suggest the CSZ may be segmented (Hughes and Carr, 1980; Weaver and Michaelson, 1985; Guffanti and Weaver, 1988; Goldfinger, 1994; Kelsey and Bockheim, 1994; Mitchell et al., 1994; Personius, 1995; Nelson and Personius, 1996; Witter, 1999), but the most recent studies suggest that for the last great earthquake in 1700, most of the subduction zone ruptured in a single M_w 9 earthquake (Satake et al., 1996; Atwater and Hemphill-Haley, 1997; Clague et al., 2000). Published estimates of the probable maximum size of subduction zone events range from moment magnitude M_W 8.3 to >9.0. Numerous detailed studies of coastal subsidence, tsunamis, and turbidites yield a wide range of recurrence intervals, but the most complete records (>4,000 years) indicate average intervals of 350 to 600 years between great earthquakes on the CSZ (Adams, 1990; Atwater and Hemphill-Haley, 1997; Witter, 1999; Clague et al., 2000; Kelsey et al., 2002; Kelsey et al., 2005; Witter et al., 2003). Tsunami inundation in buried marshes along the Washington and Oregon coast and stratigraphic evidence from the Cascadia margin support these recurrence intervals (Kelsey et al., 2005; Goldfinger, 2003).

The USGS probabilistic analysis assumes four potential locations for the eastern edge of the earthquake rupture zone for the CSZ, as shown in Figure 4B. The 2008 USGS mapping effort indicates two rupture scenarios are assumed to represent these megathrust events: 1) M_W 9.0±0.2 events that rupture the entire CSZ every 500 years and 2) M_W 8.0 to 8.7 events with rupture zones that occur on segments of the CSZ and occur over the entire length of the CSZ during a period of about 500 years (Petersen et al., 2008). The assumed distribution of earthquake magnitudes is shown on Figure 5B. This distribution assumes the larger M_W 9.0 earthquakes likely occur more often than the smaller segmented ruptures. Therefore, for our deterministic analysis, we have chosen to represent the subduction zone event by a design earthquake of M_W 9.0 at a focal depth of 15 km and a rupture distance of 86 km. This corresponds to a sudden rupture of the entire length of the Juan de Fuca-North American plate interface with an assumed rupture zone along the coastline due west of Vancouver. Based on an average of the attenuation relationships published by Zhao (2006), Atkinson and Macias (2009), and Abrahamson, et al. (2012), a subduction zone earthquake with these parameters would result in an average peak bedrock acceleration of approximately 0.19 g at the project site.

Subcrustal Event. There is no historic earthquake record of subcrustal, intraslab earthquakes in Southwest Washington. Although both the Puget Sound and Northern California regions have experienced many of these earthquakes in historic times, Wong (2005) hypothesizes that due to subduction zone geometry, geophysical conditions and local geology, Southwest Washington/Oregon may not be subject to intraslab

earthquakes. In the Puget Sound area, these moderate to large earthquakes are deep (40 to 60 km) and over 200 km from the deformation front of the subduction zone. Offshore, along the Northern California coast, the earthquakes are shallower (up to 40 km) and located along the deformation front. Estimates of the probable magnitude, distance, and frequency of subcrustal events in Southwest Washington are generally based on comparisons of the CSZ with active convergent plate margins in other parts of the world and on the historical seismic record for the region surrounding Puget Sound, where significant events known to have occurred within the subducting Juan de Fuca plate have been recorded. Published estimates of the probable maximum size of these events range from moment magnitude M_W 7.0 to 7.5. The 1949, 1965, and 2001 documented subcrustal earthquakes in the Puget Sound area correspond to M_W 7.1, 6.5, and 6.8, respectively. Published information regarding the location and geometry of the subducting zone indicates that a focal depth of 50 km is probable (Weaver and Shedlock, 1989). We have chosen to represent the subcrustal event by a characteristic earthquake of moment magnitude M_W 7.0 at a focal depth of 50 km and a rupture distance of 50 km. Based on the attenuation relationships published by Zhao (2006), and Atkinson and Boore (2003), and Abrahamson, et al. (2012), a subcrustal earthquake of this magnitude and distance would result in a peak horizontal bedrock acceleration of approximately 0.14g at the site.

Local Crustal Event. Sudden crustal movements along relatively shallow, local faults in the southwest Washington area, although rare, have been responsible for local crustal earthquakes. The precise relationship between specific earthquakes and individual faults is not well understood, since few of the faults in the area are expressed at the ground surface, and the foci of the observed earthquakes have not been located with precision. The history of local seismic activity is commonly used as a basis for determining the size and frequency to be expected of local crustal events. Although the historical record of local earthquakes is relatively short (the earliest reported seismic event in the area occurred in 1920), it can serve as a guide for estimating the potential for seismic activity in the area.

Based on fault mapping conducted by the U.S. Geological Survey (USGS, 2008), the Portland Hills Fault is the closest mapped crustal fault to the site that is considered active in the probabilistic hazard maps. The Portland Hills Fault is located approximately 7 km from the site and has a characteristic earthquake magnitude of M_W 7.0. A crustal earthquake of this magnitude and distance would result in a peak horizontal bedrock acceleration of approximately 0.33g at the site based on an average of the NGA ground motion relations developed by the Pacific Earthquake Engineering Research (PEER) by Boore and Atkinson (2008), Campbell and Bozorgnia (2008), Idriss (2008) and Chiou and Youngs (2008).

Other Seismic Hazards. Based on the presence of loose sands and soft silts below the water table at the site, there is a high risk of liquefaction and lateral spreading during a design-level earthquake. More detailed discussions regarding liquefaction and lateral spreading are provided in the Seismic Considerations section of the report. Although detailed tsunami modeling of the Columbia River due to a Cascadia Subduction Zone earthquake has not been completed, we anticipate the risk of upland damage by tsunami at the site is low due to the distance from the coast. River fluctuations may result from a tsunami generated by a CSZ earthquake. Due to the proximity of the Columbia River, there is a risk of seiche. Unless occurring on a previously unmapped fault, it is our opinion the risk of ground rupture at the site is very low.

Deterministic Earthquake Parameters

As discussed above, three distinctly different seismic sources affect seismicity in the project area. Deterministic evaluation of the earthquake sources using published attenuation relations provides estimates of peak bedrock accelerations and response spectra for each seismic source. These deterministic estimates are not associated with a relative hazard level or probability of occurrence like probabilistic estimates, but simply provide an estimate of the ground motion parameters for each seismic source at a given distance from the site. The basic parameters of each earthquake source are as follows:

TABLE 1B: DETERMINISTIC EARTHQUAKE PARAMETERS

Earthquake Source	Attenuation Relationships	Magnitude, M_w	Rupture Distance, km	Focal Depth, km	Median Peak Bedrock Acceleration, g	Average Median Peak Bedrock Acceleration, g
Subduction Zone	Zhao (2006)	9.0	86	15	0.19	
	Atkinson and Macias (2009)	9.0	86	15	0.17	0.19
	Abrahamson (2012)	9.0	86	15	0.23	
Subcrustal	Zhao (2006)	7.0	50	50	0.15	
	Atkinson and Boore, (2003)	7.0	50	50	0.10	0.14
	Abrahamson (2012)	7.0	50	50	0.18	
Local Crustal	Campbell and Bozorgnia (2008)	7.0	7	NA	0.32	
	Chiou and Youngs (2008)	7.0	7	NA	0.36	0.33
	Boore and Atkinson (2008)	7.0	7	NA	0.27	
	Idriss (2008)	7.0	7	NA	0.38	

The values summarized in Table 1B represent the average of median peak bedrock accelerations for the characteristic earthquake on the controlling faults. The upcoming ASCE *Seismic Design of Pile-Supported Piers and Wharves* references ASCE 7-05 which requires an evaluation of 150 percent of the largest median spectral response acceleration taking into account the characteristic earthquakes on all known active faults within the region. Figure 6b compares 150% of these median deterministic spectral values with the deterministic lower limit on MCE response spectrum, in accordance with Figure 21.2-1 of ASCE 7-05 to develop the deterministic Maximum Considered Earthquake (MCE) bedrock spectra. Figure 6B shows that the individual fault deterministic response spectra are lower than the deterministic lower limit on MCE response spectrum. Per Section 21.2.2 of ASCE 7-05, the deterministic spectrum shall be the greater of the 150% deterministic spectrum and the deterministic lower limit spectrum of Figure 21.2-1. Therefore, the deterministic lower limit response spectrum is selected to represent the bedrock deterministic MCE response spectrum.

Probabilistic Considerations

The probability of an earthquake of a specific magnitude occurring at a given location is commonly expressed by its return period, i.e., the average length of time between successive occurrences of an earthquake of that size or larger at that location. The return period of a design earthquake is calculated once a project design life and some measure of the acceptable risk that the design earthquake might occur or be exceeded are specified. These expected earthquake recurrences are expressed as a probability of exceedance during a given time period or design life. The ASCE standard *Seismic Design of Pile-Supported Piers and Wharves* defines three seismic hazard levels: the Operating Level Earthquake (OLE),

the Contingency Level Earthquake (CLE), and the Design Earthquake (DE). The OLE is defined by 50% probability of exceedance in 50 years, which corresponds to an earthquake with an expected recurrence interval of 72 years, and represents a performance level with minimal structural damage. The CLE is defined by 10% probability of exceedance in 50 years, which corresponds to an earthquake with an expected recurrence interval of 475 years, and represents a performance level of controlled and repairable structural damage. The DE is defined per ASCE 7-05 which develops the response spectra based on ground motions associated with the MCE. The MCE is represented by a probabilistic earthquake with a 2% probability of exceedance in 50 years (return period of 2,475years), except where subject to deterministic limitations (Leyendecker et al., 2000). The Design Earthquake (DE) response spectrum is obtained by taking two-thirds of the MCE level ground motions.

For the Dock site, located at the approximate latitude and longitude coordinates of 45.65°N and 122.71°W, the spectral acceleration values corresponding to the 72, 475 and 2,475 years of return periods were obtained for Site Class B from the 2008 USGS hazard curves and uniform-hazard maps. These spectral accelerations for the three hazard levels are plotted on Figure 7B, and the values are presented on Table 2B.

TABLE 2B: RESPONSE SPECTRA FOR DIFFERENT PROBABILISTIC HAZARD LEVELS

	Spectral Acceleration, g		
Period, seconds	**72 Years**	**475 Years**	**2,475 Years**
0	0.05	0.20	0.41
0.1	0.09	0.39	0.86
0.2	0.11	0.45	0.96
0.3	0.10	0.38	0.83
0.5	0.07	0.29	0.64
1	0.03	0.16	0.37
2	0.01	0.07	0.19
3	0.01	0.04	0.10
4	0.00	0.02	0.07
5	0.00	0.02	0.04

Deaggregation of the 2008 USGS data suggests that the Cascadia Subduction Zone, subcrustal events, and local crustal faults all contribute to the seismic hazard at the site.

Development of Target Bedrock Spectra

The site-specific analysis requires developing a bedrock target spectrum prior to selecting and scaling input acceleration time histories. The bedrock target spectra are developed for all three seismic hazard levels, which are previously discussed in the probabilistic consideration section. The target spectra for the OLE and CLE conditions can be directly represented by the site–specific probabilistic uniform hazard curves which correspond to the ground motion with 50% probability of exceedance in 50 years and 10% probability of exceedance in 50 years, respectively. The target bedrock spectrum for the DE is developed as per the requirements of ASCE 7-05. According to Chapter 21 of ASCE 7-05, the controlling target spectrum is developed by comparing the deterministic and probabilistic MCE response spectra, and taking the lower of the two spectra to represent the site-specific MCE bedrock response spectrum. The

comparison of the MCE probabilistic and deterministic response spectra are shown in Figure 8B for the dock site. The probabilistic MCE spectrum is lower than the deterministic spectrum and, therefore, based on the above criterion, the probabilistic spectrum is defined to be the MCE bedrock spectrum.

Site Response Modeling

The effect of a specific seismic event on the site is related to the type and thickness of soil overlying the bedrock at the site and the type and quantity of seismic energy delivered to the bedrock beneath the site by the earthquake. Site response analysis was completed to estimate this site-specific behavior in accordance with ASCE standard for Pile-Supported Piers and Wharves. The site response analysis consisted of three components: 1) selection of target bedrock response spectrum, 2) numerical modeling to analyze the site-specific behavior of the soils using horizontal ground motion acceleration time histories scaled to the approximate level of the target bedrock response spectrum over the periods of interest, and 3) calculation of the ratio of the surface response spectra values to the bedrock response spectra values, at each spectral period, to develop a recommended ground surface response spectrum.

The site response modeling was completed using the D-MOD2000 program by GeoMotions, LLC. D-MOD2000 is a one-dimensional non-linear, time–domain site response modeling program capable of capturing the nonlinear- hysteretic soil behavior during cyclic seismic loading and unloading. The program computes the dynamic response of a layered soil profile to vertically propagating shear waves using total stress or effective stress analyses. The effective stress option provides a means to evaluate the influence of excess pore pressure development and cyclic degradation of soil strength/stiffness (i.e., pore water pressure generation, and pore water pressure dissipation and redistribution) on the dynamic response of the soil profile. D-MOD2000 uses the hyperbolic modified Kodner and Zelasko (MKZ) model to characterize the nonlinear stress-strain soil behavior. The MKZ parameters are generally obtained by fitting the hyperbolic model to published empirical curves.

Within the D-MOD2000 program, the user creates a discretized soil profile and inputs a variety of soil modeling parameters derived from field and laboratory testing and established correlations in the geotechnical literature. A suite of scaled earthquake records are input into the program and propagated up through the soil column to the ground surface. From the modeled ground surface response for a particular soil profile, a Spectral Acceleration Ratio (SAR) can be determined for each earthquake record as the ratio of ground surface to bedrock spectral acceleration ($SA_{surface}/SA_{bedrock}$) at selected periods.

Input Parameters

For the Dock, D-MOD2000 based total and effective stress analyses were performed for evaluating the seismic response and performance of the soil underlying the site. First, a generalized subsurface profile for the site was developed based on our subsurface explorations. Two shear wave velocity profiles at the T-section of the Dock and Pier 3 of the Trestle were estimated based on boring B-26 drilled at Pier 3 and CPT-6 measurements located in the upland area. The ratio of the effective overburden stresses to the one-fourth power, $(\sigma'_{v,\ Dock}/\ \sigma'_{v,\ CPT\text{-}6})^{0.25}$, was used as an adjustment factor to derive the shear wave velocity profiles from CPT-6 measurements. The assumed soil profiles at the T-section of the Dock and Pier 3 of the Trestle are tabulated below in Tables 3B and 4B, respectively.

TABLE 3B: SUBSURFACE PROFILE AT T-SECTION OF DOCK

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
SAND	3	110	400
SAND	3	110	450
SAND	3	110	500
SAND	4	110	500
SAND	3	110	600
Very dense GRAVEL	5	125	850
Very dense GRAVEL	5	125	950
Very dense GRAVEL	5	125	1,100
Very dense GRAVEL	5	125	1,150
Very dense GRAVEL	10	125	1,200
Very dense GRAVEL	10	125	1,250
Very dense GRAVEL	10	125	1,300
Very dense GRAVEL	10	125	1,350
Very dense GRAVEL	10	125	1,400
Very dense GRAVEL	10	125	1,450
Very dense GRAVEL	10	125	1,500
Very dense GRAVEL	10	125	1,550
Very dense GRAVEL	10	125	1,600
Very dense GRAVEL	10	125	1,650
Very dense GRAVEL	10	125	1,700
Very dense GRAVEL	10	125	1,750
Very dense GRAVEL	10	125	1,800
Very dense GRAVEL	10	125	1,900
Very dense GRAVEL	10	125	2,100
Very dense GRAVEL	10	125	2,200
Troutdale	10	130	2,500

TABLE 4B SUBSURFACE PROFILE AT PIER 3 OF TRESTLE

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
Loose SAND	3	110	300
Loose SAND	3	110	400
Loose SAND	4	110	350
Loose SAND	3	110	350
Loose SAND	3	110	400
Medium dense SAND	4	110	500
Medium dense SAND	3	110	550
Medium dense SAND	3	110	500
Medium dense SAND	3	110	450
Medium dense SAND	4	110	550
Medium dense SAND	3	110	700

Material	Thickness, ft	Total Unit Weight, pcf	Estimated Shear Wave Velocity, ft/sec
Medium dense SAND	3	110	750
Medium dense SAND	3	110	850
Medium dense SAND	4	110	750
Medium dense SAND	3	110	900
Medium dense SAND	3	110	800
Medium dense SAND	3	110	850
Medium dense SAND	4	110	750
Medium dense SAND	3	110	900
Very dense GRAVEL	5	125	1,100
Very dense GRAVEL	5	125	1,200
Very dense GRAVEL	5	125	1,300
Very dense GRAVEL	5	125	1,350
Very dense GRAVEL	10	125	1,400
Very dense GRAVEL	10	125	1,450
Very dense GRAVEL	10	125	1,500
Very dense GRAVEL	10	125	1,550
Very dense GRAVEL	10	125	1,600
Very dense GRAVEL	10	125	1,650
Very dense GRAVEL	10	125	1,700
Very dense GRAVEL	10	125	1,750
Very dense GRAVEL	10	125	1,800
Very dense GRAVEL	10	125	1,850
Very dense GRAVEL	10	125	1,900
Very dense GRAVEL	10	125	2,000
Very dense GRAVEL	10	125	2,100
Very dense GRAVEL	10	125	2,200
Very dense GRAVEL	10	125	2,300
Very dense GRAVEL	10	125	2,400
Troutdale	10	130	2,500

The material properties and boundary conditions were specified in D-MOD2000 for the Dock site. The unit weights for each of the soil profile were estimated based on the laboratory unit weight test results. The sand and gravel layers encountered throughout the soil profile were assigned the depth- dependent EPRI (1993) sand and rock modulus reduction and damping curves, which accounts for the effects of confining pressure. The representative pore-pressure generation parameters for the sand layers were selected based on grain size distribution curve matching procedures with D-MOD2000. The grain size distribution curve for the sand layer was compared to the liquefiable sands and silts curves within D-MOD2000 database, and the Santa Monica Beach (SMB) sand was selected to approximate the pore-pressure generation parameters. The half-space boundary condition at the base of the model was represented by a visco-elastic boundary with a unit weight of 130 pounds per cubic foot (pcf) and a shear wave velocity of 2,500 feet per second.

Ground Motion Selection and Scaling

The target bedrock response spectrum for the site was developed for Site Class B, or rock site, conditions in accordance with the method outlined in the Target Bedrock Spectrum section of this report for OLE, CLE and MCE hazard levels. A series of earthquake acceleration-time histories have been selected and scaled to the target bedrock spectrum. From the available records, corrected free-field and basement/ground floor accelerograms were selected for input as bedrock time histories. Wherever possible, earthquakes of similar magnitude and duration to the characteristic earthquakes were selected. These records were checked for obvious errors, missing data points, and other anomalies and were transformed into a uniform data format. The selected strong-motion records are tabulated below in Table 5B.

TABLE 5B SELECTED STRONG-MOTION RECORDS

Earthquake	Recording Station	Magnitude	Rupture Distance, km	Peak Bedrock Acceleration, g
Loma Prieta (1989)	San Jose - Santa Teresa Hills	6.9	14.7	0.28
Nisqually (2001)	Olympia, WSDOT Test Lab	6.8	18.3	0.22
Chile (2010)	Curico	8.8	65.1	0.47
Chile (2010)	Hualane	8.8	50	0.46
Japan (2011)	Kuroiso (TCG001)	9	102	0.42
Japan (2011)	Yamatsuri (FKS 014)	9	76	0.23
Japan (2011)	Hachinohe (AOM 012)	9	99	0.19

The selected acceleration time histories were then scaled to reasonably match the bedrock target spectrum at periods of interest including the site fundamental period for the OLE, CLE and MCE hazard levels. The scaling process involves selecting a single factor and multiplying the acceleration time history by this factor so that its pseudo acceleration response spectrum more closely matches the target spectrum at the period of interest.

Site Response Results

Using the generalized subsurface profiles (i.e., at the T-section of the Dock and Pier 3 of the Trestle), the target spectra developed at the bedrock, and the strong ground motion records listed in the preceding tables, pseudo acceleration response spectra were computed for the Dock site with the D-MOD2000 nonlinear model. The ground surface response spectra were developed at 5% of critical damping. The ground surface spectra were compared to the input rock spectra to quantify amplification and/or attenuation through the soil column at the site. The ratio of ground surface to bedrock spectral accelerations, defined as the spectral amplification ratio (SAR), is shown on Figure 9B and Figure 10B for the CLE and MCE conditions, respectively. To estimate ground surface site response throughout the range of spectral periods, the target response spectra is multiplied by the SAR to determine the ground surface response spectrum. The results of the site-specific response modeling are shown on Figures 11B and 12B for the CLE and MCE hazard levels, respectively. Figures 11B and Figure 12B also include the code-based spectrum (i.e., for example Site Class D and Site Class E), developed using site amplification factors based on the appropriate Site Class type. The code-based spectrum is typically derived based on the 0.2 and 1 second spectral accelerations values at the bedrock and site coefficients (i.e., F_a and F_v) provided in Table 11.4-1 and Table 11.4-2 of ASCE 7-05. The code-based site coefficients and the spectral values corresponding to 0.2 and 1 second periods are provided on Table 6B for the OLE, CLE and MCE hazard

levels. The two spectral values are obtained from the map of spectral acceleration parameters provided in Chapter 22 of ACSE 7-05 for the MCE condition while the spectral values corresponding to 72- and 475-year return periods are obtained from USGS data for the OLE and CLE conditions, respectively.

TABLE 6B: SITE COEFFICIENTS AND SPECTRAL VALUES

Hazard Level, Ss and S1 Values	Site Class	F_a	F_v
OLE $S_s = 0.11$ g, $S_1 = 0.03$ g	D	1.6	2.4
	E	2.5	3.5
CLE $S_s = 0.45$ g, $S_1 = 0.16$ g	D	1.44	2.17
	E	1.87	3.33
MCE $S_s = 0.94$ g, $S_1 = 0.41$ g	D	1.12	1.59
	E	0.97	2.40

The site is generally designated as Site Class D based on the average shear wave velocity (V_{S100}) in the upper 100 ft per Section 20.4 of ASCE 7-05. For the OLE hazard level the degree of ground shaking is insufficient to cause liquefaction of the soil. Therefore, the code-based Site Class D depicted on Figure 13B is recommended for the OLE condition to estimate the ground response spectral acceleration.

For the CLE and MCE hazard levels, our analyses indicate the soil may liquefy and the site is designated as Site Class F in accordance with section 20.3.1 of ASCE 7-05. A site response analyses is required for Site Class F designations. Structures with a fundamental period less than 0.5 second are exempted from this requirement, and the response spectrum may be developed based on the appropriate Site Class for non-liquefied site conditions. Research by Youd and Carter (2005) indicates that code–based response spectra for non-liquefied conditions may be conservatively extended to represent the response spectra for structures with fundamental periods less than 1.0 sec for liquefied conditions. Per Section 21.3 of ASCE 7-05, the ground surface response spectra developed from site response analysis for Site Class F may not be less than 80% of the Site Class response spectrum values assuming no liquefaction.

The calculated and recommended site specific ground surface response spectra at the T-section of the dock and at Pier 3 of the trestle are shown on Figures 11B and 12B for the CLE and MCE, respectively. The calculated values presented on the figures are based on total stress analysis. However, effective stress analyses were also completed for comparison. As anticipated, the effective stress analyses resulted in a "softening" of the soil response and generally lower response values than the total stress analyses. The trends associated with the effective stress analyses were considered in selecting the recommended spectra. The recommended response spectra are also intended to conservatively envelope the estimated response for both the T-section of the dock and the Pier 3 location of the trestle. It should be noted that Figures 11B and 12B also include a spectra based on 80% of Site Class E in addition to site class D spectral values due to liquefaction and code considerations for liquefiable profiles.

CLE Hazard Level. The estimated CLE ground surface response spectra at periods greater than 0.5 second are less than or equal to 80% of the Site Class E response spectrum which is the minimum allowed by the code for periods in this range of interest. At periods less than 0.5 second, the code allows the use of the non-liquefied site class D spectrum. We have recommended a slight increase from the site class D spectrum at short periods to match 80% of the site class E spectrum to account for the shorter period

amplification observed in the total stress analyses of the T-section of the dock. Considering the range of analyses and uncertainties, we have recommended a single CLE hazard level response spectrum at all periods for both the dock and trestle structure. This spectrum based on 80% of the Site Class E response spectrum is shown on Figure 11B.

DE Hazard Level. The estimated MCE ground surface response spectra from the total stress analysis typically exceed either the Site Class D or 80% of Site Class E spectra at periods less than 1.8 seconds. However, total stress parameters do not account for reductions in the response due to softening of the liquefied soils observed in our effective stress analyses, particularly at short periods. At the MCE hazard level, the site class D spectrum is more conservative than the site class E spectrum and we have recommended the site class D spectrum in accordance with the recommendations in ASCE7-05. At periods between 0.89 and 1.8 seconds we conservatively recommend the design spectrum include an increase above Site Class D and E to transition to longer periods and envelop the estimated site specific ground surface response. At periods greater than approximately 1.8 seconds, the site-specific response spectrum is less than 80% of Site Class E, which is the minimum spectral amplification allowed by ASCE 7-05 for liquefied conditions. Plots of our recommended response spectra are shown on the Figure 12B for the MCE. The design earthquake (DE) response spectrum is determined by taking two-thirds of the MCE response spectrum and is shown on Figure 14B.

Conclusions

The site-specific response modeling for the Dock site was completed using total and effective stress parameters based on the generalized subsurface profiles developed at the T-section of the Dock and Pier 3 of the Trestle. The site response modeling was performed for three seismic hazard levels (i.e., OLE, CLE and DE) to meet the requirements of ASCE standard *Seismic Design of Pile-Supported Piers and Wharves*.

For the OLE hazard level, we recommend the code-based Site Class D response spectrum as shown on Figure 13B. For the CLE hazard level, the recommended spectrum is based on 80% of the code based Site Class E response spectrum. For the DE hazard level, the code-based Site Class D response spectrum is recommended for periods less than 0.89 second. At longer periods the recommended response spectrum envelopes the site-specific spectral response values and 80% of the Site Class E response spectrum. The recommended spectra for CLE and DE are shown on Figures 11B and 14B, respectively.

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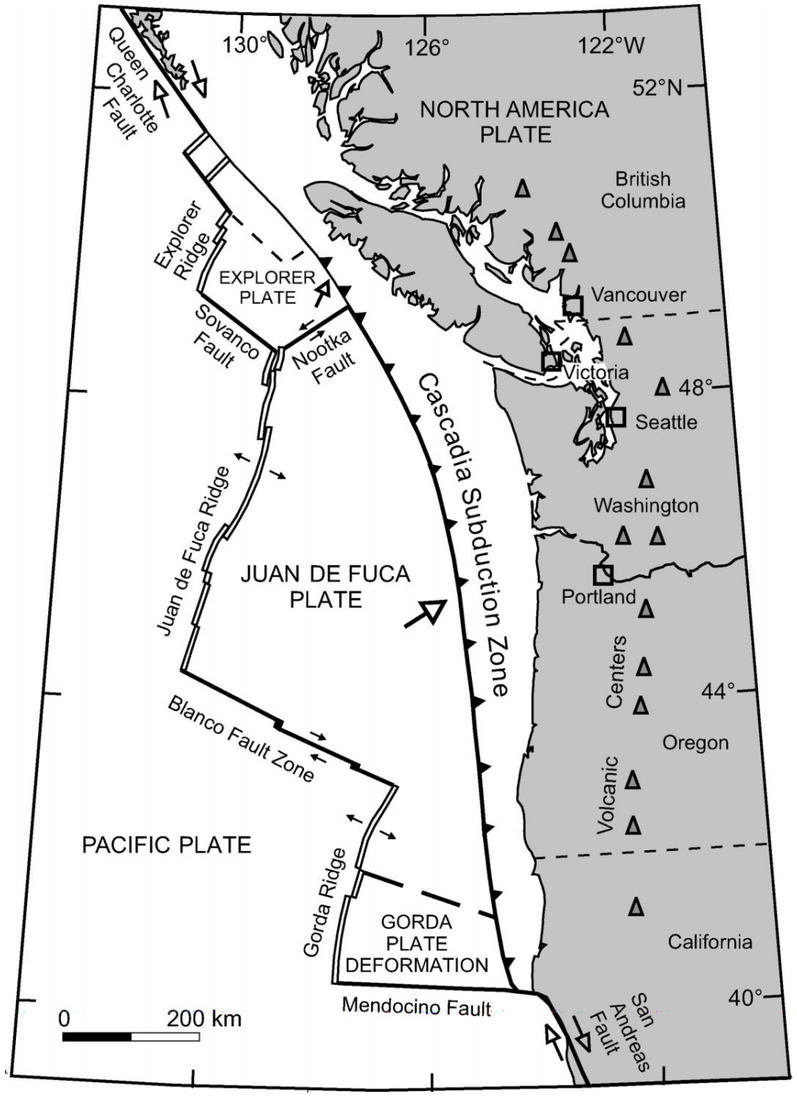
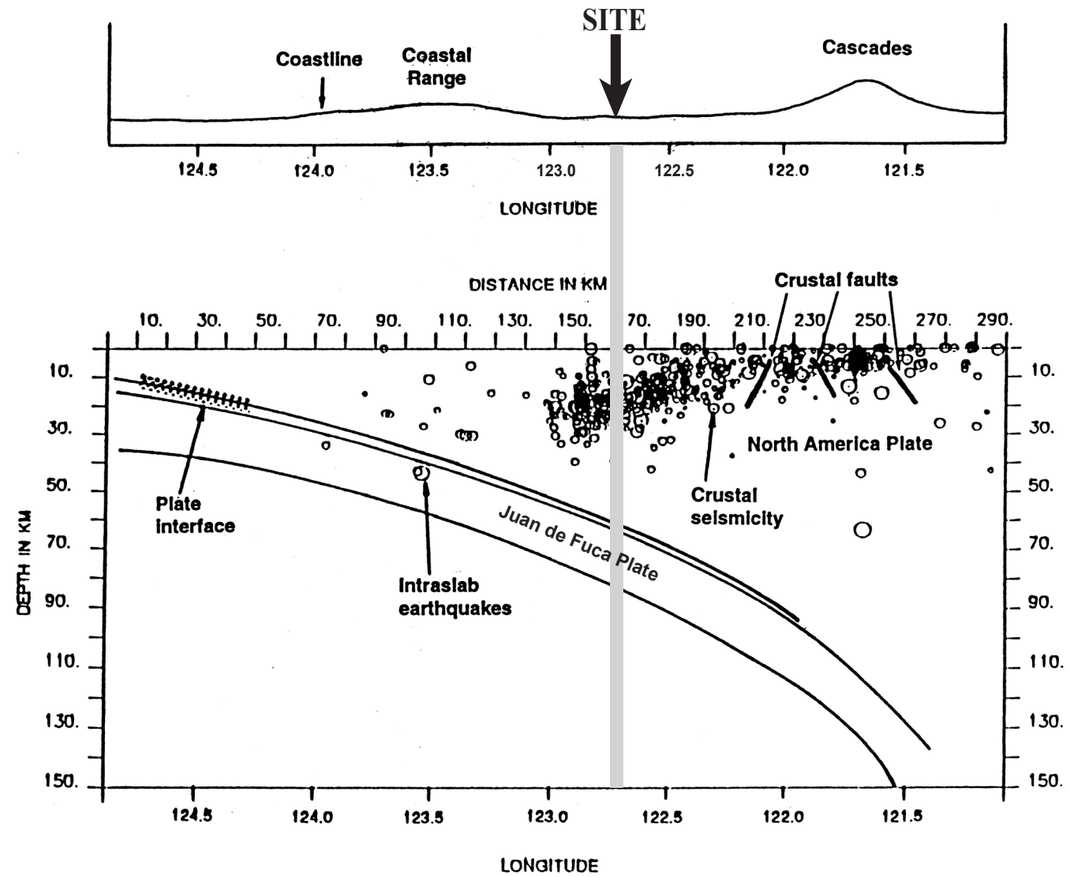


A) TECTONIC MAP OF PACIFIC NORTHWEST, SHOWING ORIENTATION AND EXTENT OF CASCADIA SUBDUCTION ZONE (MODIFIED FROM DRAGERT AND OTHERS, 1994)



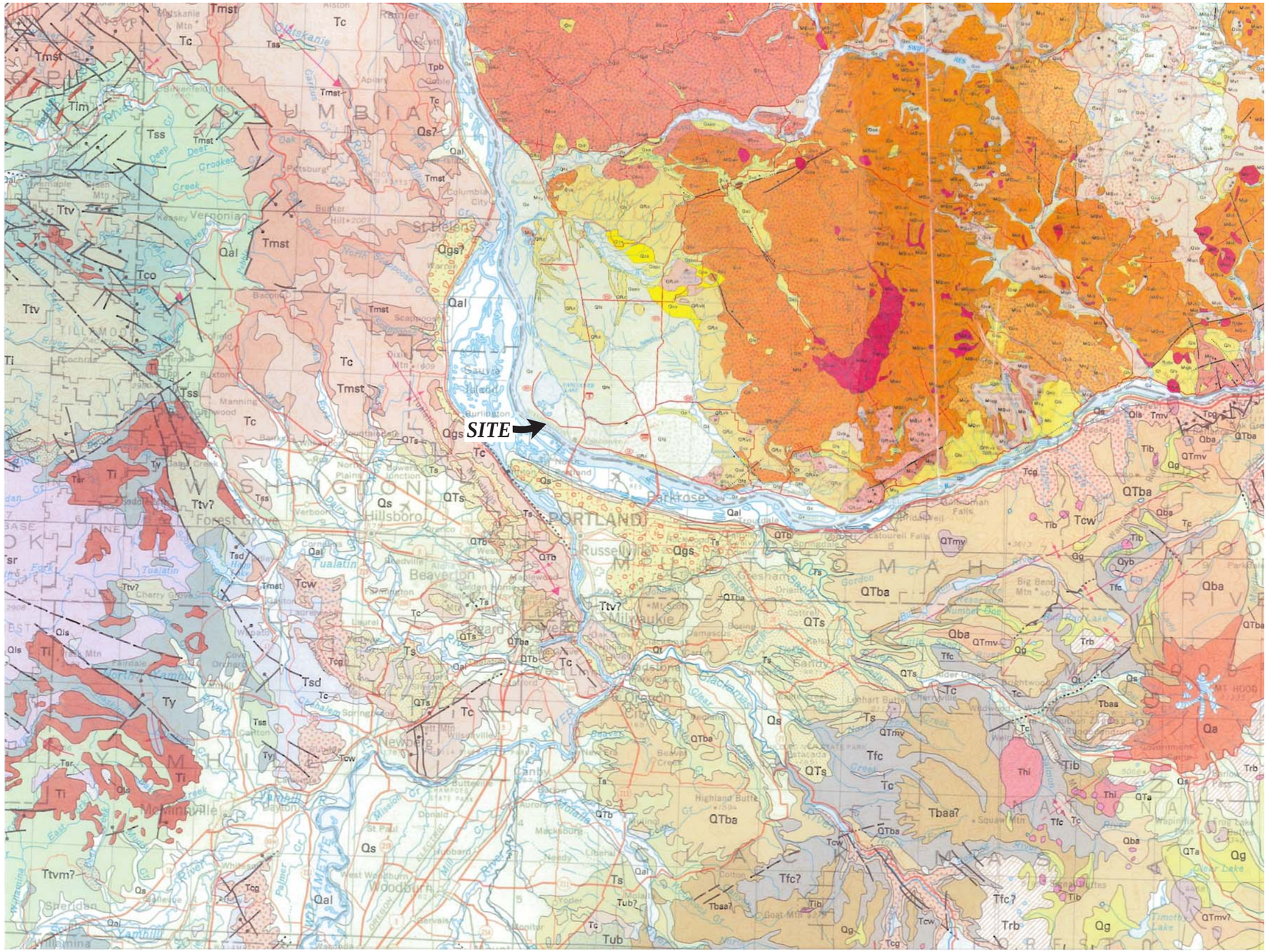
B) EAST-WEST CROSS-SECTION THROUGH WESTERN OREGON AT THE LATITUDE OF PORTLAND, SHOWING THE SEISMIC SOURCES CONSIDERED IN THE SITE-SPECIFIC SEISMIC HAZARD STUDY (MODIFIED FROM GEOMATRIX, 1995)

GRI

TECTONIC SETTING SUMMARY

SEP. 2014 | JOB NO. W1114-T3 | FIG. 1B

EX-0001-004049-PCE



FROM:

WALSH, T.J., KOROSEC, M.A., PHILLIPS, W.M., LOGAN, R.L., AND SCHASSE, H.W., 1987, GEOLOGIC MAP OF WASHINGTON-SOUTHWEST QUADRANT; 1:250,000: WASHINGTON DIVISION OF GEOLOGY AND EARTH RESOURCES, 6M-34

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North

0 10 20 MILES

0 10 20 KILOMETERS

Contact — Approximately located

Fault — Dashed where inferred; dotted where concealed; queried where doubtful; ball and bar on downthrown side

Thrust fault — Dashed where inferred; dotted where concealed; queried where doubtful; sawteeth on upper plate

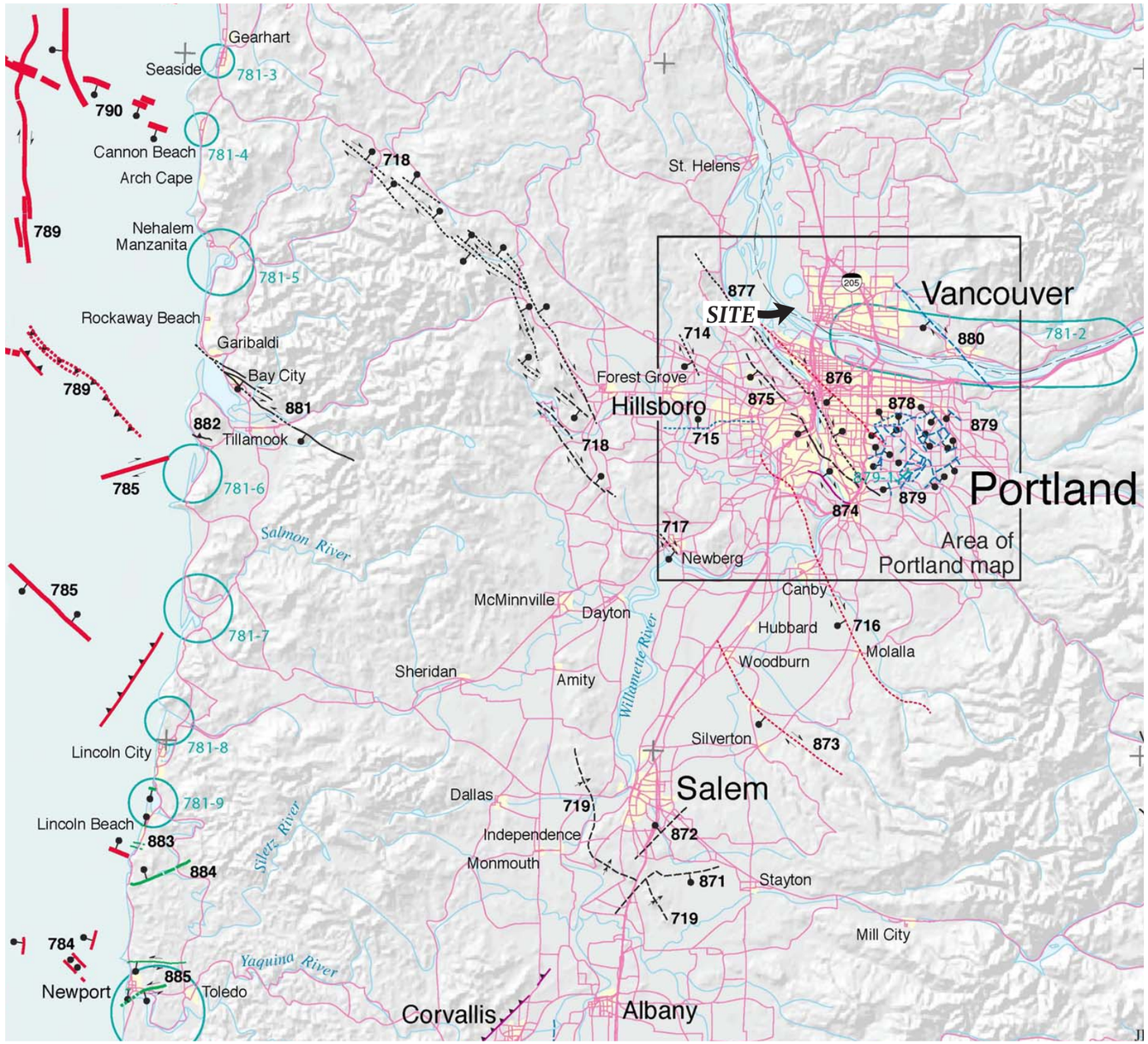
Strike and dip of bed

GRI

REGIONAL GEOLOGIC MAP

SEP. 2014 JOB NO. W1114-T3 FIG. 2B

EX-0001-004051-PCE



MAP EXPLANATION

TIME OF MOST RECENT SURFACE RUPTURE

- Holocene (<10,000 years) or post last glaciation (<15,000 years; 15 ka); no historic ruptures in Oregon to date
- Late Quaternary (<130,000; post penultimate glaciation)
- Late and middle Quaternary (<750,000 years; 750 ka)
- Quaternary, undifferentiated (<1,600,000 years; <1.6 Ma)
- Class B structure (age or origin uncertain)

SLIP RATE

- >5 mm/year
- 1.0-5.0 mm/year
- 0.2-1.0 mm/year
- <0.2 mm/year

TRACE

- Mostly continuous at map scale
- Mostly discontinuous at map scale
- Inferred or concealed

STRUCTURE TYPE AND RELATED FEATURES

- Normal or high-angle reverse fault
- Strike-slip fault
- Thrust fault
- Anticlinal fold
- Synclinal fold
- Monoclinal fold
- Plunge direction of fold
- Fault section marker

DETAILED STUDY SITES

- 731-2 Trench site
- 781-2 Subduction zone study site

CULTURAL AND GEOGRAPHIC FEATURES

- Divided highway
- Primary or secondary road
- Permanent river or stream
- Intermittent river or stream
- Permanent or intermittent lake

FAULT NUMBER	NAME OF STRUCTURE
876	EAST BANK FAULT
877	PORTLAND HILLS FAULT
880	LACAMAS LAKE FAULT
878	GRAND BUTTE FAULT

FROM: PERSONIUS, S.F., AND OTHERS, 2003, MAP OF QUATERNARY FAULTS AND FOLDS IN OREGON, USGS OPEN FILE REPORT OFR-03-095.

North

0 5 10 MILES

0 5 10 KILOMETERS

GRI

LOCAL FAULT MAP

SEP. 2014 JOB NO. W1114-T3 FIG. 3B

EX-0001-004053-PCE

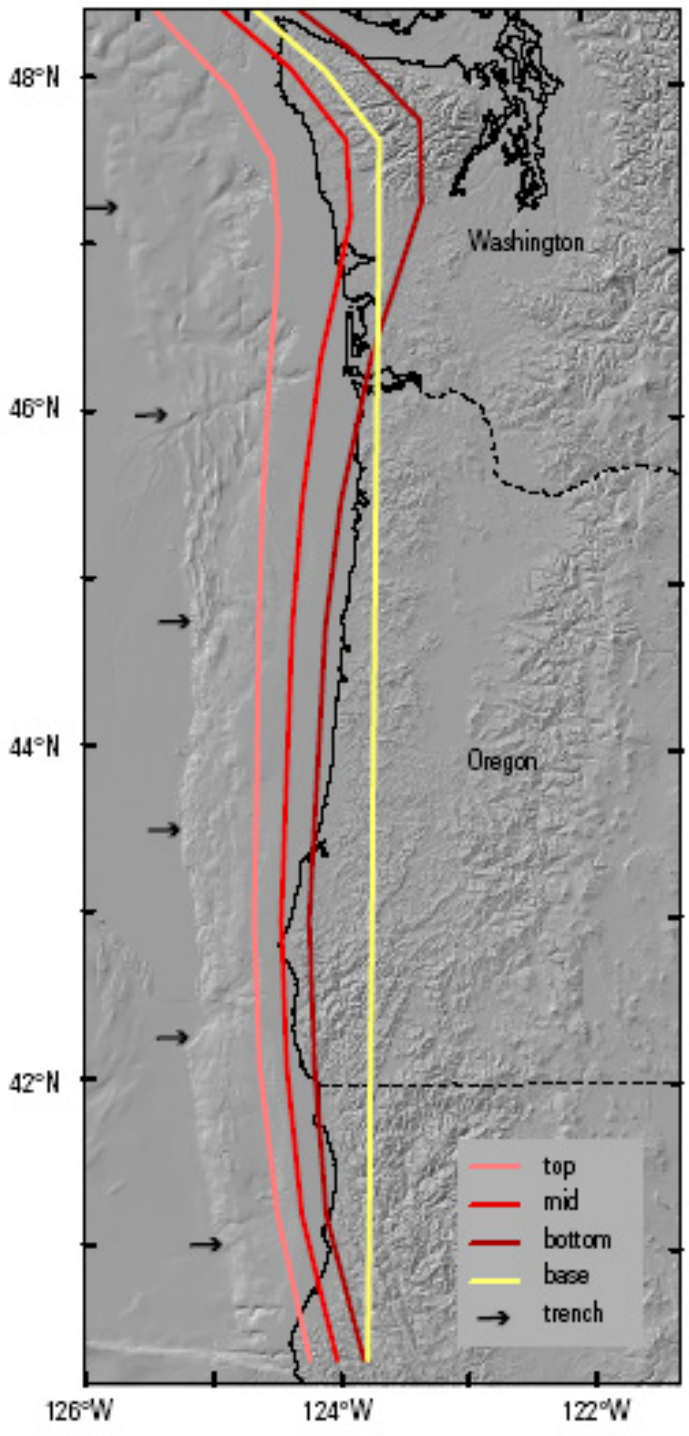


Figure 21. Location of the eastern edge of earthquake-rupture zones on the Cascadia subduction zone for the various models used in this study relative to the surficial expression of the trench: top, base of the elastic zone; mid, midpoint of the transition zone; bottom, base of the transition zones; base, base of the model that assumes ruptures extend to about 30-kilometers depth. Figure provided by Ray Weldon.

FROM: PETERSEN, MD, FRANKEL, AD, HARMSEN, SC, AND OTHERS, 2008, DOCUMENTATION FOR THE 2008 UPDATE OF THE UNITED STATES NATIONAL SEISMIC HAZARD MAPS: US GEOLOGICAL SURVEY, OPEN FILE REPORT 2008-1128

GRI

ASSUMED RUPTURE LOCATIONS
(CASCADIA SUBDUCTION ZONE)

SEP. 2014 JOB NO. W1114-T3 FIG. 4B

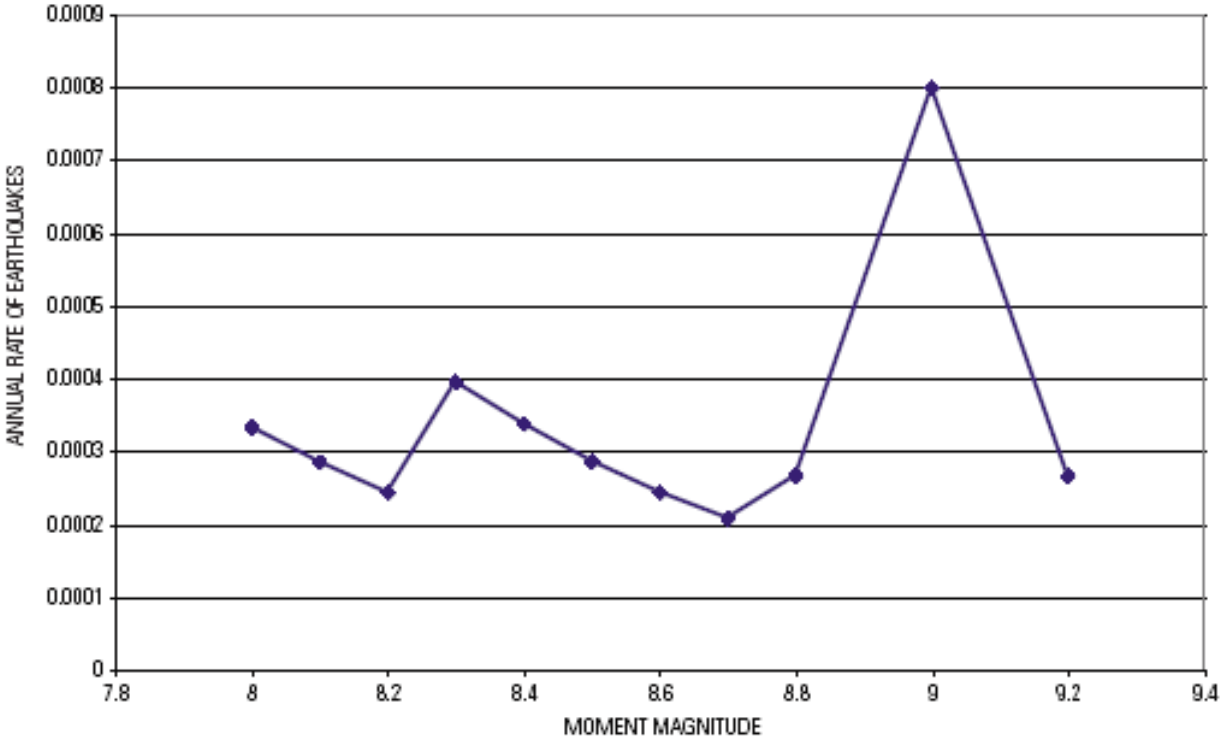


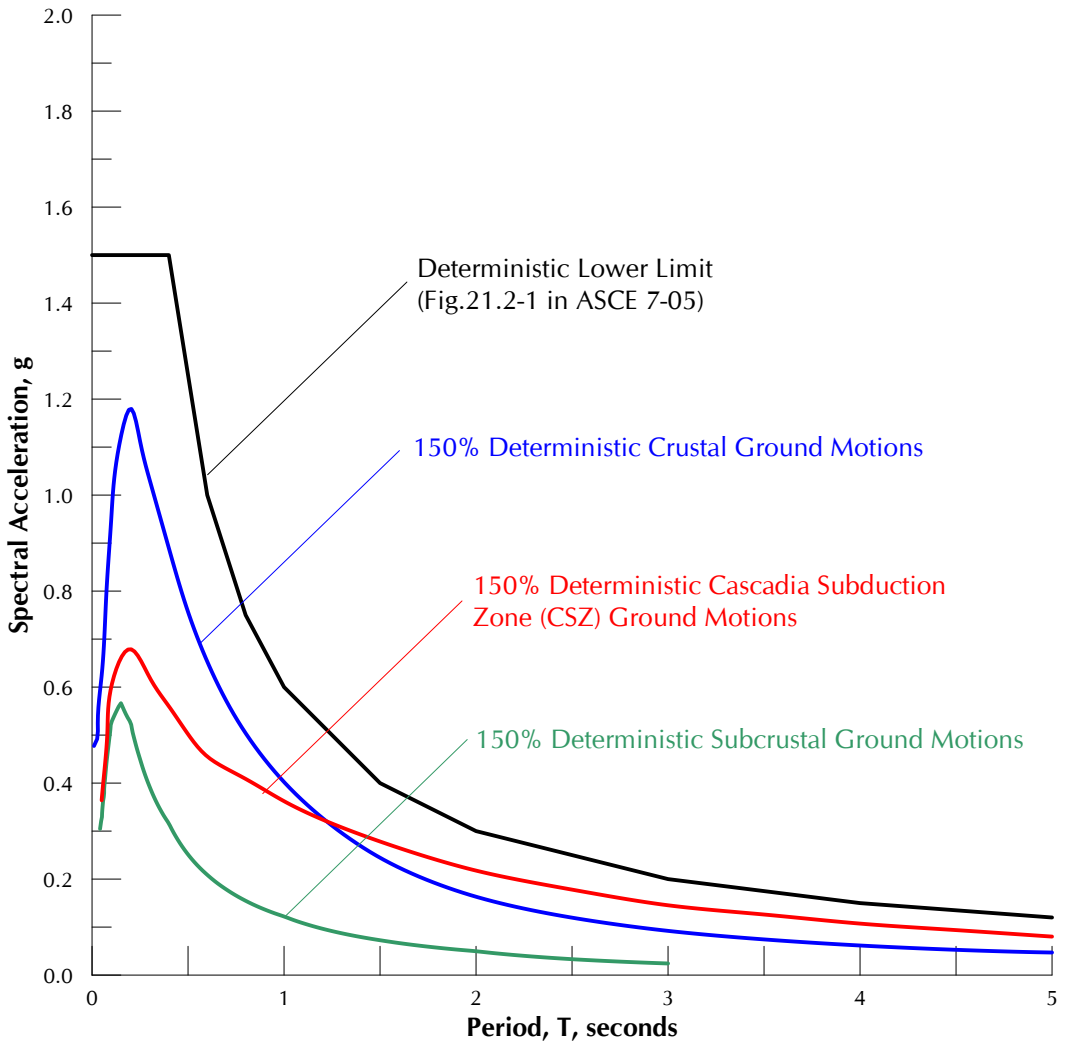
Figure 22. Magnitude-frequency distribution of the Cascadia subduction zone.

FROM: PETERSEN, M, FRANKEL, A, HARMSEN, S, AND OTHERS, 2008, DOCUMENTATION FOR THE 2008 UPDATE OF THE UNITED STATES NATIONAL SEISMIC HAZARD MAPS: US GEOLOGICAL SURVEY, OPEN FILE REPORT 2008-1128

GRI

ASSUMED
MAGNITUDE-FREQUENCY DISTRIBUTION
(CASCADIA SUBDUCTION ZONE)

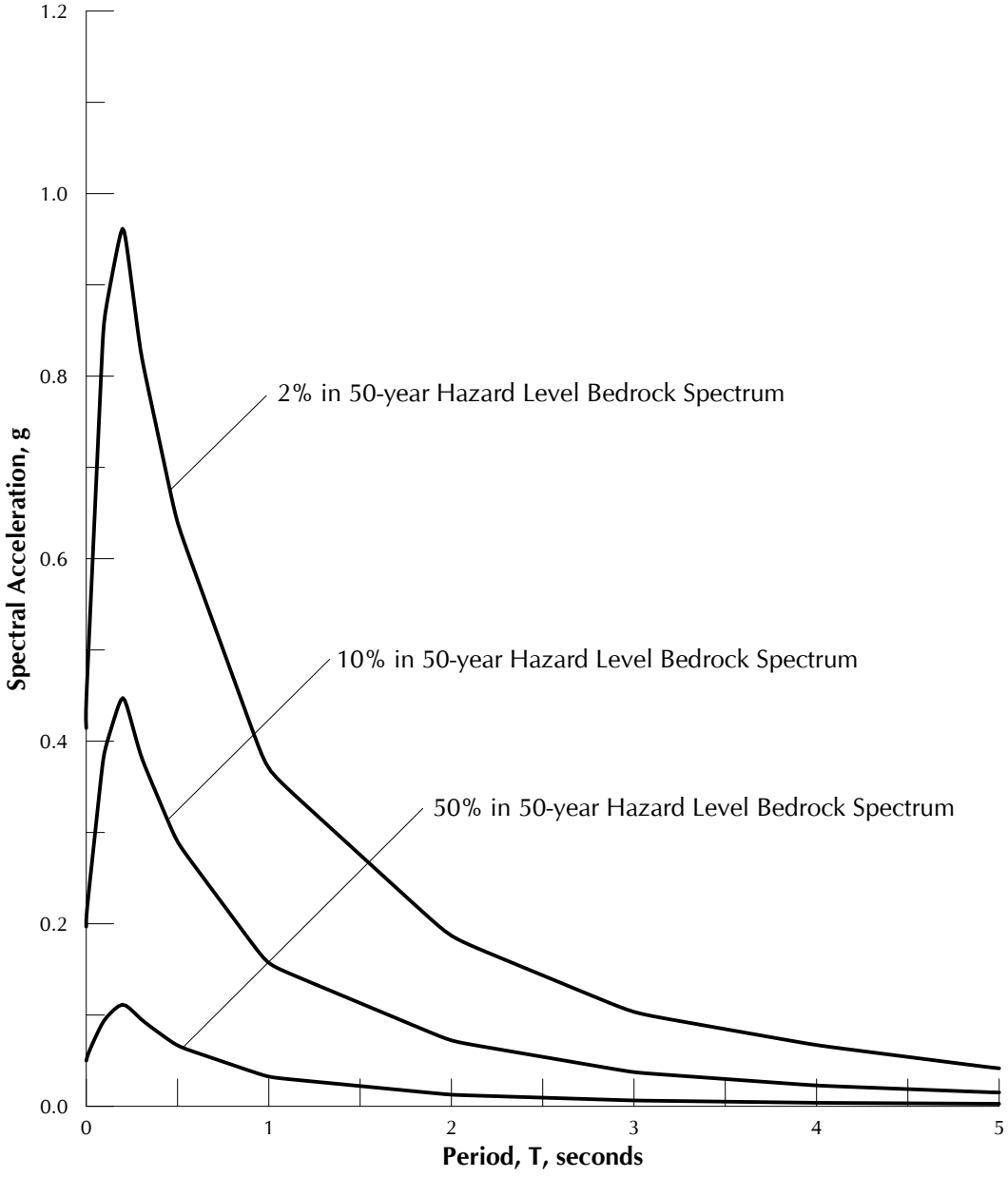
SEP. 2014 JOB NO. W1114-T3 FIG. 5B



GRI

DETERMINISTIC MCE
BEDROCK RESPONSE SPECTRA COMPARISON
(5% DAMPING)

SEP. 2014 JOB NO. W1114-T3 FIG. 6B



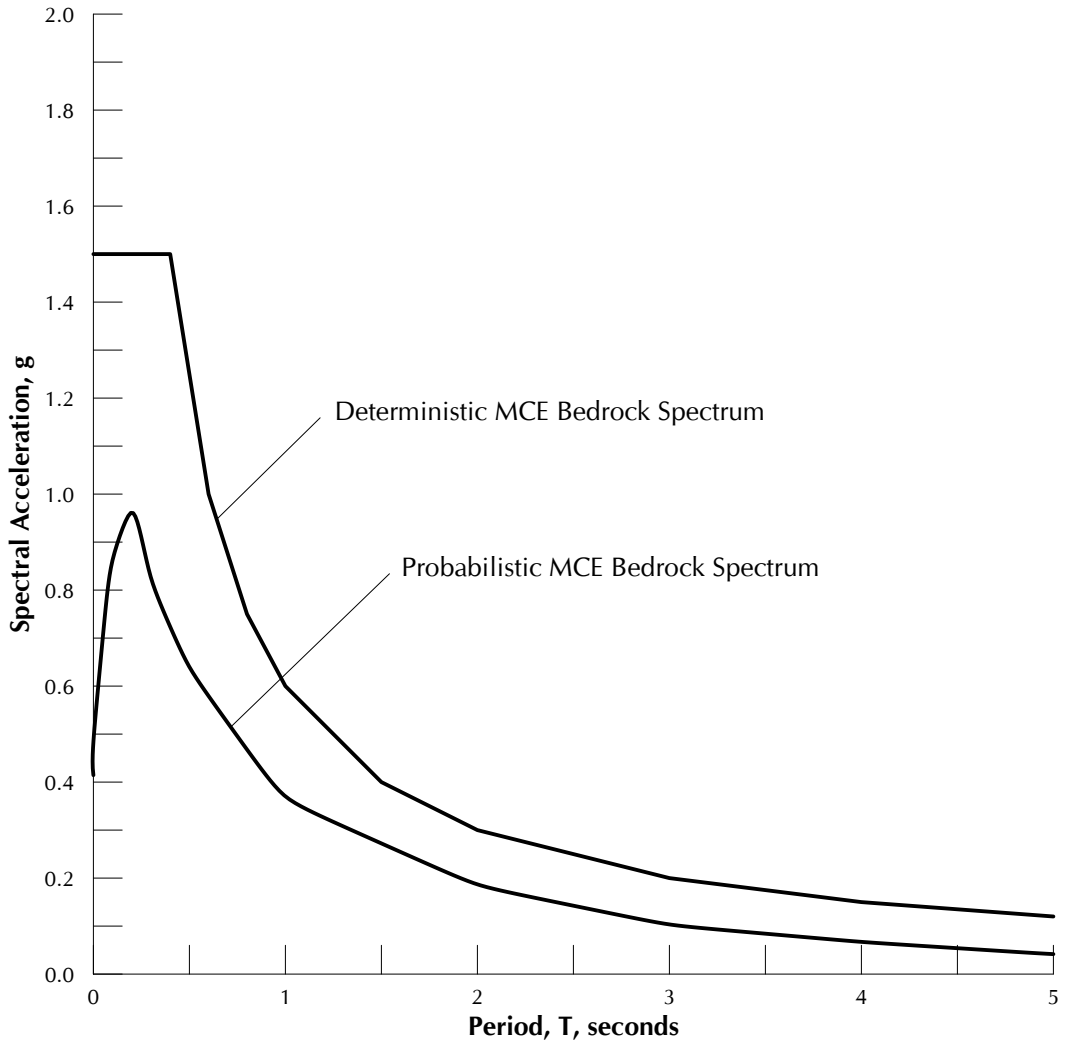
GRI

BEDROCK RESPONSE SPECTRA FOR DIFFERENT PROBABILISTIC HAZARD LEVELS

(5% DAMPING)

SEP. 2014 JOB NO. W1114-T3 FIG. 7B

EX-0001-004058-PCE

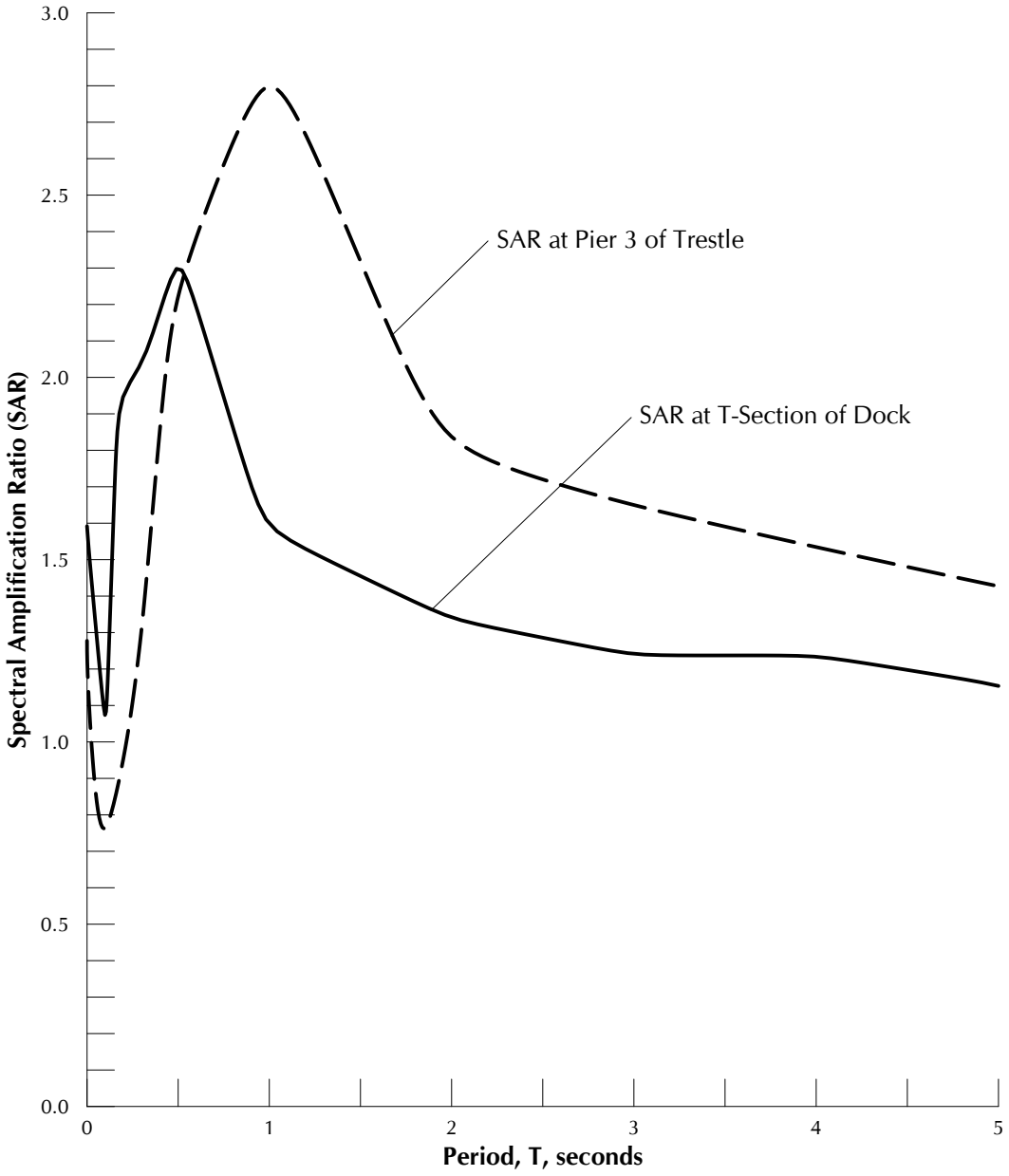


GRI

DETERMINISTIC AND PROBABILISTIC MCE BEDROCK RESPONSE SPECTRA COMPARISON

(5% DAMPING)

SEP. 2014 JOB NO. W1114-T3 FIG. 8B

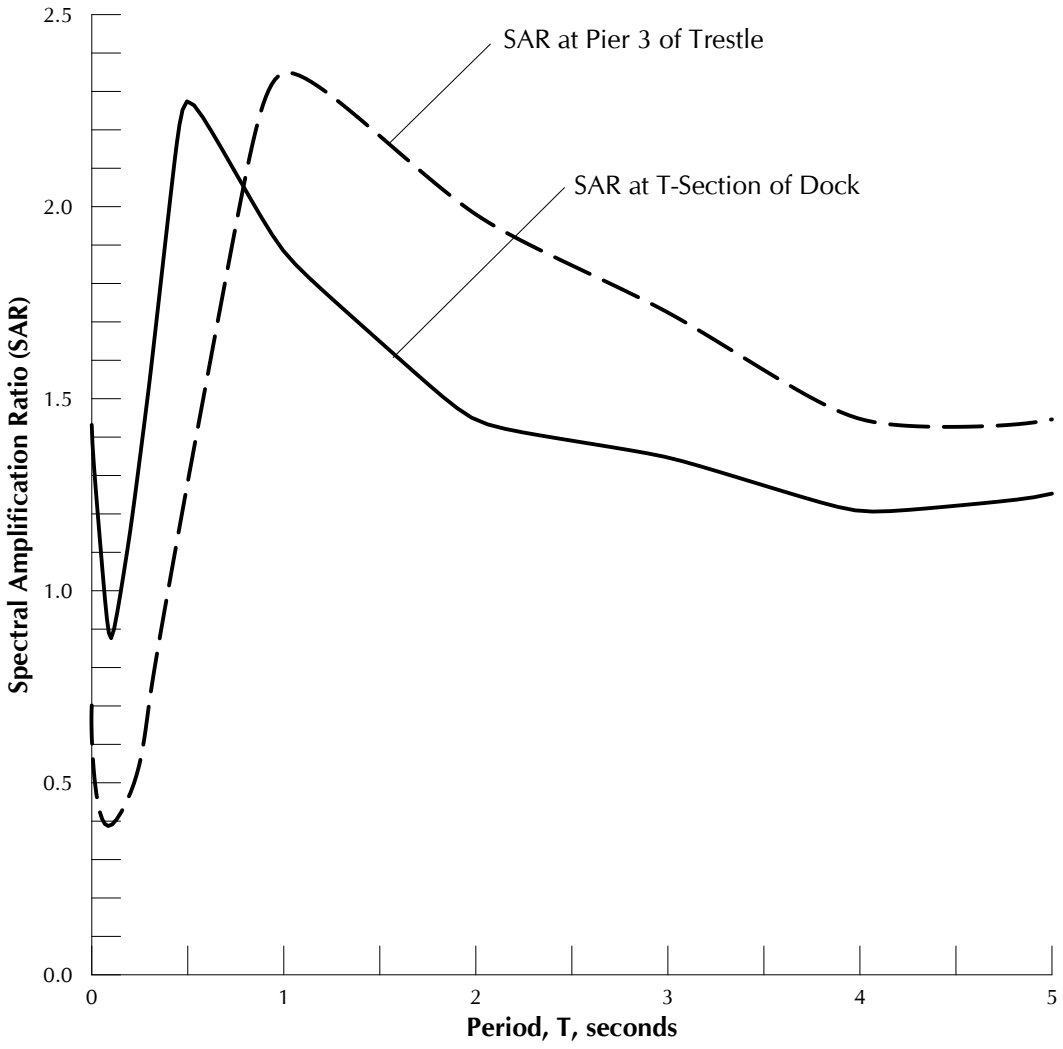


GRI

SPECTRAL AMPLIFICATION RATIO (SAR)
FOR CLE (475-YEAR) HAZARD LEVEL

SEP. 2014 JOB NO. W1114-T3 FIG. 9B

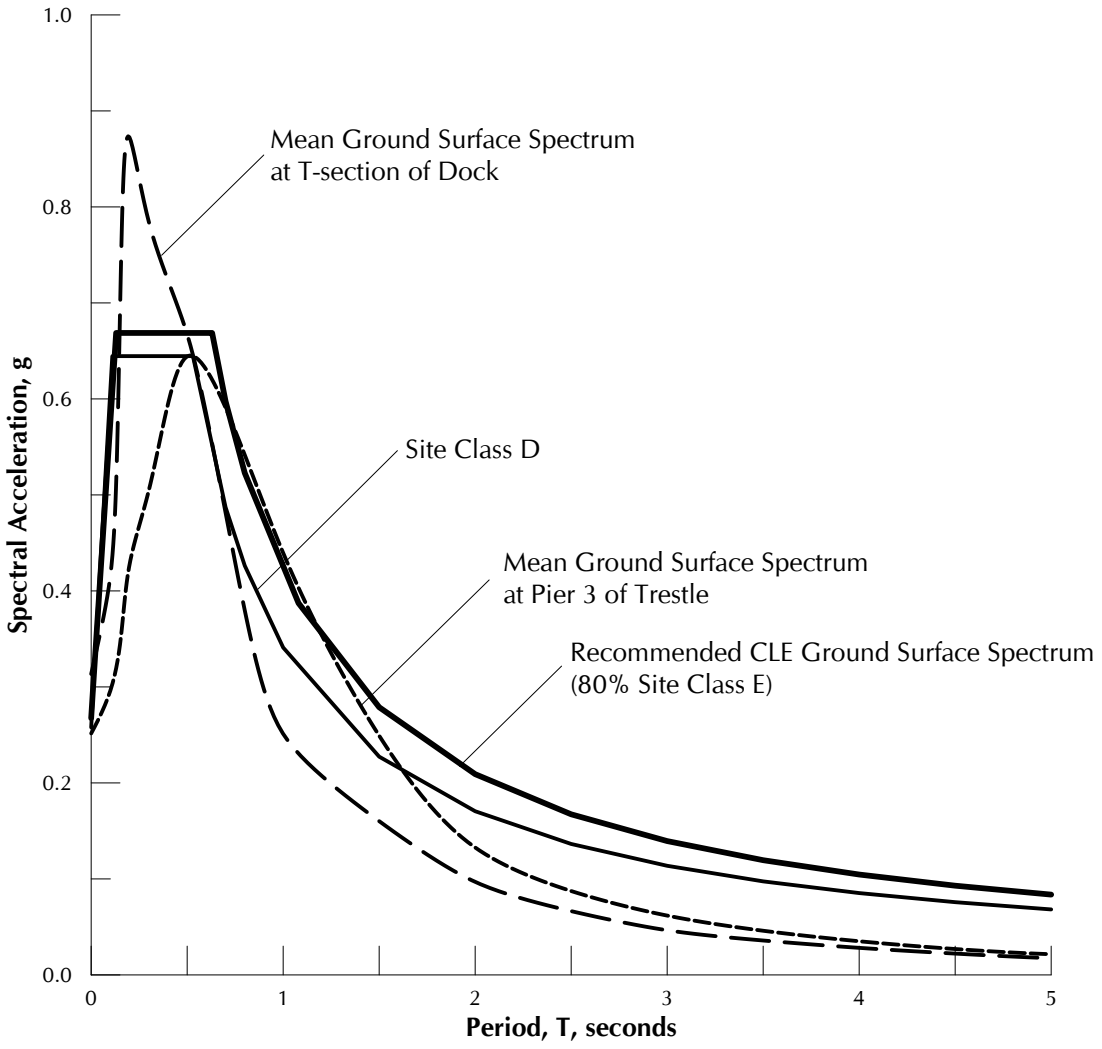
EX-0001-004060-PCE



GRI

SPECTRAL AMPLIFICATION RATIO (SAR)
FOR MCE (2,475-YEAR) HAZARD LEVEL

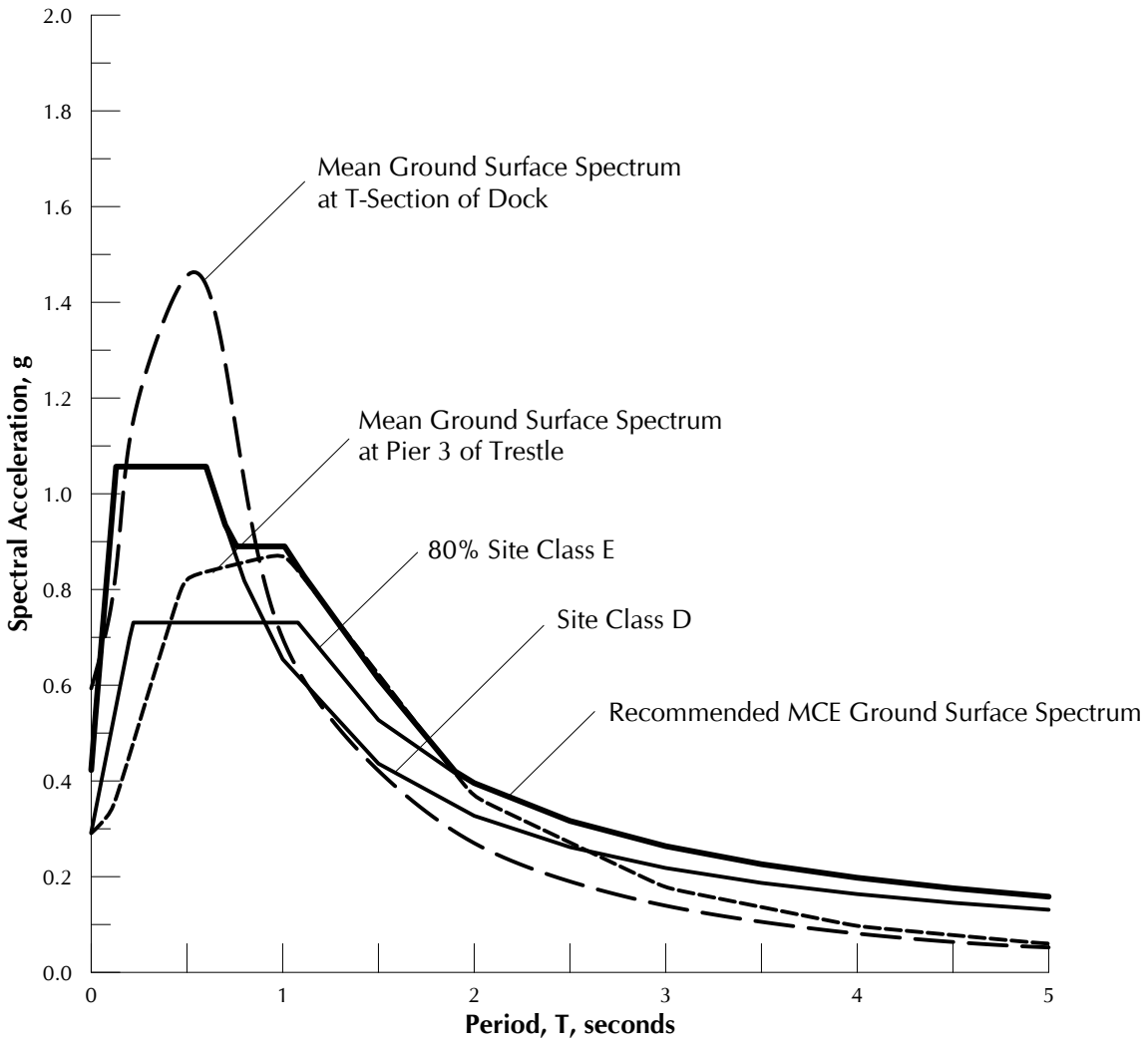
SEP. 2014 JOB NO. W1114-T3 FIG. 10B



GRI

CLE GROUND SURFACE
RESPONSE SPECTRA
(5% DAMPING)

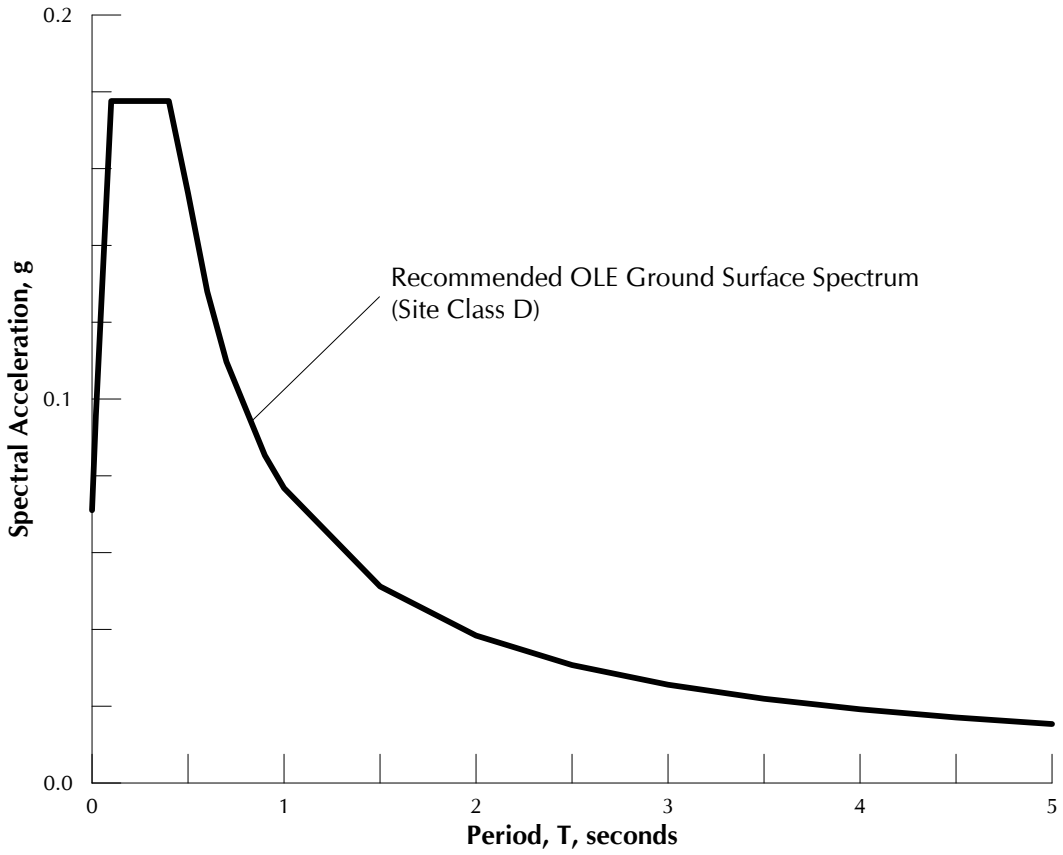
SEP. 2014 JOB NO. W1114-T3 FIG. 11B



GRI

MCE GROUND SURFACE
RESPONSE SPECTRA
(5% DAMPING)

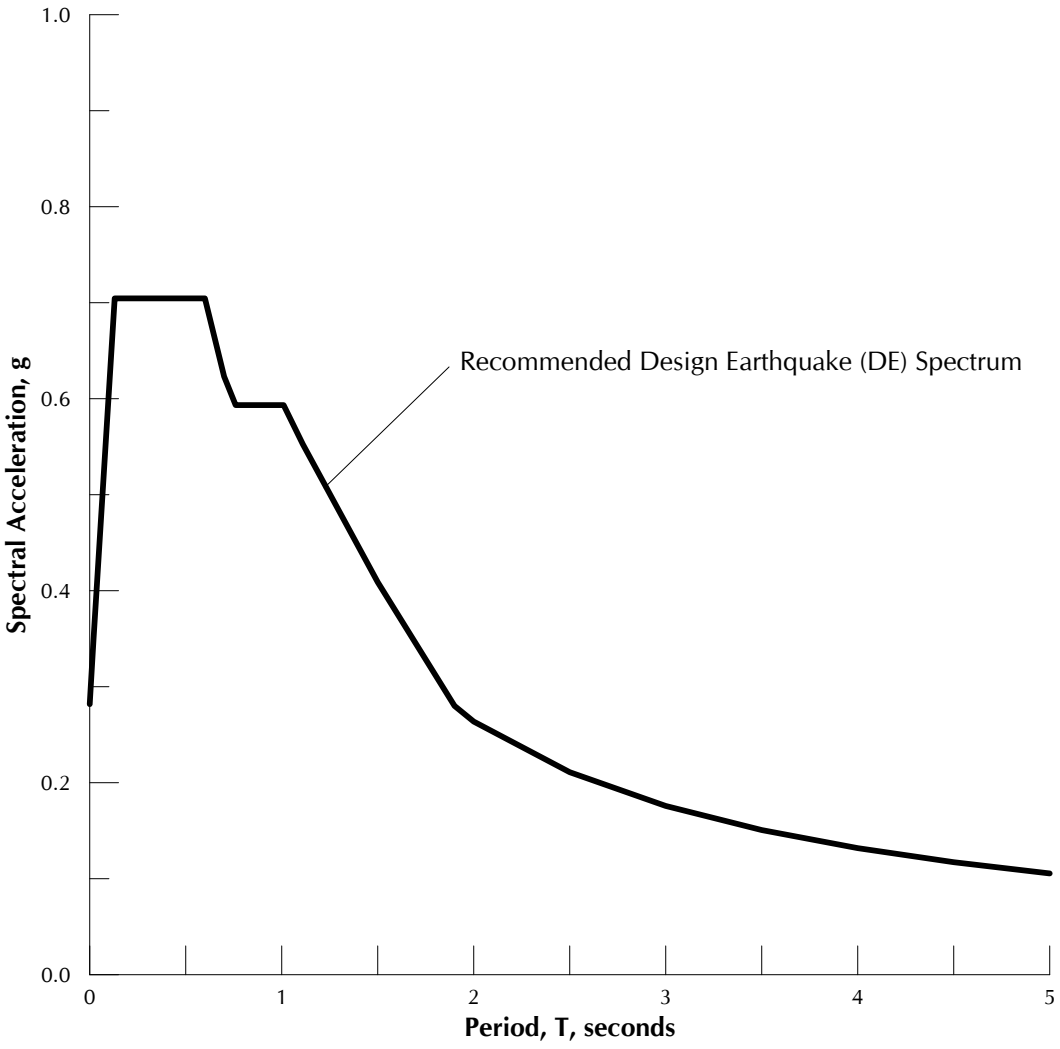
SEP. 2014 JOB NO. W1114-T3 FIG. 12B



GRI

OLE GROUND SURFACE
RESPONSE SPECTRUM
(5% DAMPING)

SEP. 2014 JOB NO. W1114-T3 FIG. 13B



GRI

DE (2/3 MCE) GROUND SURFACE RESPONSE SPECTRUM

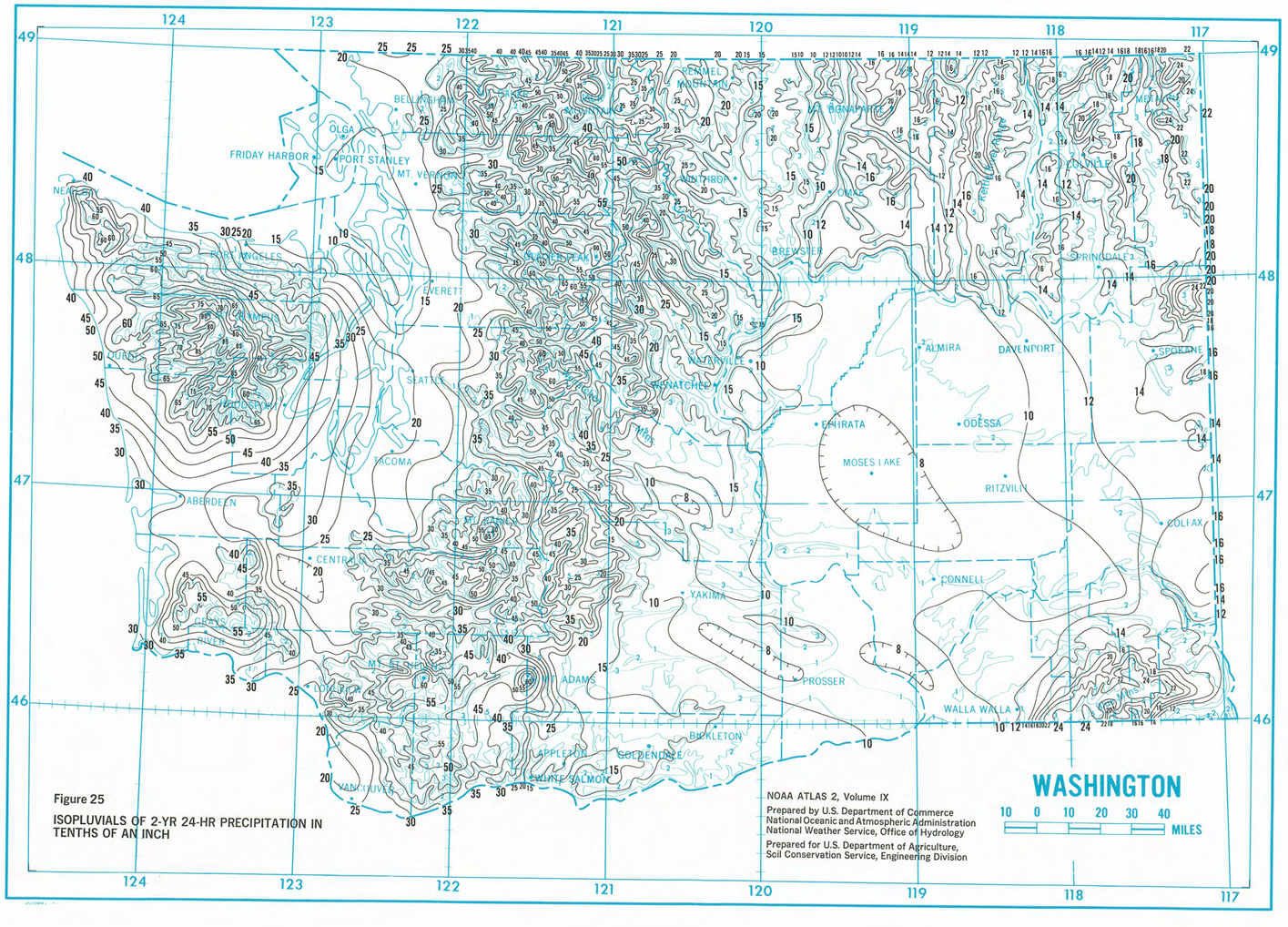
(5% DAMPING)

SEP. 2014 JOB NO. W1114-T3 FIG. 14B

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix E
Isopluvial Mapping



EX-0001-004069-PCE

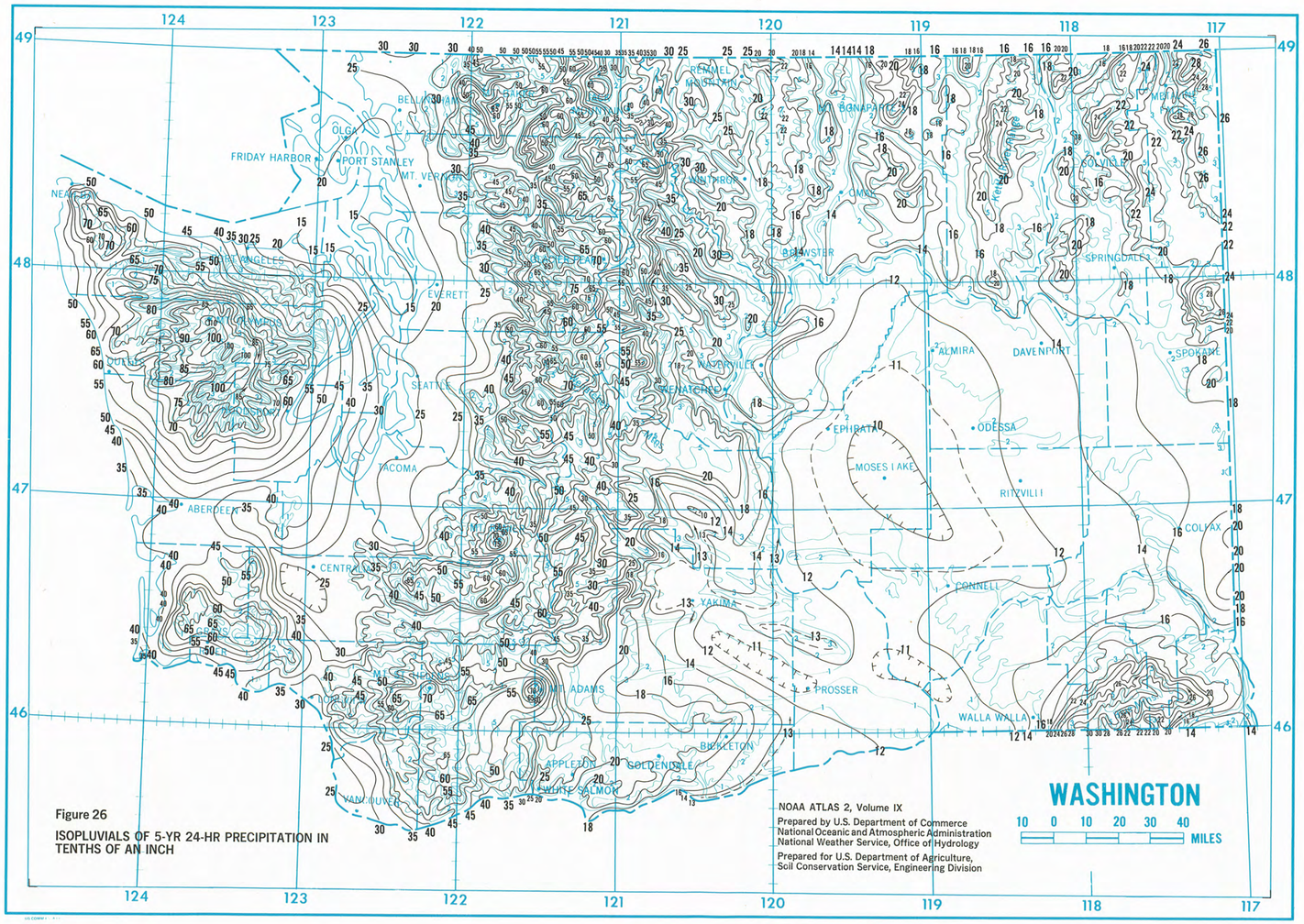


Figure 26

ISOPLUVIALS OF 5-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

EX-0001-004071-PCE

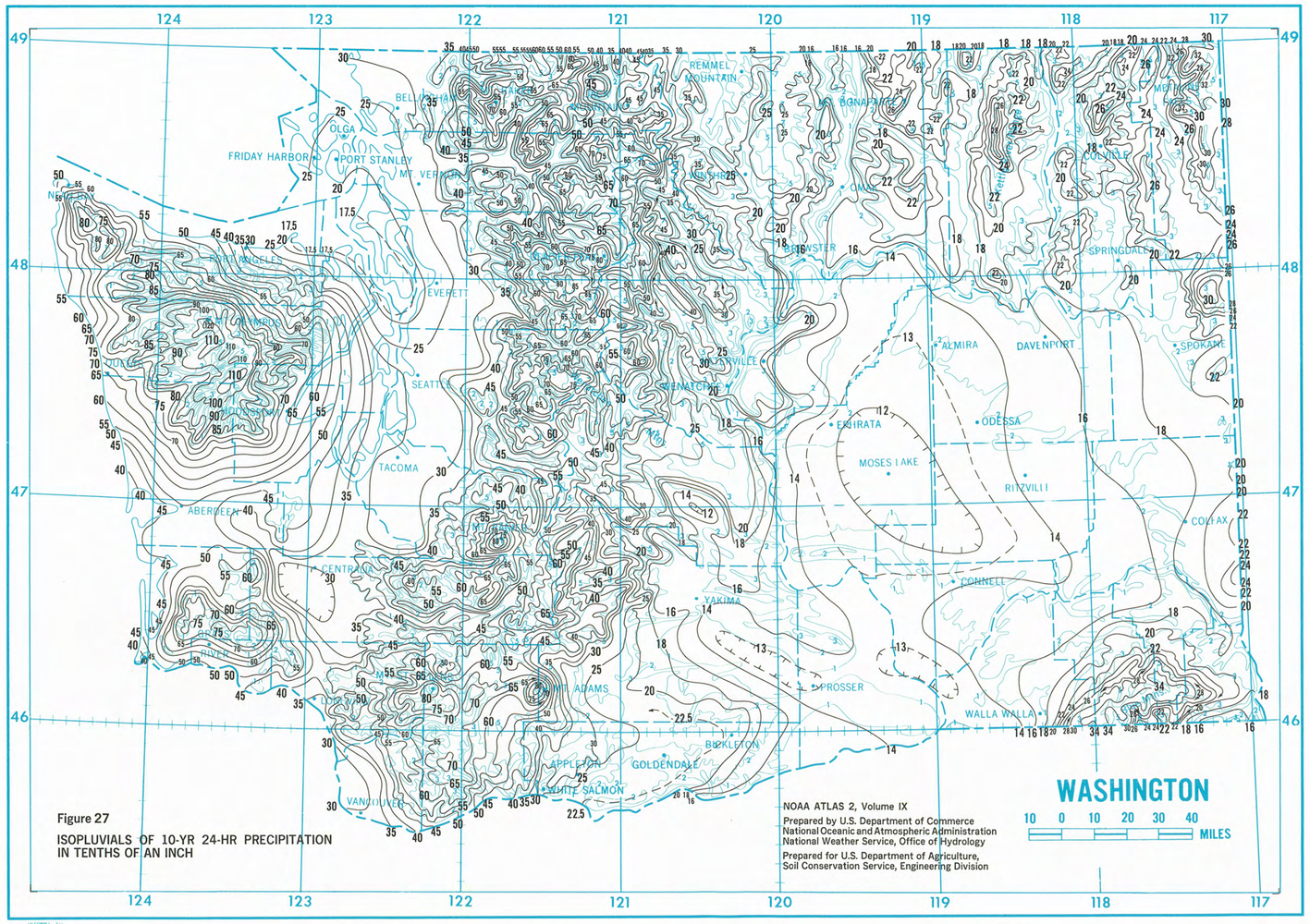
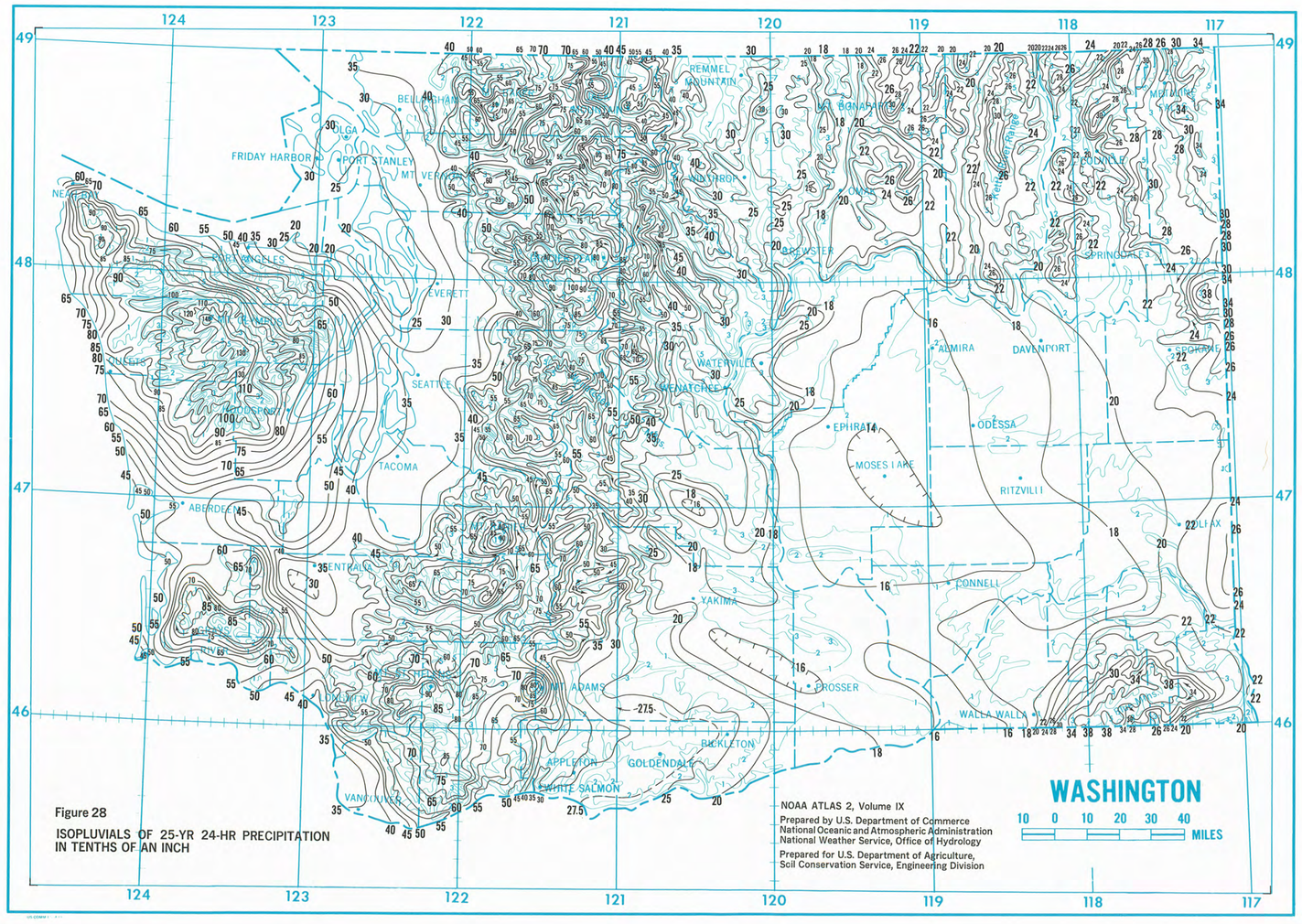


Figure 27

ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

EX-0001-004073-PCE



EX-0001-004075-PCE

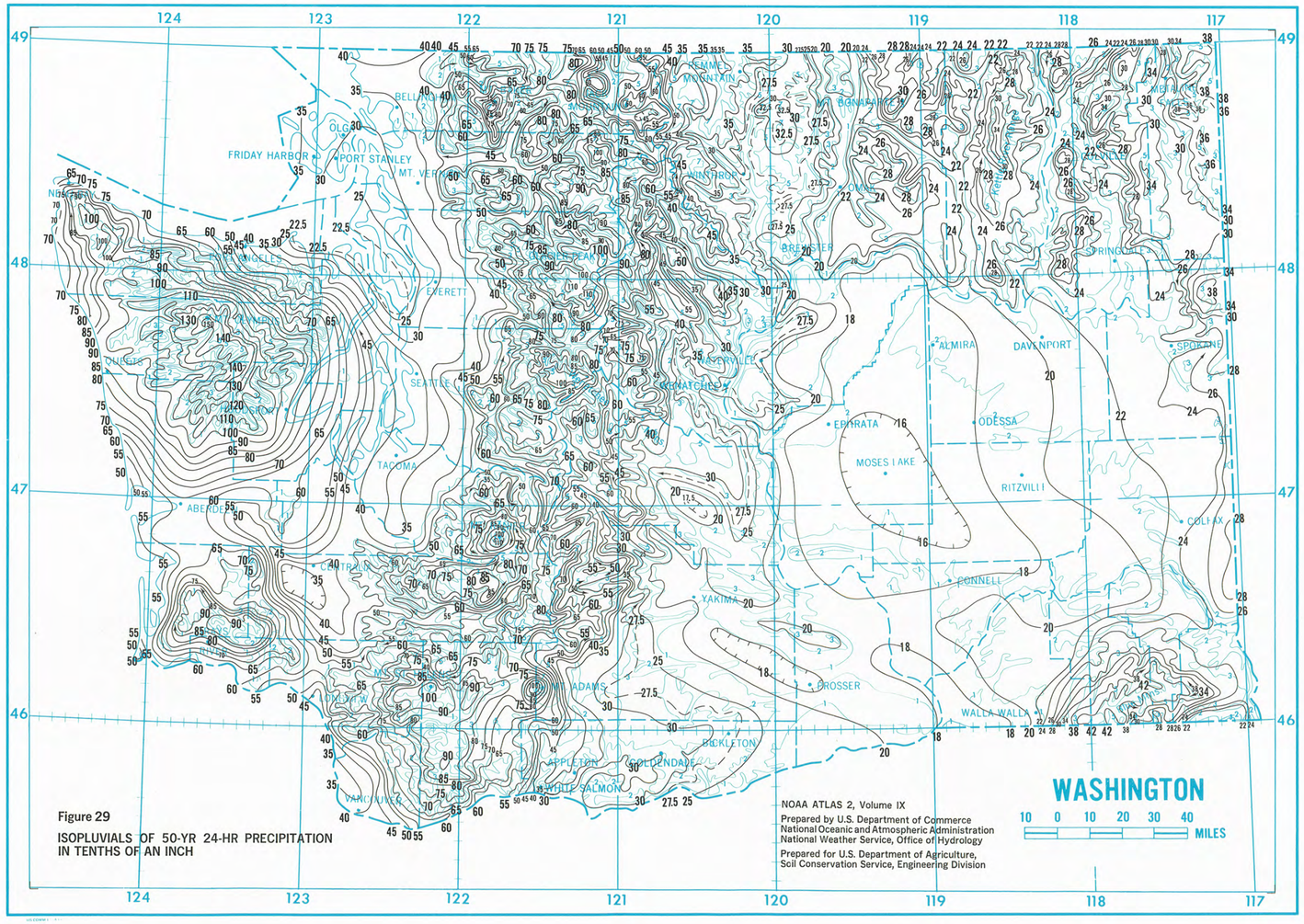


Figure 29

ISOPLUVIALS OF 50-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

EX-0001-004077-PCE

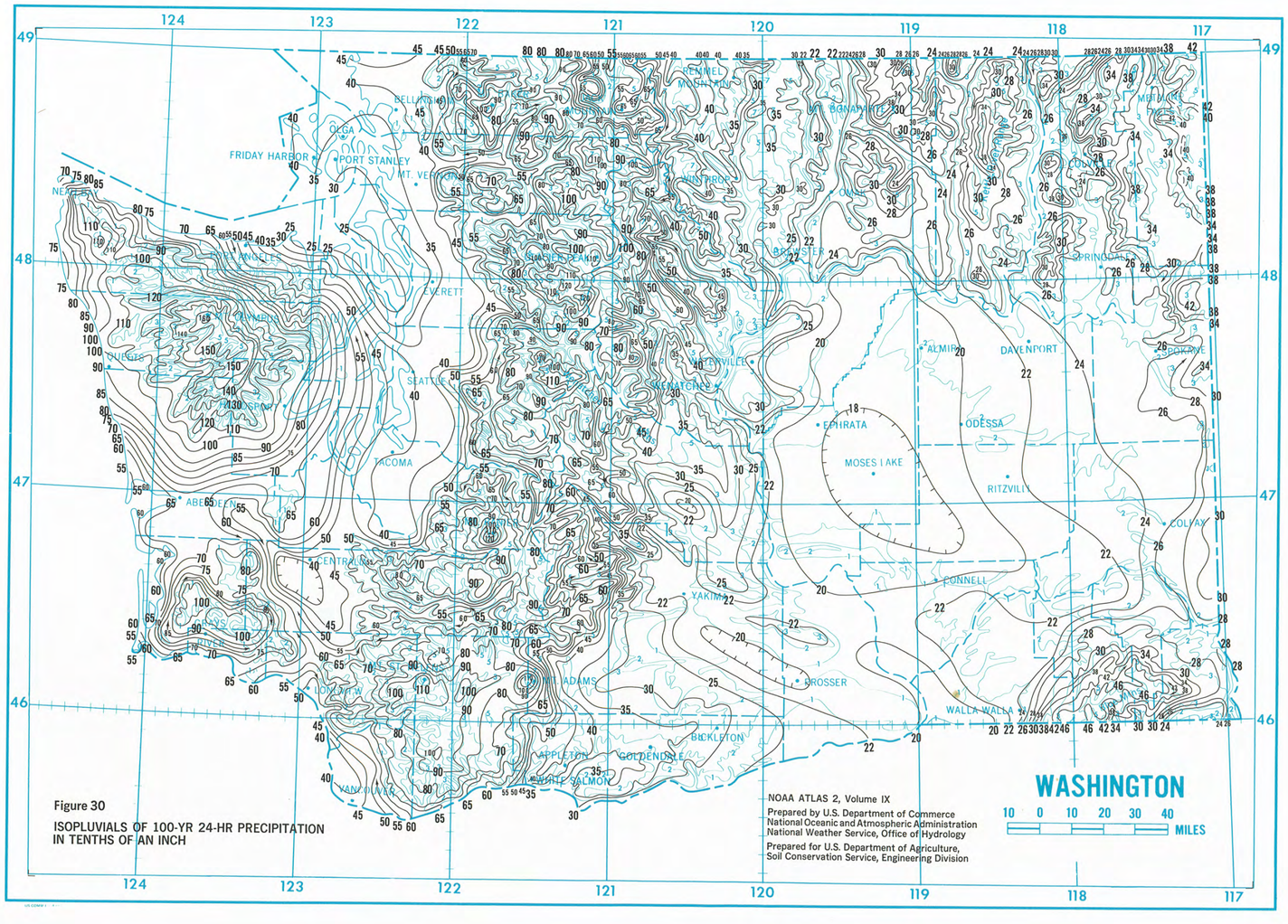


Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

☆ U.S. GOVERNMENT PRINTING OFFICE : 1974 O—507-860

EX-0001-004079-PCE

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix F
Construction Stormwater Calculations

Existing Surface Condition

Facility Area *WWHM3 Input*	Industrial Yard *Driveways (Flat)*	Roadways *Road (Flat)*	Misc. Impervious *Driveways (Flat)*	Pervious Surface *A/B Pasture (Flat)*	Open Water/Bank *Not Input in Model*	Total
200 - Unloading and Office	7.0	0.0	0.8	0.0	0.0	7.8
300 - Storage	20.8	0.0	0.0	0.0	0.0	20.8
400 - Marine Terminal	1.1	0.7	0.4	0.5	5.0	7.7
500 - Transfer Pipelines	2.4	0.6	0.3	1.6	0.0	4.9
600 - West Boiler	0.7	0.1	0.0	0.0	0.0	0.8
Rail Improvements	5.4	0.0	0.0	0.0	0.0	5.4
Total	37.4	1.4	1.6	2.0	5.0	47.4

Construction Surface Condition

Facility Area *WWHM3 Input*	Industrial Yard *Driveways (Flat)*	Roadways *Road (Flat)*	Misc. Impervious *Driveways (Flat)*	Pervious Surface *A/B Pasture (Flat)*	Open Water/Bank *Not Input in Model*	Total
200 - Unloading and Office	45.8	0.6	0.8	0.1	0.0	47.3
300 - Storage	24.6	0.3	0.0	0.0	0.0	24.9
400 - Marine Terminal	1.1	1.0	0.4	2.6	6.8	12.0
500 - Transfer Pipelines	6.4	2.1	1.1	3.3	0.0	12.9
600 - West Boiler	1.1	0.3	0.0	0.0	0.0	1.3
Rail Improvements	5.4	0.0	0.0	0.0	0.0	5.4
Total	84.4	4.2	2.4	6.0	6.8	103.9

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	VE_Construction2015_02-23
Site Name:	Vancouver Energy - Construction
Site Address:	
City:	Vancouver
Report Date:	2/24/2015
Gage:	I-5 Bridge
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.02
Version:	2014/04/24

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year
Low Flow Threshold for POC4:	50 Percent of the 2 Year
High Flow Threshold for POC4:	50 Year
Low Flow Threshold for POC5:	50 Percent of the 2 Year
High Flow Threshold for POC5:	50 Year
Low Flow Threshold for POC6:	50 Percent of the 2 Year
High Flow Threshold for POC6:	50 Year

Landuse Basin Data

Predeveloped Land Use

Area 200 - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
DRIVEWAYS FLAT	7.8
Impervious Total	7.8
Basin Total	7.8

Element Flows To:

Surface	Interflow	Groundwater

Area 300 - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
DRIVEWAYS FLAT	20.8
Impervious Total	20.8
Basin Total	20.8

Element Flows To:

Surface	Interflow	Groundwater

Area 400 - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
A B, Pasture, Flat	0.5
Pervious Total	0.5
Impervious Land Use	Acres
ROADS FLAT	0.7
DRIVEWAYS FLAT	1.1
Impervious Total	1.8
Basin Total	2.3

Element Flows To:

Surface	Interflow	Groundwater

Area 500 - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
A B, Pasture, Flat	1.5
Pervious Total	1.5
Impervious Land Use	Acres
ROADS FLAT	1
DRIVEWAYS FLAT	2.4
Impervious Total	3.4
Basin Total	4.9

Element Flows To:

Surface	Interflow	Groundwater

Area 600 - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
ROADS FLAT	0.1
DRIVEWAYS FLAT	0.7
Impervious Total	0.8
Basin Total	0.8

Element Flows To:

Surface	Interflow	Groundwater

RailImp - Existing

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
DRIVEWAYS FLAT	3.5
Impervious Total	3.5
Basin Total	3.5

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Area 200 - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
A B, Pasture, Flat	0.1
Pervious Total	0.1
Impervious Land Use	Acres
ROADS FLAT	0.6
DRIVEWAYS FLAT	46.6
Impervious Total	47.2
Basin Total	47.3

Element Flows To:

Surface	Interflow	Groundwater

Area 300 - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
ROADS FLAT	0.3
DRIVEWAYS FLAT	24.6
Impervious Total	24.9
Basin Total	24.9

Element Flows To:

Surface	Interflow	Groundwater

Area 400 - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
DRIVEWAYS FLAT	2.2
Impervious Total	2.2
Basin Total	2.2

Element Flows To:

Surface	Interflow	Groundwater

Area 500 - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
A B, Pasture, Flat	0.5
Pervious Total	0.5
Impervious Land Use	Acres
ROADS FLAT	3.2
DRIVEWAYS FLAT	9.2
Impervious Total	12.4
Basin Total	12.9

Element Flows To:

Surface	Interflow	Groundwater

Area 600 - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
ROADS FLAT	0.3
DRIVEWAYS FLAT	1.1
Impervious Total	1.4
Basin Total	1.4

Element Flows To:

Surface	Interflow	Groundwater

RailImp - Construction

Bypass:	No
GroundWater:	No
Pervious Land Use	Acres
Pervious Total	0
Impervious Land Use	Acres
DRIVEWAYS FLAT	3.5
Impervious Total	3.5
Basin Total	3.5

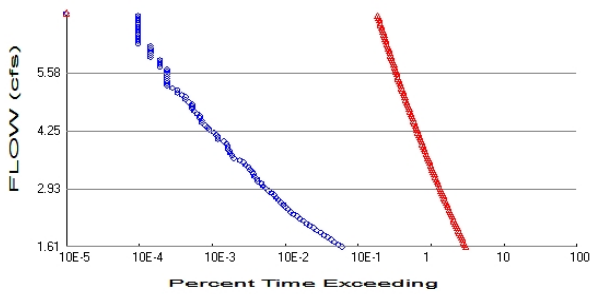
Element Flows To:

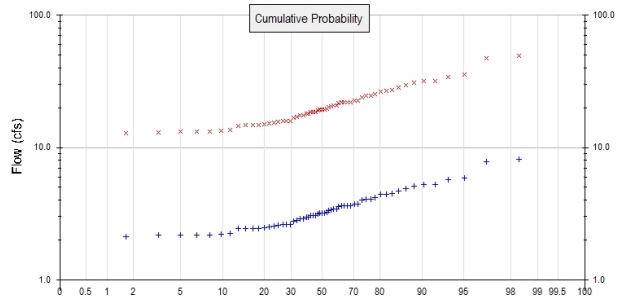
Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0
Total Impervious Area: 7.8

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.1
Total Impervious Area: 47.2

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	3.214386
5 year	4.271893
10 year	5.034589
25 year	6.071998
50 year	6.90004
100 year	7.776863

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	19.451303
5 year	25.850744
10 year	30.466169
25 year	36.744021
50 year	41.754912
100 year	47.061008

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	5.911	35.767
1950	2.758	16.688
1951	3.379	20.453
1952	3.450	20.878
1953	2.471	14.955
1954	4.409	26.682
1955	2.436	14.741
1956	4.055	24.538
1957	2.427	14.689
1958	3.587	21.705

1959	2.912	17.621
1960	3.051	18.465
1961	3.254	19.689
1962	2.183	13.209
1963	2.255	13.643
1964	2.424	14.665
1965	3.141	19.008
1966	2.557	15.476
1967	2.990	18.096
1968	5.248	31.756
1969	5.232	31.659
1970	7.762	46.976
1971	4.043	24.465
1972	3.068	18.567
1973	3.209	19.418
1974	3.621	21.909
1975	2.581	15.619
1976	2.826	17.103
1977	1.960	11.861
1978	3.192	19.317
1979	5.082	30.755
1980	2.508	15.177
1981	3.633	21.986
1982	3.641	22.031
1983	4.164	25.203
1984	2.437	14.745
1985	2.968	17.959
1986	4.515	27.323
1987	2.632	15.926
1988	2.636	15.952
1989	3.441	20.823
1990	2.108	12.753
1991	3.345	20.241
1992	2.223	13.454
1993	3.067	18.557
1994	2.635	15.948
1995	3.979	24.080
1996	5.679	34.367
1997	4.891	29.600
1998	4.713	28.520
1999	2.189	13.249
2000	2.165	13.102
2001	2.174	13.155
2002	3.758	22.743
2003	2.895	17.517
2004	3.631	21.969
2005	4.397	26.605
2006	3.725	22.539
2007	3.212	19.436
2008	8.170	49.439

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	8.1700	49.4392
2	7.7624	46.9760
3	5.9106	35.7669
4	5.6793	34.3668

5	5.2479	31.7563
6	5.2319	31.6594
7	5.0824	30.7551
8	4.8915	29.5996
9	4.7131	28.5204
10	4.5152	27.3225
11	4.4094	26.6823
12	4.3965	26.6045
13	4.1644	25.2030
14	4.0550	24.5380
15	4.0429	24.4648
16	3.9793	24.0800
17	3.7583	22.7425
18	3.7246	22.5386
19	3.6407	22.0311
20	3.6332	21.9858
21	3.6305	21.9692
22	3.6206	21.9093
23	3.5869	21.7054
24	3.4502	20.8783
25	3.4410	20.8226
26	3.3792	20.4533
27	3.3449	20.2407
28	3.2537	19.6889
29	3.2118	19.4355
30	3.2089	19.4182
31	3.1922	19.3167
32	3.1412	19.0082
33	3.0683	18.5673
34	3.0666	18.5569
35	3.0515	18.4654
36	2.9904	18.0959
37	2.9678	17.9590
38	2.9120	17.6214
39	2.8948	17.5172
40	2.8263	17.1030
41	2.7577	16.6875
42	2.6361	15.9521
43	2.6354	15.9475
44	2.6319	15.9262
45	2.5812	15.6193
46	2.5574	15.4756
47	2.5081	15.1774
48	2.4714	14.9549
49	2.4366	14.7445
50	2.4360	14.7407
51	2.4274	14.6888
52	2.4235	14.6653
53	2.2545	13.6427
54	2.2233	13.4535
55	2.1894	13.2489
56	2.1828	13.2088
57	2.1740	13.1553
58	2.1651	13.1017
59	2.1075	12.7533
60	1.9601	11.8610

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.6072	1258	63031	5010	Fail
1.6607	1118	60864	5444	Fail
1.7141	991	58844	5937	Fail
1.7676	896	56951	6356	Fail
1.8210	797	55057	6908	Fail
1.8745	712	53227	7475	Fail
1.9280	644	51418	7984	Fail
1.9814	572	49756	8698	Fail
2.0349	514	48178	9373	Fail
2.0884	455	46642	10250	Fail
2.1418	412	45106	10948	Fail
2.1953	372	43655	11735	Fail
2.2488	332	42308	12743	Fail
2.3022	305	40941	13423	Fail
2.3557	270	39615	14672	Fail
2.4091	251	38353	15280	Fail
2.4626	230	37154	16153	Fail
2.5161	209	35934	17193	Fail
2.5695	199	34819	17496	Fail
2.6230	181	33725	18632	Fail
2.6765	169	32631	19308	Fail
2.7299	158	31600	20000	Fail
2.7834	148	30632	20697	Fail
2.8368	136	29748	21873	Fail
2.8903	124	28865	23278	Fail
2.9438	112	28044	25039	Fail
2.9972	104	27140	26096	Fail
3.0507	99	26277	26542	Fail
3.1042	89	25499	28650	Fail
3.1576	87	24762	28462	Fail
3.2111	79	23984	30359	Fail
3.2645	77	23268	30218	Fail
3.3180	74	22553	30477	Fail
3.3715	70	21901	31287	Fail
3.4249	66	21291	32259	Fail
3.4784	61	20679	33900	Fail
3.5319	56	20077	35851	Fail
3.5853	50	19522	39044	Fail
3.6388	41	18975	46280	Fail
3.6923	39	18436	47271	Fail
3.7457	37	17889	48348	Fail
3.7992	36	17361	48225	Fail
3.8526	34	16898	49700	Fail
3.9061	34	16414	48276	Fail
3.9596	33	15983	48433	Fail
4.0130	30	15514	51713	Fail
4.0665	25	15063	60252	Fail
4.1200	25	14700	58800	Fail
4.1734	24	14254	59391	Fail
4.2269	22	13860	63000	Fail
4.2803	19	13475	70921	Fail
4.3338	18	13132	72955	Fail
4.3873	17	12785	75205	Fail
4.4407	15	12444	82960	Fail

4.4942	15	12116	80773	Fail
4.5477	14	11782	84157	Fail
4.6011	14	11436	81685	Fail
4.6546	13	11125	85576	Fail
4.7081	12	10807	90058	Fail
4.7615	11	10517	95609	Fail
4.8150	11	10250	93181	Fail
4.8684	11	9983	90754	Fail
4.9219	10	9705	97050	Fail
4.9754	9	9446	104955	Fail
5.0288	9	9194	102155	Fail
5.0823	8	8967	112087	Fail
5.1358	7	8750	125000	Fail
5.1892	7	8539	121985	Fail
5.2427	6	8298	138300	Fail
5.2961	5	8062	161240	Fail
5.3496	5	7862	157240	Fail
5.4031	5	7656	153120	Fail
5.4565	5	7469	149380	Fail
5.5100	5	7290	145800	Fail
5.5635	5	7113	142260	Fail
5.6169	5	6962	139240	Fail
5.6704	5	6789	135780	Fail
5.7239	4	6644	166100	Fail
5.7773	4	6474	161850	Fail
5.8308	4	6318	157950	Fail
5.8842	4	6156	153900	Fail
5.9377	3	6015	200500	Fail
5.9912	3	5874	195800	Fail
6.0446	3	5737	191233	Fail
6.0981	3	5605	186833	Fail
6.1516	3	5468	182266	Fail
6.2050	3	5321	177366	Fail
6.2585	2	5182	259100	Fail
6.3119	2	5066	253300	Fail
6.3654	2	4959	247950	Fail
6.4189	2	4839	241950	Fail
6.4723	2	4740	237000	Fail
6.5258	2	4601	230050	Fail
6.5793	2	4500	225000	Fail
6.6327	2	4399	219950	Fail
6.6862	2	4300	215000	Fail
6.7397	2	4206	210300	Fail
6.7931	2	4090	204500	Fail
6.8466	2	3991	199550	Fail
6.9000	2	3894	194700	Fail

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

Water Quality

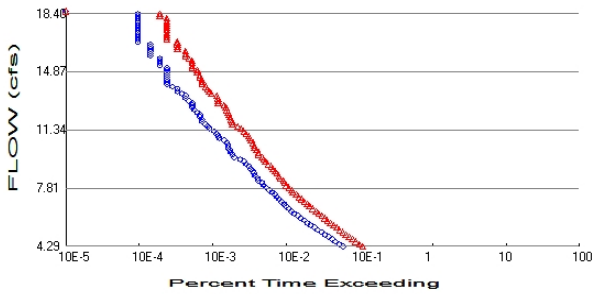
Water Quality BMP Flow and Volume for POC #1

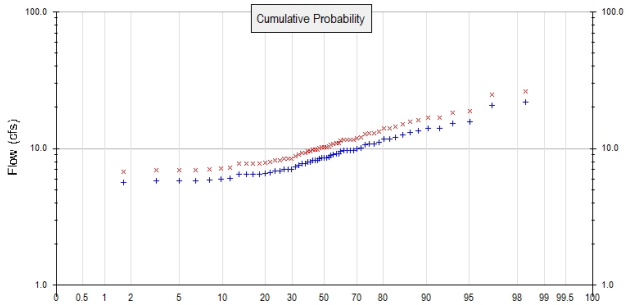
On-line facility volume:	5.3145 acre-feet
On-line facility target flow:	6.7254 cfs.
Adjusted for 15 min:	7.5997 cfs.
Off-line facility target flow:	3.8357 cfs.
Adjusted for 15 min:	4.3343 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 0
Total Impervious Area: 20.8

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0
Total Impervious Area: 24.9

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	8.571694
5 year	11.391712
10 year	13.425566
25 year	16.191986
50 year	18.400096
100 year	20.738287

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	10.261309
5 year	13.637194
10 year	16.071952
25 year	19.383674
50 year	22.027036
100 year	24.82612

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	15.762	18.869
1950	7.354	8.803
1951	9.011	10.788
1952	9.201	11.014
1953	6.590	7.889
1954	11.758	14.076
1955	6.496	7.776
1956	10.813	12.945
1957	6.473	7.749
1958	9.565	11.451
1959	7.765	9.296

1960	8.137	9.741
1961	8.676	10.387
1962	5.821	6.968
1963	6.012	7.197
1964	6.463	7.737
1965	8.376	10.028
1966	6.820	8.164
1967	7.974	9.546
1968	13.994	16.753
1969	13.952	16.702
1970	20.700	24.780
1971	10.781	12.906
1972	8.182	9.795
1973	8.557	10.244
1974	9.655	11.558
1975	6.883	8.240
1976	7.537	9.023
1977	5.227	6.257
1978	8.512	10.190
1979	13.553	16.225
1980	6.688	8.007
1981	9.689	11.598
1982	9.709	11.622
1983	11.105	13.294
1984	6.498	7.778
1985	7.914	9.474
1986	12.040	14.414
1987	7.018	8.402
1988	7.030	8.415
1989	9.176	10.985
1990	5.620	6.728
1991	8.920	10.678
1992	5.929	7.097
1993	8.178	9.790
1994	7.028	8.413
1995	10.612	12.703
1996	15.145	18.130
1997	13.044	15.615
1998	12.568	15.046
1999	5.838	6.989
2000	5.774	6.912
2001	5.797	6.940
2002	10.022	11.998
2003	7.719	9.241
2004	9.681	11.590
2005	11.724	14.035
2006	9.932	11.890
2007	8.565	10.253
2008	21.787	26.081

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	21.7867	26.0812
2	20.6996	24.7798
3	15.7617	18.8685
4	15.1447	18.1300
5	13.9943	16.7527

6	13.9516	16.7017
7	13.5531	16.2246
8	13.0439	15.6151
9	12.5683	15.0457
10	12.0404	14.4138
11	11.7583	14.0760
12	11.7240	14.0350
13	11.1051	13.2941
14	10.8132	12.9447
15	10.7811	12.9062
16	10.6115	12.7032
17	10.0221	11.9976
18	9.9323	11.8901
19	9.7086	11.6223
20	9.6886	11.5984
21	9.6813	11.5897
22	9.6550	11.5581
23	9.5651	11.4505
24	9.2006	11.0142
25	9.1761	10.9848
26	9.0113	10.7876
27	8.9196	10.6778
28	8.6765	10.3867
29	8.5648	10.2531
30	8.5572	10.2439
31	8.5124	10.1904
32	8.3765	10.0276
33	8.1822	9.7951
34	8.1776	9.7896
35	8.1373	9.7413
36	7.9745	9.5464
37	7.9141	9.4741
38	7.7653	9.2960
39	7.7194	9.2411
40	7.5369	9.0225
41	7.3538	8.8034
42	7.0297	8.4154
43	7.0277	8.4130
44	7.0183	8.4018
45	6.8831	8.2398
46	6.8197	8.1640
47	6.6883	8.0067
48	6.5903	7.8893
49	6.4976	7.7784
50	6.4959	7.7763
51	6.4730	7.7489
52	6.4627	7.7366
53	6.0120	7.1971
54	5.9287	7.0973
55	5.8385	6.9893
56	5.8208	6.9682
57	5.7972	6.9399
58	5.7736	6.9117
59	5.6201	6.7279
60	5.2269	6.2572

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
4.2858	1258	2339	185	Fail
4.4284	1117	2100	188	Fail
4.5710	992	1885	190	Fail
4.7136	894	1699	190	Fail
4.8561	797	1526	191	Fail
4.9987	712	1372	192	Fail
5.1413	642	1249	194	Fail
5.2838	572	1132	197	Fail
5.4264	514	1026	199	Fail
5.5690	455	930	204	Fail
5.7115	412	847	205	Fail
5.8541	372	774	208	Fail
5.9967	332	709	213	Fail
6.1392	305	652	213	Fail
6.2818	270	584	216	Fail
6.4244	251	540	215	Fail
6.5669	230	486	211	Fail
6.7095	209	441	211	Fail
6.8521	199	409	205	Fail
6.9946	181	373	206	Fail
7.1372	169	340	201	Fail
7.2798	158	316	200	Fail
7.4223	148	290	195	Fail
7.5649	136	263	193	Fail
7.7075	124	250	201	Fail
7.8501	112	230	205	Fail
7.9926	104	213	204	Fail
8.1352	99	202	204	Fail
8.2778	89	193	216	Fail
8.4203	87	175	201	Fail
8.5629	79	169	213	Fail
8.7055	77	158	205	Fail
8.8480	74	149	201	Fail
8.9906	70	139	198	Fail
9.1332	66	132	200	Fail
9.2757	61	120	196	Fail
9.4183	56	111	198	Fail
9.5609	50	104	208	Fail
9.7034	41	99	241	Fail
9.8460	39	89	228	Fail
9.9886	37	89	240	Fail
10.1311	36	83	230	Fail
10.2737	34	78	229	Fail
10.4163	34	77	226	Fail
10.5588	33	75	227	Fail
10.7014	30	70	233	Fail
10.8440	26	67	257	Fail
10.9866	25	65	260	Fail
11.1291	24	60	250	Fail
11.2717	22	56	254	Fail
11.4143	19	51	268	Fail
11.5568	18	46	255	Fail
11.6994	17	39	229	Fail
11.8420	15	39	260	Fail

11.9845	15	37	246	Fail
12.1271	14	36	257	Fail
12.2697	14	35	250	Fail
12.4122	13	34	261	Fail
12.5548	12	33	275	Fail
12.6974	11	32	290	Fail
12.8399	11	30	272	Fail
12.9825	11	25	227	Fail
13.1251	10	25	250	Fail
13.2676	9	25	277	Fail
13.4102	9	24	266	Fail
13.5528	8	20	250	Fail
13.6953	7	19	271	Fail
13.8379	7	18	257	Fail
13.9805	6	17	283	Fail
14.1231	5	15	300	Fail
14.2656	5	15	300	Fail
14.4082	5	15	300	Fail
14.5508	5	14	280	Fail
14.6933	5	14	280	Fail
14.8359	5	13	260	Fail
14.9785	5	13	260	Fail
15.1210	5	11	220	Fail
15.2636	4	11	275	Fail
15.4062	4	11	275	Fail
15.5487	4	11	275	Fail
15.6913	4	10	250	Fail
15.8339	3	9	300	Fail
15.9764	3	9	300	Fail
16.1190	3	9	300	Fail
16.2616	3	7	233	Fail
16.4041	3	7	233	Fail
16.5467	3	7	233	Fail
16.6893	2	7	350	Fail
16.8318	2	5	250	Fail
16.9744	2	5	250	Fail
17.1170	2	5	250	Fail
17.2596	2	5	250	Fail
17.4021	2	5	250	Fail
17.5447	2	5	250	Fail
17.6873	2	5	250	Fail
17.8298	2	5	250	Fail
17.9724	2	5	250	Fail
18.1150	2	5	250	Fail
18.2575	2	4	200	Fail
18.4001	2	4	200	Fail

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

Water Quality

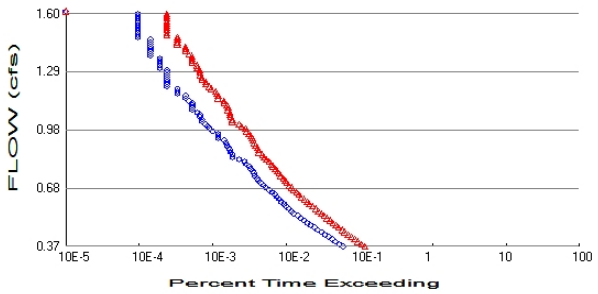
Water Quality BMP Flow and Volume for POC #2

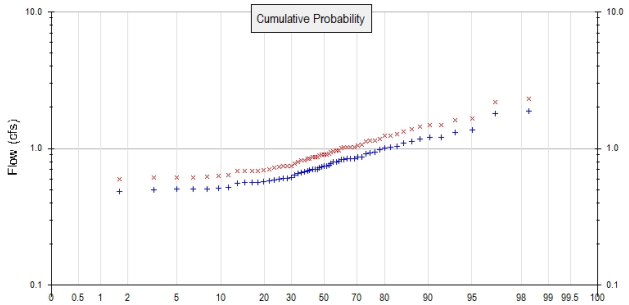
On-line facility volume:	2.8048 acre-feet
On-line facility target flow:	3.5479 cfs.
Adjusted for 15 min:	4.0091 cfs.
Off-line facility target flow:	2.0232 cfs.
Adjusted for 15 min:	2.2862 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

POC 3





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 0.5
Total Impervious Area: 1.8

Mitigated Landuse Totals for POC #3
Total Pervious Area: 0
Total Impervious Area: 2.2

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	0.742504
5 year	0.987397
10 year	1.164103
25 year	1.40455
50 year	1.596536
100 year	1.799887

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	0.906622
5 year	1.204892
10 year	1.420012
25 year	1.712613
50 year	1.946163
100 year	2.193472

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1949	1.364	1.667
1950	0.636	0.778
1951	0.802	0.953
1952	0.796	0.973
1953	0.571	0.697
1954	1.018	1.244
1955	0.562	0.687
1956	0.937	1.144
1957	0.560	0.685
1958	0.828	1.012
1959	0.672	0.821

1960	0.704	0.861
1961	0.751	0.918
1962	0.504	0.616
1963	0.520	0.636
1964	0.559	0.684
1965	0.725	0.886
1966	0.590	0.721
1967	0.690	0.843
1968	1.211	1.480
1969	1.207	1.476
1970	1.810	2.189
1971	0.933	1.140
1972	0.708	0.865
1973	0.741	0.905
1974	0.836	1.021
1975	0.596	0.728
1976	0.652	0.797
1977	0.452	0.553
1978	0.737	0.900
1979	1.173	1.434
1980	0.579	0.707
1981	0.838	1.025
1982	0.840	1.027
1983	0.976	1.175
1984	0.562	0.687
1985	0.685	0.837
1986	1.042	1.274
1987	0.607	0.742
1988	0.609	0.744
1989	0.794	0.971
1990	0.486	0.594
1991	0.772	0.943
1992	0.513	0.627
1993	0.708	0.865
1994	0.608	0.743
1995	0.918	1.122
1996	1.311	1.602
1997	1.129	1.380
1998	1.088	1.329
1999	0.505	0.618
2000	0.500	0.611
2001	0.502	0.613
2002	0.867	1.060
2003	0.668	0.816
2004	0.838	1.024
2005	1.015	1.240
2006	0.860	1.051
2007	0.741	0.906
2008	1.886	2.304

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	1.8855	2.3044
2	1.8102	2.1894
3	1.3640	1.6671
4	1.3106	1.6018
5	1.2113	1.4802

6	1.2074	1.4757
7	1.1729	1.4335
8	1.1288	1.3796
9	1.0877	1.3293
10	1.0421	1.2735
11	1.0179	1.2437
12	1.0147	1.2400
13	0.9756	1.1746
14	0.9370	1.1437
15	0.9331	1.1403
16	0.9185	1.1224
17	0.8673	1.0600
18	0.8596	1.0505
19	0.8403	1.0269
20	0.8384	1.0248
21	0.8380	1.0240
22	0.8355	1.0212
23	0.8278	1.0117
24	0.8024	0.9731
25	0.7962	0.9705
26	0.7941	0.9531
27	0.7719	0.9434
28	0.7509	0.9177
29	0.7412	0.9059
30	0.7406	0.9051
31	0.7367	0.9004
32	0.7249	0.8860
33	0.7081	0.8654
34	0.7077	0.8649
35	0.7042	0.8607
36	0.6901	0.8435
37	0.6851	0.8371
38	0.6724	0.8213
39	0.6681	0.8165
40	0.6523	0.7972
41	0.6364	0.7778
42	0.6086	0.7435
43	0.6084	0.7433
44	0.6074	0.7423
45	0.5957	0.7280
46	0.5905	0.7213
47	0.5788	0.7074
48	0.5707	0.6970
49	0.5623	0.6872
50	0.5622	0.6871
51	0.5602	0.6846
52	0.5593	0.6836
53	0.5204	0.6359
54	0.5131	0.6271
55	0.5053	0.6175
56	0.5037	0.6157
57	0.5020	0.6132
58	0.4996	0.6107
59	0.4864	0.5944
60	0.4524	0.5528

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.3713	1259	2508	199	Fail
0.3836	1120	2247	200	Fail
0.3960	989	2013	203	Fail
0.4084	894	1813	202	Fail
0.4208	800	1634	204	Fail
0.4331	711	1477	207	Fail
0.4455	643	1335	207	Fail
0.4579	573	1222	213	Fail
0.4703	513	1096	213	Fail
0.4826	454	1005	221	Fail
0.4950	410	914	222	Fail
0.5074	371	834	224	Fail
0.5198	332	763	229	Fail
0.5321	304	699	229	Fail
0.5445	269	639	237	Fail
0.5569	251	581	231	Fail
0.5693	230	536	233	Fail
0.5817	211	484	229	Fail
0.5940	198	436	220	Fail
0.6064	180	408	226	Fail
0.6188	169	373	220	Fail
0.6312	158	337	213	Fail
0.6435	147	316	214	Fail
0.6559	136	293	215	Fail
0.6683	124	264	212	Fail
0.6807	111	250	225	Fail
0.6930	104	230	221	Fail
0.7054	95	215	226	Fail
0.7178	89	205	230	Fail
0.7302	86	195	226	Fail
0.7426	78	178	228	Fail
0.7549	77	169	219	Fail
0.7673	74	160	216	Fail
0.7797	70	150	214	Fail
0.7921	67	140	208	Fail
0.8044	60	133	221	Fail
0.8168	57	124	217	Fail
0.8292	48	113	235	Fail
0.8416	39	105	269	Fail
0.8539	39	101	258	Fail
0.8663	37	90	243	Fail
0.8787	36	89	247	Fail
0.8911	35	86	245	Fail
0.9034	33	81	245	Fail
0.9158	32	78	243	Fail
0.9282	30	75	250	Fail
0.9406	25	73	292	Fail
0.9530	25	70	280	Fail
0.9653	25	66	264	Fail
0.9777	21	61	290	Fail
0.9901	19	59	310	Fail
1.0025	18	52	288	Fail
1.0148	17	48	282	Fail
1.0272	15	39	260	Fail

1.0396	15	39	260	Fail
1.0520	14	37	264	Fail
1.0643	14	36	257	Fail
1.0767	13	36	276	Fail
1.0891	11	34	309	Fail
1.1015	11	34	309	Fail
1.1138	11	33	300	Fail
1.1262	11	30	272	Fail
1.1386	10	30	300	Fail
1.1510	9	25	277	Fail
1.1634	9	25	277	Fail
1.1757	7	24	342	Fail
1.1881	7	23	328	Fail
1.2005	7	20	285	Fail
1.2129	5	19	380	Fail
1.2252	5	17	340	Fail
1.2376	5	17	340	Fail
1.2500	5	15	300	Fail
1.2624	5	15	300	Fail
1.2747	5	14	280	Fail
1.2871	5	14	280	Fail
1.2995	5	14	280	Fail
1.3119	4	13	325	Fail
1.3243	4	13	325	Fail
1.3366	4	11	275	Fail
1.3490	4	11	275	Fail
1.3614	4	11	275	Fail
1.3738	3	11	366	Fail
1.3861	3	10	333	Fail
1.3985	3	9	300	Fail
1.4109	3	9	300	Fail
1.4233	3	9	300	Fail
1.4356	3	7	233	Fail
1.4480	3	7	233	Fail
1.4604	3	7	233	Fail
1.4728	2	7	350	Fail
1.4851	2	5	250	Fail
1.4975	2	5	250	Fail
1.5099	2	5	250	Fail
1.5223	2	5	250	Fail
1.5347	2	5	250	Fail
1.5470	2	5	250	Fail
1.5594	2	5	250	Fail
1.5718	2	5	250	Fail
1.5842	2	5	250	Fail
1.5965	2	5	250	Fail

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

Water Quality

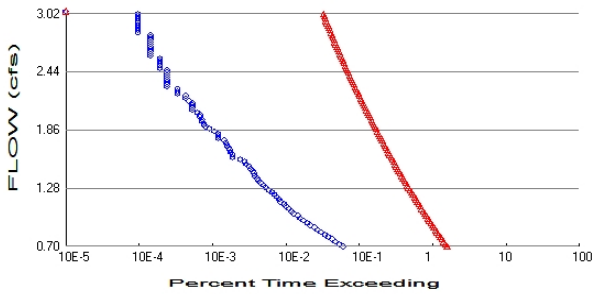
Water Quality BMP Flow and Volume for POC #3

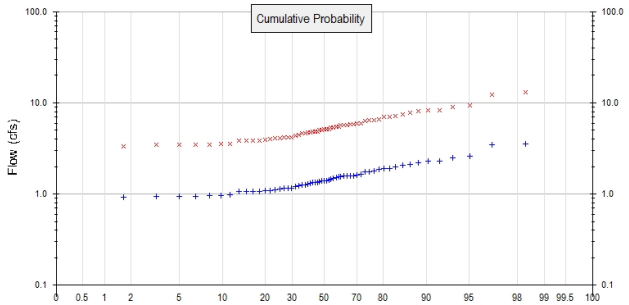
On-line facility volume:	0.169 acre-feet
On-line facility target flow:	0.2137 cfs.
Adjusted for 15 min:	0.2415 cfs.
Off-line facility target flow:	0.1218 cfs.
Adjusted for 15 min:	0.1377 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

POC 4





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #4
Total Pervious Area: 1.5
Total Impervious Area: 3.4

Mitigated Landuse Totals for POC #4
Total Pervious Area: 0.5
Total Impervious Area: 12.4

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #4

Return Period	**Flow(cfs)**
2 year	1.403297
5 year	1.866852
10 year	2.201438
25 year	2.656822
50 year	3.020503
100 year	3.405777

Flow Frequency Return Periods for Mitigated. POC #4

Return Period	**Flow(cfs)**
2 year	5.11078
5 year	6.792783
10 year	8.005961
25 year	9.656198
50 year	10.973454
100 year	12.368363

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #4

Year	**Predeveloped**	**Mitigated**
1949	2.577	9.396
1950	1.202	4.384
1951	1.541	5.395
1952	1.504	5.485
1953	1.078	3.929
1954	1.923	7.010
1955	1.062	3.873
1956	1.771	6.448
1957	1.058	3.859
1958	1.564	5.702
1959	1.270	4.630

1960	1.330	4.851
1961	1.418	5.173
1962	0.951	3.470
1963	0.983	3.584
1964	1.057	3.853
1965	1.369	4.994
1966	1.116	4.066
1967	1.304	4.754
1968	2.288	8.343
1969	2.281	8.317
1970	3.440	12.359
1971	1.763	6.427
1972	1.338	4.878
1973	1.399	5.101
1974	1.578	5.756
1975	1.125	4.103
1976	1.232	4.493
1977	0.855	3.116
1978	1.392	5.075
1979	2.215	8.080
1980	1.093	3.987
1981	1.584	5.776
1982	1.587	5.788
1983	1.859	6.635
1984	1.062	3.874
1985	1.294	4.718
1986	1.969	7.178
1987	1.147	4.184
1988	1.150	4.191
1989	1.500	5.470
1990	0.919	3.350
1991	1.458	5.317
1992	0.969	3.534
1993	1.337	4.875
1994	1.150	4.190
1995	1.735	6.326
1996	2.476	9.029
1997	2.132	7.776
1998	2.054	7.493
1999	0.955	3.481
2000	0.944	3.442
2001	0.949	3.456
2002	1.638	5.975
2003	1.262	4.602
2004	1.583	5.772
2005	1.917	6.989
2006	1.624	5.921
2007	1.400	5.106
2008	3.562	12.988

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #4

Rank	Predeveloped	Mitigated
1	3.5616	12.9884
2	3.4404	12.3591
3	2.5765	9.3964
4	2.4756	9.0286
5	2.2884	8.3430

6	2.2806	8.3173
7	2.2155	8.0798
8	2.1323	7.7762
9	2.0545	7.4927
10	1.9686	7.1781
11	1.9231	7.0101
12	1.9168	6.9894
13	1.8590	6.6349
14	1.7712	6.4476
15	1.7625	6.4273
16	1.7351	6.3263
17	1.6383	5.9748
18	1.6237	5.9212
19	1.5874	5.7880
20	1.5838	5.7759
21	1.5830	5.7717
22	1.5783	5.7559
23	1.5636	5.7023
24	1.5408	5.4850
25	1.5040	5.4704
26	1.5000	5.3947
27	1.4581	5.3175
28	1.4183	5.1725
29	1.4000	5.1059
30	1.3989	5.1015
31	1.3915	5.0747
32	1.3693	4.9937
33	1.3376	4.8779
34	1.3367	4.8751
35	1.3301	4.8511
36	1.3035	4.7540
37	1.2943	4.7182
38	1.2704	4.6297
39	1.2619	4.6020
40	1.2321	4.4932
41	1.2021	4.3840
42	1.1498	4.1910
43	1.1495	4.1898
44	1.1472	4.1840
45	1.1251	4.1034
46	1.1157	4.0659
47	1.0933	3.9873
48	1.0784	3.9292
49	1.0621	3.8736
50	1.0619	3.8726
51	1.0581	3.8589
52	1.0566	3.8528
53	0.9832	3.5843
54	0.9691	3.5344
55	0.9545	3.4807
56	0.9515	3.4701
57	0.9486	3.4564
58	0.9438	3.4420
59	0.9188	3.3505
60	0.8547	3.1161

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.7016	1257	32799	2609	Fail
0.7251	1112	31032	2790	Fail
0.7485	990	29580	2987	Fail
0.7719	894	28170	3151	Fail
0.7953	793	26656	3361	Fail
0.8188	711	25351	3565	Fail
0.8422	639	24068	3766	Fail
0.8656	570	22890	4015	Fail
0.8890	509	21775	4277	Fail
0.9125	451	20771	4605	Fail
0.9359	411	19793	4815	Fail
0.9593	367	18836	5132	Fail
0.9827	331	17967	5428	Fail
1.0061	303	17115	5648	Fail
1.0296	269	16341	6074	Fail
1.0530	251	15579	6206	Fail
1.0764	230	14870	6465	Fail
1.0998	211	14184	6722	Fail
1.1233	198	13526	6831	Fail
1.1467	178	12932	7265	Fail
1.1701	169	12375	7322	Fail
1.1935	158	11819	7480	Fail
1.2169	145	11268	7771	Fail
1.2404	136	10732	7891	Fail
1.2638	122	10284	8429	Fail
1.2872	111	9825	8851	Fail
1.3106	104	9402	9040	Fail
1.3341	94	8983	9556	Fail
1.3575	89	8638	9705	Fail
1.3809	86	8249	9591	Fail
1.4043	78	7883	10106	Fail
1.4278	77	7563	9822	Fail
1.4512	74	7241	9785	Fail
1.4746	69	6970	10101	Fail
1.4980	66	6697	10146	Fail
1.5214	61	6438	10554	Fail
1.5449	57	6179	10840	Fail
1.5683	50	5939	11878	Fail
1.5917	39	5710	14641	Fail
1.6151	39	5483	14058	Fail
1.6386	37	5243	14170	Fail
1.6620	36	5045	14013	Fail
1.6854	35	4847	13848	Fail
1.7088	33	4664	14133	Fail
1.7323	32	4475	13984	Fail
1.7557	30	4311	14370	Fail
1.7791	25	4134	16536	Fail
1.8025	25	3968	15872	Fail
1.8259	25	3814	15256	Fail
1.8494	22	3686	16754	Fail
1.8728	19	3551	18689	Fail
1.8962	17	3415	20088	Fail
1.9196	16	3309	20681	Fail
1.9431	15	3181	21206	Fail

1.9665	15	3076	20506	Fail
1.9899	14	2958	21128	Fail
2.0133	14	2851	20364	Fail
2.0367	13	2735	21038	Fail
2.0602	11	2617	23790	Fail
2.0836	11	2535	23045	Fail
2.1070	11	2445	22227	Fail
2.1304	11	2354	21400	Fail
2.1539	10	2264	22640	Fail
2.1773	9	2175	24166	Fail
2.2007	9	2114	23488	Fail
2.2241	7	2045	29214	Fail
2.2476	7	1969	28128	Fail
2.2710	7	1893	27042	Fail
2.2944	5	1827	36540	Fail
2.3178	5	1771	35420	Fail
2.3412	5	1707	34140	Fail
2.3647	5	1643	32860	Fail
2.3881	5	1588	31760	Fail
2.4115	5	1544	30879	Fail
2.4349	5	1487	29740	Fail
2.4584	5	1436	28720	Fail
2.4818	4	1385	34625	Fail
2.5052	4	1343	33575	Fail
2.5286	4	1299	32475	Fail
2.5520	4	1261	31525	Fail
2.5755	4	1223	30575	Fail
2.5989	3	1188	39600	Fail
2.6223	3	1143	38100	Fail
2.6457	3	1107	36900	Fail
2.6692	3	1069	35633	Fail
2.6926	3	1044	34800	Fail
2.7160	3	1006	33533	Fail
2.7394	3	973	32433	Fail
2.7629	3	947	31566	Fail
2.7863	3	917	30566	Fail
2.8097	3	896	29866	Fail
2.8331	2	864	43200	Fail
2.8565	2	835	41750	Fail
2.8800	2	808	40400	Fail
2.9034	2	791	39550	Fail
2.9268	2	762	38100	Fail
2.9502	2	737	36850	Fail
2.9737	2	718	35900	Fail
2.9971	2	701	35050	Fail
3.0205	2	682	34100	Fail

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

Water Quality

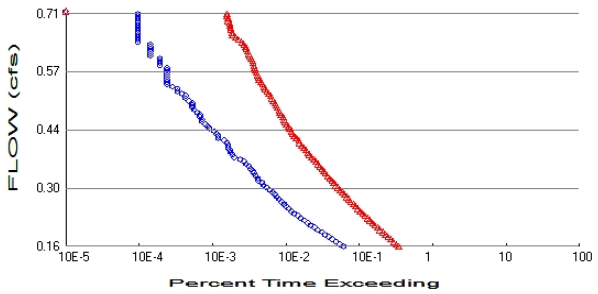
Water Quality BMP Flow and Volume for POC #4

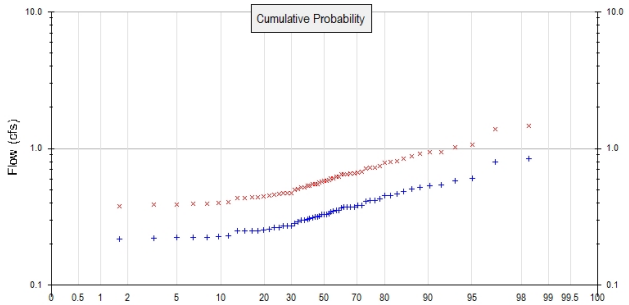
On-line facility volume:	1.3964 acre-feet
On-line facility target flow:	1.7668 cfs.
Adjusted for 15 min:	1.9964 cfs.
Off-line facility target flow:	1.0074 cfs.
Adjusted for 15 min:	1.1383 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

POC 5





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #5
Total Pervious Area: 0
Total Impervious Area: 0.8

Mitigated Landuse Totals for POC #5
Total Pervious Area: 0
Total Impervious Area: 1.4

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #5

Return Period	**Flow(cfs)**
2 year	0.329681
5 year	0.438143
10 year	0.516368
25 year	0.622769
50 year	0.707696
100 year	0.797627

Flow Frequency Return Periods for Mitigated. POC #5

Return Period	**Flow(cfs)**
2 year	0.576941
5 year	0.76675
10 year	0.903644
25 year	1.089846
50 year	1.238469
100 year	1.395847

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #5

Year	**Predeveloped**	**Mitigated**
1949	0.606	1.061
1950	0.283	0.495
1951	0.347	0.607
1952	0.354	0.619
1953	0.253	0.444
1954	0.452	0.791
1955	0.250	0.437
1956	0.416	0.728
1957	0.249	0.436
1958	0.368	0.644
1959	0.299	0.523

1960	0.313	0.548
1961	0.334	0.584
1962	0.224	0.392
1963	0.231	0.405
1964	0.249	0.435
1965	0.322	0.564
1966	0.262	0.459
1967	0.307	0.537
1968	0.538	0.942
1969	0.537	0.939
1970	0.796	1.393
1971	0.415	0.726
1972	0.315	0.551
1973	0.329	0.576
1974	0.371	0.650
1975	0.265	0.463
1976	0.290	0.507
1977	0.201	0.352
1978	0.327	0.573
1979	0.521	0.912
1980	0.257	0.450
1981	0.373	0.652
1982	0.373	0.653
1983	0.427	0.747
1984	0.250	0.437
1985	0.304	0.533
1986	0.463	0.810
1987	0.270	0.472
1988	0.270	0.473
1989	0.353	0.618
1990	0.216	0.378
1991	0.343	0.600
1992	0.228	0.399
1993	0.315	0.550
1994	0.270	0.473
1995	0.408	0.714
1996	0.582	1.019
1997	0.502	0.878
1998	0.483	0.846
1999	0.225	0.393
2000	0.222	0.389
2001	0.223	0.390
2002	0.385	0.675
2003	0.297	0.520
2004	0.372	0.652
2005	0.451	0.789
2006	0.382	0.669
2007	0.329	0.576
2008	0.838	1.466

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #5

Rank	Predeveloped	Mitigated
1	0.8380	1.4664
2	0.7961	1.3932
3	0.6062	1.0609
4	0.5825	1.0194
5	0.5382	0.9419

6	0.5366	0.9391
7	0.5213	0.9122
8	0.5017	0.8780
9	0.4834	0.8459
10	0.4631	0.8104
11	0.4522	0.7914
12	0.4509	0.7891
13	0.4271	0.7475
14	0.4159	0.7278
15	0.4147	0.7257
16	0.4081	0.7142
17	0.3855	0.6746
18	0.3820	0.6685
19	0.3734	0.6535
20	0.3726	0.6521
21	0.3724	0.6516
22	0.3713	0.6499
23	0.3679	0.6438
24	0.3539	0.6193
25	0.3529	0.6176
26	0.3466	0.6065
27	0.3431	0.6004
28	0.3337	0.5840
29	0.3294	0.5765
30	0.3291	0.5760
31	0.3274	0.5730
32	0.3222	0.5638
33	0.3147	0.5507
34	0.3145	0.5504
35	0.3130	0.5477
36	0.3067	0.5367
37	0.3044	0.5327
38	0.2987	0.5227
39	0.2969	0.5196
40	0.2899	0.5073
41	0.2828	0.4950
42	0.2704	0.4732
43	0.2703	0.4730
44	0.2699	0.4724
45	0.2647	0.4633
46	0.2623	0.4590
47	0.2572	0.4502
48	0.2535	0.4436
49	0.2499	0.4373
50	0.2498	0.4372
51	0.2490	0.4357
52	0.2486	0.4350
53	0.2312	0.4047
54	0.2280	0.3990
55	0.2246	0.3930
56	0.2239	0.3918
57	0.2230	0.3902
58	0.2221	0.3886
59	0.2162	0.3783
60	0.2010	0.3518

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1648	1282	7218	563	Fail
0.1703	1126	6621	588	Fail
0.1758	1012	6116	604	Fail
0.1813	899	5596	622	Fail
0.1868	805	5154	640	Fail
0.1923	715	4738	662	Fail
0.1977	652	4382	672	Fail
0.2032	574	3991	695	Fail
0.2087	519	3720	716	Fail
0.2142	455	3423	752	Fail
0.2197	418	3194	764	Fail
0.2252	372	2937	789	Fail
0.2306	333	2727	818	Fail
0.2361	306	2512	820	Fail
0.2416	272	2335	858	Fail
0.2471	251	2154	858	Fail
0.2526	230	2013	875	Fail
0.2581	209	1850	885	Fail
0.2635	199	1740	874	Fail
0.2690	181	1598	882	Fail
0.2745	169	1508	892	Fail
0.2800	160	1410	881	Fail
0.2855	149	1307	877	Fail
0.2910	137	1233	900	Fail
0.2964	127	1144	900	Fail
0.3019	114	1073	941	Fail
0.3074	104	1001	962	Fail
0.3129	99	943	952	Fail
0.3184	89	883	992	Fail
0.3239	87	831	955	Fail
0.3293	81	775	956	Fail
0.3348	77	725	941	Fail
0.3403	74	687	928	Fail
0.3458	70	652	931	Fail
0.3513	66	604	915	Fail
0.3568	61	570	934	Fail
0.3622	56	536	957	Fail
0.3677	50	504	1008	Fail
0.3732	41	468	1141	Fail
0.3787	39	436	1117	Fail
0.3842	37	414	1118	Fail
0.3897	36	390	1083	Fail
0.3951	34	367	1079	Fail
0.4006	34	341	1002	Fail
0.4061	33	322	975	Fail
0.4116	30	313	1043	Fail
0.4171	25	292	1168	Fail
0.4226	25	272	1088	Fail
0.4280	24	256	1066	Fail
0.4335	22	250	1136	Fail
0.4390	19	236	1242	Fail
0.4445	18	225	1250	Fail
0.4500	17	214	1258	Fail
0.4555	15	206	1373	Fail

0.4609	15	199	1326	Fail
0.4664	14	192	1371	Fail
0.4719	14	180	1285	Fail
0.4774	13	172	1323	Fail
0.4829	12	169	1408	Fail
0.4884	11	160	1454	Fail
0.4938	11	155	1409	Fail
0.4993	11	149	1354	Fail
0.5048	10	140	1400	Fail
0.5103	9	136	1511	Fail
0.5158	9	130	1444	Fail
0.5213	8	121	1512	Fail
0.5267	7	116	1657	Fail
0.5322	7	109	1557	Fail
0.5377	6	104	1733	Fail
0.5432	5	101	2020	Fail
0.5487	5	96	1920	Fail
0.5542	5	89	1779	Fail
0.5596	5	89	1779	Fail
0.5651	5	87	1740	Fail
0.5706	5	83	1660	Fail
0.5761	5	80	1600	Fail
0.5816	5	78	1560	Fail
0.5871	4	77	1925	Fail
0.5925	4	75	1875	Fail
0.5980	4	74	1850	Fail
0.6035	4	70	1750	Fail
0.6090	3	67	2233	Fail
0.6145	3	66	2200	Fail
0.6200	3	63	2100	Fail
0.6254	3	60	2000	Fail
0.6309	3	59	1966	Fail
0.6364	3	56	1866	Fail
0.6419	2	52	2600	Fail
0.6474	2	47	2350	Fail
0.6529	2	43	2150	Fail
0.6583	2	39	1950	Fail
0.6638	2	39	1950	Fail
0.6693	2	37	1850	Fail
0.6748	2	37	1850	Fail
0.6803	2	36	1800	Fail
0.6858	2	36	1800	Fail
0.6912	2	34	1700	Fail
0.6967	2	34	1700	Fail
0.7022	2	33	1650	Fail
0.7077	2	33	1650	Fail

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

Water Quality

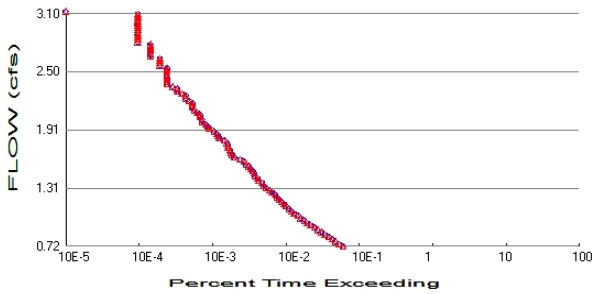
Water Quality BMP Flow and Volume for POC #5

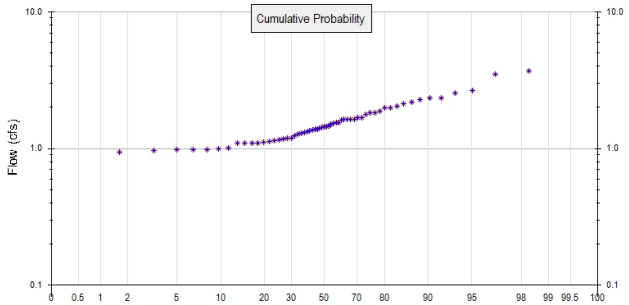
On-line facility volume:	0.1576 acre-feet
On-line facility target flow:	0.1994 cfs.
Adjusted for 15 min:	0.2254 cfs.
Off-line facility target flow:	0.1137 cfs.
Adjusted for 15 min:	0.1284 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

POC 6





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #6
Total Pervious Area: 0
Total Impervious Area: 3.5

Mitigated Landuse Totals for POC #6
Total Pervious Area: 0
Total Impervious Area: 3.5

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #6

Return Period	**Flow(cfs)**
2 year	1.442353
5 year	1.916875
10 year	2.25911
25 year	2.724614
50 year	3.096171
100 year	3.489617

Flow Frequency Return Periods for Mitigated. POC #6

Return Period	**Flow(cfs)**
2 year	1.442353
5 year	1.916875
10 year	2.25911
25 year	2.724614
50 year	3.096171
100 year	3.489617

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #6

Year	**Predeveloped**	**Mitigated**
1949	2.652	2.652
1950	1.237	1.237
1951	1.516	1.516
1952	1.548	1.548
1953	1.109	1.109
1954	1.979	1.979
1955	1.093	1.093
1956	1.820	1.820
1957	1.089	1.089
1958	1.610	1.610
1959	1.307	1.307

1960	1.369	1.369
1961	1.460	1.460
1962	0.979	0.979
1963	1.012	1.012
1964	1.087	1.087
1965	1.410	1.410
1966	1.148	1.148
1967	1.342	1.342
1968	2.355	2.355
1969	2.348	2.348
1970	3.483	3.483
1971	1.814	1.814
1972	1.377	1.377
1973	1.440	1.440
1974	1.625	1.625
1975	1.158	1.158
1976	1.268	1.268
1977	0.880	0.880
1978	1.432	1.432
1979	2.281	2.281
1980	1.125	1.125
1981	1.630	1.630
1982	1.634	1.634
1983	1.869	1.869
1984	1.093	1.093
1985	1.332	1.332
1986	2.026	2.026
1987	1.181	1.181
1988	1.183	1.183
1989	1.544	1.544
1990	0.946	0.946
1991	1.501	1.501
1992	0.998	0.998
1993	1.376	1.376
1994	1.183	1.183
1995	1.786	1.786
1996	2.548	2.548
1997	2.195	2.195
1998	2.115	2.115
1999	0.982	0.982
2000	0.972	0.972
2001	0.975	0.975
2002	1.686	1.686
2003	1.299	1.299
2004	1.629	1.629
2005	1.973	1.973
2006	1.671	1.671
2007	1.441	1.441
2008	3.666	3.666

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #6

Rank	Predeveloped	Mitigated
1	3.6660	3.6660
2	3.4831	3.4831
3	2.6522	2.6522
4	2.5484	2.5484
5	2.3548	2.3548

6	2.3476	2.3476
7	2.2806	2.2806
8	2.1949	2.1949
9	2.1149	2.1149
10	2.0260	2.0260
11	1.9786	1.9786
12	1.9728	1.9728
13	1.8687	1.8687
14	1.8195	1.8195
15	1.8141	1.8141
16	1.7856	1.7856
17	1.6864	1.6864
18	1.6713	1.6713
19	1.6337	1.6337
20	1.6303	1.6303
21	1.6291	1.6291
22	1.6246	1.6246
23	1.6095	1.6095
24	1.5482	1.5482
25	1.5441	1.5441
26	1.5163	1.5163
27	1.5009	1.5009
28	1.4600	1.4600
29	1.4412	1.4412
30	1.4399	1.4399
31	1.4324	1.4324
32	1.4095	1.4095
33	1.3768	1.3768
34	1.3760	1.3760
35	1.3693	1.3693
36	1.3419	1.3419
37	1.3317	1.3317
38	1.3067	1.3067
39	1.2989	1.2989
40	1.2682	1.2682
41	1.2374	1.2374
42	1.1829	1.1829
43	1.1826	1.1826
44	1.1810	1.1810
45	1.1582	1.1582
46	1.1476	1.1476
47	1.1254	1.1254
48	1.1089	1.1089
49	1.0933	1.0933
50	1.0931	1.0931
51	1.0892	1.0892
52	1.0875	1.0875
53	1.0116	1.0116
54	0.9976	0.9976
55	0.9824	0.9824
56	0.9795	0.9795
57	0.9755	0.9755
58	0.9715	0.9715
59	0.9457	0.9457
60	0.8795	0.8795

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.7212	1258	1258	100	Pass
0.7452	1117	1117	100	Pass
0.7692	992	992	100	Pass
0.7931	894	894	100	Pass
0.8171	797	797	100	Pass
0.8411	712	712	100	Pass
0.8651	643	643	100	Pass
0.8891	572	572	100	Pass
0.9131	514	514	100	Pass
0.9371	455	455	100	Pass
0.9611	412	412	100	Pass
0.9851	372	372	100	Pass
1.0091	332	332	100	Pass
1.0330	305	305	100	Pass
1.0570	270	270	100	Pass
1.0810	251	251	100	Pass
1.1050	230	230	100	Pass
1.1290	209	209	100	Pass
1.1530	199	199	100	Pass
1.1770	183	183	100	Pass
1.2010	169	169	100	Pass
1.2250	158	158	100	Pass
1.2490	149	149	100	Pass
1.2729	136	136	100	Pass
1.2969	126	126	100	Pass
1.3209	112	112	100	Pass
1.3449	104	104	100	Pass
1.3689	99	99	100	Pass
1.3929	89	89	100	Pass
1.4169	87	87	100	Pass
1.4409	80	80	100	Pass
1.4649	77	77	100	Pass
1.4889	74	74	100	Pass
1.5128	70	70	100	Pass
1.5368	66	66	100	Pass
1.5608	61	61	100	Pass
1.5848	56	56	100	Pass
1.6088	50	50	100	Pass
1.6328	41	41	100	Pass
1.6568	39	39	100	Pass
1.6808	37	37	100	Pass
1.7048	36	36	100	Pass
1.7287	34	34	100	Pass
1.7527	34	34	100	Pass
1.7767	33	33	100	Pass
1.8007	30	30	100	Pass
1.8247	26	26	100	Pass
1.8487	25	25	100	Pass
1.8727	24	24	100	Pass
1.8967	22	22	100	Pass
1.9207	19	19	100	Pass
1.9447	18	18	100	Pass
1.9686	17	17	100	Pass

1.9926	15	15	100	Pass
2.0166	15	15	100	Pass
2.0406	14	14	100	Pass
2.0646	14	14	100	Pass
2.0886	13	13	100	Pass
2.1126	12	12	100	Pass
2.1366	11	11	100	Pass
2.1606	11	11	100	Pass
2.1846	11	11	100	Pass
2.2085	10	10	100	Pass
2.2325	9	9	100	Pass
2.2565	9	9	100	Pass
2.2805	8	8	100	Pass
2.3045	7	7	100	Pass
2.3285	7	7	100	Pass
2.3525	6	6	100	Pass
2.3765	5	5	100	Pass
2.4005	5	5	100	Pass
2.4245	5	5	100	Pass
2.4484	5	5	100	Pass
2.4724	5	5	100	Pass
2.4964	5	5	100	Pass
2.5204	5	5	100	Pass
2.5444	5	5	100	Pass
2.5684	4	4	100	Pass
2.5924	4	4	100	Pass
2.6164	4	4	100	Pass
2.6404	4	4	100	Pass
2.6644	3	3	100	Pass
2.6883	3	3	100	Pass
2.7123	3	3	100	Pass
2.7363	3	3	100	Pass
2.7603	3	3	100	Pass
2.7843	3	3	100	Pass
2.8083	2	2	100	Pass
2.8323	2	2	100	Pass
2.8563	2	2	100	Pass
2.8803	2	2	100	Pass
2.9043	2	2	100	Pass
2.9282	2	2	100	Pass
2.9522	2	2	100	Pass
2.9762	2	2	100	Pass
3.0002	2	2	100	Pass
3.0242	2	2	100	Pass
3.0482	2	2	100	Pass
3.0722	2	2	100	Pass
3.0962	2	2	100	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #6

On-line facility volume:	0.6083 acre-feet
On-line facility target flow:	0.7694 cfs.
Adjusted for 15 min:	0.8695 cfs.
Off-line facility target flow:	0.4386 cfs.
Adjusted for 15 min:	0.4956 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   VE_Construction2015_02-23.wdm
MESSU      25   PreVE_Construction2015_02-23.MES
           27   PreVE_Construction2015_02-23.L61
           28   PreVE_Construction2015_02-23.L62
           30   POCVE_Construction2015_02-231.dat
           31   POCVE_Construction2015_02-232.dat
           32   POCVE_Construction2015_02-233.dat
           33   POCVE_Construction2015_02-234.dat
           34   POCVE_Construction2015_02-235.dat
           35   POCVE_Construction2015_02-236.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND       5
      PERLND       4
      IMPLND       1
      COPY       501
      COPY       502
      COPY       503
      COPY       504
      COPY       505
      COPY       506
      DISPLY       1
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
      DISPLY       6
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Area 200 - Existing         MAX                    1    2   30    9
    2        Area 300 - Existing         MAX                    1    2   31    9
    3        Area 400 - Existing         MAX                    1    2   32    9
    4        Area 500 - Existing         MAX                    1    2   33    9
    5        Area 600 - Existing         MAX                    1    2   34    9
    6        RailImp - Existing          MAX                    1    2   35    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  504         1    1
  505         1    1
  506         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
```

```
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
    4     A/B, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    4         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

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

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    4         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    4              0         5       1.5       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    4              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    4           0.15       0.5       0.3         0       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    4              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
```

```
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    5         0    0    1    0    0    0
    1         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    5         0    0    4    0    0    0    1    9
    1         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    5         0    0    0    0    0
    1         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    5            400      0.01       0.1       0.1
    1            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    5              0         0
    1              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    5              0         0
    1              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Area 200 - Existing***
IMPLND   5                        7.8     COPY   501     15
Area 300 - Existing***
IMPLND   5                       20.8     COPY   502     15
Area 400 - Existing***
PERLND   4                        0.5     COPY   503     12
PERLND   4                        0.5     COPY   503     13
IMPLND   1                        0.7     COPY   503     15
IMPLND   5                        1.1     COPY   503     15
Area 500 - Existing***
PERLND   4                        1.5     COPY   504     12
PERLND   4                        1.5     COPY   504     13
IMPLND   1                          1     COPY   504     15
IMPLND   5                        2.4     COPY   504     15
Area 600 - Existing***
IMPLND   1                        0.1     COPY   505     15
IMPLND   5                        0.7     COPY   505     15
RailImp - Existing***
IMPLND   5                        3.5     COPY   506     15

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

NETWORK
```

```
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   48.4        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   48.4        DISPLY   5     INPUT  TIMSER 1
COPY   506 OUTPUT MEAN   1 1   48.4        DISPLY   6     INPUT  TIMSER 1



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.02           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.02           IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
```

```
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    503 FLOW     ENGL      REPL
COPY   504 OUTPUT MEAN   1 1     48.4      WDM    504 FLOW     ENGL      REPL
COPY   505 OUTPUT MEAN   1 1     48.4      WDM    505 FLOW     ENGL      REPL
COPY   506 OUTPUT MEAN   1 1     48.4      WDM    506 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                               ***
WDM        26   VE_Construction2015_02-23.wdm
MESSU      25   MitVE_Construction2015_02-23.MES
           27   MitVE_Construction2015_02-23.L61
           28   MitVE_Construction2015_02-23.L62
           30   POCVE_Construction2015_02-231.dat
           31   POCVE_Construction2015_02-232.dat
           32   POCVE_Construction2015_02-233.dat
           33   POCVE_Construction2015_02-234.dat
           34   POCVE_Construction2015_02-235.dat
           35   POCVE_Construction2015_02-236.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       4
      IMPLND       1
      IMPLND       5
      COPY       501
      COPY       502
      COPY       503
      COPY       504
      COPY       505
      COPY       506
      DISPLY       1
      DISPLY       2
      DISPLY       3
      DISPLY       4
      DISPLY       5
      DISPLY       6
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Area 200 - Construction     MAX                    1    2   30    9
    2        Area 300 - Construction     MAX                    1    2   31    9
    3        Area 400 - Construction     MAX                    1    2   32    9
    4        Area 500 - Construction     MAX                    1    2   33    9
    5        Area 600 - Construction     MAX                    1    2   34    9
    6        RailImp - Construction      MAX                    1    2   35    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  504         1    1
  505         1    1
  506         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
```

```
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
    4     A/B, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    4         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

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

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    4         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    4              0         5       1.5       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    4              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    4           0.15       0.5       0.3         0       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    4              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
```

```
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    1              0         0
    5              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    1              0         0
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Area 200 - Construction***
PERLND   4                        0.1     COPY   501     12
PERLND   4                        0.1     COPY   501     13
IMPLND   1                        0.6     COPY   501     15
IMPLND   5                       46.6     COPY   501     15
Area 300 - Construction***
IMPLND   1                        0.3     COPY   502     15
IMPLND   5                       24.6     COPY   502     15
Area 400 - Construction***
IMPLND   5                        2.2     COPY   503     15
Area 500 - Construction***
PERLND   4                        0.5     COPY   504     12
PERLND   4                        0.5     COPY   504     13
IMPLND   1                        3.2     COPY   504     15
IMPLND   5                        9.2     COPY   504     15
Area 600 - Construction***
IMPLND   1                        0.3     COPY   505     15
IMPLND   5                        1.1     COPY   505     15
RailImp - Construction***
IMPLND   5                        3.5     COPY   506     15

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

```
NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1
COPY   504 OUTPUT MEAN   1 1   48.4        DISPLY   4     INPUT  TIMSER 1
COPY   505 OUTPUT MEAN   1 1   48.4        DISPLY   5     INPUT  TIMSER 1
COPY   506 OUTPUT MEAN   1 1   48.4        DISPLY   6     INPUT  TIMSER 1



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.02           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.02           IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
```

```
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
COPY     3 OUTPUT MEAN   1 1     48.4      WDM    703 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    803 FLOW     ENGL      REPL
COPY     4 OUTPUT MEAN   1 1     48.4      WDM    704 FLOW     ENGL      REPL
COPY   504 OUTPUT MEAN   1 1     48.4      WDM    804 FLOW     ENGL      REPL
COPY     5 OUTPUT MEAN   1 1     48.4      WDM    705 FLOW     ENGL      REPL
COPY   505 OUTPUT MEAN   1 1     48.4      WDM    805 FLOW     ENGL      REPL
COPY     6 OUTPUT MEAN   1 1     48.4      WDM    706 FLOW     ENGL      REPL
COPY   506 OUTPUT MEAN   1 1     48.4      WDM    806 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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VANCOUVER ENERGY

Construction Stormwater, Control Flow Rates

(per SWMM Element #3)

Area 200 - Rail Unloading:

Disturbed Construction Area: $A := 10.33acre$

10-Year, 24-Hour Rainfall Amount: $I := 3.2in$

10-Year, 24-Hour Storm Volume: $V := A \cdot I \cdot 1.5 = 1346418.04\ gal$

Required Minimum Treatment Rate: $Q := 750gpm$

Assumed Treatment Operation (per day): $t := 20hr$

Required Tankage Volume: $V_{tank} := V - Q \cdot t = 446418.04\ gal$

# of 20,000 gallon tanks: $N_{tank} := \frac{V_{tank}}{20000gal} = 22.32$

Area 300 - Storage:

Disturbed Construction Area: $A := 24.9acre$

10-Year, 24-Hour Rainfall Amount: $I := 3.2in$

10-Year, 24-Hour Storm Volume: $V := A \cdot I \cdot 1.5 = 3245480.07\ gal$

Required Minimum Treatment Rate: $Q := 2500gpm$

Assumed Treatment Operation (per day): $t := 20hr$

Required Tankage Volume: $V_{tank} := V - Q \cdot t = 245480.07\ gal$

# of 20,000 gallon tanks: $N_{tank} := \frac{V_{tank}}{20000gal} = 12.27$

Area 400 - Marine Terminal:

Disturbed Construction Area: $A := 2.6acre$

10-Year, 24-Hour Rainfall Amount: $I := 3.2in$

10-Year, 24-Hour Storm Volume: $V := A \cdot I \cdot 1.5 = 338885.47\ gal$

Required Minimum Treatment Rate: $Q := 250gpm$

Assumed Treatment Operation (per day): $t := 20hr$

Required Tankage Volume: $V_{tank} := V - Q \cdot t = 38885.47\ gal$

# of 20,000 gallon tanks: $N_{tank} := \frac{V_{tank}}{20000gal} = 1.94$

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix G
Environmental Control Drawings

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GENERAL EROSION PREVENTION & SEDIMENT CONTROL NOTES

1. ALL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED BY EFSEC OR THEIR DESIGNEE PRIOR TO THE COMMENCEMENT OF WORK. ONCE APPROVED, THE SITE MUST BE MAINTAINED THROUGH THE LIFE OF THE PROJECT AS SHOWN ON THE PLANS.
2. EROSION AND SEDIMENT CONTROL BMPS SHALL BE SITED, DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH THE WASHINGTON STATE DEPARTMENT OF ECOLOGY STORMWATER MANAGEMENT MANUAL FOR WESTERN WASHINGTON.
3. THE DEVELOPER AND/OR OWNER IS RESPONSIBLE FOR MAINTAINING EROSION PREVENTION AND SEDIMENT CONTROL BMPS DURING AND AFTER INSTALLATION OF ALL UTILITY WORK ASSOCIATED WITH UTILITY TRENCHES.
4. PRIOR TO ANY SITE EXCAVATION, ALL STORM DRAIN INLETS SHALL BE PROTECTED DOWN SLOPE FROM ANY DISTURBED OR CONSTRUCTION AREAS PER STANDARD DETAIL E-2.20 TO PREVENT SEDIMENT FROM ENTERING THE STORM DRAINAGE SYSTEM PRIOR TO PERMANENT STABILIZATION OF THE DISTURBED AREAS. CLEAN FILTER FABRIC AS NECESSARY TO MAINTAIN DRAINAGE. REMOVE FILTER AND CLEAN CATCH BASINS FOLLOWING COMPLETION OF SITE WORK.
5. NEWLY CONSTRUCTED OR MODIFIED INLETS AND CATCH BASINS SHALL BE PROTECTED FROM SEDIMENT IMMEDIATELY UPON INSTALLATION.
6. THE CONTRACTOR SHALL NOT ALLOW SEDIMENT OR DEBRIS TO ENTER NEW OR EXISTING PIPES, CATCH BASINS OR INFILTRATION SYSTEMS. IF THIS OCCURS, THE CONTRACTOR SHALL REMOVE ALL ACCUMULATED SEDIMENT FROM THE CATCH BASINS, DRYWELLS, AND STORM PIPES IMMEDIATELY.
7. PRIOR TO LEAVING A CONSTRUCTION SITE OR PRIOR TO DISCHARGING INTO AN INFILTRATION SYSTEM, SEDIMENT-LADEN WATER SHALL PASS THROUGH A SEDIMENT POND, TRAP, OR OTHER APPROVED BMP SYSTEM.
8. ALL EXPOSED AND UNWORKED SOILS SHALL BE STABILIZED BY THE APPROPRIATE BEST MANAGEMENT PRACTICES (BMPS). FROM OCTOBER 1 TO APRIL 30, NO SOILS SHALL BE EXPOSED AND UNWORKED FOR MORE THAN TWO (2) DAYS. FROM MAY 1 TO SEPTEMBER 30, NO SOILS SHALL BE EXPOSED AND UNWORKED FOR MORE THAN SEVEN (7) DAYS.
9. SOIL STOCKPILES SHALL BE STABILIZED FROM EROSION, PROTECTED WITH SEDIMENT TRAPPING MEASURES, AND WHEN POSSIBLE, BE LOCATED AWAY FROM STORM DRAIN INLETS, WATER WAYS AND DRAINAGE CHANNELS.
10. CONSTRUCTION ROADS AND PARKING AREAS SHALL BE STABILIZED WHEREVER THEY ARE CONSTRUCTED, WHETHER PERMANENT OR TEMPORARY, FOR THE USE OF CONSTRUCTION TRAFFIC.
11. IF THE BMPS APPLIED TO A SITE ARE INSUFFICIENT TO PREVENT SEDIMENT FROM REACHING WATER BODIES, ADJACENT PROPERTIES, STORM FACILITIES OR PUBLIC RIGHT-OF-WAY, THEN THE CONTRACTOR SHALL INSTALL ADDITIONAL ALTERNATIVE BMPS.

PROTECTION OF ADJACENT PROPERTIES, ROADS/STREETS AND PAVED SURFACES

12. PROVIDE A 12-INCH DEEP PAD OF CRUSHED ROCK FOR A DISTANCE OF 100 FEET INTO THE SITE FOR ALL ACCESS POINTS UTILIZED BY CONSTRUCTION EQUIPMENT AND TRUCKS. PAD WIDTH SHALL BE A MINIMUM OF 20 FEET. ALL VEHICLES LEAVING THE SITE SHALL EGRESS ACROSS THE PAD. ACCUMULATED SEDIMENT SHALL BE PERIODICALLY REMOVED, OR ADDITIONAL ROCK SHALL BE PLACED UPON THE PAD SURFACE. ROCK SHALL BE CLEAN 4-INCH TO 8-INCH QUARRY SPALLS. ALL MATERIALS SPILLED, DROPPED, WASHED OR TRACKED FROM VEHICLES ONTO ROADWAYS OR INTO STORM DRAINS SHALL BE REMOVED IMMEDIATELY.
13. PAVEMENT SWEEPING AND SHOVELLING IS REQUIRED. WASHING THE PAVEMENT INTO THE STORM SYSTEM IS NOT PERMITTED.
14. IF SEDIMENT, MUD OR DEBRIS IS TRANSPORTED ONTO A PAVED SURFACE OR ROADWAY, THE PAVED SURFACE OR ROADWAY SHALL BE THOROUGHLY CLEANED WITH HIGH EFFICIENCY STREET SWEEPERS AT THE END OF EACH WORKDAY, OR MORE OFTEN IF NECESSARY. SIGNIFICANT SOIL DEPOSITS SHALL BE REMOVED FROM ROADS BY SHOVELLING AND SWEEPING. STREET WASHING IS NOT ALLOWED UNLESS APPROVED BY EFSEC AND ONLY AFTER SEDIMENT IS REMOVED IN THE MANNER DESCRIBED ABOVE.
15. A WHEEL WASH MAY BE REQUIRED IF CONSTRUCTION ENTRANCE IS NOT SUFFICIENT IN PREVENTING SEDIMENT FROM BEING TRACKED ONTO PAVEMENT. WHEEL WASH SHALL BE PER STANDARD PLAN E-1.06 AND THE STORMWATER MANUAL.
16. INSTALL SEDIMENT FENCE PER STANDARD PLAN E-2.33 PRIOR TO BUILDING CONSTRUCTION AND/OR EXCAVATION TO PREVENT SILT INTRUSION UPON ADJACENT LOTS. IF CONSTRUCTION OCCURS SIMULTANEOUSLY ON ADJACENT LOTS AND THE LOTS HAVE THE SAME OWNER DURING CONSTRUCTION, THE SILT FENCE ALONG THE COMMON LOT LINE MAY BE ELIMINATED.
17. PROPOSED PERMEABLE PAVEMENT AREAS SHALL BE SHOWN ON THE EROSION CONTROL PLAN. PERMEABLE PAVEMENT AREAS SHALL BE PROTECTED FROM SEDIMENT DURING AND AFTER INSTALLATION.

MAINTENANCE OF EROSION PREVENTION AND SEDIMENT CONTROL BMPS

18. ALL EROSION PREVENTION AND SEDIMENT CONTROL BMPS SHALL BE REGULARLY INSPECTED AND MAINTAINED TO ENSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION.
19. THE CONTRACTOR SHALL MAINTAIN AND HAVE ON-SITE A WRITTEN LOG OF EROSION PREVENTION AND SEDIMENT CONTROL BMP MAINTENANCE.
20. ALL TEMPORARY EROSION PREVENTION AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER SITE STABILIZATION IS ACHIEVED OR AFTER TEMPORARY BMPS ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED OR STABILIZED ON SITE. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED PER THE STORMWATER MANUAL.

DUST CONTROL

21. IN AREAS SUBJECT TO SURFACE AND AIR MOVEMENT OF DUST, REFER TO THE STORMWATER MANUAL FOR DUST CONTROL BMPS.

TEMPORARY SEEDING

22. EXPOSED SURFACES THAT WILL NOT BE BROUGHT TO FINAL GRADE OR GIVEN A PERMANENT COVER TREATMENT WITHIN 30 DAYS OF THE EXPOSURE SHALL HAVE SEED MIX AND MULCH PLACED TO STABILIZE THE SOIL AND REDUCE EROSION SEDIMENTATION. SEEDED AREAS SHALL BE CHECKED REGULARLY TO ASSURE A GOOD STAND OF GRASS IS BEING MAINTAINED. AREAS THAT FAIL TO ESTABLISH VEGETATION COVER ADEQUATE TO PREVENT EROSION WILL BE RESEEDED AS SOON AS SUCH AREAS ARE IDENTIFIED.
23. AN APPROVED TEMPORARY SEEDING MIXTURE SHALL BE APPLIED TO THE PREPARED SEED BED AT A RATE OF 120 LBS/ACRE. NOTE: "HYDROSEEDING" APPLICATIONS WITH APPROVED SEED-MULCH-FERTILIZER MIXTURES MAY ALSO BE USED.

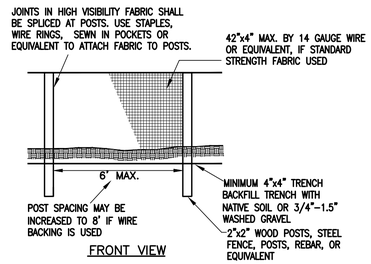
GENERAL CONSTRUCTION, STORMWATER MONITORING AND TREATMENT NOTES

1.

~ NOTES PENDING PERMIT APPROVALS ~

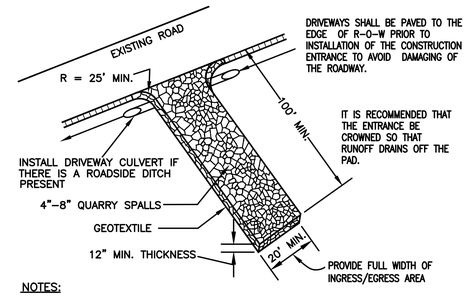
LEGEND

HIGH VISIBILITY FENCE — HVF
INTERCEPTOR DIKE AND SWALE
SILT FENCE
COMPOST SOCK — CS
WICK DRAINS — WD
TURBIDITY CURTAIN — TC
STABILIZED CONSTRUCTION ENTRANCE/EXIT
CONSTRUCTION ROAD/PARKING AREA STABILIZATION
SURFACE ROUGHENING
LAYDOWN AREA
WHEEL WASH
CONCRETE WASHOUT AREA
STORM DRAIN INLET PROTECTION
WEIR/STORAGE TANKS
ENHANCED SAND FILTRATION



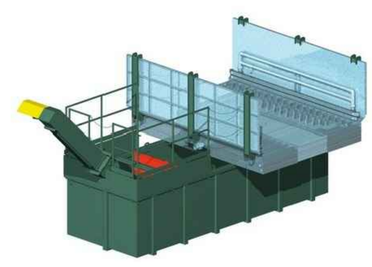
NOTES:
1. ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY.
2. IF THE HIGH VISIBILITY FABRIC HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.

HIGH VISIBILITY FENCE (1 / -)
NTS
BMP C103



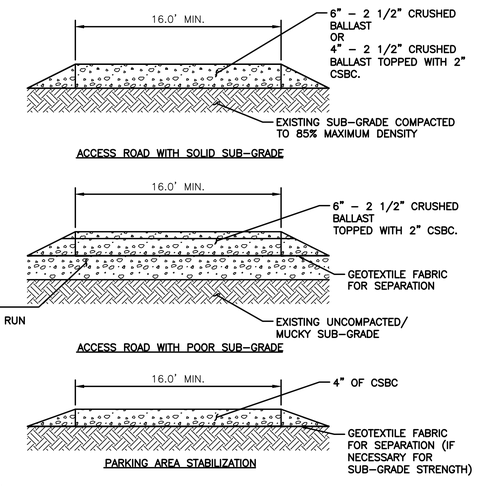
NOTES:
1. IF THE ENTRANCE SITS ON A SLOPE, PLACE A FILTER FABRIC FENCE DOWN GRADIENT.
2. TOP DRESS THE PAD WITH CLEAN 3" MINUS ROCK WHEN THE CONSTRUCTION ENTRANCE BECOMES CLOGGED WITH SEDIMENTS.
3. ANY SEDIMENT CARRIED FROM THE SITE ONTO THE STREET SHALL BE CLEANED UP IMMEDIATELY.
4. IF EQUIPMENT TRAVELS EXTENSIVELY ON UNSTABILIZED ROADS ON THE SITE, A TIRE AND VEHICLE UNDERCARRIAGE WASH NEAR THE ENTRANCE WILL BE NEEDED. PERFORM WASHING ON CRUSHED ROCK. WASH WATER WILL REQUIRE TREATMENT IN A SEDIMENT POND OR TRAP.
5. WHERE CONSTRUCTION ACCESS ABUTS A CURB, MINIMUM 2" DIAMETER PVC PIPE AND COLD-PATCH ASPHALT SHOULD BE USED TO CONSTRUCT THE APPROACH IN ORDER TO PROTECT THE CURB AND MINIMIZE OBSTRUCTION TO STORMWATER FLOW IN THE GUTTER.
6. TRUCKS LEAVING THE SITE SHALL EGRESS ACROSS THE FULL LENGTH OF THE PAD.
7. SINGLE FAMILY LOT ENTRANCES MAY HAVE THE PAD LENGTH REDUCED TO 2 0 FEET IN LENGTH AND ROCK SHALL BE CLEANED 2 INCH TO 4INCH.

STABILIZED CONSTRUCTION ENTRANCE/EXIT (2 / -)
NTS
BMP C105



NOTES:
1. WHEEL WASH SHALL BE CAPABLE OF WASHING UP TO 150 TRUCKS PER DAY. WHEEL WASH SHALL BE AN IN-GROUND TEMPORARY MODEL WITH INTEGRAL SOLIDS REMOVAL.
2. WHEEL WASH WATER SHALL BE FILTERED OR REPLACED EACH DAY. MAY BE CONNECTED TO SANITARY SEWER.
3. UNIT SHALL BE INSPECTED DAILY TO ENSURE PROPER OPERATION.
4. WHEEL WASH SHALL BE CONLINE 400C OR EQUAL.

WHEEL WASH (3 / -)
NTS
BMP C106



NOTES:
1. CONSTRUCTION ROAD AND PARKING AREA STABILIZATION NECESSARY WHERE EXISTING ASPHALT OR EXISTING GRAVEL ROADS ARE NOT AVAILABLE OR ARE INSUFFICIENT TO SUPPORT CONSTRUCTION LOADS.

CONSTRUCTION ROAD/PARKING AREA STABILIZATION (1 / -)
NTS
BMP C107

SAM ADAMS — STATE OF WASHINGTON — 27330 — REGISTERED PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL NOTES AND DETAILS – 1

DESIGN:	DRS	START DATE:	2/18/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/26/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-EC-001 — SHEET 1 / 1 — REV.

Last Saved by: Tony.pritchett on: Feb 18, 2015 3:02 PM File: Q:\Vancouver\2013\A13.0287\02\CAD\Dwgs\03_0100-EC-001.dwg

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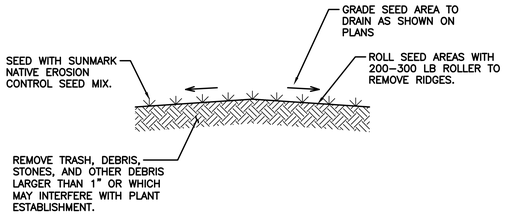
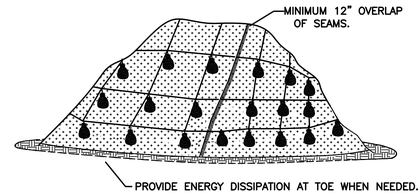


NOTES:

1. SEEDING SHALL BE ACCOMPLISHED WITH A HYDROSEED/MULCH MIXTURE. HYDROSEEDING SHALL OCCUR BETWEEN MARCH 1 AND MAY 15 AND SEPTEMBER 1 TO OCTOBER 1. PROCEED WITH SEEDING ONLY WHEN EXISTING AND FORECASTED WEATHER CONDITIONS ARE SUITABLE FOR WORK. DO NOT SEED WHEN THE GROUND IS FROZEN, SNOW COVERED, MUDDY OR WHEN AIR TEMPERATURES EXCEEDS 90 DEGREES FAHRENHEIT.
2. EROSION CONTROL SEED MIX SHALL BE SUNMARK NATIVE EROSION CONTROL SEED MIX OR APPROVED EQUAL. SUNMARK SEEDS INTERNATIONAL, INC 18032 NE AIRPORT WAY, PORTLAND, OREGON 97230. (1–888–214–7333). SEED MIX SHALL MEET THE FOLLOWING COMPOSITION BY WEIGHT:
   a. NATIVE EROSION CONTROL MIX (1 LB/1000 SF OR 45 LBS. PER ACRE)
   (Tony Add Table from 0100–LA–001)
3. HYROSEED MULCH SHALL BE A 100% BIODEGRADABLE DYED–WOOD CELLULOSE FIBER MULCH APPLIEDAT 2,000 LBS PER ACRE WITH NON–ASPHALTIC TACKIFIER PER MANUFACTURER'S RECOMMENDATIONS.
4. 100% OF HYDROSEED AREAS SHALL SHOW A UNIFORM DISTRIBUTION OF MATERIALS. AREAS NOT RECEIVING A UNIFORM APPLICATION OF SEED, MULCH OR MULCH AT THE SPECIFIED RATE SHALL BE RESEEDED AT THE CONTRACTORS EXPENSE.
5. PROTECT STRUCTURES, SIDEWALKS, PAVEMENTS AND OTHER FACILITIES, TREES, SHRUBS, AND PLANTINGS FROM OVER–SPRAYING OR OTHER DAMAGE CAUSED BY SEEDING OPERATIONS.
6. MAINTENANCE OF THE PLANTED AREAS THROUGH THE ESTABLISHMENT PERIOD SHALL INCLUDE WATERING, PROTECTION FROM INSECTS, AND DISEASES AND WEEDING.
7. CONTRACTOR SHALL PROVIDE TEMPORARY ESTABLISHMENT WATERING OF NON IRRIGATED EROSION CONTROL SEED AREAS DURING ESTABLISHMENT AND MAINTENANCE PERIOD. UNLESS OTHERWISE INDICATED, CONTRACTOR SHALL REMOVE TEMPORARY IRRIGATION EQUIPMENT AT THE END OF THE MAINTENANCE AND WARRANTY PERIOD.
8. RE–SEED STAGING AREAS AND OTHER AREAS DISTURBED DURING CONSTRUCTION.
9. CONTRACTOR SHALL MAINTAIN SEEDED AREAS FOR A MINIMUM OF 6 MONTHS FOLLOWING THE END OF CONSTRUCTION. CONTRACTOR SHALL WARRANTY ALL SEEDED AREAS FOR A MINIMUM OF 2–YEARS FOLLOWING CONSTRUCTION.

TEMPORARY SEEDING (1 / –)
NTS BMP CI20

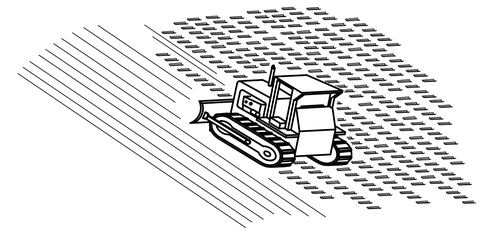


PLASTIC SHEETING

NOTES:

1. PLASTIC SHEETING IS USED TO PROVIDE IMMEDIATE PROTECTION TO SLOPES AND STOCKPILES.
2. DO NOT USE PLASTIC COVERING UPSLOPE OF AREAS SUCH AS STEEP AND/OR UNSTABLE SLOPES THAT MIGHT BE ADVERSELY AFFECTED BY CONCENTRATED RUNOFF.
3. WHEN POSSIBLE, INSTALL AN INTERCEPTOR DIKE AT THE TOP OF THE PLASTIC TO DIVERT FLOWS AWAY FROM THE PLASTIC.
4. TOE–IN THE TOP OF THE SHEETING IN A 6"x6" TRENCH BACKFILLED WITH COMPACTED NATIVE MATERIAL.
5. INSTALL A GRAVEL BERM, RIPRAP, OR OTHER SUITABLE PROTECTION AT THE TOP OF THE SLOPE IN ORDER TO DISSIPATE RUNOFF VELOCITY.
6. ANCHOR THE PLASTIC USING SANDBAGS OR OTHER SUITABLE TETHERED ANCHOR SYSTEM SPACED ON A 10' GRID SPACING IN ALL DIRECTIONS.
7. OVERLAP SEAMS 1–2', TAPE, ROLL AND STAKE THE SEAMS AND THEN WEIGH DOWN THE ENTIRE LENGTH.
8. PROVIDE ENERGY DISSIPATION AT TOE WHEN NEEDED.
9. REPLACE TORN SHEETS AND REPAIR OPEN SEAMS. COMPLETELY REMOVE AND REPLACE PLASTIC WHEN IT BEGINS TO DETERIORATE.

PLASTIC COVERING (2 / –)
NTS BMP CI23

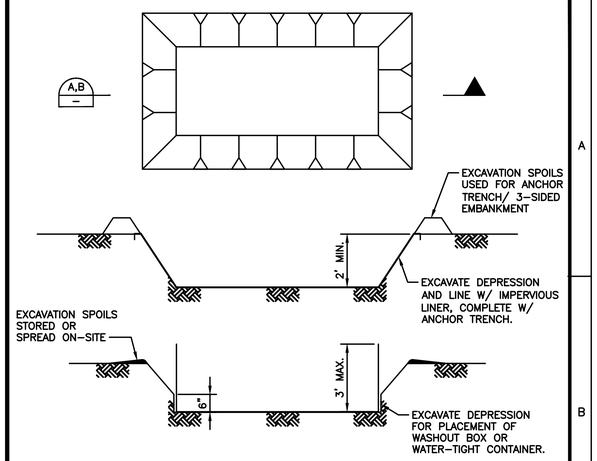


TRACKING

NOTES:

'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, FERTILIZER, MULCH, RAINFALL AND DECREASE RUNOFF.

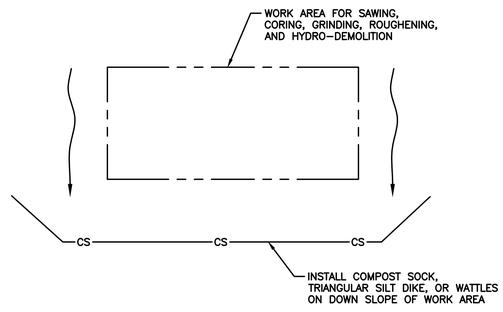
SURFACE ROUGHENING (3 / –)
NTS BMP CI30



NOTES:

1. PROVIDE DESIGNATED CONCRETE WASHOUT AREAS.
2. DISPOSAL OF SOLIDS SHALL BE TO LANDFILL OR RE–USE TO QUARRY, OR BATCH PLANT.
3. LIQUIDS SHALL BE PH NEUTRALIZED PRIOR TO HAUL OFF OR DISPOSAL TO SANITARY SEWER.
4. USE SUCTION STYLE PUMPS W/ 1/4" TRASH SCREEN ON INLET PIPING TO REMOVE LIQUID WASTE.

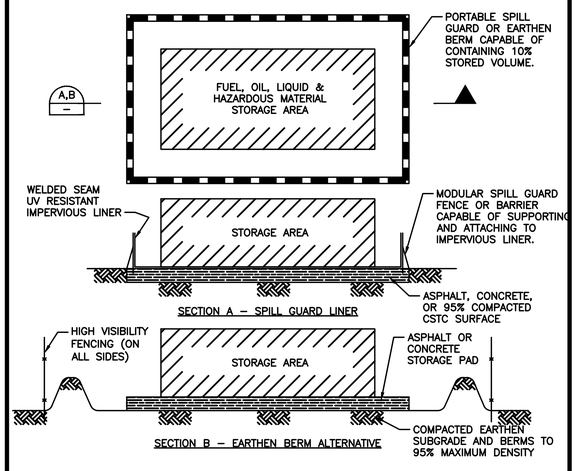
CONCRETE WASHOUT AREA (4 / –)
NTS BMP CI51



NOTES:

1. INSTALL TEMPORARY CONTAINMENT MEASURES ON DOWNSLOPE SIDE OF WORK AREAS.
2. VACUUM SLURRY AND CUTTINGS DURING CUTTING AND SURFACING OPERATIONS.
3. SLURRY AND CUTTINGS SHALL NOT REMAIN ON PERMANENT CONCRETE OR ASPHALT PAVEMENT OVERNIGHT.
4. SLURRY AND CUTTINGS SHALL NOT DRAIN TO ANY NATURAL OR CONSTRUCTED DRAINAGE CONVEYANCE INCLUDING STORMWATER SYSTEMS. THIS MAY REQUIRE ADDITIONAL BLOCKING OF CATCH BASINS.
5. DISPOSE OF COLLECTED SLURRY AND CUTTINGS IN A MANNER THAT DOES NOT VIOLATE GROUND WATER OR SURFACE WATER QUALITY STANDARDS.
6. 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 OF PROCESS WATER IN A MANNER THAT DOES NOT VIOLATE GROUND WATER OR SURFACE WATER QUALITY STANDARDS.
7. HANDLE AND DISPOSE OF 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.

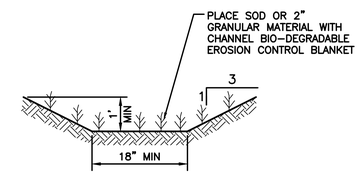
SAWCUTTING AND SURFACING POLLUTION PREVENTION (5 / –)
NTS BMP CI52



NOTES:

1. PROVIDE DELINEATED MATERIAL DELIVERY, STORAGE & CONTAINMENT AREA AT ALL PROJECT SITES.
2. INSPECT ALL CONTAINERS DAILY FOR EVIDENCE OF DAMAGE OR LEAKS AND REPLACE IMMEDIATELY.
3. CLEAN CONTAINMENT AREA INCLUDING SOIL EXCAVATION/REPLACEMENT AFTER ANY SPILL.

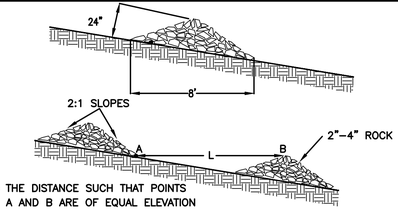
MATERIAL DELIVERY, STORAGE AND CONTAINMENT (6 / –)
NTS BMP CI53



NOTES:

1. GRADE CUTOFF DITCHES WHERE SHOWN ON–SITE @ MINIMUM 1% LONGITUDINAL SLOPE.
2. SEE LANDSCAPE DRAWING 0100_LA–001 FOR EROSION CONTROL SEED MIX. APPLY WITH TACKIFIER.
3. INSTALL ROCK CHECK DAMS PER DETAIL 8.
4. MAINTAIN VEGETATION IN DITCH DURING CONSTRUCTION UNTIL FINAL GRADING AND INSTALLATION OF STORM DRAIN SYSTEM.

INTERSEPTOR SWALE (7 / –)
NTS BMP C200



SPACING BETWEEN CHECK DAMS

CHECK DAM NOTES:

1. CHECK DAMS ARE CONSTRUCTED ACROSS A SWALE OR DITCH TO REDUCE VELOCITIES OF CONCENTRATED FLOWS, THEREBY REDUCING EROSION AND ALLOWING A SIGNIFICANT AMOUNT OF SUSPENDED SEDIMENT TO SETTLE OUT.
2. CHECK DAMS SHALL BE USED IN TEMPORARY OR PERMANENT CHANNELS THAT DRAIN 10 ACRES OR LESS, ARE NOT YET VEGETATED, AND WHEN INSTALLING CHANNEL LINING IS NOT FEASIBLE.
3. USE TYPICAL ROCK SIZE OF 2–4 INCH. PLACE ROCK BY HAND OR BY MECHANICAL MEANS RATHER THAN DUMPING THE ROCK. BRIDGE ENTIRE DITCH OR SWALE WIDTH AND ENSURE THE CENTER OF THE DAM IS 6" LOWER THAN THE OUTER ENDS. FOR HIGHER VELOCITY FLOWS: ±5 FPS USE 6"–12" RIPRAP, AND HAND PLACE LARGER ROCK ON UPSTREAM SIDE OF DAM.
4. REMOVE CHECK DAMS FROM GRASS–LINED DITCHES AND SWALES ONCE THE GRASS IS ESTABLISHED. SEED, MULCH OR MAT THE AREA WHERE THE CHECK DAMS WERE, IMMEDIATELY FOLLOWING REMOVAL.
5. INSPECT ONCE PER WEEK ON ACTIVE SITES, ONCE EVERY TWO WEEKS ON INACTIVE SITES, AND WITHIN 24 HOURS FOLLOWING A 0.5 INCH RAIN EVENT. REMOVE SEDIMENT ONCE IT REACHES ONE–THIRD THE DEPTH OF THE ROCK WEIR. REPLACE ROCK WEIR WHEN FILTERING CAPACITY IS REDUCED BY ONE–HALF.
6. SPACING TABLE FOR CHECK DAMS:

DITCH GRADE	MINIMUM WEIR DEPTH		
	6 INCH	12 INCH	18 INCH
6%	**	L=16 ft O.C.	L=26 ft O.C.
5%	**	L= 20 ft	L= 30 ft
4%	**	L= 26 ft	L= 40 ft
3%	15 ft	L= 33 ft	L= 50 ft
2%	25 ft	L= 50 ft	L= 80 ft
1%	25 ft	L= 50 ft	L= 80 ft

**NOT ALLOWED

CHECK DAMS (8 / –)
NTS BMP C207

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL NOTES AND DETAILS – 2

DESIGN:	DRS	START DATE:	2/19/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/26/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100–EC–002 | SHEET: 1/1 | REV.:

Last Saved by: Tony.pritchett on: Feb 19, 2015 7:19 AM File: Q:\Vancouver\2013\A13.0267\02\CADD\Dwgs\03_0100-EC-002.dwg

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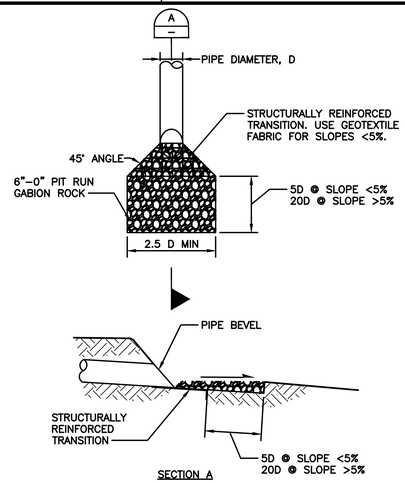
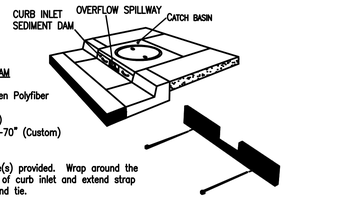


SECTION A

NOTES:
1. DETAIL PROVIDED FOR GENERAL GUIDANCE ONLY. FOR LARGE DIAMETER OUTLETS > 12", HIGH VELOCITY DISCHARGES, OR SUBMERGED OUTLETS PROTECTION SHALL BE SITE SPECIFICALLY ENGINEERED.
2. INSTALL CHECK DAMS ON OUTLET ON STEEP SLOPES AND NATURAL STONE LEVEL SPREADER EVERY 10 FEET.

OUTLET PROTECTION (1)
NTS BMP C209

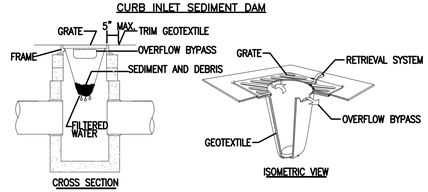


CURB INLET SEDIMENT DAM

Material: 100% Non-woven Polyfiber
Color: Blue
Height: 5" (Custom)
Widths: 36" – 54" –70" (Custom)

Installation:
Place strap through hole(s) provided. Wrap around the horizontal rod in mouth of curb inlet and extend strap through adjacent hole and tie.

CURB INLET SEDIMENT DAM

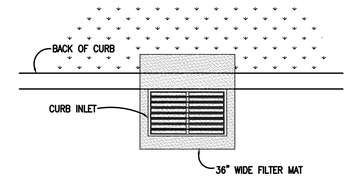


CROSS SECTION — ISOMETRIC VIEW

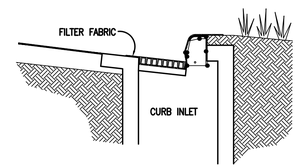
1. INLET PROTECTION MUST BE REGULARLY INSPECTED TO INSURE PROPER PLACEMENT/FUNCTION AND MAINTENANCE.

FILTER BAG

NOTES:
1. SIZE THE BELOW GRATE INLET DEVICE (BGID) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE REMOVAL SYSTEM MUST ALLOW REMOVAL OF THE BGID WITHOUT SPILLING THE COLLECTED MATERIAL.
3. THE BGID SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
4. THE CONTRACTOR SHALL INSPECT THE BAG AFTER EACH STORM EVENT AND AT REGULAR INTERVALS.
5. THE FILTER BAG SHALL BE CLEANED OR REPLACED WHEN THE BAG BECOMES HALF FULL.



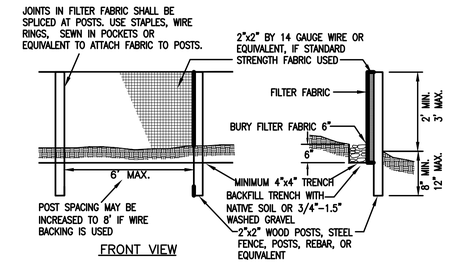
PLAN VIEW



FILTER MAT

NOTES:
1. USE FILTER MAT SEDIMENT BARRIER WHEN CURB INLET IS LOCATED IN GENTLY SLOPING STREET, WITH MINIMAL NEED, WHERE WATER CAN FILTER 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 MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.

STORM DRAIN INLET PROTECTION (2)
NTS BMP C220



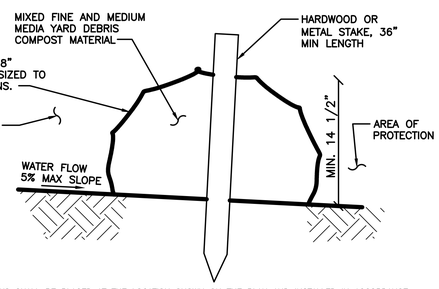
FRONT VIEW — SIDE VIEW

NOTE: FILTER FABRIC FENCES SHALL BE INSTALLED ALONG CONTOUR WHENEVER POSSIBLE

MAINTENANCE STANDARDS: ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY

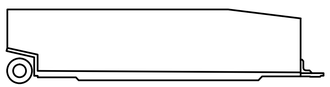
1. SILT FENCES AND FILTER BARRIERS SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
2. IF CONCENTRATED FLOWS ARE EVIDENT UPHILL OF THE FENCE, THEY MUST BE INTERCEPTED AND CONVEYED TO A SEDIMENT POND.
3. IT IS IMPORTANT TO CHECK THE UPHILL SIDE OF THE FENCE FOR SIGNS OF THE 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.
4. SEDIMENT DEPOSITS SHALL EITHER BE REMOVED WHEN THE DEPOSIT REACHES APPROXIMATELY ONE-THIRD THE HEIGHT OF THE SILT FENCE, OR A SECOND SILT FENCE SHALL BE INSTALLED.
5. IF THE FILTER FABRIC (GEOTEXTILE) HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.

SILT FENCE (3)
NTS BMP C233



NOTES:
1. FILTER SOCKS SHALL BE PLACED AT THE LOCATION SHOWN ON THE PLAN AND INSTALLED IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS.
2. USE 2"x2"x36" HARD WOOD STAKES FOR INSTALLS WITH A MINIMUM 12" DRIVE DEPTH.
3. STEEL POSTS MAY BE USED AND SHALL BE ROLLED FROM HIGH CARBON STEEL AND HAVE A MINIMUM OF 1.25 LB/FT. POSTS SHALL BE PAINTED WITH HIGH-GRADE WEATHER RESISTANT BROWN OR BLACK STEEL PAINT. STEEL POSTS SHALL BE EQUIPPED WITH ANCHOR PLATE HAVING A MINIMUM AREA OF 14 SQUARE INCHES. POSTS SHALL BE STUDDED, EMBOSSED, OR BUNCHED. POSTS AND ANCHOR POSTS SHALL CONFORM TO THE REQUIREMENTS OF ASTM A702.
4. FILTER SOCKS FILLED AT PROJECT SITE MAY BE UP TO 250 FEET LONG. CONNECTED SOCKS SHALL BE OVERLAPPED A MINIMUM OF 5 FEET.
5. REMOVE SEDIMENT FROM BEHIND FILTER SOCK ONCE IT ACCUMULATES TO ONE-HALF OF THE ORIGINAL HEIGHT OF THE FILTER SOCK.
6. INSPECT FILTER SOCKS AFTER EACH RUNOFF EVENT. REMOVE AND REPLACE IF THERE ARE ANY SIGNS OF UNDERCUTTING OR DOWNSTREAM RILLS ARE OBSERVED.
7. FILTER SOCKS SHALL BE REMOVED FROM SLOPES AFTER STABILIZATION IS COMPLETE UNLESS DIRECTED TO LEAVE IN PLACE BY PERMITTING AGENCY.

COMPOST SOCK DETAIL (4)
NTS BMP C235



STORAGE TANK
NTS

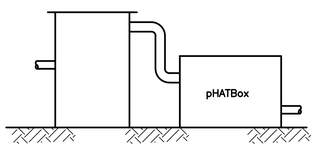
WEIR TANK
NTS

NOTES:
1. TANKS FOR STORAGE AND DEWATERING WATER SHALL BE CLEANED AND TESTED PRIOR TO DELIVERY. TANKS SHALL BE FREE OF ALL CHEMICAL AND HAZARDOUS MATERIAL RESIDUE.
2. STORAGE TANKS SHALL BE COATED INTERNALLY.
3. TANKS SHALL BE PRE-MANUFACTURED, FIXED AXLE WITH ALL NECESSARY PIPING CONNECTIONS AND VALVING.
4. INSPECTION AND CLEANING MAN-WAYS SHALL BE PROVIDED FOR EACH BAY W/I WEIR TANKS.
5. PIPING CONNECTIONS SHALL BE FITTED WITH CONTROL VALVES.
6. TANKS SHALL HAVE LEVEL GAUGE.
7. CONSTRUCTED SEDIMENT PONDS MEETING REQUIREMENTS OF BMP C241 MAY BE SUBSTITUTED.

WEIR AND STORAGE TANKS (5)
NTS BMP C241

NOTES:
1. PROVIDE SAND FILTRATION DEVICES WITH OPTION FOR ADDITION OF BIOLOGICALLY FRIENDLY FLOCCULANT. IF ADDITIONAL PRETREATMENT IS REQUIRED USE WEIR TANKS W/ FLOCCULANT UPSTREAM.
2. SYSTEM SHALL BE CAPABLE OF AUTOMATIC BACKWASH FOR TIMED, PRESSURE DIFFERENTIAL OR MANUAL BACKWASH INTERVALS.
3. PROVIDE DOWNSTREAM FLOW COMPOSITE WATER QUALITY MONITOR TO TEST FOR TURBIDITY, ZINC, AND COPPER.
4. PROVIDE ADDITIONAL CARTRIDGE OR BAG FILTERS TO ENSURE WATER QUALITY BENCHMARKS ARE ACHIEVED.
5. INSPECT AND PROVIDE PERSONNEL FOR MONITORING DAILY. REPLACE MEDIA AS NECESSARY.

ENHANCED SAND FILTRATION (6)
NTS BMP C250/C251



NOTES:
1. PH NEUTRALIZATION SYSTEMS SHALL INCLUDE REAL TIME PH MONITORING AND DATA RECORDING.
2. SYSTEM SHALL BE FULLY AUTOMATED AND CAPABLE OF MEETING NECESSARY DESIGN FLOW RATES.
3. CONTRACTOR SHALL INSPECT AND MONITOR SYSTEM DAILY.

PH NEUTRALIZATION (7)
NTS BMP C253

SAM ADAMS — STATE OF WASHINGTON — 27330 — REGISTERED PROFESSIONAL ENGINEER

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NO.	DATE	REVISION	BY	CK'D	APP

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL NOTES AND DETAILS – 3

DESIGN:	DRS	START DATE:	12/23/2014	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/19/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-EC-003 — SHEET 1/1 — REV.

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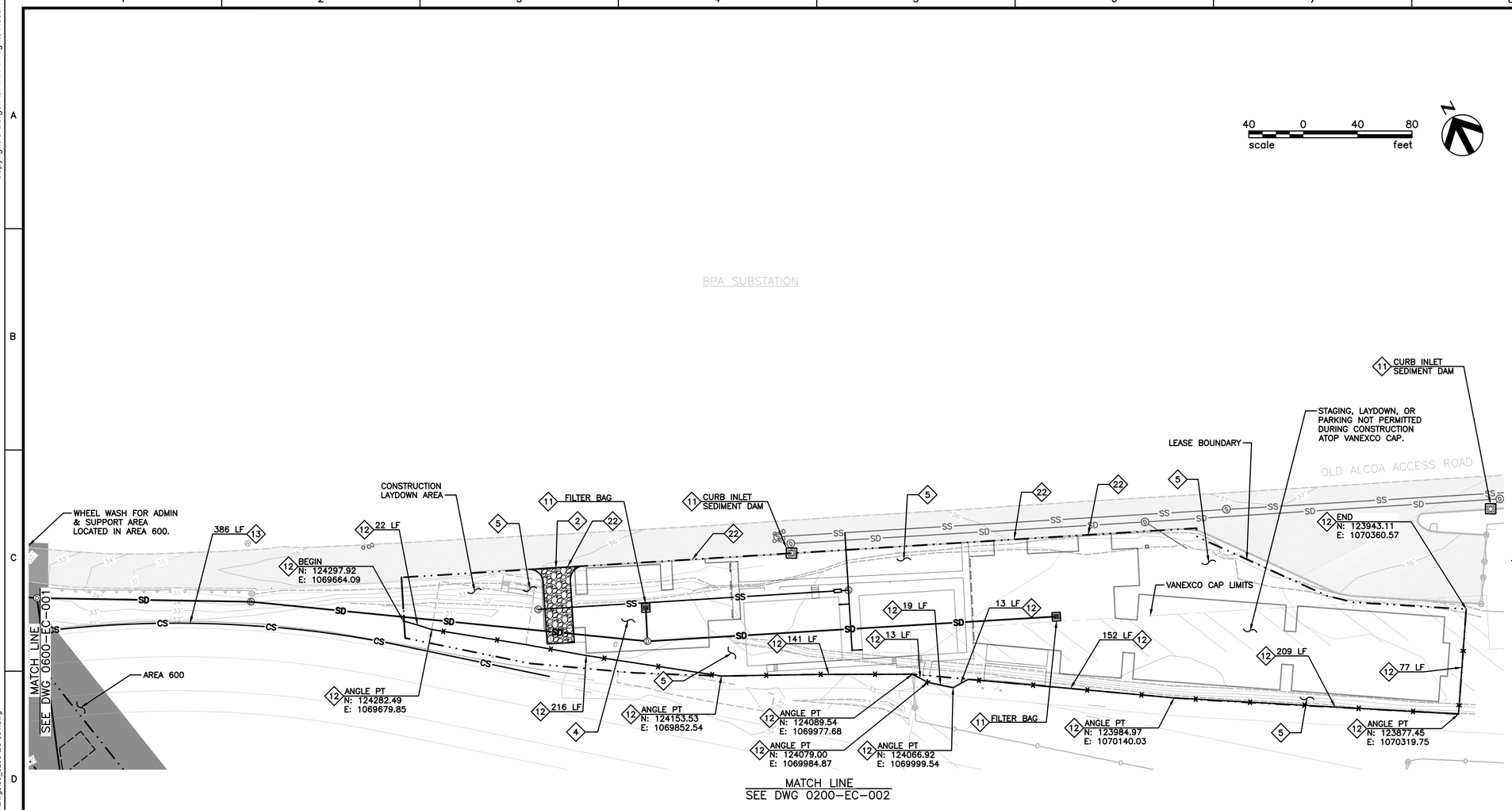

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

2 INSTALL STABILIZED CONSTRUCTION ENTRANCE/EXIT. SEE DETAIL 2 ON DWG 0100-EC-001.

4 CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.

5 INSTALL TEMPORARY AND PERMANENT SEEDING IMMEDIATELY FOLLOWING FINAL GRADING. SEE DETAIL 2 ON DWG 0100-EC-002.

7 CONCRETE WASHOUT IS LOCATED IN AREA 300. SEE DWG 0300-EC-001 AND 0300-EC-002 FOR LOCATION.

11 INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.

12 INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-ED-003.

13 INSTALL COMPOST SOCK IN ACCORDANCE WITH DETAIL 4 ON DWG 0100-ED-003. INSTALL DOWN GRADIENT ON ALL TRENCHING AND UTILITY INSTALLATIONS OUTSIDE OF SILT FENCING AREAS. OVERLAP WITH SILT FENC A MINIMUM OF 50'.

22 INSTALL COMPOST SOCK CONTAINMENT TEMPORARILY DURING SAWCUTTING. VACUUM SLURRY AND DISPOSE OF TO SANITARY SEWER. CONTRACTOR SHALL PROTECT ALL SURFACE WATER FROM SAWCUTTING SLURRIES, AND PROVIDE CONTAINMENT FOR ALL CONCRETE OR ASPHALT DEBRIS.

SAM ADAMS STATE OF WASHINGTON 27330 REGISTERED PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

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(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 200
ENVIRONMENTAL CONTROL PLAN – 1

DESIGN:	DRS	START DATE:	2/19/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER	SHEET	REV.
0200-EC-001	1 / 1	

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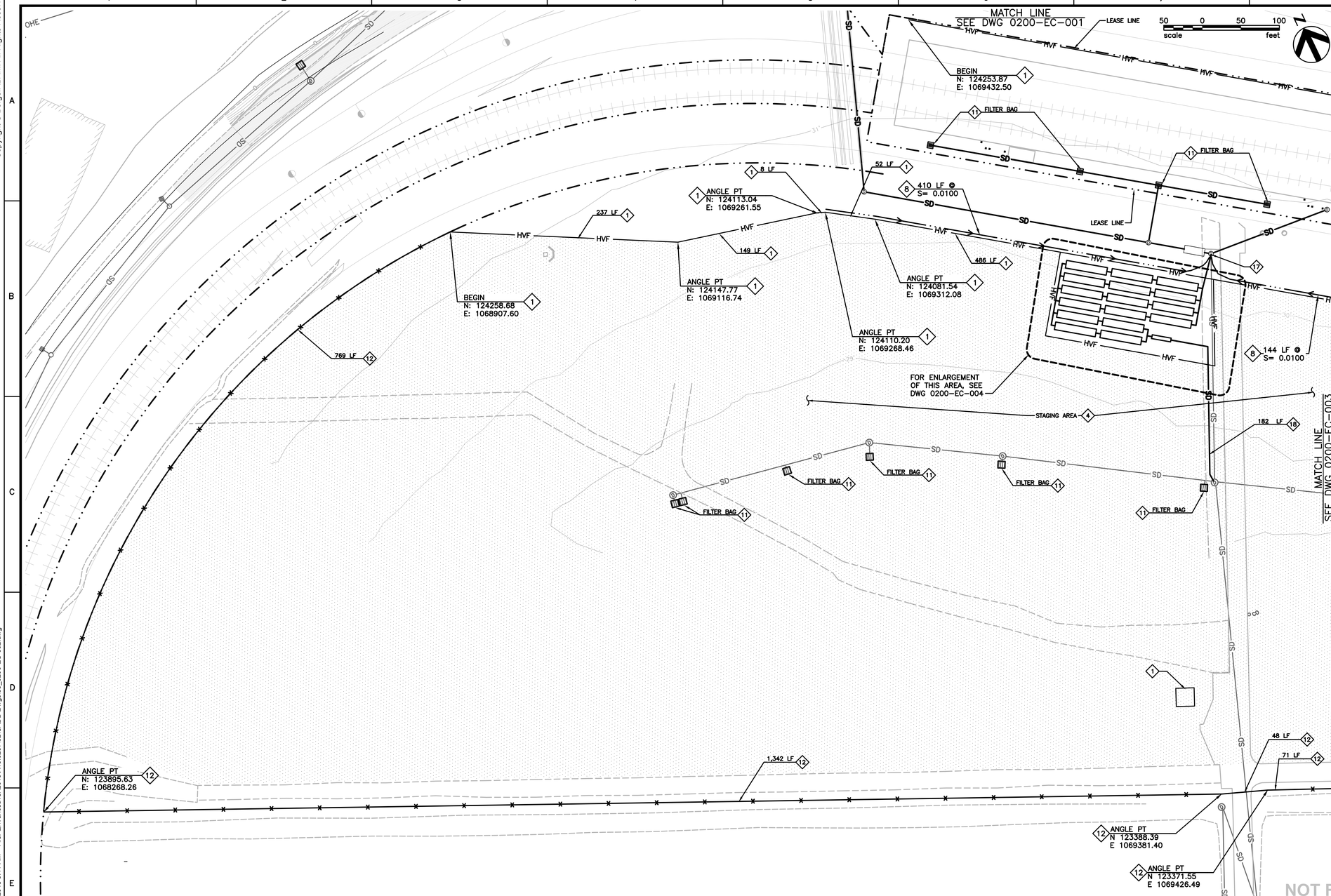

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
7. CONCRETE WASHOUT IS LOCATED IN AREA 300. SEE DWG 0300-EC-002 FOR LOCATION.
8. CONSTRUCT STORMWATER INTERCEPTOR IN THE LOCATION SHOWN. GENTLY GRADE LAYDOWN AREA TO INTERCEPTOR SWALE AS NECESSARY. SEE DETAIL 7 ON DWG 0100-EC-002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.
17. INSTALL PIPE PLUG ON DOWNSTREAM SIDE OF EXISTING STORM DRAIN STRUCTURE. CONTRACTOR SHALL PROVIDE PACKAGE STORMWATER HANDLING SUCTION PRIME PUMPING SYSTEM COMPLETE WITH GENERATOR, ON-SITE REDUNDANT PUMP, AND AUTODIALER NOTIFICATION SYSTEM.
18. INSTALL SOLID WALL, FUSED TEMPORARY HDPE PUMP EFFLUENT LINE AND MANIFOLD TO STORAGE/SURGE TANKS FOR TREATMENT.

PERMIT SET
NOT FOR CONSTRUCTION

SAM ADAMS
STATE OF WASHINGTON
22330
REGISTERED
PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 200
ENVIRONMENTAL CONTROL PLAN – 2

DESIGN:	DRS	START DATE:	2/20/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0200-EC-002
SHEET: 1 / 1
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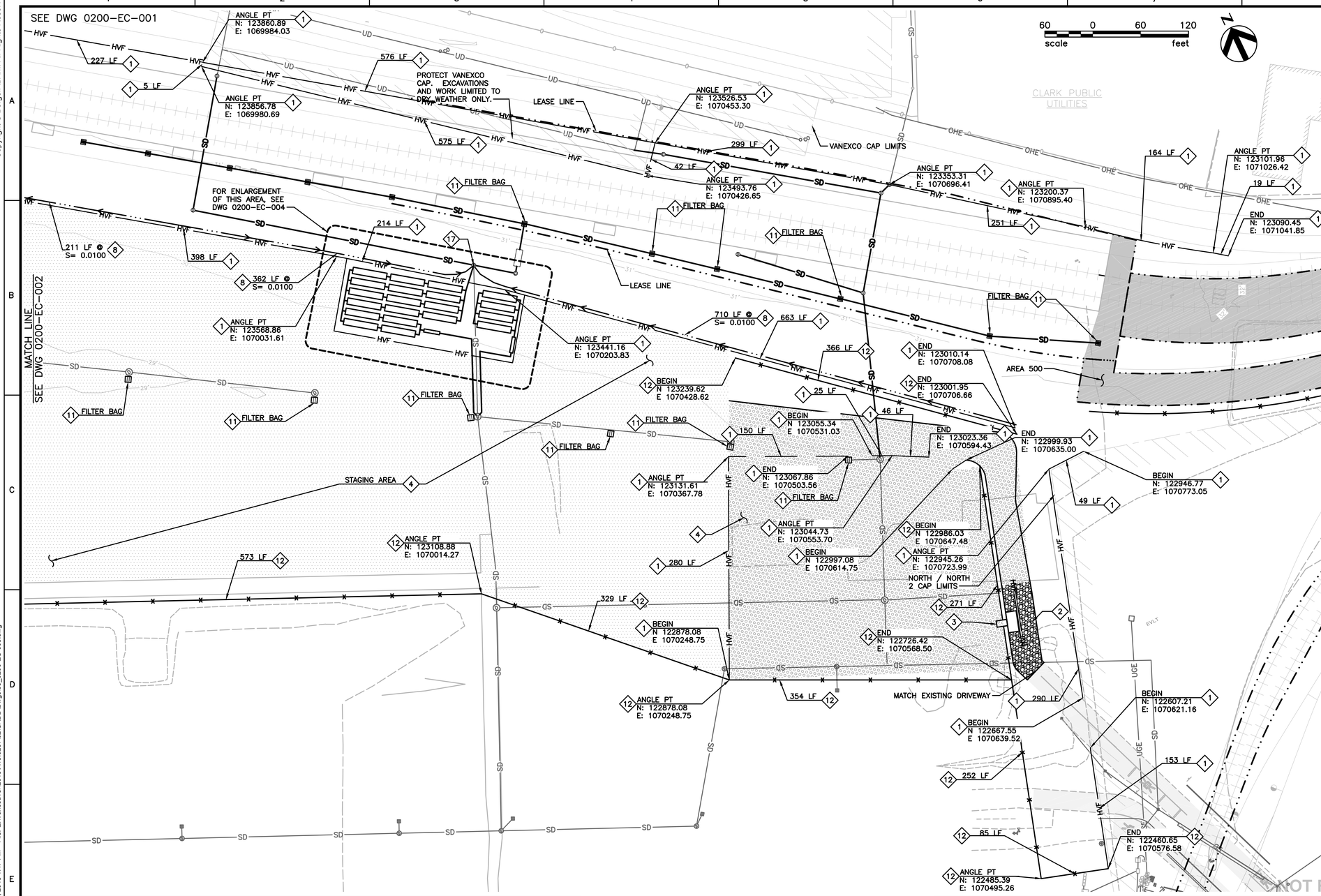

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.
2. INSTALL STABILIZED CONSTRUCTION ENTRANCE/EXIT. SEE DETAIL 2 ON DWG 0100-EC-001.
3. INSTALL PACKAGED WHEEL WASH DURING PERIODS OF GROUND DISTURBANCE DURING THE WET SEASON. SEE DETAIL 3 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
7. CONCRETE WASHOUT IS LOCATED IN AREA 300. SEE DWG 0300-EC-001 AND 0300-EC-003 FOR LOCATION.
8. CONSTRUCT STORMWATER INTERCEPTOR IN THE LOCATION SHOWN. GENTLY GRADE LAYDOWN AREA TO INTERCEPTOR SWALE AS NECESSARY. SEE DETAIL 7 ON DWG 0100-EC-002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.

SAM ADAMS STATE OF WASHINGTON 27330 REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 200
ENVIRONMENTAL CONTROL PLAN – 3

DESIGN:	DRS	START DATE:	2/24/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0200-EC-003 | SHEET 1/1 | REV.

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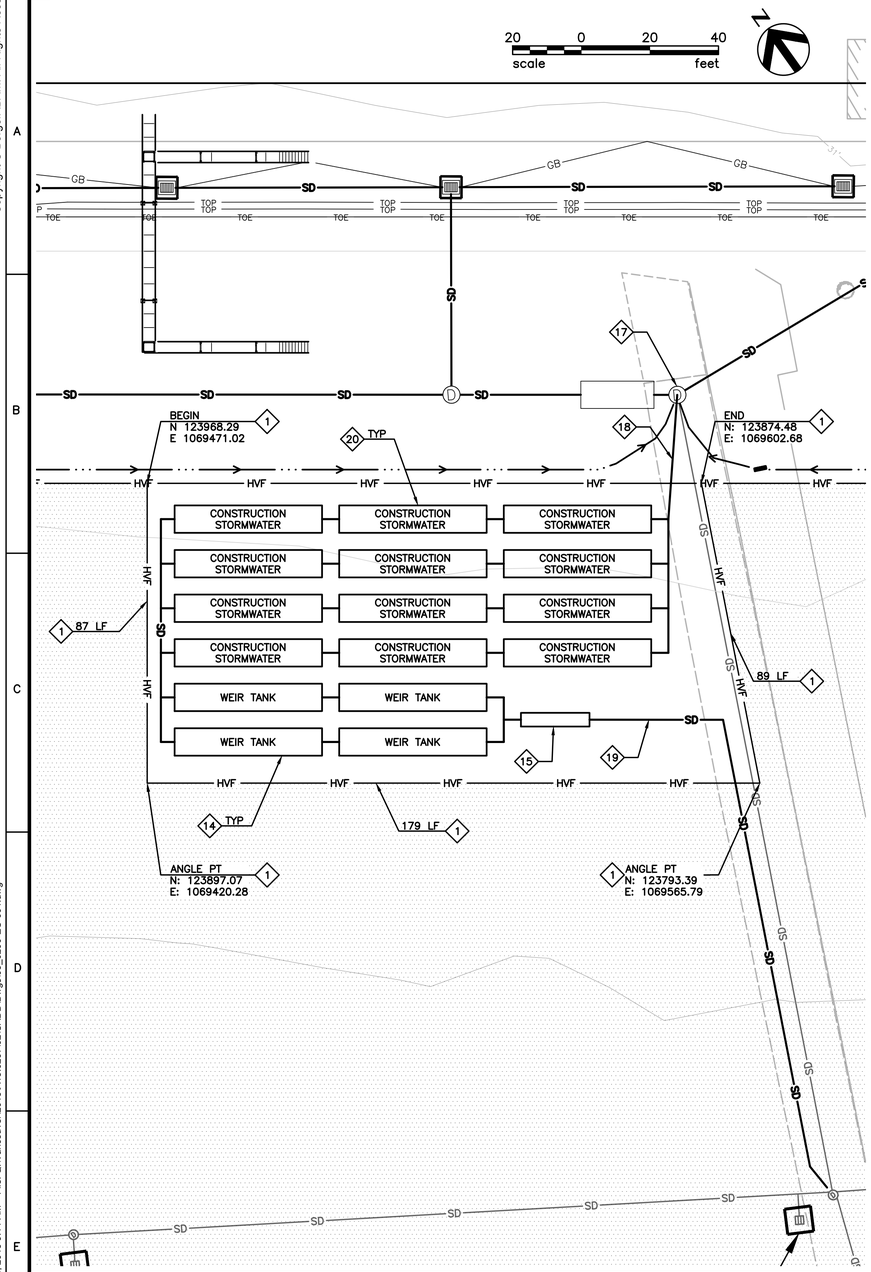

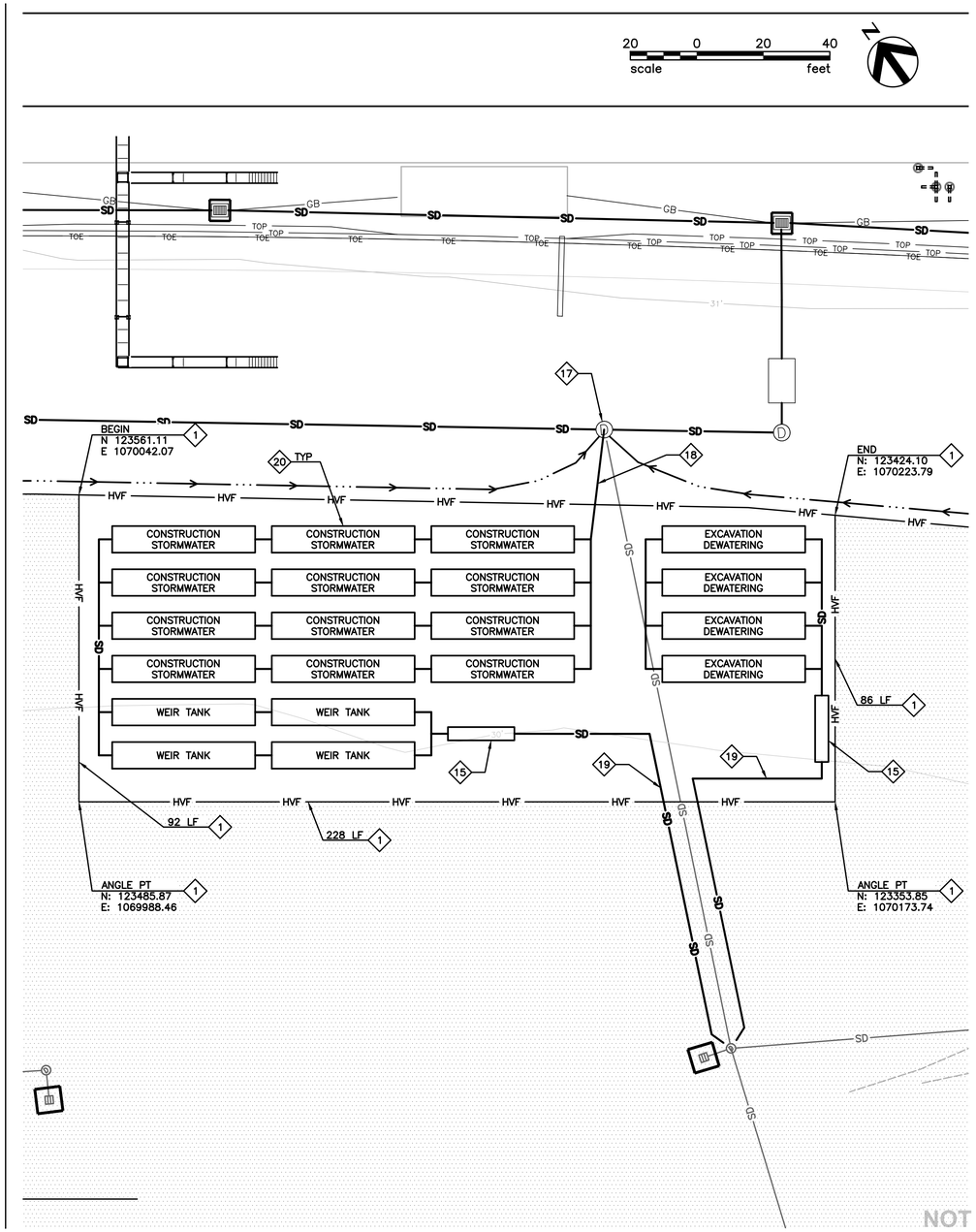

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100–EC–001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100–CD–001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN–PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET–WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100–EC–002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100–EC–002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON–SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100–EC–001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100–EC–001.
4. CONSTRUCT PARKING AREA STABILIZATION ON–SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100–EC–002.
8. CONSTRUCT STORMWATER INTERCEPTOR IN THE LOCATION SHOWN. GENTLY GRADE LAYDOWN AREA TO INTERCEPTOR SWALE AS NECESSARY. SEE DETAIL 7 ON DWG 0100–EC–002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100–EC–003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100–EC–003.
14. INSTALL WEIR TANKS FOR BASIC SEDIMENT TREATMENT. SEE DETAIL 5 ON DWG 0100–EC–003.
15. INSTALL ENHANCED SAND FILTRATION AND ADDITIONAL TREATMENT AS REQUIRED TO MEET PERMIT CONDITIONS. SEE DETAIL 6 ON DWG 0100–EC–003.
17. INSTALL PIPE PLUG ON DOWNSTREAM SIDE OF EXISTING STORM DRAIN STRUCTURE. CONTRACTOR SHALL PROVIDE PACKAGE STORMWATER HANDLING SUCTION PRIME PUMPING SYSTEM COMPLETE WITH GENERATOR, ON–SITE REDUNDANT PUMP, AND AUTODIALER NOTIFICATION SYSTEM.
18. INSTALL SOLID WALL, FUSED TEMPORARY HDPE PUMP EFFLUENT LINE AND MANIFOLD TO STORAGE/SURGE TANKS FOR TREATMENT.
19. INSTALL STORMWATER TREATMENT SYSTEM OUTFALL PIPING TO EXISTING STORM DRAIN. CONTRACTOR SHALL PROVIDE FLOW COMPOSITE SAMPLER AND PORT TO EXTRACT DAILY GRAB SAMPLES.
20. INSTALL 1.5 MILLION GALLONS OF STORAGE/SURGE TANKS.

SAM ADAMS
STATE OF WASHINGTON
27330
REGISTERED
PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 200
ENVIRONMENTAL CONTROL PLAN – 4

DESIGN:	DRS	START DATE:	2/20/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/20/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER	SHEET	REV.
0200–EC–004	1 / 1	

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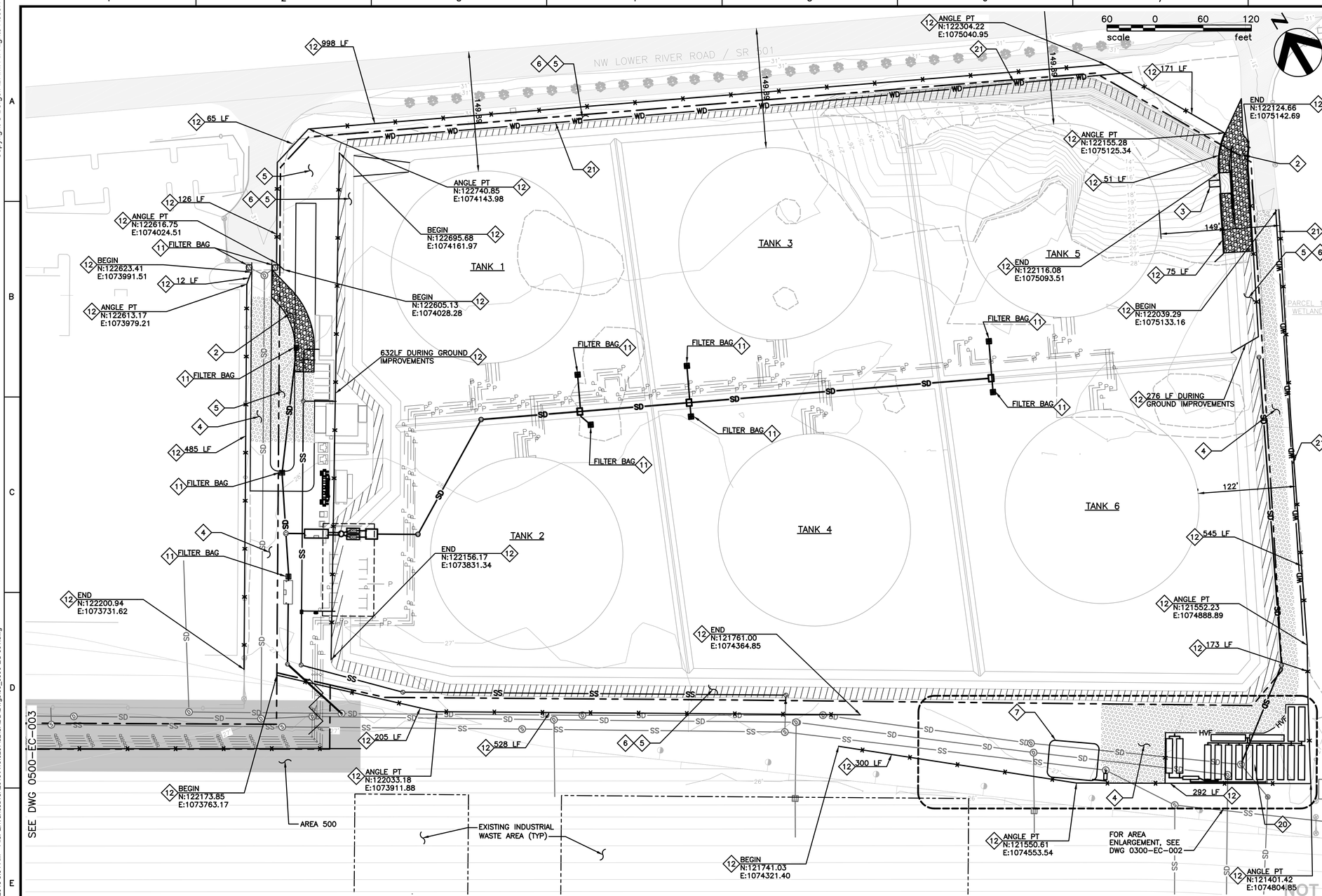

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.
2. INSTALL STABILIZED CONSTRUCTION ENTRANCE/EXIT. SEE DETAIL 2 ON DWG 0100-EC-001.
3. INSTALL PACKAGED WHEEL WASH DURING PERIODS OF GROUND DISTURBANCE DURING THE WET SEASON. SEE DETAIL 3 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
5. INSTALL TEMPORARY AND PERMANENT SEEDING IMMEDIATELY FOLLOWING FINAL GRADING. SEE DETAIL 2 ON DWG 0100-EC-002.
6. PERFORM SURFACE ROUGHENING ON PRIMARY CONTAINMENT BERMS DURING CONSTRUCTION. SEE DETAIL 4 ON DWG 0100-EC-002.
7. INSTALL CONCRETE WASHOUT AREA IN ACCORDANCE WITH DETAIL 6 ON DRAWING 0100-EC-002.
8. CONSTRUCT STORMWATER INTERCEPTOR IN THE LOCATION SHOWN. GENTLY GRADE LAYDOWN AREA TO INTERCEPTOR SWALE AS NECESSARY. SEE DETAIL 7 ON DWG 0100-EC-002.
11. INSTALL CHECK DAMS IN EXISTING BIOFILTRATION SWALE AS SHOWN. SEE DETAIL 8 ON DWG 0100-EC-002.
12. INSTALL SILT FENCE. SEE DETAIL 3 IN DWG0100-EC-003.
20. INSTALL 60,000 GALLONS OF STORAGE/SURGE TANKS.
21. INSTALL WICK DRAINS AT 16' O.C. MINIMUM SPACING WHERE SHOWN WHEN GROUND IMPROVEMENTS ARE WITHIN 150 FEET OF ADJACENT WETLANDS. CONTRACTOR SHALL SUBMIT ENGINEERED DESIGN FOR REVIEW AND APPROVAL.

SAM ADAMS STATE OF WASHINGTON 27330 REGISTERED PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
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Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 300
ENVIRONMENTAL CONTROL PLAN

DESIGN:	DRS	START DATE:	2/23/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0300-EC-001 | SHEET 1/1 | REV.

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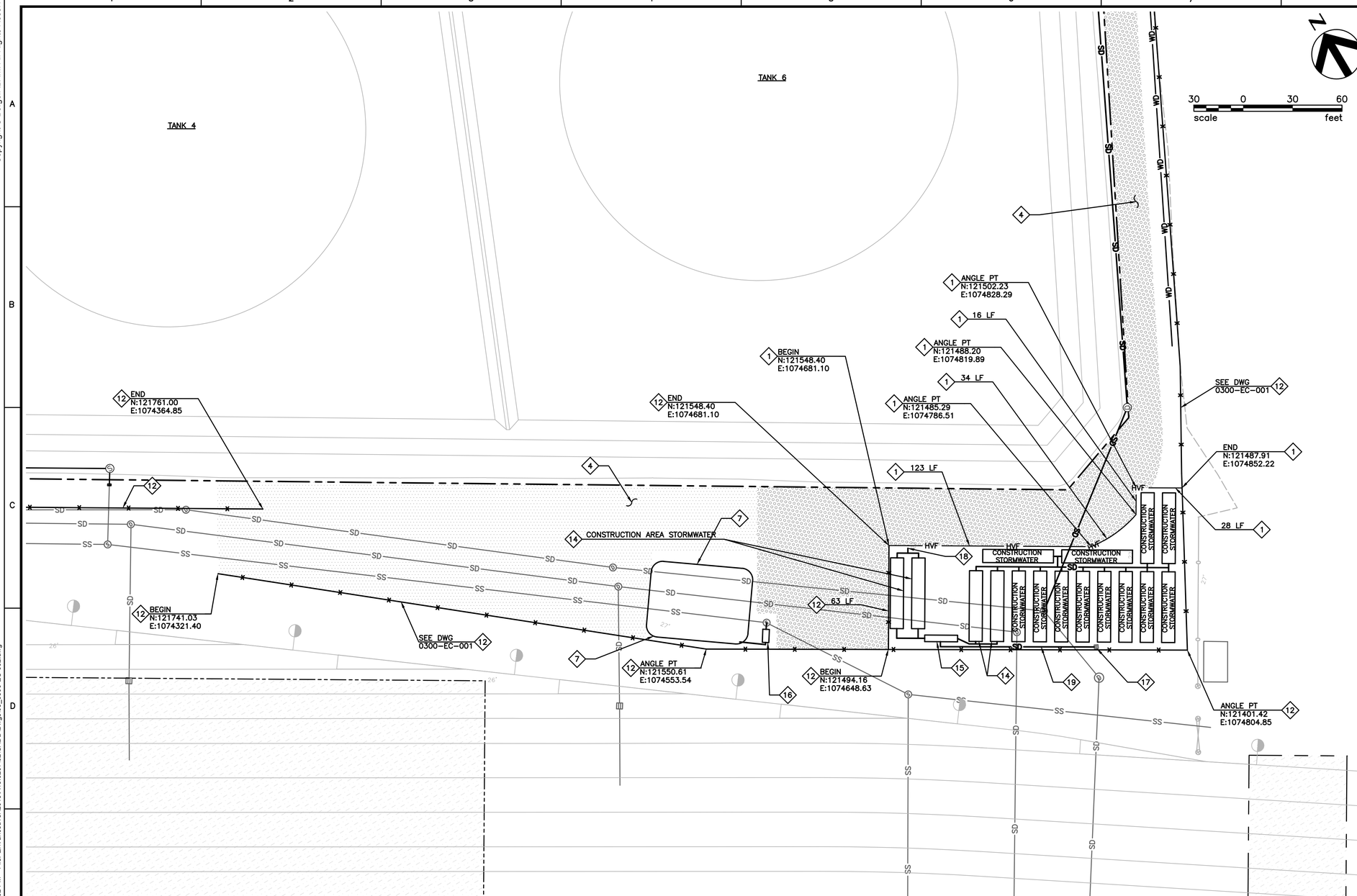

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
7. INSTALL CONCRETE WASHOUT AREA. SEE DETAIL 6 ON DWG 0100-EC-002
8. CONSTRUCT STORMWATER INTERCEPTOR IN THE LOCATION SHOWN. GENTLY GRADE LAYDOWN AREA TO INTERCEPTOR SWALE AS NECESSARY. SEE DETAIL 7 ON DWG 0100-EC-002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.
14. INSTALL WEIR TANKS FOR BASIC SEDIMENT TREATMENT. SEE DETAIL 6 ON DWG 0100-EC-003.
15. INSTALL ENHANCED SAND FILTRATION AND ADDITIONAL TREATMENT AS REQUIRED TO MEET PERMIT CONDITIONS. SEE DETAIL 6 ON DWG 0100-EC-003.
16. INSTALL PH NEUTRALIZATION TREATMENT AS REQUIRED TO MEET PERMIT CONDITIONS. SEE DETAIL 7 ON DWG 0100-EC-003.
18. INSTALL SOLID WALL, FUSED TEMPORARY HDPE PUMP EFFLUENT LINE AND MANIFOLD TO STORAGE/SURGE TANKS FOR TREATMENT.
19. INSTALL STORMWATER TREATMENT SYSTEM OUTFALL PIPING TO EXISTING STORM DRAIN. CONTRACTOR SHALL PROVIDE FLOW COMPOSIT SAMPLER AND PORT TO EXTRACT DAILY GRAB SAMPLES.
20. INSTALL 60,000 GALLONS OF STORAGE/SURGE TANKS.

SAM ADAMS
STATE OF WASHINGTON
27330
REGISTERED
PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	CK'D	APP

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700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 300
ENVIRONMENTAL CONTROL PLAN

DESIGN:	DRS	START DATE:	2/17/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/20/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0300-EC-002
SHEET: 1/1
REV.

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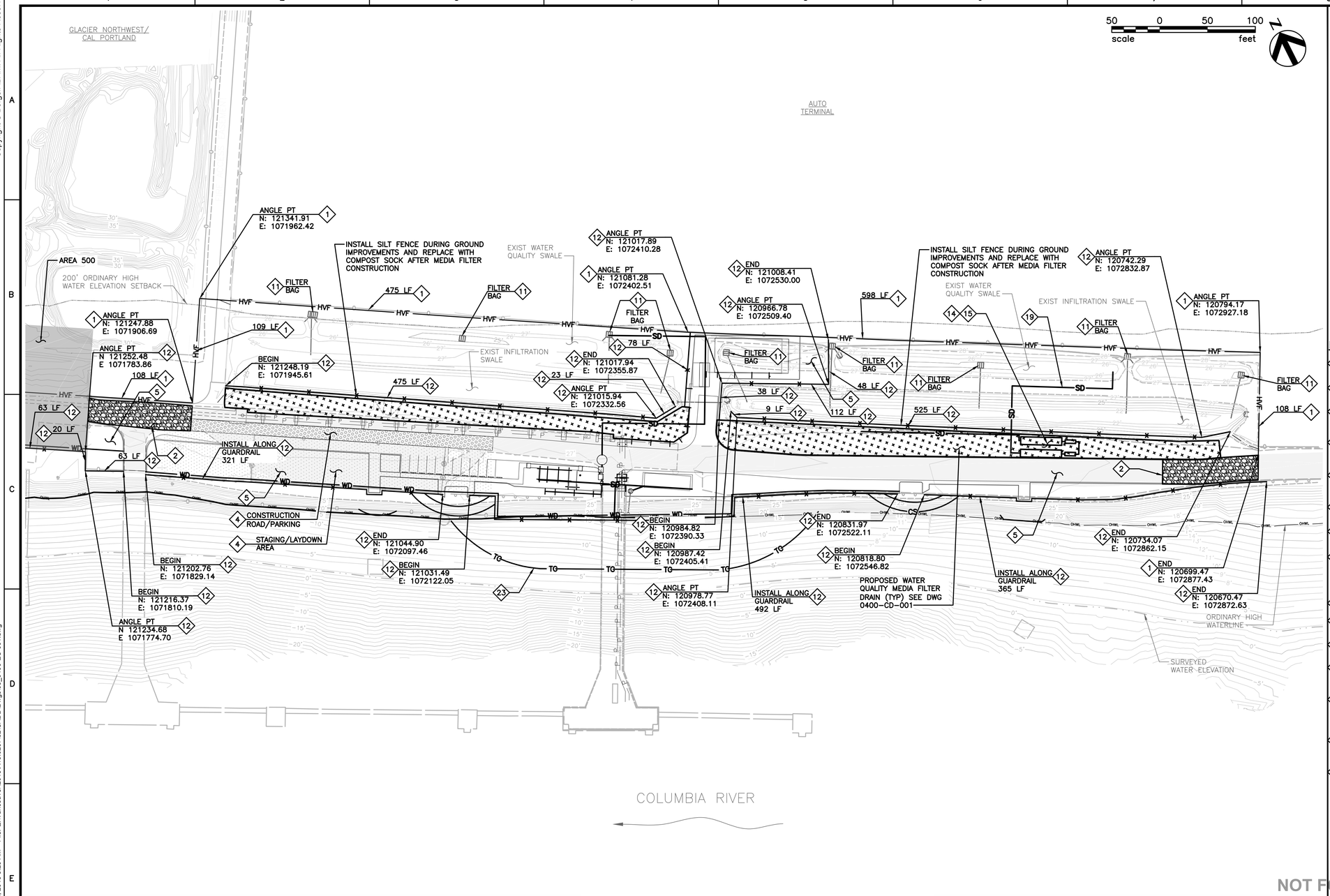

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
3. CONTRACTOR IS RESPONSIBLE TO ENSURE THAT ENVIRONMENTAL CONTROLS IN-PLACE DURING CONSTRUCTION ARE SUFFICIENT TO MEET PERMIT REQUIREMENTS AND ARE MAINTAINED AT ALL TIMES. ENVIRONMENTAL CONTROL PLANS ASSUME WET SEASON CONSTRUCTION. CONTRACTOR MAY NEED TO SUPPLEMENT CONTROLS AS NECESSARY TO MEET PERMITTED CONDITIONS.
4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1. INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.
2. INSTALL STABILIZED CONSTRUCTION ENTRANCE/EXIT. SEE DETAIL 2 ON DWG 0100-EC-001.
3. INSTALL PACKAGED WHEEL WASH DURING PERIODS OF GROUND DISTURBANCE DURING THE WET SEASON. SEE DETAIL 3 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
5. INSTALL TEMPORARY AND PERMANENT SEEDING IMMEDIATELY FOLLOWING FINAL GRADING. SEE DETAIL 2 ON DWG 0100-EC-002.
7. CONCRETE WASHOUT IS LOCATED IN AREA 300. SEE DWG 0300-EC-001 AND 0300-EC-002 FOR LOCATION.
9. INSTALL CHECK DAMS IN EXISTING BIOFILTRATION SWALE AS SHOWN. SEE DETAIL 8 ON DWG 0100-EC-002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.
13. INSTALL COMPOST SOCK IN ACCORDANCE WITH DETAIL 4 ON DRAWING 0100-EC-003
14. INSTALL WEIR TANKS FOR BASIC SEDIMENT TREATMENT. SEE DETAIL 5 ON DWG 0100-EC-003.
15. INSTALL ENHANCED SAND FILTRATION AND ADDITIONAL TREATMENT AS REQUIRED TO MEET PERMIT CONDITIONS. SEE DETAIL 6 ON DWG 0100-EC-003.
19. INSTALL STORMWATER TREATMENT SYSTEM OUTFALL PIPING TO EXISTING STORM DRAIN. CONTRACTOR SHALL PROVIDE FLOW COMPOSITE SAMPLER AND PORT TO EXTRACT DAILY GRAB SAMPLES.
21. INSTALL WICK DRAINS AT 8' O.C. MAXIMUM SPACING ALONG COLUMBIA RIVER WATERFRONT. CONTRACTOR SHALL SUBMIT ENGINEERED DESIGN FOR REVIEW AND APPROVAL.
23. INSTALL TYPE II TURBIDITY CURTAIN DURING GROUND IMPROVEMENT WORK NEAR THE ABUTMENT.

SAM ADAMS STATE OF WASHINGTON 47330 REGISTERED PROFESSIONAL ENGINEER

PERMIT SET
NOT FOR CONSTRUCTION
PRELIMINARY

NO.	DATE	REVISION	BY	CK'D	APP

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700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 400
ENVIRONMENTAL CONTROL PLAN

DESIGN:	DRS	START DATE:	2/23/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0400-EC-001 | SHEET: 1/1 | REV.

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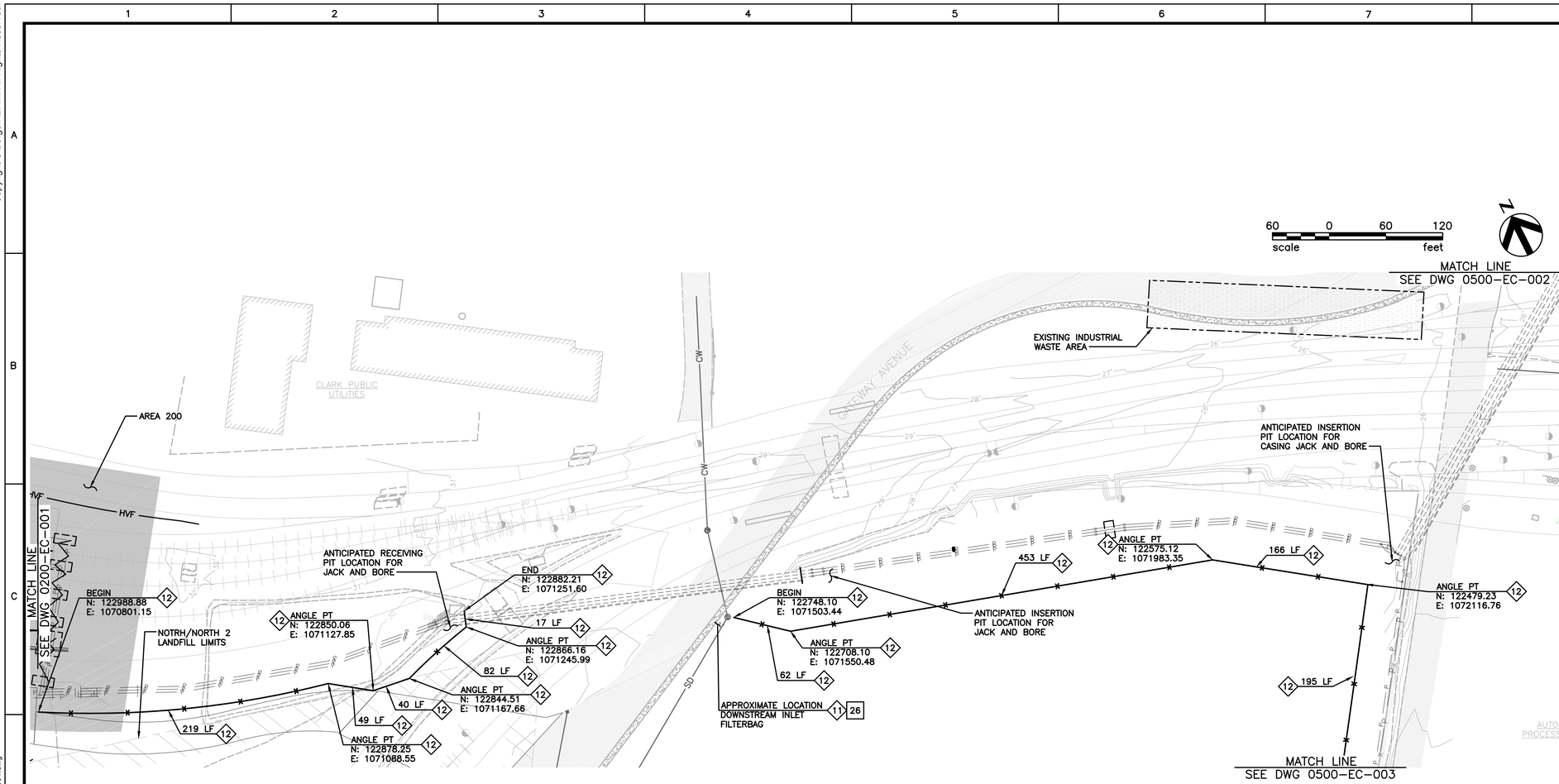

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
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4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1 INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.

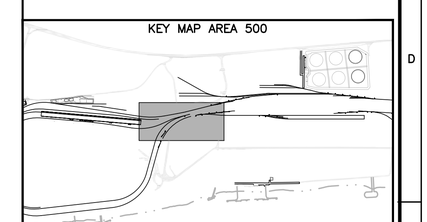
11 INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.

12 INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.

DRAINAGE NOTES:

26 RETROFIT SPILL TRAP WITHIN EXISTING INLET PER DETAIL 4 ON DRAWING 0100-CD-006.

KEY MAP AREA 500



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SAM ADAMSKY
STATE OF WASHINGTON
47330
REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY

NO.	DATE	REVISION	BY	CK'D	APP

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(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL PLAN – TRANSFER PIPELINE AREA – 1

DESIGN:	DRS	START DATE:	2/23/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0500-EC-001
SHEET: 1/1
REV.

Last Saved by: Tony.pritchett on: Feb 23, 2015 9:12 AM File: Q:\Vancouver\2013\A13.0267\02\CADD\Dwgs\03_0500-EC-001.dwg

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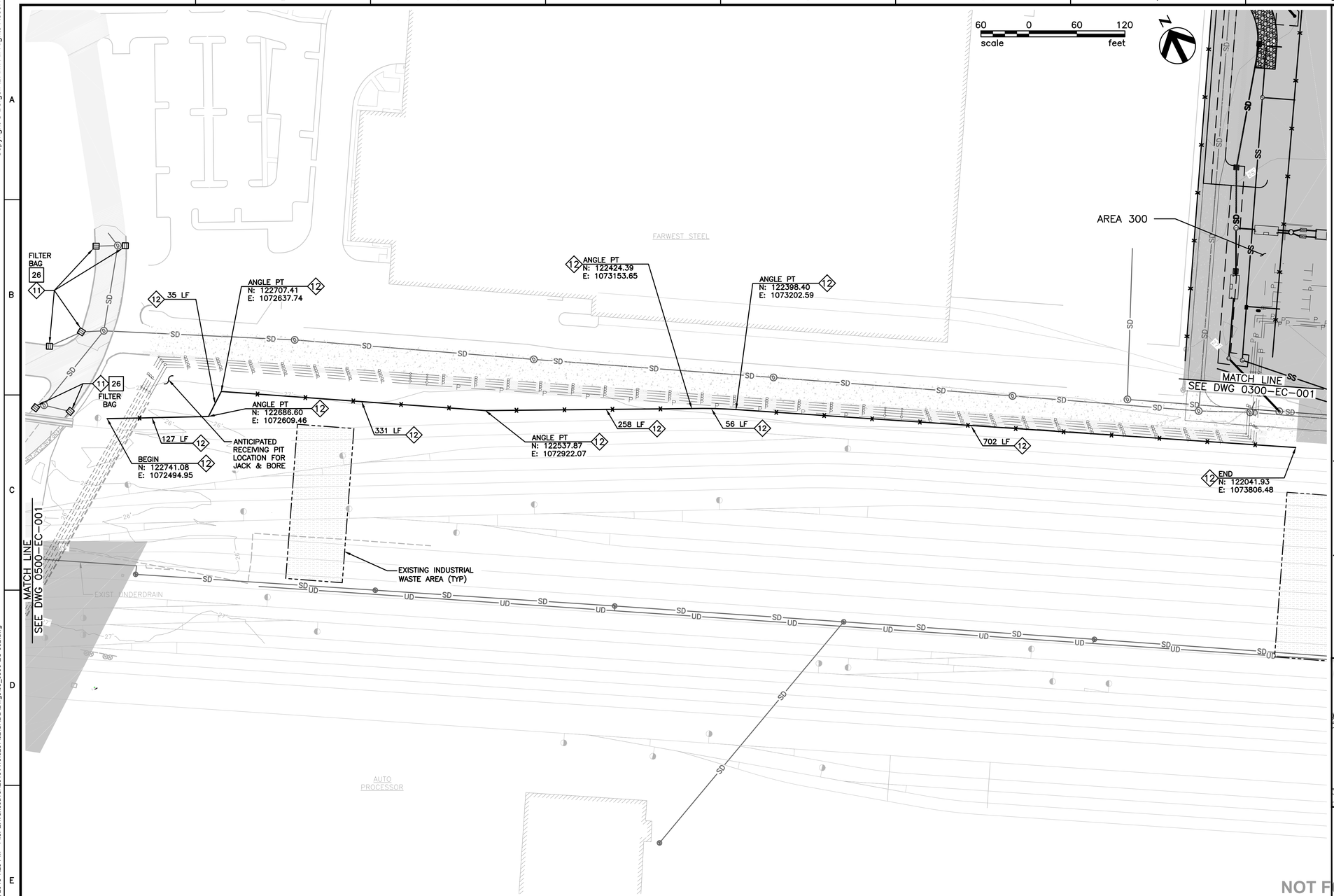

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
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4. STOCKPILED MATERIAL SHALL BE COVERED WITH PLASTIC COVERING TO THE MAXIMUM EXTENT PRACTICAL DURING WET-WEATHER SEASON. STOCKPILED MATERIAL NOT USED FOR 3 DAYS DURING DRY SEASON SHALL BE COVERED. WHERE FORECAST CALLS FOR RAIN AND/OR HIGH WINDS DURING DRY SEASON INSTALL PLASTIC COVERING ON STOCKPILED MATERIAL. SEE DETAIL 3 ON DWG 0100-EC-002.
5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

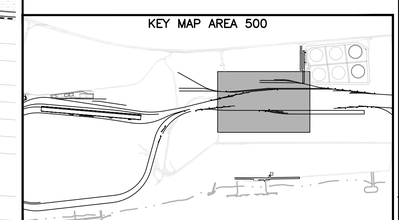
11 INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.

12 INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.

DRAINAGE NOTES:

26 RETROFIT SPILL TRAP WITHIN EXISTING INLET PER DETAIL 4 ON DRAWING 0100-CD-006.

KEY MAP AREA 500



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SAM ADAMS
STATE OF WASHINGTON
27330
REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

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Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL PLAN – TRANSFER PIPELINE AREA – 2

DESIGN:	DRS	START DATE:	2/17/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/23/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER	SHEET	REV.
0500-EC-002	1/1	

Last Saved by: Tony.pritchett on: Feb 17, 2015 1:25 PM File: Q:\Vancouver\2013\A13.0287\02\CADD\Dwgs\03_0500-EC-002.dwg

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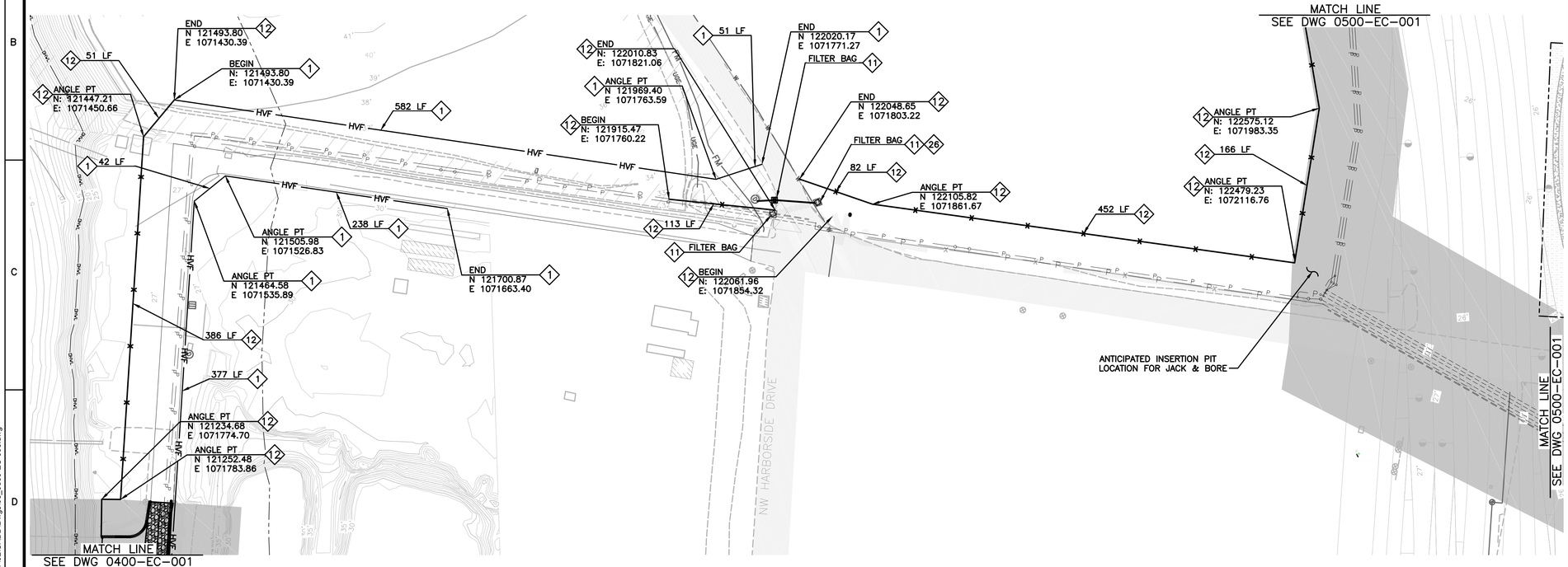

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
2. LAYOUT OF PROPOSED ENVIRONMENTAL CONTROL ELEMENTS IS SCHEMATIC, ACTUAL LOCATIONS AND CONFIGURATIONS MAY VARY. CONTRACTOR SHALL REVIEW ALL PERMIT DOCUMENTS, CONDITIONS OF APPROVAL, AND APPLICABLE SITE SPECIFIC STORMWATER POLLUTION CONTROL PLANS PRIOR TO CONSTRUCTION. CONTRACTOR SHALL CONSTRUCT ALL ENVIRONMENTAL CONTROL ELEMENTS IN ACCORDANCE WITH DOCUMENT PERMIT REQUIREMENTS.
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5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

1 INSTALL HIGH VISIBILITY FENCING. SEE DETAIL 1 ON DWG 0100-EC-001.

11 INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.

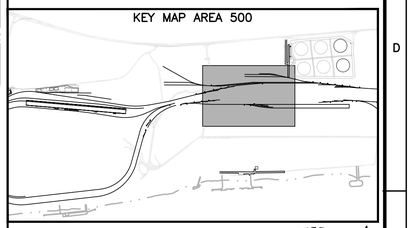
12 INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.

13 INSTALL COMPOST SOCK IN ACCORDANCE WITH DETAIL 4 ON DRAWING 0100-EC-003

DRAINAGE NOTES:

26 RETROFIT SPILL TRAP WITHIN EXISTING INLET PER DETAIL 4 ON DRAWING 0100-CD-006.

KEY MAP AREA 500



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700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: ENVIRONMENTAL CONTROL PLAN – TRANSFER PIPELINE AREA – 3

DESIGN:	DRS	START DATE:	2/24/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0500-EC-003 | SHEET 1/1 | REV.

Last Saved by: Tony.pritchett on: Feb 24, 2015 12:27 PM File: Q:\Vancouver\2013\A13.0267\02\CADD\Dwgs\03_0500-EC-003.dwg

EX-0001-004189-PCE

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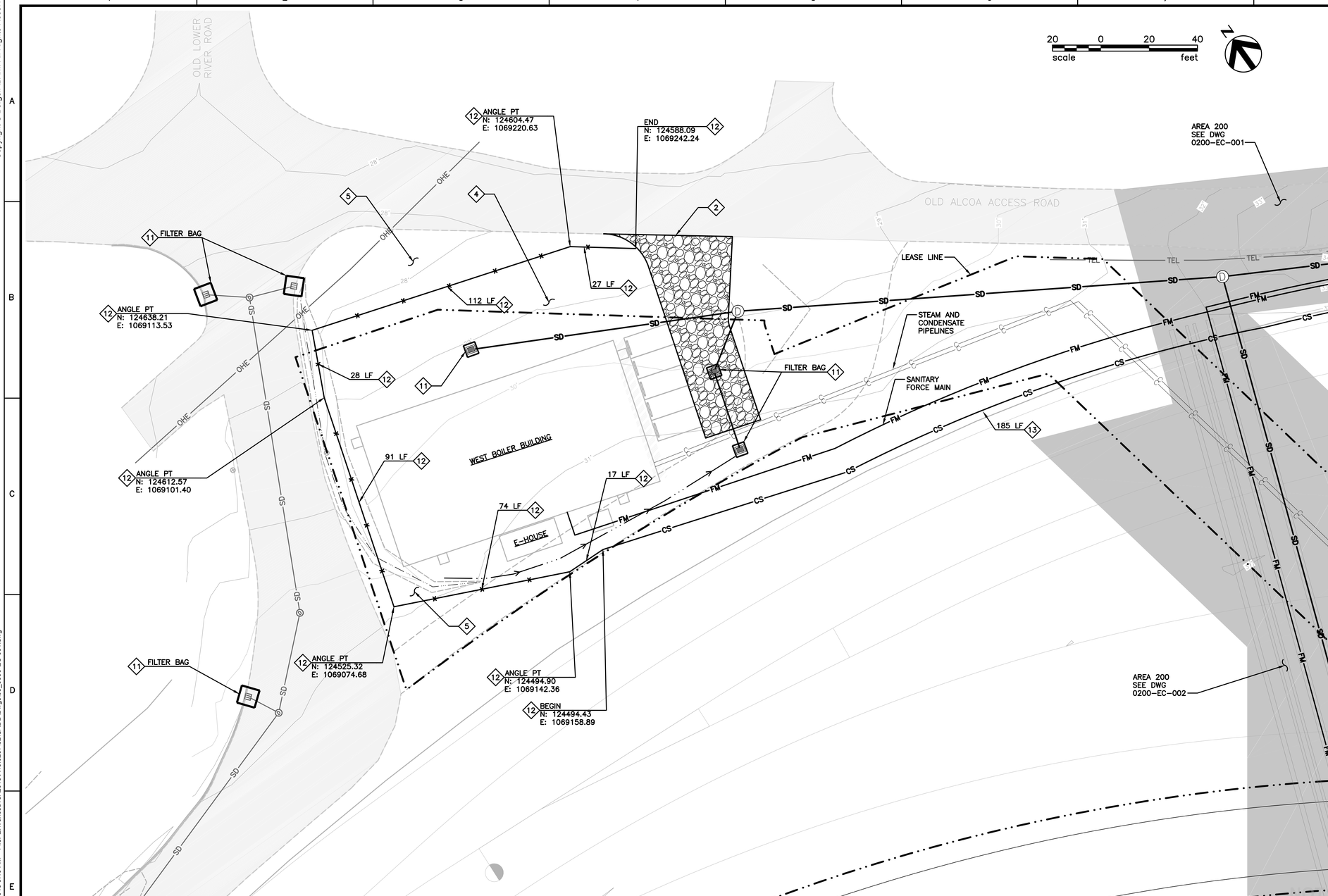

GENERAL NOTES:

1. SEE LEGEND ON SHEET 0100-EC-001 FOR SPECIFIC EROSION PREVENTION, SEDIMENT CONTROL, AND CONSTRUCTION STORMWATER RELATED SYMBOLOGY. SEE LEGEND ON SHEET 0100-CD-001 FOR EXISTING AND PROPOSED SITE DEVELOPMENT FEATURES.
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5. PROVIDE MATERIAL, STORAGE AND CONTAINMENT BMPs FOR LIQUIDS AND HAZARDOUS MATERIAL. SEE DETAIL 5 ON DWG 0100-EC-002.
6. DURING TRENCHING AND DEEP EXCAVATIONS WHERE GROUNDWATER IS ENCOUNTERED AND EXCAVATION DEWATERING OCCURS, CONTRACTOR SHALL PROVIDE DEWATERING PUMPS AND ON-SITE STORAGE TANKS. CONTRACTOR SHALL TEST ALL DEWATERING WATER IN ACCORDANCE WITH MONITORING REQUIREMENTS ON DWG 0100-EC-001. CONTRACTOR SHALL HAUL OFF AND LEGALLY DISPOSE OF CONTAMINATED EXCAVATION DEWATERING WATER OR PROVIDE TREATMENT FOR DEWATERING WATER IF NECESSARY PRIOR TO RELEASE TO STORM DRAIN.

ENVIRONMENTAL CONTROL NOTES:

2. INSTALL STABILIZED CONSTRUCTION ENTRANCE/EXIT. SEE DETAIL 2 ON DWG 0100-EC-001.
4. CONSTRUCT PARKING AREA STABILIZATION ON-SITE IN LAYDOWN, STAGING, AND CONSTRUCTION PERSONNEL PARKING AREAS. SEE DETAIL 1 ON DWG 0100-EC-002.
5. INSTALL TEMPORARY AND PERMANENT SEEDING IMMEDIATELY FOLLOWING FINAL GRADING. SEE DETAIL 2 ON DWG 0100-EC-002.
7. CONCRETE WASHOUT IS LOCATED IN AREA 300. SEE DWG 0300-EC-001 AND 0300-EC-002 FOR LOCATION. OR INSTALL CONCRETE WASHOUT AREA IN ACCORDANCE WITH DETAIL 6 ON DRAWING 0100-EC-002.
11. INSTALL INLET PROTECTION (TYPE AS NOTED) AT ALL EXISTING INLETS PRIOR TO BEGINNING CONSTRUCTION. INSTALL INLET PROTECTION AT ALL NEWLY CONSTRUCTED FACILITIES IMMEDIATELY UPON INSTALLATION. SEE DETAIL 2 ON DWG 0100-EC-003.
12. INSTALL SILT FENCE. SEE DETAIL 3 ON DWG 0100-EC-003.
13. INSTALL COMPOST SOCK IN ACCORDANCE WITH DETAIL 4 ON DRAWING 0100-EC-003 DURING TRENCHING AND CONSTRUCTION OF FORCE MAIN AND PIPELINES.

SAM ADAMS STATE OF WASHINGTON 47330 REGISTERED PROFESSIONAL ENGINEER

PRELIMINARY
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NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: AREA 600
ENVIRONMENTAL CONTROL PLAN

DESIGN:	DRS	START DATE:	2/23/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/24/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0600-EC-001
SHEET: 1 / 1
REV.

Last Saved by: Tony.pritchett on: Feb 23, 2015 9:19 AM File: Q:\Vancouver\2013\A13.0267\02\CADD\Dwgs\03_0600-EC-001.dwg

EX-0001-004191-PCE

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix H
Construction BMPs

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

1. Restrict clearing to approved limits.
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits, or internal roads.
4. Protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications.

Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: Stabilized Construction Entrance / Exit

Purpose

Stabilized Construction entrances 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 entrances for each residence, rather than only at the main subdivision entrance.

Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

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.

Design and Installation Specifications

See Figure 4.1.1 for details. Note: the 100' 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').

Construct stabilized construction entrances 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. 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 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.
- Fencing (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.
- 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.

Maintenance Standards

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

- 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, street sweeping, 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 or street sweeping. 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 shall be considered. The sediment would then be washed into the sump where it can be controlled.
- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm 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), fencing (see BMP C103) 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.

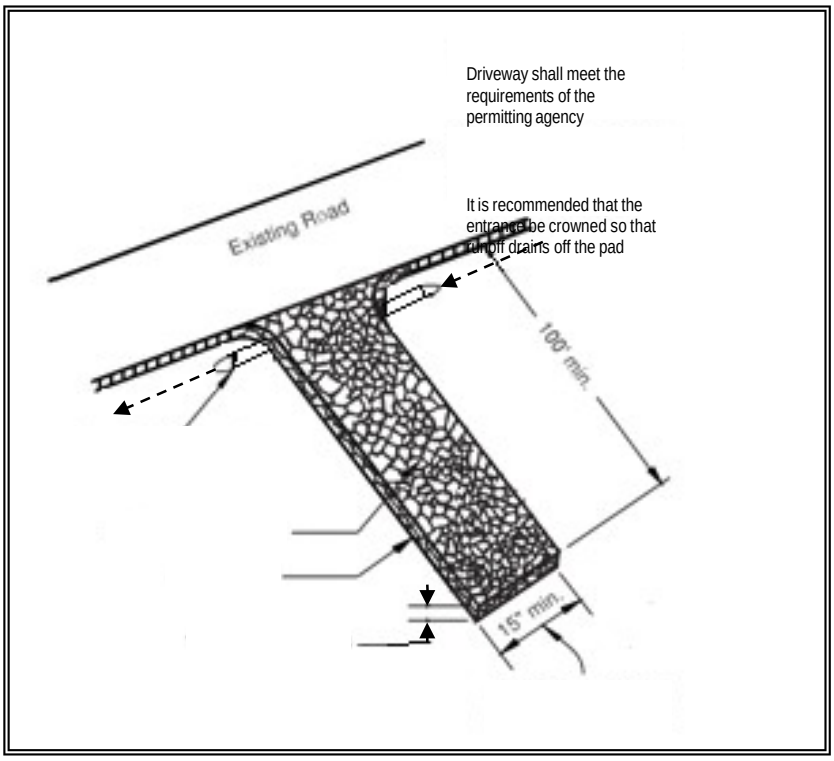

Figure 4.1.1 – Stabilized Construction Entrance

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C105. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement.

- 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 x 10-foot sump can be very effective.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with local sewer district approval.
- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.

Design and Installation Specifications

Suggested details are shown in Figure 4.1.2. The Local Permitting Authority may allow other designs. A minimum of 6 inches of asphalt treated base (ATB) 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 should 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 re-suspension 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 should start out the day with fresh water.

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

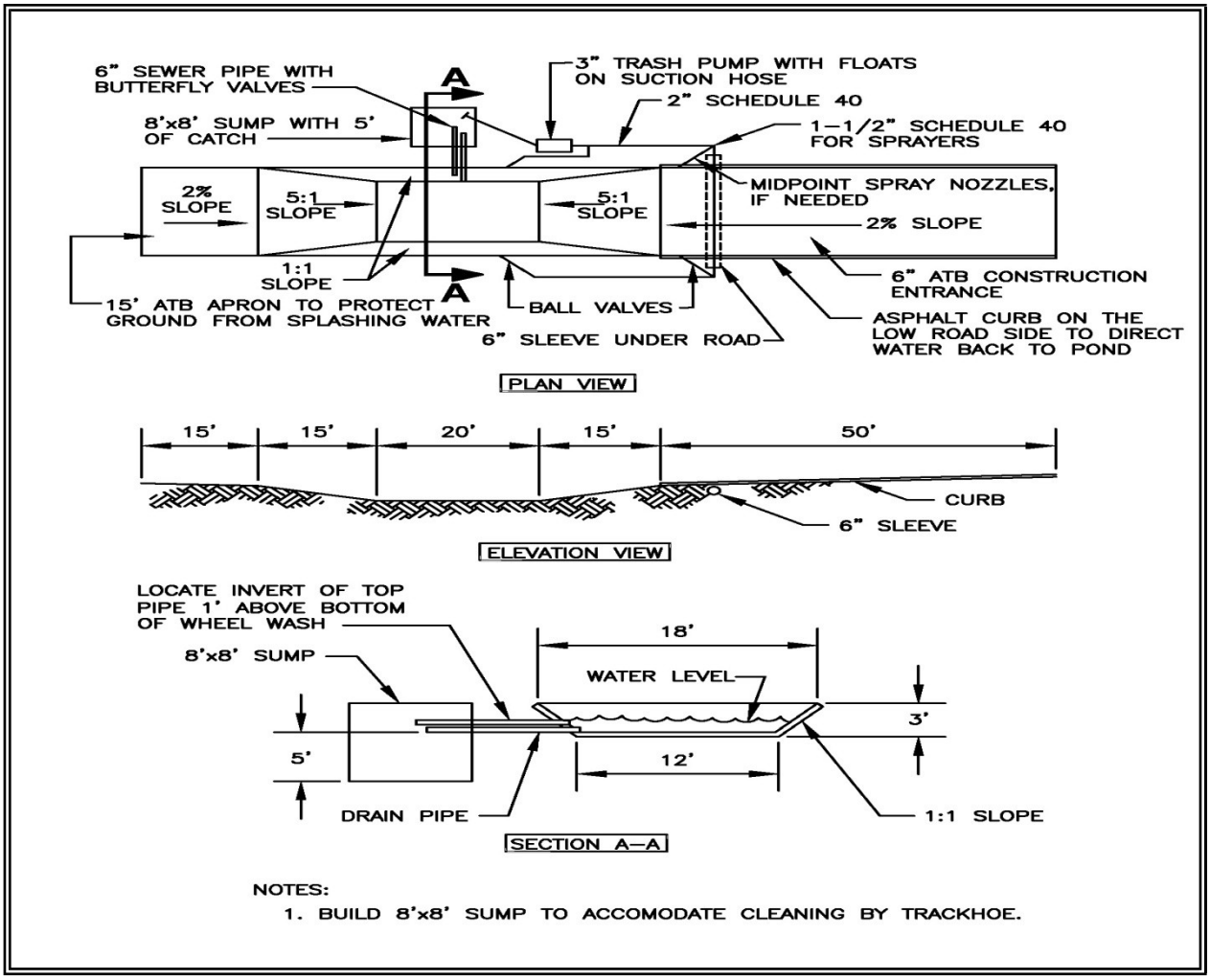

Figure 4.1.2 – Wheel Wash

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 x 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.

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.

- High Visibility Fencing (see BMP C103) 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.
- 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. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for roadbase stabilization, pH monitoring and BMPs (BMPs C252 and C253) are necessary to evaluate and minimize the effects on stormwater. 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.
- 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 storm drain system (see BMP C220).

Maintenance Standards

Inspect stabilized areas regularly, especially after large storm events. Crushed rock, gravel base, 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 pre-construction

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. A well-established vegetative cover 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.

Review 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.
- 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) which will prevent erosion.

Design and Installation Specifications

Seed retention/detention ponds as required.

Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. 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.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- 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.

- When installing seed via hydroseeding operations, only about 1/3 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 25-30 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 800-1000 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/MBFMs (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.
- Apply these mixes, with the exception of the wetland mix at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used.
- Consult the local suppliers 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 local authority may be used.
- Other mixes may be appropriate, depending on the soil type and

hydrology of the area.

- Table 4.1.2 lists the standard mix for areas requiring a temporary vegetative cover

Table 4.1.2
Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye - *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

- Table 4.1.3 lists a recommended mix for landscaping seed.

Table 4.1.3
Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or *Festuca rubra*	30	98	90

- Table 4.1.4 lists a turf seed mix for dry situations where there is no need for watering. This mix requires very little maintenance.

Table 4.1.4
Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90
Colonial bentgrass *Agrostis tenuis*	5	98	90

- Table 4.1.5 lists a mix for bioswales and other intermittently wet areas.

Table 4.1.5
Bioswale Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

* *Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

Table 4.1.6
Wet Area Seed Mix*

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

* *Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix*

- Table 4.1.7 lists a recommended meadow seed mix 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. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

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Table 4.1.7 Meadow Seed Mix			
	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

- **Roughening and Rototilling:**
  - The seedbed should be firm and rough. Roughen all soil no matter what the slope. Track walk slopes before seeding if engineering purposes require compaction. Backblading or smoothing of slopes greater than 4H:1V is not allowed if they are to be seeded.
  - Restoration-based landscape practices require deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade 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 complete the rototilling process in multiple lifts, or prepare the engineered soil system per specifications and place to achieve the specified depth.
- **Fertilizers:**
  - Conducting soil tests to determine the exact type and quantity of fertilizer is recommended. This will prevent the over-application of fertilizer.
  - Organic matter is the most appropriate form of fertilizer because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form.
  - In general, use 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer at a rate of 90 pounds per acre. Always use slow-release fertilizers because they are more efficient and have fewer environmental impacts. Do not add fertilizer to the hydromulch machine, or agitate, more than 20 minutes before use. Too much agitation destroys the slow-release coating.
  - There are numerous products available that take 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 provides a good source of long-term, slow-release, available nitrogen.

- **Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix:**
  - On steep slopes use Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products. Apply BFM/MBFM products at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Achieve a minimum of 95 percent soil coverage during application. Numerous products are available commercially. Installed products per manufacturer's instructions. Most products require 24-36 hours to cure before rainfall and cannot be installed on wet or saturated soils

  Generally, products come in 40-50 pound bags and include all necessary ingredients except for seed and fertilizer.

  - BFMs and MBFMs provide good alternatives to blankets in most areas requiring vegetation establishment. Advantages over blankets include:
  - BFM and MBFMs do not require surface preparation.
  - Helicopters can assist in installing BFM and MBFMs in remote areas.
  - On slopes steeper than 2.5H:1V, blanket installers may require ropes and harnesses for safety.
  - Installing BFM and MBFMs can save at least $1,000 per acre compared to blankets.

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, use an alternate method such as sodding, mulching, or nets/blankets. If winter weather prevents adequate grass growth, this time limit may be relaxed at the discretion of the local authority 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 Equivalent

Ecology has approved products as able to meet the requirements of BMP C120. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html.

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 should be used:

- For less 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 or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 4.1.8. Always use a 2-inch minimum mulch thickness; increase the thickness until the ground is 95% covered (i.e. not visible under the mulch layer).

Note: Thickness 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 should 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" (TMECC) Test Method 02.02-B.

Coarse Compost

Minimum Percent passing 3" sieve openings 100%

Minimum Percent passing 1" sieve openings 90%

Minimum Percent passing ¾" sieve openings 70%

Minimum Percent passing ¼" sieve openings 40%

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

mulch mixes if applicable.

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.

Table 4.1.8
Mulch Standards and Guidelines

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2"-3" thick; 5 bales per 1,000 sf or 2-3 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. 25-30 lbs per 1,000 sf or 1,500 - 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 ¾-1 inch clog hydromulch equipment. Fibers should be kept to less than ¾ 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". 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 BMP T5.13 (see Chapter 5 of Volume V of this manual) 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 shall 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% 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.

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 “hog or hogged 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 ⅜-inches. 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 specification (9-14.4(4))

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 six 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 $1.50-2.00 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:
  1. Temporary ditch liner.
  2. Pond liner in temporary sediment pond.
  3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
  4. Emergency slope protection during heavy rains.
  5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
  1. Run plastic up and down slope, not across slope.
  2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
  3. Minimum of 8-inch overlap at seams.
  4. On long or wide slopes, or slopes subject to wind, tape all seams.

5. 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.
6. 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.
7. 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.
8. 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 0.06 millimeters.
- 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 Equivalent

Ecology has approved products as able to meet the requirements of BMP C123. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

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 for 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 4.1.5 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 should 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 should 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

- Areas that are graded in this manner should be seeded as quickly as

Standards

possible.

- Regular inspections should be made of the area. If rills appear, they should be re-graded and re-seeded immediately.

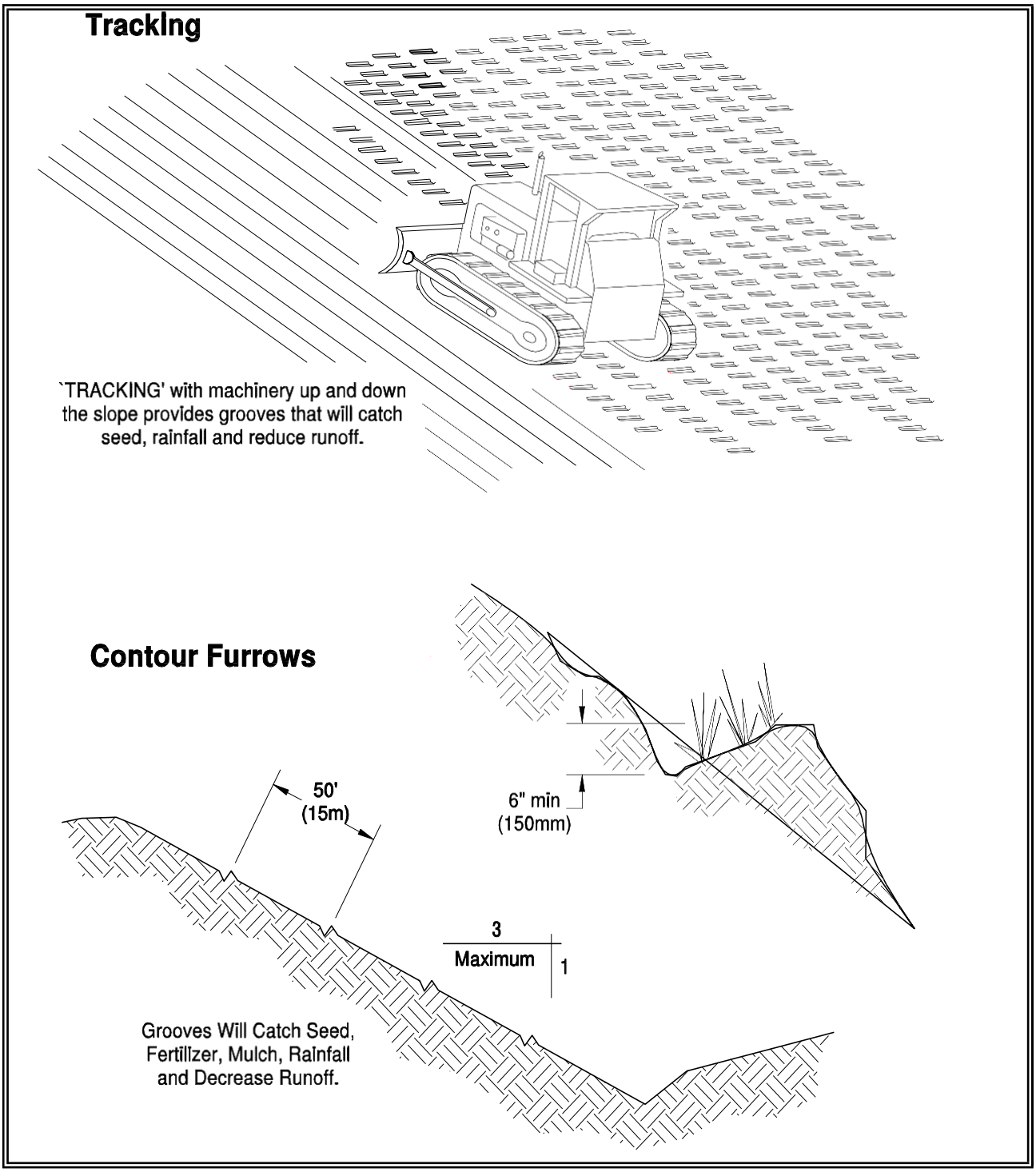


Figure 4.1.5 – Surface Roughening by Tracking and Contour Furrows

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

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 Stabilized Construction Entrance (BMP C105).
- 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. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. 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 .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 local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority 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 large 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 should be kept covered and out of both sun and rain.
- Re-stock 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

Design and Installation Specifications

- Assure that washout of concrete trucks, chutes, pumps, and internals is performed at an approved off-site location or in designated concrete washout areas. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Refer to BMP C154 for information on concrete washout areas.
- 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.
- Wash off hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels into formed areas only.
- Wash equipment difficult to move, such as concrete pavers in areas that do not directly drain to natural or constructed stormwater conveyances.
- Do not allow washdown from areas, such as concrete aggregate driveways, to drain directly to natural or constructed stormwater conveyances.
- Contain washwater and leftover product in a lined container when no formed areas are available. Dispose of contained concrete in a manner that does not violate ground water or surface water quality standards.
- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMPs C252 and C253 for pH adjustment requirements.
- Refer to the Construction Stormwater General Permit 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 created through sawcutting or surfacing 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 ground water 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 ground water 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)
- 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.
- Material Safety Data Sheets (MSDS) 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 (Oct 1 – 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, and within 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% of the total enclosed container volume of all containers, or 110% 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 (Oct 1 – 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 clean-up material (spill kit).
- The spill kit should include, at a minimum:
    - 1-Water Resistant Nylon Bag
    - 3-Oil Absorbent Socks 3”x 4’
    - 2-Oil Absorbent Socks 3”x 10’
    - 12-Oil Absorbent Pads 17”x19”
    - 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 to prevent pollutants from entering surface waters or ground water.

Conditions of Use

Concrete washout area best management practices 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 trucks, pumpers, or other concrete coated equipment are washed on-site.
- Note: If less than 10 concrete trucks or pumpers need to be washed out on-site, the washwater may be disposed of in a formed area awaiting concrete or an upland disposal site where it will not contaminate surface or ground water. The upland disposal site shall be at least 50 feet from sensitive areas such as storm drains, open ditches, or water bodies, including wetlands.

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 trucks onto the ground, or into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas.
- 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.

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 Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.
- A sign should be installed adjacent to each temporary concrete washout facility 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, or water bodies, including wetlands.
- Allow convenient access for concrete trucks, preferably near the area where the concrete is being poured.
- If trucks need to leave a paved area to access washout, prevent track- out with a pad of rock or quarry spalls (see BMP C105). These areas should be far enough away from other construction traffic to reduce the likelihood of accidental damage and spills.
- The number of facilities you install should depend on the expected demand for storage capacity.
- On large sites with extensive concrete work, washouts should be placed in multiple locations for ease of use by concrete truck drivers.

On-site Temporary Concrete Washout Facility, Transit Truck Washout Procedures:

- Temporary concrete washout facilities shall be located a minimum of 50 ft from sensitive areas including storm drain inlets, open drainage facilities, and watercourses. See Figures 4.1.7 and 4.1.8.
- Concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Washout of concrete trucks shall be performed in designated areas only.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of off-site.
- Once concrete wastes are washed into the designated 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.

- Temporary Above-Grade Concrete Washout Facility
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- Temporary Below-Grade Concrete Washout Facility
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details below, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material shall be a minimum of 10 mil polyethylene sheeting and should 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

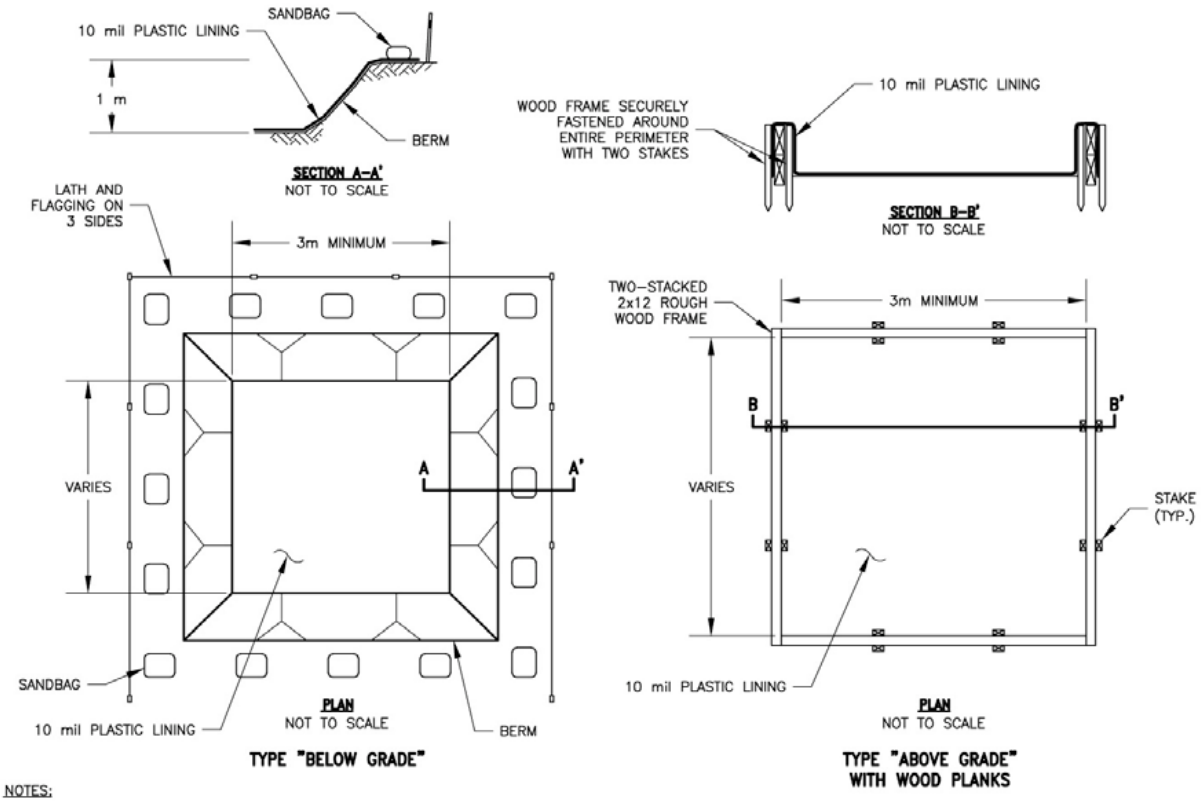
- Inspect and verify that concrete washout BMPs are in place prior to the commencement of concrete work.
- During periods of concrete work, inspect daily to verify continued performance.
  - Check overall condition and performance.
  - Check remaining capacity (% full).
  - If using self-installed washout facilities, verify plastic liners are intact and sidewalls are not damaged.
  - If using prefabricated containers, check for leaks.
- Washout facilities shall be maintained to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Washout facilities must be cleaned, or new facilities must be

constructed and ready for use once the washout is 75% full.

- If the washout 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 local approval.
  - Place a secure, non-collapsing, non-water collecting cover over the concrete washout facility 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 Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.
- Materials used to construct temporary concrete washout facilities 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 temporary concrete washout facilities shall be backfilled, repaired, and stabilized to prevent erosion.



NOTES:

1. ACTUAL LAYOUT DETERMINED IN THE FIELD.
2. THE CONCRETE WASHOUT SIGN (SEE PAGE 6) SHALL BE INSTALLED WITHIN 10 m OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

Figure 4.1.7a – Concrete Washout Area

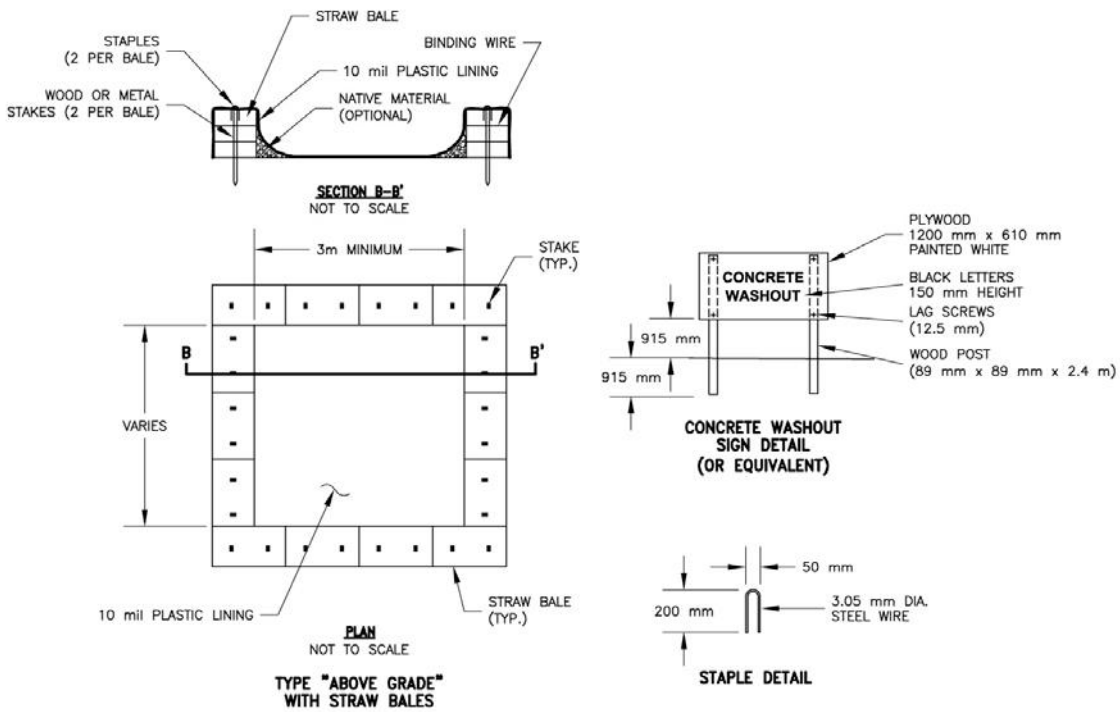


Figure 4.1.7b – Concrete Washout Area

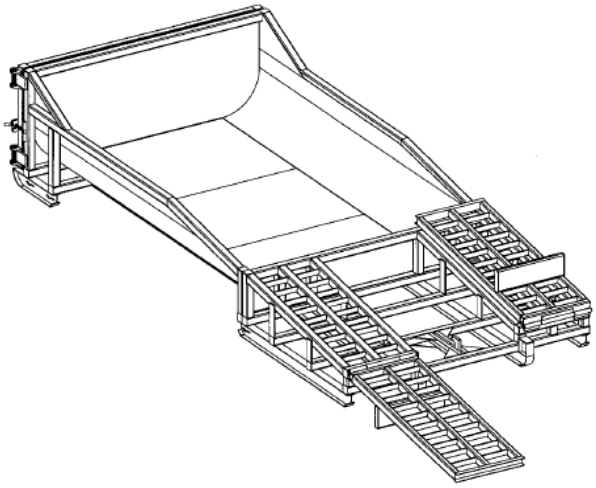


Figure 4.1.8 – Prefabricated Concrete Washout Container w/Ramp

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project proponent designates at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL) who is responsible for ensuring compliance with all local, state, and federal erosion and sediment control and water quality requirements.

Conditions of Use

A CESCL shall be made available on projects one acre or larger that discharge stormwater to surface waters of the state. Sites less than one acre may have a person without CESCL certification conduct inspections; sampling is not required on sites that disturb less than an acre.

- The CESCL shall:
  - Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum ESC training and certification requirements established by Ecology (see details below).

    Ecology will maintain a list of ESC training and certification providers at:

    http://www.ecy.wa.gov/programs/wq/stormwater/cescl.html

    OR

  - Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: www.cpesc.net

Specifications

- Certification shall remain valid for three 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, 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.

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 should 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:
    1. Locations of BMPs inspected.
    2. Locations of BMPs that need maintenance.
    3. Locations of BMPs that failed to operate as designed or intended.
    4. Locations of where additional or different BMPs are required.
    5. 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.
    6. Any water quality monitoring performed during inspection.
    7. 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.

4.2 Runoff Conveyance and Treatment BMPs

This section contains the standards and specifications for Runoff Conveyance and Treatment BMPs. Table 4.2.1, below, shows the relationship of the BMPs in Section 4.2 to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in Section 3.3.3.

Table 4.2.1 Runoff Conveyance and Treatment BMPs by SWPPP Element

BMP or Element Name	**Element #3** Control Flow Rates	**Element #4** Install Sediment Controls	**Element #6** Protect Slopes	**Element #7** Protect Drain Inlets	**Element #8** Stabilize Channels and Outlets	**Element #9** Control Pollutants	**Element #10** Control De-Watering	**Element #13** Protect Low Impact Development
BMP C200: Interceptor Dike and Swale			✓					✓
BMP C201: Grass-Lined Channels			✓					✓
BMP C202: Channel Lining					✓			
BMP C203: Water Bars	✓		✓				✓	
BMP C204: Pipe Slope Drains			✓					
BMP C205: Subsurface Drains			✓					
BMP C206: Level Spreader			✓				✓	
BMP C207: Check Dams	✓		✓		✓			✓
BMP C208: Triangular Silt Dike (TSD) (Geotextile Encased Check Dam)			✓					✓
BMP C209: Outlet Protection	✓				✓			
BMP C220: Storm Drain Inlet Protection				✓				
BMP C231: Brush Barrier		✓						✓
BMP C232: Gravel Filter Berm		✓						
BMP C233: Silt Fence		✓						✓
BMP C234: Vegetated Strip		✓						✓
BMP C235: Wattles	✓	✓						
BMP C236: Vegetated Filtration							✓	
BMP C240: Sediment Trap	✓	✓						
BMP C241: Temporary Sediment Pond	✓	✓						
BMP C250: Construction Stormwater Chemical Treatment		✓				✓		
BMP C251: Construction Stormwater Filtration		✓				✓		
BMP C252: High pH Neutralization Using CO_2						✓		
BMP C253: pH Control for High pH Water						✓		

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 storm 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 facility which can safely convey 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.
- Sub-basin tributary area should be one acre or less.
- Design capacity for the peak volumetric flow rate calculated using a 10-minute time step from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution, for temporary facilities. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model. For facilities that will also serve on a permanent basis, consult the local government's drainage requirements.

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%, and maximum is 1%.
Compaction	Minimum of 90 percent ASTM D698 Standard proctor

Horizontal Spacing of Interceptor Dikes:

Average Slope	Slope Percent	Flowpath Length
20H:1V or less	3-5%	300 feet
(10 to 20)H:1V	5-10%	200 feet
(4 to 10)H:1V	10-25%	100 feet
(2 to 4)H:1V	25-50%	50 feet

Stabilization depends on velocity and reach

Slopes <5%	Seed and mulch applied within 5 days of dike construction (see BMP C121, Mulching).
Slopes 5 - 40%	Dependent on runoff velocities and dike materials. Stabilization should 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 facility.
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

Interceptor swales shall meet the following criteria:

Bottom Width	2 feet minimum, the cross-section bottom shall be level.
Depth	1-foot minimum.
Side Slope	2H:1V of 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*, *Channel Lining*, 12 inches thick 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 C202: Channel Lining

Purpose

To protect channels by providing a channel liner using either blankets or riprap.

Conditions of Use

When natural soils or vegetated stabilized soils in a channel are not adequate to prevent channel erosion.

- When a permanent ditch or pipe system is to be installed and a temporary measure is needed.
- In almost all cases, synthetic and organic coconut blankets are more effective than riprap for protecting channels from erosion. Blankets can be used with and without vegetation. Blanketed channels can be designed to handle any expected flow and longevity requirement. Some synthetic blankets have a predicted life span of 50 years or more, even in sunlight.
- Other reasons why blankets are better than rock include the availability of blankets over rock. In many areas of the state, rock is not easily obtainable or is very expensive to haul to a site. Blankets can be delivered anywhere. Rock requires the use of dump trucks to haul and heavy equipment to place. Blankets usually only require laborers with hand tools, and sometimes a backhoe.
- The Federal Highway Administration recommends not using flexible liners whenever the slope exceeds 10 percent or the shear stress exceeds 8 lbs/ft^2.

Design and Installation Specifications

See BMP C122 for information on blankets.

Since riprap is used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay.

- Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.
- The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of drainage structure damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.
- Stone for riprap shall consist of field stone or quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended.
- A lining of engineering filter fabric (geotextile) shall be placed

between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The geotextile should be keyed in at the top of the bank.

- Filter fabric shall not be used on slopes greater than 1-1/2H:1V as slippage may occur. It should be used in conjunction with a layer of coarse aggregate (granular filter blanket) when the riprap to be placed is 12 inches and larger.

BMP C207: Check Dams

Purpose

Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use

Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.

- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from a permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.
- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.
- Place check dams perpendicular to the flow of water.
- The dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.
- Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam.
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- Keep the maximum height at 2 feet at the center of the dam.
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the check dam at 2H:1V or flatter.

- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, filter fabric is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure 4.2.7 depicts a typical rock check dam.

Maintenance Standards

Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

Approved as Equivalent

Ecology has approved products as able to meet the requirements of BMP C207. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

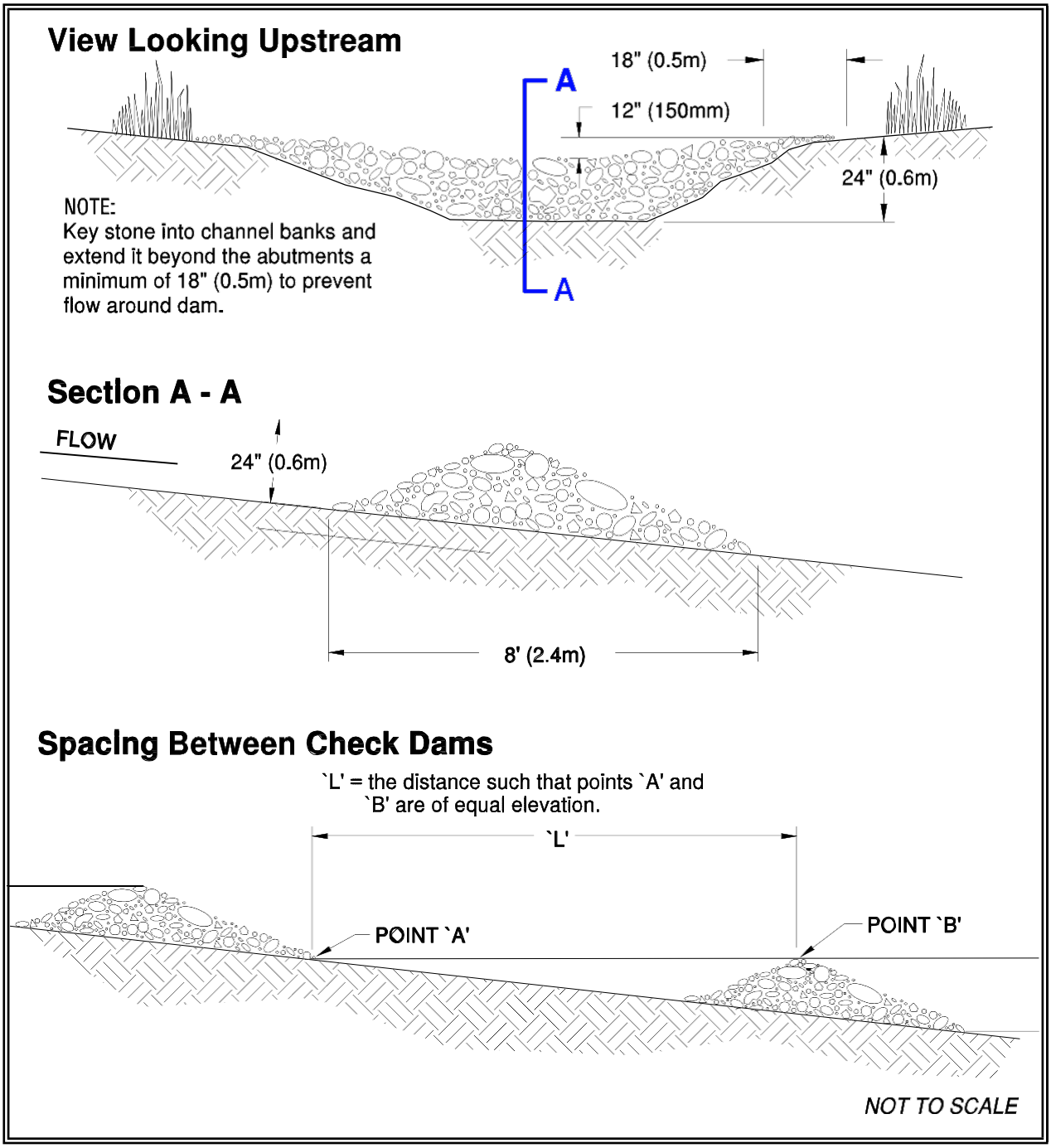


Figure 4.2.7 – Rock Check Dam

BMP C209: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of use

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation or 1-foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the culvert.

- Standard wingwalls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. (See WSDOT Hydraulic Manual, available through WSDOT Engineering Publications).
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for riprap outlet protection:
  1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
  2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 48-inch riprap. Minimum thickness is 2 feet.
  3. For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion.
- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over- widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a HPA. See Volume V for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.
- Add rock as needed to maintain the intended function.
- Clean energy dissipater if sediment builds up.

BMP C220: Storm Drain Inlet Protection

Purpose

Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use storm drain inlet protection at inlets that are operational before permanent stabilization of the disturbed drainage area. 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 consider 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. Provide 18-inches of sod around each finished lawn and yard drain.

Table 4.2.2 lists several options for inlet protection. All of the methods for storm drain inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to one acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 4.2.2

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 will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30′ X 30′/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		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			18 month expected life.

Design and Installation Specifications

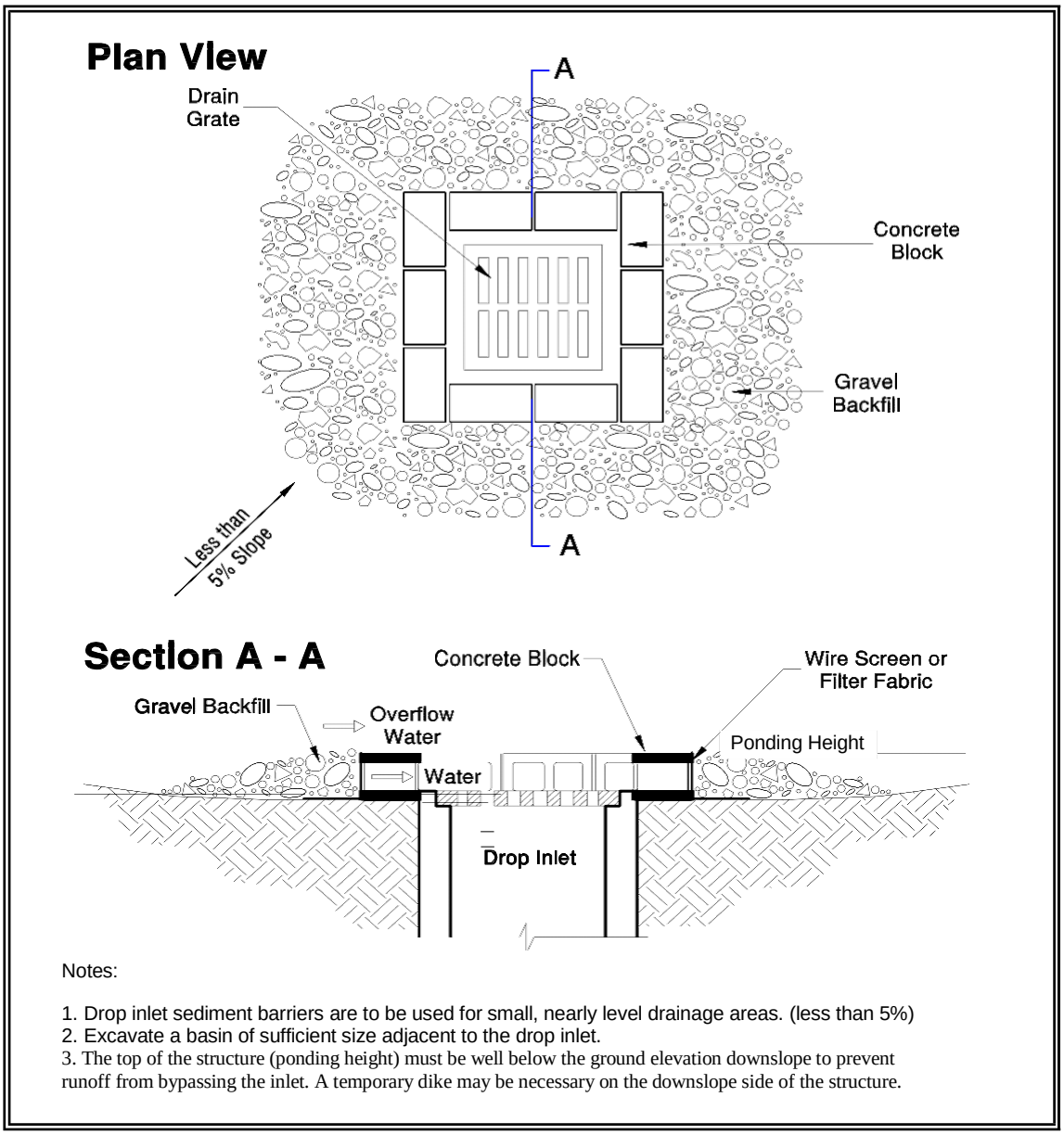
Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Provide a depth of 1-2 ft 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 4.2.8.

- 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 2x4 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 ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel donut.
- Provide an inlet slope of 3H:1V.

- Provide an outlet slope of 2H:1V.
- Provide a1-foot wide level stone area between the structure and the inlet.
- Use inlet slope stones 3 inches in diameter or larger.
- Use gravel ½- to ¾-inch at a minimum thickness of 1-foot for the outlet slope.



Notes:

1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the downslope side of the structure.

Figure 4.2.8 – Block and Gravel Filter

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 ½-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.

Catchbasin 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 catchbasin 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.

- 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 catchbasin filter in the catchbasin 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 ½-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 a curb inlet with concrete blocks and gravel. See Figure 4.2.9.

- Use wire mesh with ½-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 2x4 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 4.2.10.

- 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.

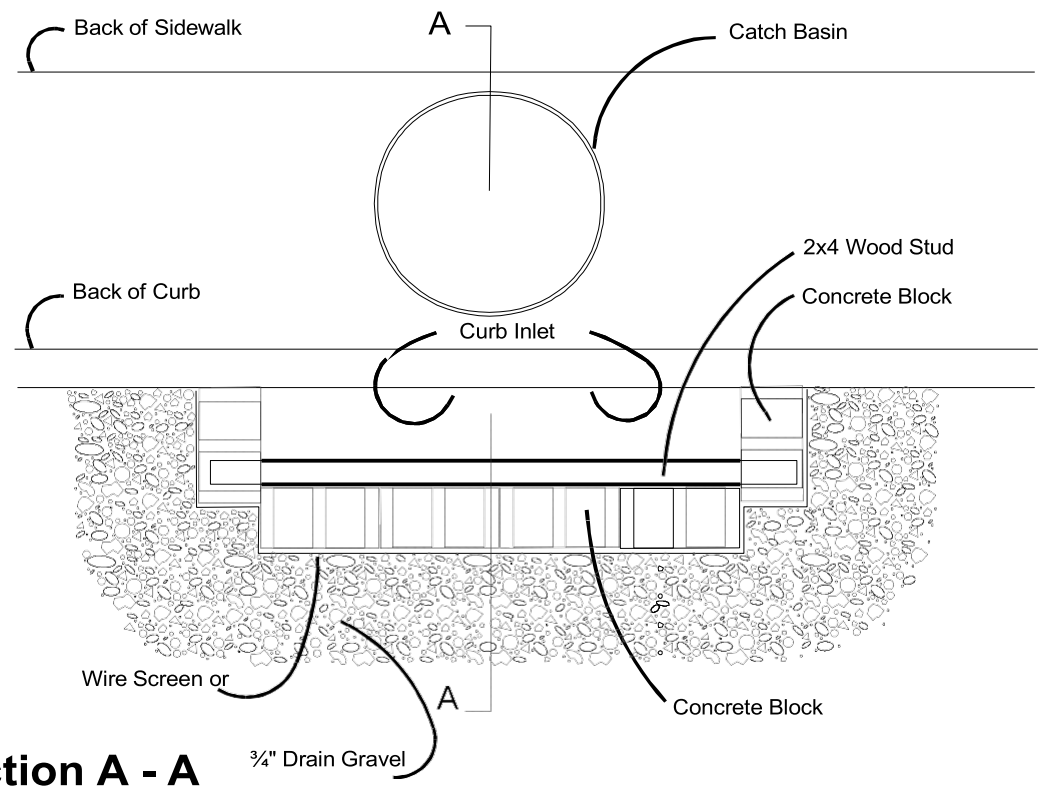
Maintenance Standards

- Inspect catch basin filters frequently, especially after storm events. Clean and replace clogged inserts. For systems with clogged stone filters: pull away the stones from the inlet and clean or replace. An alternative approach would be to use the clogged stone as fill and put fresh stone 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 Equivalent

Ecology has approved products as able to meet the requirements of BMP C220. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

Plan View



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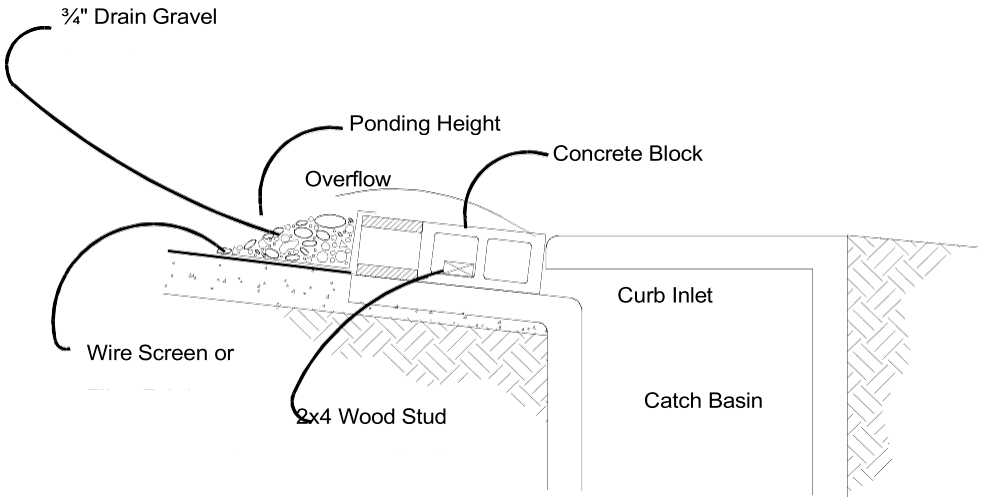
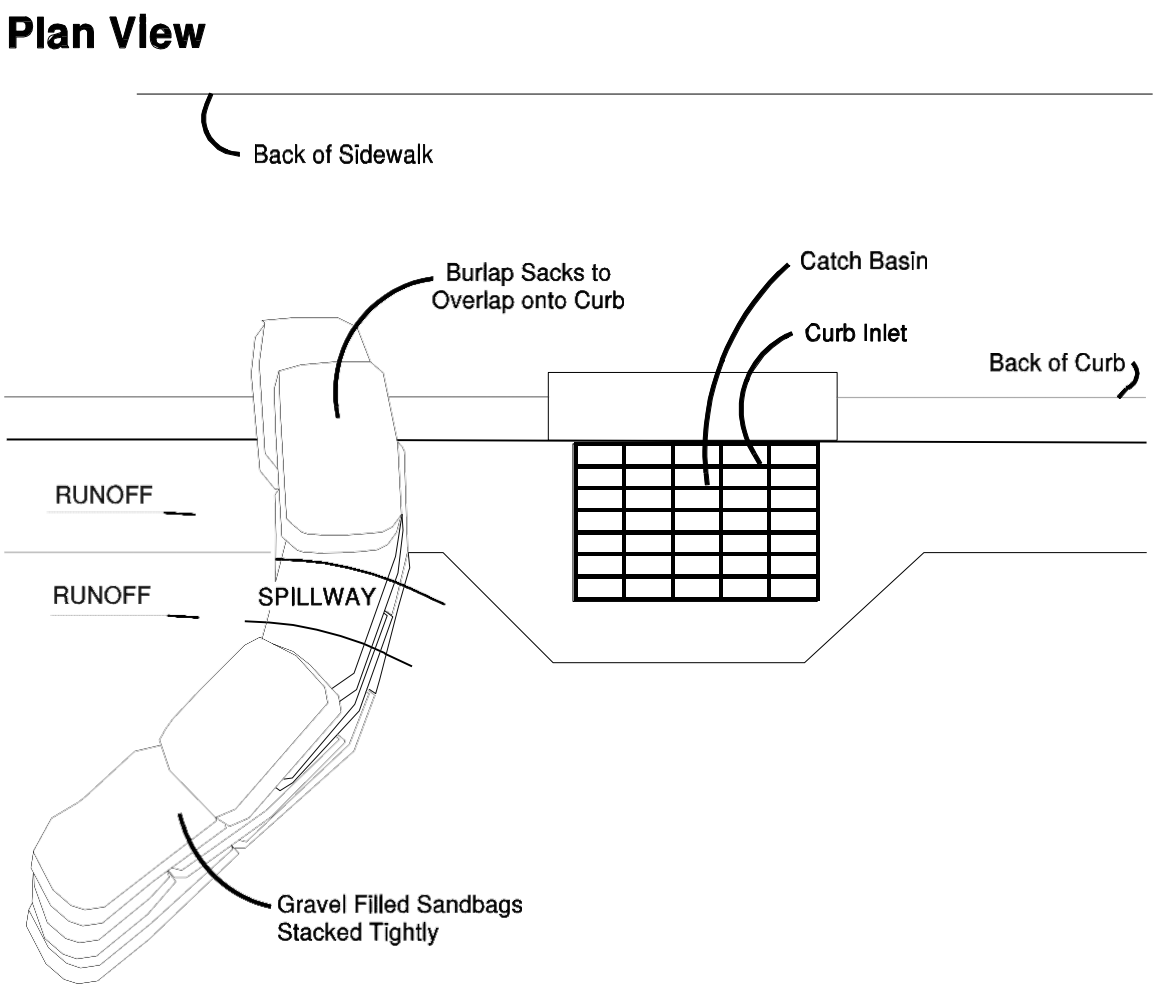


NOTES:

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

Figure 4.2.9 – Block and Gravel Curb Inlet Protection



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.2.10 – 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 4.2.12 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 pond.
- 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.

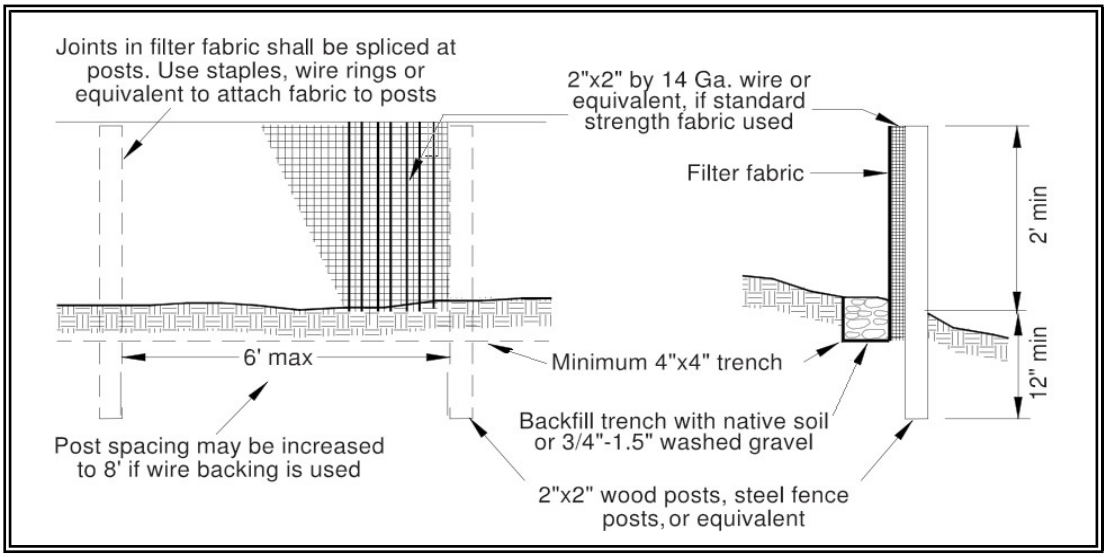


Figure 4.2.12 – Silt Fence

Design and Installation Specifications

- Use in combination with sediment basins or other 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 cfs.
- 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 4.2.3):

Table 4.2.3 Geotextile Standards	
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#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

- Support standard strength fabrics with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric. Silt fence materials are available that have synthetic mesh backing attached.
- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.
- One-hundred percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by local regulations.
- Refer to Figure 4.2.12 for standard silt fence details. 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-feet min. and a 2½-feet max. height above the original ground surface.
  - The filter fabric shall be sewn together at the point of manufacture to form filter 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 filter fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the filter fabric to the posts in a manner

that reduces the potential for tearing.

- Support the filter 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 up-slope side of the posts with the filter fabric up-slope 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 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.
- Bury the bottom of the filter fabric 4-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the filter fabric, so that no flow can pass beneath the fence and scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the ground 3-inches min.
- Drive or place the fence posts into the ground 18-inches min. A 12–inch min. 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-inches by 2-inches wide min. and a 3-feet min. length. Wood posts shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel rebar 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 lbs./ft.
    - 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 gravel 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.

- Gravel check dams shall be approximately 1-foot deep at the back of the fence. Gravel 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.
- Gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Gravel check dams shall be located every 10 feet along the fence where the fence must cross contours.

- Refer to Figure 4.2.13 for slicing method details. Silt fence installation using the slicing method specifications:
  1. The base of both end posts must be at least 2- to 4-inches above the top of the filter fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
  2. Install posts 3- to 4-feet apart in critical retention areas and 6- to 7-feet apart in standard applications.
  3. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the filter fabric, enabling posts to support the filter fabric from upstream water pressure.
  4. Install posts with the nipples facing away from the filter fabric.
  5. Attach the filter fabric to each post with three ties, all spaced within the top 8-inches of the filter fabric. Attach each tie diagonally 45 degrees through the filter 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.
  6. Wrap approximately 6-inches of fabric around the end posts and secure with 3 ties.
  7. No more than 24-inches of a 36-inch filter fabric is allowed above ground level.
  8. Compact the soil immediately next to the filter 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.

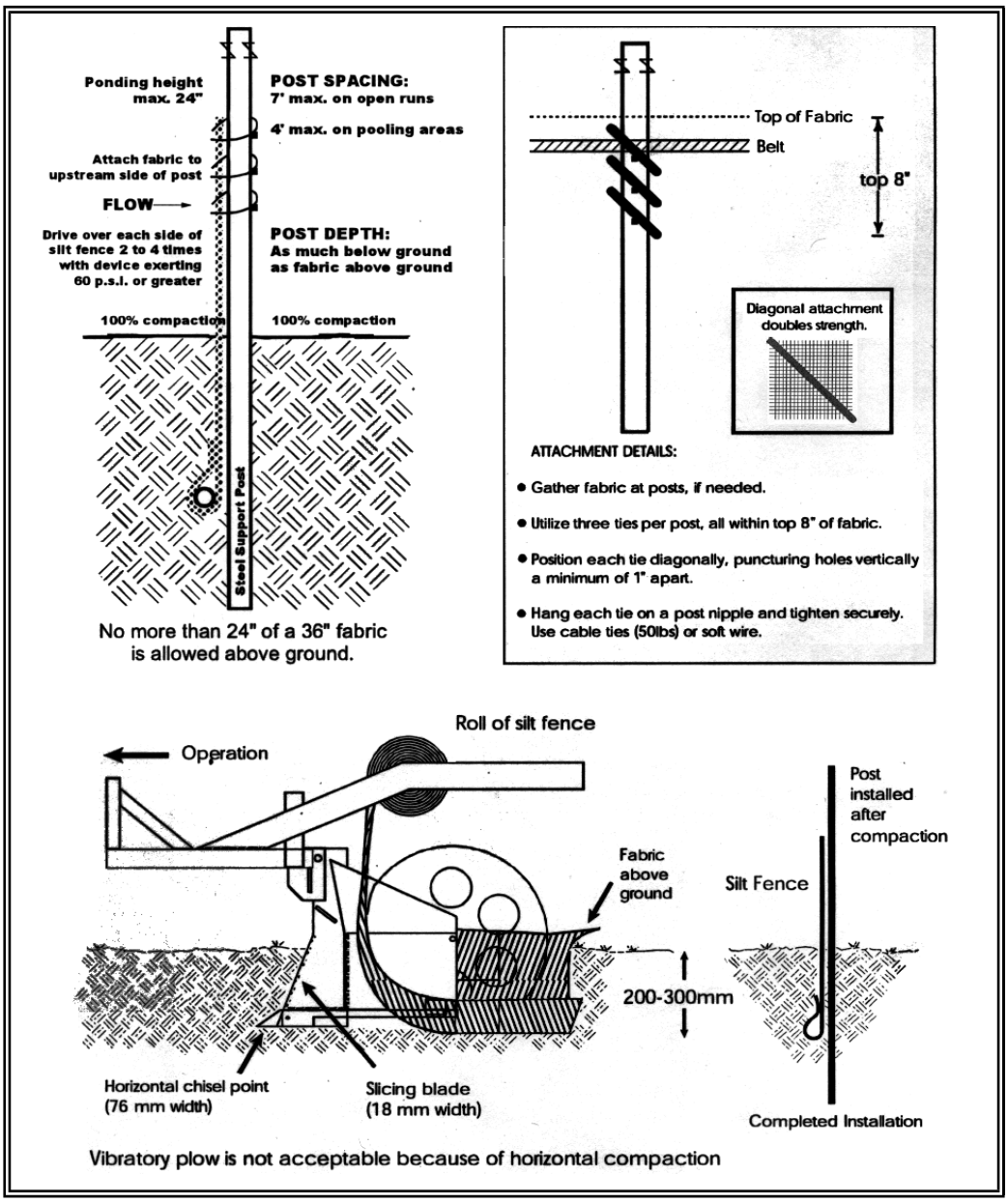


Figure 4.2.13 – Silt Fence Installation by Slicing Method

Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the silt fence to a sediment pond.
- Check the uphill side of the fence for signs of the 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 filter fabric that has deteriorated due to ultraviolet breakdown.

BMP C235: Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. 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. See Figure 4.2.14 for typical construction details. WSDOT Standard Plan I-30.30-00 also provides information on Wattles (http://www.wsdot.wa.gov/Design/Standards/Plans.htm#SectionI)

Conditions of Use

- 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. Generally, Wattles are typically effective for one to two seasons.
- Prevent rilling beneath wattles by properly entrenching and abutting wattles together to prevent water from passing between them.

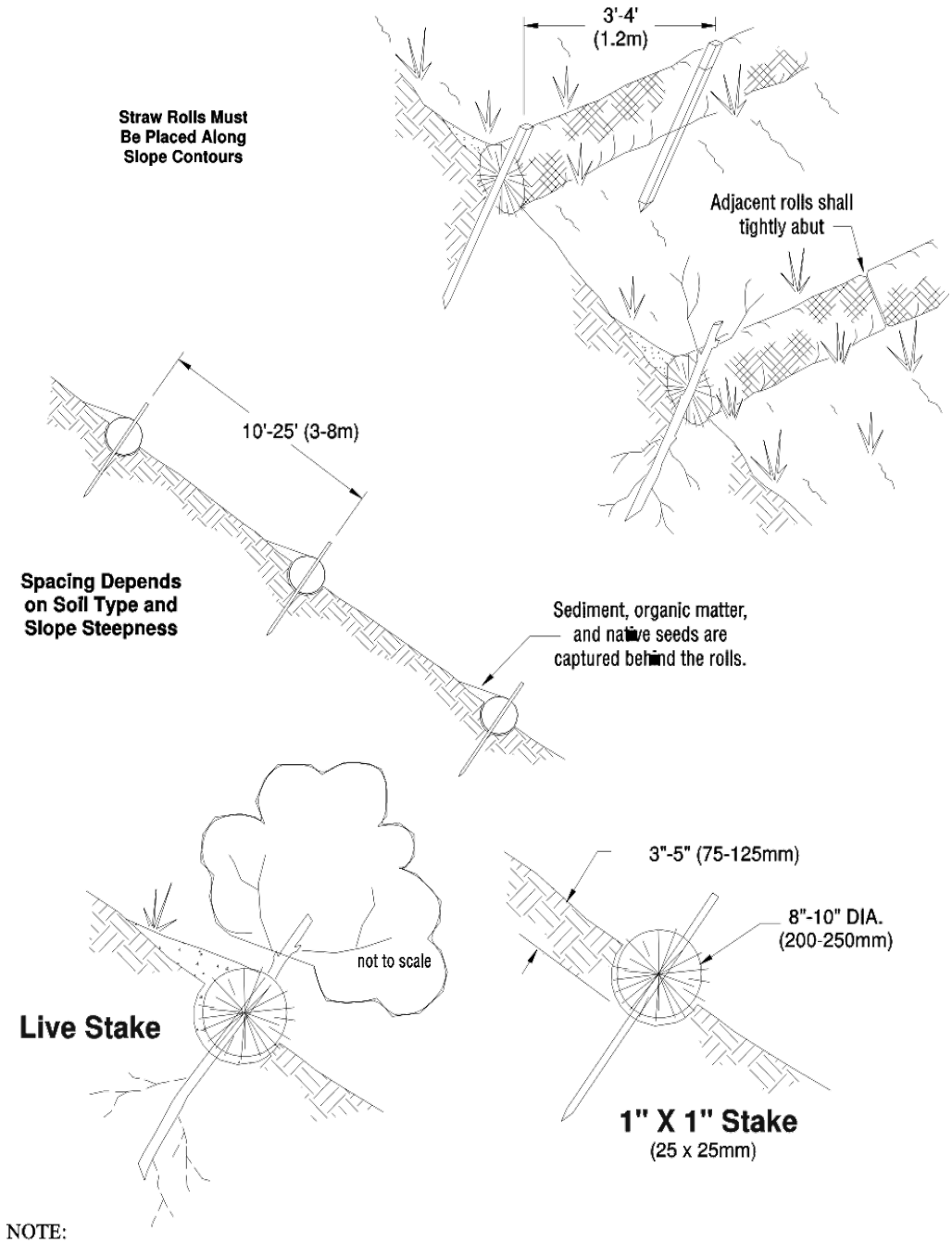
Design Criteria

- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should 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 should be dug to a depth of 5- to 7- inches, or 1/2 to 2/3 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 at intervals of 10- to 25-feet 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 abut tightly end to end. Do not overlap the ends.
- 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 3/4 x 3/4 x 24 inches min. Willow cuttings or 3/8-inch rebar can also be used for stakes.
- 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.



NOTE:
1. Straw roll installation requires the placement and secure staking of the roll in a trench, 3"-5" (75-125mm) deep, dug on contour. runoff must not be allowed to run under or around roll.

Figure 4.2.14 – Wattles

- 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 Equivalent

Ecology has approved products as able to meet the requirements of BMP C235. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Local jurisdictions may choose not to accept this product approved as equivalent, or may require additional testing prior to consideration for local use. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMP C241: Temporary Sediment Pond

Purpose

Sediment ponds remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal best management practice.

A sediment pond shall be used where the contributing drainage area is 3 acres or more. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

Design and Installation Specifications

- Sediment basins must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.
- Structures having a maximum storage capacity at the top of the dam of 10 acre-ft (435,600 ft^3) or more are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC).
- See Figures 4.2.18, 4.2.19, and 4.2.20 for details.
- If permanent runoff control facilities are part of the project, they should be used for sediment retention. The surface area requirements of the sediment basin must be met. This may require temporarily enlarging the permanent basin to comply with the surface area requirements. The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the pond from the surface or by pumping. The permanent control structure must be installed after the site is fully stabilized. .
- Use of infiltration facilities for sedimentation basins during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2 feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized. The infiltration pretreatment facility should be fully constructed and used with the sedimentation basin to help prevent clogging.
- Determining Pond Geometry

Obtain the discharge from the hydrologic calculations of the peak flow for the 2-year runoff event (Q_2). The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used.

Determine the required surface area at the top of the riser pipe with the equation:

$SA = 2 \times Q_2/0.00096$ or

2080 square feet per cfs of inflow

See BMP C240 for more information on the derivation of the surface area calculation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from Step 2 above) at top of riser.
- Minimum 3.5-foot depth from top of riser to bottom of pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.
- Sizing of Discharge Mechanisms.

The outlet for the basin consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm. If, due to site conditions and basin geometry, a separate emergency spill- way is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. The runoff calculations should be based on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

The principal spillway designed by the procedures contained in this standard will result in some reduction in the peak rate of runoff.

However, the riser outlet design will not adequately control the basin discharge to the predevelopment discharge limitations as stated in Minimum Requirement #7: Flow Control. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation basin, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations. The size of the basin, the expected life of the construction project, the anticipated downstream effects and the anticipated weather conditions during construction, should be considered to determine the need of additional discharge control. See Figure 4.2.21 for riser inflow curves.

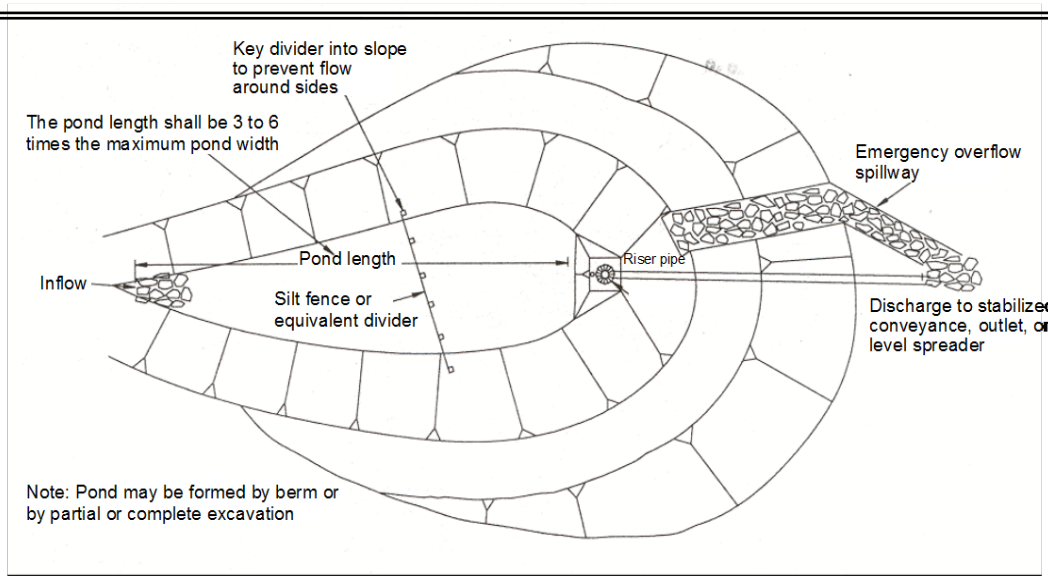


Figure 4.2.18 – Sediment Pond Plan View

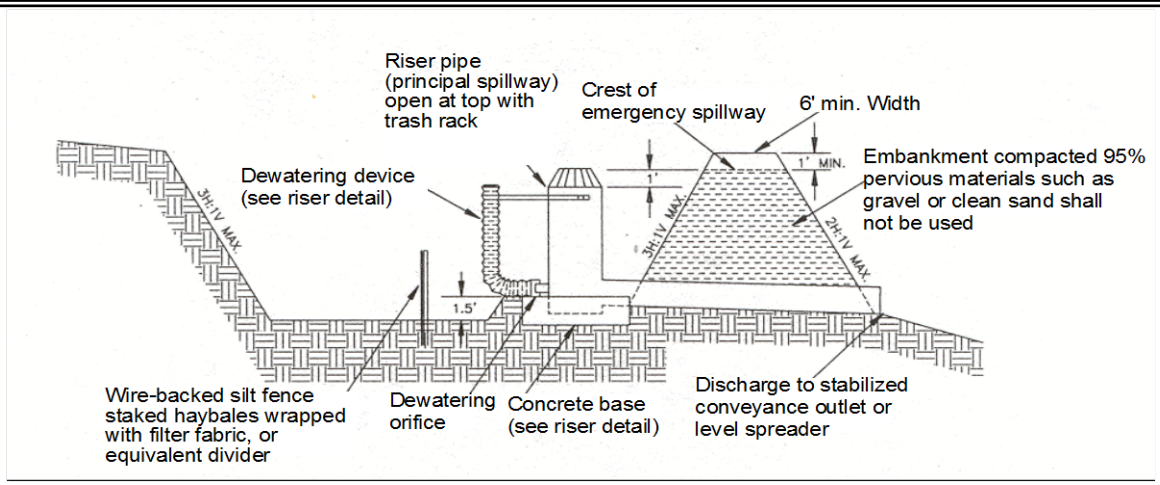


Figure 4.2.19 – Sediment Pond Cross Section

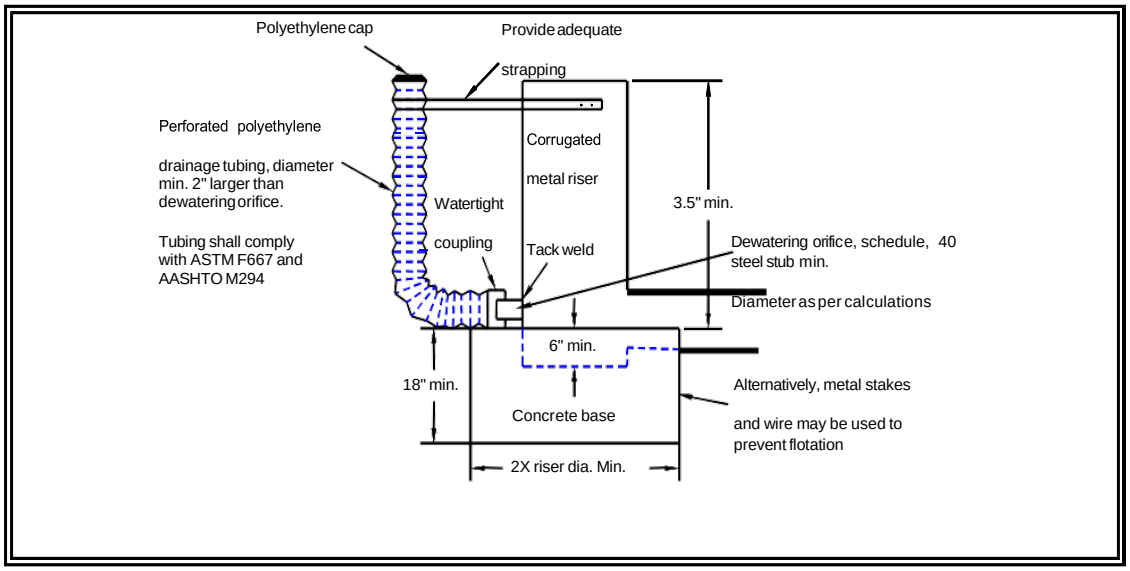


Figure 4.2.20 – Sediment Pond Riser Detail

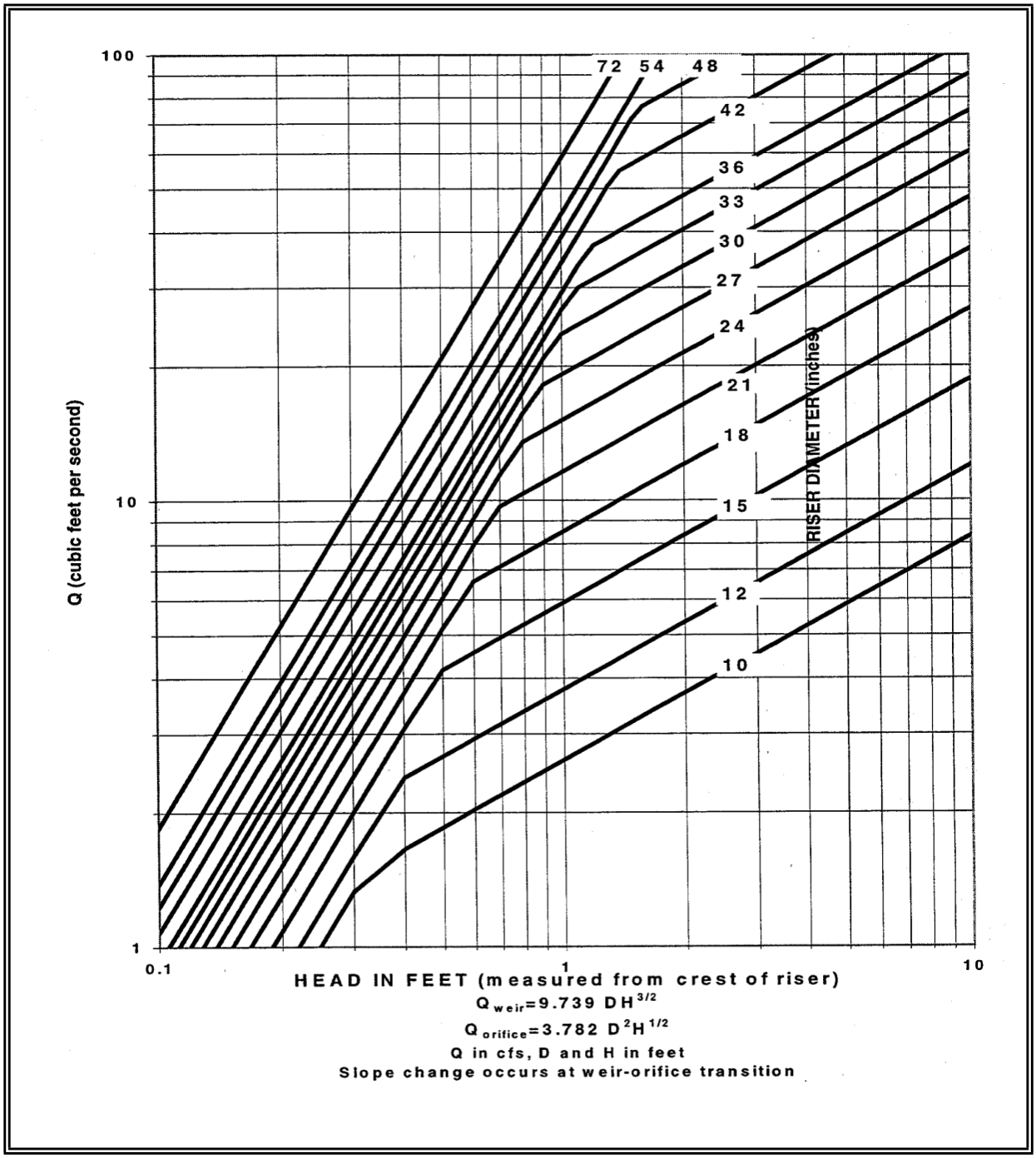


Figure 4.2.21 – Riser Inflow Curves

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Principal Spillway: Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the site's 15-minute, 10-year flowrate. If using the Western Washington Hydrology Model (WWHM), Version 2 or 3, design flow is the 10-year (1 hour) flow for the developed (unmitigated) site, multiplied by a factor of

1.6. Use Figure 4.2.21 to determine this diameter (*h* = 1-foot). *Note: A permanent control structure may be used instead of a temporary riser.*

Emergency Overflow Spillway: Determine the required size and design of the emergency overflow spillway for the developed 100-year peak flow using the method contained in Volume III.

Dewatering Orifice: Determine the size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_s (2h)^{0.5}}{0.6\text{x}3600Tg^{0.5}}$$

where A_O = orifice area (square feet)
A_S = pond surface area (square feet)
h = head of water above orifice (height of riser in feet)
T = dewatering time (24 hours)
g = acceleration of gravity (32.2 feet/second^2)

Convert the required surface area to the required diameter *D* of the orifice:

$$D = 24\text{x}\sqrt{\frac{A_o}{\pi}} = 13.54\text{x}\sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

- Additional Design Specifications

  The pond shall be divided into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between cells. The divider shall be at least one- half the height of the riser and a minimum of one foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with filter fabric (geotextile) may be used. If the pond is more than 6 feet deep, a different mechanism must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent

erosion under or around the barrier.

To aid in determining sediment depth, one-foot intervals shall be prominently marked on the riser.

If an embankment of more than 6 feet is proposed, the pond must comply with the criteria contained in Volume III regarding dam safety for detention BMPs.

- The most common structural failure of sedimentation basins is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction sequences to prevent piping will be:

  1. Tight connections between riser and barrel and other pipe connections.
  2. Adequate anchoring of riser.
  3. Proper soil compaction of the embankment and riser footing.
  4. Proper construction of anti-seep devices.

Maintenance Standards

- Sediment shall be removed from the pond when it reaches 1–foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

BMP C250: Construction Stormwater Chemical Treatment

Purpose

This BMP applies when using stormwater chemicals in batch treatment or flow-through treatment.

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt.

Traditional erosion and sediment control BMPs may not be adequate to ensure compliance with the water quality standards for turbidity in receiving water.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Chemical treatment may be required to meet turbidity stormwater discharge requirements, especially when construction is to proceed through the wet season.

Conditions of Use

Formal written approval from Ecology is required for the use of chemical treatment regardless of site size. The Local Permitting Authority may also require review and approval. When approved, the chemical treatment systems must be included in the Construction Stormwater Pollution Prevention Plan (SWPPP).

Design and Installation Specifications

See Appendix II-B for background information on chemical treatment.

Criteria for Chemical Treatment Product Use: Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The Chemical Technology Assessment Protocol (CTAPE) must be used to evaluate chemicals proposed for stormwater treatment.

Only chemicals approved by Ecology under the CTAPE may be used for stormwater treatment. The approved chemicals, their allowable application techniques (batch treatment or flow-through treatment), allowable application rates, and conditions of use can be found at the Department of Ecology Emerging Technologies website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Treatment System Design Considerations: The design and operation of a chemical treatment system should take into consideration the factors that determine optimum, cost-effective performance. It is important to recognize the following:

- Only Ecology approved chemicals may be used and must follow approved dose rate.
- The pH of the stormwater must be in the proper range for the polymers to be effective, which is typically 6.5 to 8.5
- The coagulant must be mixed rapidly into the water to ensure proper dispersion.
- A flocculation step is important to increase the rate of settling, to

produce the lowest turbidity, and to keep the dosage rate as low as possible.

- Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. Discharge from a batch treatment system should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge. Currently, flow-through systems always discharge through the chemically enhanced sand filtration system.
- System discharge rates must take into account downstream conveyance integrity.

Polymer Batch Treatment Process Description:

A batch chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), a storage pond, pumps, a chemical feed system, treatment cells, and interconnecting piping.

The batch treatment system shall use a minimum of two lined treatment cells in addition to an untreated stormwater storage pond. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be ponds or tanks. Ponds with constructed earthen embankments greater than six feet high or which impound more than 10 acre-feet require special engineering analyses. The Ecology Dam Safety Section has specific design criteria for dams in Washington State (see http://www.ecy.wa.gov/programs/wr/dams/GuidanceDocs.html).

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

The first step in the treatment sequence is to check the pH of the stormwater in the untreated stormwater storage pond. The pH is adjusted by the application of carbon dioxide or a base until the stormwater in the storage pond is within the desired pH range, 6.5 to 8.5. When used, carbon dioxide is added immediately downstream of the transfer pump. Typically sodium bicarbonate (baking soda) is used as a base, although other bases may be used. When needed, base is added directly to the untreated stormwater storage pond. The stormwater is recirculated with the treatment pump to provide mixing in the storage pond. Initial pH adjustments should be based on daily bench tests. Further pH adjustments can be made at any point in the process.

Once the stormwater is within the desired pH range (dependant on polymer being used), the stormwater is pumped from the untreated stormwater

storage pond to a treatment cell as polymer is added. The polymer is added upstream of the pump to facilitate rapid mixing.

After polymer addition, the water is kept in a lined treatment cell for clarification of the sediment-floc. In a batch mode process, clarification typically takes from 30 minutes to several hours. Prior to discharge samples are withdrawn for analysis of pH, flocculent chemical concentration, and turbidity. If both are acceptable, the treated water is discharged.

Several configurations have been developed to withdraw treated water from the treatment cell. The original configuration is a device that withdraws the treated water from just beneath the water surface using a float with adjustable struts that prevent the float from settling on the cell bottom. This reduces the possibility of picking up sediment-floc from the bottom of the pond. The struts are usually set at a minimum clearance of about 12 inches; that is, the float will come within 12 inches of the bottom of the cell. Other systems have used vertical guides or cables which constrain the float, allowing it to drift up and down with the water level.

More recent designs have an H-shaped array of pipes, set on the horizontal.

This scheme provides for withdrawal from four points rather than one. This configuration reduces the likelihood of sucking settled solids from the bottom. It also reduces the tendency for a vortex to form. Inlet diffusers, a long floating or fixed pipe with many small holes in it, are also an option.

Safety is a primary concern. Design should consider the hazards associated with operations, such as sampling. Facilities should be designed to reduce slip hazards and drowning. Tanks and ponds should have life rings, ladders, or steps extending from the bottom to the top.

Polymer Batch Treatment Process Description:

At a minimum, a flow-through chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond, and the chemically enhanced sand filtration system.

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

Stormwater is then pumped from the untreated stormwater storage pond to the chemically enhanced sand filtration system where polymer is added.

Adjustments to pH may be necessary before chemical addition. The sand filtration system continually monitors the stormwater for turbidity and pH. If the discharge water is ever out of an acceptable range for turbidity or pH, the water is recycled to the untreated stormwater pond where it can be retreated.

For batch treatment and flow-through treatment, the following equipment should be located in a lockable shed:

- The chemical injector.
- Secondary containment for acid, caustic, buffering compound, and treatment chemical.
- Emergency shower and eyewash.
- Monitoring equipment which consists of a pH meter and a turbidimeter

System Sizing:

Certain sites are required to implement flow control for the developed sites. These sites must also control stormwater release rates during construction. Generally, these are sites that discharge stormwater directly, or indirectly, through a conveyance system, into a fresh water. System sizing is dependent on flow control requirements.

Sizing Criteria for Batch Treatment Systems for Flow Control Exempt Water Bodies:

The total volume of the untreated stormwater storage pond and treatment ponds or tanks must be large enough to treat stormwater that is produced during multiple day storm events. It is recommended that at a minimum the untreated stormwater storage pond be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Primary settling should be encouraged in the untreated stormwater storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate times the desired drawdown time. A 4-hour drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by two hours of settling.

If the discharge is directly to a flow control exempt receiving water listed in Appendix I-E of Volume I or to an infiltration system, there is no discharge flow limit.

Ponds sized for flow control water bodies must at a minimum meet the sizing criteria for flow control exempt waters.

Sizing Criteria for Flow-Through Treatment Systems for Flow Control Exempt Water Bodies:

When sizing storage ponds or tanks for flow-through systems for flow control exempt water bodies, the treatment system capacity should be a factor. The untreated stormwater storage pond or tank should be sized to hold

1.5 times the runoff volume of the 10-year, 24-hour storm event minus the treatment system flowrate for an 8-hour period. For a chitosan- enhanced sand filtration system, the treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft². Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the chemical treatment system to accommodate extreme storms. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Sizing Criteria for Flow Control Water Bodies:

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction.

Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from ½ of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond and treatment cells.

The following is how WWHM can be used to determine the release rates from the chemical treatment systems:

1. Determine the pre-developed flow durations to be matched by entering the existing land use area under the "Pre-developed" scenario in WWHM. The default flow range is from ½ of the 2-year flow through the 10-year flow.
2. Enter the post developed land use area in the "Developed Unmitigated" scenario in WWHM.
3. Copy the land use information from the "Developed Unmitigated" to "Developed Mitigated" scenario.
4. While in the "Developed Mitigated" scenario, add a pond element under the basin element containing the post-developed land use areas. This pond element represents information on the available untreated stormwater storage and discharge from the chemical treatment system. In cases where the discharge from the chemical treatment system is controlled by a pump, a stage/storage/discharge (SSD) table representing the pond must be generated outside WWHM and imported into WWHM. WWHM can route the runoff from the post- developed condition through this SSD table (the pond) and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial SSD table proved to be inadequate, the designer would have to modify the SSD table outside WWHM and re-import in WWHM and route the runoff through it again. The iteration

will continue until a pond that complies with the flow duration standard is correctly sized.

Notes on SSD table characteristics:

- The pump discharge rate would likely be initially set at just below½ of the 2-year flow from the pre-developed condition. As runoff coming into the untreated stormwater storage pond increases and the available untreated stormwater storage volume gets used up, it would be necessary to increase the pump discharge rate above ½ of the 2-year. The increase(s) above ½ of the 2-year must be such that they provide some relief to the untreated stormwater storage needs but at the same time will not cause violations of the flow duration standard at the higher flows. The final design SSD table will identify the appropriate pumping rates and the corresponding stage and storages.
- When building such a flow control system, the design must ensure that any automatic adjustments to the pumping rates will be as a result of changes to the available storage in accordance with the final design SSD table.

5. It should be noted that the above procedures would be used to meet the flow control requirements. The chemical treatment system must be able to meet the runoff treatment requirements. It is likely that the discharge flow rate of ½ of the 2-year or more may exceed the treatment capacity of the system. If that is the case, the untreated stormwater discharge rate(s) (i.e., influent to the treatment system) must be reduced to allow proper treatment. Any reduction in the flows would likely result in the need for a larger untreated stormwater storage volume.

   If the discharge is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent scouring solids from the drainage system. If the municipal storm drainage system discharges to a water body not on the flow control exempt list, the project site is subject to flow control requirements. Obtain permission from the owner of the collection system before discharging to it.

If system design does not allow you to discharge at the slower rates as described above and if the site has a retention or detention pond that will serve the planned development, the discharge from the treatment system may be directed to the permanent retention/detention pond to comply with the flow control requirement. In this case, the untreated stormwater storage pond and treatment system will be sized according to the sizing criteria for flow-through treatment systems for flow control exempt water bodies described earlier except all discharge (water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent retention/detention pond. If site constraints make locating the untreated stormwater storage pond difficult, the permanent

retention/detention pond may be divided to serve as the untreated stormwater storage pond and the post-treatment flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The post-treatment flow control pond's revised dimensions must be entered into the WWHM and the WWHM must be run to confirm compliance with the flow control requirement.

Maintenance Standards

Monitoring: At a minimum, the following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site. Additional testing may be required by the NPDES permit based on site conditions.

Operational Monitoring:

- Total volume treated and discharged.
- Flow must be continuously monitored and recorded at not greater than 15-minute intervals.
- Type and amount of chemical used for pH adjustment.
- Amount of polymer used for treatment.
- Settling time.

Compliance Monitoring:

- Influent and effluent pH, flocculent chemical concentration, and turbidity must be continuously monitored and recorded at not greater than 15-minute intervals. pH and turbidity of the receiving water.

Biomonitoring:

Treated stormwater must be non-toxic to aquatic organisms. Treated stormwater must be tested for aquatic toxicity or residual chemicals. Frequency of biomonitoring will be determined by Ecology.

Residual chemical tests must be approved by Ecology prior to their use.

If testing treated stormwater for aquatic toxicity, you must test for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. Acute toxicity tests shall be conducted per the CTAPE protocol.

Discharge Compliance: Prior to discharge, treated stormwater must be sampled and tested for compliance with pH, flocculent chemical concentration, and turbidity limits. These limits may be established by the Construction Stormwater General Permit or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units. Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality

standards is determined in the receiving water.

Operator Training: Each contractor who intends to use chemical treatment shall be trained by an experienced contractor. Each site using chemical treatment must have an operator trained and certified by an organization approved by Ecology.

Standard BMPs: Surface stabilization BMPs should be implemented on site to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment off site.

Sediment Removal and Disposal:

- Sediment shall be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells. Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.
- Sediment that is known to be non-toxic may be incorporated into the site away from drainages.

BMP C251: Construction Stormwater Filtration

Purpose

Filtration removes sediment from runoff originating from disturbed areas of the site.

Background Information:

Filtration with sand media has been used for over a century to treat water and wastewater. The use of sand filtration for treatment of stormwater has developed recently, generally to treat runoff from streets, parking lots, and residential areas. The application of filtration to construction stormwater treatment is currently under development.

Conditions of Use

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

The use of construction stormwater filtration does not require approval from Ecology as long as treatment chemicals are not used. Filtration in conjunction with polymer treatment requires testing under the Chemical Technology Assessment Protocol – Ecology (CTAPE) before it can be initiated. Approval from the appropriate regional Ecology office must be obtained at each site where polymers use is proposed prior to use. For more guidance on stormwater chemical treatment see BMP C250.

Design and Installation Specifications

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow. Rapid sand filters are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. In contrast, slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. Slow sand filtration has generally been used to treat stormwater. Slow sand filtration is mechanically simple in comparison to rapid sand filtration but requires a much larger filter area.

Filtration Equipment. Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

Treatment Process Description. Stormwater is collected at interception point(s) on the site and is diverted to an untreated stormwater sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The untreated stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems

using gravity.

Maintenance Standards

Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the untreated stormwater stored in the holding pond or tank, backwash return to the untreated stormwater pond or tank may be appropriate. However, other means of treatment and disposal may be necessary.

- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.

Sizing Criteria for Flow-Through Treatment Systems for Flow Control Exempt Water Bodies:

When sizing storage ponds or tanks for flow-through systems for flow control exempt water bodies the treatment system capacity should be a factor. The untreated stormwater storage pond or tank should be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event minus the treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft². Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the chemical treatment system to accommodate extreme storms. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. Worst-case conditions (i.e., producing the most runoff) should be used for analyses (most likely conditions present prior to final landscaping).

Sizing Criteria for Flow Control Water Bodies:

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction.

Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from 1/2 of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond, the filtration system, and the flow rate through the filter system.

The following is how WWHM can be used to determine the release rates from the filtration systems:

1. Determine the pre-developed flow durations to be matched by entering the land use area under the “Pre-developed” scenario in WWHM. The default flow range is from ½ of the 2-year flow

through the 10-year flow.

2. Enter the post developed land use area in the "Developed Unmitigated" scenario in WWHM.
3. Copy the land use information from the "Developed Unmitigated" to "Developed Mitigated" scenario.
4. There are two possible ways to model stormwater filtration systems:
   a. The stormwater filtration system uses an untreated stormwater storage pond/tank and the discharge from this pond/tank is pumped to one or more filters. In-line filtration chemicals would be added to the flow right after the pond/tank and before the filter(s). Because the discharge is pumped, WWHM can't generate a stage/storage /discharge (SSD) table for this system. This system is modeled the same way as described in BMP C250 and is as follows:

      While in the "Developed Mitigated" scenario, add a pond element under the basin element containing the post-developed land use areas. This pond element represents information on the available untreated stormwater storage and discharge from the filtration system. In cases where the discharge from the filtration system is controlled by a pump, a stage/storage/discharge (SSD) table representing the pond must be generated outside WWHM and imported into WWHM. WWHM can route the runoff from the post-developed condition through this SSD table (the pond) and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial SSD table proved to be out of compliance, the designer would have to modify the SSD table outside WWHM and re-import in WWHM and route the runoff through it again. The iteration will continue until a pond that enables compliance with the flow duration standard is designed.

      Notes on SSD table characteristics:

      - The pump discharge rate would likely be initially set at just below ½ if the 2-year flow from the pre-developed condition. As runoff coming into the untreated stormwater storage pond increases and the available untreated stormwater storage volume gets used up, it would be necessary to increase the pump discharge rate above ½ of the 2-year. The increase(s) above ½ of the 2-year must be such that they provide some relief to the untreated stormwater storage needs but at the same time they will not cause violations of the flow duration standard at the higher flows. The final design SSD table will identify the appropriate pumping rates and the corresponding stage and storages.
      - When building such a flow control system, the design must

ensure that any automatic adjustments to the pumping rates will be as a result of changes to the available storage in accordance with the final design SSD table.

b. The stormwater filtration system uses a storage pond/tank and the discharge from this pond/tank gravity flows to the filter. This is usually a slow sand filter system and it is possible to model it in WWHM as a Filter element or as a combination of Pond and Filter element placed in series. The stage/storage/discharge table(s) may then be generated within WWHM as follows:

   i. While in the "Developed Mitigated" scenario, add a Filter element under the basin element containing the post-developed land use areas. The length and width of this filter element would have to be the same as the bottom length and width of the upstream untreated stormwater storage pond/tank.

   ii. In cases where the length and width of the filter is not the same as those for the bottom of the upstream untreated stormwater storage tank/pond, the treatment system may be modeled as a Pond element followed by a Filter element. By having these two elements, WWHM would then generate a SSD table for the storage pond which then gravity flows to the Filter element. The Filter element downstream of the untreated stormwater storage pond would have a storage component through the media, and an overflow component for when the filtration capacity is exceeded.

   WWHM can route the runoff from the post-developed condition through the treatment systems in 4b and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial sizing estimates for the treatment system proved to be inadequate, the designer would have to modify the system and route the runoff through it again. The iteration would continue until compliance with the flow duration standard is achieved.

5. It should be noted that the above procedures would be used to meet the flow control requirements. The filtration system must be able to meet the runoff treatment requirements. It is likely that the discharge flow rate of ½ of the 2-year or more may exceed the treatment capacity of the system. If that is the case, the untreated stormwater discharge rate(s) (i.e., influent to the treatment system) must be reduced to allow proper treatment. Any reduction in the flows would likely result in the need for a larger untreated stormwater storage volume.

If system design does not allow you to discharge at the slower rates as described above and if the site has a retention or detention pond that will serve the planned development, the discharge from the treatment system may be directed to the permanent retention/detention pond to comply with

the flow control requirements. In this case, the untreated stormwater storage pond and treatment system will be sized according to the sizing criteria for flow- through treatment systems for flow control exempt waterbodies described earlier except all discharges (water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent retention/detention pond. If site constraints make locating the untreated stormwater storage pond difficult, the permanent retention/detention pond may be divided to serve as the untreated stormwater discharge pond and the post-treatment flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post- treatment flow control must be achieved. The post-treatment flow control pond's revised dimensions must be entered into the WWHM and the WWHM must be run to confirm compliance with the flow control requirement.

BMP C253: pH Control for High pH Water

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. Stormwater with pH levels exceeding water quality standards may be treated by infiltration, dispersion in vegetation or compost, pumping to a sanitary sewer, disposal at a permitted concrete batch plant with pH neutralization capabilities, or carbon dioxide sparging. BMP C252 gives guidelines for carbon dioxide sparging.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this pH range is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Conditions of Use

Causes of High pH:

High pH levels at construction sites are most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Design and Installation Specifications

Disposal Methods:

Infiltration

- Infiltration is only allowed if soil type allows all water to infiltrate (no surface runoff) without causing or contributing to a violation of surface or ground water quality standards.
- Infiltration techniques should be consistent with Volume V, Chapter 7

Dispersion

Use BMP T5.30 Full Dispersion

Sanitary Sewer Disposal

- Local sewer authority approval is required prior to disposal via the sanitary sewer.

Concrete Batch Plant Disposal

- Only permitted facilities may accept high pH water.
- Facility should be contacted before treatment to ensure they can accept the high pH water.

Stormwater Discharge

Any pH treatment options that generate treated water that must be discharged off site are subject to flow control requirements. Sites that must implement flow control for the developed site must also control stormwater release rates

during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix I
Example of General Permit

Issuance Date: December 1, 2010
Effective Date: January 1, 2011
Expiration Date: December 31, 2015

CONSTRUCTION STORMWATER GENERAL PERMIT

National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit for Stormwater Discharges Associated with Construction Activity

State of Washington
Department of Ecology
Olympia, Washington 98504

In compliance with the provisions of
Chapter 90.48 Revised Code of Washington
(State of Washington Water Pollution Control Act)
and
Title 33 United States Code, Section 1251 et seq.
The Federal Water Pollution Control Act (The Clean Water Act)

Until this permit expires, is modified or revoked, Permittees that have properly obtained coverage under this general permit are authorized to discharge in accordance with the special and general conditions that follow.

Kelly Susewind, P.E., P.G.
Water Quality Program Manager
Washington State Department of Ecology

TABLE OF CONTENTS

LIST OF TABLES 3

SPECIAL CONDITIONS 5

S1. PERMIT COVERAGE 5
S2. APPLICATION REQUIREMENTS 8
S3. COMPLIANCE WITH STANDARDS 11
S4. MONITORING REQUIREMENTS 12
S5. REPORTING AND RECORDKEEPING REQUIREMENTS 19
S6. PERMIT FEES 22
S7. SOLID AND LIQUID WASTE DISPOSAL 22
S8. DISCHARGES TO 303(D) OR TMDL WATER BODIES 22
S9. STORMWATER POLLUTION PREVENTION PLAN 26
S10. NOTICE OF TERMINATION 34

GENERAL CONDITIONS 36

G1. DISCHARGE VIOLATIONS 36
G2. SIGNATORY REQUIREMENTS 36
G3. RIGHT OF INSPECTION AND ENTRY 37
G4. GENERAL PERMIT MODIFICATION AND REVOCATION 37
G5. REVOCATION OF COVERAGE UNDER THE PERMIT 37
G6. REPORTING A CAUSE FOR MODIFICATION 38
G7. COMPLIANCE WITH OTHER LAWS AND STATUTES 38
G8. DUTY TO REAPPLY 38
G9. TRANSFER OF GENERAL PERMIT COVERAGE 39
G10. REMOVED SUBSTANCES 39
G11. DUTY TO PROVIDE INFORMATION 39
G12. OTHER REQUIREMENTS OF 40 CFR 39
G13. ADDITIONAL MONITORING 39
G14. PENALTIES FOR VIOLATING PERMIT CONDITIONS 40
G15. UPSET 40

EX-0001-004284-PCE

G16. PROPERTY RIGHTS 40
G17. DUTY TO COMPLY 40
G18. TOXIC POLLUTANTS 41
G19. PENALTIES FOR TAMPERING 41
G20. REPORTING PLANNED CHANGES 41
G21. REPORTING OTHER INFORMATION 42
G22. REPORTING ANTICIPATED NON-COMPLIANCE 42
G23. REQUESTS TO BE EXCLUDED FROM COVERAGE UNDER THE PERMIT 42
G24. APPEALS 42
G25. SEVERABILITY 43
G26. BYPASS PROHIBITED 43
APPENDIX A – DEFINITIONS 46
APPENDIX B – ACRONYMS 54

LIST OF TABLES

Table 1. Summary of Permit Report Submittals 4
Table 2. Summary of Required On-site Documentation 4
Table 3. Summary of Primary Monitoring Requirements 12
Table 4. Monitoring and Reporting Requirements 16
Table 5. Turbidity, Fine Sediment & Phosphorus Sampling and Limits for 303(d)-Listed ... 24
Table 6. pH Sampling and Limits for 303(d)-Listed Waters 24

EX-0001-004285-PCE

SUMMARY OF PERMIT REPORT SUBMITTALS

Refer to the Special and General Conditions within this permit for additional submittal requirements. Appendix A provides a list of definitions. Appendix B provides a list of acronyms.

Table 1. Summary of Permit Report Submittals

Permit Section	Submittal	Frequency	First Submittal Date
S5.A and S8	High Turbidity/Transparency Phone Reporting	As Necessary	Within 24 hours
S5.B	Discharge Monitoring Report	Monthly*	Within 15 days of applicable monitoring period
S5.F and S8	Noncompliance Notification	As necessary	Immediately
S5.F	Noncompliance Notification – Written Report	As necessary	Within 5 Days of non-compliance
G2.	Notice of Change in Authorization	As necessary	
G6.	Permit Application for Substantive Changes to the Discharge	As necessary	
G8.	Application for Permit Renewal	1/permit cycle	No later than 180 days before expiration
G9.	Notice of Permit Transfer	As necessary	
G20.	Notice of Planned Changes	As necessary	
G22.	Reporting Anticipated Non-compliance	As necessary	

SPECIAL NOTE: *Permittees must submit Discharge Monitoring Reports (DMRs) to the Washington State Department of Ecology monthly, regardless of site discharge, for the full duration of permit coverage. Refer to Section S5.B of this General Permit for more specific information regarding DMRs.

Table 2. Summary of Required On-site Documentation

Document Title	Permit Conditions
Permit Coverage Letter	See Conditions S2, S5
Construction Stormwater General Permit	See Conditions S2, S5
Site Log Book	See Conditions S4, S5
Stormwater Pollution Prevention Plan (SWPPP)	See Conditions S9, S5

EX-0001-004286-PCE

SPECIAL CONDITIONS

S1. PERMIT COVERAGE

A. Permit Area

This Construction Stormwater General Permit (CSWGP) covers all areas of Washington State, except for federal and Tribal lands as specified in Special Condition S1.E.3.

B. Operators Required to Seek Coverage Under this General Permit:

1. Operators of the following construction activities are required to seek coverage under this CSWGP:

   a. Clearing, grading and/or excavation that results in the disturbance of one or more acres and discharges stormwater to surface waters of the State; and clearing, grading and/or excavation on sites smaller than one acre that are part of a larger common plan of development or sale, if the common plan of development or sale will ultimately disturb one acre or more and discharge stormwater to surface waters of the State.

      i. This includes forest practices (including, but not limited to, class IV conversions) that are part of a construction activity that will result in the disturbance of one or more acres, and discharge to surface waters of the State (that is, forest practices that prepare a site for construction activities); and

   b. Any size construction activity discharging stormwater to waters of the State that the Department of Ecology ("Ecology"):

      i. Determines to be a significant contributor of pollutants to waters of the State of Washington.

      ii. Reasonably expects to cause a violation of any water quality standard.

2. Operators of the following activities are not required to seek coverage under this CSWGP (unless specifically required under Special Condition S1.B.1.b. above):

   a. Construction activities that discharge all stormwater and non-stormwater to ground water, sanitary sewer, or combined sewer, and have no point source discharge to either surface water or a storm sewer system that drains to surface waters of the State.

   b. Construction activities covered under an Erosivity Waiver (Special Condition S2.C).

   c. Routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of a facility.

EX-0001-004287-PCE

C. Authorized Discharges:

1. Stormwater Associated with Construction Activity. Subject to compliance with the terms and conditions of this permit, Permittees are authorized to discharge stormwater associated with construction activity to surface waters of the State or to a storm sewer system that drains to surface waters of the State. (Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.)

2. Stormwater Associated with Construction Support Activity. This permit also authorizes stormwater discharge from support activities related to the permitted construction site (for example, an on-site portable rock crusher, off-site equipment staging yards, material storage areas, borrow areas, etc.) provided:

   a. The support activity relates directly to the permitted construction site that is required to have a NPDES permit; and

   b. The support activity is not a commercial operation serving multiple unrelated construction projects, and does not operate beyond the completion of the construction activity; and

   c. Appropriate controls and measures are identified in the Stormwater Pollution Prevention Plan (SWPPP) for the discharges from the support activity areas.

3. Non-Stormwater Discharges. The categories and sources of non-stormwater discharges identified below are authorized conditionally, provided the discharge is consistent with the terms and conditions of this permit:

   a. Discharges from fire-fighting activities.

   b. Fire hydrant system flushing.

   c. Potable water, including uncontaminated water line flushing.

   d. Pipeline hydrostatic test water.

   e. Uncontaminated air conditioning or compressor condensate.

   f. Uncontaminated ground water or spring water.

   g. Uncontaminated excavation dewatering water (in accordance with S9.D.10).

   h. Uncontaminated discharges from foundation or footing drains.

   i. Water used to control dust. Permittees must minimize the amount of dust control water used.

   j. Routine external building wash down that does not use detergents.

   k. Landscape irrigation water.

   The SWPPP must adequately address all authorized non-stormwater discharges, except for discharges from fire-fighting activities, and must comply with Special

EX-0001-004288-PCE

Condition S3. At a minimum, discharges from potable water (including water line flushing), fire hydrant system flushing, and pipeline hydrostatic test water must undergo the following: dechlorination to a concentration of 0.1 parts per million (ppm) or less, and pH adjustment to within 6.5 – 8.5 standard units (su), if necessary.

D. Prohibited Discharges:

The following discharges to waters of the State, including ground water, are prohibited.

1. Concrete wastewater.
2. Wastewater from washout and clean-up of stucco, paint, form release oils, curing compounds and other construction materials.
3. Process wastewater as defined by 40 Code of Federal Regulations (CFR) 122.1 (see Appendix A of this permit).
4. Slurry materials and waste from shaft drilling.
5. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.
6. Soaps or solvents used in vehicle and equipment washing.
7. Wheel wash wastewater, unless discharged according to Special Condition S9.D.9.d.
8. Discharges from dewatering activities, including discharges from dewatering of trenches and excavations, unless managed according to Special Condition S9.D.10.

E. Limits on Coverage

Ecology may require any discharger to apply for and obtain coverage under an individual permit or another more specific general permit. Such alternative coverage will be required when Ecology determines that this CSWGP does not provide adequate assurance that water quality will be protected, or there is a reasonable potential for the project to cause or contribute to a violation of water quality standards.

The following stormwater discharges are not covered by this permit:

1. Post-construction stormwater discharges that originate from the site after completion of construction activities and the site has undergone final stabilization.
2. Non-point source silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance, from which there is natural runoff as excluded in 40 CFR Subpart 122.
3. Stormwater from any federal project or project on federal land or land within an Indian Reservation except for the Puyallup Reservation. Within the Puyallup

EX-0001-004289-PCE

Reservation, any project that discharges to surface water on land held in trust by the federal government may be covered by this permit.

4. Stormwater from any site covered under an existing NPDES individual permit in which stormwater management and/or treatment requirements are included for all stormwater discharges associated with construction activity.

5. Stormwater from a site where an applicable Total Maximum Daily Load (TMDL) requirement specifically precludes or prohibits discharges from construction activity.

S2. APPLICATION REQUIREMENTS

A. Permit Application Forms

1. Notice of Intent Form/Timeline

a. Operators of new or previously unpermitted construction activities must submit a complete and accurate permit application (Notice of Intent, or NOI) to Ecology.

b. The operator must submit the NOI at least 60 days before discharging stormwater from construction activities and must submit it on or before the date of the first public notice (see Special Condition S2.B below for details). The 30-day public comment period required by WAC 173-226-130(5) begins on the publication date of the second public notice. Unless Ecology responds to the complete application in writing, based on public comments, or any other relevant factors, coverage under the general permit will automatically commence on the thirty-first day following receipt by Ecology of a completed NOI, or the issuance date of this permit, whichever is later, unless Ecology specifies a later date in writing.

c. Applicants who propose to discharge to a storm or sewer system operated by Seattle, King County, Snohomish County, Tacoma, Pierce County, or Clark County must also submit a copy of the NOI to the appropriate jurisdiction.

d. If an applicant intends to use a Best Management Practice (BMP) selected on the basis of Special Condition S9.C.4 (“demonstrably equivalent” BMPs), the applicant must notify Ecology of its selection as part of the NOI. In the event the applicant selects BMPs after submission of the NOI, it must provide notice of the selection of an equivalent BMP to Ecology at least 60 days before intended use of the equivalent BMP.

e. Permittees must notify Ecology regarding any changes to the information provided on the NOI by submitting an updated NOI. Examples of such changes include, but are not limited to,

i. changes to the Permittee’s mailing address,

ii. changes to the on-site contact person information, and

EX-0001-004290-PCE

iii. changes to the area/acreage affected by construction activity.

2. Transfer of Coverage Form

The Permittee can transfer current coverage under this permit to one or more new operators, including operators of sites within a Common Plan of Development, provided the Permittee submits a Transfer of Coverage Form in accordance with General Condition G9. Transfers do not require public notice.

B. Public Notice

For new or previously unpermitted construction activities, the applicant must publish a public notice at least one time each week for two consecutive weeks, at least 7 days apart, in a newspaper with general circulation in the county where the construction is to take place. The notice must contain:

1. A statement that "The applicant is seeking coverage under the Washington State Department of Ecology's Construction Stormwater NPDES and State Waste Discharge General Permit."

2. The name, address and location of the construction site.

3. The name and address of the applicant.

4. The type of construction activity that will result in a discharge (for example, residential construction, commercial construction, etc.), and the number of acres to be disturbed.

5. The name of the receiving water(s) (that is, the surface water(s) to which the site will discharge), or, if the discharge is through a storm sewer system, the name of the operator of the system.

6. The statement: "Any persons desiring to present their views to the Washington State Department of Ecology regarding this application, or interested in Ecology's action on this application, may notify Ecology in writing no later than 30 days of the last date of publication of this notice. Ecology reviews public comments and considers whether discharges from this project would cause a measurable change in receiving water quality, and, if so, whether the project is necessary and in the overriding public interest according to Tier II antidegradation requirements under WAC 173-201A-320. Comments can be submitted to: Department of Ecology, P.O. Box 47696, Olympia, WA 98504-7696 Attn: Water Quality Program, Construction Stormwater."

EX-0001-004291-PCE

C. Erosivity Waiver

Construction site operators may qualify for an erosivity waiver from the CSWGP if the following conditions are met:

1. The site will result in the disturbance of fewer than 5 acres and the site is not a portion of a common plan of development or sale that will disturb 5 acres or greater.

2. Calculation of Erosivity "R" Factor and Regional Timeframe:

   a. The project's rainfall erosivity factor ("R" Factor) must be less than 5 during the period of construction activity, as calculated using either the Texas A&M University online rainfall erosivity calculator at: http://ei.tamu.edu/ or EPA's calculator at http://cfpub.epa.gov/npdes/stormwater/lew/lewcalculator.cfm. The period of construction activity starts when the land is first disturbed and ends with final stabilization. In addition:

   b. The entire period of construction activity must fall within the following timeframes:

      i. For sites west of the Cascades Crest: June 15 – September 15.

      ii. For sites east of the Cascades Crest, excluding the Central Basin: June 15 – October 15.

      iii. For sites east of the Cascades Crest, within the Central Basin: no additional timeframe restrictions apply. The Central Basin is defined as the portions of Eastern Washington with mean annual precipitation of less than 12 inches. For a map of the Central Basin (Region 2), refer to http://www.ecy.wa.gov/pubs/ecy070202.pdf.

3. Construction site operators must submit a complete Erosivity Waiver certification form at least one week before disturbing the land. Certification must include statements that the operator will:

   a. Comply with applicable local stormwater requirements; and

   b. Implement appropriate erosion and sediment control BMPs to prevent violations of water quality standards.

4. This waiver is not available for facilities declared significant contributors of pollutants as defined in Special Condition S1.B.1.b.

5. This waiver does not apply to construction activities which include non-stormwater discharges listed in Special Condition S1.C.3.

6. If construction activity extends beyond the certified waiver period for any reason, the operator must either:

   a. Recalculate the rainfall erosivity "R" factor using the original start date and a new projected ending date and, if the "R" factor is still under 5 and the entire

EX-0001-004292-PCE

project falls within the applicable regional timeframe in Special Condition S2.C.2.b, complete and submit an amended waiver certification form before the original waiver expires; or

b. Submit a complete permit application to Ecology in accordance with Special Condition S2.A and B before the end of the certified waiver period.

S3. COMPLIANCE WITH STANDARDS

A. Discharges must not cause or contribute to a violation of surface water quality standards (Chapter 173-201A WAC), ground water quality standards (Chapter 173-200 WAC), sediment management standards (Chapter 173-204 WAC), and human health-based criteria in the National Toxics Rule (40 CFR Part 131.36). Discharges not in compliance with these standards are not authorized.

B. Prior to the discharge of stormwater and non-stormwater to waters of the State, the Permittee must apply all known, available, and reasonable methods of prevention, control, and treatment (AKART). This includes the preparation and implementation of an adequate Stormwater Pollution Prevention Plan (SWPPP), with all appropriate BMPs installed and maintained in accordance with the SWPPP and the terms and conditions of this permit.

C. Ecology presumes that a Permittee complies with water quality standards unless discharge monitoring data or other site-specific information demonstrates that a discharge causes or contributes to a violation of water quality standards, when the Permittee complies with the following conditions. The Permittee must fully:

1. Comply with all permit conditions, including planning, sampling, monitoring, reporting, and recordkeeping conditions.

2. Implement stormwater BMPs contained in stormwater management manuals published or approved by Ecology, or BMPs that are demonstrably equivalent to BMPs contained in stormwater technical manuals published or approved by Ecology, including the proper selection, implementation, and maintenance of all applicable and appropriate BMPs for on-site pollution control. (For purposes of this section, the stormwater manuals listed in Appendix 10 of the Phase I Municipal Stormwater Permit are approved by Ecology.)

D. Where construction sites also discharge to ground water, the ground water discharges must also meet the terms and conditions of this CSWGP. Permittees who discharge to ground water through an injection well must also comply with any applicable requirements of the Underground Injection Control (UIC) regulations, Chapter 173-218 WAC.

EX-0001-004293-PCE

S4. MONITORING REQUIREMENTS, BENCHMARKS AND REPORTING TRIGGERS

Table 3. Summary of Primary Monitoring Requirements

Size of Soil Disturbance[1]	Weekly Site Inspections	Weekly Sampling w/ Turbidity Meter	Weekly Sampling w/ Transparency Tube	Weekly pH Sampling[2]	Requires CESCL Certification?
Sites that disturb less than 1 acre, but are part of a larger Common Plan of Development	Required	Not Required	Not Required	Not Required	No
Sites that disturb 1 acre or more, but fewer than 5 acres	Required	Sampling Required – either method[3]		Required	Yes
Sites that disturb 5 acres or more	Required	Required	Not Required[4]	Required	Yes

A. Site Log Book

The Permittee must maintain a site log book that contains a record of the implementation of the SWPPP and other permit requirements, including the installation and maintenance of BMPs, site inspections, and stormwater monitoring.

B. Site Inspections

The Permittee's (operator's) site inspections must include all areas disturbed by construction activities, all BMPs, and all stormwater discharge points. (See Special Conditions S4.B.3 and B.4 below for detailed requirements of the Permittee's Certified Erosion and Sediment Control Lead [CESCL]).

[1] Soil disturbance is calculated by adding together all areas affected by construction activity. Construction activity means clearing, grading, excavation, and any other activity that disturbs the surface of the land, including ingress/egress from the site.

[2] If construction activity results in the disturbance of 1 acre or more, and involves significant concrete work (1,000 cubic yards of poured or recycled concrete over the life of a project) or the use of engineered soils (soil amendments including but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD], or fly ash), and stormwater from the affected area drains to surface waters of the State or to a storm sewer stormwater collection system that drains to other surface waters of the State, the Permittee must conduct pH monitoring sampling in accordance with Special Condition S4.D.

[3] Sites with one or more acres, but fewer than 5 acres of soil disturbance, must conduct turbidity or transparency sampling in accordance with Special Condition S4.C.

[4] Sites equal to or greater than 5 acres of soil disturbance must conduct turbidity sampling using a turbidity meter in accordance with Special Condition S4.C.

EX-0001-004294-PCE

Construction sites one acre or larger that discharge stormwater to surface waters of the State must have site inspections conducted by a certified CESCL. Sites less than one acre may have a person without CESCL certification conduct inspections; sampling is not required on sites that disturb less than an acre.

1. The Permittee must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. The Permittee must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.

   Based on the results of the inspection, the Permittee must correct the problems identified by:

   a. Reviewing the SWPPP for compliance with Special Condition S9 and making appropriate revisions within 7 days of the inspection.

   b. Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems no later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when an extension is requested by a Permittee within the initial 10-day response period.

   c. Documenting BMP implementation and maintenance in the site log book.

2. The Permittee must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The Permittee may reduce the inspection frequency for temporarily stabilized, inactive sites to once every calendar month.

3. The Permittee must have staff knowledgeable in the principles and practices of erosion and sediment control. The CESCL (sites one acre or more) or inspector (sites less than one acre) must have the skills to assess the:

   a. Site conditions and construction activities that could impact the quality of stormwater, and

   b. Effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

4. The SWPPP must identify the CESCL or inspector, who must be present on site or on-call at all times. The CESCL must obtain this certification through an approved erosion and sediment control training program that meets the minimum training standards established by Ecology (see BMP C160 in the manual referred to in Special Condition S9.C.1 and 2).

EX-0001-004295-PCE

5. The Permittee must summarize the results of each inspection in an inspection report or checklist and enter the report/checklist into, or attach it to, the site log book. At a minimum, each inspection report or checklist must include:

    a. Inspection date and time.

    b. Weather information, the general conditions during inspection and the approximate amount of precipitation since the last inspection, and precipitation within the last 24 hours.

    c. A summary or list of all implemented BMPs, including observations of all erosion/sediment control structures or practices.

    d. A description of the locations:

        i. Of BMPs inspected.

        ii. Of BMPs that need maintenance and why.

        iii. Of BMPs that failed to operate as designed or intended, and

        iv. Where additional or different BMPs are needed, and why.

    e. A description of stormwater discharged from the site. The Permittee must note the presence of suspended sediment, turbidity, discoloration, and oil sheen, as applicable.

    f. Any water quality monitoring performed during inspection.

    g. General comments and notes, including a brief description of any BMP repairs, maintenance or installations made following the inspection.

    h. A summary report and a schedule of implementation of the remedial actions that the Permittee plans to take if the site inspection indicates that the site is out of compliance. The remedial actions taken must meet the requirements of the SWPPP and the permit.

    i. The name, title, and signature of the person conducting the site inspection, a phone number or other reliable method to reach this person, and the following statement: "I certify that this report is true, accurate, and complete to the best of my knowledge and belief."

C. <u>Turbidity/Transparency Sampling Requirements</u>

1. Sampling Methods

    a. If construction activity involves the disturbance of 5 acres or more, the Permittee must conduct turbidity sampling per Special Condition S4.C.

    b. If construction activity involves 1 acre or more but fewer than 5 acres of soil disturbance, the Permittee must conduct either transparency sampling **or** turbidity sampling per Special Condition S4.C.

EX-0001-004296-PCE

2. Sampling Frequency

   a. The Permittee must sample all discharge locations at least once every calendar week when stormwater (or authorized non-stormwater) discharges from the site or enters any on-site surface waters of the state (for example, a creek running through a site).

   b. Samples must be representative of the flow and characteristics of the discharge.

   c. Sampling is not required when there is no discharge during a calendar week.

   d. Sampling is not required outside of normal working hours or during unsafe conditions.

   e. If the Permittee is unable to sample during a monitoring period, the Permittee must include a brief explanation in the monthly Discharge Monitoring Report (DMR).

   f. Sampling is not required before construction activity begins.

3. Sampling Locations

   a. Sampling is required at all points where stormwater associated with construction activity (or authorized non-stormwater) is discharged off site, including where it enters any on-site surface waters of the state (for example, a creek running through a site).

   b. The Permittee may discontinue sampling at discharge points that drain areas of the project that are fully stabilized to prevent erosion.

   c. The Permittee must identify all sampling point(s) on the SWPPP site map and clearly mark these points in the field with a flag, tape, stake or other visible marker.

   d. Sampling is not required for discharge that is sent directly to sanitary or combined sewer systems.

4. Sampling and Analysis Methods

   a. The Permittee performs turbidity analysis with a calibrated turbidity meter (turbidimeter) either on site or at an accredited lab. The Permittee must record the results in the site log book in nephelometric turbidity units (NTU).

   b. The Permittee performs transparency analysis on site with a 1¾-inch-diameter, 60-centimeter (cm)-long transparency tube. The Permittee will record the results in the site log book in centimeters (cm). Transparency tubes are available from: http://watermonitoringequip.com/pages/stream.html.

EX-0001-004297-PCE

Table 4. Monitoring and Reporting Requirements

Parameter	Unit	Analytical Method	Sampling Frequency	Benchmark Value	Phone Reporting Trigger Value
Turbidity	NTU	SM2130 or EPA 180.1	Weekly, if discharging	25 NTU	250 NTU
Transparency	cm	Manufacturer instructions, or Ecology guidance	Weekly, if discharging	33 cm	6 cm

5. Turbidity/Transparency Benchmark Values and Reporting Triggers

The benchmark value for turbidity is 25 NTU or less. The benchmark value for transparency is 33 centimeters (cm). Note: Benchmark values do not apply to discharges to segments of water bodies on Washington State's 303(d) list (Category 5) for turbidity, fine sediment, or phosphorus; these discharges are subject to a numeric effluent limit for turbidity. Refer to Special Condition S8 for more information.

a. Turbidity 26 – 249 NTU, or Transparency 32 – 7 cm:

If the discharge turbidity is 26 to 249 NTU; or if discharge transparency is less than 33 cm, but equal to or greater than 6 cm, the Permittee must:

i. Review the SWPPP for compliance with Special Condition S9 and make appropriate revisions within 7 days of the date the discharge exceeded the benchmark.

ii. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible, addressing the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period.

iii. Document BMP implementation and maintenance in the site log book.

b. Turbidity 250 NTU or greater, or Transparency 6 cm or less:

If a discharge point's turbidity is 250 NTU or greater, or if discharge transparency is less than or equal to 6 cm, the Permittee must complete the reporting and adaptive management process described below.

i. Telephone the applicable Ecology Region's Environmental Report Tracking System (ERTS) number within 24 hours, in accordance with Special Condition S5.F.

- Central Region (Okanogan, Chelan, Douglas, Kittitas, Yakima, Klickitat, Benton): (509) 575-2490

EX-0001-004298-PCE

- Eastern Region (Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman): (509) 329-3400
- Northwest Region (Kitsap, Snohomish, Island, King, San Juan, Skagit, Whatcom): (425) 649-7000
- Southwest Region (Grays Harbor, Lewis, Mason, Thurston, Pierce, Clark, Cowlitz, Skamania, Wahkiakum, Clallam, Jefferson, Pacific): (360) 407-6300

These numbers are also listed at the following web site: http://www.ecy.wa.gov/programs/wq/stormwater/construction/permit.html

ii. Review the SWPPP for compliance with Special Condition S9 and make appropriate revisions within 7 days of the date the discharge exceeded the benchmark.

iii. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible, addressing the problems within 10 days of the date the discharge exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when the Permittee requests an extension within the initial 10-day response period.

iv. Document BMP implementation and maintenance in the site log book.

v. Continue to sample discharges daily until:

a) Turbidity is 25 NTU (or lower); or

b) Transparency is 33 cm (or greater); or

c) The Permittee has demonstrated compliance with the water quality limit for turbidity:

1) No more than 5 NTU over background turbidity, if background is less than 50 NTU, or

2) No more than 10% over background turbidity, if background is 50 NTU or greater; or

d) The discharge stops or is eliminated.

D. pH Sampling Requirements -- Significant Concrete Work or Engineered Soils

If construction activity results in the disturbance of 1 acre or more, **and** involves significant concrete work (significant concrete work means greater than 1000 cubic yards poured concrete or recycled concrete used over the life of a project) or the use of engineered soils (soil amendments including but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD], or fly ash), and stormwater from the affected area

EX-0001-004299-PCE

drains to surface waters of the State or to a storm sewer system that drains to surface waters of the state, the Permittee must conduct pH monitoring as set forth below. Note: In addition, discharges to segments of water bodies on Washington State's 303(d) list (Category 5) for high pH are subject to a numeric effluent limit for pH; refer to Special Condition S8.

1. For sites with significant concrete work, the Permittee must begin the pH monitoring period when the concrete is first poured and exposed to precipitation, and continue weekly throughout and after the concrete pour and curing period, until stormwater pH is in the range of 6.5 to 8.5 (su).

2. For sites with engineered soils, the Permittee must begin the pH monitoring period when the soil amendments are first exposed to precipitation and must continue until the area of engineered soils is fully stabilized.

3. During the applicable pH monitoring period defined above, the Permittee must obtain a representative sample of stormwater and conduct pH analysis at least once per week.

4. The Permittee must monitor pH in the sediment trap/pond(s) or other locations that receive stormwater runoff from the area of significant concrete work or engineered soils before the stormwater discharges to surface waters.

5. The benchmark value for pH is 8.5 standard units. Anytime sampling indicates that pH is 8.5 or greater, the Permittee must either:

    a. Prevent the high pH water (8.5 or above) from entering storm sewer systems or surface waters; or

    b. If necessary, adjust or neutralize the high pH water until it is in the range of pH 6.5 to 8.5 (su) using an appropriate treatment BMP such as carbon dioxide (CO_2) sparging or dry ice. The Permittee must obtain written approval from Ecology before using any form of chemical treatment other than CO_2 sparging or dry ice.

6. The Permittee must perform pH analysis on site with a calibrated pH meter, pH test kit, or wide range pH indicator paper. The Permittee must record pH monitoring results in the site log book.

EX-0001-004300-PCE

S5. REPORTING AND RECORDKEEPING REQUIREMENTS

A. High Turbidity Phone Reporting

Anytime sampling performed in accordance with Special Condition S4.C indicates turbidity has reached the 250 NTU phone reporting level, the Permittee must call Ecology's Regional office by phone within 24 hours of analysis. The web site is http://www.ecy.wa.gov/programs/wq/stormwater/construction/permit.html. Also see phone numbers in Special Condition S4.C.5.b.i.

B. Discharge Monitoring Reports

Permittees required to conduct water quality sampling in accordance with Special Conditions S4.C (Turbidity/Transparency), S4.D (pH), S8 (303[d]/TMDL sampling), and/or G13 (Additional Sampling) must submit the results to Ecology.

Permittees must submit monitoring data using Ecology's WebDMR program. To find out more information and to sign up for WebDMR go to: http://www.ecy.wa.gov/programs/wq/permits/paris/webdmr.html.

Permittees unable to submit electronically (for example, those who do not have an internet connection) must contact Ecology to request a waiver and obtain instructions on how to obtain a paper copy DMR at:

Mailing Address:
Department of Ecology
Water Quality Program
Attn: Stormwater Compliance Specialist
PO Box 47696
Olympia, WA 98504-7696

Permittees who obtain a waiver not to use WebDMR must use the forms provided to them by Ecology; submittals must be mailed to the address above. Permittees shall submit DMR forms to be received by Ecology within 15 days following the end of each month.

If there was no discharge during a given monitoring period, all Permittees must submit a DMR as required with “no discharge" entered in place of the monitoring results. For more information, contact Ecology staff using information provided at the following web site: http://www.ecy.wa.gov/programs/spills/response/assistancesoil%20map.pdf

C. Records Retention

The Permittee must retain records of all monitoring information (site log book, sampling results, inspection reports/checklists, etc.), Stormwater Pollution Prevention Plan, and any other documentation of compliance with permit requirements for the entire life of the construction project and for a minimum of three years following the termination of permit coverage. Such information must include all calibration and maintenance records, and records of all data used to complete the application for this

EX-0001-004301-PCE

permit. This period of retention must be extended during the course of any unresolved litigation regarding the discharge of pollutants by the Permittee or when requested by Ecology.

D. Recording Results

For each measurement or sample taken, the Permittee must record the following information:

1. Date, place, method, and time of sampling or measurement.
2. The first and last name of the individual who performed the sampling or measurement.
3. The date(s) the analyses were performed.
4. The first and last name of the individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all analyses.

E. Additional Monitoring by the Permittee

If the Permittee monitors any pollutant more frequently than required by this permit using test procedures specified by Special Condition S4 of this permit, the results of this monitoring must be included in the calculation and reporting of the data submitted in the Permittee's DMR.

F. Noncompliance Notification

In the event the Permittee is unable to comply with any part of the terms and conditions of this permit, and the resulting noncompliance may cause a threat to human health or the environment, the Permittee must:

1. Immediately notify Ecology of the failure to comply by calling the applicable Regional office ERTS phone number (find at http://www.ecy.wa.gov/programs/spills/response/assistancesoil%20map.pdf) or refer to Special Condition S4.C.5.b.i.
2. Immediately take action to prevent the discharge/pollution, or otherwise stop or correct the noncompliance, and, if applicable, repeat sampling and analysis of any noncompliance immediately and submit the results to Ecology within five (5) days of becoming aware of the violation.
3. Submit a detailed written report to Ecology within five (5) days, unless requested earlier by Ecology. The report must contain a description of the noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

EX-0001-004302-PCE

The Permittee must report any unanticipated bypass and/or upset that exceeds any effluent limit in the permit in accordance with the 24-hour reporting requirement contained in 40 C.F.R. 122.41(l)(6)).

Compliance with these requirements does not relieve the Permittee from responsibility to maintain continuous compliance with the terms and conditions of this permit or the resulting liability for failure to comply. Refer to Section G14 of this permit for specific information regarding non-compliance.

G. Access to Plans and Records

1. The Permittee must retain the following permit documentation (plans and records) on site, or within reasonable access to the site, for use by the operator or for on-site review by Ecology or the local jurisdiction:

   a. General Permit.

   b. Permit Coverage Letter.

   c. Stormwater Pollution Prevention Plan (SWPPP).

   d. Site Log Book.

2. The Permittee must address written requests for plans and records listed above (Special Condition S5.G.1) as follows:

   a. The Permittee must provide a copy of plans and records to Ecology within 14 days of receipt of a written request from Ecology.

   b. The Permittee must provide a copy of plans and records to the public when requested in writing. Upon receiving a written request from the public for the Permittee's plans and records, the Permittee must either:

      i. Provide a copy of the plans and records to the requester within 14 days of a receipt of the written request; or

      ii. Notify the requester within 10 days of receipt of the written request of the location and times within normal business hours when the plans and records may be viewed; and provide access to the plans and records within 14 days of receipt of the written request; or

      Within 14 days of receipt of the written request, the Permittee may submit a copy of the plans and records to Ecology for viewing and/or copying by the requester at an Ecology office, or a mutually agreed location. If plans and records are viewed and/or copied at a location other than at an Ecology office, the Permittee will provide reasonable access to copying services for which a reasonable fee may be charged. The Permittee must notify the requester within 10 days of receipt of the request where the plans and records may be viewed and/or copied.

EX-0001-004303-PCE

S6. PERMIT FEES

The Permittee must pay permit fees assessed by Ecology. Fees for stormwater discharges covered under this permit are established by Chapter 173-224 WAC. Ecology continues to assess permit fees until the permit is terminated in accordance with Special Condition S10 or revoked in accordance with General Condition G5.

S7. SOLID AND LIQUID WASTE DISPOSAL

The Permittee must handle and dispose of solid and liquid wastes generated by construction activity, such as demolition debris, construction materials, contaminated materials, and waste materials from maintenance activities, including liquids and solids from cleaning catch basins and other stormwater facilities, in accordance with:

A. Special Condition S3, Compliance with Standards.

B. WAC 173-216-110.

C. Other applicable regulations.

S8. DISCHARGES TO 303(D) OR TMDL WATER BODIES

A. Sampling and Numeric Effluent Limits For Certain Discharges to 303(d)-listed Water Bodies

1. Permittees who discharge to segments of water bodies listed as impaired by the State of Washington under Section 303(d) of the Clean Water Act for turbidity, fine sediment, high pH, or phosphorus, must conduct water quality sampling according to the requirements of this section, and Special Conditions S4.C.2.b-f and S4.C.3.b-d, and must comply with the applicable numeric effluent limitations in S8.C and S8.D.

2. All references and requirements associated with Section 303(d) of the Clean Water Act mean the most current listing by Ecology of impaired waters (Category 5) that exists on January 1, 2011, or the date when the operator's complete permit application is received by Ecology, whichever is later.

B. Limits on Coverage for New Discharges to TMDL or 303(d)-listed Waters

Operators of construction sites that discharge to a 303(d)-listed water body are not eligible for coverage under this permit *unless* the operator:

1. Prevents exposing stormwater to pollutants for which the water body is impaired, and retains documentation in the SWPPP that details procedures taken to prevent exposure on site; or

2. Documents that the pollutants for which the water body is impaired are not present at the site, and retains documentation of this finding within the SWPPP; or

EX-0001-004304-PCE

3. Provides Ecology with data indicating the discharge is not expected to cause or contribute to an exceedance of a water quality standard, and retains such data on site with the SWPPP. The operator must provide data and other technical information to Ecology that sufficiently demonstrate:

   a. For discharges to waters without an EPA-approved or -established TMDL, that the discharge of the pollutant for which the water is impaired will meet in-stream water quality criteria at the point of discharge to the water body; or

   b. For discharges to waters with an EPA-approved or -established TMDL, that there is sufficient remaining wasteload allocation in the TMDL to allow construction stormwater discharge and that existing dischargers to the water body are subject to compliance schedules designed to bring the water body into attainment with water quality standards.

   Operators of construction sites are eligible for coverage under this permit if Ecology issues permit coverage based upon an affirmative determination that the discharge will not cause or contribute to the existing impairment.

C. Sampling and Numeric Effluent Limits for Discharges to Water Bodies on the 303(d) List for Turbidity, Fine Sediment, or Phosphorus

1. Permittees who discharge to segments of water bodies on the 303(d) list (Category 5) for turbidity, fine sediment, or phosphorus must conduct turbidity sampling in accordance with Special Condition S4.C.2 and comply with either of the numeric effluent limits noted in Table 5 below.

2. As an alternative to the 25 NTU effluent limit noted in Table 5 below (applied at the point where stormwater [or authorized non-stormwater] is discharged off-site), permittees may choose to comply with the surface water quality standard for turbidity. The standard is: no more than 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or no more than a 10% increase in turbidity when the background turbidity is more than 50 NTU. In order to use the water quality standard requirement, the sampling must take place at the following locations:

   a. Background turbidity in the 303(d)-listed receiving water immediately upstream (upgradient) or outside the area of influence of the discharge.

   b. Turbidity at the point of discharge into the 303(d)-listed receiving water, inside the area of influence of the discharge.

3. Discharges that exceed the numeric effluent limit for turbidity constitute a violation of this permit.

4. Permittees whose discharges exceed the numeric effluent limit shall sample discharges daily until the violation is corrected and comply with the non-compliance notification requirements in Special Condition S5.F.

EX-0001-004305-PCE

Table 5. Turbidity, Fine Sediment & Phosphorus Sampling and Limits for 303(d)-Listed Waters

Parameter identified in 303(d) listing	Parameter Sampled	Unit	Analytical Method	Sampling Frequency	Numeric Effluent Limit[1]
• Turbidity • Fine Sediment • Phosphorus	Turbidity	NTU	SM2130 or EPA180.1	Weekly, if discharging	25 NTU, at the point where stormwater is discharged from the site; OR In compliance with the surface water quality standard for turbidity (S8.C.1.a)

[1]Permittees subject to a numeric effluent limit for turbidity may, at their discretion, choose either numeric effluent limitation based on site-specific considerations including, but not limited to, safety, access and convenience.

D. Discharges to Water Bodies on the 303(d) List for High pH

1. Permittees who discharge to segments of water bodies on the 303(d) list (Category 5) for high pH must conduct pH sampling in accordance with the table below, and comply with the numeric effluent limit of pH 6.5 to 8.5 su (Table 6).

Table 6. pH Sampling and Limits for 303(d)-Listed Waters

Parameter identified in 303(d) listing	Parameter Sampled/Units	Analytical Method	Sampling Frequency	Numeric Effluent Limit
High pH	pH /Standard Units	pH meter	Weekly, if discharging	In the range of 6.5 – 8.5

2. At the Permittee's discretion, compliance with the limit shall be assessed at one of the following locations:

   a. Directly in the 303(d)-listed water body segment, inside the immediate area of influence of the discharge; or

   b. Alternatively, the permittee may measure pH at the point where the discharge leaves the construction site, rather than in the receiving water.

3. Discharges that exceed the numeric effluent limit for pH (outside the range of 6.5 – 8.5 su) constitute a violation of this permit.

4. Permittees whose discharges exceed the numeric effluent limit shall sample discharges daily until the violation is corrected and comply with the non-compliance notification requirements in Special Condition S5.F.

EX-0001-004306-PCE

E. Sampling and Limits for Sites Discharging to Waters Covered by a TMDL or Another Pollution Control Plan

1. Discharges to a water body that is subject to a Total Maximum Daily Load (TMDL) for turbidity, fine sediment, high pH, or phosphorus must be consistent with the TMDL. Refer to http://www.ecy.wa.gov/programs/wq/tmdl/index.html for more information on TMDLs.

   a. Where an applicable TMDL sets specific waste load allocations or requirements for discharges covered by this permit, discharges must be consistent with any specific waste load allocations or requirements established by the applicable TMDL.

      i. The Permittee must sample discharges weekly or as otherwise specified by the TMDL to evaluate compliance with the specific waste load allocations or requirements.

      ii. Analytical methods used to meet the monitoring requirements must conform to the latest revision of the Guidelines Establishing Test Procedures for the Analysis of Pollutants contained in 40 CFR Part 136. Turbidity and pH methods need not be accredited or registered unless conducted at a laboratory which must otherwise be accredited or registered.

   b. Where an applicable TMDL has established a general waste load allocation for construction stormwater discharges, but has not identified specific requirements, compliance with Special Conditions S4 (Monitoring) and S9 (SWPPPs) will constitute compliance with the approved TMDL.

   c. Where an applicable TMDL has not specified a waste load allocation for construction stormwater discharges, but has not excluded these discharges, compliance with Special Conditions S4 (Monitoring) and S9 (SWPPPs) will constitute compliance with the approved TMDL.

   d. Where an applicable TMDL specifically precludes or prohibits discharges from construction activity, the operator is not eligible for coverage under this permit.

2. Applicable TMDL means a TMDL for turbidity, fine sediment, high pH, or phosphorus that is completed and approved by EPA before January 1, 2011, or before the date the operator's complete permit application is received by Ecology, whichever is later. TMDLs completed after the operator's complete permit application is received by Ecology become applicable to the Permittee only if they are imposed through an administrative order by Ecology, or through a modification of permit coverage.

EX-0001-004307-PCE

S9. STORMWATER POLLUTION PREVENTION PLAN

The Permittee must prepare and properly implement an adequate Stormwater Pollution Prevention Plan (SWPPP) for construction activity in accordance with the requirements of this permit beginning with initial soil disturbance and until final stabilization.

A. The Permittee's SWPPP must meet the following objectives:

1. To implement best management practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity.

2. To prevent violations of surface water quality, ground water quality, or sediment management standards.

3. To control peak volumetric flow rates and velocities of stormwater discharges.

B. General Requirements

1. The SWPPP must include a narrative and drawings. All BMPs must be clearly referenced in the narrative and marked on the drawings. The SWPPP narrative must include documentation to explain and justify the pollution prevention decisions made for the project. Documentation must include:

   a. Information about existing site conditions (topography, drainage, soils, vegetation, etc.).

   b. Potential erosion problem areas.

   c. The 12 elements of a SWPPP in Special Condition S9.D.1-12, including BMPs used to address each element.

   d. Construction phasing/sequence and general BMP implementation schedule.

   e. The actions to be taken if BMP performance goals are not achieved—for example, a contingency plan for additional treatment and/or storage of stormwater that would violate the water quality standards if discharged.

   f. Engineering calculations for ponds and any other designed structures.

2. The Permittee must modify the SWPPP 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, or would be, ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The Permittee must then:

   a. Review the SWPPP for compliance with Special Condition S9 and make appropriate revisions within 7 days of the inspection or investigation.

   b. Immediately begin the process to fully implement and maintain appropriate source control and/or treatment BMPs as soon as possible, addressing the problems no later than 10 days from the inspection or investigation. If

EX-0001-004308-PCE

installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when an extension is requested by a Permittee within the initial 10-day response period,

c. Document BMP implementation and maintenance in the site log book.

The Permittee must modify the SWPPP whenever there is a change in design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the State.

C. Stormwater Best Management Practices (BMPs)

BMPs must be consistent with:

1. Stormwater Management Manual for Western Washington (most recent edition), for sites west of the crest of the Cascade Mountains; or

2. Stormwater Management Manual for Eastern Washington (most recent edition), for sites east of the crest of the Cascade Mountains; or

3. Revisions to the manuals listed in Special Condition S9.C.1. & 2., or other stormwater management guidance documents or manuals which provide an equivalent level of pollution prevention, that are approved by Ecology and incorporated into this permit in accordance with the permit modification requirements of WAC 173-226-230; or

4. Documentation in the SWPPP that the BMPs selected provide an equivalent level of pollution prevention, compared to the applicable Stormwater Management Manuals, including:

   a. The technical basis for the selection of all stormwater BMPs (scientific, technical studies, and/or modeling) that support the performance claims for the BMPs being selected.

   b. An assessment of how the selected BMP will satisfy AKART requirements and the applicable federal technology-based treatment requirements under 40 CFR part 125.3.

D. SWPPP – Narrative Contents and Requirements

The Permittee must include each of the 12 elements below in Special Condition S9.D.1-12 in the narrative of the SWPPP and implement them unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the SWPPP.

1. Preserve Vegetation/Mark Clearing Limits

   a. Before beginning land-disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area.

EX-0001-004309-PCE

b. Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practicable.

2. Establish Construction Access

a. Limit construction vehicle access and exit to one route, if possible.

b. Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking sediment onto roads.

c. Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.

d. If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or pickup and transport of the sediment to a controlled sediment disposal area.

e. Conduct street washing only after sediment removal in accordance with Special Condition S9.D.2.d. Control street wash wastewater by pumping back on site or otherwise preventing it from discharging into systems tributary to waters of the State.

3. Control Flow Rates

a. Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site, as required by local plan approval authority.

b. Where necessary to comply with Special Condition S9.D.3.a, construct stormwater retention or detention facilities as one of the first steps in grading. Assure that detention facilities function properly before constructing site improvements (for example, impervious surfaces).

c. If permanent infiltration ponds are used for flow control during construction, protect these facilities from siltation during the construction phase.

4. Install Sediment Controls

The Permittee must design, install and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants. At a minimum, the Permittee must design, install and maintain such controls to:

a. Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs must be functional before other land disturbing activities take place.

b. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of

EX-0001-004310-PCE

resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.

c. Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Special Condition S9.D.3.a.

d. Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

e. Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible.

f. Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

5. Stabilize Soils

a. The Permittee must stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base on areas to be paved, and dust control.

b. The Permittee must control stormwater volume and velocity within the site to minimize soil erosion.

c. The Permittee must control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.

d. Depending on the geographic location of the project, the Permittee must not allow soils to remain exposed and unworked for more than the time periods set forth below to prevent erosion:

West of the Cascade Mountains Crest
During the dry season (May 1 - Sept. 30): 7 days
During the wet season (October 1 - April 30): 2 days

East of the Cascade Mountains Crest, except for Central Basin*
During the dry season (July 1 - September 30): 10 days
During the wet season (October 1 - June 30): 5 days

The Central Basin*, East of the Cascade Mountains Crest

EX-0001-004311-PCE

During the dry Season (July 1 - September 30): 30 days
During the wet season (October 1 - June 30): 15 days

*Note: The Central Basin is defined as the portions of Eastern Washington with mean annual precipitation of less than 12 inches.

e. The Permittee must stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.

f. The Permittee must stabilize soil stockpiles from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

g. The Permittee must minimize the amount of soil exposed during construction activity.

h. The Permittee must minimize the disturbance of steep slopes.

i. The Permittee must minimize soil compaction and, unless infeasible, preserve topsoil.

6. Protect Slopes

a. The Permittee must design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).

b. The Permittee must divert off-site stormwater (run-on) or ground water away from slopes and disturbed areas with interceptor dikes, pipes, and/or swales. Off-site stormwater should be managed separately from stormwater generated on the site.

c. At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion.

i. West of the Cascade Mountains Crest: Temporary pipe slope drains must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped area."

EX-0001-004312-PCE

ii. East of the Cascade Mountains Crest: Temporary pipe slope drains must handle the expected peak flow velocity from a 6-month, 3-hour storm for the developed condition, referred to as the short duration storm.

d. Place excavated material on the uphill side of trenches, consistent with safety and space considerations.

e. Place check dams at regular intervals within constructed channels that are cut down a slope.

7. Protect Drain Inlets

a. Protect all storm drain inlets made operable during construction so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.

b. Clean or remove and replace inlet protection devices when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

8. Stabilize Channels and Outlets

a. Design, construct and stabilize all on-site conveyance channels to prevent erosion from the following expected peak flows:

i. West of the Cascade Mountains Crest: Channels must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the WWHM to predict flows, bare soil areas should be modeled as "landscaped area."

ii. East of the Cascade Mountains Crest: Channels must handle the expected peak flow velocity from a 6-month, 3-hour storm for the developed condition, referred to as the short duration storm.

b. Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes, and downstream reaches at the outlets of all conveyance systems.

9. Control Pollutants

Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants. The Permittee must:

EX-0001-004313-PCE

a. Handle and dispose of all pollutants, including waste materials and demolition debris that occur on site in a manner that does not cause contamination of stormwater.

b. Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.

c. Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.

d. Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer with local sewer district approval.

e. Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures.

f. Use BMPs to prevent contamination of stormwater runoff by pH-modifying sources. The sources for this contamination include, but are not limited to: bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters. (Also refer to the definition for "concrete wastewater" in Appendix A--Definitions.)

g. Adjust the pH of stormwater if necessary to prevent violations of water quality standards.

h. Assure that washout of concrete trucks is performed offsite or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the State is prohibited.

i. Obtain written approval from Ecology before using chemical treatment other than CO_2 or dry ice to adjust pH.

10. Control Dewatering

a. Permittees must discharge foundation, vault, and trench dewatering water, which have characteristics similar to stormwater runoff at the site, into a

EX-0001-004314-PCE

controlled conveyance system before discharge to a sediment trap or sediment pond.

b. Permittees may discharge clean, non-turbid dewatering water, such as well-point ground water, to systems tributary to, or directly into surface waters of the State, as specified in Special Condition S9.D.8, provided the dewatering flow does not cause erosion or flooding of receiving waters. Do not route clean dewatering water through stormwater sediment ponds. Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.

c. Other treatment or disposal options may include:

   i. Infiltration.

   ii. Transport off site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.

   iii. Ecology-approved on-site chemical treatment or other suitable treatment technologies.

   iv. Sanitary or combined sewer discharge with local sewer district approval, if there is no other option.

   v. Use of a sedimentation bag with discharge to a ditch or swale for small volumes of localized dewatering.

d. Permittees must handle highly turbid or contaminated dewatering water separately from stormwater.

11. Maintain BMPs

    a. Permittees must maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.

    b. Permittees must remove all temporary erosion and sediment control BMPs within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed.

12. Manage the Project

    a. Phase development projects to the maximum degree practicable and take into account seasonal work limitations.

    b. Inspection and monitoring -- Inspect, maintain and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with Special Condition S4.

    c. Maintaining an updated construction SWPPP -- Maintain, update, and implement the SWPPP in accordance with Special Conditions S3, S4 and S9.

EX-0001-004315-PCE

E. SWPPP – Map Contents and Requirements

The Permittee's SWPPP must also include a vicinity map or general location map (for example, a USGS quadrangle map, a portion of a county or city map, or other appropriate map) with enough detail to identify the location of the construction site and receiving waters within one mile of the site.

The SWPPP must also include a legible site map (or maps) showing the entire construction site. The following features must be identified, unless not applicable due to site conditions:

1. The direction of north, property lines, and existing structures and roads.
2. Cut and fill slopes indicating the top and bottom of slope catch lines.
3. Approximate slopes, contours, and direction of stormwater flow before and after major grading activities.
4. Areas of soil disturbance and areas that will not be disturbed.
5. Locations of structural and nonstructural controls (BMPs) identified in the SWPPP.
6. Locations of off-site material, stockpiles, waste storage, borrow areas, and vehicle/equipment storage areas.
7. Locations of all surface water bodies, including wetlands.
8. Locations where stormwater or non-stormwater discharges off-site and/or to a surface water body, including wetlands.
9. Location of water quality sampling station(s), if sampling is required by state or local permitting authority.
10. Areas where final stabilization has been accomplished and no further construction-phase permit requirements apply.

S10. NOTICE OF TERMINATION

A. The site is eligible for termination of coverage when it has met any of the following conditions:

1. The site has undergone final stabilization, the Permittee has removed all temporary BMPs (except biodegradable BMPs clearly manufactured with the intention for the material to be left in place and not interfere with maintenance or land use), and all stormwater discharges associated with construction activity have been eliminated; or
2. All portions of the site that have not undergone final stabilization per Special Condition S10.A.1 have been sold and/or transferred (per General Condition G9), and the Permittee no longer has operational control of the construction activity; or

EX-0001-004316-PCE

3. For residential construction only, the Permittee has completed temporary stabilization and the homeowners have taken possession of the residences.

B. When the site is eligible for termination, the Permittee must submit a complete and accurate Notice of Termination (NOT) form, signed in accordance with General Condition G2, to:

Department of Ecology
Water Quality Program - Construction Stormwater
PO Box 47696
Olympia, Washington 98504-7696

The termination is effective on the date Ecology receives the NOT form, unless Ecology notifies the Permittee within 30 days that termination request is denied because the Permittee has not met the eligibility requirements in Special Condition S10.A.

Permittees transferring the property to a new property owner or operator/permittee are required to complete and submit the Notice of Transfer form to Ecology, but are not required to submit a Notice of Termination form for this type of transaction.

EX-0001-004317-PCE

GENERAL CONDITIONS

G1. DISCHARGE VIOLATIONS

All discharges and activities authorized by this general permit must be consistent with the terms and conditions of this general permit. Any discharge of any pollutant more frequent than or at a level in excess of that identified and authorized by the general permit must constitute a violation of the terms and conditions of this permit.

G2. SIGNATORY REQUIREMENTS

A. All permit applications must bear a certification of correctness to be signed:

1. In the case of corporations, by a responsible corporate officer of at least the level of vice president of a corporation;
2. In the case of a partnership, by a general partner of a partnership;
3. In the case of sole proprietorship, by the proprietor; or
4. In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official.

B. All reports required by this permit and other information requested by Ecology must be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

1. The authorization is made in writing by a person described above and submitted to the Ecology.
2. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters.

C. Changes to authorization. If an authorization under paragraph G2.B.2 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph G2.B.2 above must be submitted to Ecology prior to or together with any reports, information, or applications to be signed by an authorized representative.

D. Certification. Any person signing a document under this section must make the following certification:

"I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering

EX-0001-004318-PCE

information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

G3. RIGHT OF INSPECTION AND ENTRY

The Permittee must allow an authorized representative of Ecology, upon the presentation of credentials and such other documents as may be required by law:

A. To enter upon the premises where a discharge is located or where any records are kept under the terms and conditions of this permit.

B. To have access to and copy – at reasonable times and at reasonable cost -- any records required to be kept under the terms and conditions of this permit.

C. To inspect -- at reasonable times – any facilities, equipment (including monitoring and control equipment), practices, methods, or operations regulated or required under this permit.

D. To sample or monitor – at reasonable times – any substances or parameters at any location for purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act.

G4. GENERAL PERMIT MODIFICATION AND REVOCATION

This permit may be modified, revoked and reissued, or terminated in accordance with the provisions of Chapter 173-226 WAC. Grounds for modification, revocation and reissuance, or termination include, but are not limited to, the following:

A. When a change occurs in the technology or practices for control or abatement of pollutants applicable to the category of dischargers covered under this permit.

B. When effluent limitation guidelines or standards are promulgated pursuant to the CWA or Chapter 90.48 RCW, for the category of dischargers covered under this permit.

C. When a water quality management plan containing requirements applicable to the category of dischargers covered under this permit is approved, or

D. When information is obtained that indicates cumulative effects on the environment from dischargers covered under this permit are unacceptable.

G5. REVOCATION OF COVERAGE UNDER THE PERMIT

Pursuant to Chapter 43.21B RCW and Chapter 173-226 WAC, the Director may terminate coverage for any discharger under this permit for cause. Cases where coverage may be terminated include, but are not limited to, the following:

EX-0001-004319-PCE

A. Violation of any term or condition of this permit.

B. Obtaining coverage under this permit by misrepresentation or failure to disclose fully all relevant facts.

C. A change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge.

D. Failure or refusal of the Permittee to allow entry as required in RCW 90.48.090.

E. A determination that the permitted activity endangers human health or the environment, or contributes to water quality standards violations.

F. Nonpayment of permit fees or penalties assessed pursuant to RCW 90.48.465 and Chapter 173-224 WAC.

G. Failure of the Permittee to satisfy the public notice requirements of WAC 173-226-130(5), when applicable.

The Director may require any discharger under this permit to apply for and obtain coverage under an individual permit or another more specific general permit. Permittees who have their coverage revoked for cause according to WAC 173-226-240 may request temporary coverage under this permit during the time an individual permit is being developed, provided the request is made within ninety (90) days from the time of revocation and is submitted along with a complete individual permit application form.

G6. REPORTING A CAUSE FOR MODIFICATION

The Permittee must submit a new application, or a supplement to the previous application, whenever a material change to the construction activity or in the quantity or type of discharge is anticipated which is not specifically authorized by this permit. This application must be submitted at least sixty (60) days prior to any proposed changes. Filing a request for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not relieve the Permittee of the duty to comply with the existing permit until it is modified or reissued.

G7. COMPLIANCE WITH OTHER LAWS AND STATUTES

Nothing in this permit will be construed as excusing the Permittee from compliance with any applicable federal, state, or local statutes, ordinances, or regulations.

G8. DUTY TO REAPPLY

The Permittee must apply for permit renewal at least 180 days prior to the specified expiration date of this permit.

EX-0001-004320-PCE

G9. TRANSFER OF GENERAL PERMIT COVERAGE

Coverage under this general permit is automatically transferred to a new discharger, including operators of lots/parcels within a common plan of development or sale, **if**:

A. A written agreement (Transfer of Coverage Form) between the current discharger (Permittee) and new discharger, signed by both parties and containing a specific date for transfer of permit responsibility, coverage, and liability is submitted to the Director; and

B. The Director does not notify the current discharger and new discharger of the Director's intent to revoke coverage under the general permit. If this notice is not given, the transfer is effective on the date specified in the written agreement.

When a current discharger (Permittee) transfers a portion of a permitted site, the current discharger must also submit an updated application form (NOI) to the Director indicating the remaining permitted acreage after the transfer.

G10. REMOVED SUBSTANCES

The Permittee must not re-suspend or reintroduce collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of stormwater to the final effluent stream for discharge to state waters.

G11. DUTY TO PROVIDE INFORMATION

The Permittee must submit to Ecology, within a reasonable time, all information that Ecology may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The Permittee must also submit to Ecology, upon request, copies of records required to be kept by this permit [40 CFR 122.41(h)].

G12. OTHER REQUIREMENTS OF 40 CFR

All other requirements of 40 CFR 122.41 and 122.42 are incorporated in this permit by reference.

G13. ADDITIONAL MONITORING

Ecology may establish specific monitoring requirements in addition to those contained in this permit by administrative order or permit modification.

EX-0001-004321-PCE

G14. PENALTIES FOR VIOLATING PERMIT CONDITIONS

Any person who is found guilty of willfully violating the terms and conditions of this permit shall be deemed guilty of a crime, and upon conviction thereof shall be punished by a fine of up to ten thousand dollars ($10,000) and costs of prosecution, or by imprisonment in the discretion of the court. Each day upon which a willful violation occurs may be deemed a separate and additional violation.

Any person who violates the terms and conditions of a waste discharge permit shall incur, in addition to any other penalty as provided by law, a civil penalty in the amount of up to ten thousand dollars ($10,000) for every such violation. Each and every such violation shall be a separate and distinct offense, and in case of a continuing violation, every day's continuance shall be deemed to be a separate and distinct violation.

G15. UPSET

Definition – "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of the following paragraph are met.

A Permittee who wishes to establish the affirmative defense of upset must demonstrate, through properly signed, contemporaneous operating logs or other relevant evidence that: 1) an upset occurred and that the Permittee can identify the cause(s) of the upset; 2) the permitted facility was being properly operated at the time of the upset; 3) the Permittee submitted notice of the upset as required in Special Condition S5.F, and; 4) the Permittee complied with any remedial measures required under this permit.

In any enforcement proceeding, the Permittee seeking to establish the occurrence of an upset has the burden of proof.

G16. PROPERTY RIGHTS

This permit does not convey any property rights of any sort, or any exclusive privilege.

G17. DUTY TO COMPLY

The Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application.

EX-0001-004322-PCE

G18. TOXIC POLLUTANTS

The Permittee must comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if this permit has not yet been modified to incorporate the requirement.

G19. PENALTIES FOR TAMPERING

The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. If a conviction of a person is for a violation committed after a first conviction of such person under this condition, punishment shall be a fine of not more than $20,000 per day of violation, or imprisonment of not more than four (4) years, or both.

G20. REPORTING PLANNED CHANGES

The Permittee must, as soon as possible, give notice to Ecology of planned physical alterations, modifications or additions to the permitted construction activity. The Permittee should be aware that, depending on the nature and size of the changes to the original permit, a new public notice and other permit process requirements may be required. Changes in activities that require reporting to Ecology include those that will result in:

A. The permitted facility being determined to be a new source pursuant to 40 CFR 122.29(b).

B. A significant change in the nature or an increase in quantity of pollutants discharged, including but not limited to: for sites 5 acres or larger, a 20% or greater increase in acreage disturbed by construction activity.

C. A change in or addition of surface water(s) receiving stormwater or non-stormwater from the construction activity.

D. A change in the construction plans and/or activity that affects the Permittee's monitoring requirements in Special Condition S4.

Following such notice, permit coverage may be modified, or revoked and reissued pursuant to 40 CFR 122.62(a) to specify and limit any pollutants not previously limited. Until such modification is effective, any new or increased discharge in excess of permit limits or not specifically authorized by this permit constitutes a violation.

EX-0001-004323-PCE

G21. REPORTING OTHER INFORMATION

Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to Ecology, it must promptly submit such facts or information.

G22. REPORTING ANTICIPATED NON-COMPLIANCE

The Permittee must give advance notice to Ecology by submission of a new application or supplement thereto at least forty-five (45) days prior to commencement of such discharges, of any facility expansions, production increases, or other planned changes, such as process modifications, in the permitted facility or activity which may result in noncompliance with permit limits or conditions. Any maintenance of facilities, which might necessitate unavoidable interruption of operation and degradation of effluent quality, must be scheduled during non-critical water quality periods and carried out in a manner approved by Ecology.

G23. REQUESTS TO BE EXCLUDED FROM COVERAGE UNDER THE PERMIT

Any discharger authorized by this permit may request to be excluded from coverage under the general permit by applying for an individual permit. The discharger must submit to the Director an application as described in WAC 173-220-040 or WAC 173-216-070, whichever is applicable, with reasons supporting the request. These reasons will fully document how an individual permit will apply to the applicant in a way that the general permit cannot. Ecology may make specific requests for information to support the request. The Director will either issue an individual permit or deny the request with a statement explaining the reason for the denial. When an individual permit is issued to a discharger otherwise subject to the construction stormwater general permit, the applicability of the construction stormwater general permit to that Permittee is automatically terminated on the effective date of the individual permit.

G24. APPEALS

A. The terms and conditions of this general permit, as they apply to the appropriate class of dischargers, are subject to appeal by any person within 30 days of issuance of this general permit, in accordance with Chapter 43.21B RCW, and Chapter 173-226 WAC.

B. The terms and conditions of this general permit, as they apply to an individual discharger, are appealable in accordance with Chapter 43.21B RCW within 30 days of the effective date of coverage of that discharger. Consideration of an appeal of general permit coverage of an individual discharger is limited to the general permit's applicability or nonapplicability to that individual discharger.

C. The appeal of general permit coverage of an individual discharger does not affect any other dischargers covered under this general permit. If the terms and conditions of this general permit are found to be inapplicable to any individual discharger(s), the matter

EX-0001-004324-PCE

shall be remanded to Ecology for consideration of issuance of an individual permit or permits.

G25. SEVERABILITY

The provisions of this permit are severable, and if any provision of this permit, or application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

G26. BYPASS PROHIBITED

A. Bypass Procedures

Bypass, which is the intentional diversion of waste streams from any portion of a treatment facility, is prohibited for stormwater events below the design criteria for stormwater management. Ecology may take enforcement action against a Permittee for bypass unless one of the following circumstances (1, 2, 3 or 4) is applicable.

1. Bypass of stormwater is consistent with the design criteria and part of an approved management practice in the applicable stormwater management manual.

2. Bypass for essential maintenance without the potential to cause violation of permit limits or conditions.

   Bypass is authorized if it is for essential maintenance and does not have the potential to cause violations of limitations or other conditions of this permit, or adversely impact public health.

3. Bypass of stormwater is unavoidable, unanticipated, and results in noncompliance of this permit.

   This bypass is permitted only if:

   a. Bypass is unavoidable to prevent loss of life, personal injury, or severe property damage. “Severe property damage” means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass.

   b. There are no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, maintenance during normal periods of equipment downtime (but not if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance), or transport of untreated wastes to another treatment facility.

EX-0001-004325-PCE

c. Ecology is properly notified of the bypass as required in Special Condition S5.F of this permit.

4. A planned action that would cause bypass of stormwater and has the potential to result in noncompliance of this permit during a storm event.

   The Permittee must notify Ecology at least thirty (30) days before the planned date of bypass. The notice must contain:

   a. a description of the bypass and its cause

   b. an analysis of all known alternatives which would eliminate, reduce, or mitigate the need for bypassing.

   c. a cost-effectiveness analysis of alternatives including comparative resource damage assessment.

   d. the minimum and maximum duration of bypass under each alternative.

   e. a recommendation as to the preferred alternative for conducting the bypass.

   f. the projected date of bypass initiation.

   g. a statement of compliance with SEPA.

   h. a request for modification of water quality standards as provided for in WAC 173-201A-110, if an exceedance of any water quality standard is anticipated.

   i. steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass.

5. For probable construction bypasses, the need to bypass is to be identified as early in the planning process as possible. The analysis required above must be considered during preparation of the Stormwater Pollution Prevention Plan (SWPPP) and must be included to the extent practical. In cases where the probable need to bypass is determined early, continued analysis is necessary up to and including the construction period in an effort to minimize or eliminate the bypass.

   Ecology will consider the following before issuing an administrative order for this type bypass:

   a. If the bypass is necessary to perform construction or maintenance-related activities essential to meet the requirements of this permit.

   b. If there are feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, stopping production, maintenance during normal periods of equipment down time, or transport of untreated wastes to another treatment facility.

   c. If the bypass is planned and scheduled to minimize adverse effects on the public and the environment.

EX-0001-004326-PCE

After consideration of the above and the adverse effects of the proposed bypass and any other relevant factors, Ecology will approve, conditionally approve, or deny the request. The public must be notified and given an opportunity to comment on bypass incidents of significant duration, to the extent feasible. Approval of a request to bypass will be by administrative order issued by Ecology under RCW 90.48.120.

B. Duty to Mitigate

The Permittee is required to take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

EX-0001-004327-PCE

APPENDIX A – DEFINITIONS

AKART is an acronym for "all known, available, and reasonable methods of prevention, control, and treatment." AKART represents the most current methodology that can be reasonably required for preventing, controlling, or abating the pollutants and controlling pollution associated with a discharge.

Applicable TMDL means a TMDL for turbidity, fine sediment, high pH, or phosphorus, which was completed and approved by EPA before January 1, 2011, or before the date the operator's complete permit application is received by Ecology, whichever is later.

Applicant means an operator seeking coverage under this permit.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other physical, structural and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices to control: stormwater associated with construction activity, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Buffer means an area designated by a local jurisdiction that is contiguous to and intended to protect a sensitive area.

Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

Calendar Day A period of 24 consecutive hours starting at 12:00 midnight and ending the following 12:00 midnight.

Calendar Week (same as Week) means a period of seven consecutive days starting at 12:01 a.m. (0:01 hours) on Sunday.

Certified Erosion and Sediment Control Lead (CESCL) means a person who has current certification through an approved erosion and sediment control training program that meets the minimum training standards established by Ecology (see BMP C160 in the SWMM).

Clean Water Act (CWA) means the Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483, and 97-117; USC 1251 et seq.

Combined Sewer means a sewer which has been designed to serve as a sanitary sewer and a storm sewer, and into which inflow is allowed by local ordinance.

Common Plan of Development or Sale means a site where multiple separate and distinct construction activities may be taking place at different times on different schedules and/or by different contractors, but still under a single plan. Examples include: 1) phased projects and projects with multiple filings or lots, even if the separate phases or filings/lots will be constructed under separate contract or by separate owners (e.g., a development where lots are sold to separate builders); 2) a development plan that may be phased over multiple years, but is still under a

EX-0001-004328-PCE

consistent plan for long-term development; 3) projects in a contiguous area that may be unrelated but still under the same contract, such as construction of a building extension and a new parking lot at the same facility; and 4) linear projects such as roads, pipelines, or utilities. If the project is part of a common plan of development or sale, the disturbed area of the entire plan must be used in determining permit requirements.

Composite Sample means a mixture of grab samples collected at the same sampling point at different times, formed either by continuous sampling or by mixing discrete samples. May be "time-composite" (collected at constant time intervals) or "flow-proportional" (collected either as a constant sample volume at time intervals proportional to stream flow, or collected by increasing the volume of each aliquot as the flow increases while maintaining a constant time interval between the aliquots.

Concrete wastewater means any water used in the production, pouring and/or clean-up of concrete or concrete products, and any water used to cut, grind, wash, or otherwise modify concrete or concrete products. Examples include water used for or resulting from concrete truck/mixer/pumper/tool/chute rinsing or washing, concrete saw cutting and surfacing (sawing, coring, grinding, roughening, hydro-demolition, bridge and road surfacing). When stormwater comingles with concrete wastewater, the resulting water is considered concrete wastewater and must be managed to prevent discharge to waters of the state, including ground water.

Construction Activity means land disturbing operations including clearing, grading or excavation which disturbs the surface of the land. Such activities may include road construction, construction of residential houses, office buildings, or industrial buildings, and demolition activity.

Contaminant means any hazardous substance that does not occur naturally or occurs at greater than natural background levels. See definition of “hazardous substance” and WAC 173-340-200.

Demonstrably Equivalent means that the technical basis for the selection of all stormwater BMPs is documented within a SWPPP, including:

1. The method and reasons for choosing the stormwater BMPs selected.
2. The pollutant removal performance expected from the BMPs selected.
3. The technical basis supporting the performance claims for the BMPs selected, including any available data concerning field performance of the BMPs selected.
4. An assessment of how the selected BMPs will comply with state water quality standards.
5. An assessment of how the selected BMPs will satisfy both applicable federal technology-based treatment requirements and state requirements to use all known, available, and reasonable methods of prevention, control, and treatment (AKART).

Department means the Washington State Department of Ecology.

Detention means the temporary storage of stormwater to improve quality and/or to reduce the mass flow rate of discharge.

EX-0001-004329-PCE

Dewatering means the act of pumping ground water or stormwater away from an active construction site.

Director means the Director of the Washington Department of Ecology or his/her authorized representative.

Discharger means an owner or operator of any facility or activity subject to regulation under Chapter 90.48 RCW or the Federal Clean Water Act.

Domestic Wastewater means water carrying human wastes, including kitchen, bath, and laundry wastes from residences, buildings, industrial establishments, or other places, together with such ground water infiltration or surface waters as may be present.

Ecology means the Washington State Department of Ecology.

Engineered Soils means the use of soil amendments including, but not limited, to Portland cement treated base (CTB), cement kiln dust (CKD), or fly ash to achieve certain desirable soil characteristics.

Equivalent BMPs means operational, source control, treatment, or innovative BMPs which result in equal or better quality of stormwater discharge to surface water or to ground water than BMPs selected from the SWMM.

Erosion means the wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

Erosion and Sediment Control BMPs means BMPs intended to prevent erosion and sedimentation, such as preserving natural vegetation, seeding, mulching and matting, plastic covering, filter fences, sediment traps, and ponds. Erosion and sediment control BMPs are synonymous with stabilization and structural BMPs.

Final Stabilization (same as fully stabilized or full stabilization) means the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as riprap, gabions or geotextiles) which prevents erosion.

Ground Water means water in a saturated zone or stratum beneath the land surface or a surface water body.

Hazardous Substance means any dangerous or extremely hazardous waste as defined in RCW 70.105.010 (5) and (6), or any dangerous or extremely dangerous waste as designated by rule under chapter 70.105 RCW; any hazardous sub-stance as defined in RCW 70.105.010(14) or any hazardous substance as defined by rule under chapter 70.105 RCW; any substance that, on the effective date of this section, is a hazardous substance under section 101(14) of the federal cleanup law, 42 U.S.C., Sec. 9601(14); petroleum or petroleum products; and any substance or category of substances, including solid waste decomposition products, determined by the director

EX-0001-004330-PCE

by rule to present a threat to human health or the environment if released into the environment. The term hazardous substance does not include any of the following when contained in an underground storage tank from which there is not a release: crude oil or any fraction thereof or petroleum, if the tank is in compliance with all applicable federal, state, and local law.

Injection Well means a well that is used for the subsurface emplacement of fluids. (See Well.)

Jurisdiction means a political unit such as a city, town or county; incorporated for local self-government.

National Pollutant Discharge Elimination System (NPDES) means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the State from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington Department of Ecology.

Notice of Intent (NOI) means the application for, or a request for coverage under this general permit pursuant to WAC 173-226-200.

Notice of Termination (NOT) means a request for termination of coverage under this general permit as specified by Special Condition S10 of this permit.

Operator means any party associated with a construction project that meets either of the following two criteria:

- The party has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications; or
- The party has day-to-day operational control of those activities at a project that are necessary to ensure compliance with a SWPPP for the site or other permit conditions (e.g., they are authorized to direct workers at a site to carry out activities required by the SWPPP or comply with other permit conditions).

Permittee means individual or entity that receives notice of coverage under this general permit.

pH means a liquid's measure of acidity or alkalinity. A pH of 7 is defined as neutral. Large variations above or below this value are considered harmful to most aquatic life.

pH monitoring period means the time period in which the pH of stormwater runoff from a site must be tested a minimum of once every seven days to determine if stormwater pH is between 6.5 and 8.5.

Point source means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, and container from which pollutants are or may be discharged to surface waters of the State. This term does not include return flows from irrigated agriculture. (See Fact Sheet for further explanation.)

EX-0001-004331-PCE

Pollutant means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, domestic sewage sludge (biosolids), munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste. This term does not include sewage from vessels within the meaning of section 312 of the CWA, nor does it include dredged or fill material discharged in accordance with a permit issued under section 404 of the CWA.

Pollution means contamination or other alteration of the physical, chemical, or biological properties of waters of the State; including change in temperature, taste, color, turbidity, or odor of the waters; or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare; or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses; or to livestock, wild animals, birds, fish or other aquatic life.

Process wastewater means any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product (40 CFR 122.1).

Receiving water means the water body at the point of discharge. If the discharge is to a storm sewer system, either surface or subsurface, the receiving water is the water body to which the storm system discharges. Systems designed primarily for other purposes such as for ground water drainage, redirecting stream natural flows, or for conveyance of irrigation water/return flows that coincidentally convey stormwater are considered the receiving water.

Representative means a stormwater or wastewater sample which represents the flow and characteristics of the discharge. Representative samples may be a grab sample, a time-proportionate composite sample, or a flow proportionate sample. Ecology's Construction Stormwater Monitoring Manual provides guidance on representative sampling.

Sanitary sewer means a sewer which is designed to convey domestic wastewater.

Sediment means the fragmented material that originates from the weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.

Sedimentation means the depositing or formation of sediment.

Sensitive area means a water body, wetland, stream, aquifer recharge area, or channel migration zone.

SEPA (State Environmental Policy Act) means the Washington State Law, RCW 43.21C.020, intended to prevent or eliminate damage to the environment.

Significant Amount means an amount of a pollutant in a discharge that is amenable to available and reasonable methods of prevention or treatment; or an amount of a pollutant that has a

EX-0001-004332-PCE

reasonable potential to cause a violation of surface or ground water quality or sediment management standards.

Significant concrete work means greater than 1000 cubic yards poured concrete or recycled concrete over the life of a project.

Significant Contributor of Pollutants means a facility determined by Ecology to be a contributor of a significant amount(s) of a pollutant(s) to waters of the State of Washington.

Site means the land or water area where any "facility or activity" is physically located or conducted.

Source control BMPs means physical, structural or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are erosion control practices, maintenance of stormwater facilities, constructing roofs over storage and working areas, and directing wash water and similar discharges to the sanitary sewer or a dead end sump.

Stabilization means the application of appropriate BMPs to prevent the erosion of soils, such as, temporary and permanent seeding, vegetative covers, mulching and matting, plastic covering and sodding. See also the definition of Erosion and Sediment Control BMPs.

Storm drain means any drain which drains directly into a storm sewer system, usually found along roadways or in parking lots.

Storm sewer system means a means a conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains designed or used for collecting or conveying stormwater. This does not include systems which are part of a combined sewer or Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

Stormwater means that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes, and other features of a stormwater drainage system into a defined surface water body, or a constructed infiltration facility.

Stormwater Management Manual (SWMM) or Manual means the technical Manual published by Ecology for use by local governments that contain descriptions of and design criteria for BMPs to prevent, control, or treat pollutants in stormwater.

Stormwater Pollution Prevention Plan (SWPPP) means a documented plan to implement measures to identify, prevent, and control the contamination of point source discharges of stormwater.

Surface Waters of the State includes lakes, rivers, ponds, streams, inland waters, salt waters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

EX-0001-004333-PCE

Temporary Stabilization means the exposed ground surface has been covered with appropriate materials to provide temporary stabilization of the surface from water or wind erosion. Materials include, but are not limited to, mulch, riprap, erosion control mats or blankets and temporary cover crops. Seeding alone is not considered stabilization. Temporary stabilization is not a substitute for the more permanent "final stabilization."

Total Maximum Daily Load (TMDL) means a calculation of the maximum amount of a pollutant that a water body can receive and still meet state water quality standards. Percentages of the total maximum daily load are allocated to the various pollutant sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The TMDL calculations must include a "margin of safety" to ensure that the water body can be protected in case there are unforeseen events or unknown sources of the pollutant. The calculation must also account for seasonable variation in water quality.

Treatment BMPs means BMPs that are intended to remove pollutants from stormwater. A few examples of treatment BMPs are detention ponds, oil/water separators, biofiltration, and constructed wetlands.

Transparency means a measurement of water clarity in centimeters (cm), using a 60 cm transparency tube. The transparency tube is used to estimate the relative clarity or transparency of water by noting the depth at which a black and white Secchi disc becomes visible when water is released from a value in the bottom of the tube. A transparency tube is sometimes referred to as a "turbidity tube."

Turbidity means the clarity of water expressed as nephelometric turbidity units (NTU) and measured with a calibrated turbidimeter.

Uncontaminated means free from any contaminant, as defined in MTCA cleanup regulations. See definition of "contaminant" and WAC 173-340-200.

Waste Load Allocation (WLA) means the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality based effluent limitation (40 CFR 130.2[h]).

Water quality means the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose.

Waters of the State includes those waters as defined as "waters of the United States" in 40 CFR Subpart 122.2 within the geographic boundaries of Washington State and "waters of the State" as defined in Chapter 90.48 RCW, which include lakes, rivers, ponds, streams, inland waters, underground waters, salt waters, and all other surface waters and water courses within the jurisdiction of the state of Washington.

Well means a bored, drilled or driven shaft, or dug hole whose depth is greater than the largest surface dimension. (See Injection well.)

EX-0001-004334-PCE

Wheel wash wastewater means any water used in, or resulting from the operation of, a tire bath or wheel wash (BMP C106: Wheel Wash), or other structure or practice that uses water to physically remove mud and debris from vehicles leaving a construction site and prevent track-out onto roads. When stormwater comingles with wheel wash wastewater, the resulting water is considered wheel wash wastewater and must be managed according to Special Condition S9.D.9.

EX-0001-004335-PCE

APPENDIX B – ACRONYMS

AKART	All Known, Available, and Reasonable Methods of Prevention, Control, and Treatment
BMP	Best Management Practice
CESCL	Certified Erosion and Sediment Control Lead
CFR	Code of Federal Regulations
CKD	Cement Kiln Dust
cm	Centimeters
CTB	Cement-Treated Base
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
FR	Federal Register
NOI	Notice of Intent
NOT	Notice of Termination
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
SWMM	Stormwater Management Manual
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
UIC	Underground Injection Control
USC	United States Code
USEPA	United States Environmental Protection Agency
WAC	Washington Administrative Code
WQ	Water Quality
WWHM	Western Washington Hydrology Model

EX-0001-004336-PCE

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix J
Alternative 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 20-30 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 should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.

- As required by local governments.
- Phase construction to preserve natural vegetation on the project site for as long as possible during the construction period.

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. Local governments may also have ordinances to save natural vegetation and trees.
- 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 2-3 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 madrona 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.

Maintenance Standards

- Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.
- 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 (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C102: Buffer Zones

Purpose

Creation of an undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

Conditions of Use

Natural buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can be used to protect natural swales and can be incorporated into the natural landscaping of an area.

Critical-areas buffer zones should not be used as sediment treatment areas. These areas shall remain completely undisturbed. The local permitting authority may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method in protecting sensitive areas and buffers. Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Vegetative buffer zones for streams, lakes or other waterways shall be established by the local permitting authority or other state or federal permits or approvals.

Maintenance Standards

Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed. Replace all damaged flagging immediately.

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 should 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. 100 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 $4,000-6,000 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 Figure 4.1.3 and Figure 4.1.4 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:
  1. Complete final grade and track walk up and down the slope.
  2. Install hydromulch with seed and fertilizer.
  3. Dig a small trench, approximately 12 inches wide by 6 inches deep along the top of the slope.
  4. 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.
  5. 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.
  6. If the blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket should overlap the leading edge of the lower blanket and be stapled. On steeper slopes, this overlap should 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 sites:
  1. WSDOT (Section 3.2.4):

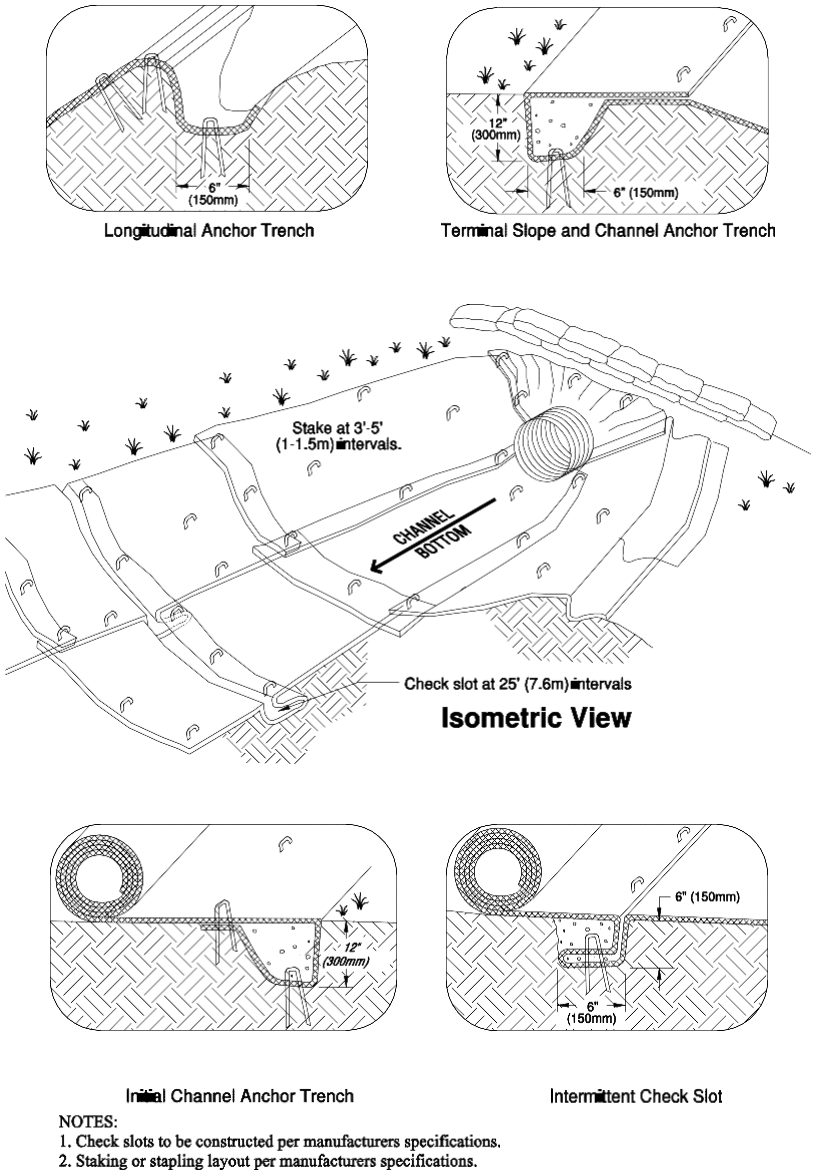
     http://www.wsdot.wa.gov/NR/rdonlyres/3B41E087-FA86-4717-932D-D7A8556CCD57/0/ErosionTrainingManual.pdf
  2. Texas Transportation Institute:

     http://www.txdot.gov/business/doing_business/product_evaluation/erosion_control.htm
- 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.
- 100-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



NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.

Figure 4.1.3 – Channel Installation

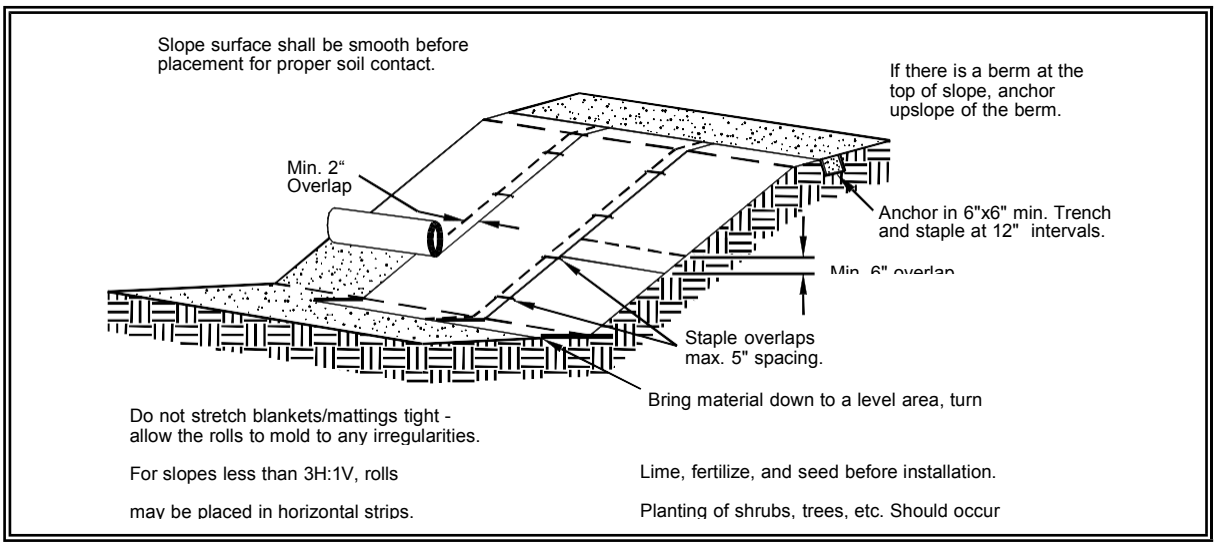


Figure 4.1.4 – Slope Installation

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 ten percent or the permeability is less than 0.6 inches per hour.
  See http://www.ecy.wa.gov/programs/swfa/organics/soil.html 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 reestablish 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 BMP T5.13 (see Chapter 5 of Volume V of this manual) 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 conditions if functioning properly.
- Areas that already have good topsoil, such as undisturbed areas, do not require soil amendments.
- Restore, to the maximum extent practical, 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 topsoil, incorporate amendments into on-site soil, or import 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 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 re- structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.
- A minimum organic content of 10% dry weight in planting beds, and 5% 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 should be limited to 25 percent passing through a 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 incorporation amendments to meet the organic content requirement, use compost that meets the compost specification for Bioretention (See BMP T7.30 in Chapter 7 of Volume V of this manual), with the exception that the compost may have up to 35% bio solids of manure.

- Sections three through seven of the document entitled, *Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington,* provides useful guidance for implementing whichever option is chosen. It includes guidance for pre-approved default strategies and guidance for custom strategies. Check with your local jurisdiction concerning its acceptance of this guidance. It is available through the organization, Soils for Salmon. As of this printing the document may be found at: http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf.
- 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 top soil 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 ground water 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:
    1. Re-install topsoil within 4 to 6 weeks.
    2. Do not allow the saturation of topsoil with water.
    3. 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 C126: Polyacrylamide (PAM) for Soil Erosion Protection

Purpose

Polyacrylamide (PAM) is used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of a rain event significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

Conditions of Use

PAM shall not be directly applied to water or allowed to enter a water body.

In areas that drain to a sediment pond, PAM can be applied to bare soil under the following conditions:

- During rough grading operations.
- In Staging areas.
- Balanced cut and fill earthwork.
- Haul roads prior to placement of crushed rock surfacing.
- Compacted soil roadbase.
- Stockpiles.
- After final grade and before paving or final seeding and planting.
- Pit sites.
- Sites having a winter shut down. In the case of winter shut down, or where soil will remain unworked for several months, PAM should be used together with mulch.

Design and Installation Specifications

PAM may be applied with water in dissolved form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of 2/3 pound PAM per 1,000 gallons water (80 mg/L) per 1 acre of bare soil. Table 4.1.9 can be used to determine the PAM and water application rate for a disturbed soil area.
Higher concentrations of PAM **do not** provide any additional effectiveness.

Table 4.1.9
PAM and Water Application Rates

Disturbed Area (ac)	PAM (lbs)	Water (gal)
0.50	0.33	500
1.00	0.66	1,000

1.50	1.00	1,500
2.00	1.32	2,000
2.50	1.65	2,500
3.00	2.00	3,000
3.50	2.33	3,500
4.00	2.65	4,000
4.50	3.00	4,500
5.00	3.33	5,000
4.50	3.00	4,500

The Preferred Method:

- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (2/3 pound PAM/1000 gallons/acre).
- PAM has infinite solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM.
- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.
- Add PAM /Water mixture to the truck
- Completely fill the water truck to specified volume.
- Spray PAM/Water mixture onto dry soil until the soil surface is uniformly and completely wetted.

An Alternate Method:

PAM may also be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5-10 acres, a hand- held "organ grinder" fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas.

The following shall be used for application of powdered PAM:

- Powered PAM shall be used in conjunction with other BMPs and not in place of other BMPs.
- Do not use PAM on a slope that flows directly into a stream or wetland. The stormwater runoff shall pass through a sediment control BMP prior to discharging to surface waters.
- Do not add PAM to water discharging from site.

- When the total drainage area is greater than or equal to 5 acres, PAM treated areas shall drain to a sediment pond.
- Areas less than 5 acres shall drain to sediment control BMPs, such as a minimum of 3 check dams per acre. The total number of check dams used shall be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam shall be spaced evenly in the drainage channel through which stormwater flows are discharged off-site.
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site.
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used.
- PAM can be applied to wet soil, but dry soil is preferred due to less sediment loss.
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil.
- Keep the granular PAM supply out of the sun. Granular PAM loses its effectiveness in three months after exposure to sunlight and air.
- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage.
- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough towel rather than washing with water-this only makes cleanup messier and take longer.
- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used.

  The specific PAM copolymer formulation must be anionic. **Cationic PAM shall not be used in any application because of known aquatic toxicity problems.** Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, will be used for soil applications. Recent media attention and high interest in PAM has resulted in some entrepreneurial exploitation of the term "polymer." All PAM are polymers, but not all polymers are PAM, and not all PAM products comply with ANSI/NSF Standard 60. PAM use shall be reviewed and approved by the local permitting authority.

- PAM designated for these uses should be "water soluble" or "linear" or "non-crosslinked". Cross-linked or water absorbent PAM, polymerized in highly acidic (pH<2) conditions, are used to maintain soil moisture content.
- The PAM anionic charge density may vary from 2-30 percent; a value of 18 percent is typical. Studies conducted by the United States Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12- 15 mg/mole), highly anionic (>20% hydrolysis) PAM.
- PAM tackifiers are available and being used in place of guar and alpha plantago. Typically, PAM tackifiers should be used at a rate of no more than 0.5-1 lb. per 1000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 –5 lbs. per acre, which can be too much. In addition, pump problems can occur at higher rates due to increased viscosity.

Maintenance Standards

- PAM may be reapplied on actively worked areas after a 48-hour period.
- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after two months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.
- Loss of sediment and PAM may be a basis for penalties per RCW 90.48.080.

BMP C131: Gradient Terraces

Purpose

Gradient terraces reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity.

Conditions of Use

- Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available. See Figure 4.1.6 for gradient terraces.

Design and Installation Specifications

- The maximum vertical spacing of gradient terraces should be determined by the following method:

$$VI = (0.8)s + y$$

Where: VI = vertical interval in feet

s = land rise per 100 feet, expressed in feet

y = a soil and cover variable with values from 1.0 to 4.0

Values of "y" are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1½ tons of straw/acre equivalent) is on the surface.

- The minimum constructed cross-section should meet the design dimensions.
- The top of the constructed ridge should not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace should have a cross section equal to that specified for the terrace channel.
- Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length (0.6%). For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type.
- All gradient terraces should have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Vegetative cover should be used in the outlet channel.
- The design elevation of the water surface of the terrace should not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.
- Vertical spacing determined by the above methods may be increased as

much as 0.5 feet or 10 percent, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet. The drainage area above the terrace should not exceed the area that would be drained by a terrace with normal spacing.

- The terrace should have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge should have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel should be
- 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The terrace can be constructed wide enough to be maintained using a small vehicle.

Maintenance Standards

- Maintenance should be performed as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

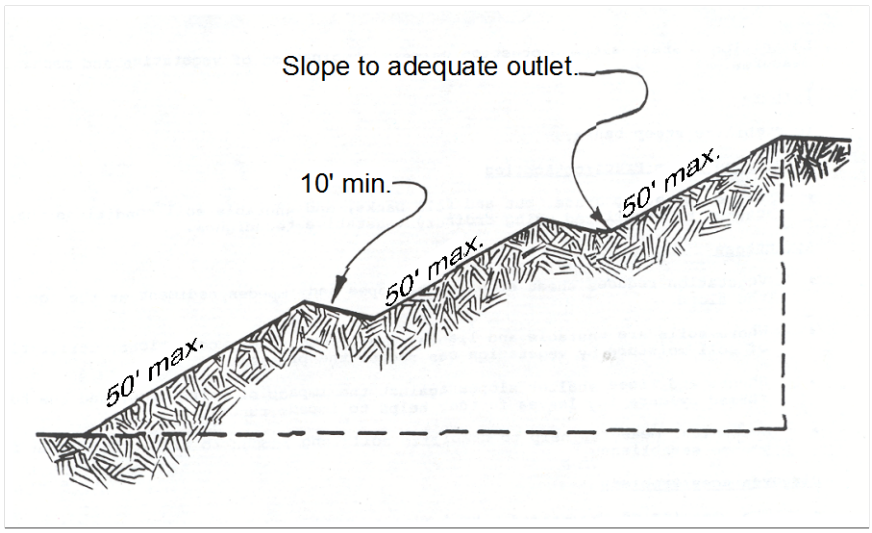


Figure 4.1.6 – Gradient Terraces

BMP C201: Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. See Figure 4.2.1 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 should 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 using a 10-minute time step from a 10-year, 24-hour storm, assuming a Type 1A rainfall distribution. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model to determine a flow rate which the channel must contain.
- Where the grass-lined channel will also function as a permanent stormwater conveyance facility, consult the drainage conveyance requirements of the local government with jurisdiction.
- 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 ft/sec, a temporary channel liner is required. Geotextile or special mulch protection such as fiberglass roving or straw and netting provides stability until the vegetation is fully established. See Figure 4.2.2.

- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. 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, should carry peak runoff for temporary construction drainage facilities 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.

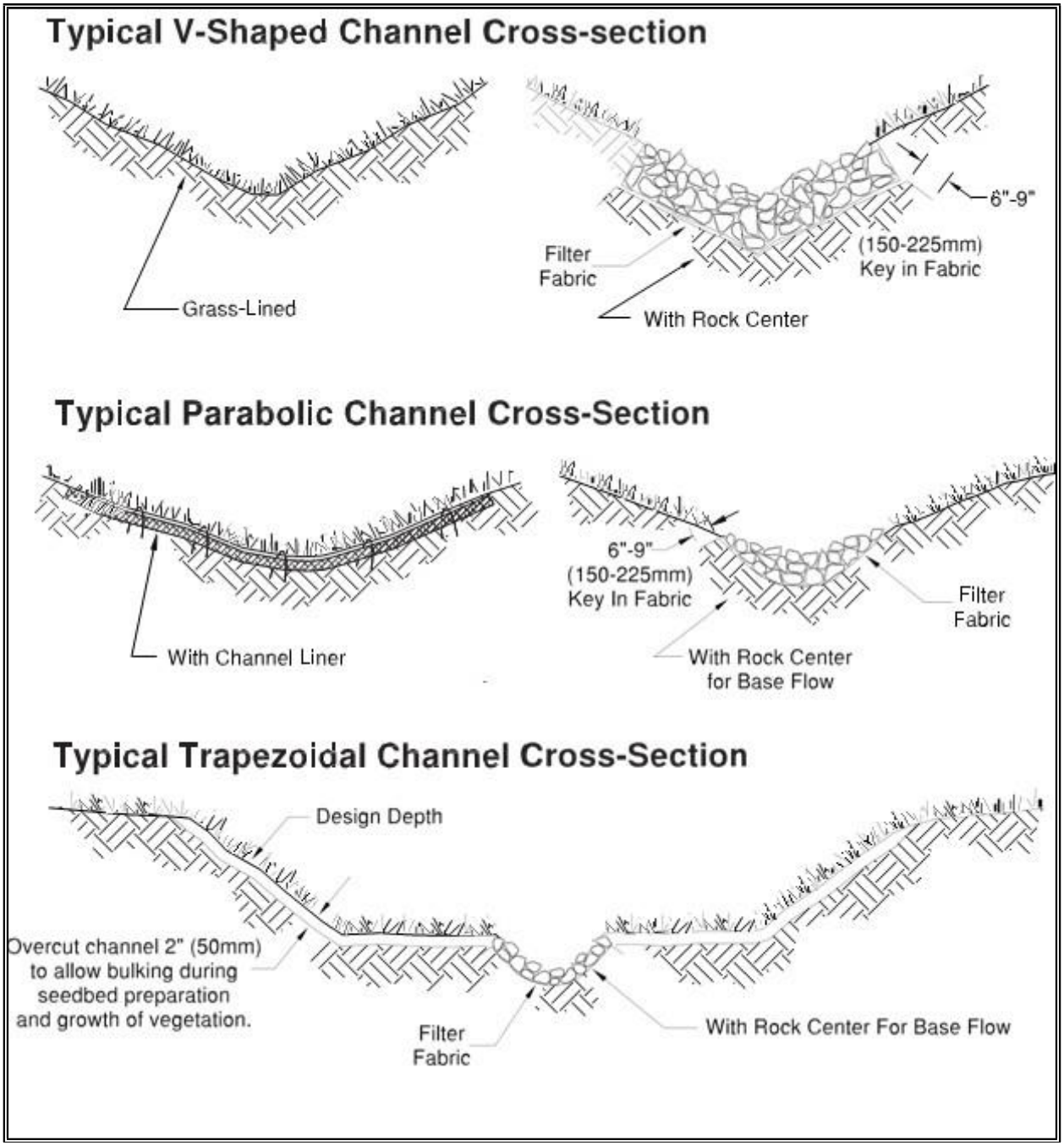
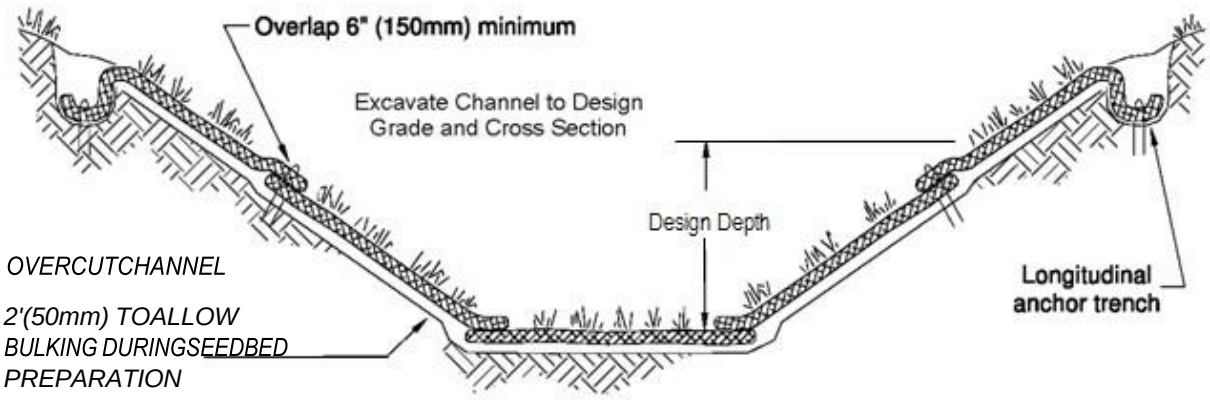
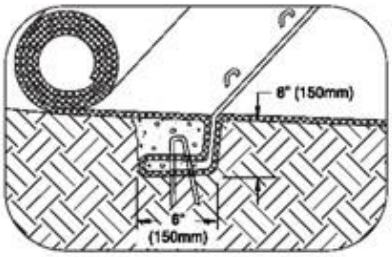


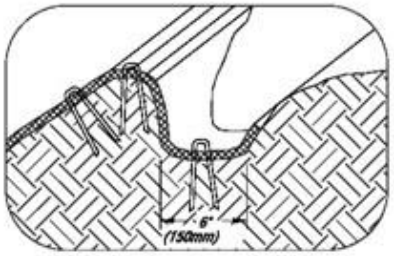
Figure 4.2.1 – Typical Grass-Lined Channels





TYPICAL INSTALLATION

WITHEROSIONCONTROL BLANKETSOR TURF REINFORCEMENT MATS

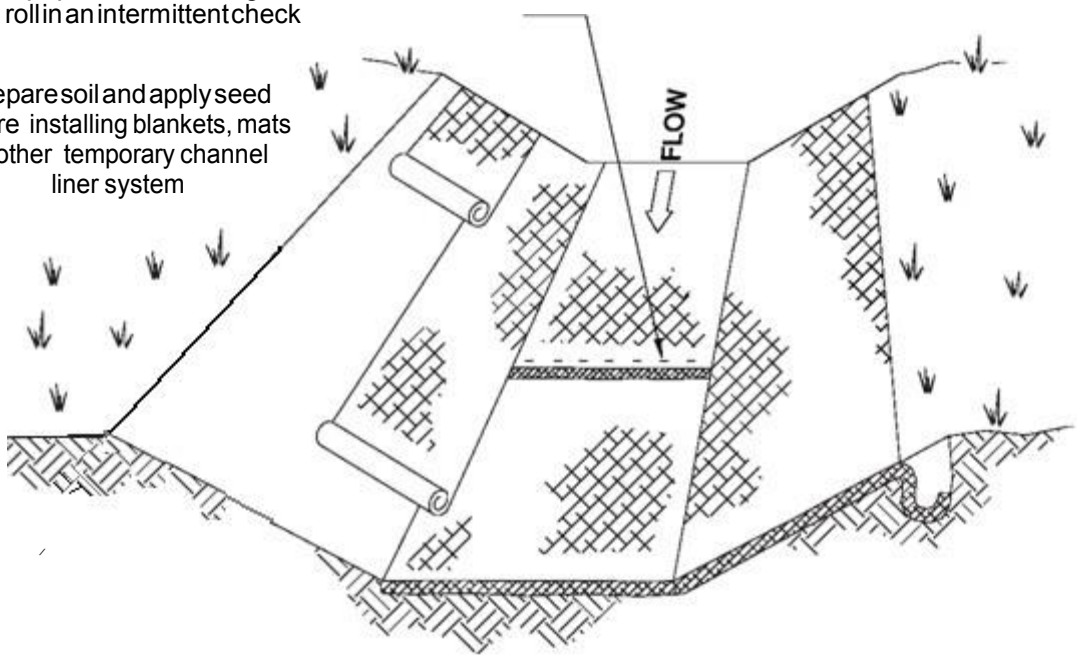


Intermittent Check Slot

Longitudinal Anchor Trench

Shingle-lap spliced ends or begin new roll in an intermittent check slot

Prepare soil and apply seed before installing blankets, mats or other temporary channel liner system



NOTES:

1 Design velocities exceeding 2 ft/sec (0.5m/sec) require temporary blankets, mats or similar liners to protect seed and soil until vegetation becomes established.

2 Grass-lined channels with design velocities exceeding 6 ft/sec (2m/sec) should include turf reinforcement mats.

Figure 4.2.2 – Temporary Channel Liners

BMP C203: Water Bars

Purpose

A small ditch or ridge of material is constructed diagonally across a road or right-of-way to divert stormwater runoff from the road surface, wheel tracks, or a shallow road ditch. See Figure 4.2.3.

Conditions of use

Clearing right-of-way and construction of access for power lines, pipelines, and other similar installations often require long narrow right-of-ways over sloping terrain. Disturbance and compaction promotes gully formation in these cleared strips by increasing the volume and velocity of runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small predesigned diversions.

- Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design and Installation

Height: 8-inch minimum measured from the channel bottom to the ridge top.

- Side slope of channel: 2H:1V maximum; 3H:1V or flatter when vehicles will cross

Specifications

- Base width of ridge: 6-inch minimum.
- Locate them to use natural drainage systems and to discharge into well vegetated stable areas.
- Guideline for Spacing:

Slope %	Spacing (ft)
< 5	125
5 - 10	100
10 - 20	75
20 - 35	50
> 35	Use rock lined ditch

- Grade of water bar and angle: Select angle that results in ditch slope less than 2 percent.
- Install as soon as the clearing and grading is complete. Reconstruct when construction is complete on a section when utilities are being installed.
- Compact the ridge when installed.
- Stabilize, seed, and mulch the portions that are not subject to traffic. Gravel the areas crossed by vehicles.

Maintenance Standards

Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage.

- Immediately remove sediment from the flow area and repair the dike.

- Check outlet areas and make timely repairs as needed.
- When permanent road drainage is established and the area above the temporary right-of-way diversion is permanently stabilized, remove the dikes and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

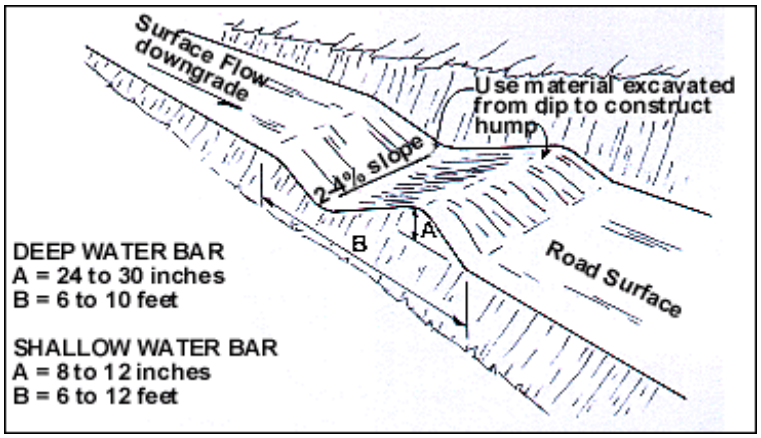


Figure 4.2.3 – Water Bar

BMP C204: Pipe Slope Drains

Purpose

To use a pipe to convey stormwater anytime water needs to be diverted away from or over bare soil to prevent gullies, channel erosion, and saturation of slide-prone soils.

Conditions of Use

Pipe slope drains should be used when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion (Figure 4.2.4).

On highway projects, pipe slope drains should be used at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed. Used in conjunction with sand bags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

Water can be collected, channeled with sand bags, Triangular Silt Dikes, berms, or other material, and piped to temporary sediment ponds.

Pipe slope drains can be:

- Connected to new catch basins and used temporarily until all permanent piping is installed;
- Used to drain water collected from aquifers exposed on cut slopes and take it to the base of the slope;
- Used to collect clean runoff from plastic sheeting and direct it away from exposed soil;
- Installed in conjunction with silt fence to drain collected water to a controlled area;
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement; and,
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects.

There are now several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet.

Design and Installation Specifications

Size the pipe to convey the flow. The capacity for temporary drains shall be sufficient to handle the peak volumetric flow rate calculated using a 10-minute time step from a 10-year, 24-hour storm event, assuming a Type 1A rainfall distribution. Alternatively, use 1.6 times the 10-year, 1-hour flow indicated by an approved continuous runoff model.

Consult local drainage requirements for sizing permanent pipe slope drains.

- Use care in clearing vegetated slopes for installation.
- Re-establish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use diversion dikes or swales to collect water at the top of the slope.
- Ensure that the entrance area is stable and large enough to direct flow into the pipe.
- Piping of water through the berm at the entrance area is a common failure mode.
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3 percent. Sand bags may also be used at pipe entrances as a temporary measure.
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections shall be securely fastened together, fused or have gasketed watertight fittings, and shall be securely anchored into the soil.
- Thrust blocks should be installed anytime 90 degree bends are utilized. Depending on size of pipe and flow, these can be constructed with sand bags, straw bales staked in place, “t” posts and wire, or ecology blocks.
- Pipe needs to be secured along its full length to prevent movement. This can be done with steel “t” posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-20 feet of pipe length or so, depending on the size of the pipe and quantity of water to divert.
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron (see BMP C209 Outlet Protection, for the appropriate outlet material).
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.
- Materials specifications for any permanent piped system shall be set by the local government.

Maintenance Standards

Check inlet and outlet points regularly, especially after storms.

The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags.

- The outlet point should be free of erosion and installed with appropriate outlet protection.
- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and wind-throw.
- Normally the pipe slope is so steep that clogging is not a problem with smooth wall pipe, however, debris may become lodged in the pipe.

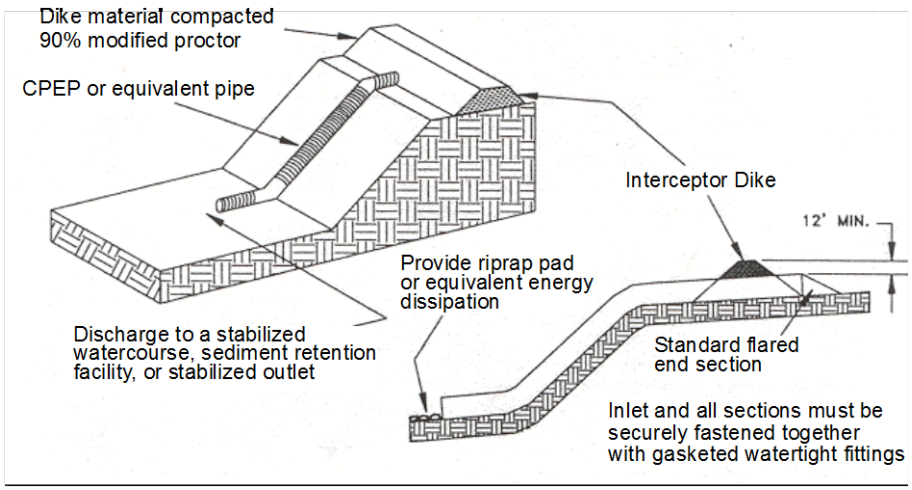


Figure 4.2.4 – Pipe Slope Drain

BMP C205: Subsurface Drains

Purpose

To intercept, collect, and convey ground water to a satisfactory outlet, using a perforated pipe or conduit below the ground surface. Subsurface drains are also known as "french drains." The perforated pipe provides a dewatering mechanism to drain excessively wet soils, provide a stable base for construction, improve stability of structures with shallow foundations, or to reduce hydrostatic pressure to improve slope stability.

Conditions of Use

Use when excessive water must be removed from the soil. The soil permeability, depth to water table and impervious layers are all factors which may govern the use of subsurface drains.

Design and Installation Specifications

Relief drains are used either to lower the water table in large, relatively flat areas, improve the growth of vegetation, or to remove surface water. Relief drains are installed along a slope and drain in the direction of the slope.

They can be installed in a grid pattern, a herringbone pattern, or a random pattern.

- **Interceptor drains** are used to remove excess ground water from a slope, stabilize steep slopes, and lower the water table immediately below a slope to prevent the soil from becoming saturated.

Interceptor drains are installed perpendicular to a slope and drain to the side of the slope.

They usually consist of a single pipe or series of single pipes instead of a patterned layout.

- **Depth and spacing of interceptor drains** --The depth of an interceptor drain is determined primarily by the depth to which the water table is to be lowered or the depth to a confining layer. For practical reasons, the maximum depth is usually limited to 6 feet, with a minimum cover of 2 feet to protect the conduit.
- The soil should have depth and sufficient permeability to permit installation of an effective drainage system at a depth of 2 to 6 feet.
- An adequate outlet for the drainage system must be available either by gravity or by pumping.
- The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required).
- This standard does not apply to subsurface drains for building foundations or deep excavations.
- The capacity of an interceptor drain is determined by calculating the maximum rate of ground water flow to be intercepted. Therefore, it is good practice to make complete subsurface investigations, including hydraulic conductivity of the soil, before designing a subsurface drainage system.
- **Size of drain**--Size subsurface drains to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4 inches.

- The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve this velocity at a minimum. The maximum allowable velocity using a sand-gravel filter or envelope is 9 ft/sec.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters should surround the drain to a minimum of 3-inch thickness.
- The outlet of the subsurface drain shall empty into a sediment pond through a catch basin. If free of sediment, it can then empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- The trench shall be constructed on a continuous grade with no reverse grades or low spots.
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.
- Do not install permanent drains near trees to avoid the tree roots that tend to clog the line. Use solid pipe with watertight connections where it is necessary to pass a subsurface drainage system through a stand of trees.
- **Outlet**--Ensure that the outlet of a drain empties into a channel or other watercourse above the normal water level.
- Secure an animal guard to the outlet end of the pipe to keep out rodents.
- Use outlet pipe of corrugated metal, cast iron, or heavy-duty plastic without perforations and at least 10 feet long. Do not use an envelope or filter material around the outlet pipe, and bury at least two-thirds of the pipe length.
- When outlet velocities exceed those allowable for the receiving stream, outlet protection must be provided.

Maintenance Standards

Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment or roots.

- The outlet shall be kept clean and free of debris.
- Surface inlets shall be kept open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem.
- Where drains are crossed by heavy vehicles, the line shall be checked to ensure that it is not crushed.

BMP C206: Level Spreader

Purpose

To provide a temporary outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope. To convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation or an engineered filter strip.

Conditions of Use

Used when a concentrated flow of water needs to be dispersed over a large area with existing stable vegetation.

- Items to consider are:
  1. What is the risk of erosion or damage if the flow may become concentrated?
  2. Is an easement required if discharged to adjoining property?
  3. Most of the flow should be as ground water and not as surface flow.
  4. Is there an unstable area downstream that cannot accept additional ground water?
- Use only where the slopes are gentle, the water volume is relatively low, and the soil will adsorb most of the low flow events.

Design and Installation Specifications

Use above undisturbed areas that are stabilized by existing vegetation.

If the level spreader has any low points, flow will concentrate, create channels and may cause erosion.

- Discharge area below the outlet must be uniform with a slope flatter than 5H:1V.
- Outlet to be constructed level in a stable, undisturbed soil profile (not on fill).
- The runoff shall not re-concentrate after release unless intercepted by another downstream measure.
- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1 percent. The grade of the level spreader shall be 0 percent to ensure uniform spreading of storm runoff.
- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2- to 4-inch or 3/4-inch to 1½-inch size.
- The spreader length shall be determined by estimating the peak flow expected from the 10-year, 24-hour design storm. The length of the spreader shall be a minimum of 15 feet for 0.1 cfs and shall increase by 10 feet for each 0.1 cfs thereafter to a maximum of 0.5 cfs per spreader. Use multiple spreaders for higher flows.
- The width of the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length.

- Level spreaders shall be setback from the property line unless there is an easement for flow.
- Level spreaders, when installed every so often in grassy swales, keep the flows from concentrating. Materials that can be used include sand bags, lumber, logs, concrete, and pipe. To function properly, the material needs to be installed level and on contour. Figures 4.2.5Figure425 and 4.2.6 provide a cross-section and a detail of a level spreader. A capped perforated pipe could also be used as a spreader.

Maintenance Standards

The spreader should be inspected after every runoff event to ensure that it is functioning correctly.

- The contractor should avoid the placement of any material on the structure and should prevent construction traffic from crossing over the structure.
- If the spreader is damaged by construction traffic, it shall be immediately repaired.

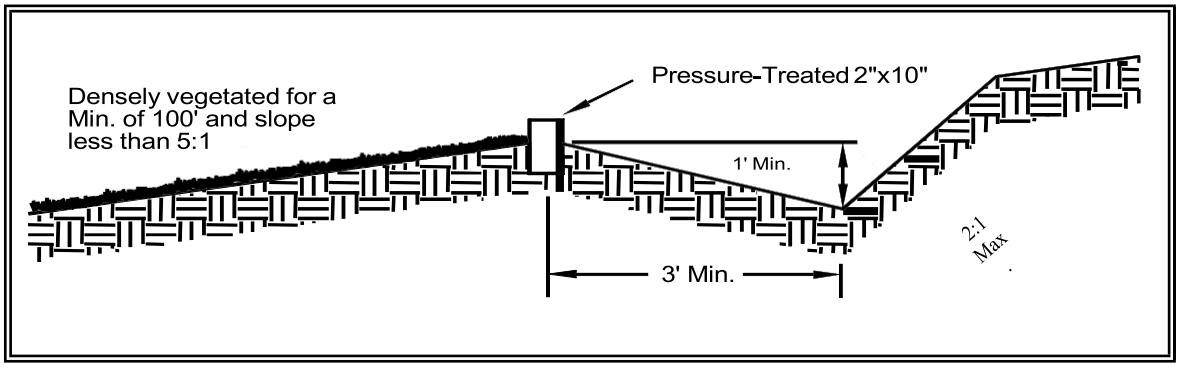


Figure 4.2.5 – Cross Section of Level Spreader

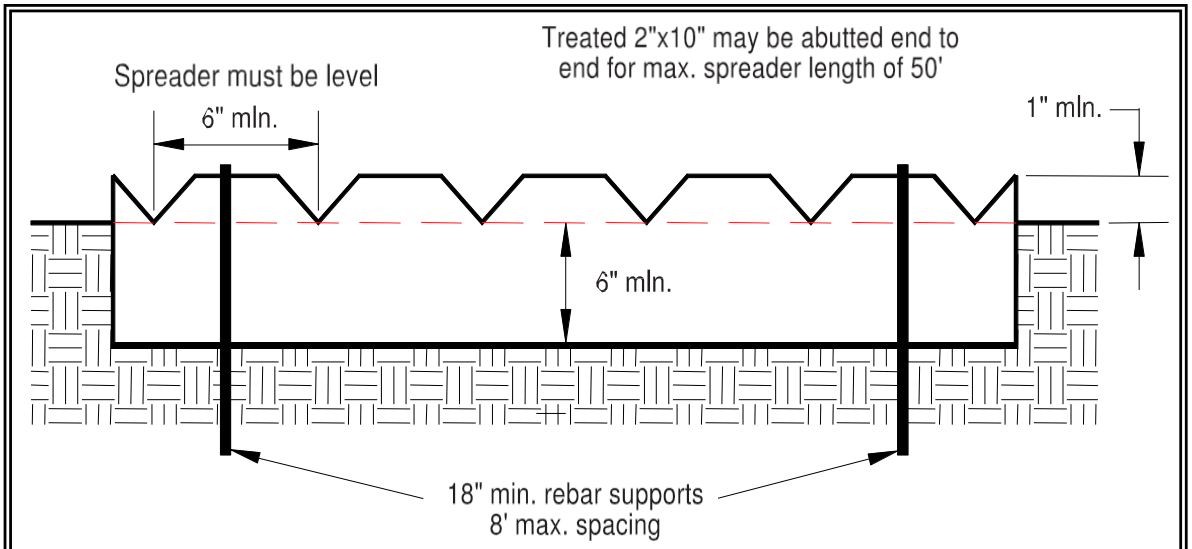


Figure 4.2.6 – Detail of Level Spreader

BMP C208: Triangular Silt Dike (TSD) (Geotextile Encased Check Dam)

Purpose

Triangular silt dikes may be used as check dams, for perimeter protection, for temporary soil stockpile protection, for drop inlet protection, or as a temporary interceptor dike.

Conditions of use

- May be used on soil or pavement with adhesive or staples.
- TSDs have been used to build temporary:
  1. sediment ponds;
  2. diversion ditches;
  3. concrete wash out facilities;
  4. curbing;
  5. water bars;
  6. level spreaders; and, berms

Design and Installation Specifications

Made of urethane foam sewn into a woven geosynthetic fabric.

It is triangular, 10 inches to 14 inches high in the center, with a 20-inch to 28-inch base. A 2–foot apron extends beyond both sides of the triangle along its standard section of 7 feet. A sleeve at one end allows attachment of additional sections as needed.

- Install with ends curved up to prevent water from flowing around the ends.
- The fabric flaps and check dam units are attached to the ground with wire staples. Wire staples should be No. 11 gauge wire and should be 200 mm to 300 mm in length.
- When multiple units are installed, the sleeve of fabric at the end of the unit shall overlap the abutting unit and be stapled.
- Check dams should be located and installed as soon as construction will allow.
- Check dams should be placed perpendicular to the flow of water.
- When used as check dams, the leading edge must be secured with rocks, sandbags, or a small key slot and staples.
- In the case of grass-lined ditches and swales, check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance Standards

- Triangular silt dams shall be inspected for performance and sediment accumulation during and after each runoff producing rainfall.
- Sediment shall be removed when it reaches one half the height of the dam.
- Anticipate submergence and deposition above the triangular silt dam and erosion from high flows around the edges of the dam. Immediately repair any damage or any undercutting of the dam.

BMP C231: Brush Barrier

Purpose

The purpose of brush barriers is to reduce 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.

Conditions of Use

- Brush barriers may be used downslope of all disturbed areas of less than one-quarter acre.
- Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a brush barrier, rather than by a sediment pond, is when the area draining to the barrier is small.
- Brush barriers should only be installed on contours.

Design and Installation Specifications

- Height 2 feet (minimum) to 5 feet (maximum).
- Width 5 feet at base (minimum) to 15 feet (maximum).
- Filter fabric (geotextile) may be anchored over the brush berm to enhance the filtration ability of the barrier. Ten-ounce burlap is an adequate alternative to filter fabric.
- Chipped site vegetation, composted mulch, or wood-based mulch (hog fuel) can be used to construct brush barriers.
- A 100 percent biodegradable installation can be constructed using 10-ounce burlap held in place by wooden stakes. Figure 4.2.11 depicts a typical brush barrier.

Maintenance Standards

- There shall be no signs of erosion or concentrated runoff under or around the barrier. If concentrated flows are bypassing the barrier, it must be expanded or augmented by toed-in filter fabric.
- The dimensions of the barrier must be maintained.

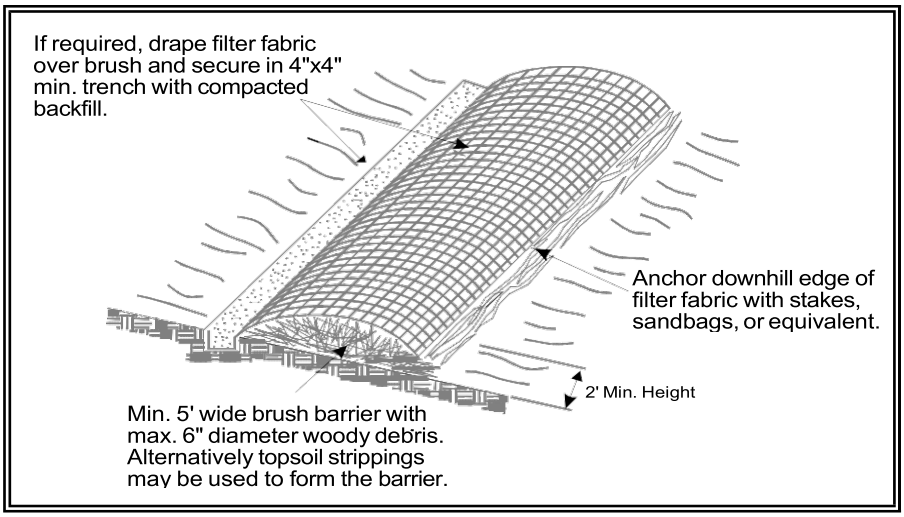


Figure 4.2.11 – Brush Barrier

BMP C232: Gravel Filter Berm

Purpose	A gravel filter berm is constructed on rights-of-way or traffic areas within a construction site to retain sediment by using a filter berm of gravel or crushed rock.
Conditions of Use	Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites.

Design and Installation Specifications	• Berm material shall be ¾ to 3 inches in size, washed well-grade gravel or crushed rock with less than 5 percent fines.
	• Spacing of berms:
	  • Every 300 feet on slopes less than 5 percent
	  • Every 200 feet on slopes between 5 percent and 10 percent
	  • Every 100 feet on slopes greater than 10 percent
	• Berm dimensions:
	  • 1 foot high with 3H:1V side slopes
	  • 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm

Maintenance Standards	• Regular inspection is required. Sediment shall be removed and filter material replaced as needed.

BMP C234: Vegetated Strip

Purpose

Vegetated strips reduce 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.

- Vegetated strips may be used downslope of all disturbed areas.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the following criteria are met (see Table 4.2.4):

Table 4.2.4

Contributing Drainage Area for Vegetated Strips

Average Contributing area Slope	Average Contributing area Percent Slope	Max Contributing area Flowpath Length
1.5H:1V or flatter	67% or flatter	100 feet
2H:1V or flatter	50% or flatter	115 feet
4H:1V or flatter	25% or flatter	150 feet
6H:1V or flatter	16.7% or flatter	200 feet
10H:1V or flatter	10% or flatter	250 feet

Design and Installation Specifications

- The vegetated strip shall consist of a minimum of a 25-foot flowpath length continuous strip of dense vegetation with topsoil. Grass-covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- The slope within the strip shall not exceed 4H:1V.
- The uphill boundary of the vegetated strip shall be delineated with clearing limits.

Maintenance Standards

- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch.
- If more than 5 feet of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed.
- If there are indications that concentrated flows are traveling across the buffer, surface water controls must be installed to reduce the flows entering the buffer, or additional perimeter protection must be installed.

BMP C236: Vegetative Filtration

Purpose

Vegetative Filtration may be used in conjunction with BMP C241 Temporary Sediment Ponds, BMP C206 Level Spreader and a pumping system with surface intake to improve turbidity levels of stormwater discharges by filtering through existing vegetation where undisturbed forest floor duff layer or established lawn with thatch layer are present. Vegetative Filtration can also be used to infiltrate dewatering waste from foundations, vaults, and trenches as long as runoff does not occur.

Conditions of Use

- For every five acre of disturbed soil use one acre of grass field, farm pasture, or wooded area. Reduce or increase this area depending on project size, ground water table height, and other site conditions.
- Wetlands shall not be used for filtration.
- Do not use this BMP in areas with a high ground water table, or in areas that will have a high seasonal ground water table during the use of this BMP.
- This BMP may be less effective on soils that prevent the infiltration of the water, such as hard till.
- Using other effective source control measures throughout a construction site will prevent the generation of additional highly turbid water and may reduce the time period or area need for this BMP.
- Stop distributing water into the vegetated area if standing water or erosion results.

Design Criteria

- Find land adjacent to the project that has a vegetated field, preferably a farm field, or wooded area.
- If the project site does not contain enough vegetated field area consider obtaining permission from adjacent landowners (especially for farm fields).
- Install a pump and downstream distribution manifold depending on the project size. Generally, the main distribution line should reach 100 to 200-feet long (many large projects, or projects on tight soil, will require systems that reach several thousand feet long with numerous branch lines off of the main distribution line).
- The manifold should have several valves, allowing for control over the distribution area in the field.
- Install several branches of 4” schedule 20, swaged-fit common septic tight-lined sewer line, or 6” fire hose, which can convey the turbid water out to various sections of the field. See Figure 4.2.15.
- Determine the branch length based on the field area geography and number of branches. Typically, branches stretch from 200-feet to several thousand feet. Always, lay branches on contour with the slope.
- On uneven ground, sprinklers perform well. Space sprinkler heads so

that spray patterns do not overlap.

- On relatively even surfaces, a level spreader using 4-inch perforated pipe may be used as an alternative option to the sprinkler head setup. Install drain pipe at the highest point on the field and at various lower elevations to ensure full coverage of the filtration area. Pipe should be place with the holes up to allow for a gentle weeping of stormwater evenly out all holes. Leveling the pipe by staking and using sandbags may be required.
- To prevent the over saturation of the field area, rotate the use of branches or spray heads. Do this as needed based on monitoring the spray field.
- Monitor the spray field on a daily basis to ensure that over saturation of any portion of the field doesn't occur at any time. The presence of standing puddles of water or creation of concentrated flows visually signify that over saturation of the field has occurred.
- Since the operator is handling contaminated water, physically monitor the vegetated spray field all the way down to the nearest surface water, or furthest spray area, to ensure that the water has not caused overland or concentrated flows, and has not created erosion around the spray nozzle.
- Monitoring usually needs to take place 3-5 times per day to ensure sheet-flow into state waters. Do not exceed water quality standards for turbidity.
- Ecology strongly recommends that a separate inspection log be developed, maintained and kept with the existing site logbook to aid the operator conducting inspections. This separate "Field Filtration Logbook" can also aid the facility in demonstrating compliance with permit conditions.

Maintenance Standards

- Inspect the spray nozzles daily, at a minimum, for leaks and plugging from sediment particles.
- If erosion, concentrated flows, or over saturation of the field occurs, rotate the use of branches or spray heads or move the branches to a new field location.
- Check all branches and the manifold for unintended leaks.

Flowpath Guidelines for Vegetative Filtration		
Average Slope	Average Area % Slope	Estimated Flowpath Length (ft)
1.5H:1V	67%	250
2H:1V	50%	200
4H:1V	25%	150
6H:1V	16.7%	115
10H:1V	10%	100

Figure 4.2.15 – Manifold and Braches in a wooded, vegetated spray field

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

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or trap or other appropriate sediment removal best management practice. Non-engineered sediment traps may be used on-site prior to an engineered sediment trap or sediment pond to provide additional sediment removal capacity.

It is 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 six 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 and ponds 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.

Whenever possible, sediment-laden water shall be discharged into on-site, relatively level, vegetated areas (see BMP C234 – Vegetated Strip). This is the only way to effectively remove fine particles from runoff unless chemical treatment or filtration is used. This can be particularly useful after initial treatment in a sediment trap or pond. The areas of release must be evaluated on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Vegetated wetlands shall not be used for this purpose. Frequently, it may be possible to pump water from the collection point at the downhill end of the site to an upslope vegetated area. Pumping shall only augment the treatment system, not replace it, because of the possibility of pump failure or runoff volume in excess of pump capacity.

All projects that are constructing permanent facilities for runoff quantity control should use the rough-graded or final-graded permanent facilities for traps and ponds. This includes combined facilities and infiltration facilities. When permanent facilities are used as temporary sedimentation facilities, the surface area requirement of a sediment trap or pond must be met. If the surface area requirements are larger than the surface area of the permanent facility, then the trap or pond shall be enlarged to comply with the surface area requirement. The permanent pond shall also be divided into two cells as required for sediment ponds.

Either a permanent control structure or the temporary control structure (described in BMP C241, Temporary Sediment Pond) can be used. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the pond. A shut-off valve may be added to the control structure to allow complete retention of stormwater in emergency situations.

In this case, an emergency overflow weir must be added.

A skimmer may be used for the sediment trap outlet if approved by the Local Permitting Authority.

Design and Installation Specifications

- See Figures 4.2.16 and 4.2.17 for details.
- If permanent runoff control facilities are part of the project, they should be used for sediment retention.
- 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:

  $SA = FS(Q_2/V_S)$

  where

  Q_2 = Design inflow based on the peak discharge from the developed 2-year runoff event from the contributing drainage area as computed in the hydrologic analysis. The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used.

  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 (V_S) of 0.00096 ft/sec.

  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

  2080 square feet per cfs of inflow

  Note: Even if permanent facilities 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.
- To aid in determining sediment depth, all sediment traps shall have a staff gauge with a prominent mark 1-foot above the bottom of the trap.
- 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.

Maintenance Standards

- Sediment shall be removed from the trap when it reaches 1-foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

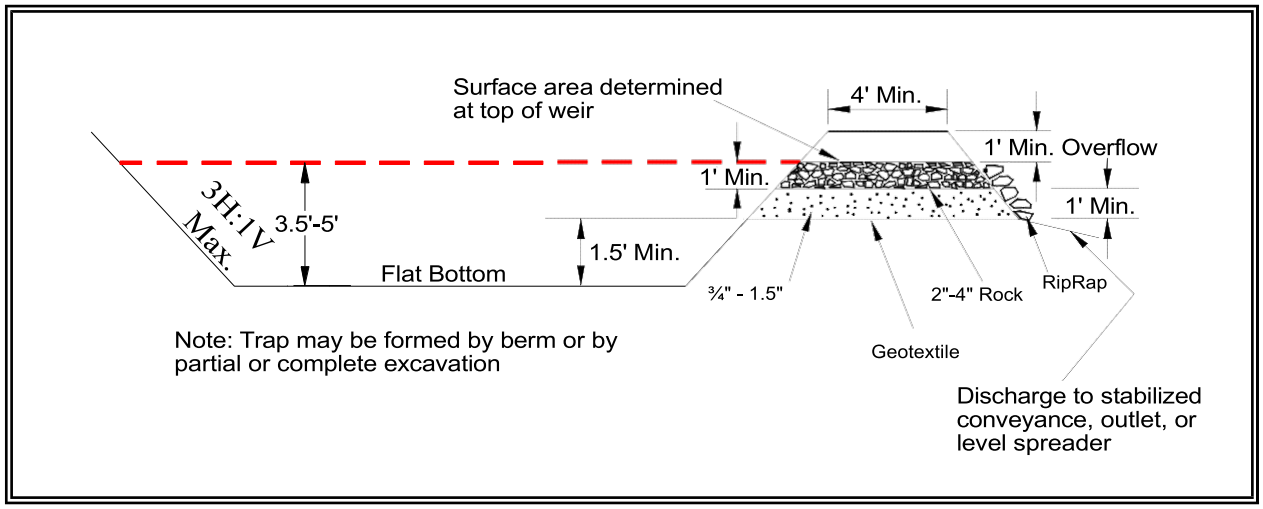


Figure 4.2.16 – Cross Section of Sediment Trap

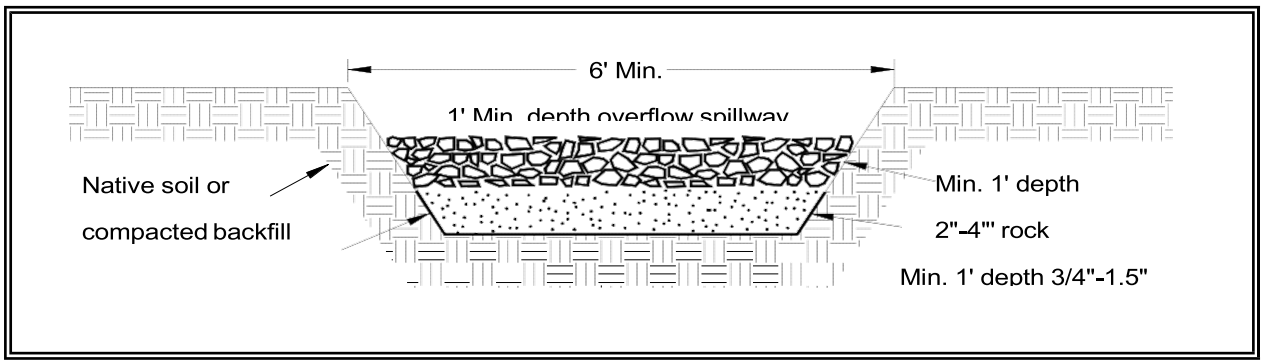


Figure 4.2.17 – Sediment Trap Outlet

BMP C252: High pH Neutralization Using CO_2

Purpose

When pH levels in stormwater rise above 8.5 it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5, this process is called pH neutralization. pH neutralization involves the use of solid or compressed carbon dioxide gas in water requiring neutralization. Neutralized stormwater may be discharged to surface waters under the General Construction NPDES permit.

Neutralized process water such as concrete truck wash-out, hydro-demolition, or saw-cutting slurry must be managed to prevent discharge to surface waters. Any stormwater contaminated during concrete work is considered process wastewater and must not be discharged to surface waters.

Reason for pH Neutralization:

A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this neutral pH is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Calcium hardness can contribute to high pH values and cause toxicity that is associated with high pH conditions. A high level of calcium hardness in waters of the state is not allowed.

The water quality standard for pH in Washington State is in the range of

6.5 to 8.5. Ground water standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

Conditions of Use

Causes of High pH:

High pH at construction sites is most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures). The principal caustic agent in cement is calcium hydroxide (free lime).

Advantages of CO_2 Sparging:

- Rapidly neutralizes high pH water.
- Cost effective and safer to handle than acid compounds.
- CO_2 is self-buffering. It is difficult to overdose and create harmfully low pH levels.
- Material is readily available.

The Chemical Process:

When carbon dioxide (CO_2) is added to water (H_2O), carbonic acid (H_2CO_3) is formed which can further dissociate into a proton (H^+) and a bicarbonate anion (HCO_3^-) as shown below:

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

The free proton is a weak acid that can lower the pH. Water temperature has

an effect on the reaction as well. The colder the water temperature is the slower the reaction occurs and the warmer the water temperature is the quicker the reaction occurs. Most construction applications in Washington State have water temperatures in the 50°F or higher range so the reaction is almost simultaneous.

Design and Installation Specifications

Treatment Process:

High pH water may be treated using continuous treatment, continuous discharge systems. These manufactured systems continuously monitor influent and effluent pH to ensure that pH values are within an acceptable range before being discharged. All systems must have fail safe automatic shut off switches in the event that pH is not within the acceptable discharge range. Only trained operators may operate manufactured systems. System manufacturers often provide trained operators or training on their devices.

The following procedure may be used when not using a continuous discharge system:

1. Prior to treatment, the appropriate jurisdiction should be notified in accordance with the regulations set by the jurisdiction.
2. Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater on-site.
3. Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
4. Transfer water to be treated to the treatment structure. Ensure that treatment structure size is sufficient to hold the amount of water that is to be treated. Do not fill tank completely, allow at least 2 feet of freeboard.
5. The operator samples the water for pH and notes the clarity of the water. As a rule of thumb, less CO2 is necessary for clearer water. This information should be recorded.
6. In the pH adjustment structure, add CO2 until the pH falls in the range of 6.9-7.1. Remember that pH water quality standards apply so adjusting pH to within 0.2 pH units of receiving water (background pH) is recommended. It is unlikely that pH can be adjusted to within 0.2 pH units using dry ice. Compressed carbon dioxide gas should be introduced to the water using a carbon dioxide diffuser located near the bottom of the tank, this will allow carbon dioxide to bubble up through the water and diffuse more evenly.
7. Slowly discharge the water making sure water does not get stirred up in the process. Release about 80% of the water from the structure leaving any sludge behind.
8. Discharge treated water through a pond or drainage system.
9. Excess sludge needs to be disposed of properly as concrete waste. If several batches of water are undergoing pH treatment, sludge can be left in treatment structure for the next batch treatment. Dispose of sludge when it fills 50% of tank volume.

Sites that must implement flow control for the developed site must also control stormwater release rates during construction. All treated stormwater must go through a flow control facility before being released to surface waters which require flow control.

Maintenance Standards

Safety and Materials Handling:

- All equipment should be handled in accordance with OSHA rules and regulations.
- Follow manufacturer guidelines for materials handling.

Operator Records:

Each operator should provide:

- A diagram of the monitoring and treatment equipment.
- A description of the pumping rates and capacity the treatment equipment is capable of treating.

Each operator should keep a written record of the following:

- Client name and phone number.
- Date of treatment.
- Weather conditions.
- Project name and location.
- Volume of water treated.
- pH of untreated water.
- Amount of CO_2 needed to adjust water to a pH range of 6.9-7.1.
- pH of treated water.
- Discharge point location and description.

A copy of this record should be given to the client/contractor who should retain the record for three years.

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix K
Historical Water Sampling Data

18 March 2013

Technical Memorandum

To: Matt Graves, Port of Vancouver

From: Alan Flemming

Subject: Terminal 4 Pond Particle Size Distribution and Sample Analysis
Port of Vancouver Decant Facility
K/J 1092004*00

This technical memorandum summarizes the sampling and particle size distribution (PSD) analyses completed for the Terminal 4 stormwater pond, and presents a discussion of initial indications of the data. Four locations near the pond were sampled on 28 January 2013 and on 28 February 2013; one at the outlet (T4M) and three at the inlets (M1, 1D, 1A). In October 2012, three locations were sampled and optical/microscopic particle size distribution analyses were completed for locations T4M, M001, and 1D001. These data and the particle size distribution histograms are presented in the following pages and discussed below. The approximate sample locations and areas draining to each location are shown on Figure 1.

Table 1: Sample Points

Sample Location - Description	Approx. Drainage Area
T4M – Pond Outlet	250 acres
M1 (1M, M001) – East Side of Pond; maintenance shop, Terminal 3	120 acres
1D (1D001) – Parcel 1D; West side of pond, parking lot/laydown area	75 acres
1A – Parcel 1A; North side of Pond, Farwest Steel, new construction	55 acres

Table 2: Sample Data

Sample Point	T4M		M1		1D		1A	
Sample Date (2013)	Jan	Feb	Jan	Feb	Jan	Feb	Jan	Feb
Turbidity (NTU)	25.5	24.5	68.6	61.8	81.3	422.0	196.1	500.0
TSS (mg/L)	< 5.0	< 5.0	31.0	45	24.0	55	34.0	270
pH	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Conductivity (umhos/cm)	74.1	52	18.1	63	16.8	60	67.0	63
total Cu (µg/L)	44.7	33	123.0	120	13.3	78	27.3	57
dissolved Cu (µg/L)	18.3	14	20.7	33	3.43	6.2	3.48	4.5
% dissolved Cu	41%	42%	17%	28%	26%	8%	13%	8%
total Zn (µg/L)	87.9	54	109.0	170	47.2	320	64.6	170
dissolved Zn (µg/L)	71.1	30	62.0	110	24.8	13	< 4.0	< 4.0
% dissolved Zn	81%	56%	57%	65%	53%	4%	0%	0%
mean particle size (µm)	0.969	0.975	2.008	1.033	2.137	2.059	11.04	2.357
median part. size (µm)	0.677	0.693	1.664	0.656	1.646	0.744	2.240	1.146

Notes:

1 - Red values would exceed ISGP benchmarks.

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Abbreviations:

µg/L = micrograms per liter
µm = micron/micrometer
umhos/cm = micromho per centimeter
Mg/L = milligrams per liter
NTU = nephelometric turbidity unit
TSS = total suspended solids
Cu = copper
Zn = zinc

Turbidity and copper are the only parameters that exceeded the Industrial Stormwater General Permit (ISGP) benchmarks at the Pond outlet for these sampling events. Turbidity exceeded the benchmark by a very small amount, and that parameter may improve as the pond continues to age and construction completion reduces influent solids concentrations. Sample point M1 appears to be a significant source of copper, particularly in the dissolved fraction, which is assumed to originate from copper concentrate handling in that drainage basin.

Parcel 1A appears to be a significant source of turbidity, which is presumed to originate from construction activity. Turbidity at sample location 1A is more than twice the level at the other locations for the January sample, but Total Suspended Solids (TSS) is not significantly higher. This sample also has a higher percentage of larger particles with high surface area and high conductivity. A similar high turbidity and low TSS occurs at sample location 1D for the February sample. In any case, the pond appears to be effective at reducing both turbidity and TSS to near benchmark levels. As construction activity is reduced, turbidity in the pond effluent is anticipated to continue to improve.

The laser PSDs presented in the figures on the following pages show that the inlet and outlet samples have a high percentage of particles near the 0.5 micron (µm) size (except for sample point 1A, which has a high percentage at 0.2 µm) and near the 2.0 µm size. These particular particle size distributions may be due to coagulation and preferential settling of other size ranges, but this cannot be confirmed with the current data. Additional analysis would be required to characterize the settling behavior. It should also be noted that these particle sizes are at the bottom of the size range of settleable airborne dust which may never settle in a turbulent atmosphere unless washed out by rain. Additional characterization of airborne particulate matter at the port may be helpful in understanding contamination in the stormwater if it confirms high copper concentrations in airborne dust.

Sample point M1 has both a high total copper level and a high dissolved copper level. The other inlet samples have low dissolved copper levels and relatively low total copper levels. This sample data appears to confirm the source of copper in the pond is through sample point M1 and its watershed east of the pond. The high dissolved copper level measured at sample point M1 appears to pass through the pond with little removal, and the observed reduction in dissolved copper level at the pond outlet may be due only to dilution.

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Based on the analytical methods used in sample preparation before analysis, metals associated with particles smaller than 0.45 µm may be reported as dissolved metals because they may pass through the filter used to separate particulate from the dissolved fraction. Based on review of particle size on a volume percent (%) basis (data not presented here) for the January T4M sample, 13% of the particles by volume were less than 0.452 µm, and for the February T4M sample, 1.8% of the particles by volume were less than 0.452 µm. Approximately 40% of the copper and 70% of the zinc are reported as dissolved in these same samples. This difference between the percent of particles that are less than 0.45 µm and the percentages of dissolved metals suggests that metals reported as dissolved may be truly dissolved, and not associated with particles less than 0.45 µm.

Comparisons of the particle size distributions obtained through optical methods data generally show similar PSDs in October and January. This suggests that the particle size distributions were similar for these two sampling events. However, the optical analyses generally show much larger particle sizes than the laser analyses. For the optical analysis, the sample is shaken by hand, and then observed under a microscope. For the laser particle size distribution, the sample is circulated during the analysis by a pump operating at 1865 revolutions per minute (rpm). The larger particles observed in the optical analysis are likely to be coagulated particles that are broken apart by the pump during the laser PSD analysis. This supposition is supported by the descriptions in the Chemoptix reports. For example, the T4M sample from October includes the following description: “This particle assemblage contained large fractions of soft amalgamates with ~ 1 µm particle inclusions. Despite their poor consolidation, the amalgamates remained intact despite brisk hand-agitation. The data presented here represent the amalgamates…” Similar descriptions were included for all the October samples and most of the January samples.

Review of the laser PSD data suggests that the pond effectively removes particles larger than approximately 5 µm. This may be occurring through settling of naturally coagulated particles. However, as discussed above, the optical analyses show much larger particle amalgamates in both the pond inlets and outlet. It may be that amalgamates containing larger particles have sufficient density to settle in the pond, while those containing only finer particles do not. It also appears that no particles larger than ~ 8 µm are reaching the inlets at sample points M1 and 1D in January. This may be due to removal of larger particles by sweeping or removal in catch basin sumps or inserts. A size distribution analysis of sweeper truck waste might help confirm this last supposition. The high turbidity and high total zinc measured at sample point 1D in February may be related to the larger particles (10-20 µm) seen in this sample and may be the result of the area not having been swept recently.

On a length basis, the optical analyses of samples from locations 1D and 1A appear to be very similar in January; however, on an area basis (data not presented here), the sample from location 1A appears to have larger particles. On a length basis, the optical analysis at 1D also shows smaller particles in October. As noted above in the discussion on turbidity and TSS, and

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as indicated by its higher conductivity, the January sample from location 1A is likely to have different types of particles from the other two locations and samples.

We recommend that the port consider collecting at least one additional sample at these same locations and request the same analyses, to characterize the potential variability in stormwater influent and effluent at the Terminal 4 Pond. We also recommend the port consider characterization of the airborne dust at the port, and its copper concentration. Kennedy/Jenks Consultants (Kennedy/Jenks) can assist with developing a specific sampling plan to determine the contribution of airborne pollutants to the port's stormwater runoff if the port chooses to pursue this option.

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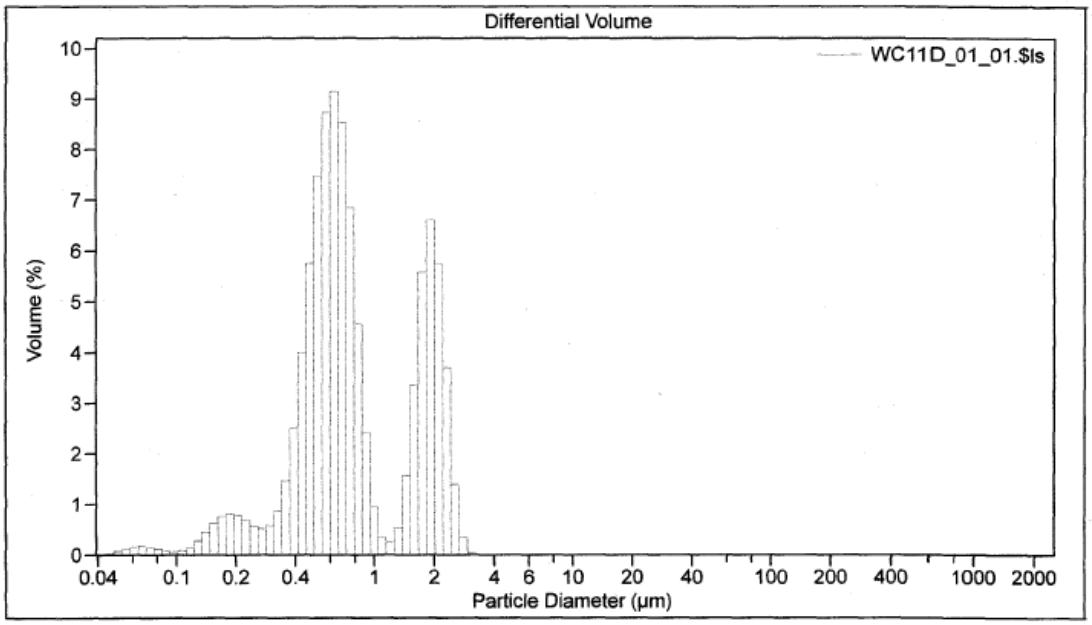
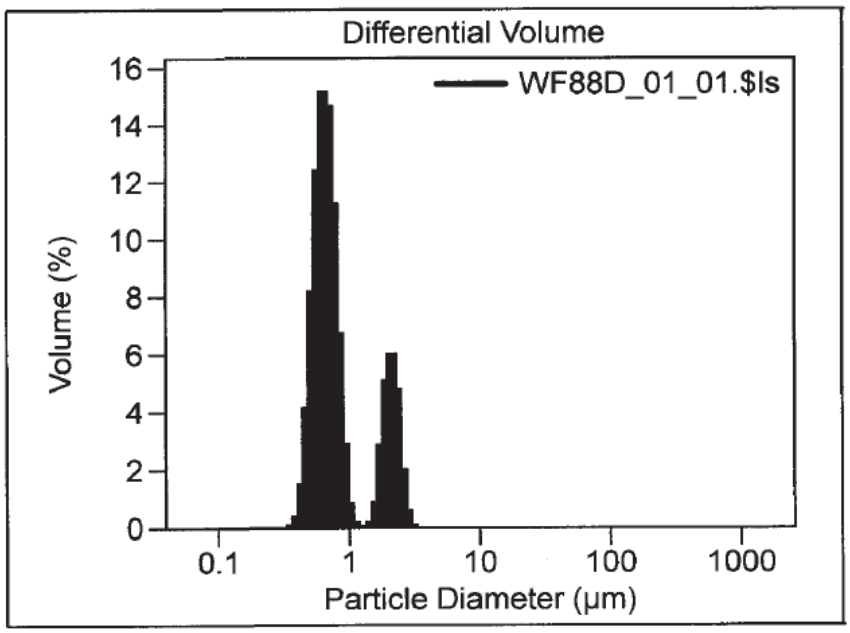
Technical Memorandum

Matt Graves, Port of Vancouver
18 March 2013
1092004*00
Page 5

T4M – Pond Outlet
28 January 2013 top figure, 28 February 13 bottom figure, (same analysis, presentation differs)
- very similar results for two samples, bimodal at ~0.5 and ~ 2.0 µm, all < ~5.0 µm





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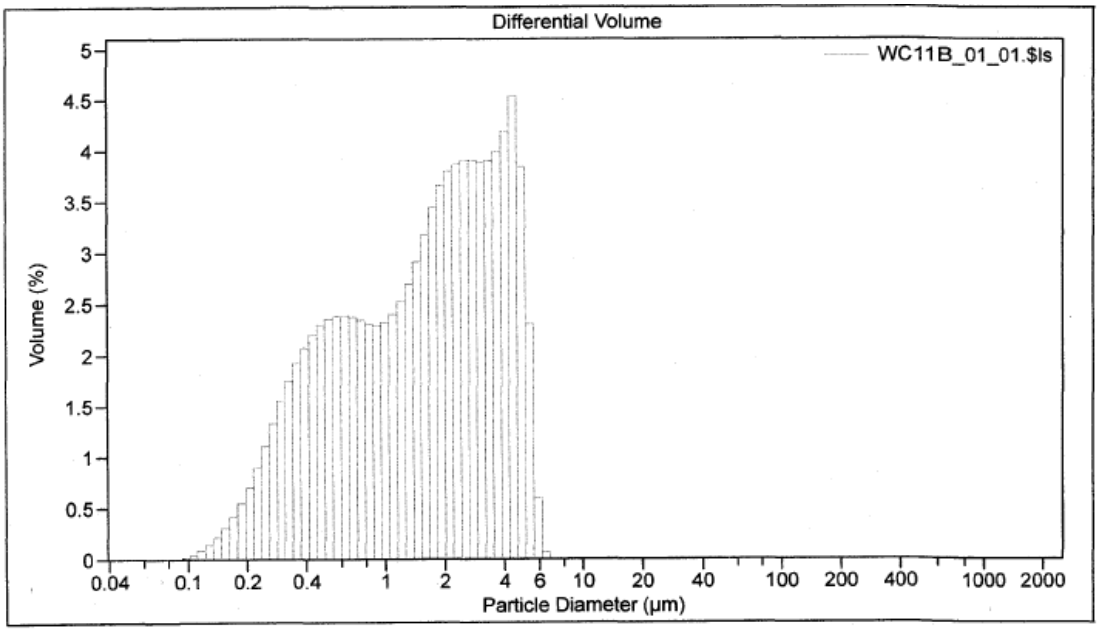
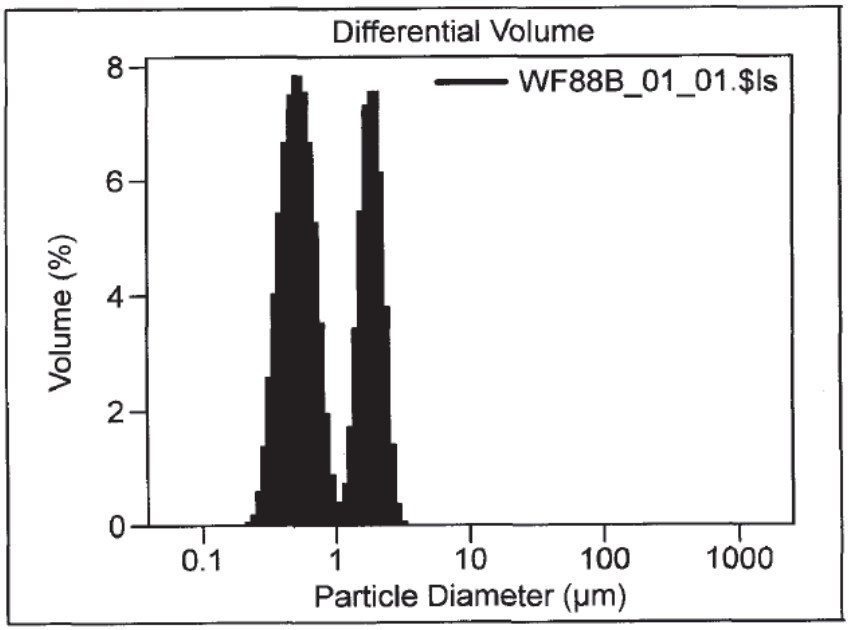
Technical Memorandum

Matt Graves, Port of Vancouver
18 March 2013
1092004*00

M1 – East Side of Pond; maintenance shop, Terminal 2

28 January 2013 top figure, 28 February 13 bottom figure, (same analysis, presentation differs)
- similar bimodal samples at ~0.4 and ~ 3.0 µm, all < ~6.0 µm, variability unexplained





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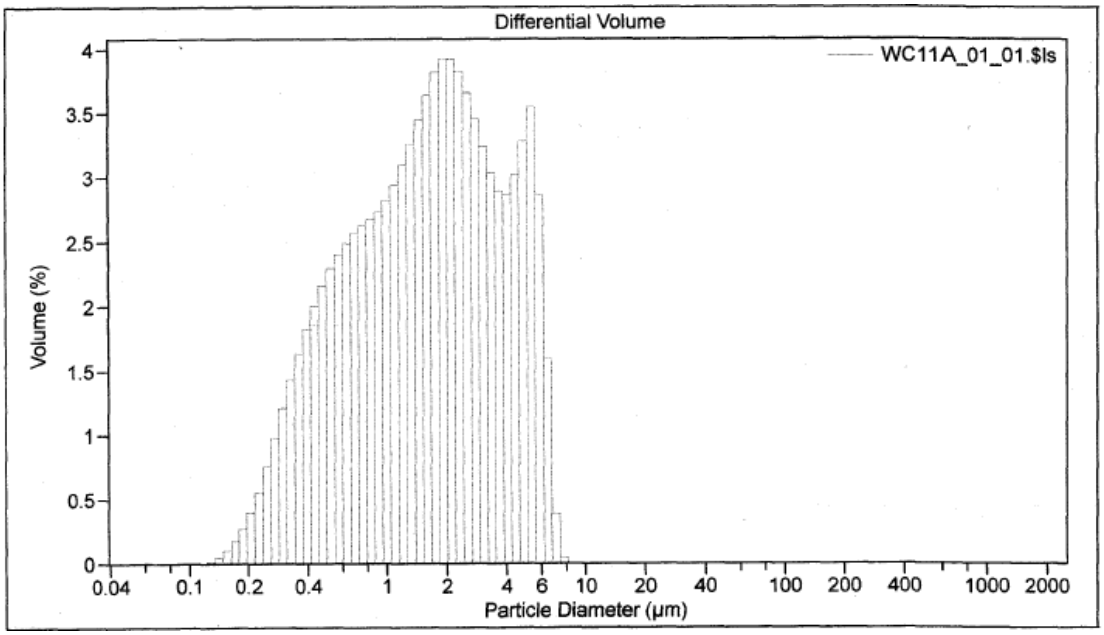
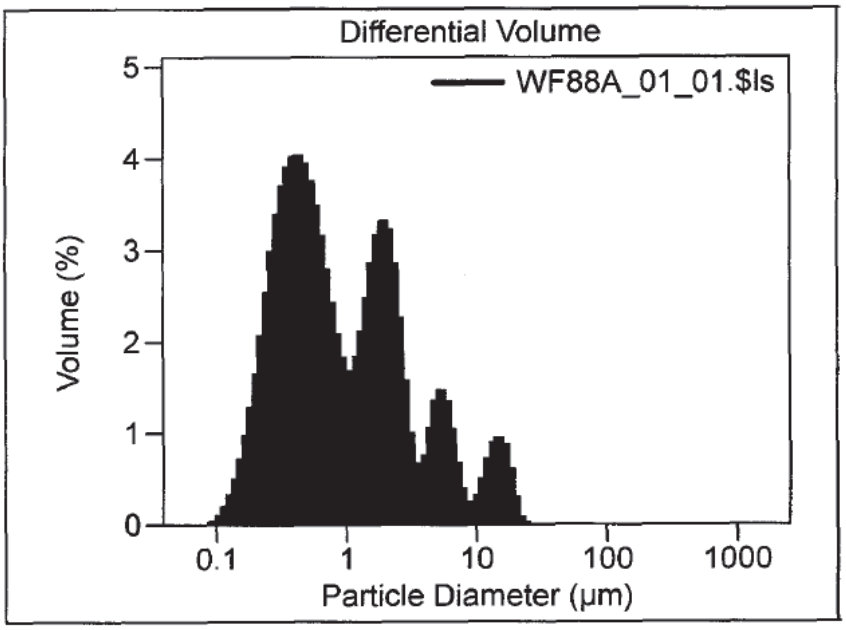
Matt Graves, Port of Vancouver
18 March 2013
1092004*00
Page 7

1D – Parcel 1D; West side of pond, parking lot/laydown area

28 January 2013 top figure, 28 February 13 bottom figure, (same analysis, presentation differs) - samples variable, may be due to timing of sweeping?,





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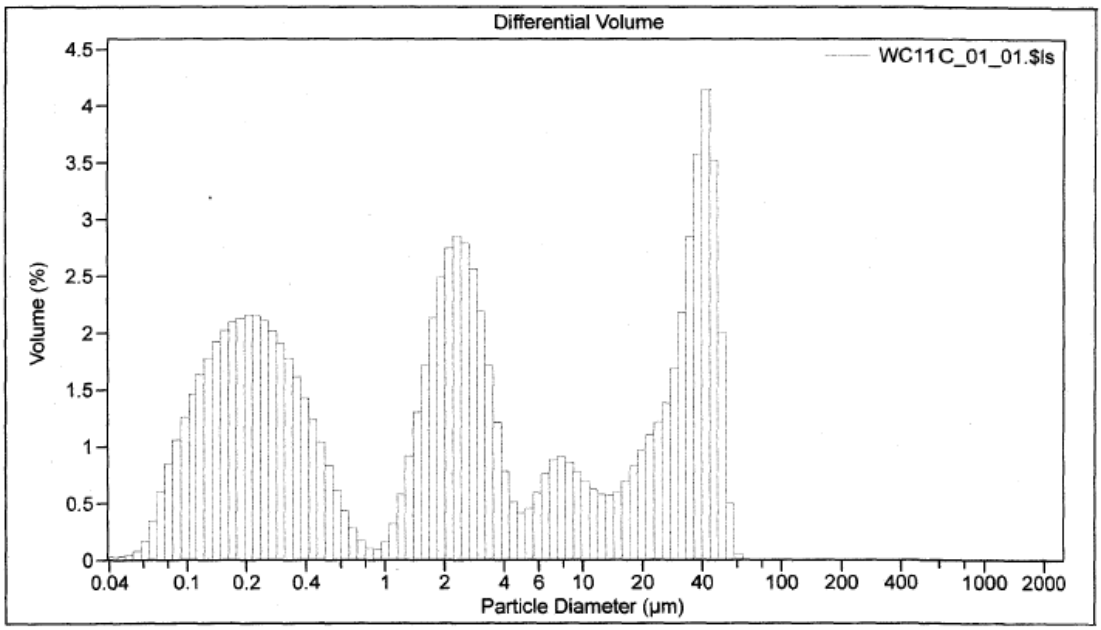
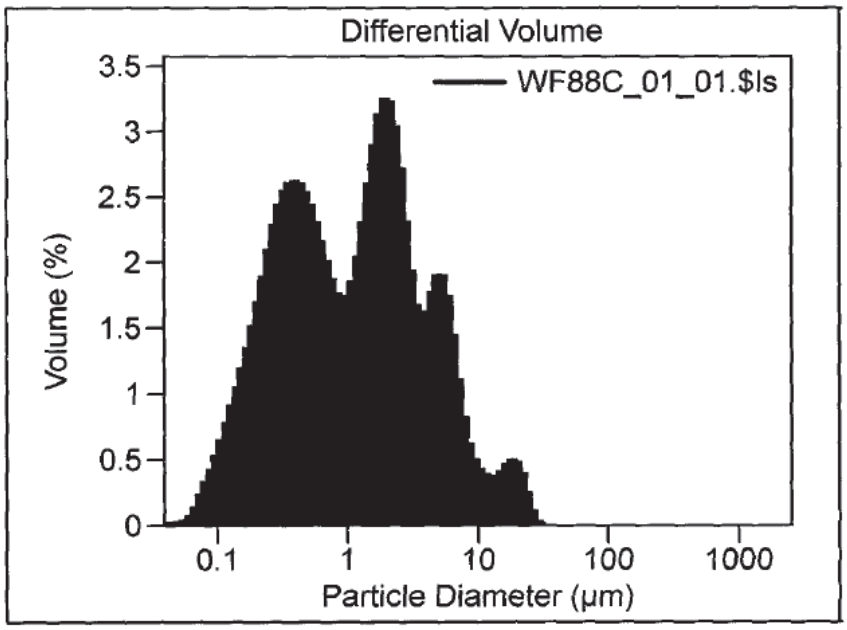
Matt Graves, Port of Vancouver
18 March 2013
1092004*00

1A – Parcel 1A; North side of Pond, Farwest Steel, new construction

28 January 2013 top figure, 28 February 13 bottom figure, (same analysis, presentation differs)
- similar distributions below ~ 20 µm , ~ 40 µm particles in January may be due to construction





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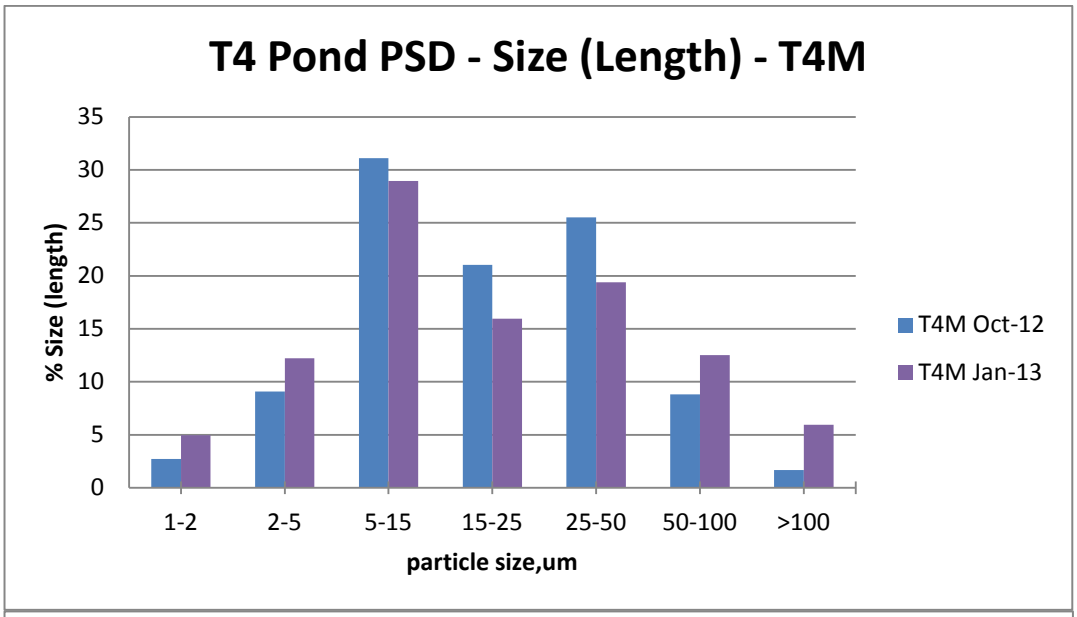
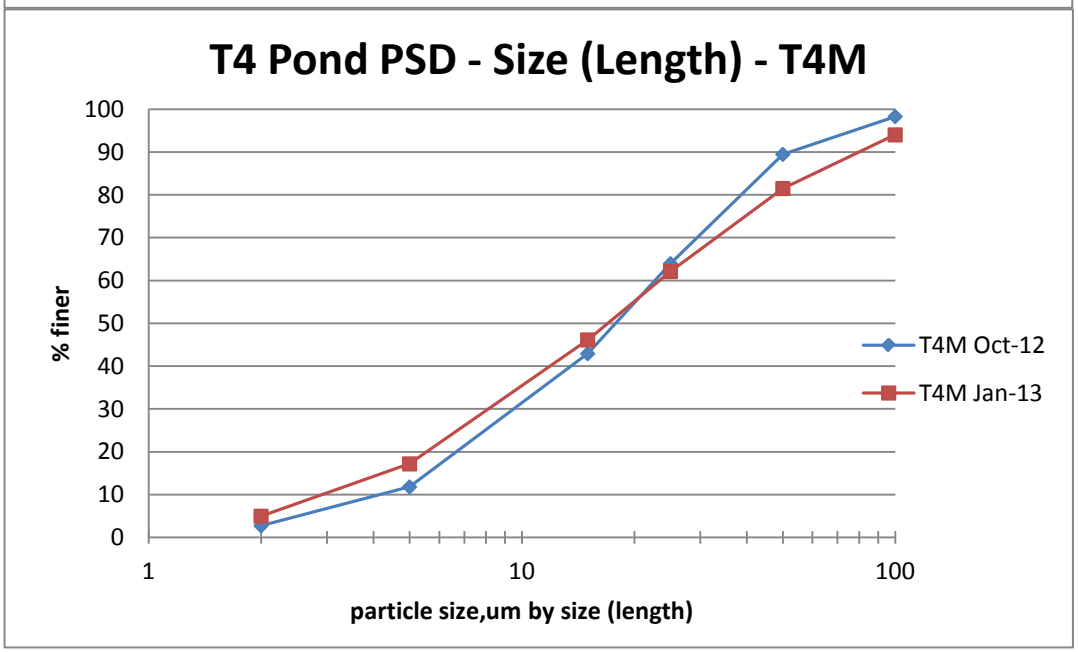
Technical Memorandum

Matt Graves, Port of Vancouver
18 March 2013
1092004*00
Page 9

OPTICAL DATA

T4M





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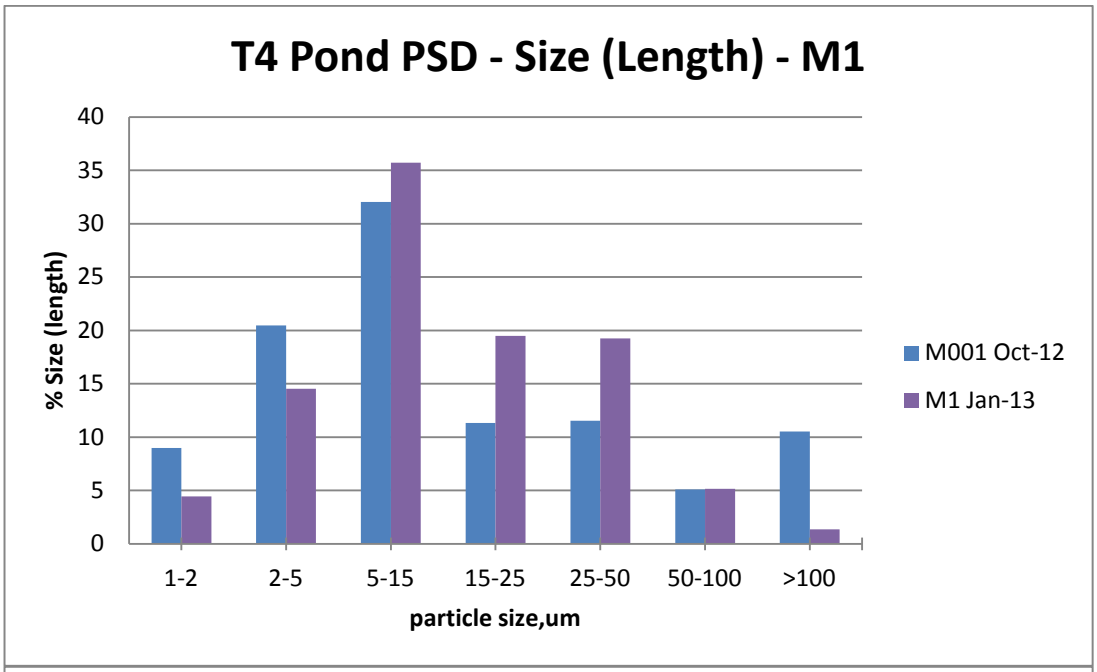
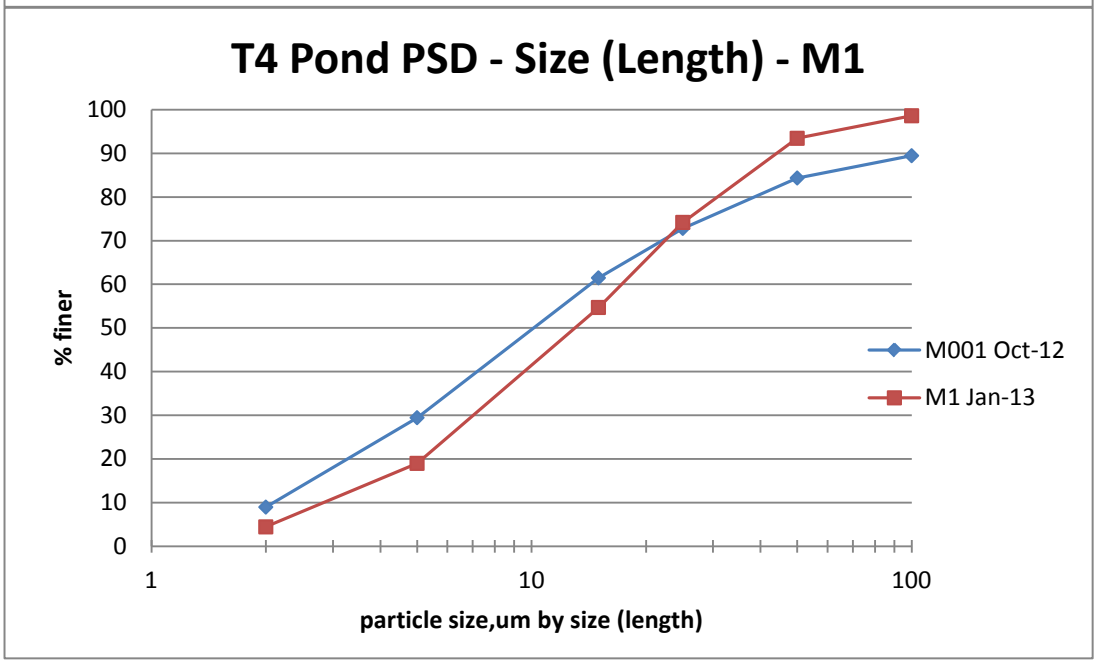
Technical Memorandum

Matt Graves, Port of Vancouver
18 March 2013
1092004*00
Page 10

M1





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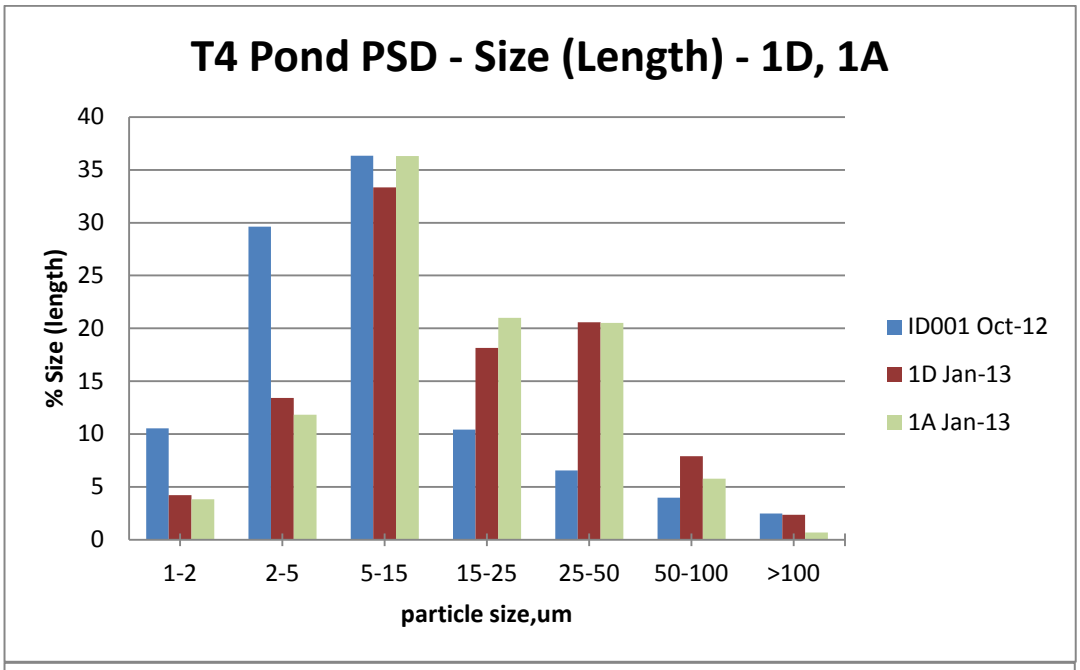
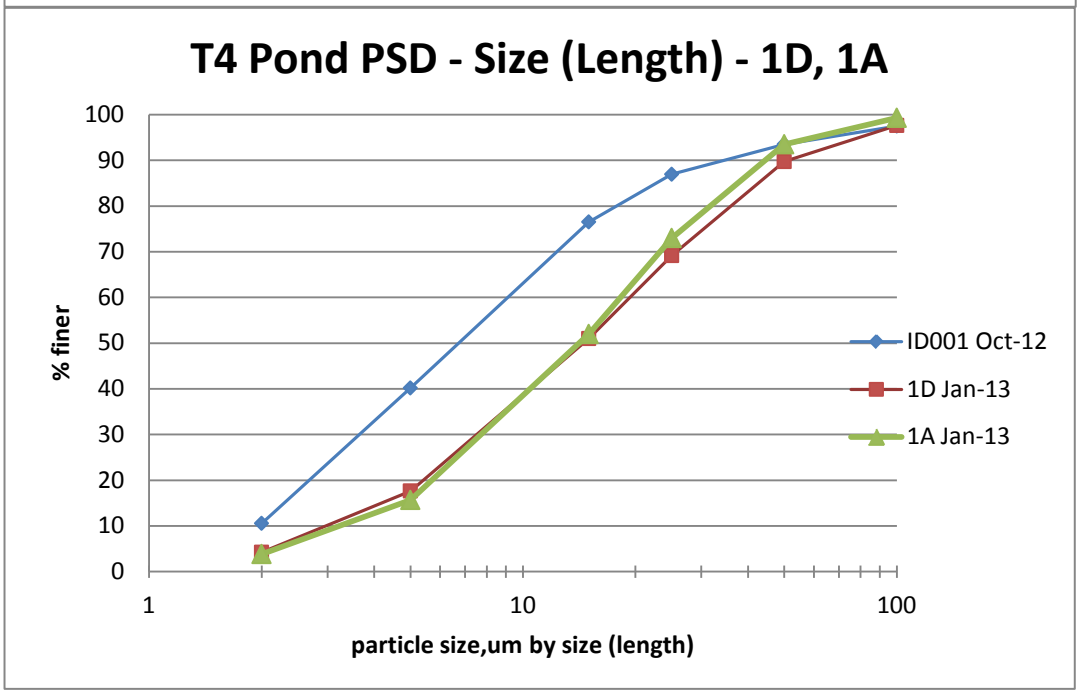
Technical Memorandum

Matt Graves, Port of Vancouver
18 March 2013
1092004*00

1D & 1A





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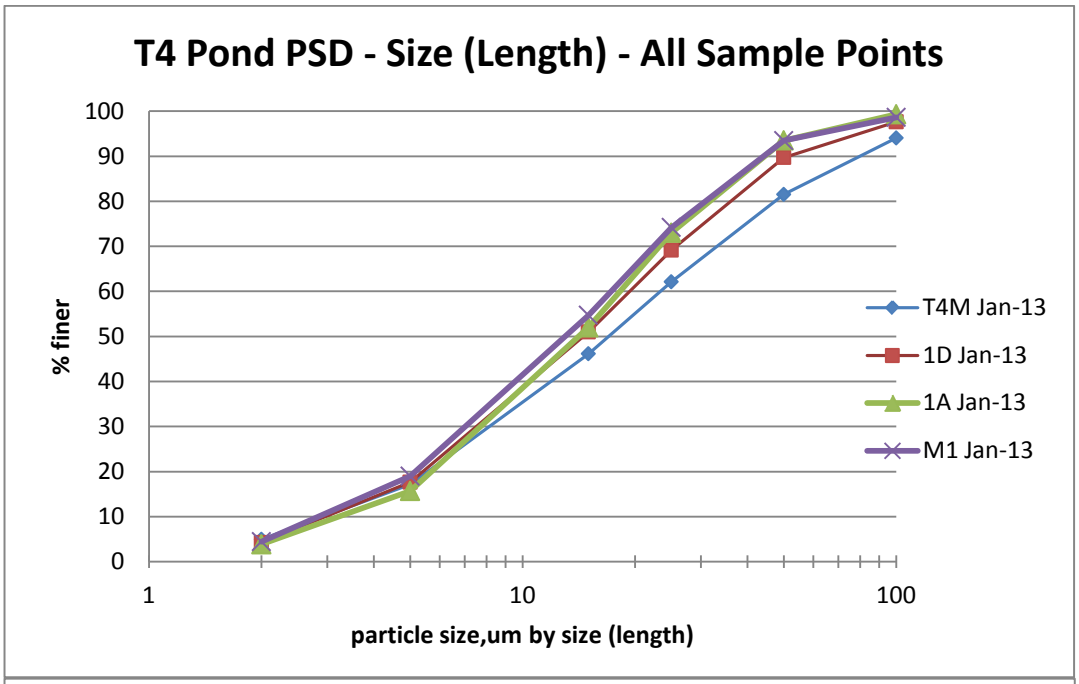
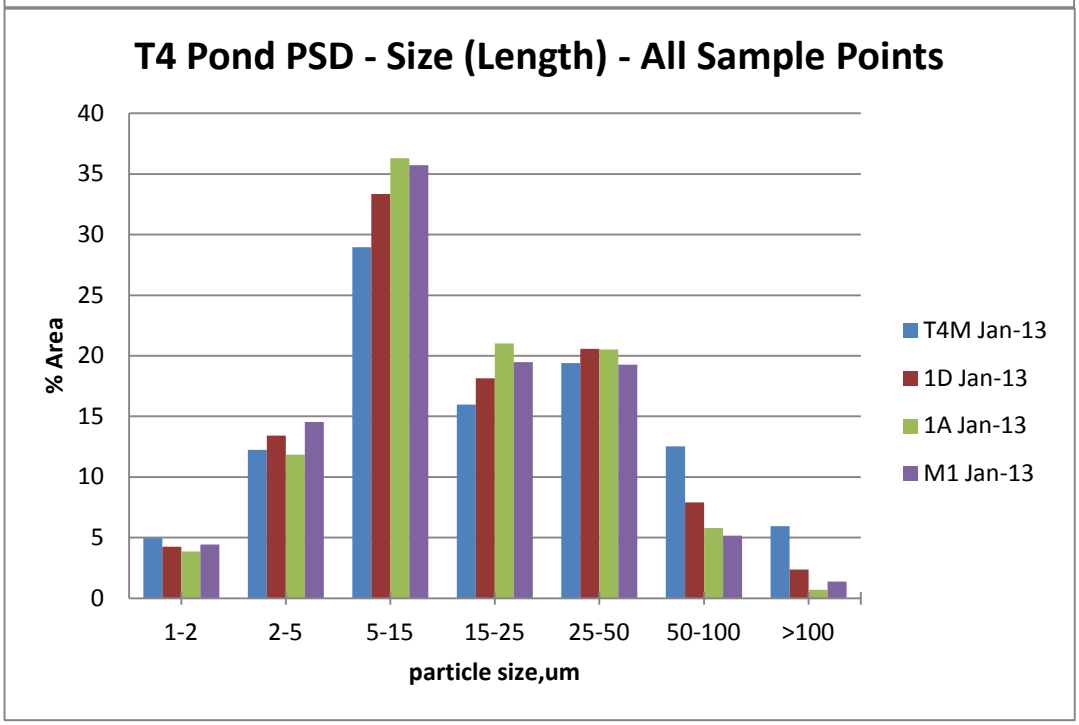
Jan 13 – All Samples





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Approximate location of sample point

Approximate subbasin boundary

Kennedy/Jenks Consultants

TERMINAL 4 POND SAMPLING LOCATIOINS AND DRAINAGE BASINS

FIGURE 1

EX-0001-004399-PCE

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix L
Site Inspection Forms

Site Inspection Form

General Information			
Project Name:			
Inspector Name:		**Title:** **CESCL # :**	
Date:		**Time:**	
Inspection Type:	□ After a rain event □ Weekly □ Turbidity/transparency benchmark exceedance □ Other		
Weather			
Precipitation	Since last inspection	In last 24 hours	
Description of General Site Conditions:			

Inspection of BMPs
Element 1: Mark Clearing Limits
BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 2: Establish Construction Access

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 3: Control Flow Rates

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 4: Install Sediment Controls

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
		Y	N		Y	N	NIP

BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
		Y	N		Y	N	NIP

BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
		Y	N		Y	N	NIP

BMP:							
Location	Inspected			Functioning			Problem/Corrective Action
		Y	N		Y	N	NIP

Element 5: Stabilize Soils

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 6: Protect Slopes

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 7: Protect Drain Inlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 8: Stabilize Channels and Outlets

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 9: Control Pollutants

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Element 10: Control Dewatering

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

BMP:

Location	Inspected		Functioning			Problem/Corrective Action
	Y	N	Y	N	NIP	

Stormwater Discharges From the Site			
	Observed?		Problem/Corrective Action
	Y	N	
Location			
Turbidity			
Discoloration			
Sheen			
Location			
Turbidity			
Discoloration			
Sheen			

Water Quality Monitoring
Was any water quality monitoring conducted? ☐ Yes ☐ No If water quality monitoring was conducted, record results here:
If water quality monitoring indicated turbidity 250 NTU or greater; or transparency 6 cm or less, was Ecology notified by phone within 24 hrs? ☐ Yes ☐ No
If Ecology was notified, indicate the date, time, contact name and phone number below: Date: Time: Contact Name: Phone #:
General Comments and Notes Include BMP repairs, maintenance, or installations made as a result of the inspection.
Were Photos Taken? ☐ Yes ☐ No If photos taken, describe photos below:

Construction Stormwater Pollution Prevention Plan

Vancouver Energy
EFSEC Application for Site Certification No. 2013-01
Docket No. EF131590

Appendix M
Cap Restoration Details

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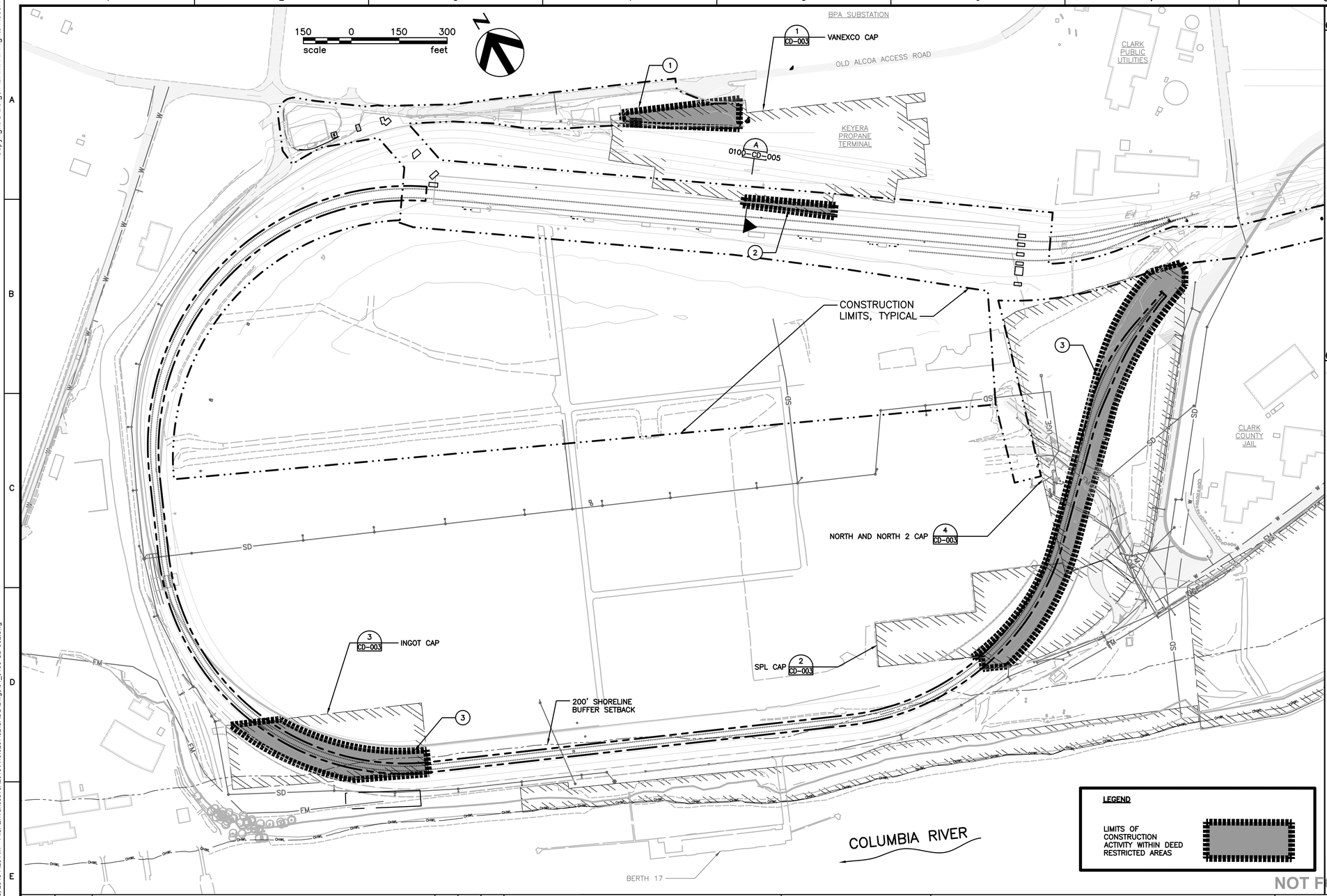

GENERAL NOTES:

1. CONTRACTOR'S ACTIVITY SHALL STRICTLY COMPLY WITH ALL PERMITTED CONDITIONS OF APPROVAL.
2. EXCAVATIONS AND GROUND DISTURBING ACTIVITIES WITHIN DEED RESTRICTED AREAS REQUIRES NOTIFICATION TO THE WASHINGTON STATE ENERGY FACILITY SITE EVALUATION COUNCIL (EFSEC) AND COMPLIANCE WITH THE APPROVED CONTAMINATED MEDIA MANAGEMENT PLAN, APPLICABLE PORT PROTOCOLS AND ADDITIONAL REQUIREMENTS PROVIDED BY EFSEC.
3. SPECIFIC LIMITS FOR THE EAST LANDFILL LIMITS ARE PROVIDED BASED UPON PRIOR SURVEY'S CONDUCTED BY HDJ DESIGN GROUP. WORK LIMIT SHALL ENCROACH UPON THE BOUNDARY OF THE EAST LANDFILL.
4. WHERE KNOWN, ADDITIONAL AREAS OF CONCERN AND POSSIBLE CONTAMINATED MEDIA LOCATIONS HAVE BEEN GENERALLY DEPICTED. CONTRACTOR SHALL COORDINATE FULLY WITH PORT OF VANCOUVER ENVIRONMENTAL STAFF AND INSPECTORS FOR MONITORING AND TESTING OF EXCAVATED MEDIA FOR POSSIBLE CONTAMINATES. PORTIONS OF AREA 200 AND AREA 500 ARE SPECIFICALLY IDENTIFIED WHERE CONTAMINATION IS LIKELY TO BE ENCOUNTERED DURING EXCAVATIONS.
5. IF MEDIA INCLUDING SOILS, OR GROUNDWATER ARE ENCOUNTERED THAT INDICATE POSSIBLE CONTAMINATION, CONTRACTOR SHALL NOTIFY VANCOUVER ENERGY SITE MANAGER, PORT OF VANCOUVER AND EFSEC IMMEDIATELY PRIOR TO PROCEEDING. SIGNS OF CONTAMINATION INCLUDE UNUSUALLY DARK SOIL AND ODORS.
6. IN AREAS OF CONCERN EXCAVATED MATERIAL SHALL BE PLACED IN SEALED WATER-TIGHT CONTAINERS OR LINED STAGING AREAS IMMEDIATELY ADJACENT TO THE WORK AREA FOR TESTING AND CLASSIFICATION OF MATERIAL PRIOR TO HAUL OFF.

CONTAMINATED MEDIA NOTES:

1. CONSTRUCTION ACTIVITIES WITHIN THIS PORTION OF THE VANEXCO CAP WILL BE LIMITED TO GROUND DISTURBANCES ABOVE THE EXISTING CONCRETE CAP. SOME MINOR EXPOSURE OF THE CONCRETE SURFACE MAY OCCUR IN LOCALIZED AREAS. NO WORK WITHIN THIS AREA WILL REMOVE OR PENETRATE PORTIONS OF THE CAP.

2. CONSTRUCTION ACTIVITIES WITHIN THIS PORTION OF THE VANEXCO CAP WILL RESULT IN MODIFICATION OF THE UNDERDRAIN SYSTEM AND HDPE LINER. DISCHARGES FROM THE UNDERDRAIN SYSTEM WILL BE RE-ROUTED TO AVOID CONFLICTS WITH THE PROPOSED RAIL UNLOADING BUILDING FOUNDATIONS AND CONTAINMENT TRENCHES, SEE DWG 0100-CD-006 FOR LINER PENETRATION DETAIL, AND SHEET 0100-CD-007 FOR NEW STORMWATER DETAILS. LINER WILL BE EXTENDED TO AND TIED INTO THE GRADE BEAMS OF THE RAIL UNLOADING BUILDING FOUNDATION SEE DWG 0100-CD-006 FOR DETAILS. FOUNDATIONS OF THE RAIL UNLOADING BUILDING WITHIN THE EXISTING CAP AREA WILL BE LIMITED TO SHALLOW SPREAD FOOTINGS TO LIMIT EXCAVATION ACTIVITIES. CONSTRUCTION OF RAIL UNLOADING BUILDING CONSISTS OF FULLY IMPERVIOUS ROOF WITH CAST-IN-PLACE CONCRETE SURFACING WITH FLOOR DRAINS. ALL RAINWATER WILL BE COLLECTED AND DIVERTED, THEREBY EXCLUDING SURFACE WATER FROM ENTERING CAP AREA.

3. CONSTRUCTION WITHIN THE INGOT CAP, SPL CAP, AND NORTH AND NORTH 2 CAP AREAS ARE LIMITED TO RAIL IMPROVEMENTS ONLY. RAIL LINES TO BE UNDER TSJV CONTROL ARE PERMITTED UNDER EFSEC APPLICATION. CONSTRUCTION DRAWINGS, DETAILS, AND CONSTRUCTION ADMINISTRATION FOR ADDITIONAL 2 RAIL LOOPS WILL BE COMPLETED BY THE PORT OF VANCOUVER AS DISCUSSED IN THE LEASE AGREEMENT.

PERMIT SET
NOT FOR CONSTRUCTION

SAM ADAMS — STATE OF WASHINGTON — 22330 — REGISTERED PROFESSIONAL ENGINEER

NO.	DATE	REVISION	BY	CK'D	APP

BergerABAM
700 NE Multnomah Street, Suite 900
Portland, Oregon 97232-4189
(503) 872-4100 FAX: (503) 872-4101

VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: CONTAMINATED MEDIA LOCATIONS – 1

DESIGN:	DRS	START DATE:	2/25/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/25/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-CD-002 — SHEET 1/1 — REV.

Last Saved by: Tony.pritchett on: Feb 25, 2015 7:20 AM File: Q:\Vancouver\2013\A13.0267\02\CADD\Dwgs\04_0100-CD-002.dwg

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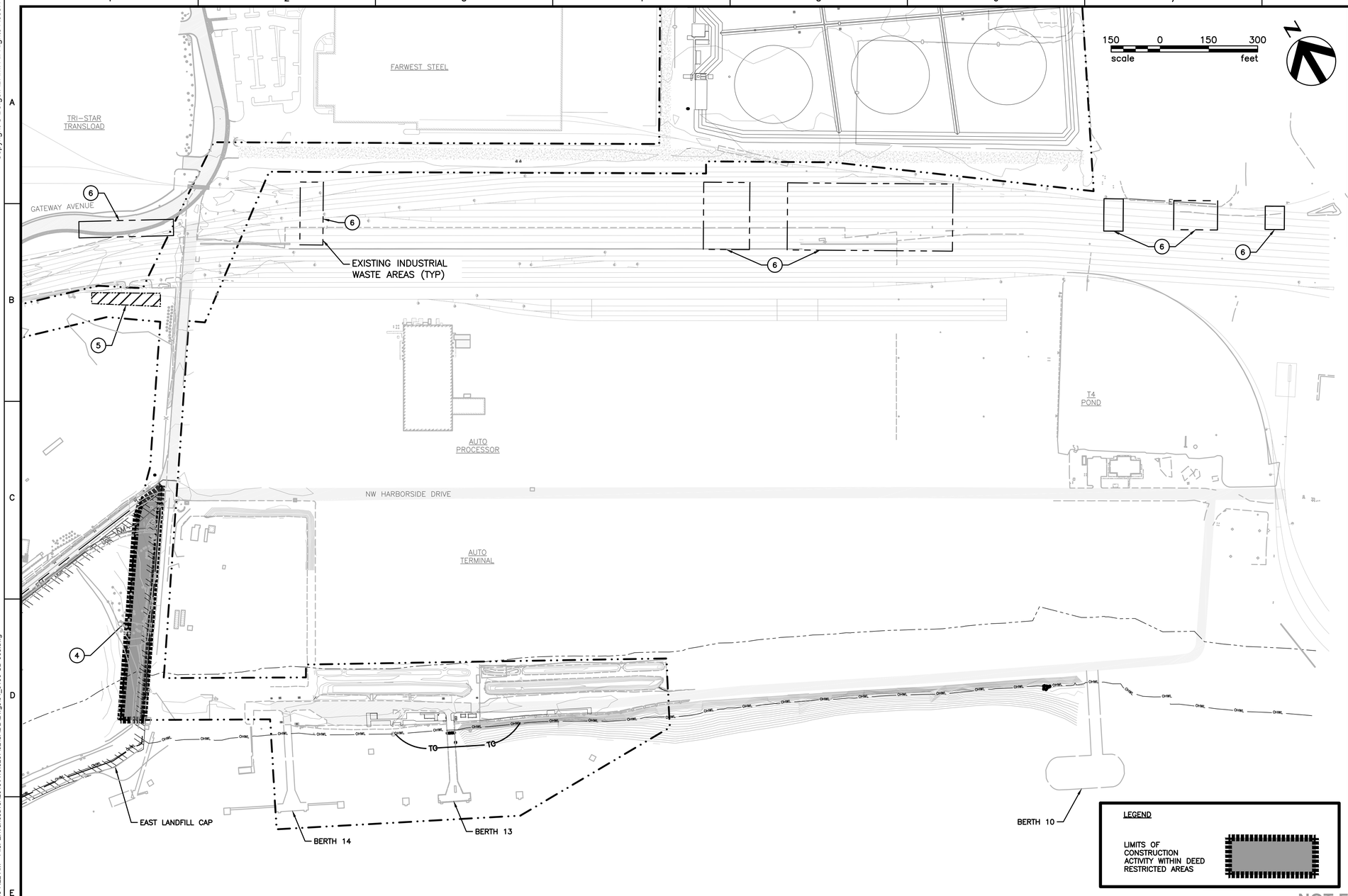

GENERAL NOTES:

1. CONTRACTOR'S ACTIVITY SHALL STRICTLY COMPLY WITH ALL PERMITTED CONDITIONS OF APPROVAL.
2. EXCAVATIONS AND GROUND DISTURBING ACTIVITIES WITHIN DEED RESTRICTED AREAS REQUIRES NOTIFICATION TO THE WASHINGTON STATE ENERGY FACILITY SITE EVALUATION COUNCIL (EFSEC) AND COMPLIANCE WITH THE APPROVED CONTAMINATED MEDIA MANAGEMENT PLAN, APPLICABLE PORT PROTOCOLS AND ADDITIONAL REQUIREMENTS PROVIDED BY EFSEC.
3. SPECIFIC LIMITS FOR THE EAST LANDFILL LIMITS ARE PROVIDED BASED UPON PRIOR SURVEY'S CONDUCTED BY HDJ DESIGN GROUP. WORK LIMIT SHALL ENCROACH UPON THE BOUNDARY OF THE EAST LANDFILL.
4. WHERE KNOWN, ADDITIONAL AREAS OF CONCERN AND POSSIBLE CONTAMINATED MEDIA LOCATIONS HAVE BEEN GENERALLY DEPICTED. CONTRACTOR SHALL COORDINATE FULLY WITH PORT OF VANCOUVER ENVIRONMENTAL STAFF AND INSPECTORS FOR MONITORING AND TESTING OF EXCAVATED MEDIA FOR POSSIBLE CONTAMINATES. PORTIONS OF AREA 200 AND AREA 500 ARE SPECIFICALLY IDENTIFIED WHERE CONTAMINATION IS LIKELY TO BE ENCOUNTERED DURING EXCAVATIONS.
5. IF MEDIA INCLUDING SOILS, OR GROUNDWATER ARE ENCOUNTERED THAT INDICATE POSSIBLE CONTAMINATION, CONTRACTOR SHALL NOTIFY VANCOUVER ENERGY SITE MANAGER, PORT OF VANCOUVER AND EFSEC IMMEDIATELY PRIOR TO PROCEEDING. SIGNS OF CONTAMINATION INCLUDE UNUSUALLY DARK SOIL AND ODORS.
6. IN AREAS OF CONCERN EXCAVATED MATERIAL SHALL BE PLACED IN SEALED WATER-TIGHT CONTAINERS OR LINED STAGING AREAS IMMEDIATELY ADJACENT TO THE WORK AREA FOR TESTING AND CLASSIFICATION OF MATERIAL PRIOR TO HAUL OFF.

CONTAMINATED MEDIA NOTES:

4. CONSTRUCTION WITHIN THE EAST LANDFILL CAP AREA CONSISTS OF GRADING A SUITABLE LEVEL BENCH WITHIN THE DEED RESTRICTED AREA TO CONSTRUCT FOUNDATIONS FOR THE CRUDE OIL PIPELINE. CONSTRUCTION ACTIVITIES SHALL NOT ENCROACH UPON THE LANDFILL AREA ITSELF AND SHALL REMAIN EAST OF THE HIGH VISIBILITY FENCING DELINEATED ON THE EROSION CONTROL PLANS.

5. PORT OF VANCOUVER IDENTIFIED POCKETS OF CONTAMINATED GROUNDWATER AND SOIL WITHIN THIS AREA. CONTRACTOR SHALL BE ADVISED THAT WORK ADJACENT TO THIS AREA WILL REQUIRE TESTING OF EXCAVATED MATERIAL PRIOR TO DISPOSAL.

6. NO CONSTRUCTION ACTIVITY IS PROPOSED IN THESE AREAS OF INDUSTRIAL WASTE. PORT HAS COMPLETED CLEANUP OF THESE SITES DURING RAIL CONSTRUCTION WHERE FEASIBLE.

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SAM ADAMS
STATE OF WASHINGTON
27330
REGISTERED PROFESSIONAL ENGINEER

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: CONTAMINATED MEDIA LOCATIONS – 2

DESIGN:	DRS	START DATE:	2/25/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/25/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER: 0100-CD-003
SHEET: 1/1
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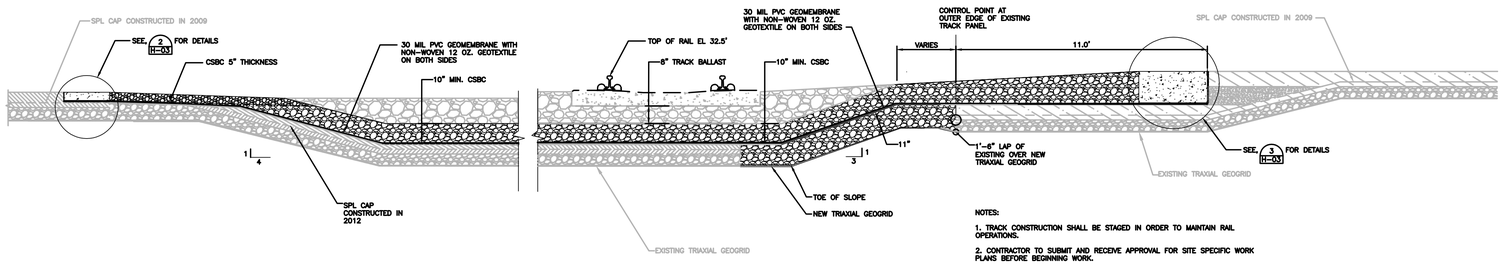


NOTES:

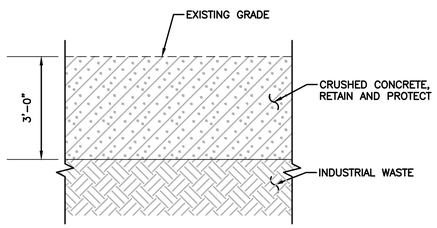
1. TRACK CONSTRUCTION SHALL BE STAGED IN ORDER TO MAINTAIN RAIL OPERATIONS.

2. CONTRACTOR TO SUBMIT AND RECEIVE APPROVAL FOR SITE SPECIFIC WORK PLANS BEFORE BEGINNING WORK.

SPL CAP SECTION

NTS

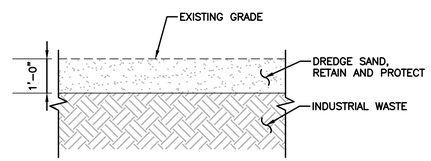
1 / 0100-CD-002



TYPICAL INGOT CAP SECTION

NTS

2 / 0100-CD-002



TYPICAL NORTH/NORTH 2 LANDFILL CAP SECTION

NTS

3 / 0100-CD-002

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SAM ADAMS, STATE OF WASHINGTON, 27330, REGISTERED PROFESSIONAL ENGINEER

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: EXISTING CAP SECTIONS

DESIGN:	DRS	START DATE:	2/3/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/3/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER	SHEET	REV.
0100-CD-004	1 / 1	

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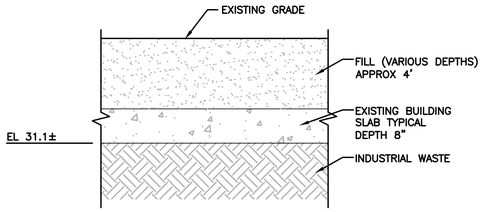
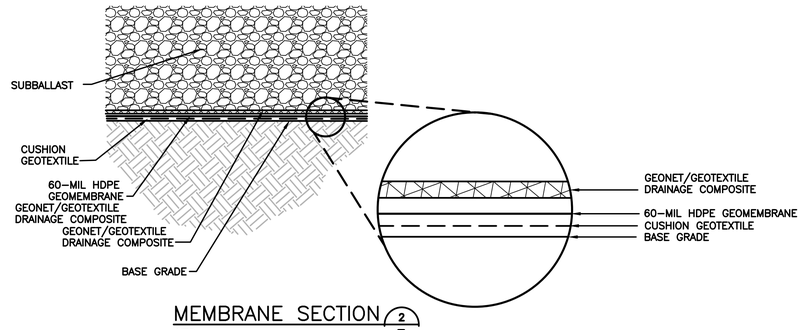


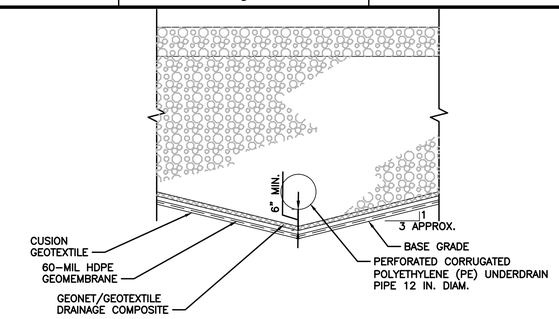
VANEXCO/ ROD MILL CONCRETE SECTION 1

NTS



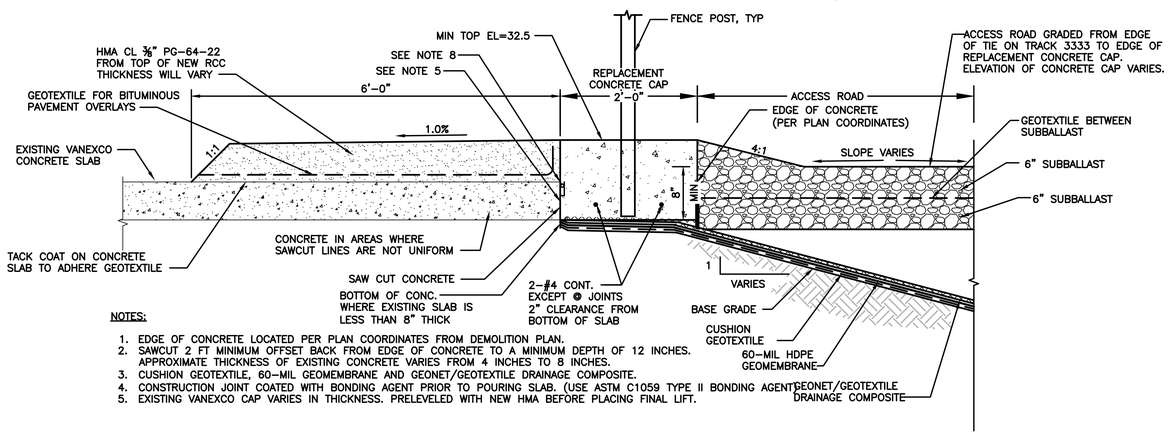
MEMBRANE SECTION 2

NTS



UNDERDRAIN PIPE SECTION 3

NTS

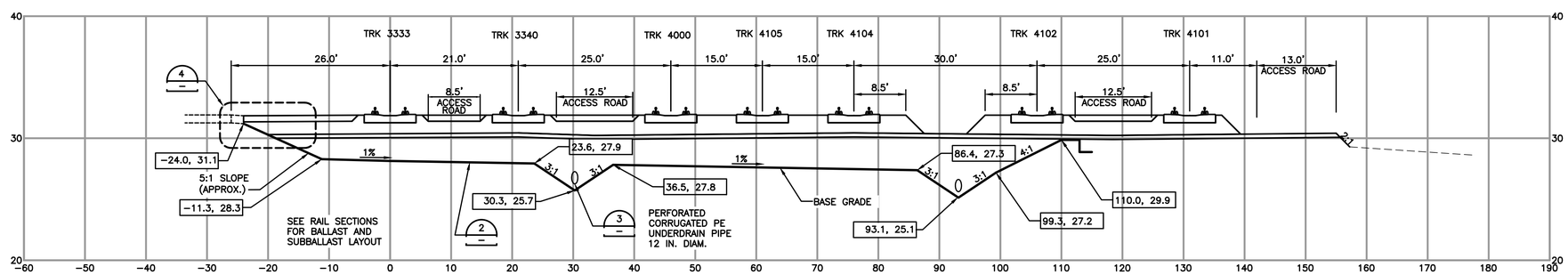


NOTES:

1. EDGE OF CONCRETE LOCATED PER PLAN COORDINATES FROM DEMOLITION PLAN.
2. SAWCUT 2 FT MINIMUM OFFSET BACK FROM EDGE OF CONCRETE TO A MINIMUM DEPTH OF 12 INCHES. APPROXIMATE THICKNESS OF EXISTING CONCRETE VARIES FROM 4 INCHES TO 8 INCHES.
3. CUSHION GEOTEXTILE, 60-MIL GEOMEMBRANE AND GEONET/GEOTEXTILE DRAINAGE COMPOSITE.
4. CONSTRUCTION JOINT COATED WITH BONDING AGENT PRIOR TO POURING SLAB. (USE ASTM C1059 TYPE II BONDING AGENT)
5. EXISTING VANEXCO CAP VARIES IN THICKNESS. PRELEVELED WITH NEW HMA BEFORE PLACING FINAL LIFT.

CONCRETE CAP CONNECTION DETAIL 4

NTS



VANEXCO LINER SECTION

SCALE: 1"=10' HORIZ
1"=5' VERT

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: EXISTING VANEXCO SECTIONS

DESIGN:	DRS	START DATE:	2/9/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/9/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

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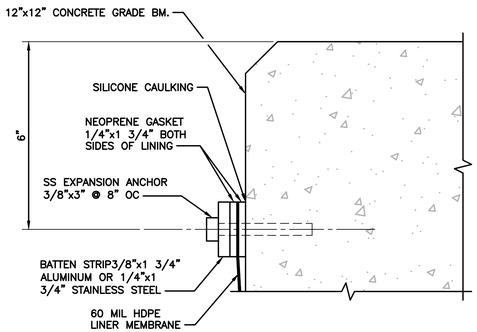
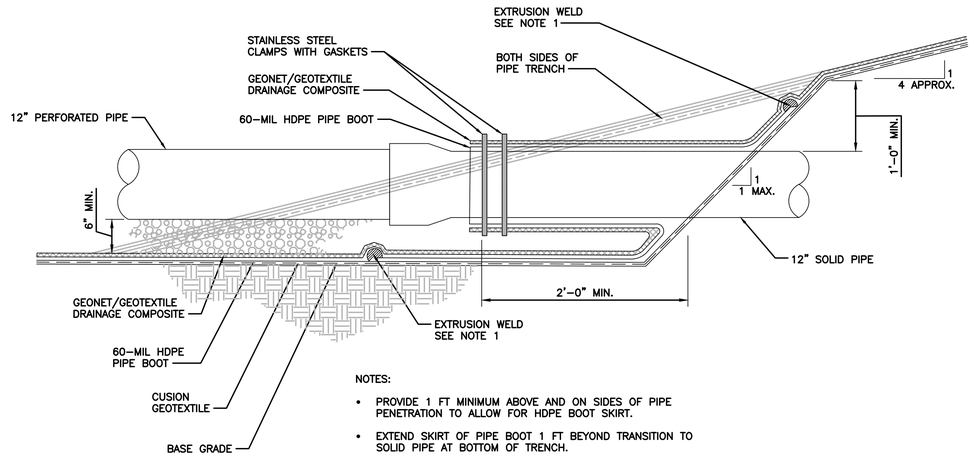


MEMBRANE/GRADE BEAM CONNECTION 1

NTS



NOTES:

- PROVIDE 1 FT MINIMUM ABOVE AND ON SIDES OF PIPE PENETRATION TO ALLOW FOR HDPE BOOT SKIRT.
- EXTEND SKIRT OF PIPE BOOT 1 FT BEYOND TRANSITION TO SOLID PIPE AT BOTTOM OF TRENCH.

MEMBRANE PIPE PENETRATION BOOT 2

NTS

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VANCOUVER ENERGY
Tesoro Savage Petroleum Terminal LLC

PROJECT: VANCOUVER ENERGY
PORT OF VANCOUVER, WASHINGTON

DESCRIPTION: VANEXCO RESTORATION DETAILS

DESIGN:	DRS	START DATE:	2/2/2015	SCALE:	AS SHOWN
DRAWN:	TNP	PRINT DATE:	2/3/2015	PROJECT MANAGER:	SAVAGE_PM
CHECKED:	MCH	APPROVED:	SA	SIZE:	24X36

DRAWING NUMBER	SHEET	REV.
0100-CD-006	1/1	

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